OPERATORS, ORGANIZATIONAL, DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE MANUAL (INCLUDING REPAIR PARTS AND SPECIAL TOOLS LIST)

FOR

TRUCK, FIRE FIGHTING, 4X4,
MODEL 1350 PKP/200 AFFF
NSN 4210-00-484-5729

HEADQUARTERS, DEPARTMENT OF THE ARMY
29 DECEMBER 1986

REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

You can help improve this manual. If you find any mistake or if you know of a way to improve the procedures, please let us know. Mail your letter, DA Form 2028 (Recommended Changes to Publications and Blank Forms), or DA Form 2028-2 located in the back of this manual direct to: Commander, U.S. Army Troop Support Command, ATTN: AMSTR-MCTS, 4300 Goodfellow Boulevard, St. Louis, MO 63120-1798. A reply will be furnished directly to you.

REPORTING EQUIPMENT IMPROVEMENTS (EIR's)

If the Fire Fighting Truck needs improvement, let us know. Send us an EIR. You, the user, are the only one who can tell us what you do not like about your equipment. Let us know why you do not like the design or performance. Put it on an SF 368 (Quality Deficiency Report). Mail it to us at: U.S. Army Troop Support Command, ATTN: AMSTR-QX, 4300 Goodfellow Blvd., St. Louis, MO 63120-1798. We will send you a reply.

TRUCK SERVICE MANUAL

CTS-2311 SERVICE MANUAL
S-SERIES
1978-1979-1980

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WHEELS-TIRES

WHEELS-TIRES 2032

FAILURE ANALYSIS 2167

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AIR CLEANERS

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GENERAL

Air must be clean if engine is to deliver proper performance throughout its life span. Dirty air introduced into the engine may ruin the carefully engineered close tolerance of the engine.

Air cleaners are designed to supply clean air to the engine; and if not kept clean, the supply of air will become restricted. This will cause loss of power, sluggish performance and poor gas mileage.

Four types of air cleaners are used on International vehicles. They are the modulated dry type, dry type, oil bath type and combination oil bath and dry type.

A description of the operation of each type is given in the following paragraphs.

OPERATION

Due to the many variations in size and shape of air cleaners used on International vehicles, no attempt has been made to accurately illustrate all variations. Thus, all illustrations herein are only typical of the type of air cleaner being represented.

Modulated Dry Type Air Cleaner

The modulated dry type air cleaner (Fig. 1) provides a thermostatically controlled damper connected to an exhaust manifold stove to provide faster engine warm-up in any weather.

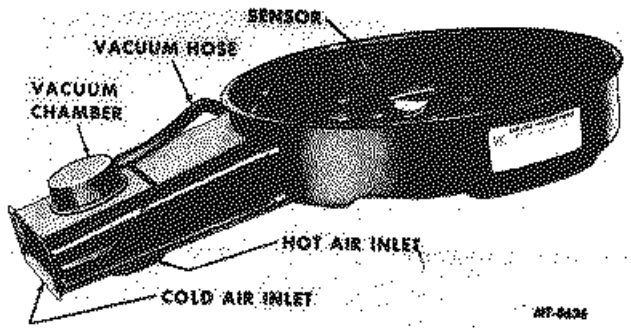


Fig. 1 Typical Modulated Dry Type Air Cleaner (Air cleaner lid and element removed for illustration purposes.)

The air temperature sensor mounted inside air cleaner body and the vacuum chamber mounted on top of inlet tube are factory calibrated units. Operation of the system is completely automatic. The damper, operated by the sensor-controlled vacuum chamber, regulates air entering carburetor to 36-37° C (98-100° F) at all outside temperatures. Hot and cold air conditions are thereby eliminated and better carburetor calibration can be accomplished.

Dry Type Air Cleaner

Dry type air cleaners employ dry type elements sealed within the air cleaner such that all air drawn into the engine must pass through the air cleaner element. The direction of air flow through the element of dry type air cleaners illustrated in Figs. 2 and 3 is from the outside to inside of filter element. This permits excess foreign particles to fall free from outside surface of element prolonging element service life.

The air cleaner in Fig. 3 is equipped with a vacuator valve. Vacuator valves provide a means of escape for foreign particles from the air cleaner without the necessity of air cleaner disassembly.

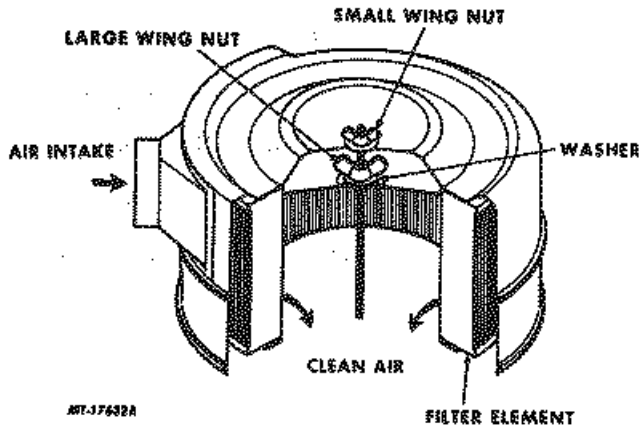


Fig. 2 Typical Dry Type Air Cleaner

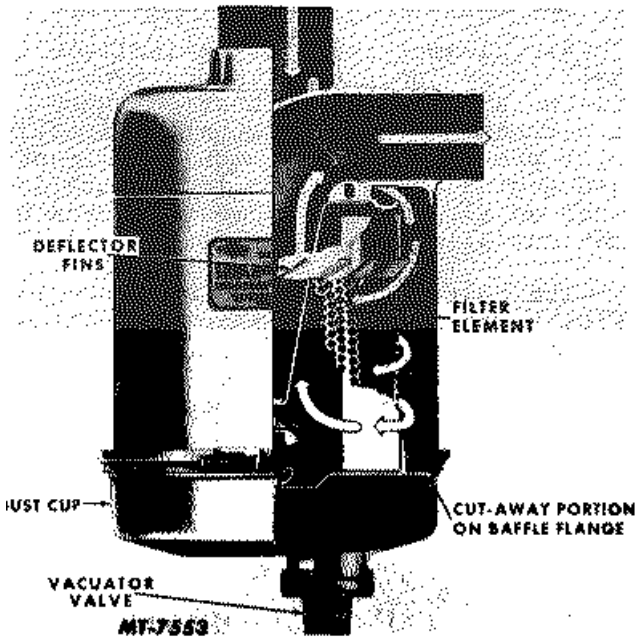


Fig. 3 Typical Dry Type Air Cleaner

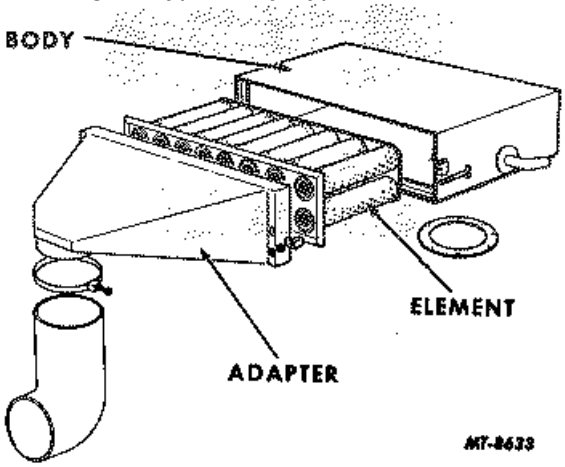


Fig. 4 Typical Dry Type Air Cleaner (Box Type)

The box dry type air cleaner shown in Fig. 4 differs from the other dry type air cleaners illustrated, in that air passes through the air cleaner element from inside to outside (Fig. 5).

Oil Bath Air Cleaner.

All oil bath air cleaners, regardless of size or shape (see Figs. 6 and 7), clean air in the following manner. Uncleaned air is drawn through the upper

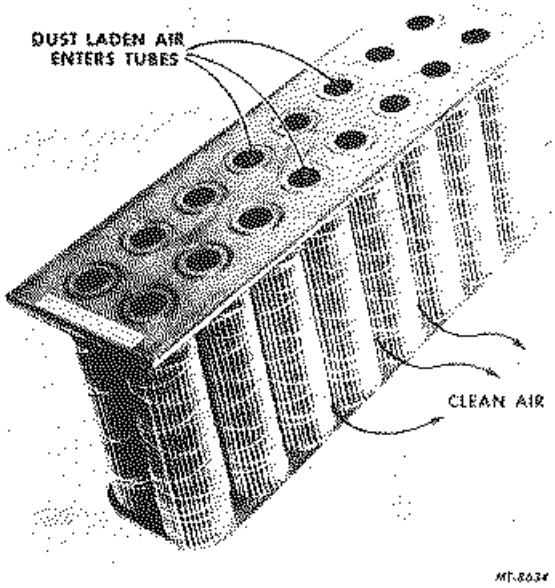


Fig. 5 Box Type Dry Air Cleaner Element

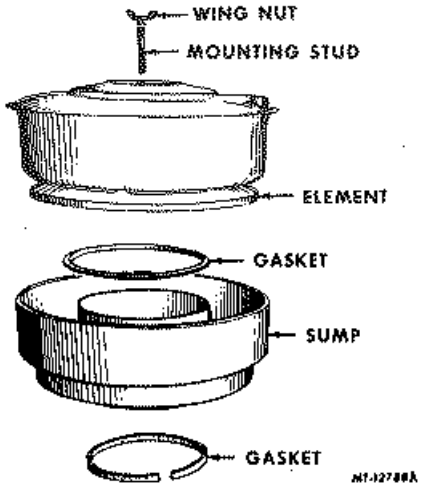


Fig. 6 Typical Oil Bath Air Cleaner

portion of the unit and then downward at high velocity. Just above the oil reservoir, in the bottom of the cleaner, the direction of air travel is suddenly reversed. This reversal of air flow causes the larger particles of dirt to fall into the oil. The partially cleaned air then travels upward through an oil-moistened filtering element where any remaining dirt and dust particles are removed. The cleaned air then enters the carburetor.

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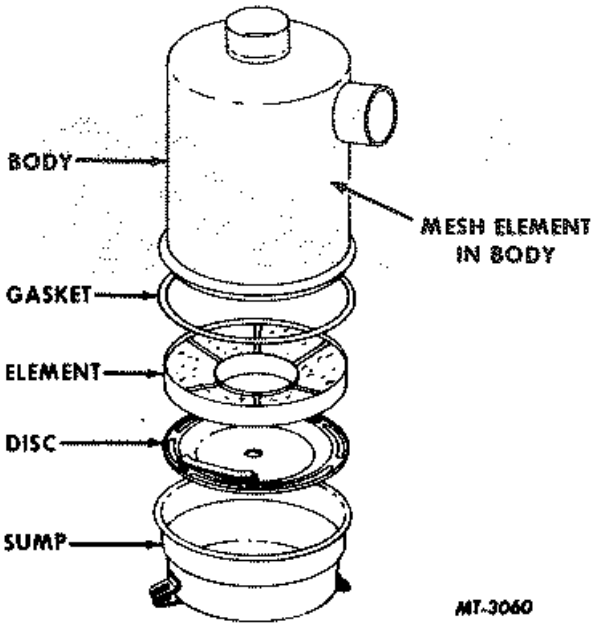


Fig. 7 Typical Oil Bath Air Cleaner

Combination Oil Bath and Dry Type Air Cleaner

The combination oil bath and dry type air cleaner is a two-stage air cleaner. Air entering the air cleaner first flows through an oil bath type air cleaner and then through a dry type element before entering the engine. Fig. 8 illustrates a typical combination oil bath and dry type air cleaner with an adapter arrangement.

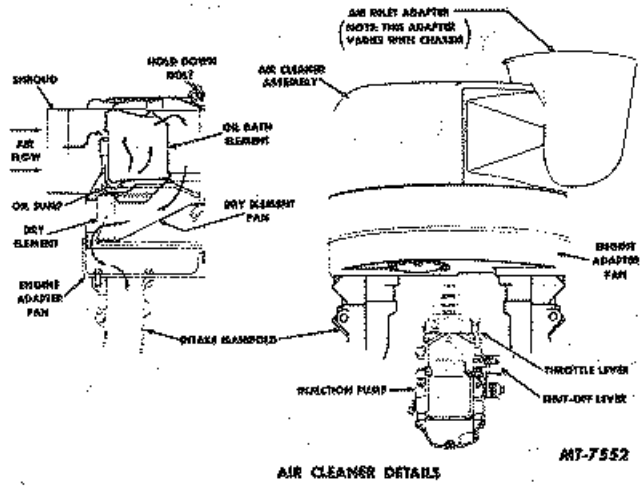


Fig. 8 Typical Combination Oil Bath And Dry Type Air Cleaner

Air Cleaner Restriction Indicators

Air cleaner restriction indicators used in conjunction with dry type air cleaners perform the function which their name implies. Actuated directly by a pressure drop between air cleaner and engine, restriction indicators show when an air cleaner element has reached maximum allowable restriction.

The restriction indicator shown in Fig. 9 contains a red signal band located in the indicator housing above the window and is not visible when engine is stopped if air cleaner does not require servicing.



Fig. 9 Air Cleaner Restriction Indicator

After starting the engine, the band may drop sufficiently to be seen in upper part of window. This must not be mistaken as a signal for element service.

During operation, the red signal band will gradually drop in window as dirt accumulates in filter element. When filter element reaches the maximum allowable restriction, the red band reaches the bottom of window and automatically locks in this position. The band will remain fully exposed even after stopping the engine. When this happens, filter element service is required.

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After servicing filter element, reset signal (red band) by pressing reset button and then releasing. This allows red signal band to again rise above window.

Where a direct reading air cleaner restriction gauge (Fig. 10) is used, the maximum allowable restriction is 25 inches of water measured at the air cleaner outlet during any phase of engine operation. When this happens, filter element service is required.

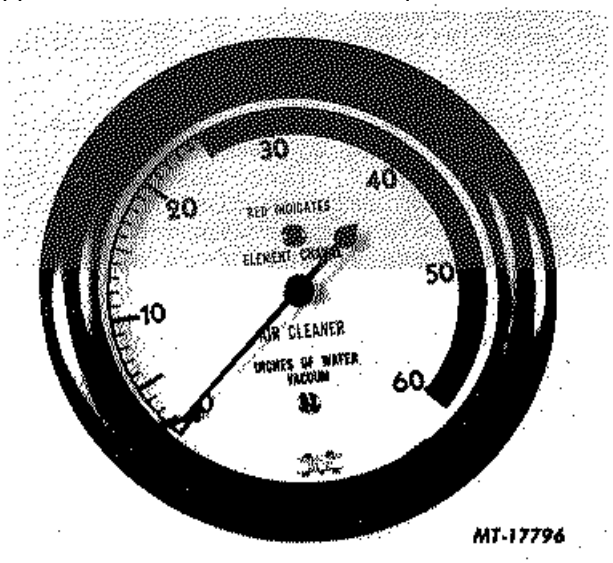


Fig. 10 Air Cleaner Restriction Gauge

SERVICING

NOTE: Refer to the applicable owner's manual to obtain recommended mileage intervals for air cleaner element replacement and service.

Modulated Dry Type Air Cleaner

Service of modulated dry type air cleaner paper element is limited, consisting mainly of checking the element for punctures or splits by looking through element toward light. Tap element lightly on a flat surface or use low air pressure to remove dirt particles. Do not wash or oil element.

Operation of the vacuum chamber and temperature sensor may be checked by conducting the following tests.

NOTE: Tests should be conducted with engine started from cold and ambient temperature of vehicle being not less than 40° F. Air cleaner must have all hoses, piping and cover in place. No leaks permitted.

1. With engine off inlet tube damper should be in full down position to close heat tube inlet pipe from exhaust manifold stove. Damper position can be determined by looking in end of inlet tube and should be parallel to tube bottom. If damper assembly is not in the correct position, vacuum chamber should be removed and damper movement loosened. Replace vacuum chamber and recheck damper position.

2. Start engine and note that damper has rotated up to close off cold air inlet. Observe damper position by looking in the inlet tube. If damper did not immediately close cold air inlet, shut off engine and disconnect the two hoses from sensor. Connect the two hose ends together using suitable tubing.

   Restart engine and again check damper location. If damper fully closes cold air inlet, temperature sensor is defective and must be replaced. If damper did not close cold air inlet, sensor is okay but damper has bind or vacuum chamber is defective. Remove vacuum chamber and check damper for free movement. If damper moves free replace vacuum chamber.

3. After a cold start operate engine for 10 minutes at medium RPM. When engine is at normal operating temperature, slow engine to idle and observe position of inlet tube damper. If damper has not rotated all or part way down to allow some cold air to enter inlet tube, replace temperature sensor.

Vacuum Chamber Replacement (Fig. 11)

Vacuum chamber is replaced by bending tab nearest inlet tube entrance down from inside of tube. Disconnect vacuum hose and lift vacuum chamber, sliding rear tab out of its slot and disengaging damper hook from damper.

The new chamber is attached by engaging hook in damper, sliding rear tab into its slot and fitting front tab into place. A spring preload should be felt when vacuum chamber is pressed firmly against top of inlet tube. If no preload is felt, check the installation or

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be sure parts are not faulty. Press front vacuum chamber tab firmly against tube inside surface. Connect vacuum hose.

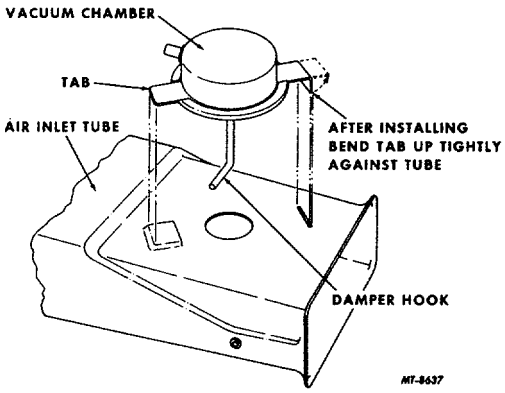


Fig. 11 Vacuum Chamber Replacement

Temperature Sensor Replacement (Fig. 12)

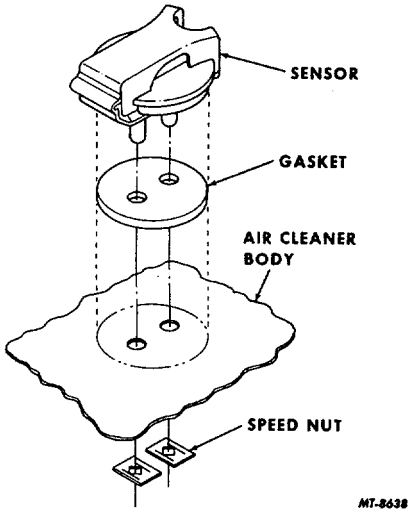


Fig. 12 Temperature Sensor Replacement

Disconnect two vacuum hoses attached to sensor inlet and outlet tubes on underside of air cleaner body. Remove clamps or speed nuts from tubes and lift sensor from body. Position new sensor and gasket inside air cleaner body. Firmly press two new speed nuts or clamps on tubes to hold sensor in place. Attach vacuum hoses to sensor tubes.

Dry Type Air Cleaners

Non washable Element

Dry type air cleaners equipped with Non washable element may be serviced by removing element and wiping inside surfaces of air cleaner free of foreign particles.

Elements may be cleaned with compressed air [not to exceed 276 kilopascals (40 psi)] directing air stream up and down pleats on clean air side of element. Hold air nozzle approximately 15 centimeters (6 in.) from element surface.

Do not strike rim of element against any hard surface. Damage could result to the rim and affect sealing at reassembly.

Before reassembly place a light on inside of element and inspect outside surface of element for punctures or splits.

If so equipped, inspect air cleaner and element gaskets and replace if necessary on reassembly.

Washable Element

Dry type air cleaners equipped with washable element may be serviced by removing element and wiping inside surfaces of air cleaner free of foreign particles.

If air cleaner is equipped with a vacuator valve, remove valve and clean.

Elements may be cleaned with compressed air [not to exceed 276 kilopascals (40 psi)] directing air stream up and down pleats on clean air side of element or by washing. When using compressed air hold air nozzle approximately 15 centimeters (6 in.) from element surface.

When washing element remove all loose dust with a flow of water. Use a hose without a nozzle and do not permit water pressure to exceed 276 kilopascals (40 psi).

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Next, immerse element in a solution of nonsudsing household detergent and warm water [not to exceed 60° C (140° F)] for approximately 15 minutes. Agitate element occasionally to aid cleaning action.

Remove element and rinse thoroughly by running clean water through element from clean air side to dirty side until water passing through element is clear. Use a hose without a nozzle and do not permit water pressure to exceed 276 kilopascals (40 psi).

Allow element to dry completely.

CAUTION: Never use compressed air on light bulbs to hasten drying. High pressure air can tear holes in paper pleats and light bulbs can cause burning.

Inspect element after cleaning by inserting a light bulb inside element and inspecting outside surface of element for punctures or splits.

If so equipped, inspect air cleaner and element gaskets and replace if necessary on reassembly.

It is not recommended to attempt cleaning box dry type elements. When box dry type elements have reached maximum allowable restriction as outlined in the applicable operator's manual, they should be replaced.

Oil Bath Air Cleaners

Remove cover or sump. Wash mesh element and sump in cleaning solvent or kerosene. Some oil bath air cleaners have two mesh elements: one removable and one integral in the body assembly.

Cleaning solvent must be flushed through element with sufficient force and volume to dislodge foreign material. Use a long bristle brush to assist in dislodging any dirt or dust. Air cleaners having integral elements can be submerged and agitated briskly in cleaning solvent to force the cleaning fluid through the element.

NOTE: Steam cleaners may be used to perform the cleaning operation if the air cleaner is unusually dirty; however, be careful not to damage the air cleaner.

Refill sump to oil level mark and oil mesh element freely with engine oil of same viscosity used in crankcase. Allow excess oil to drip from element before installation.

Combination Oil Bath and Dry Type Air Cleaners

Refer to the oil bath air cleaner and dry type air cleaner service instructions contained in this manual section to service the corresponding sections of combination oil bath and dry type air cleaners.

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FUEL SYSTEM

CARBURETOR MODEL 2210C

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FUEL SYSTEM

GENERAL INFORMATION

The outward appearance of the 2210C model carburetor described in this service manual may differ with engine model, vehicle model or year. The difference will be mainly in the emission components used and their location. The different components are shown in Figures 1, 2, 3, 4, 5 and 6.

The dual throat 2210C series carburetor is used with manual and automatic transmissions. This carburetor is equipped with a hot idle compensator valve which is a thermostatically operated air bleed to relieve an overrich condition at idle. Each throat of the carburetor has its own throttle valve and main metering systems and is supplemented by the float, accelerating idle and power systems.

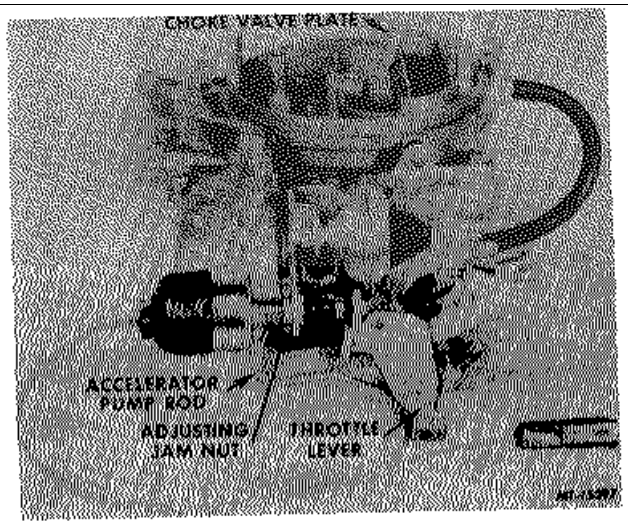


Fig . 3

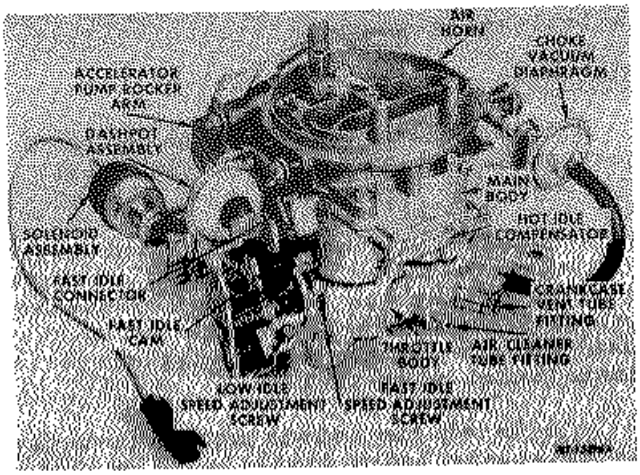


Fig. 1

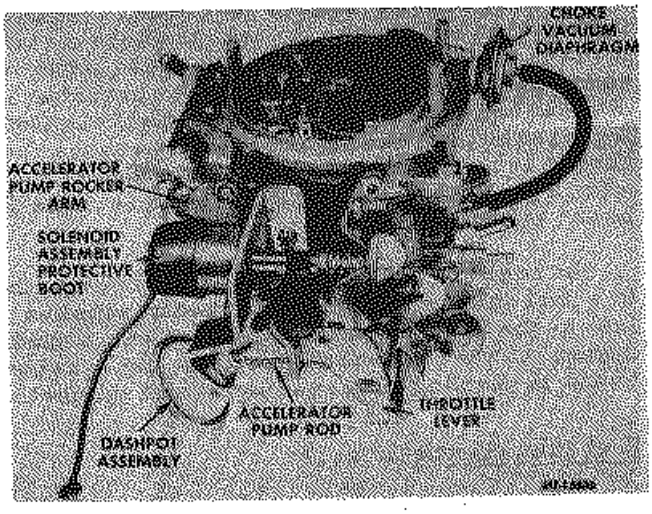


Fig. 4

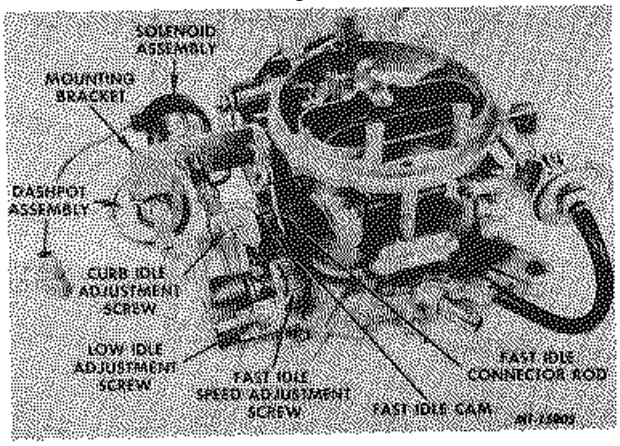


Fig. 2

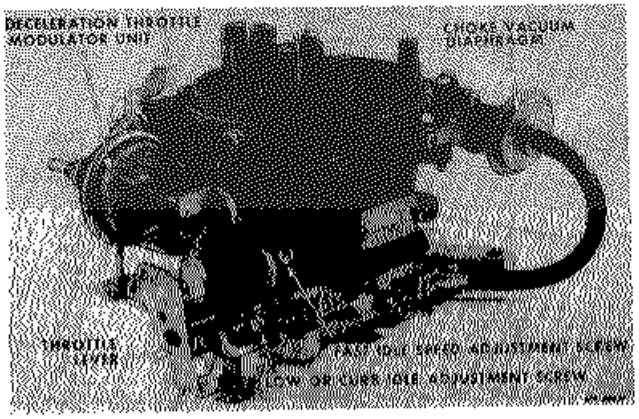


Fig. 5

FUEL SYSTEM

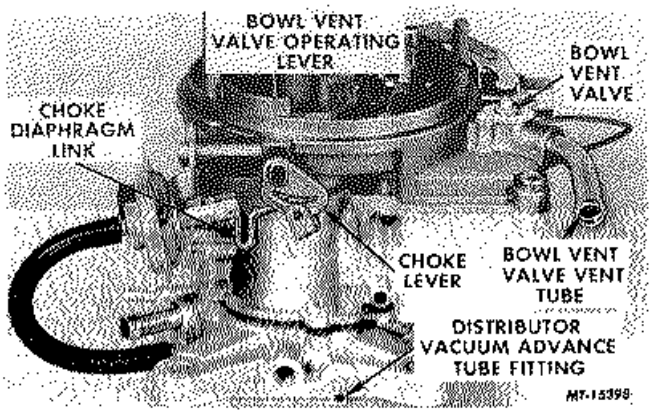


Fig. 6

CARBURETOR SYSTEMS

The carburetor utilizes four basic fuel metering systems. The Idle System provides a rich mixture for smooth idle and low speed performance; the Accelerator Pump System provides additional fuel during acceleration; the Main Metering System provides an economical mixture for normal cruising conditions; and the Power Enrichment System provides a richer mixture when high power output is desired.

In addition to these four basic systems, there is a fuel inlet system that constantly supplies fuel to the basic metering systems, and a choke system which temporarily enriches the mixture to aid in starting and running a cold engine.

Fuel Inlet System (Fig. 7)

All fuel enters the fuel bowl through the fuel inlet fitting in the bowl cover.

The "Viton" tipped fuel inlet needle seats directly in the fuel inlet seat. The fuel inlet needle is controlled by a nitrophyl float (a cellular buoyant material which cannot collapse or leak) and stainless steel float lever which is hinged by a "Delrin" float fulcrum pin.

The fuel inlet system must constantly maintain the specified level of fuel as the basic fuel metering systems are calibrated to deliver the proper mixture only when fuel is at this level. When fuel level in the bowl drops, the float also drops permitting additional fuel to flow past the fuel inlet needle into the bowl. A baffle over the needle assists in separating air bubbles from the fuel to provide a more solid fuel supply in the bowl.

The float chamber is vented internally into the air horn. An external vent actuated by the pump lever is opened at curb idle or when engine is not running to release fuel vapors from the bowls to the canister.

Idle System (Fig. 8)

Fuel used during curb idle and low speed operation flows through main metering jet into main well.

A horizontal connecting passage permits fuel to flow from main well into idle well. Fuel continues up the idle well and through an idle feed restriction into an idle channel where fuel is mixed with air which enters through idle air bleeds located in the air horn.

At curb idle fuel and air mixture flows down the idle channel and is further mixed or broken up by air entering idle channel through transfer slot which is above the throttle valve at curb idle.

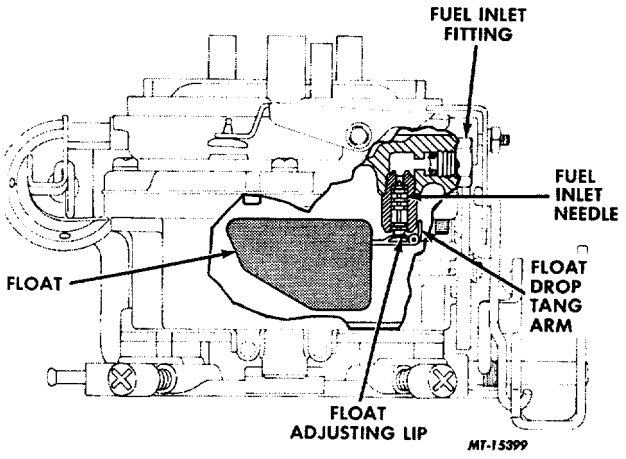
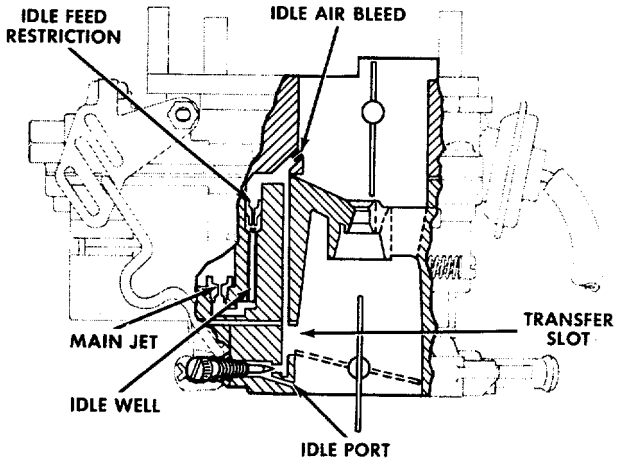


Fig. 7 Fuel Inlet System



MT-15400

Fig. 8

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FUEL SYSTEM

During low speed operation the throttle valve moves exposing transfer slot and fuel begins to flow through transfer slot as well as idle port. As the throttle valves are opened further and engine speed increases, the air flow through the carburetor also increases. This increased air flow creates a vacuum or depression in the venturi and the main metering system begins to discharge fuel.

Main Metering System (Fig. 9)

As the engine approaches cruising speed, increased air flow through the venturi creates vacuum (low pressure area) in the venturi of the carburetor. Near atmospheric pressure present in the bowl in area above fuel causes the fuel to flow to lower pressure area created by venturi and magnified by booster venturi.

Fuel flows through main jet into main well; air enters through main well air bleeds and into main well through holes in main well tube. The mixture of fuel and air being lighter than raw fuel responds faster to changes in venturi vacuum and is also more readily vaporized when discharged into the venturi.

The main discharge nozzle passage is a part of the booster venturi which is an integral part of main body casting. Distribution tabs in the main venturi provide further vaporization of fuel and air mixture.

The main metering system is calibrated to deliver a lean mixture for best overall economy. When additional power is required, a vacuum operated power system enriches fuel-air mixture.

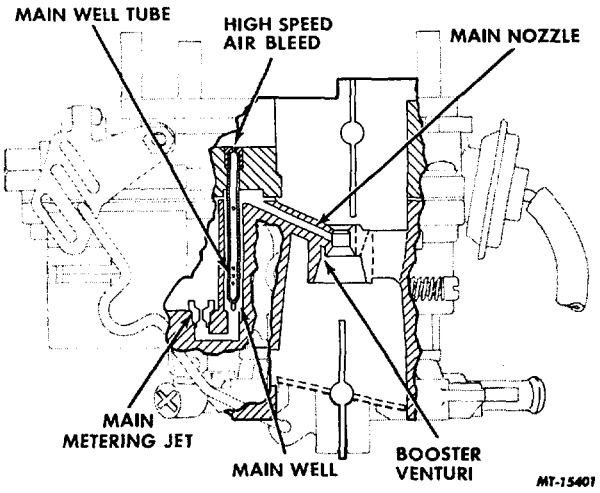


Fig. 9

Power Enrichment System (Fig. 10)

The power enrichment system consists of a two-stage power valve installed in the center of carburetor body between main jets and a vacuum piston installed in bowl cover. A vacuum passage leads from top of piston down to manifold flange.

When manifold vacuum is high, vacuum piston is raised to top of its cylinder and the spring on piston stem is compressed.

When manifold vacuum drops to a predetermined level, the spring overcomes vacuum and pushes piston stem down.

The piston stem, in turn, pushes the power valve stem down opening power valve and permitting fuel to flow through power valve, through power valve channel restrictions and into main well on either side of power valve.

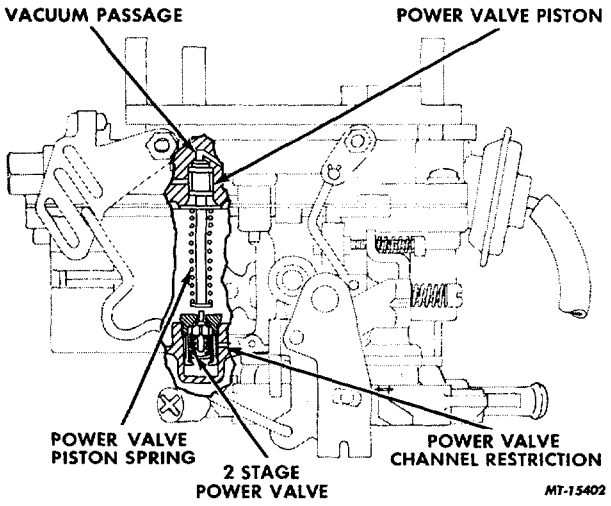


Fig. 10

Accelerating Pump System (Fig. 11)

When throttle valves are opened suddenly, air flow through the carburetor responds almost immediately. However, there is a brief time interval or lag before fuel can overcome its inertia and maintain the desired fuel-air ratio.

The piston type accelerating pump system mechanically supplies fuel necessary to overcome this deficiency for a short period of time.

Fuel enters pump cylinder from fuel bowl through a slot in the pump well above normal position of pump piston. When engine is turned off, fuel vapors in pump cylinder are vented through the area between pump rod and pump plunger.

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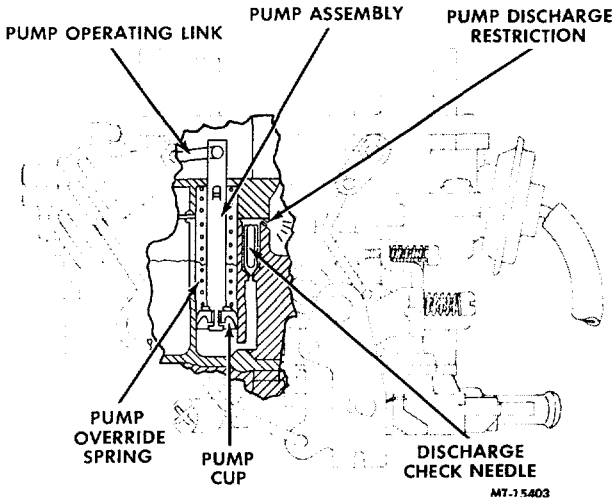


Fig. 11

As throttle lever is moved, the pump link operating through a system of levers and a pump override spring pushes the pump piston down. Fuel is forced through a passage around pump discharge needle valve and out pump discharge jets which are drilled in the main body.

Automatic Choke System (Fig. 12)

The automatic choke provides richer air-fuel mixture required for starting and operating a cold engine. A bi-metal spring inside choke housing, which is installed on the intake manifold, holds choke valve in closed position.

When engine starts, manifold vacuum is applied to choke diaphragm through a rubber hose from throttle body to choke diaphragm assembly. The adjustment of the choke valve opening, when the engine starts and vacuum is applied to choke diaphragm, is called vacuum kick (Pull Down).

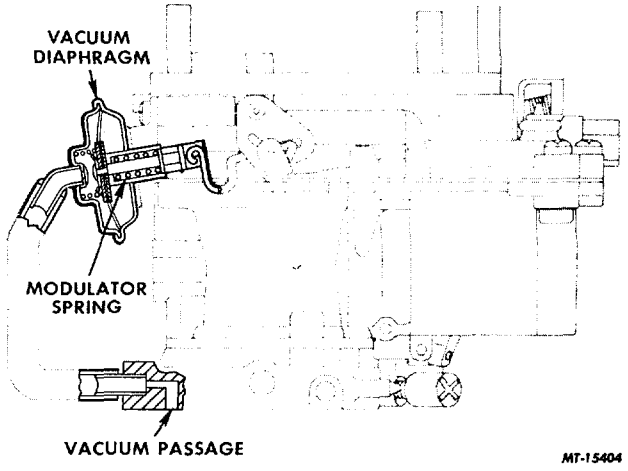


Fig. 12

Manifold vacuum alone is not strong enough to provide the proper degree of choke opening during the entire choking period. The impact of in rushing air past the offset choke valve provides additional opening force.

As engine warms up, manifold heat transmitted to choke housing relaxes the bi-metal spring until it eventually permits choke to open fully.

Deceleration Throttle Modulator System (Fig. 13)

Normally an engine will emit relatively high levels of unburned hydrocarbons during "closed throttle" deceleration. This is because intake of fuel-air mixture is not sufficient to support complete combustion and the engine "misfires" resulting in fuel being passed through the engine unburned. The deceleration throttle modulator system overcomes this condition by maintaining a slightly greater throttle opening (high idle) during initial deceleration which permits intake of just enough additional fuel-air mixture to promote combustion and eliminate misfire.

The engine speed sensor is calibrated to activate or deactivate (extend or retract) throttle modulator unit at approximately 1850 rpm engine speed.

Above 1850 rpm engine speed, the solenoid vacuum valve is activated (held open) by electrical current from engine speed sensor unit. This permits manifold vacuum to act upon the diaphragm of throttle modulator unit extending modulator unit to high idle position. Upon deceleration, the returning carburetor throttle lever contacts extended modulator, thus holding throttle in high idle position.

When engine speed drops below 1850 rpm, the speed sensor unit deactivates the solenoid vacuum valve allowing valve to close and bleed.

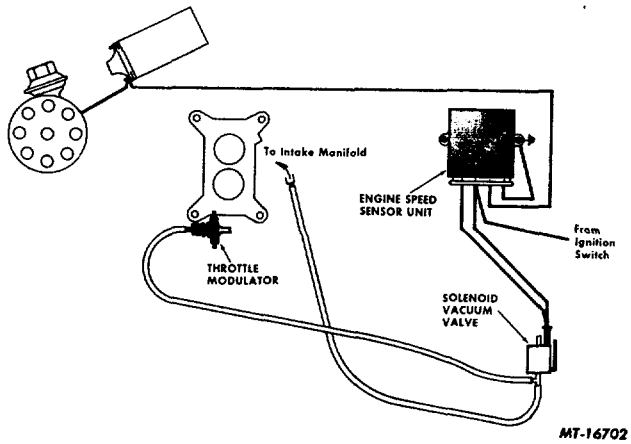


Fig. 13 Deceleration Throttle Modulator System (Typical)

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vacuum from throttle modulator diaphragm spring to retract the modulator unit and allow the throttle lever to return to normal curb idle position.

For DTM operational test, refer to FUEL SYSTEM, Section CTS-2733, CTS-2694 or CTS-2721, Emission Control Systems for Gasoline Engines.

DISASSEMBLY OF CARBURETOR

1. Remove dashpot solenoid or deceleration throttle modulator and bracket from body as an assembly (Fig. 14 and Fig. 15).

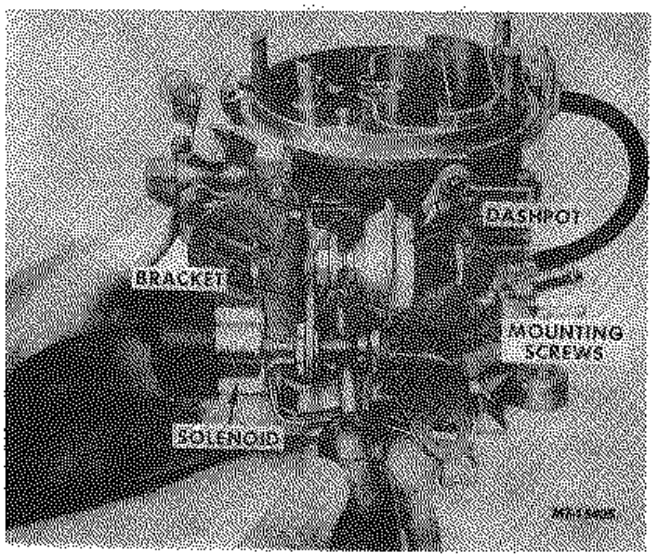


Fig. 14 Removing Dashpot Solenoid Bracket (Where Used

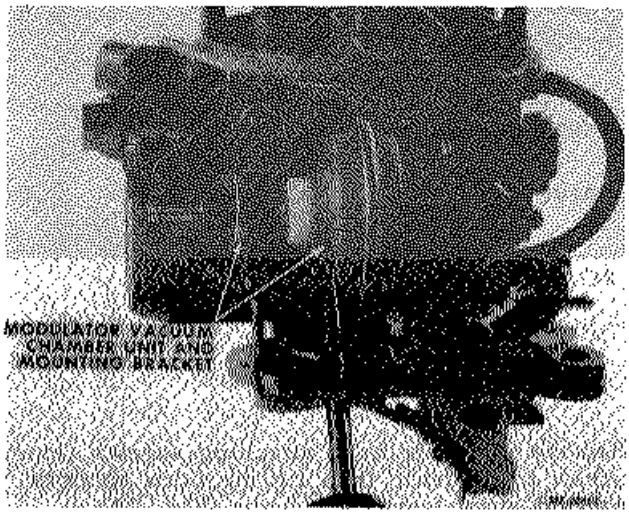


Fig. 15 Removing Modulator Vacuum Chamber Unit and Bracket (Where Used)

2. Remove nut and washer attaching accelerator pump rocker arm to accelerator pump shaft. Remove arm from flats on pump shaft. Then disengage accelerator pump rod from center slot in arm and from hole in throttle lever (Fig. 16).

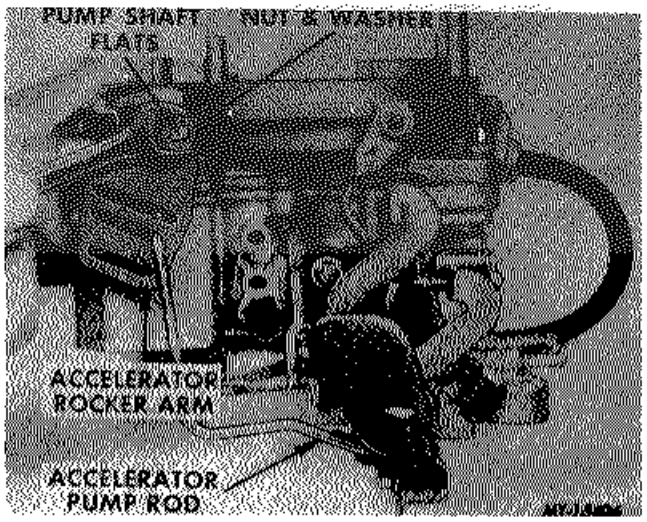


Fig. 16 Removing Accelerator Pump Rocker Arm

3. Remove nut and washer that attaches choke lever-to-choke shaft. Disengage fast idle connector rod from lever and fast idle cam (*Fig.* 17).

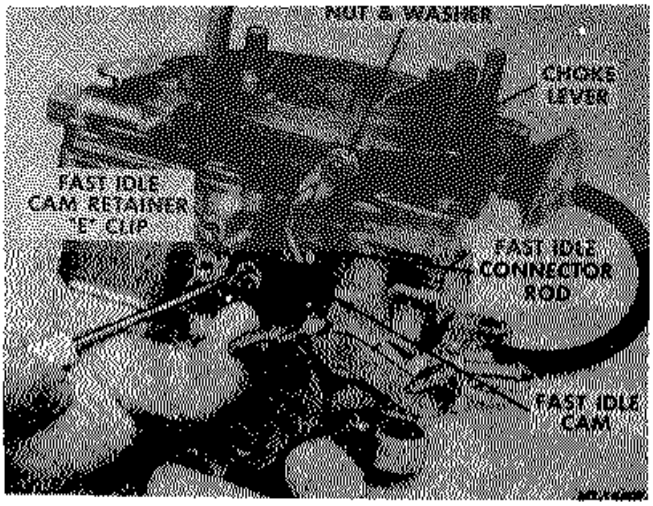


Fig. 17 Removing Fast Idle Cam

4. Remove choke vacuum diaphragm hose from throttle body tube fitting. Remove screws that attach choke diaphragm and mounting brackets to air horn. Also, remove link (rod) from choke shaft lever. Place choke unit to one side to be cleaned as special item. A liquid cleaner may damage diaphragm material (Fig. 18).

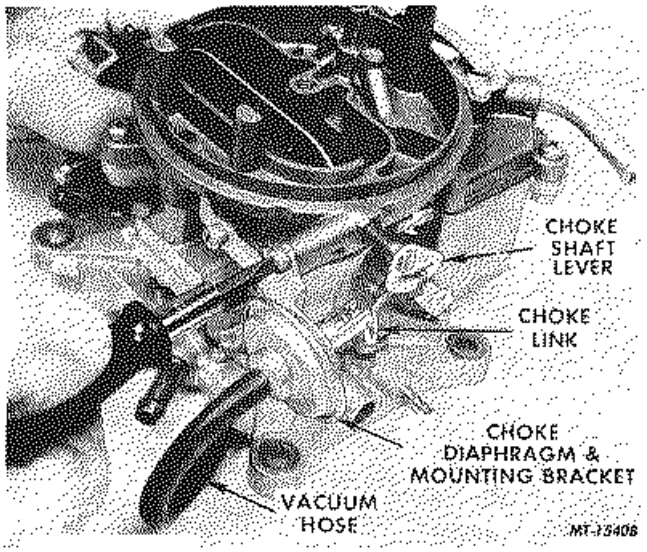


Fig. 18 Removing Vacuum Diaphragm

5. Where bowl vent valve is used, remove "E" clip that retains bowl vent valve operating lever on stub shaft on air horn. Slide lever off shaft, being careful not to lose lever spring--note position of spring (Fig. 19).

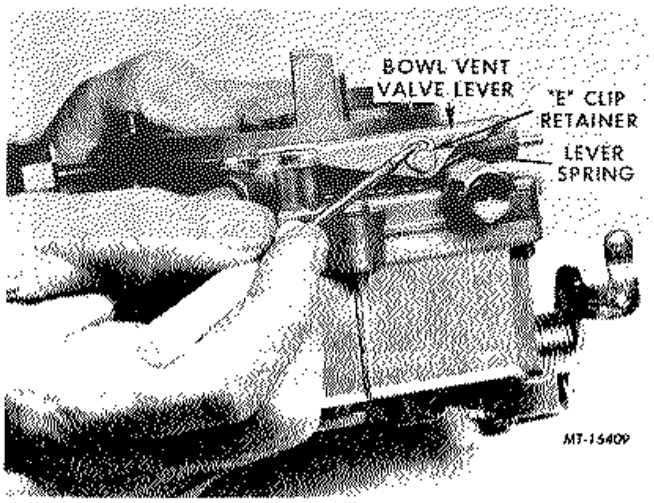


Fig. 19 Removing Bowl Vent Lever (Where Used)

6. Figure 20 illustrates the position of vent bowl lever spring for assembly.

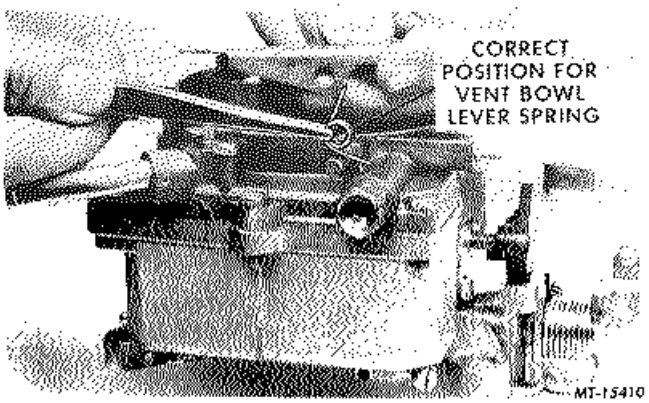


Fig. 20 Correct Spring Position

7. Remove bowl vent valve retainer, valve and spring (Fig. 21).

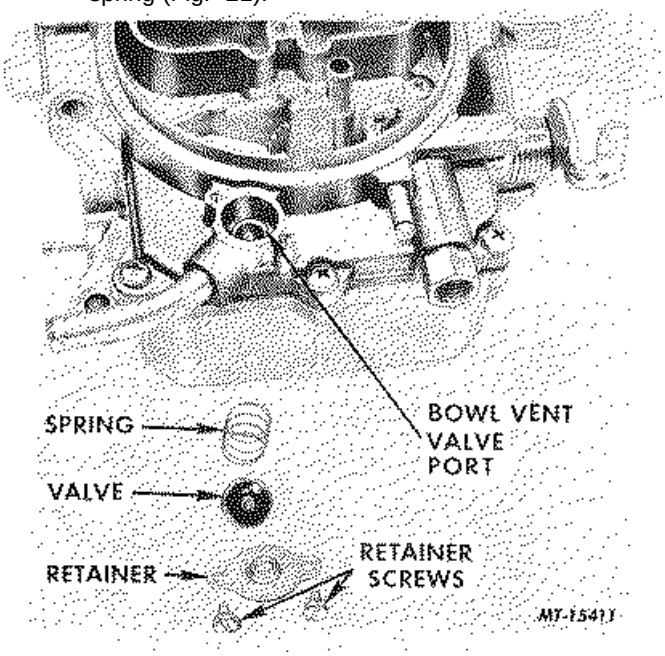


Fig. 21

8. Remove eight air horn attaching screws (long screw in center); then lift air horn straight up and away from main body (Fig. 22).

Use extreme care when handling air horn so as not to bend or damage main well tubes.

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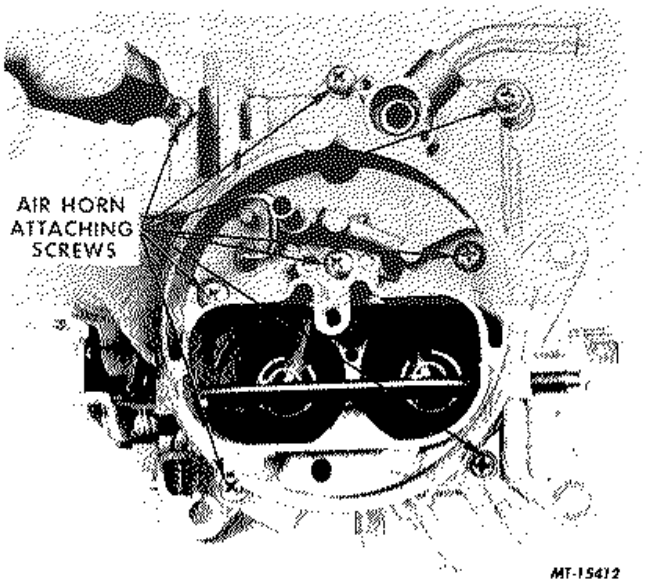


Fig. 22 Location of Screws

9. Disengage accelerator pump plunger from pump shaft by pushing up on bottom of plunger, then tilting slightly toward center slide off pump shaft. Slide plunger stem out of air horn and remove compression spring (Fig. 23).

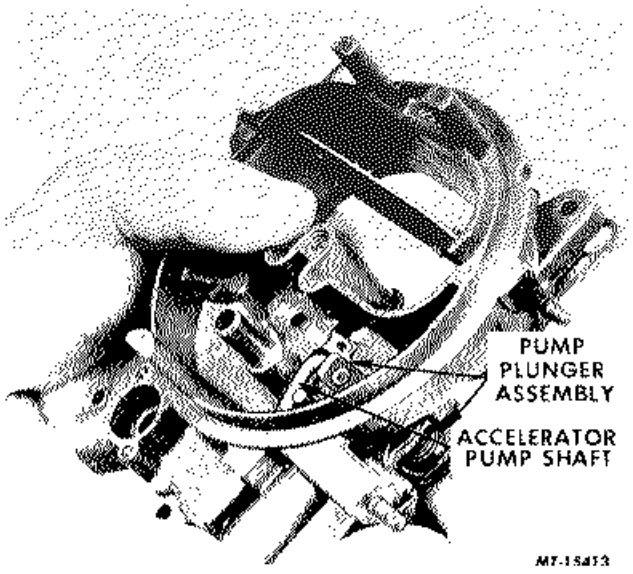


Fig. 23

10. Do not lose seal washer on accelerator pump upon removal (Fig. 24).

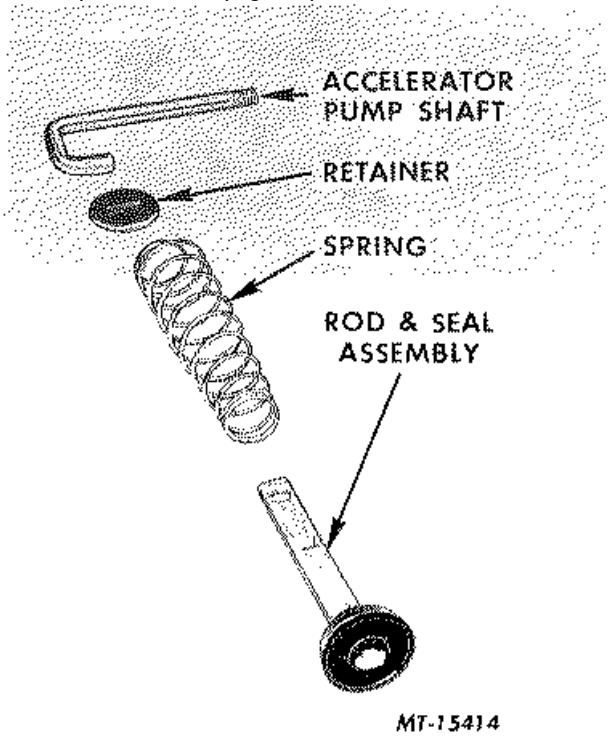


Fig. 24 Pump Plunger Assembly

11. With air horn inverted, remove screw that attaches fuel baffle to air horn (Fig. 25).

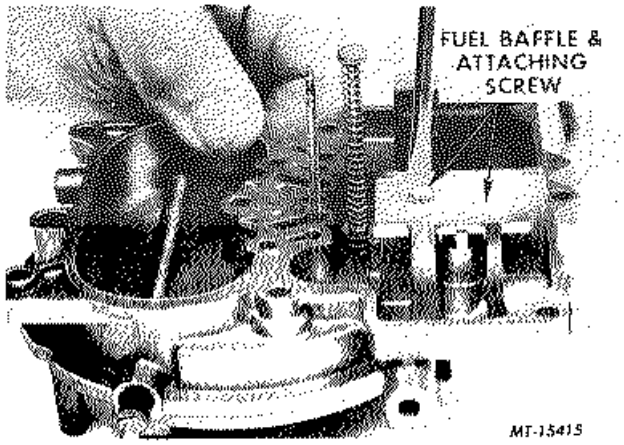


Fig. 25 Location of Fuel Baffle

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12. Slide nylon float fulcrum pin out of air horn, then remove float (Fig. 26).

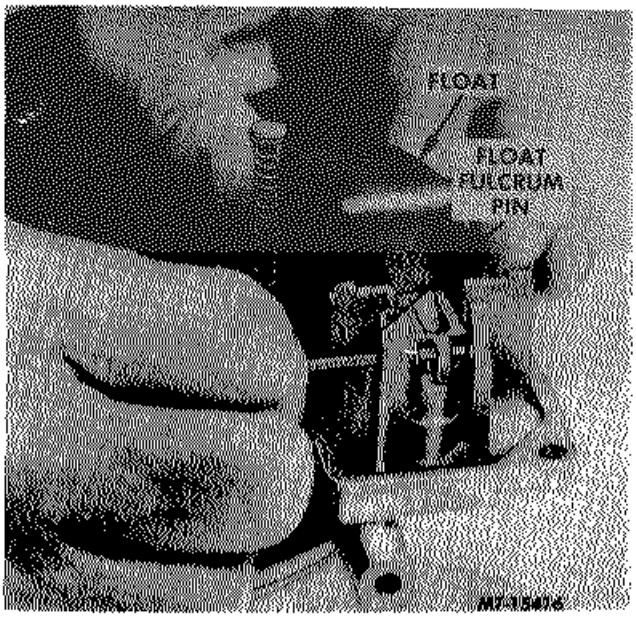


Fig. 26 Removing Float

13. Remove needle valve, seat and gasket from air horn (Fig. 27).

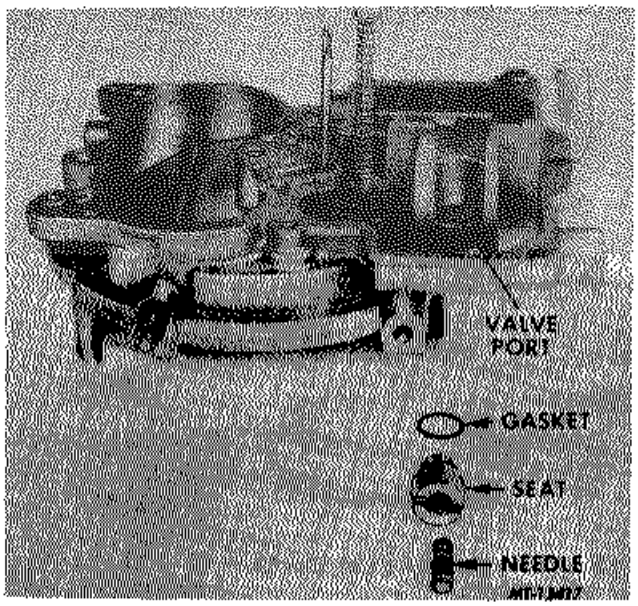


Fig. 27

14. Remove staking from vacuum power piston using a suitable tool (*Fig.* 28).

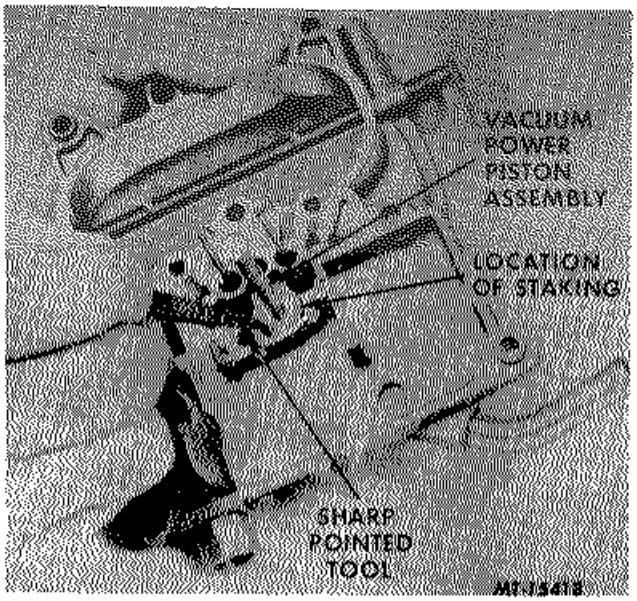


Fig. 28 Removing Staking

15. Remove vacuum power piston using needle nose pliers and small hammer (Fig. 29).

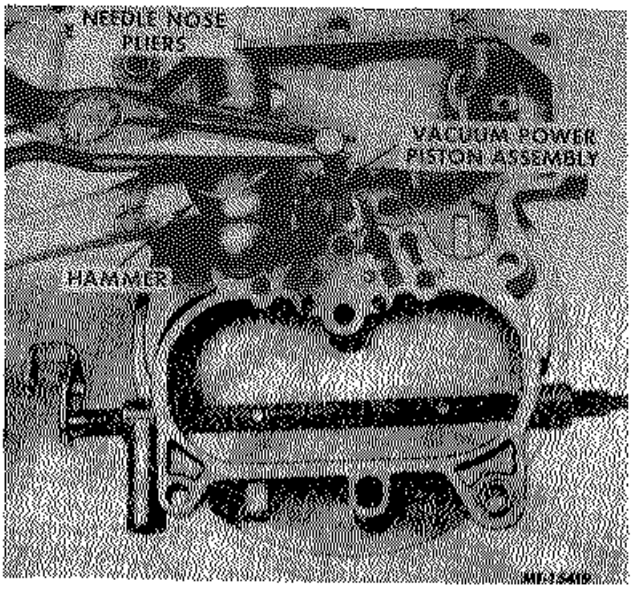


Fig. 29 Removing Power Piston

16. Do not damage or bend main well tubes in air horn. These tubes are press fit in air horn and will be damaged if removed. They can be cleaned in a solvent and blown dry with compressed air. If carburetor parts are cleaned in a basket, be sure other carburetor parts do not strike these tubes (*Fig.* 30.

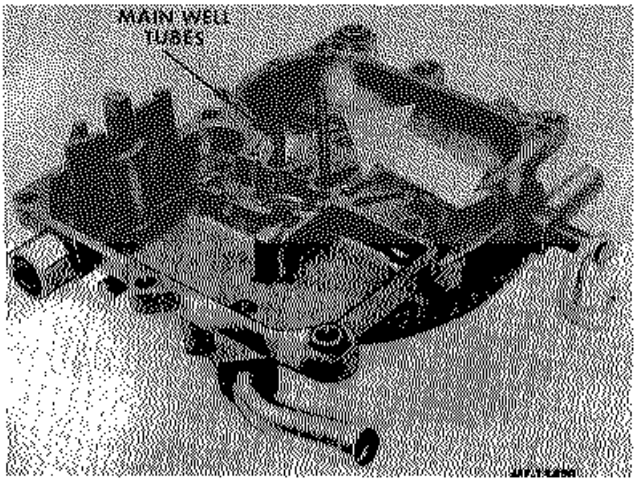


Fig. 30 Location of Well Tubes

17. Remove choke plate screws and remove choke plate and shaft (Fig. 31).

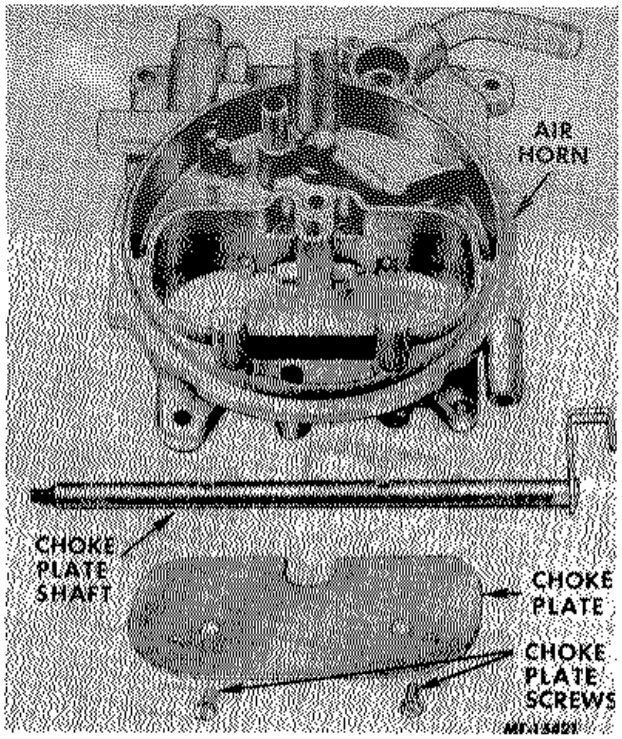


Fig. 31

18. Invert main body and remove accelerator pump discharge needle (Fig. 32).
19. Remove main jets using SE-1772-6 from main body (Fig. 33).
20. Remove power valve (using SE-1772-2) from main body (Fig. 34).

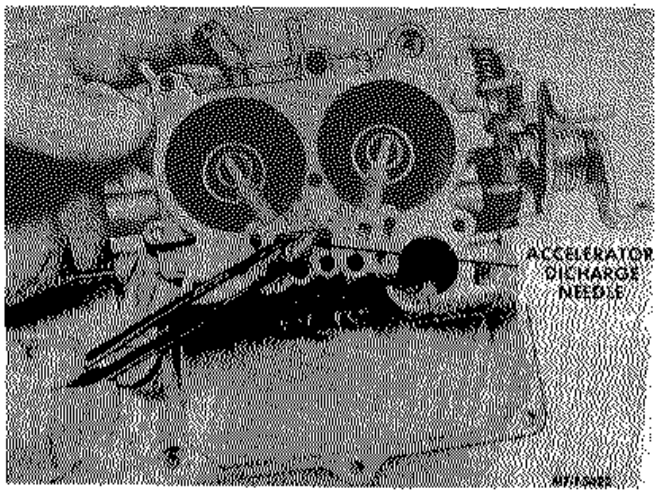


Fig. 32 Location of Discharge Needle

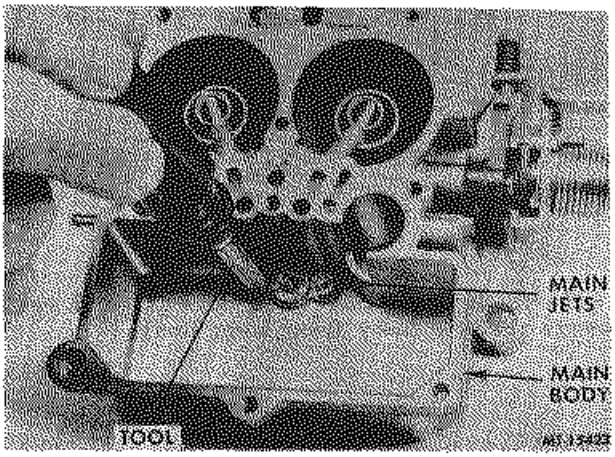


Fig. 33 Using SE-1772-6 Tool

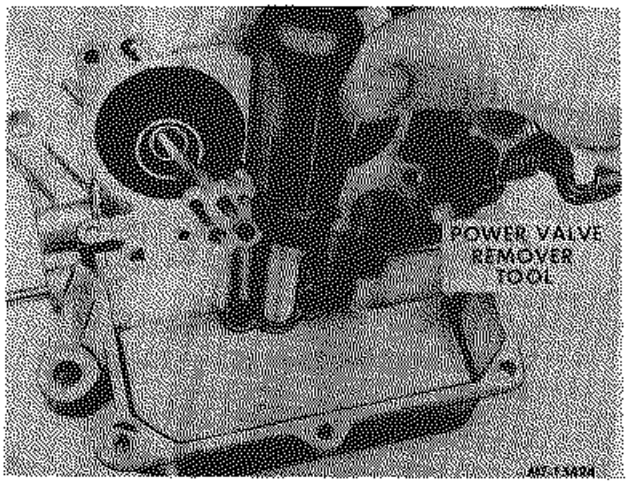


Fig. 34 Removing Power Valve with SE-1772-7 Tool

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21. Fig. 35 shows exploded view of power valve main body and SE-1772-7 remover.

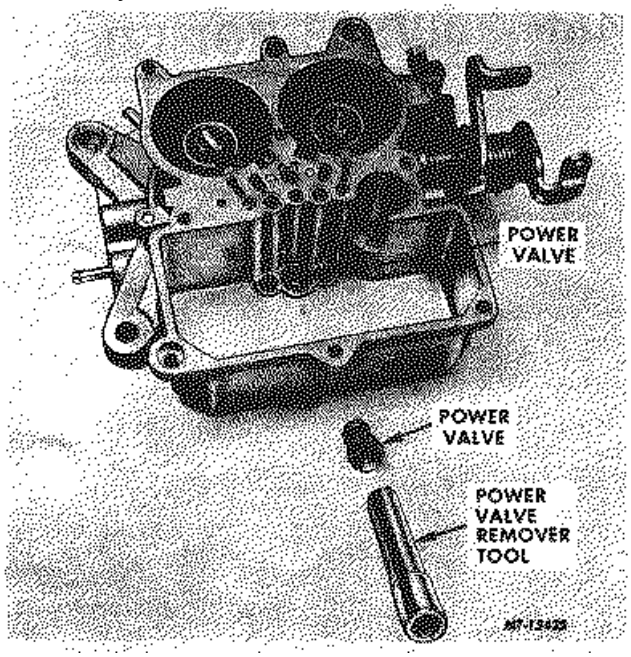


Fig. 35

22. Remove throttle body (five screws) and remove throttle body from main body (Fig. 36).

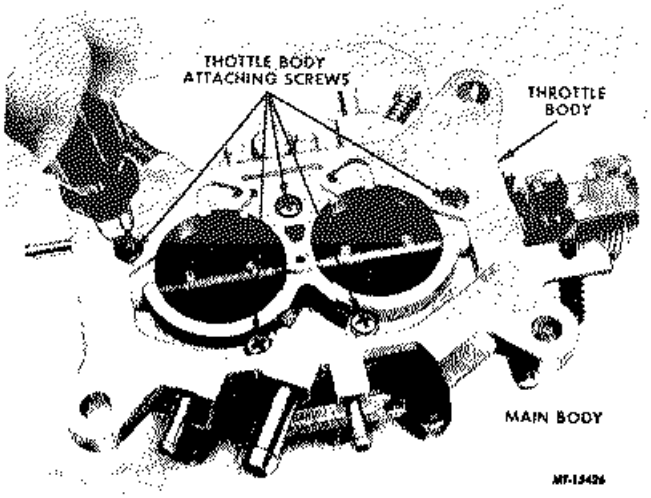


Fig. 36 Location of Throttle Body Attaching Screws

23. Remove hot idle compensator valve cover and valve from main body (Fig. 37).

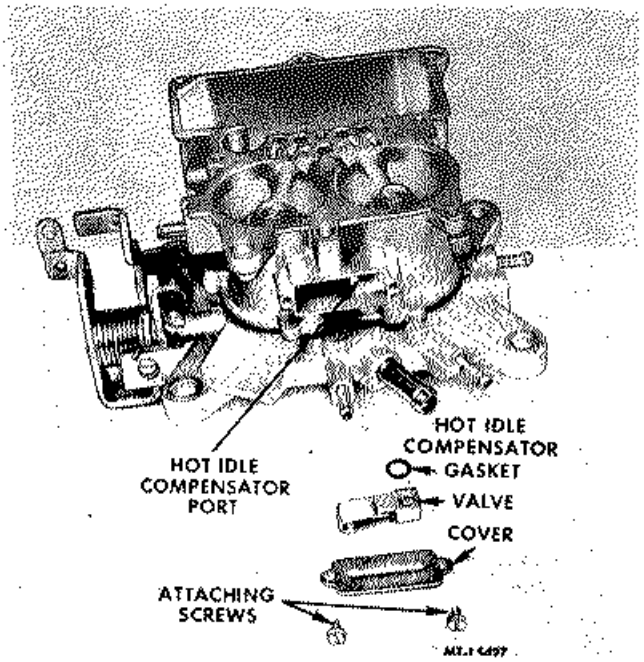


Fig. 37

24. Fig. 38 shows exploded view of throttle body and main body.

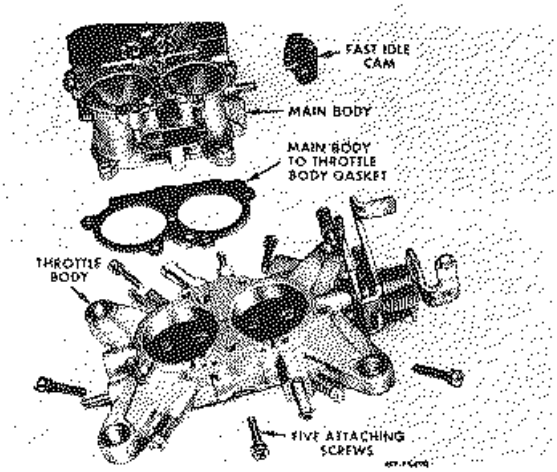


Fig. 38

25. Fig. 39 shows exploded view of idle mixture screws, low idle and fast idle screw from throttle body and shaft. Be sure to count the number of turns when removing the mixture screws.

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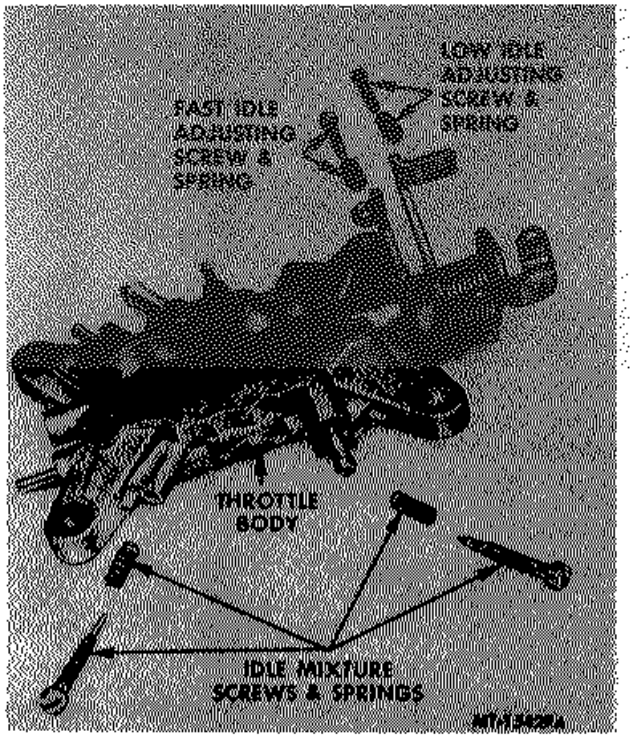


Fig. 39

CLEANING

After disassembly, parts should be thoroughly cleaned in a commercial carburetor cleaner or solvent. All passages should be blown out with compressed air. Do not clean any rubber or plastic parts in cleaning solvent.

If parts are agitated while immersed in cleaner, the main well tubes which are pressed into the air horn must be protected from bending or damage. They cannot be replaced.

Carburetor jets and passages should never be cleaned with a drill, wire or similar object. This method of cleaning may distort jets and passages and affect carburetor performance. A buffing wheel, wire brush, file or other sharp instrument should not be used to remove carbon deposits, as the protective plating on the part might be removed by scratching or filing.

INSPECTION

Check for cracks, warpage, stripped screw threads, damaged or marred mating surfaces on all major castings. The passages in castings should be free of restrictions. Install new castings as required. Check float assembly for damage or any condition that would impair this item from further service. The choke and throttle valves should be replaced if the edges have been nicked or if the protective plating has been removed.

Be sure that choke and throttle shafts are not bent or scored. Replace any broken or distorted springs. Replace all screws and lock washers that show signs of stripped threads or distortion.

CARBURETOR REASSEMBLY

For the most part, reassembly of this carburetor can be accomplished in reverse order of steps given in DISASSEMBLY. Any additional information will be noted in each step as well as proper adjustments.

1. Install idle mixture screws and springs in body. (The tapered portion must be straight and smooth. If the tapered portion is grooved or ridged, a new idle mixture screw should be installed to insure having correct idle mixture control.) Do not use a screwdriver. Turn screws lightly against their seat with fingers. Back off the number of turns (from the seat) counted at disassembly. (Screws should be equal number of turns on both sides.)

2. Invert main body and place a new gasket in position. Place throttle body on main body and align. Install attaching screws and tighten to 4.38 N/mm (25 inch pounds.).

3. Install hot idle compensator valve cover and valve to main body (refer to Fig. 37).

4. Install power valve using SE-1772-7 in main body (refer to Fig. 34).

5. Install main jets using SE-1772-6 in main body (refer to Fig. 33).

6. Install accelerator pump discharge needle in main body (refer to Fig. 32).

   Check needle operation by pouring clean gasoline into fuel bowl, approximately 25 mm (1") deep. Slide accelerator pump plunger into cylinder. Raise plunger and press down lightly on plunger stem to expell all air from pump passage. Using a small brass rod, hold discharge needle down on its seat. Again raise plunger and press downward. No fuel should be emitted from pump discharge passage. If fuel does emit from discharge passage, it indicates the presence of dirt or a damaged or worn check discharge needle or seat.

   Clean passage again and retest as above. If leakage is still evident, attempt to form a new seat. Remove and discard old needle and install a new one. Retest as described previously.

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If service fix does not correct the condition, a new main body should be installed.

7. Install choke plate shaft in air horn and install choke plate on shaft. The choke shaft must float freely to operate correctly. If choke sticks in bearing bores or appears to be gummed from deposits in air horn, a thorough cleaning will be required (refer to Fig 31).

8. Before installing vacuum power piston make sure all previous staking is removed from cylinder, after which install vacuum power piston in its cylinder. Lock in position by prick punching rim of cylinder (at least three places). Do not overstake. Compress piston to be sure no binding exists. If piston sticks or binds enough to hinder smooth operation, a new piston should be installed (refer to Fig. 28 and Fig. 29).

9. Install needle valve, seat and gasket in air horn (refer to Fig. 27).

10. Install float, float fulcrum pin and fuel baffle (refer to Fig. 25 and Fig. 26).

11. Measuring Float Setting

    The carburetor is equipped with a Viton tipped fuel inlet needle. The tip is flexible enough to make a good seal on needle seat and to give increased resistance to flooding. (Care should be taken to perform this operation accurately in order to secure best performance and fuel economy.)

    a. To correctly set float, invert air horn so that weight of float only is forcing needle against seat.

    b. Measure the clearance between top of float and float stop (Fig. 40). For clearance see carburetor specifications. (Use Gauge Set SE-2425.) Be sure gauge is perfectly level when measuring. If adjustment is necessary, bend float lip toward or away from needle using a narrow screwdriver until correct clearance of setting has been obtained.

    c. Check float drop by holding air horn in an upright position. The bottom edge of float should be parallel to underside surface of air horn. If an adjustment is necessary, bend tang arm until parallel surfaces have been obtained.

12. Install accelerator pump. Slide accelerator pump plunger compression spring over plunger stem with small diameter toward plunger (refer to Fig. 24).

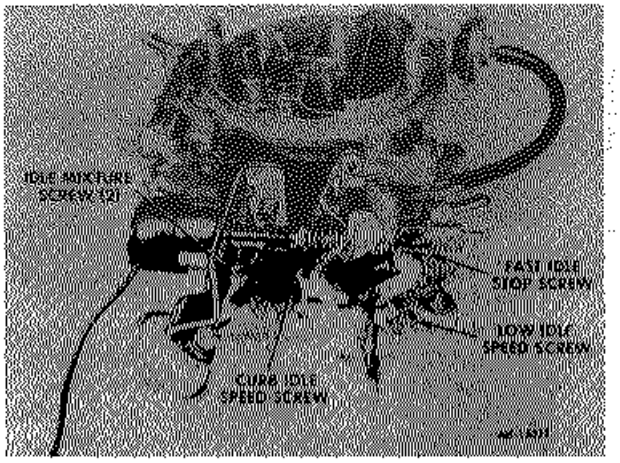


Fig. 40 Float Setting with Gauge Set SE-2425

Install pump shaft in air horn. As plunger is being installed in air horn, slightly tilt plunger to engage with plunger shaft (refer to Fig. 23).

13. Install air horn. Place a new gasket on air horn; then check to be sure main well tubes are straight. Lower air horn straight down on main body, guiding accelerator pump plunger into its cylinder. Do not cut lip of plunger on sharp edge of cylinder.

    Install attaching screws (long screw in center) and tighten to 4.38 N/mm (25 inch pounds). (Refer to Fig. 22.)

14. Install bowl vent valve retainer, valve and spring (refer to Fig. 21).

15. Install bowl vent valve operating lever spring as illustrated in Fig. 20. Then install bowl vent valve operating lever on stub shaft being careful that spring is in correct position. Install "E" retainer clip (refer to Fig. 19).

16. Install choke diaphragm and mounting bracket assembly to air horn. Install link rod from diaphragm to choke shaft lever. Install vacuum diaphragm hose from diaphragm to throttle body (refer to Fig. 18).

17. Install fast idle connecting rod from lever to fast idle cam (refer to Fig. 16).

18. Install accelerator pump rocker arm to accelerator shaft. Then place accelerator pump rod in middle slot of arm and in hole of throttle lever (refer to Fig. 14).

19. Install dashpot, solenoid and bracket as an assembly (refer to Fig. 13).

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OFF ENGINE CARBURETOR ADJUSTMENTS

1. Checking Bowl Vent Valve Clearance
   Using gauge from SE-2425 Gauge Set and with throttle valves set at curb idle, adjust by bending the arm on pump lever to change arc of contact with throttle lever (Fig. 41).

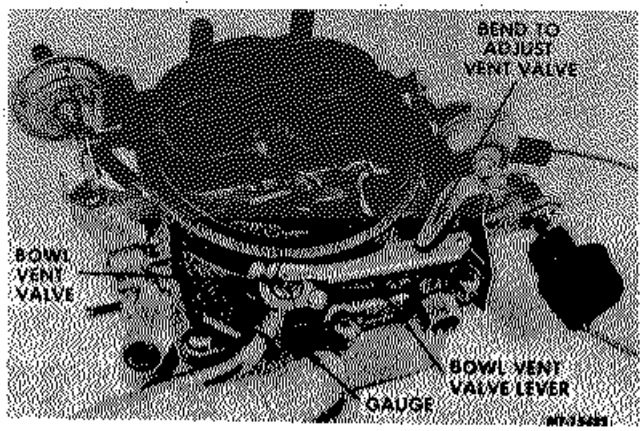


Fig. 41 Checking Bowl Vent Valve with SE-2425 Gauge Set

2. Vacuum Kick Adjustment
   The choke diaphragm adjustment controls fuel delivery while the engine is running. It positions the choke plate within the air horn by action of linkage between choke shaft and diaphragm. Place fast idle screw on top of cam step. Depress diaphragm with a small drift or screwdriver (Fig. 42).

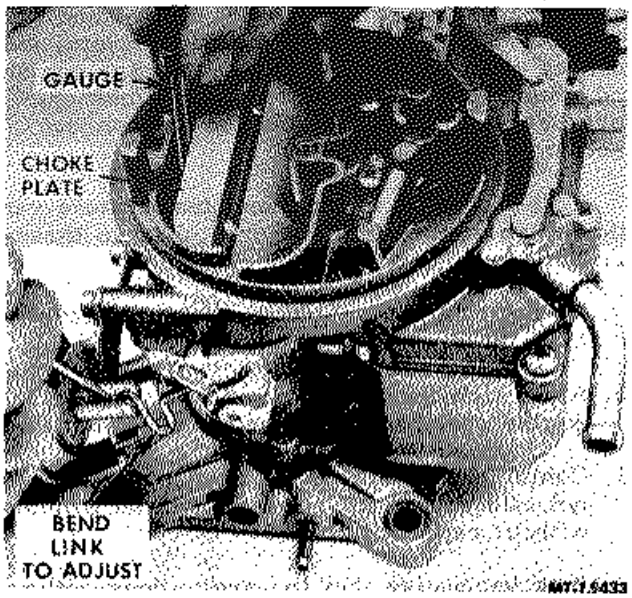


Fig. 42 Vacuum Kick Adjustment Using SE-2425 Gauge Set

Insert the proper gauge from SE-2425 Gauge Set between choke plate and wall of air horn (see CARBURETOR SPECIFICATIONS). Apply sufficient closing pressure on lever which attaches to choke rod to provide a minimum choke plate opening without distortion of diaphragm link. Note that cylindrical stem of diaphragm will extend as an internal spring is compressed. This spring must be fully compressed for proper measurement of vacuum kick adjustment.

An adjustment will be necessary if a slight drag is not obtained as gauge is removed. Shorten or lengthen diaphragm link to obtain correct choke opening. Length changes should be made carefully by bending (opening or closing) the bend provided in diaphragm link (Fig. 42). Do not apply twisting or bending force to diaphragm.

3. Fast Idle Cam Adjustment (Fig. 43)

   Fast idle cam position adjustment can be made on the bench. This adjustment is important to assure that speeds of each step or cam occur at the proper time during engine warm-up.

   With fast idle speed adjustment screw contacting second highest speed step on fast idle cam, move choke valve toward closed position with light pressure on choke plate.

   Insert specified gauge from SE-2425 Gauge Set between top of choke plate and wall of air horn (see CARBURETOR SPECIFICA-

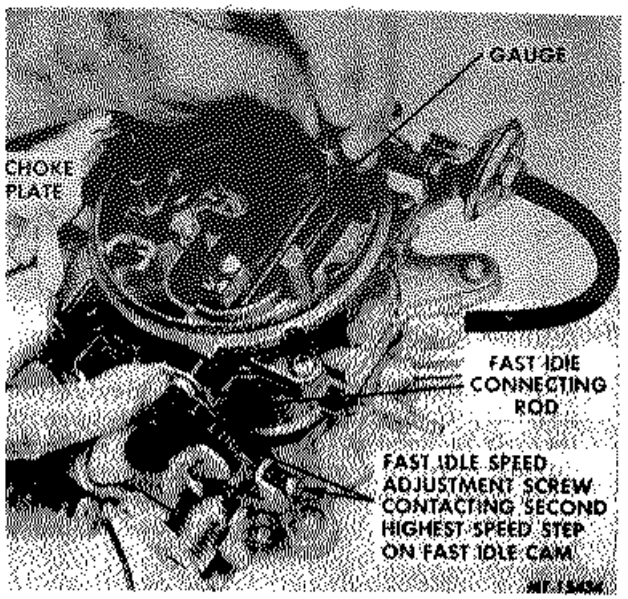


Fig. 43 Fast Idle Cam Adjustment

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TIONS). An adjustment will be necessary if a slight drag is not obtained as gauge is being removed.

If adjustment is necessary, bend fast idle connecting rod at angle until correct valve opening has been obtained (Fig. 43).

4. Adjust Accelerator Pump (Fig. 44)

Adjust accelerator pump by backing off curb idle adjusting screw. Open choke valve so that fast idle cam allows throttle valve to be completely seated in bores. Be sure pump connector rod is installed in correct slot of accelerator pump rocker arm.

Close throttle valves tightly. Measure distance between top of air horn and end of plunger shaft. Use tee scale to measure specified clearance (see SPECIFICATIONS for setting).

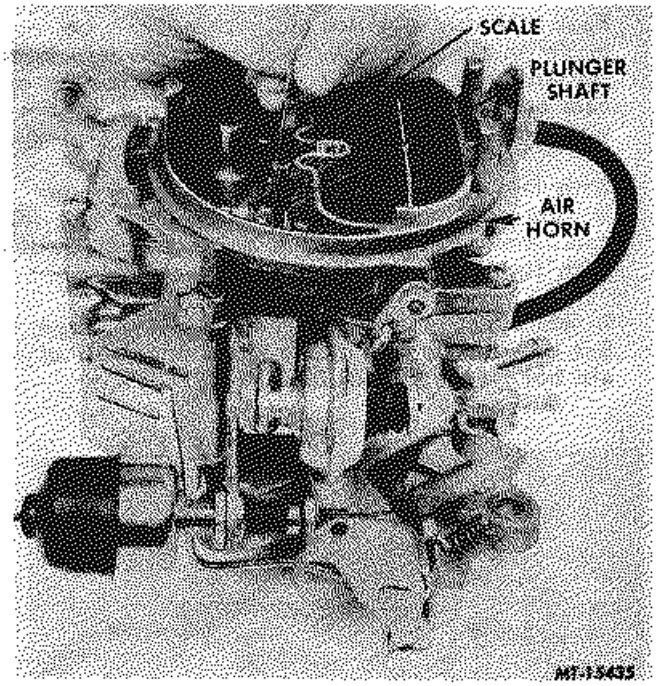


Fig. 44

5. Adjusting Choke Unloader (Fig. 45)

Choke unloader is a mechanical device to partially open choke valve at wide open throttle. It is used to eliminate choke enrichment during cranking of engine. Engines which have flooded or stalled by excessive choke enrichment can be cleaned by use of the unloader.

To adjust unloader, hold throttle valves in wide open position, insert specified gauge

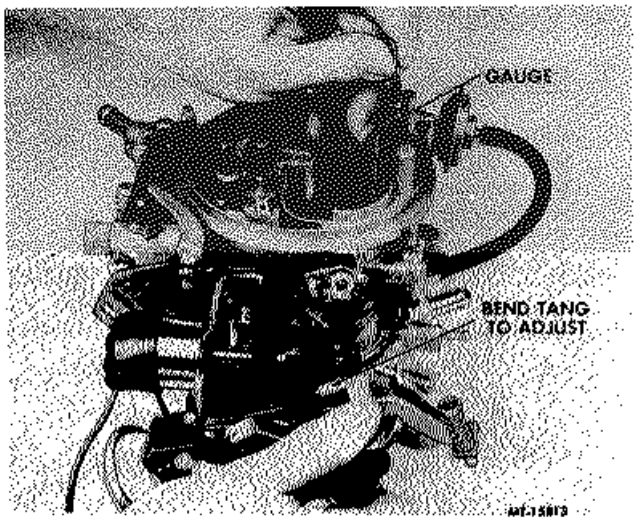


Fig. 45 Adjusting Choke Unloader

from SE-2425 Gauge Set between upper edge of choke valve and inner wall of air horn (see SPECIFICATIONS).

With a finger slightly pressed against shaft lever, a slight drag should be felt as gauge is being withdrawn. If an adjustment is necessary, bend unloader tang on throttle lever until correct opening has been obtained.

ON ENGINE CARBURETOR ADJUSTMENTS

Idle Air-Fuel Mixture

Idle speed and fuel mixture adjustment must be made with engine at normal operating temperature, parking brake applied, air cleaner in place, transmission in neutral and air conditioning "OFF." When making idle adjustments, disconnect vacuum hose from vapor storage canister and plug end of hose. After idle adjustments have been made, remove plug and reconnect hose to canister.

To compensate for fuel and temperature variation when setting idle mixture, observe these precautions.

1. Do not idle engine continuously for more than three minutes at one time.

2. After each three minutes of idling increase engine speed to 2000 rpm for one minute.

3. Continue with idle adjustment procedure. Do not idle engine for more than three minutes without repeating Step 2.

It is imperative that the precautions outlined above be followed on V8 engines where extended idling could permit sufficient increase in engine

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coolant temperature to activate high temperature vacuum control valve (where used) and thereby affect engine ignition timing and idle speed.

Adjustment Procedure without Exhaust Analyzer (Speed Drop Method)

1. Connect tachometer to engine. (Tachometer should have an expanded scale of 400 to 800 or 0 to 1000 rpm and 1 to 2% accuracy.)

2. Remove limiter cap(s). To prevent damage to screw threads or seat, file or grind away side of cap. Do not pry cap off.

3. Operate engine until it reaches normal operating temperature.

4. Gently seat idle mixture screws.

5. Carefully adjust idle mixture screws (equal number of turns) to produce maximum idle speed.

6. Carefully adjust curb idle speed screw to give engine speed higher than mid point of idle speed range per specifications. Then carefully adjust curb idle mixture screw (equal number of turns) in until mid point of idle speed range specification is obtained (see SPECIFICATIONS).

7. Install new plastic (service) limiter cap(s) with tab in mid position.

Adjustment Procedure with Exhaust Analyzer

If exhaust analysis equipment is available, the following procedure can be used to establish the recommended idle settings. Exhaust analysis equipment must have a "percent of carbon monoxide" meter which gives accurate reading in the 0 to 5% CO range.

Idle speed and fuel mixture adjustment must be made with parking brake applied, air cleaner in place, transmission in neutral and air conditioning "OFF."

When making idle adjustments, disconnect vacuum hose from vapor storage canister and plug end of hose. After idle adjustments have been made, remove plug and reconnect hose to canister.

To compensate for fuel and temperature variations when setting idle mixture, observe these precautions.

1. Do not idle engine continuously for more than three minutes at one time.

2. After each three minutes of idling, increase engine speed to 2000 rpm for one minute.

3. Continue with idle adjustment procedure. Do not idle engine for more than three minutes without repeating Step 2.

Winter grade gasolines, being more volatile than summer grade, can yield vapors which result in excessively rich or erratic air-fuel mixtures, particularly at high engine temperatures. Because of this, care must be taken when making carburetor idle mixture adjustments with the exhaust analyzer. Attempts to adjust idle mixture screw(s) leaner to overcome a rich mixture caused by evaporation of winter grade fuel at high engine temperatures can result in an extremely lean mixture and associated starting and driveability problems when vehicle is cold. Therefore, with winter grade gasolines, observe the following additional precaution.

Idle mixture adjustments must be made as soon as possible after engine will run without choke (choke plate fully open) before engine temperature becomes sufficiently high to cause evaporation of winter grade gasolines. Enrichment of the idle mixture by fuel evaporation can be detected by observing test meter readings. Readings should remain stable. A gradual increase in engine idle speed (rpm) or a tendency for the CO meter to climb toward the rich side without any adjustments being made indicates a richening of the mixture due to fuel evaporation. When this condition occurs, engine should be allowed to cool before making final mixture adjustments.

Setting Procedure

1. Connect tachometer to engine. (Tachometer should have an expanded scale of 400 to 800 or 0 to 1000 rpm and 1 to 2% accuracy.)

2. Disconnect air injection hose(s) at air manifold check valve(s) and plug air manifold check valve(s).

3. Operate engine until it reaches normal operating temperature (unless winter grade gasoline is used).

4. Adjust curb idle speed to specifications.

5. Prepare SE-2507 Exhaust Analyzer, or equivalent, and insert exhaust sample probe into vehicle's tail pipe (refer to test equipment manufacturer's instructions for preparation and hook-up procedures).

6. Observe percent of carbon monoxide (% CO) indicated on analyzer dial and adjust idle mixture screw(s) to obtain specified CO setting (see Emission Control System Tune-Up Specifications), if necessary.

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7. Readjust idle speed, if necessary, and readjust mixture screw(s) to provide specified CO setting at the specified speed.

8. If specified CO setting cannot be obtained, establish proper mixture screw(s) setting as follows:

   a. Remove limiter cap(s). To prevent damage to screw threads or seat, file or grind away side of cap. Do not pry cap off.

   b. Gently seat idle mixture screws.

   c. Adjust idle speed and mixture screw(s) (equal number of turns) to provide the specified CO setting at specified speed.

   d. Install new plastic (service) limiter cap(s) with tab in mid position.

   e. Disconnect test equipment from engine and reconnect air injection hose(s) to air manifold check valve(s).

Curb Idle Speed Adjustment Procedure

Curb idle speed adjustments must be made with engine at normal operating temperature, parking brake applied, air cleaner in place, transmission in neutral and air conditioning OFF.

The engine curb idle speed is adjusted as follows:

1. Be sure throttle stop solenoid (where used) is energized and extended (see "Throttle Stop Solenoid Operation Test").

2. Loosen jam nut on throttle stop solenoid and rotate solenoid to adjust curb idle speed (Fig. 46). Be careful to avoid twisting wire off the solenoid. After making speed adjustment, retighten jam nut.

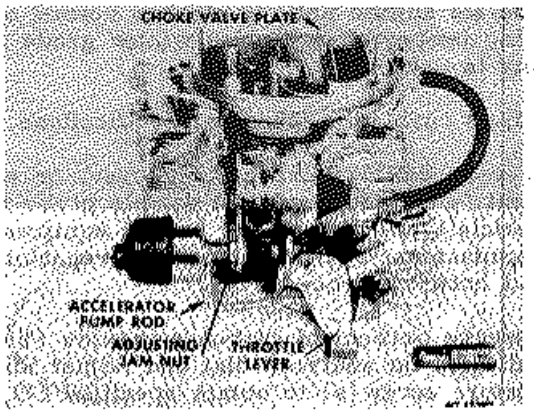


Fig. 46 Adjusting Curb Idle Speed By Rotating Solenoid

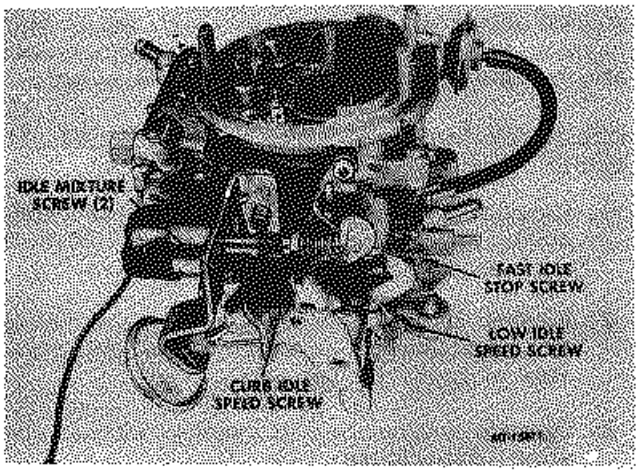


Fig. 47 Adjusting Curb Idle Speed with Adjusting Screw

3. Figure 47 shows adjusting curb idle speed with adjusting screw between throttle lever and solenoid (same carburetors).

   Adjust curb idle speed on carburetor using deceleration throttle modulator vacuum chamber unit by turning the low idle speed screw.

Throttle Stop Solenoid Operation Test

The following procedure can be used to check operation of throttle stop solenoid. Engine should be at normal operating temperature when making this test.

1. With engine shut off, hold throttle open by moving carburetor throttle lever.

2. Observe throttle stop solenoid while an assistant turns ignition "ON." Solenoid plunger should extend (move out) from solenoid housing (a distinct "click" should be heard). If solenoid operates, proceed to Step 3.

   If solenoid does not operate:

   a. Check electrical supply circuit by using a 12-volt test lamp to determine if solenoid feed wire is energized when ignition switch is "ON." If no supply current is indicated, make necessary repairs.

   b. If electrical supple circuit is satisfactory, throttle stop solenoid is defective and should be replaced. When new solenoid is installed, it will be necessary to reset engine curb idle speed per "Curb Idle Speed Adjustment Procedure."

3. Release throttle lever. Solenoid plunger should remain extended holding throttle in curb idle speed position.

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4. Observe solenoid while assistant turns ignition switch "OFF." Solenoid plunger should retract into solenoid housing permitting throttle to return to low idle speed position.

   If throttle lever does not return to low idle position, check dashpot setting and low idle speed adjustment (see "Dashpot Adjustment Procedure" and "Low Idle Speed Adjustment Procedure").

   To avoid damage to ignition system components, keep ignition switch "OFF" except when actually making tests.

Fuel Bowl Vent Adjustment Procedure (Where Used)

The external bowl vent may be checked and adjusted as follows:

1. Operate engine until thoroughly warmed up and adjust curb idle speed per "Curb Idle Speed Adjustment Procedure."

2. With engine running, remove air cleaner.

3. Measure clearance between tip of vent valve which protrudes from valve cover and rocker lever which should be within specified range (see CARBURETOR SPECIFICATIONS). If adjustment is required, use pliers to bend actuating lever (refer to Fig 42) to provide proper clearance.

4. Replace air cleaner.

Low Idle Speed Adjustment Procedure

The following procedure should be used to set low idle speed which is obtained when throttle stop solenoid fails or is deactivated. Low idle speed adjustment must be made with engine at normal operating temperatures, parking brake applied, air cleaner in place, transmission in neutral and air conditioning "OFF."

1. Adjust engine curb idle speed (per "Curb Idle Speed Adjustment Procedure") and adjust dashpot (where used) to specified clearance (see CARBURETOR SPECIFICATIONS).

2. Disconnect throttle stop solenoid (where used) electrical supply wire. The idle speed should drop as the solenoid plunger retracts.

3. Set low idle speed to specified rpm (see CARBURETOR SPECIFICATIONS) by adjusting low idle speed adjusting screw.

4. Reconnect throttle stop solenoid electrical supply wire.

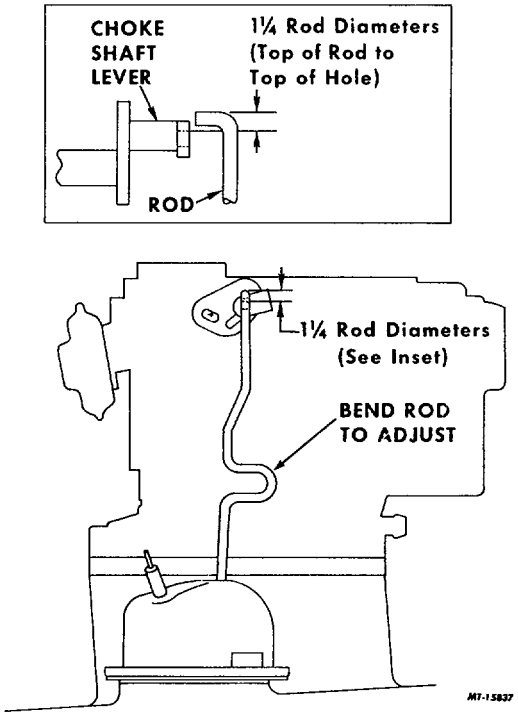


Fig. 48 Automatic Choke Adjustment V-400

Automatic Choke Adjustment Procedure for V-400 Engine (Fig. 48)

If automatic choke does not function properly (will not close choke plate when engine is cold or will not open choke plate after engine is warm), check for free operation of carburetor choke plate shaft and operating linkage. If linkage is free, check choke control (bi-metal) spring. If spring has lost its tension or will not respond to temperature change, replace choke control assembly.

Proper choke operation depends upon correct carburetor choke linkage adjustments and correct operation of choke vacuum diaphragm and electrical choke heating system. When faulty operation of the choke is suspected, check operation of choke vacuum diaphragm and check carburetor choke adjustments. Also, check operation of choke heating system as outlined under "Choke Heating System Operation Tests."

Tension of bi-metal choke control spring is preset at assembly. Minor choke adjustments can be made by changing the length of the choke operating rod from choke control housing to choke plate shaft lever.

Choke adjustment can be checked as outlined below. Engine and choke control assembly must

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be stabilized at room temperature 21.1 26.7 C (70-80 F) for a minimum of seven hours before making this check.

1. Disconnect choke control rod from carburetor choke shaft lever.
2. Hold carburetor choke plate fully closed.
3. Allowing choke control (bi-metal) spring to assume its free position, loosely hold upper end of choke control rod against choke shaft lever. Do not stretch or compress bi-metal spring.
4. With choke plate and choke control rod held as indicated in Steps 2 and 3, end of choke control rod should be located approximately 1-1/4 rod diameter above hole in choke shaft lever (top of hole to top of rod) as shown in Fig. 48.
5. If necessary, lengthen or shorten choke control rod to obtain correct setting as specified in Step 4. Adjust length by opening or closing the bend provided in rod. Care should be taken not to distort bi-metal spring when bending control rod.
6. Reconnect choke control rod to carburetor choke plate shaft lever.

Automatic Choke (With Index Marks) Adjustment Procedure V-304 & V-345 Engines Restrained Bi-Metal Choke(Fig. 49)

The automatic choke setting may be adjusted as follows. The model 2210C carburetor has a divorced choke. The thermostat coil is located in a choke housing which is mounted on the intake manifold. To adjust choke setting:

1. Pry cover from choke housing to expose index marks.

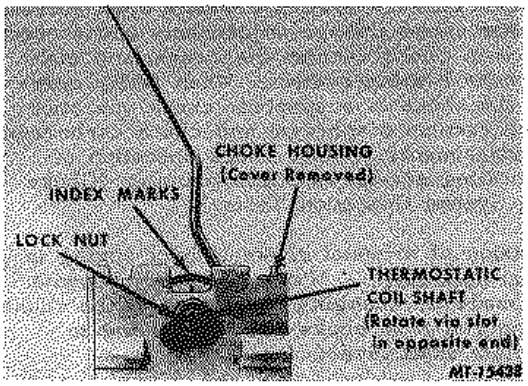


Fig. 49 Adjusting Automatic Choke for V-304 & V-345 Engines

2. Loosen lock nut on thermostatic coil shaft (Fig. 49).
3. Using a screwdriver, rotate coil shaft to obtain desired setting (see CARBURETOR SPECIFICATIONS) as indicated by index marks on side of choke housing (Fig. 49).

Automatic Choke (Without Index Marks) Adjusting Procedure V-304, V-345 and MV-404 Engines Unrestrained Bi-Metal Choke (Fig. 50 & Fig. 51)

Unrestrained bi-metal choke may be adjusted as follows. Engine and choke control assembly must be stabilized at room temperature of 21.1 26.7 C (70-80 F) for a minimum of seven hours before making this check.

1. Disconnect choke control rod from carburetor choke shaft lever.
2. Remove cover from housing.
3. Hold carburetor choke plate fully closed.
4. Allowing choke control (bi-metal) spring to assume its free position, loosely hold upper end of choke control rod against choke shaft lever. Do not stretch or compress bi-metal spring.

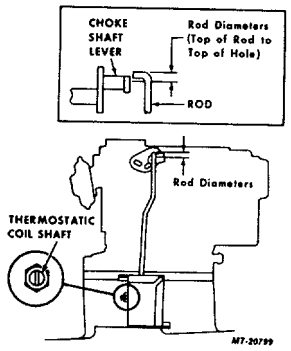


Fig. 50

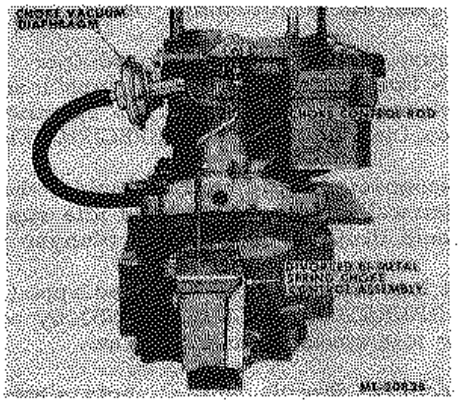


Fig. 51

5. With choke plate and choke control rod held as indicated in Steps 3 and 4, end of choke control rod should be located a certain number of rod diameters above the hole in the choke shaft lever (top of hole to top of rod). This is shown in Fig. 50 and in specifications below:

Engine	Specification
V-304	1-1/2 Rod
V-345	1/2 Rod
MV-404	1/2 Rod

6. If necessary, loosen lock nut on thermostatic coil shaft to obtain desired rod height. Tighten lock nut.

7. Install choke box cover and reconnect choke control rod to carburetor choke plate shaft lever.

Electrical Choke (Where Used) Heating Operation Test

1. Electrical Supply Circuit (from ignition switch) Test:

   Disconnect wiring harness connector (supply wire) from heat control switch. Connect a 12-volt test lamp between wiring harness connector and ground (Fig. 52). With ignition switch "ON" test lamp should light. If test lamp does not light, supply circuit (from ignition switch) is faulty and should be repaired as needed.

   The same electrical supply check is used for V-400 engine.

   To avoid damage to ignition system components, keep ignition switch "OFF" except when making circuit test.

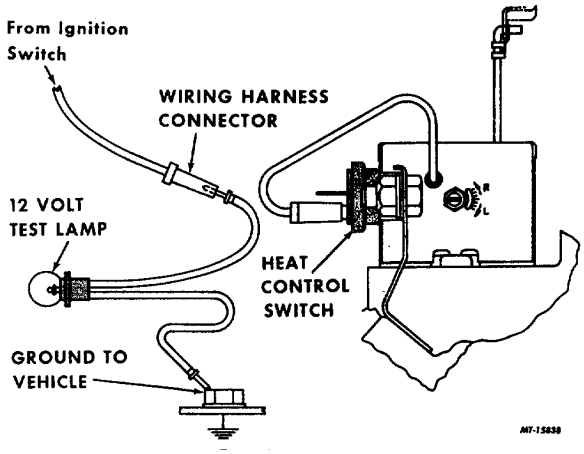


Fig. 52. Checking Electric Supply Circuit

2. Heating Element (Calrod) Test:

   Disconnect heating element wire connector from heat control switch. Using a "jumper" wire, connect battery voltage directly to heating element wire (Fig. 53). The heating element should become hot (choke housing cover should feel warm to the touch). If heating element does not become hot within 3-5 minutes, heating element is faulty; replace choke control assembly.

   Do not operate heating element for more than 15 minutes. Extended operation will damage heating element and thermostatic (bi-metal) choke spring.

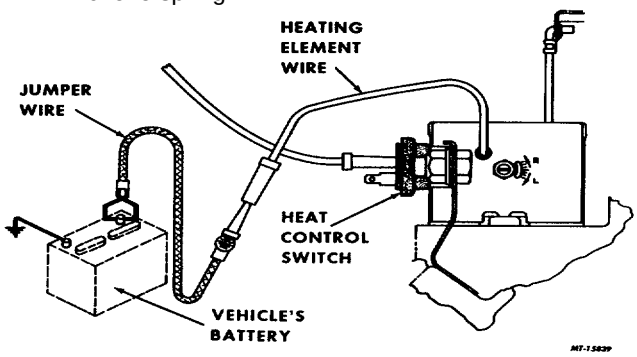


Fig. 53. Checking Heating Element (V-304 & V-345 Shown)

3. Heat Control Switch Tests:

   The following continuity tests can be used to check operation of choke heat control switch. The low temperature and room temperature tests should be performed with switch removed from vehicle. The switch should be allowed to stabilize at the test temperatures for a minimum of one-half hour.

   a. Low Temperature Test - Below 8.9 C (48 F)

      Allow switch to stabilize at low temperature below 8.9 C (48 F) for at least 1/2 hour. Connect a continuity test lamp across switch terminals (Fig. 54). Switch should be open (test lamp not lit). If switch is closed (test lamp lit, switch is faulty and should be replaced.

   b. Room Temperature Test - Above 20 C (68 F)

      Allow switch to stabilize at room temperature above 20 C (68F) for at least 1/2

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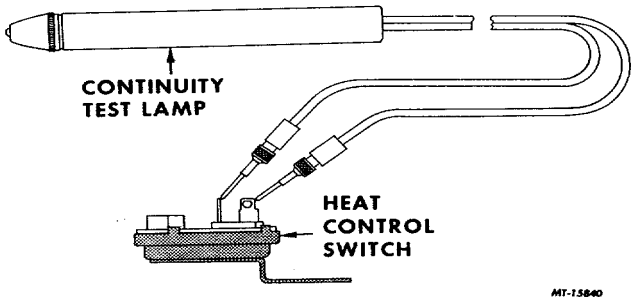


Fig. 54. Control Switch Continuity Test

hour. Connect a continuity test lamp across switch terminal (Fig. 54). Switch should be closed (test lamp lit). If switch is open (test lamp not lit), switch is faulty and should be replaced.

c. High Temperature Cut-off Test (Engine Operating)

Engine and switch must be established at room temperature above 20 C (68 F) so that switch is closed on V-304 and V-345 engines. Be sure switch is snug against choke control housing the full width of housing. With electrical supply and heating element wires connected to switch, connect a 12-volt test lamp between heating element terminal of switch and ground as shown in Fig. 55 for V-304 and V-345 engines and Fig. 56 for V-400 engine.

Turn ignition switch "ON." Test lamp should light. Start engine and operate

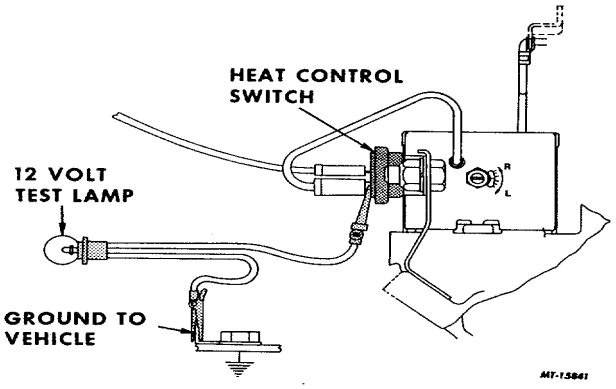


Fig. 55. Temperature Cut-Off Test (V-304 & V-345 Engines)

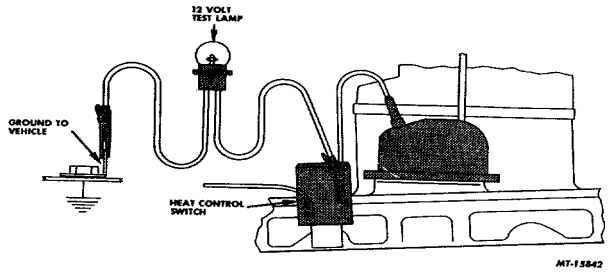


Fig. 56. Temperature Cut-Off Test (V-400 Engine)

at curb idle speed. Record time from engine start until switch opens (test lamp goes out). Switch should be open (test lamp should go out) when switch temperature exceeds approximately 54 C (130 F). If switch does not open, it is faulty and should be replaced.

Fast Idle Adjustment (Automatic Choke)

The following procedure should be used to obtain the correct fast idle setting.

1. Operate engine until it reaches normal operating temperature.
2. Shut off engine. Remove air cleaner. Disconnect and plug vacuum signal hose at EGR valve.
3. Connect tachometer to engine.
4. With engine stopped, open throttle and move choke plate to full choke (closed) position.
5. Holding choke plate closed, close throttle. This will hold fast idle cam in full choke position and throttle plates in fast idle position.
6. Without touching accelerator, start engine. Allow engine to stabilize and observe tachometer. Engine speed should be specified fast idle speed (see CARBURETOR SPECIFICATIONS). If necessary, adjust fast idle stop screw to obtain specified fast idle speed.

   Throttle linkage (accelerator pedal) must not be moved between Steps 5 and 6. If linkage is disturbed, fast idle cam will not remain in fast idle position and it will be necessary to repeat Steps 4 and 5.
7. Reinstall air cleaner. Unplug and connect vacuum signal hose to EGR valve.

Dashpot Adjustment Procedure

Carburetor dashpot clearance can be checked and adjusted as follows.

1. Engine curb idle speed must be set to specifications per "Curb Idle Speed Adjustment Procedure."

2. With engine running at curb idle speed, depress dashpot plunger completely into dashpot and measure clearance between plunger and throttle lever pad using a gauge from SE-2425 Gauge Set.

3. If clearance is not within specifications (see CARBURETOR SPECIFICATIONS), loosen jam nut on dashpot and rotate dashpot to achieve specified clearance. Retighten dashpot jam nut (Fig. 57).

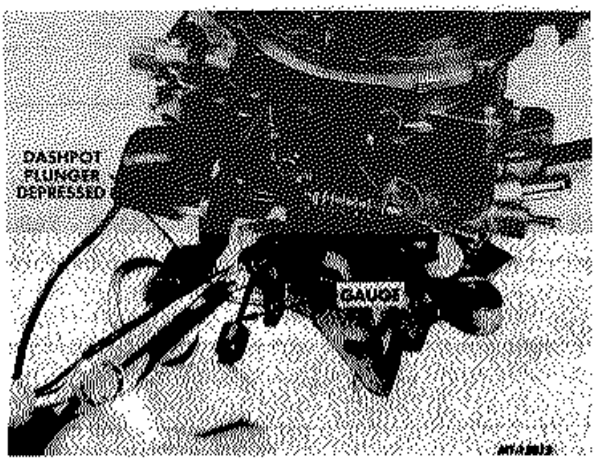


Fig. 57. Dashpot Adjustment (Typical)

Hot Idle Compensator Operation Test

It is recommended that this operation test be performed at time of engine tune-up or when engine idle is erratic and cannot be corrected using normal procedures.

1. With engine running, remove air cleaner.

2. Cover hot idle compensator air inlet port in carburetor air horn (Fig. 58). An improvement in engine idle quality with air inlet port covered indicates that hot idle compensator valve is not functioning properly.

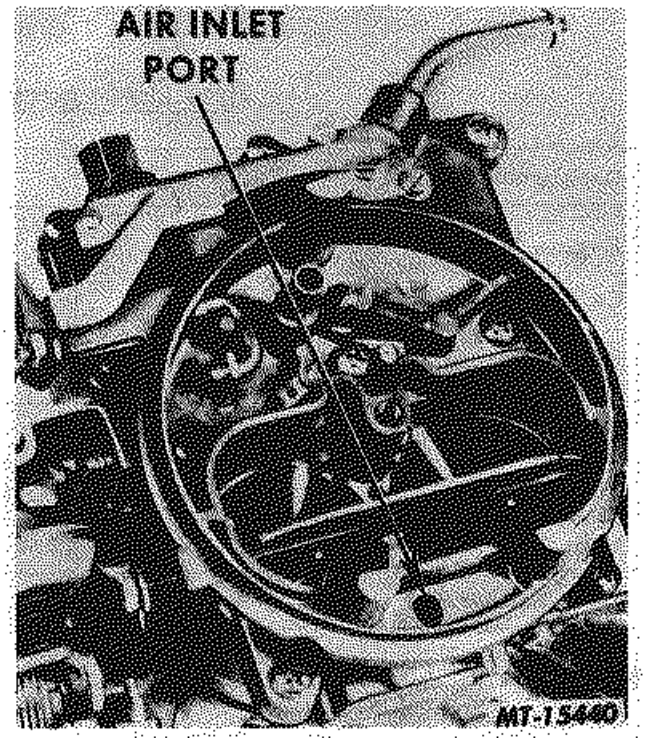


Fig. 58. Hot Idle Compensator Air Inlet Port Location

   a. Remove hot idle compensator cover and bi-metal valve assembly to assure valve seat gasket is in good condition and in place in counterbore of carburetor hole. Replace gasket if excessively worn or damaged.

   b. If replacement of valve seat gasket does not improve idle quality, bi-metal valve assembly is faulty and should be replaced.

3. Replace air cleaner after completing test.

The following specifications cover production carburetors from 1973 through 1977, both light duty emission class vehicles and heavy duty emission class vehicles.

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CARBURETOR SPECIFICATIONS

1973 LIGHT DUTY EMISSION CLASS VEHICLES

Carburetor Model	2210C					
Engine Model	V-304	V-345	V-304	V-345	V-304	V-345
Carburetor: Part Number List Number	436901-C91 6443		436901-C92 6443-1		448670-C91 6776	
Throttle Body Bore	39.67 mm (1-9/16")					
Venturi	29.36 mm (1-5/32")		30.02 mm (1.182")		30.02 mm (1.182")	
Main Jet	#49		#52		#52	
Float Setting (1)	5.08 mm (.200")					
Fuel Level	12.7 mm (1/2")					
Curb Idle Speed, RPM (2) (Throttle Stop Solenoid Activated)	700					
Preliminary Mixture Adjustment Speed, RPM (For Speed Drop Method)	745	760	745	760	745	760
Idle Mixture Setting, CO (For Exhaust Analyzer)	1.5% Max					
Low Idle Speed, RPM (Throttle Stop Solenoid Deactivated)	575 ± 25					
Fast Idle Speed, RPM (3) (Top Step - Hot)	2200					
Automatic Choke Setting	Index (Summer) 2 Notches Rich (Winter)				Index	
Dashpot Setting	1.78 - 2.29 mm (.070 - .090")					
Fuel Bowl Vent Adjustment Clearance	.254 - .508 mm (.010 - .020")					
Fast Idle Cam Adjustment	2.95 + .381 mm (.116 + .015") - #32 Drill					
Vacuum Kick Adjustment	2.92 - 3.68 mm (.115 - .145")		3.05 - 3.56 mm (.120 - .140")			
Choke Unloader Adjustment	5.79 + .762 mm (.228 + .030") - #1 Drill					
Accelerator Pump Adjustment	17.78 mm (.700")					

(1) Between top of float and float stop with air horn inverted.
(2) Transmission in Neutral, air conditioning "OFF."
(3) With EGR signal hose disconnected and plugged.

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CARBURETOR SPECIFICATIONS

1974 LIGHT DUTY EMISSION CLASS VEHICLES (EXCEPT CALIFORNIA)

Carburetor Model	2210C		
Engine Model	V-304	V-345	V-400
Carburetor Part No. Carburetor List No.	451911-C91 6828		444561-C91 6674-1
Throttle Body Bore	39.67 mm (1-9/16")		
Venturi	30.02 mm (1.182")		32.77 mm (1.290")
Main Jet	#52		#61
Fuel Level	12.7 mm (1/2")		
Float Setting (1)	5.08 mm (.200") - #7 Drill		
Curb Idle Speed, RPM (2) (Throttle Stop Solenoid Activated)	700 ± 25		
Preliminary Mixture Adjustment Speed, RPM (For Speed Drop Method)	745	760	746
Idle Mixture Setting, CO (For Exhaust Analyzer)	1.5% Maximum		
Low Idle Speed, RPM (Throttle Stop Solenoid Deactivated)	575 + 25		
Fast Idle Speed, RPM - Top Step, Hot (3)	2200		2000
Automatic Choke Setting	Index		Preset (4)
Choke Qualification Setting	3.05 - 3.56 mm (.120 - .140")		4.04 - 4.55 mm (.159 - .179")
Choke Unloader Setting	5.791 ± .762 mm (.228 ± .030")		5.029 ± .762 mm (.198 ± .030")
Dashpot Setting	1.78 - 2.29 mm (.070 - .090")		
Fuel Bowl Vent Adjustment Clearance	381 ± .254 mm (.015 ± .010")		
Accelerator Pump Setting	16.51 mm (.650")		

(1) Between top of float and float stop with air horn inverted.

(2) Transmission in Neutral, air conditioning "OFF."

(3) With vacuum hose disconnected from EGR valve and plugged.

(4) 1-1/4 rod diameter preload (see Automatic Choke Adjustment Procedure).

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CARBURETOR SPECIFICATIONS

1974, 1975, 1976, 1977 & 1978 FEDERAL HEAVY DUTY ENGINES (NOT CALIFORNIA)

Carburetor Model	2210C		
Engine Model	V-304	V-345	MV-404
Carburetor: Production Part No. List No.	441192-C92 6620-2 465663-C91 7309/7309-1		465529-C91 7214/7214-1 - - - - - -
Throttle Body Bore	39.675 mm (1-9/16")		
Venturi	30.02 mm (1.182")		32.77 mm (1.290")
Main Jet	#53	#53	#602
Fuel Level	12.7 mm @ 37.92 kPa (½" @ 5.5 psi)		
Float Level Setting (1)	4.57 mm (.180") #7 Drill		4.57 mm (.180") #15 Drill
Automatic Choke Setting	(3)		Preset
Choke Qualification Setting	1.01 - 1.78 mm (.040" - .070")		3.43 ± .38 mm (.135" + .015")
Choke Unloader Setting	5.029 - 6.553 mm (.198 - .258")		5.791 ± .762 mm (.228 ± .030")
Fast Idle Setting, RPM	2200		1800
High Idle Speed, RPM (Throttle Modulator Extended)	1300 - 1400		1350 ± 50
Curb Idle Speed, RPM (2)	650 - 700		515 - 575
Idle Mixture Setting, CO	2% Max.	1.5% Max.	5% - 2.5%

(1) Between top of float and float stop with air horn inverted.
(2) Transmission in Neutral, air conditioning "OFF."
(3) Restrained bimetal (choke with index marks) 1 notch lean. Unrestrained bimetal (choke without index marks) preset.

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CARBURETOR SPECIFICATIONS

1974, 1975, 1976, 1977, 1978 CALIFORNIA HEAVY DUTY ENGINES

Carburetor Model	2210C		
Engine Model	V-304/V-345	V-345	MV-404
Carburetor: Production Part No. List No. Production Part No. List No. Production Part No. List No.	 465663-C91 7309/7309-1 441192-C92 6620-2 487857-C91	 463359-C91 7133 483449-C91 7940 487860-C91 8241	 476109-C91 7657 465532-C91 7217 8244
Throttle Body Bore	39.67 mm (1-9/16")		
Venturi	30.02 mm (1.182")		32.77 (1.290")
Main Jet	#532	#542	#622
Fuel Level	12.7 mm @37.92 kPa (½..@5.5 psi)		
Float Level Setting (1)	4.57 mm (.180") - #7 Drill		
Automatic Choke Setting	(3)		Preset
Choke Qualification Setting	1.01 - 1.78 mm (.040 - .070")		3.05 - 3.81 mm (.120 - .150")
Choke Unloader Setting	5.03 - 6.55 mm (.198 - .258")		
Fast Idle Setting, RPM	2200	2200	1800
High Idle Speed, RPM	1350 ± 50	1450 ± 50	1350 ± 50
Curb Idle Speed, RPM (2)	650 - 700	625 - 675	525 - 575
Idle Mixture Setting, CO	2% Max.	0.5% - 1.5%	0.5% - 2.5%

(1) Between top of float and float stop with air horninverted.
(2) Transmission in Neutral, air conditioning "OFF."
(3) Restrained bimetal "choke with index marks) 1 notch lean. Unrestrained bimetal (choke without index marks) preset.

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CARBURETOR SPECIFICATIONS

1979 HEAVY DUTY ENGINES

Carburetor Model	2210C	
Engine Model	V-345	MV-404
Carburetor:		
Production Part No.		476109-C91
List No.		7657
Production Part No.	483449-C91	
List No.	7940	
Production Part No.	487857-C91	487860-C91
List No.	8241	8244
Throttle Body Bore	39.67 mm (1.562")	
Venturi	30.07 mm (1.184")	32.82 (1.292")
Main Jet	#542	#622
Fuel Level	12.7 mm @ 37.92 kPa (½"	@ 5.5 psi)
Float Level Setting (1)	4.57 mm (.180") - #7 Drill	
Automatic Choke Setting	(3)	Preset
Choke Qualification Setting	1.01 - 1.78 mm	3.05 - 3.81 mm
(.040 - .070")	(.120 - .150")	
Choke Unloader Setting	5.03 - 6.55 mm (.198 - .258")	
Fast Idle Setting, RPM	2200	1800
High Idle Speed, RPM	1350 + 50	1350 + 50
Curb Idle Speed, RPM (2)	625 - 675	525 - 575
Idle Mixture Setting, CO	0.5% - 1.5%	0.5% - 2.5%

(1) Between top of float and float stop with air horn inverted.

(2) Transmission in Neutral, air conditioning "OFF."

(3) Restrained bimetal (choke with index marks) 1 notch lean. Unrestrained bimetal (choke without index marks) preset.

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CARBURETOR SPECIFICATIONS

1979 (CANADIAN) HEAVY DUTY ENGINES

Carburetor Model	2210C		
Engine Model	V-304	V-345	MV-404
Carburetor: Production Part No. List No.	465663-C91 7309-1		465529-C91 7214-1 - - - - - -
Throttle Body Bore	39.675 mm (1-9/16")		
Venturi	30.02 mm (1.182")		32.77 mm (1.29(
Main Jet	#53	#53	#602
Fuel Level	12.7 mm @ 37.92 kPa (½" @ 5.5 psi)		
Float Level Setting (1)	4.57 mm (.180")		4.57 mm (.180")
	#7 Drill		#15 Drill
Automatic Choke Setting	(3)		Preset
Choke Qualification Setting	1.01 - 1.78 mm		3.43 + .38 mm
	(.040" - .070")		(.135" + .015")
Choke Unloader Setting	5.029 - 6.553 mm		5.791 + .762 mm
	(.198 - .258")		(.228 + .030")
Fast Idle Setting, RPM	2200		1800
High Idle Speed, RPM (Throttle Modulator Extended)	1300 - 1400		1350 ± 50
Curb Idle Speed, RPM (2)	650 - 700		515 - 575
Idle mixture Setting, CO	2% Max.	1.5% Max.	.5% - 2.5%

(1) Between top of float and float stop with air horn inverted.
(2) Transmission in Neutral, air conditioning "OFF."
(3) Restrained bimetal (choke with index marks) 1 notch lean. Unrestrained bimetal (choke without index marks) preset.

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FUEL SYSTEM

CARBURETOR MODELS 2300, 2300C, 2300G AND 2300EG

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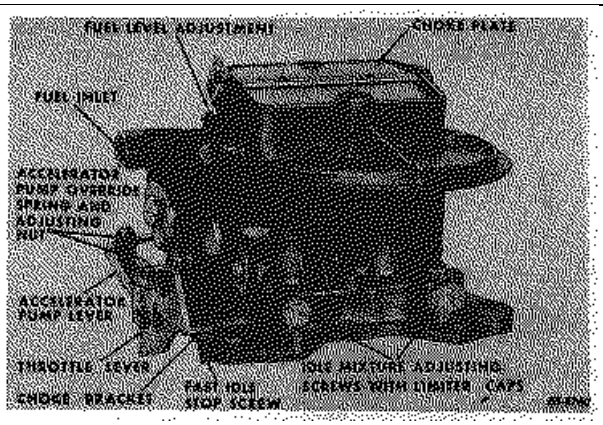


Fig. 1. Model 2300 Carburetor

DESCRIPTION

The model 2300 series carburetors (Figs. 1, 2 and 3) are of the two-barrel downdraft type. Each barrel has its own venturi, idle system, main metering system, booster venturi and throttle plate, but the same fuel inlet and air inlet supplies both barrels.

The metering body or block contains all the fuel metering passages for the basic systems. The metering body permits rapid servicing and trouble shooting.

Automatic and manually operated chokes are used on the model 2300C and 2300 respectively.

The carburetor is teamed with the distributor to effect spark timing that will satisfy all engine speed and load conditions.

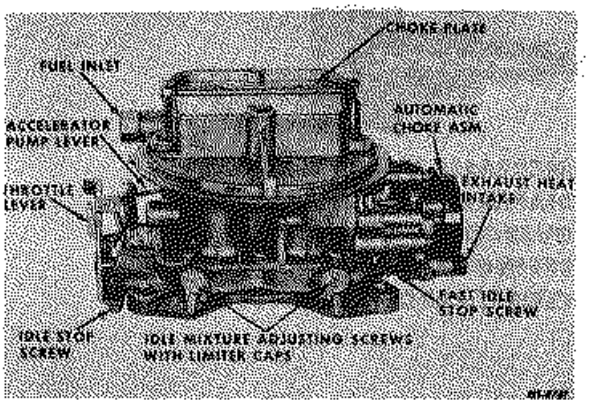


Fig. 2. Model 2300C Carburetor with Automatic Choke

A diaphragm-type operated accelerator pump is located in the bottom of the fuel bowl. The pump functions when pump lever is activated by cam on throttle lever assembly. An override spring on pump lever adjusting screw allows a prolonged discharge of fuel for smooth acceleration.

A synthetic check valve located within the accelerator pump assembly uncovers the opening between the fuel bowl and accelerator pump to admit fuel from the fuel bowl. When the accelerator pump is operated, the valve closes the opening, blocking a reverse flow of fuel to the bowl, causing fuel delivery through the pump discharge nozzle.

Dashpot

The dashpot used on some carburetors is an antistall device. It affords protection against loading the engine when the accelerator pedal is suddenly released. The dashpot acts to retard the closing rate of the throttle as it approaches the idle position. This gives the engine time to dissipate the raw fuel discharged into the manifold, thus overcoming the hazard of stalling.

Idle Mixture Control

There is an external system employed to limit the richness of the idle mixture. This is accomplished by the use of idle limiter caps and idle mixture screws having a 15 degree needle taper. The cap limits the travel of the idle mixture screw to the extent that the idle mixture cannot be set so rich that the exhaust emission level does not meet requirements.

Governor

The governor limits the maximum operating speed of the engine. The governor consists of two units: a throttle-actuating mechanism and a controlling unit.

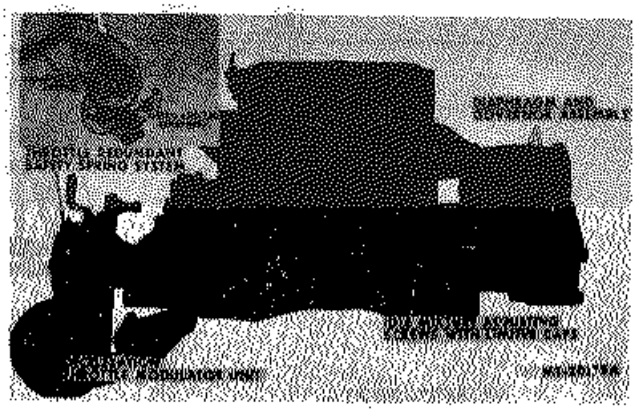


Fig. 3. Model 2300G Carburetor with Governor, Redundant Safety Spring and Deceleration Throttle Modulator

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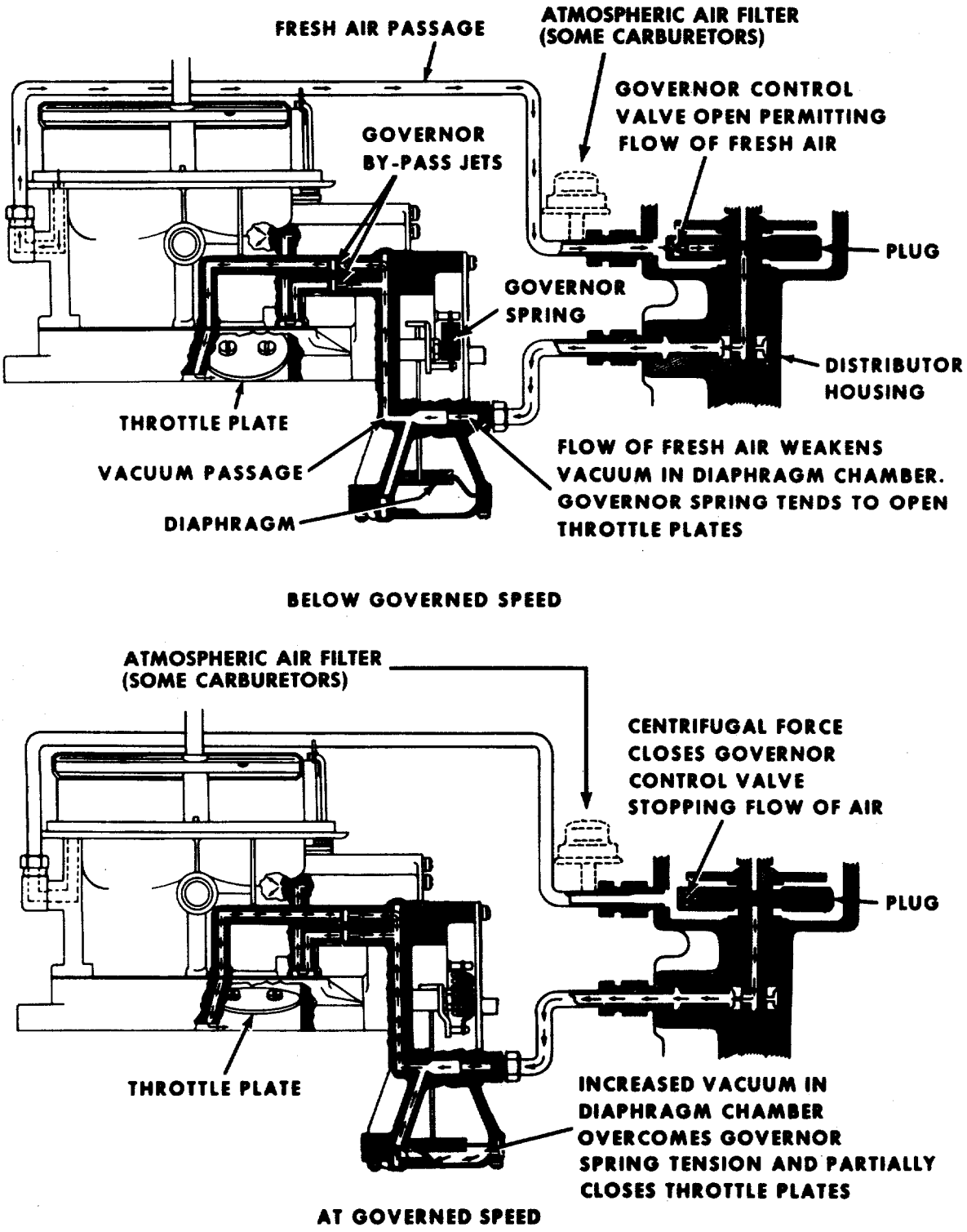


Fig. 4. Governor Operation

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The throttle-actuating unit consists of a diaphragm assembly, governor lever and governor spring. This unit is connected to the primary throttle shaft in such a way that tension of the governor spring tends to open the throttle when the accelerator pedal is depressed. Two calibrated jets in the vacuum passages meter venturi and manifold vacuum to control the governor operating diaphragm.

The control unit located in the distributor housing consists of a rotating, centrifugally operated valve which is driven by the distributor shaft at one-half engine speed. The tension of the valve spring holds the valve open. As rotation speed increases, centrifugal force acting on the valve weight overcomes spring tension, closing the valve. Spring tension can be adjusted manually to regulate the speed at which the valve closes.

Below governed speed venturi and manifold vacuum draws filtered air through the open governor valve (Fig. 4). Vacuum in the diaphragm chamber, being weakened by the flow of air, is not strong enough to move the governor diaphragm. The throttle plates are controlled by position of the accelerator pedal.

When governed speed is reached, centrifugal force acting on the valve weight closes the valve, >J restricting the flow of air. The resulting increased vacuum moves the diaphragm and lever against the tension of the governor spring to partially close or prevent further opening of the throttle plates. Further movement of the accelerator pedal will not increase engine speed, since vacuum acting on the diaphragm holds the throttle plates in partially closed position. Governed engine speed is held constant by balance between centrifugal force on the valve weight and tension of the valve spring.

Any slight change in engine speed will cause the governor valve to react immediately either increasing or decreasing the flow of air through the valve. A change in air flow will cause an instant response from the diaphragm to increase or decrease the throttle opening. When the accelerator is released, control is taken from the governor by the throttle lever, and the accelerator return spring closes the throttle plates to lower the engine speed.

Fuel Inlet System (Fig. 5)

The fuel enters the fuel bowl through a filter screen and into the fuel inlet valve which is frequently referred to as the fuel inlet needle and seat assembly. The amount of fuel entering the fuel bowl is determined by the space between the top of the movable needle and its seat and also by the pressure from the fuel pump. Move-

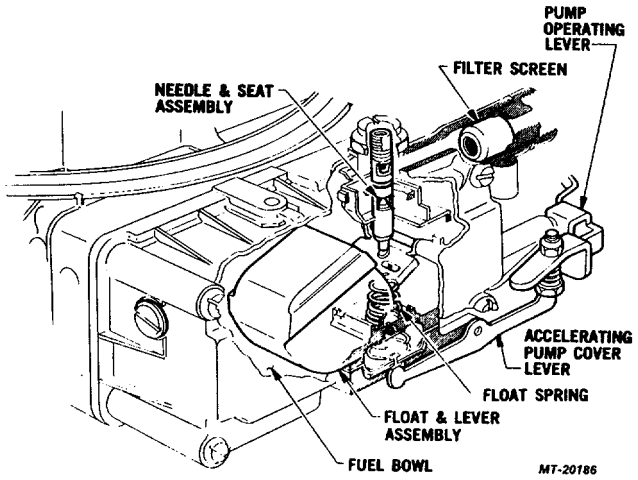


Fig. 5. Fuel Inlet System

ment of the needle in relation to the seat is controlled by the float and lever assembly which raises and falls with the fuel level. As the fuel level drops, the float drops, opening the needle valve to allow fuel to enter the float chamber.

When the fuel reaches a specified level, the float moves the needle valve to a position into the seat where it restricts the flow of fuel, admitting only enough to replace that being used. Any slight change in the fuel level causes a corresponding movement of the float, opening or closing the fuel inlet needle valve to immediately restore or hold the correct fuel level.

The fuel inlet system must constantly maintain the specified level of fuel as all the other metering systems are calibrated to deliver the proper mixture only when the fuel is at this level.

Prior to the introduction of the emission control systems, most all fuel bowls were vented to the atmosphere. On later model carburetors, fuel bowls are vented internally and vapors are burned in the engine.

Idle System (Fig. 6)

The 2300 carburetor uses two identical idle systems, one for each bore. At idle, near atmospheric pressure in the fuel bowl will cause the fuel to flow through the idle system to the greatly reduced pressure zone (manifold vacuum) below the throttle plate.

Fuel flows from the fuel bowl, through the main metering jet, the idle well and the idle feed restriction. The fuel blends with air inducted through the idle air bleed and the mixture is metered by the idle adjusting needle and is discharged through the idle discharge hole into the throttle bore below the throttle plate.

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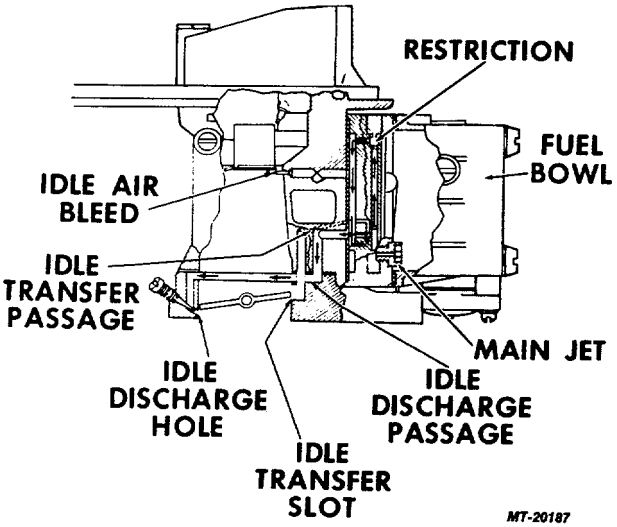


Fig. 6. Idle System Fuel Air Flow

Upstream of the idle discharge and the throttle plate is an idle transfer slot, imposing manifold vacuum on the slot and causing air/fuel mixture to be discharged through the slot into the throttle bore. This transfer slot provides a smooth transition from idle to main metering system operation.

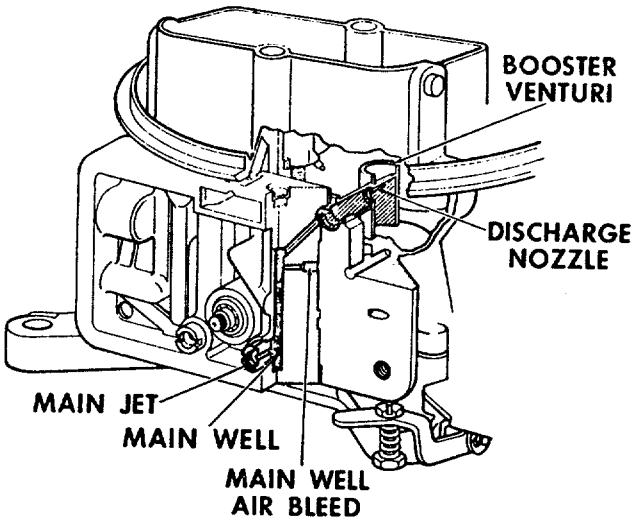
Main Metering System (Fig. 7)

As the throttle plates open in response to speed and/or load demand, the air flow through the carburetor main venturi increases in velocity, inducing an increased depression on the main metering system, causing air/fuel mixture to flow from the main discharge nozzle. The flow from the idle system gradually decreases and reverses as the carburetor approaches a wide open throttle condition.

In the main metering system, the fuel flows from the fuel bowl through the main metering jet which meters the fuel into the main well. The fuel mixes with air inducted through the main well air bleed in the side of the well. The emulsion created then passes through the discharge channel and is discharged into the carburetor venturi by the discharge nozzle.

Power Enrichment System (Fig. 8)

The enriched air/fuel mixture required under heavy load conditions is provided by a supplementary fuel metering system and the power valve which is controlled by manifold vacuum. Since manifold vacuum is proportional to engine load, the enrichment can be triggered at any required point in the load range. Some versions of this carburetor contain a two-stage power valve which can be calibrated to enrich the air/ fuel ratio in two increments in the load range in



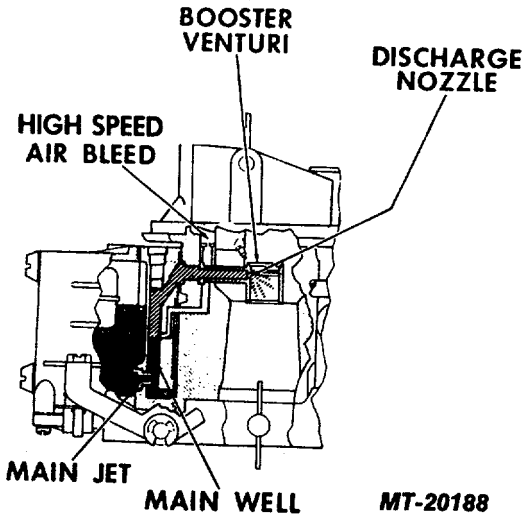


Fig. 7. Main Metering Fuel Air Flow

order to provide more precise calibration where required for emission control.

The power valve in this carburetor is a diaphragm actuated, spring loaded conical valve normally closed under high manifold vacuum conditions (cruise or idle) by the force of the vacuum acting on the diaphragm. When the manifold vacuum is reduced to a given level (acceleration or load), the spring force will open the valve, providing a path for fuel to flow from the fuel bowl to the main metering well, bypassing the main metering jet. As engine load decreases, manifold vacuum increases and the valve returns to the closed position, eliminating the supplementary fuel.

Two-Stage Power Valve (Fig. 9)

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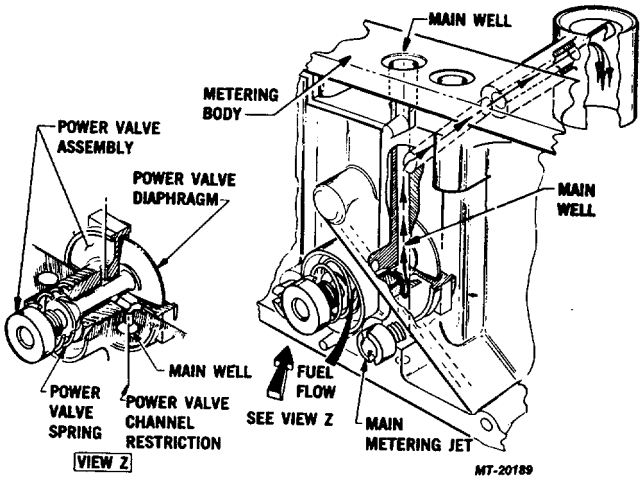


Fig. 8. Power Enrichment Fuel Air Flow

The added supply of fuel necessary for high speed ⌀ full power operation is delivered by a fully automatic power enrichment system. Manifold vacuum on the power valve diaphragm actuates the power enrichment system.

To provide a leaner light load and light partthrottle operation, a two-stage diaphragm-actuated power valve is used in some model 2300 series carburetors.

During light load and light part-throttle operation where manifold vacuum drops to a predetermined level, the first stage of the power valve opens and enriches the mixture slightly. As manifold vacuum decreases on acceleration or steeper grades, the second stage opens, providing full power enrichment. The two-stage power valve is serviced as an assembly and is not adjustable in the field.

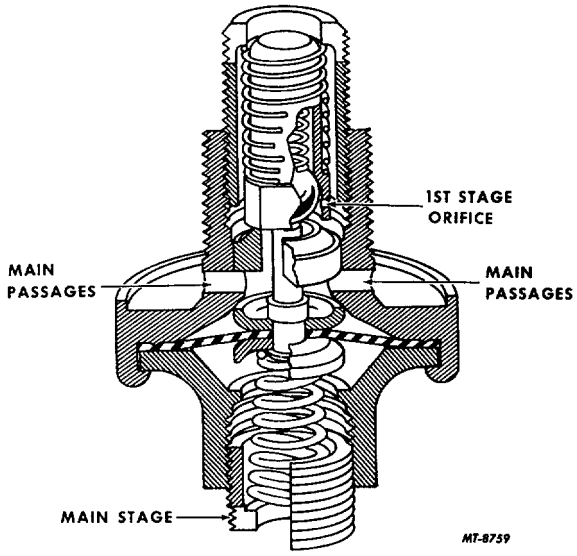


Fig. 9. Two-Stage Power Valve

Power Valve Modulator (Figs. 10 & 11)

The power valve modulator is incorporated in the power valve vacuum system to ensure fuel enrichment during high speed, wide open throttle operation. As wide open throttle engine speed approaches the maximum engine RPM, intake manifold vacuum may rise to a level sufficient to close the second stage of the power valve, thereby reducing fuel flow and engine power. The power valve modulator system is designed to bleed off power valve cavity vacuum when the throttle plates are opened to 50 degrees or greater. At this angle a hole in the throttle shaft and the hole in the throttle body are aligned, permitting flow of clean air from the air cleaner to the power valve cavity, thus reducing cavity vacuum and insuring full fuel enrichment.

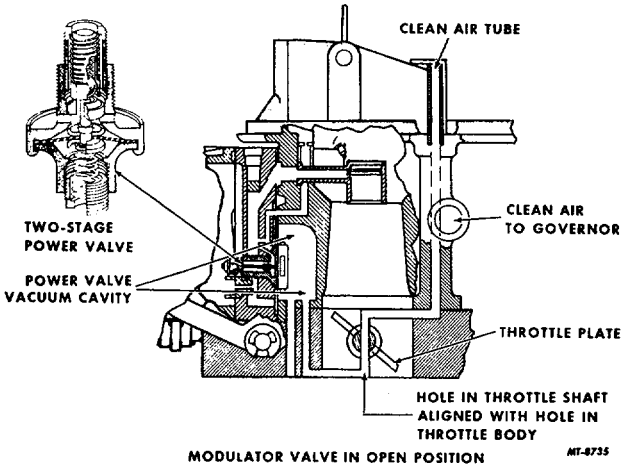


Fig. 10. Modulator Valve in Open Position Power Valve Open

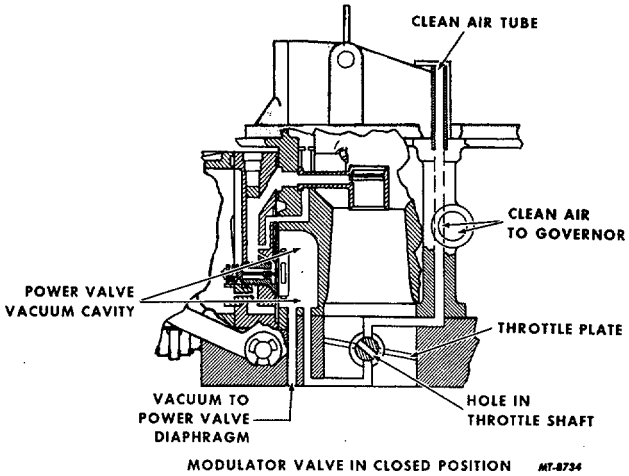


Fig. 11. Modulator Valve in Closed Position Power Valve Closed

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Acceleration Pump System (Fig. 12)

The accelerating pump is located in the bottom of the fuel bowl. The function of the pump is to discharge fuel into the carburetor upon acceleration demand in order to compensate for the inertia of the fuel metering system with a temporary, instantaneous enrichment of the air/fuel mixture. The pump consists of a spring loaded diaphragm, a normally closed needle check valve (discharge) and a normally open ball or plastic check valve (inlet). The pump is actuated by a rotating mechanical link mounted between the diaphragm and the throttle lever assembly.

As the throttle is opened, a cam mounted to the throttle lever rotates the pump lever, depressing the pump diaphragm. Hydraulic pressure forces fuel in the pump cavity and channels past the needle check valve and out the pump discharge nozzles into the air stream.

Upon return of the throttle lever toward idle position, the diaphragm spring returns the diaphragm and the resultant pressure differential causes the discharge valve to close and the inlet ball or plastic check valve to open, allowing the pump cavity to refill with fuel from the bowl.

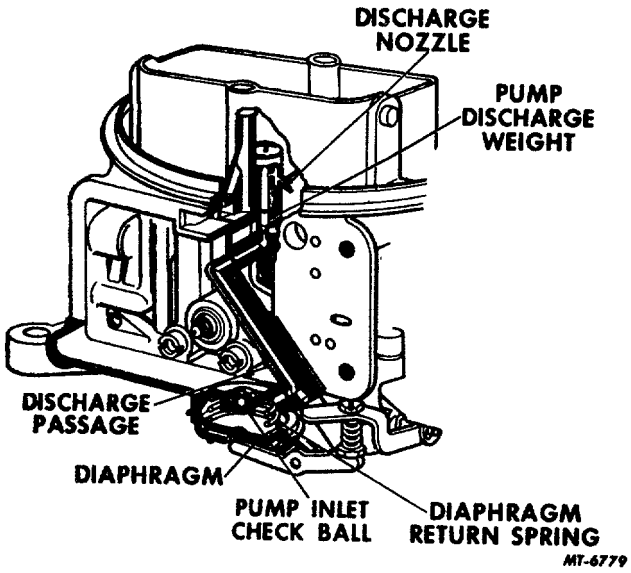


Fig. 12. Acceleration Pump Fuel Flow (shown with inlet check ball not used on early models).

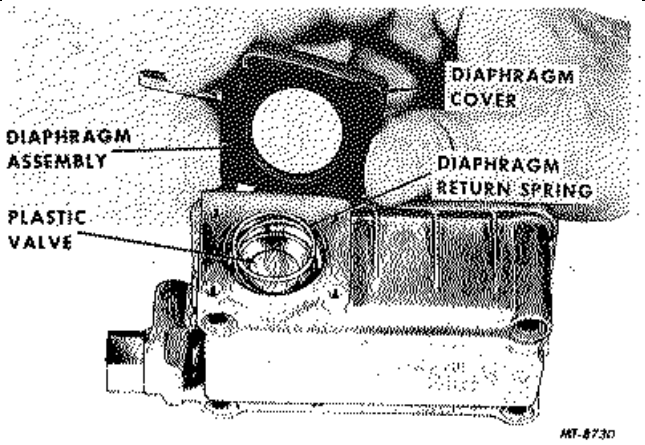


Fig. 13. Acceleration Pump Assembly (shown with plastic pump inlet valve used on later model carburetors).

Choke System (Fig. 14)

The function of the choke system is to provide a rich air/fuel mixture necessary for cold starting and engine warm-up.

The choke plate, which is manually operated on governor type carburetors, may be closed during the engine cranking period and partially opened during the warm-up period. This induces a low pressure on the fuel metering system, causing both the main and idle systems to discharge more fuel producing mixtures rich enough to insure smooth power as the engine warms up.

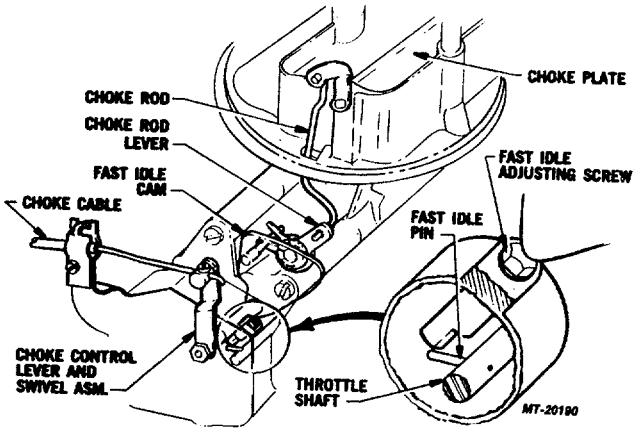


Fig. 14. Manual Choke System

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During the full choke period, the high point of the fast idle cam is in contact with the fast idle adjusting screw which sets the throttle plates at a predetermined angle causing engine RPM to be high upon starting. As the choke is manually opened, the cam moves rotationally away from the fast idle adjusting screw allowing the engine to resume its normal idle speed setting.

Throttle Modulator 1970-1971 Vehicles Under 6000 Lbs. GVW (Fig. 15)

To provide acceptable exhaust emission levels, the carburetors of certain vehicles require the use of a throttle modulator. The throttle modulator is vacuum operated and functions above a predetermined road speed to aid in the control of exhaust emission during engine deceleration.

Fig. 15 shows throttle modulator diagram. A speed sensor (spinner valve) is driven by the speedometer cable. A vacuum source and bleed line are piped into the speed sensor. The sensor is designed to open the bleed line to the vacuum source when vehicle road speed is below the predetermined cutoff speed (approximately 24 MPH). As long as the bleed line is open, no vacuum is available to extend the modulator. When the vehicle passes the road speed cutoff point, the bleed line is closed, making vacuum available to actuate the modulator.

The throttle plate is held in a partially open position during vehicle deceleration to aid combustion and provide an acceptable exhaust emission level.

When the vehicle decelerates to the cutoff speed, the vacuum bleed line is opened by the speed sensor, causing the modulator to retract and allow the throttle lever to close the throttle plate to curb idle position.

The speed sensor and throttle modulator are serviced only as complete replacement units.

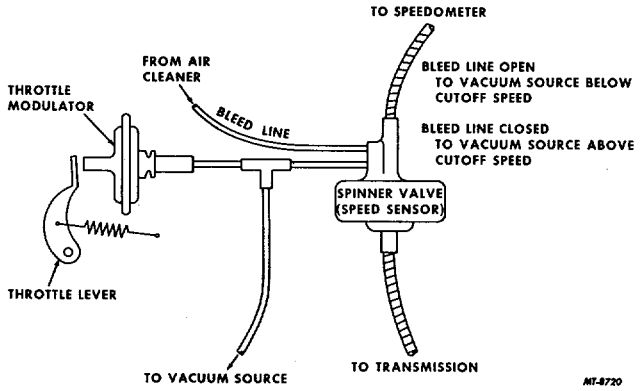


Fig. 15. Throttle Modulator Diagram

Deceleration Throttle Modulator System 1973 California and 1974 thru 1978 Federal Vehicles Over 6000 Lbs. GVM (Fig. 16)

The deceleration throttle modulator system (DTM) consists basically of a vacuum operated throttle modulator unit on the carburetor, a solenoid vacuum valve and engine speed sensor unit (Fig. 16).

Normally an engine will emit relatively high levels of unburned hydrocarbons during "closed throttle" deceleration. This is because the intake of air/fuel mixture is not sufficient to support complete combustion and the engine "misfires" resulting in fuel being passed through the engine unburned. The deceleration throttle modulator system overcomes this condition by maintaining a slightly greater throttle opening (high idle) during initial deceleration which permits intake of just enough additional air/fuel mixture to promote combustion and eliminate misfire.

The engine speed sensor is calibrated to activate or deactivate (extend or retract) the throttle modulator unit at approximately 1850 RPM engine speed.

Above 1850 RPM engine speed, the solenoid vacuum valve is activated (held open) by electrical current from the engine speed sensor unit. This permits manifold vacuum to act upon the diaphragm of the throttle modulator unit extending the modulator unit to the high idle position. Upon deceleration, the returning carburetor throttle lever contacts the extended modulator, thus holding the throttle in high idle position.

When engine speed drops below 1850 RPM, the speed sensor unit deactivates the solenoid vacuum valve allowing the valve to close and bleed the vacuum from the throttle modulator

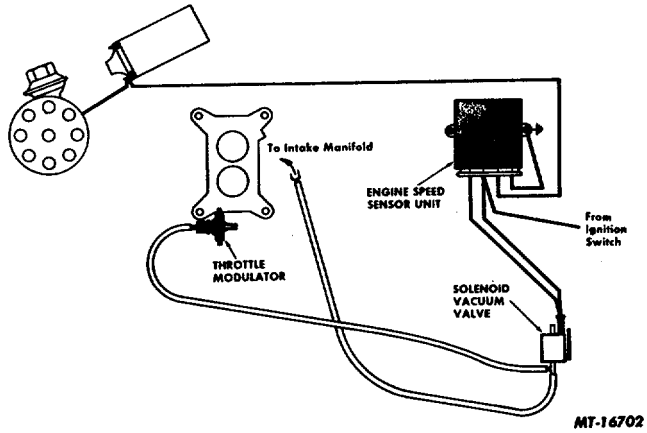


Fig. 16. Deceleration Throttle Modulator System (Typical) - Five Wire Separate Type

diaphragm spring to retract the modulator unit and allow the throttle lever to return to normal curb idle position.

For deceleration throttle modulator service instructions, see Truck Service Manual CTS-2733, CTS-2721 or CTS-2694, FUEL SYSTEM.

Redundant Throttle Closing Linkage (Fig. 3)

The model 2300G carburetor, appearing on vehicles produced after September 1, 1975, are equipped with redundant throttle closing linkage as an added safety feature. The purpose of this redundant linkage is to return the throttle to the idle position in the event throttle return spring becomes disconnected or linkage breaks.

The redundant linkage consists of a safety spring, trip lever, retaining lever and throttle lever as shown in Fig. 3. Under normal operation the safety spring is held in a coiled (loaded) position by the notch in the retaining lever and alto of the trip lever. The throttle return spring supplies the force necessary to keep the notch and tab engaged. In the loaded position, the throttle lever may be operated with the usual restraining force of the throttle return spring.

If the throttle return spring becomes disconnected, the notch and tab will become disengaged allowing the force of the loaded safety spring to snap the throttle to the idle position. Although vehicles may be driven in this condition, the redundant throttle closing linkage should be reloaded as soon as possible.

MAJOR SUBASSEMBLIES

There are three major subassemblies of the model 2300 series carburetors and they are: 1) the main body assembly, 2) the fuel bowl and metering body assembly, and 3) the throttle body assembly. The centrifugal-vacuum type governor is integral with the throttle body on the model 2300G.

The die-cast fuel bowl and metering body assemblies contain the fuel chamber, fuel inlet needle valve, accelerating pump, main jets and fuel metering passages. The die-cast throttle body assembly contains the throttle plates, throttle linkage and various fuel and vacuum passages.

Special Tools

The overhaul procedure which follows can be accomplished with ordinary tools. However, the use of carburetor tool set SE-1772 is strongly recommended. Use of the tools in this set not only protects parts which ordinary tools might damage, but also saves time as well.

Legend for Fig. 17.

Key	Description
1	RETAINER, Diaphragm Link
2	SPRING, Governor
3	HOUSING, W/Cover, Governor
4	NEEDLE, Discharge Pump Valve
5	PLATE, Choke
6	SCREW, Choke Plate
7	SHAFT, Choke, Assembly
8	RO)D, Choke
9	SEAL, Choke Rod
10	STOP, Idle Adjusting Needle
11	NI:EDLE, Idle Adjusting
12	BODY, W/Shaft, Throttle
13	GASKET, Carburetor Mounting
14	LEVER, Accelerator Pump, Assembly
15	HOUSING, Throttle Operating Shaft, Assembly with Safety Redundant Throttle Closing Linkage
16	CAM, Accelerator Pump Operating
17	PLATE, Back-Up, Assembly
18	FITTING, Fuel Inlet
19	DIAPHRAGM, Accelerator Pump, Assembly
20	VALVE, Accelerator Pump Check
21	SCREEN, Fuel Filter
22	BOWL, W/Plugs, Float
23	VALVE, Carburetor Fuel Inlet
24	WIRE, Governor Seal
25	SEAL, Governor Wire
26	FLOAT, Carburetor, Assembly
27	JET, Main
28	BODY
29	VALVE, Power Jet, Assembly
30	ELBOW, Inverted Flared Tube
31	DIAPHRAGM, Governor, Assembly
32	SCREW, Throttle Plate
33	CHAMBER, Vacuum Throttle Modulator

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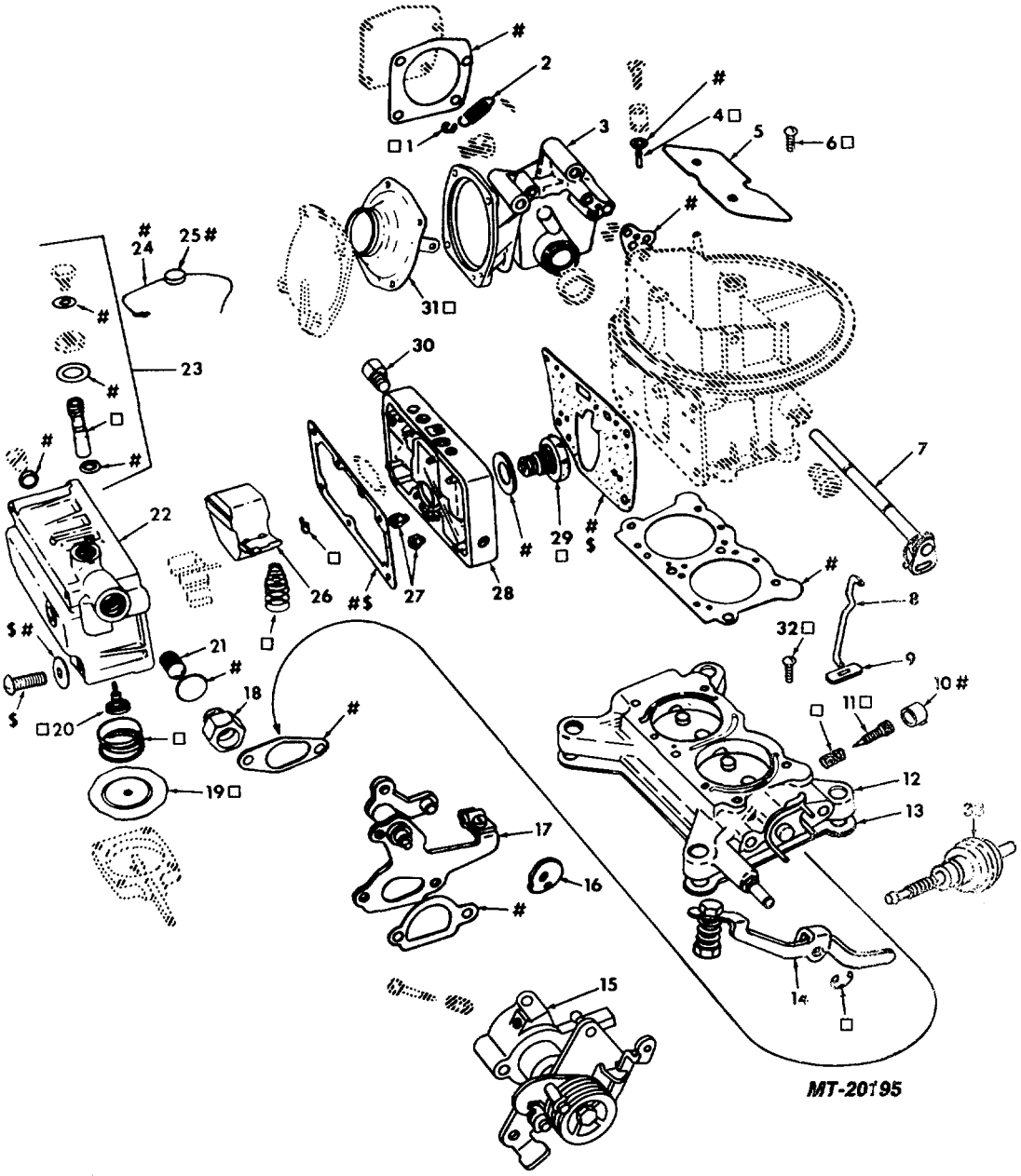


Fig. 17 Carburetor Assembly (Exploded View)

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DISASSEMBLY

During disassembly use separate containers for holding component parts of the three major subassemblies. Separation of the carburetor into three subassemblies is the first step in the overhaul procedure. Discard all gaskets and parts which have replacements in the repair kit.

1. Remove the four fuel bowl screws and disassemble fuel bowl and metering body from the main body (Fig. 18). Separate fuel bowl from metering body and discard gaskets.
2. Invert carburetor and remove the five throttle body to main body screws (Fig. 19). For governor-equipped model carburetor (2300G), also remove governor cover plate and governor-to-throttle body mounting screws. Separate throttle body from main body and discard gasket.

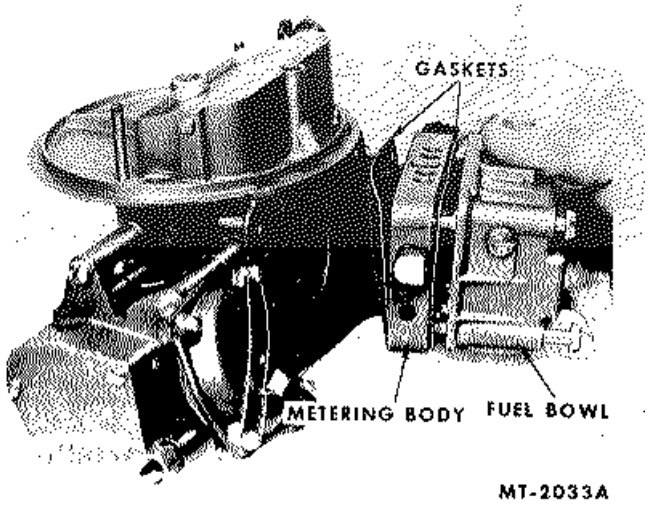


Fig. 18 Separating Fuel Bowl and Metering Body from Main Body

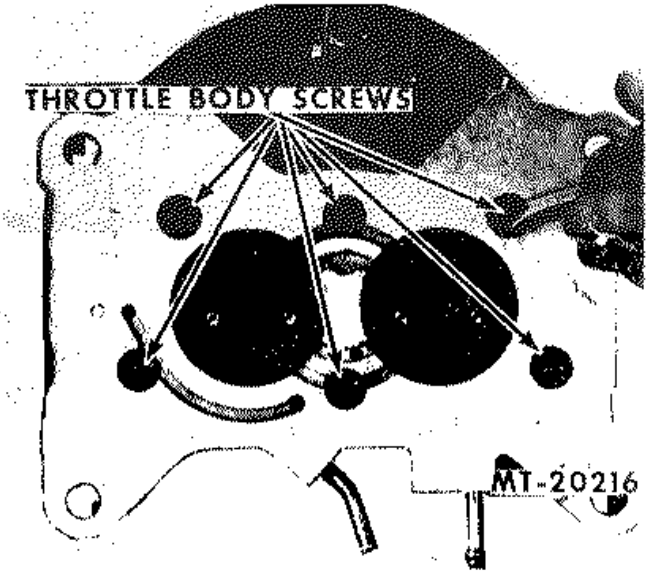


Fig. 19 Removing Throttle Body Screws

DISASSEMBLY OF SUBASSEMBLIES

Fuel Bowl and Metering Body (Fig. 20)

Legend for Fig. 20

Key	Description	Key	Description
1	RETAINER, Float Shaft	20	COVER, Accelerating Pump, Assembly
2	FLOAT, Assembly	21	DIAPHRAGM, Accelerating Pump
3	SPRING, Float	22	SPRING, Accelerating Pump Diaphragm
4	PLATE, Baffle	23	FITTING, Fuel Inlet
11	SCREW, Lock, Fuel Valve Seat	24	GASKET, Fuel Inlet Fitting
12	GASKET, Fuel Valve Seat Screw	25	SCREEN, Filter, Fuel Inlet
13	NUT, Adjusting, Fuel Valve Seat	26	GASKET, Metering Body
14	GASKET, Fuel Valve Seat Adjusting Nut	27	VALVE, Power, Assembly
15	SEAT, Fuel Valve, Assembly	28	GASKET, Power Valve
16	"O" RING, Fuel Valve Seat	31	JETS, Main
17	PLUG, Check, Fuel Level	32	VALVE, Synthetic
18	GASKET, Fuel Level Check Plug	33	TUBE, Fuel Pump Transfer
19	SCREW, Fuel Pump Cover	34	"O" RING, Fuel Pump Transfer Tube

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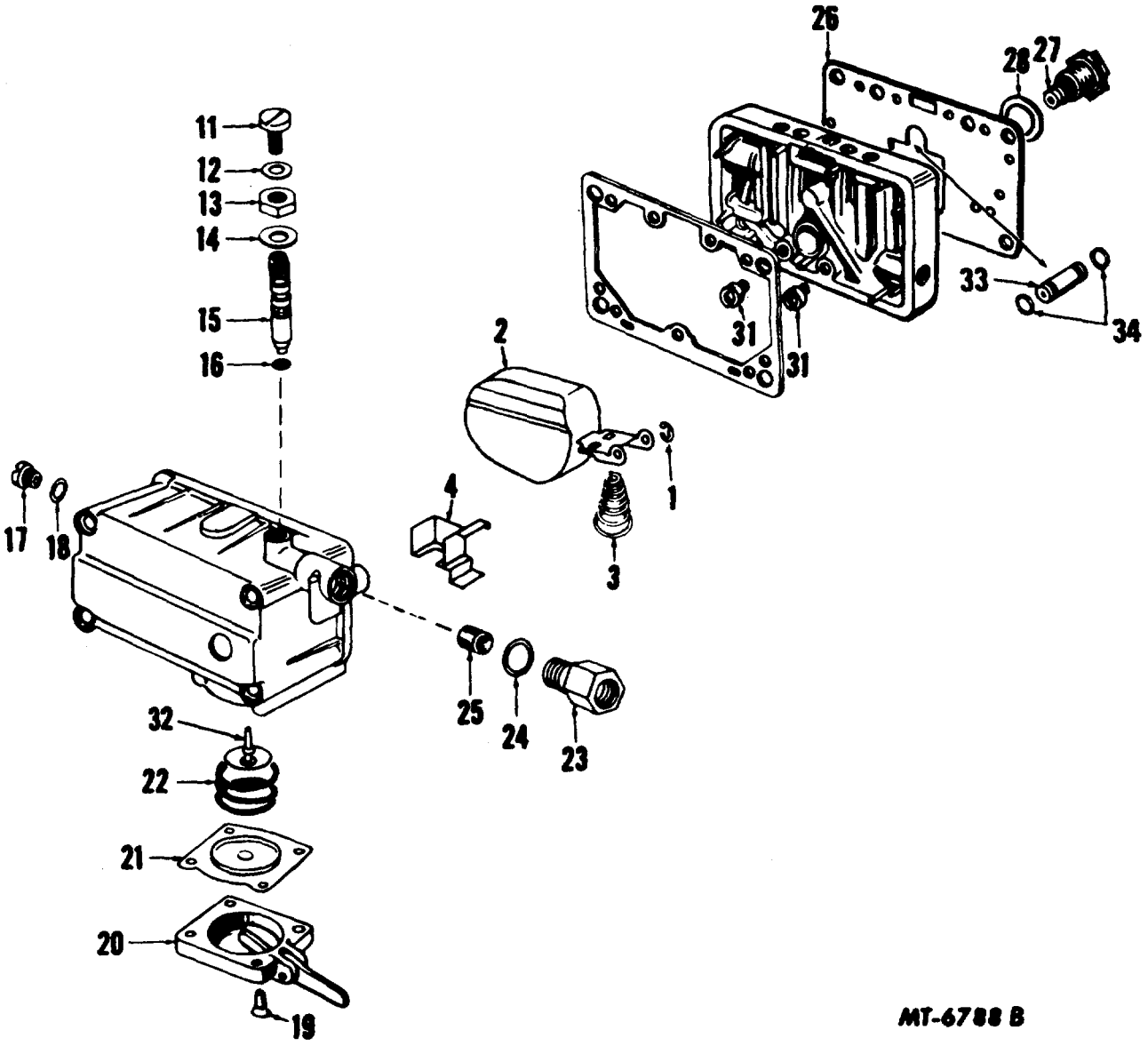


Fig. 20 Exploded View of Fuel Bowl and Metering Block

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1. Remove the float and hinge retainer (Fig. 21) and slide float and hinge assembly and float spring out of fuel bowl (Fig. 22).

2. Remove fuel inlet baffle from bowl.

3. Remove fuel inlet seat adjusting lock screw.

4. Unscrew adjustable inlet seat and needle assembly from fuel bowl. Needle and seat assembly are not to be further disassembled.

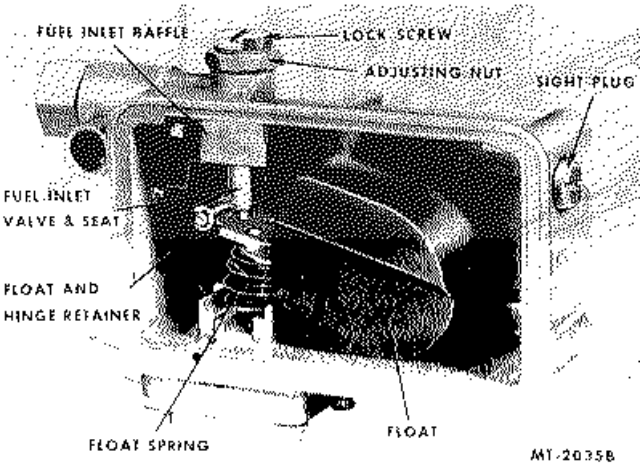


Fig. 21 Interior of Fuel Bowl

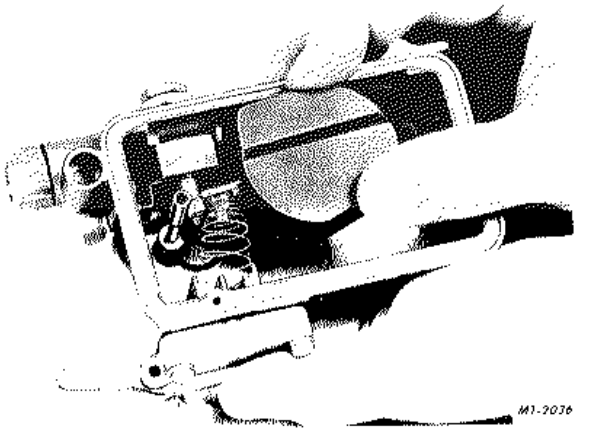


Fig. 22 Removing Float and Hinge Assembly

5. Remove the four pump diaphragm cover screws. Lift off the pump diaphragm cover, diaphragm assembly and return spring (Fig. 23). If it is necessary to remove the accelerator pump synthetic valve (where used), grasp it firmly and pull it out. If the valve tip breaks off during removal, be sure to remove the tip from the fuel bowl. Removal of the valve necessitates replacement with a new valve.

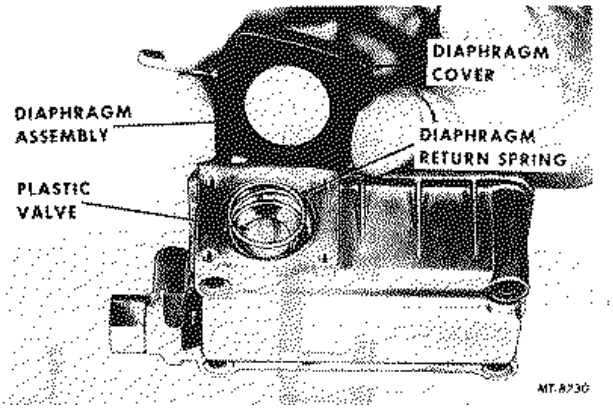


Fig. 23 Removing Pump Diaphragm and Cover

6. Use a box end wrench and remove the fuel inlet fitting and gasket. Discard gasket. Remove the filter screen assembly.

7. Remove fuel level sight plug and gasket.

8. Remove bowl vent baffle from metering body.

9. Use special tool SE-1772-6 and remove main jets from metering body (Fig. 24).

10. Using special socket SE-1772-1 remove the power valve assembly and gasket (Fig. 25). Discard gasket.

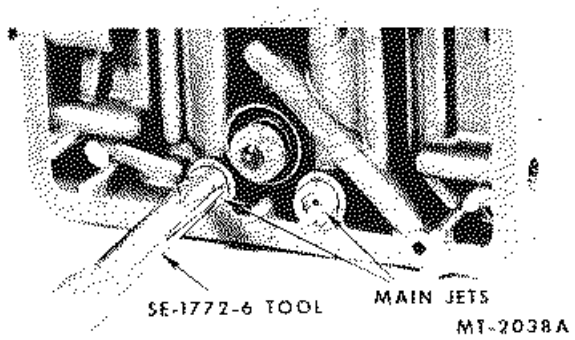


Fig. 24 Removing Main Jets

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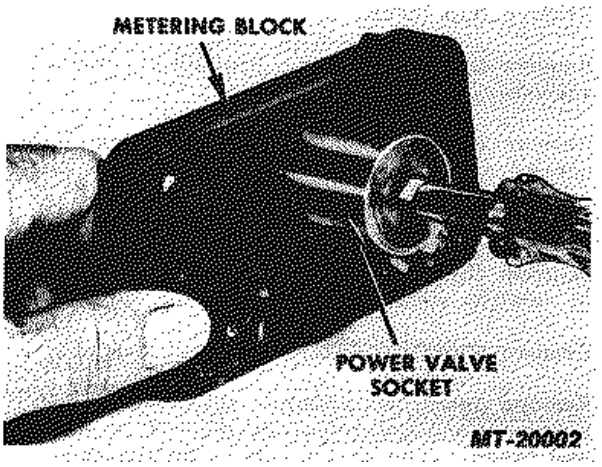


Fig. 25 Removing Power Valve

Main Body

1. Lightly scribe a mark along the choke shaft on the choke plate to insure proper positioning of choke plate during reassembly.
2. File off the staking from choke plate retaining screws to prevent damaging choke shaft threads during screw removal. Remove the two choke plate screws and slide choke plate out of choke shaft. Use new screws during reassembly.
3. Slide choke shaft out of main body. Note the choke lever override sprong on end of shaft.
4. Using cross-recess head screwdriver remove pump discharge nozzle screw (Fig. 26). Remove pump discharge nozzle and gaskets. Discard gaskets.
5. Invert main body and shake out pump discharge needle, 2300G only (Fig. 27).

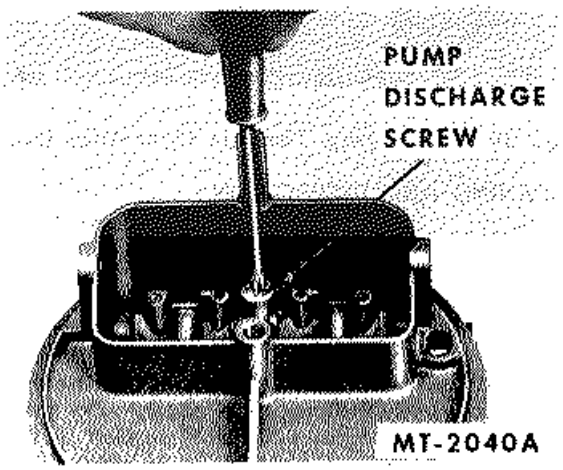


Fig. 26 Removing Pump Discharge Nozzle Screw

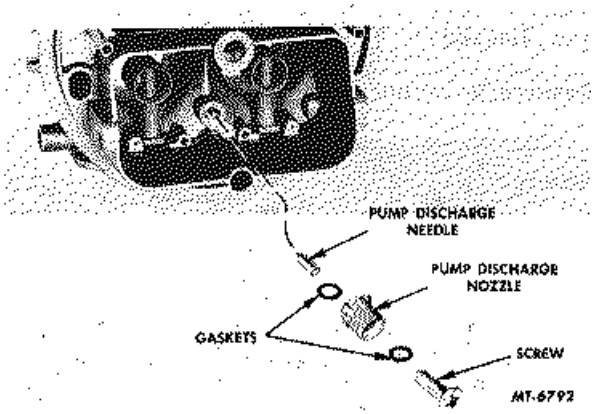


Fig. 27 Removing Pump Discharge Nozzle and Needle (2300G Only)

6. Models 2300 and 2300C use a pump discharge check ball in lieu of a needle as shown in

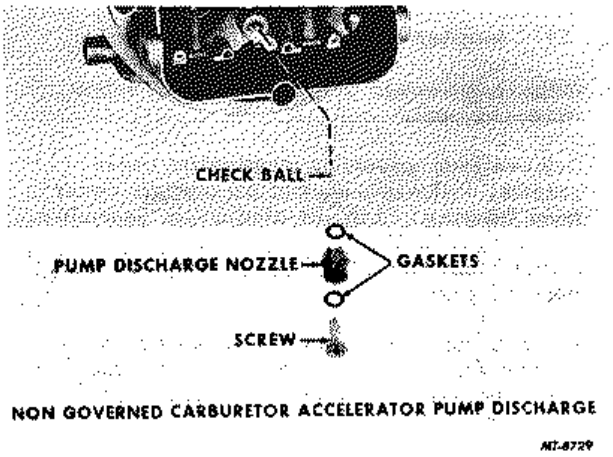


Fig. 28 Removing Pump Discharge Check Ball (2300 and 2300C Only)

Throttle Body

The disassembly of the throttle body will vary some between the governed and the nongoverned type carburetor. Since the governor type (2300G) is more detailed, the disassembly of the throttle body for that unit is described here.

1. Remove seal wire four screws, cover, gasket and governor spring.
2. Remove governor diaphragm retainer, governor lever nut and lockwasher.
3. Remove governor housing (three) screws and remove governor housing from throttle body and shaft.

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4. Remove governor body seal and gasket and discard.
5 Remove governor line fitting (Fig. 29).

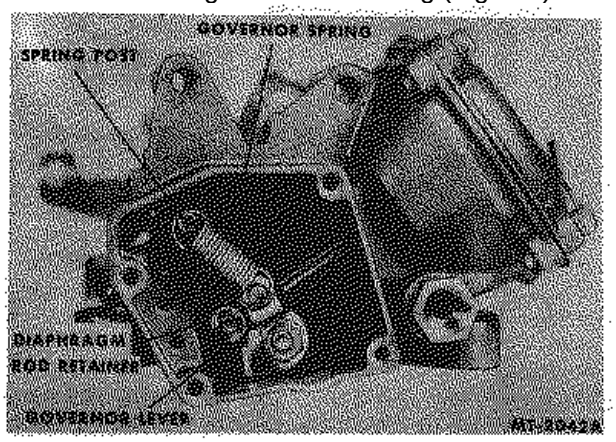


Fig. 29 Interior View of Governor Housing

6. Remove governor diaphragm cover safety wire and seal.
7. Remove four governor diaphragm cover screws, lockwashers and diaphragm cover from housing. Lift off diaphragm assembly.
8. Remove the two governor bypass jets from back of governor.
9. Remove four fuel pump cover assembly screws and remove cover. Remove the fuel pump lever retainer and slide lever off its stud.
10. Remove the two throttle operating housing screws and lift off throttle operating housing assembly. Remove complete back-up plate assembly.
11. If the pump cam must be removed use the following disassembly procedure.
12. Straighten lock tab on throttle operating shaft nut lock washer and remove nut and lock washer.
13. Hold redundant spring concentric with throttle operating shaft and remove spring drum.
14. Remove "spacer" washer.
15. Release redundant spring from long spring perch and remove redundant spring.
16. Remove catch lever bushing and pin assembly.
17. Remove trip lever.
18. Remove accelerator pump operating lever assembly retainer.
19. Remove the two throttle operating housing screws and remove housing assembly.
20. Straighten lock tabs on throttle operating driver (inside throttle operating housing). Position the flats of the throttle shaft driver in relation with the idle adjusting screw.
21 Remove operating lever and shaft assembly.
22. Remove pump cam retainer screw, noting hole position and reference number on cam and lever. The cast numbers on the cam are facing toward the throttle operating housing. Then remove cam (do not put cam in carburetor cleaner).
23. Remove the (hot engine) idle screw and spring.
24. Remove idle limiter caps, idle adjusting screws and springs. To prevent damaging screw threads and seat during cap removal, file or grind away the side of the plastic cap -do not pry off.

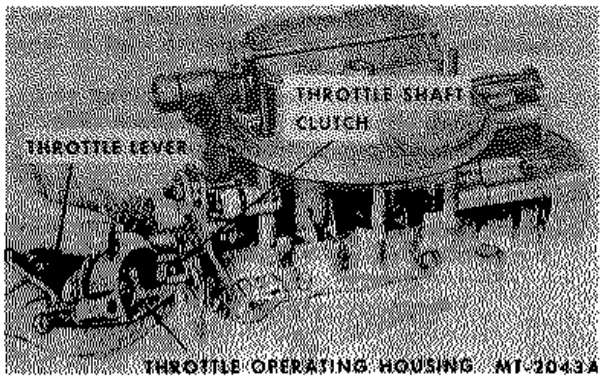


Fig. 30 Removing Throttle Operating Housing

CLEANING AND INSPECTION

Cleaning

1. Soak all parts except throttle body bushings and dashpot or throttle modulator in a standard carburetor cleaner. If a commercial solvent is not available, lacquer thinner or denatured alcohol may be used. Do not lower parts into sediment which settles to bottom of cleaning tank. Agitate parts while in solution to insure a thorough cleaning. After

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the parts have been sufficiently soaked, rinse them in hot water to remove all traces of the cleaning solution. Scrub away remaining foreign matter with a stiff brush (not wire) while rinsing parts and castings.

2. Dry all parts with compressed air. Also direct compressed air through jets, nozzles and passages in castings.
3. Always discard diaphragms. Reuse of old diaphragms may cause unsatisfactory carburetor performance.
4, Carburetor jets and passages should never be cleaned with a drill, wire or similar object. This method of cleaning will distort jets and passages. A buffing wheel, wire brush, file or other sharp instrument should not be used to remove carbon deposits, since these tools might also remove the protective plating on the carburetor parts. Parts such as "O" rings, gaskets, diaphragms and seals should never be exposed to solvent because of its deteriorating effect on them.

Inspection

1. Major Castings: Check for cracks, warpage, stripped screw threads or damaged mating surfaces. Passages in castings must be free of restrictions.
2. Float Assembly: Should be discarded if float is damaged in any way.
3. Choke Plate: Should be replaced if edges have been nicked or if protective plating has been damaged.
4. Choke Shaft: Should be replaced if bent or nicked.
5. Choke and Throttle Linkage: Discard and replace any linkages that are bent or worn.
6. Springs: Distorted or broken springs must be replaced.
7. Governor: Check for cracks or stripped threads in housing and replace if any irregularities are found.
8. Screws, Lockwashers and Nuts: If stripped threads, distortion or other damage is found in any of these parts, discard and replace.

REASSEMBLY

Throttle Body (2300G)

1. Install the two idle adjusting screws with original springs. Turn screws in very gently until they just seat, then back them off three complete turns. Do not force needle against its seat, as this will groove tip and make idle adjustment difficult.
2. Install the two governor bypass jets and governor fitting in the governor housing.
3. Slide the governor diaphragm and rod assembly into governor housing. Place cover in position and secure with four screws and lockwashers. Install new seal wire and seal.
4. Place governor lever in housing and insert small lever stud in the diaphragm rod. Secure with diaphragm rod retainer.
5. Place governor body seal on rear of governor housing and slide governor housing onto throttle shaft.
6. Insert end of throttle shaft into governor lever and install governor lever lockwasher and nut.
7. Install governor spring, one end on governor lever stud and the other on spring pin.
8. Insert fast idle pin in throttle operating housing assembly.
9. The following parts are held in place on the carburetor with the throttle operating housing screws and should be installed in this order: Position back-up plate on throttle body. Make sure that the choke rod is inserted in the choke control lever. Holding throttle plate in the closed position and throttle lever assembly against the stop, assemble throttle operating housing to throttle body.

Throttle Body (2300 and 2300C)

Assembly of the throttle body for model 2300 and 2300C carburetors will differ from the model 2300G as follows:

1. Throttle lever is integral with throttle shaft, and throttle shaft operates direct instead of through a throttle operating mechanism.
2. Choke and fast idle cam bracket mounts to main body instead of throttle body.
3. Dashpot or throttle modulator bracket mounts to base of throttle body.
4. Accelerator pump lever and shaft, which are also integral, are installed in hole on side of throttle body.

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5. Throttle stop screw and spring are mounted in the throttle lever itself.

Main Body (2300G)

1. Before installing new pump discharge needle, check its seat in main body. If seat is rough, insert old needle in seat and using a small brass rod and fiber mallet tap lightly on seat. Check to see that seat has not been damaged and discard old needle. Install new discharge needle.
2. Install new pump discharge nozzle gaskets and the discharge nozzle. Secure with pump discharge nozzle screw.
3. If choke rod was removed from main body, place choke rod seal over opening and thread choke rod through the seal.
4. Slide choke shaft with integral lever and spring assembly into main body and noting scribe marks on the choke plate install the plate on shaft. Note that upper end of choke rod engages in spring and slot in choke shaft lever. Turn the two screws through shaft and choke plate but do not tighten. Check the movement of the choke shaft and plate for binding and if none is evident, tighten screws. Stake screws by squeezing with pliers.
5. Place a new throttle body to main body gasket on the main body and assemble throttle body to the main body. Note that lower end of choke rod engages with choke lever on throttle body. Secure throttle body to main body with mounting screws.
6. Align governor housing on end of throttle body with mounting bosses on main body. Insert new gasket between governor housing and main body and install the three mounting screws.

Main Body (2300 and 2300C)

Assembly of the main body for model '2300 and 2300C carburetors will be the same as above, except that choke and fast idle cam bracket mounts to side of main body instead of throttle body. Choke lever on bracket faces to inside and engages with the choke rod. Also, a pump discharge check ball is used instead of a needle.

Fuel Bowl and Metering Body

1. Using special socket SE-1772-1 install new gasket and power valve assembly in metering body.
2. Install the two main jets using special tool SE-1772-6.
3. Install bowl vent baffle on metering body and secure in position by installing fuel bowl to metering body gasket. Be sure all punchings are removed from gasket and pump passages and gaskets align with pump passages in metering body.
4. Install fuel filter screen, fuel inlet fitting and new fuel inlet fitting gasket.
5. Lubricate the tip of a new accelerator pump synthetic valve (where used) with a small amount of petroleum jelly and insert tip into accelerator pump cavity center hole. Using a pair of needle nose pliers reach into the fuel bowl and grasp the valve tip. Pull the valve in until it seats in the pump cavity wall and cut off the tip at the retaining shoulder.
6. Where used, check accelerator pump inlet check ball travel (Fig. 31). Clearance between ball and retainer bar is specified at .011 to .017" Best operation can be expected with clearance set at low end of specifications (.011"-.014").

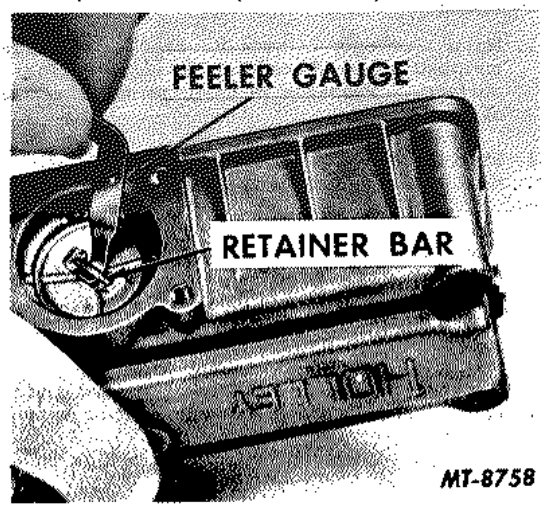


Fig. 31 Checking Accelerator Pump Inlet Check Ball Clearance (Not Used on All Carb.)

Adjustment is made by bending retainer bar. If adjustment is necessary, extreme care must be taken to prevent possible damage to ball and/or seat.

It is emphasized that the check ball setting mentioned above is a critical item in obtaining instant pump response to throttle movement. Ball travel in excess of .017" can easily cause a lag in fuel injection with consequent engine falter during throttle opening.

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7. Position pump diaphragm spring in recess and install diaphragm assembly. Note that the flat rivet head faces up. Place pump diaphragm cover in position making sure the holes are aligned. Install the four screws and lock washers. Tighten them alternately to evenly compress the diaphragm.
8. Obtain new "O" ring and using petroleum jelly as a lubricant slide "O" ring into groove on needle and seat assembly Install assembly in fuel bowl. Always use new gasket between adjusting nut and fuel bowl and also between lock screw and adjusting nut.
9. Insert fuel inlet baffle in bowl over needle and seat assembly.
10. Place conical spring on locator of float lever and slide the float with the spring onto shaft in fuel bowl. Secure with retainer.
11. The float is made of cellular plastic material; its buoyancy is unaffected by leaks (sometimes experienced with hollow floats) or absorption. While the final fuel filter adjustment is made with the carburetor installed on the engine, a bench adjustment can be made before installing bowl as follows:
    a. Loosen lock screw enough to allow adjusting nut to be turned.
    b. With fuel bowl inverted turn adjusting nut until float lever is parallel with floor of bowl (Fig. 32). Tighten lock screw. Fig. 32 Bench Adjustment of Fuel Bowl Float

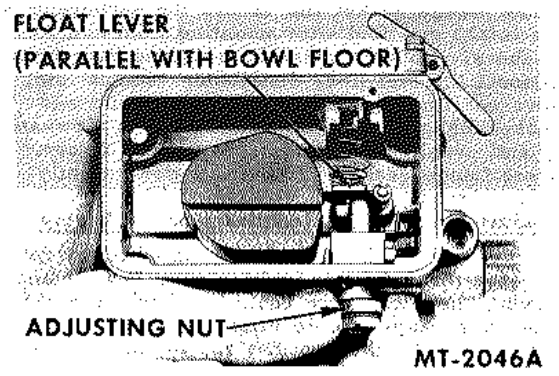


Fig. 32 Bench Adjustment of Fuel Bowl Float

12. Install fuel bowl screw gaskets on fuel bowl screws. This will prevent threads from shaving off gasket particles into fuel bowl.
13. Position metering body gasket (see Fig. 33) on the dowels on the back of the metering body. Place metering body baffle on locating studs and assemble fuel bowl gasket MT-20194

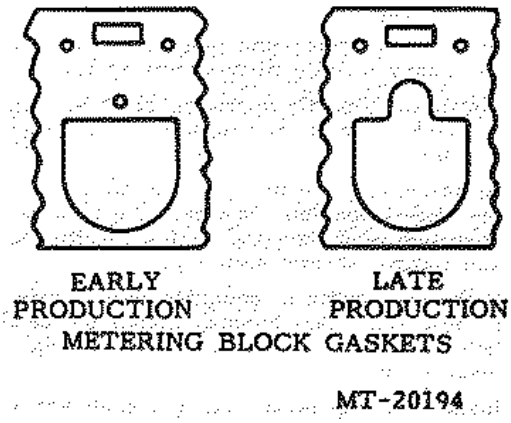


Fig. 33 Both Metering Body Gaskets are Furnished in Carburetor Rebuild Kits

making sure the pump passage in the gasket is aligned with the pump passage in the metering body. Assemble metering body on main body and fuel bowl on metering body. Insert four fuel bowl screws and tighten securely.

14. When positioning fuel bowl the accelerating pump lever must be slightly depressed to clear the diaphragm pump lever. When spring loaded bowl screws are used the following procedure should be used.
    Tighten each spring loaded bowl screw by rotating screw head until screw assembly bottoms in main body. Bottoming of screw assembly is accomplished when screw head "springs back" about one quarter (1/4) turn when screw driver is removed from slot. Excessive rotation of screw head can destroy spring.

Throttle Operating Housing

If the throttle operating housing was disassembled, use the following for reassembly. Refer to Fig. 17 for the correct location of the parts.

1. Install the engine (HOT) idle screw and spring in the throttle operating housing. Turn screw in until spring tension is felt.
2. Install the purr' cam retainer screw noting hole position and reference number on cam and lever. The cast number on the cam should face toward the throttle operating housing. Then install the cam and screw.
3. Install the operating lever and shaft assembly. Position the flats of the throttle shaft driver in relation with the hot idle adjusting screw.

4. Bend locking tabs on throttle shaft driver lock washer.
5. Install the accelerating pump lever and the secondary throttle plate operating lever.
6. Install two throttle operating shaft housing assembly screws in throttle operating shaft housing.
7. While holding the primary throttle plate in the closed position, assemble the throttle operating shaft housing on the throttle body and tighten screws securely.
8. If the carburetor is equipped with a safety throttle redundant spring, install the catch lever assembly on the throttle operating lever shaft.
9. Install the trip lever over the shaft redundant spring perch.
10. Install throttle operating shaft spacer on throttle operating shaft.
11. Install the curved end of the redundant spring on the short spring perch.
12. Install the short straight end of the redundant spring on the long spring perch.
13. Holding the redundant spring concentric with the throttle operating shaft, install the redundant spring bushing.
14. Install the throttle operating shaft nut lock washer on the throttle operating shaft.
15. Install the throttle operating shaft nut, tighten securely, and bend tab on lock washer to retain nut.

INSTALLATION AND ADJUSTMENTS

Off Engine Fast Idle Adjustment (1975 through 1978 Vehicles)

As part of a complete carburetor overhaul, the fast idle adjustment can be performed before installing the carburetor on the engine. This is done as follows:

1. After carburetor is completely assembled open throttle with throttle leak; this will allow the choke plate to be closed.
2. Invert carburetor. Insert gauge (from gauge set SE-2425 or drill of same diameter, using throttle plate clearance chart) upstream between throttle plate and throttle body bore (Fig. 34).
3. With the gauge or drill held between the primary throttle plate and bore (see Fig. 34) adjust fast idle screw until it touches the cam lightly.
4. After carburetor is installed on the engine, warm engine, connect tachometer and check fast idle reading against specifications

.

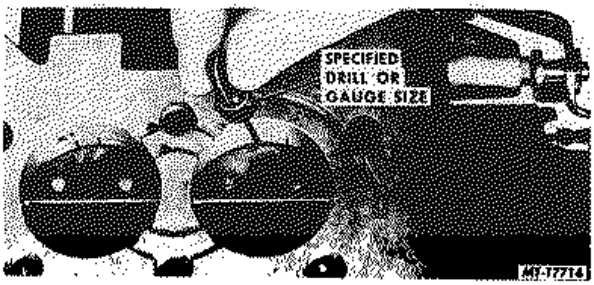


Fig. 34 Checking Throttle Plate Clearance

Throttle Plate Clearance
(Gauge or Drill Size)

Engine	Federal	California
V-304	030	
V-345	030	034
MV-404	055	055
V-537	055	055

This off-engine fast idle speed setting provides good engine operation in cold ambient temperatures.

Installing Carburetor on Engine

Always make a thorough inspection of the carburetor before installing on the engine. Operate the choke and throttle levers to be sure choke and throttle plates function properly. Make sure unit is clean and undamaged in any way. Mating surface of intake manifold must also be clean and free of burrs or damage. Use a new flange gasket and secure the carburetor to the intake manifold with mounting nuts and lock washers. Do not tighten nuts all the way down. Connect the fuel line, distributor vacuum line, governor lines (where used) and throttle and choke linkage. Tighten mounting nuts alternately and evenly in a crisscross pattern to compress flange gasket. Draw nuts down tightly.

Loading the Throttle Redundant Safety Spring

Loading the linkage is accomplished by rotating the throttle lever to wide open throttle and moving the accelerator control rod to the right. Then attach the throttle return spring to the trip lever Secure the opposite end of throttle return spring (see Fig. 3).

CAUTION

Whenever throttle return spring is disconnected at either end, the throttle linkage at the carburetor will snap to the closed position with a spring force sufficient to cause possible personal injury.

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On Engine Fast Idle Adjustment (1975 through 1978 Vehicles)

When adjusting the fast idle speed with carburetor on engine, use the following procedure:

1. Warm up engine to operating temperature.
2. Shut off engine, remove air cleaner and connect tachometer.
3. Remove idle stop screw and spring (Fig. 35) and then reinstall screw. Depress accelerator pedal to floor. Close choke plate and release accelerator pedal.
4. Turn idle screw in until light contact is made with internal stop.
5. Open choke and start engine. Observe engine speed and compare with fast idle speed shown on specification chart provided. If a change is required proceed in the following manner.
6. With engine still running, record the number of turns of the idle speed screw adjustment required to increase or decrease RPM to specified setting (see Fig. 35).
7. Before shutting off engine, back out idle speed screw to prevent engine run-on or dieseling (See Fig. 35). Then shut off engine.
8. Depress accelerator pedal to floor. Close choke and release accelerator pedal, then reset idle screw until lightly contacting internal stop. Turn idle screw in or out the additional number of turns recorded in Step 6.
9. Now adjust fast idle adjusting screw until it just touches the fast idle cam (see Fig. 35).

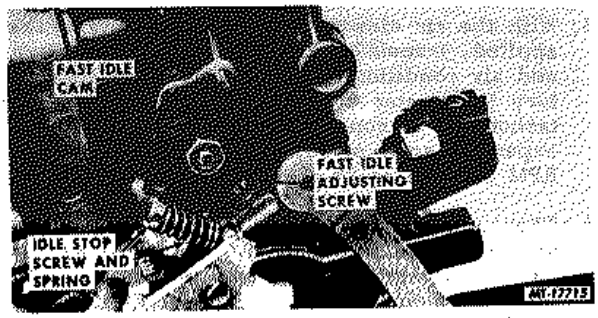


Fig. 35 Fast Idle Adjustment

Fast Idle Setting RPM

Engine	Federal	California
V-304	2200	----
V-345	2200	2000
MV-404	2400	2400
V-537	2000	2000

10. Open choke and start engine; observe tachometer. Engine should be at proper fast idle speed setting.
11. To prevent engine from dieseling back off idle adjustment screw. Shut down engine.
12. Reinstall idle screw and spring.
13. Reinstall air cleaner; reset proper curb idle speed (See SPECIFICATIONS).

Fast Idle (2300G 1969 thru 1974)

1. Adjust fast idle stud so as to have .018" to .020" clearance between stud and fast idle cam when throttle plates are set for curb idle and choke plate is fully open.
2. This adjustment must be set before adjusting the idle mixture adjusting screws.

Fast Idle (2300 and 2300C)

1. Set throttle lever stop screw so that screw just touches fast idle cam at curb idle.
2. This adjustment must be set before adjusting the idle mixture adjusting screws.

Idle Speed and Fuel Mixture Adjustment--After Unit Rebuild. Light-Duty (Under 6000 Lbs. GVW) Exhaust Emission Controlled Engines.

Idle speed and fuel mixture settings must be made with the engine at normal operating temperature, parking brake applied, choke open, air cleaner on, air conditioning on and transmission in neutral.

1. Connect a satisfactory tachometer to the engine. A satisfactory tachometer is considered to be one with an expanded scale of 400 to 800 or 0 to 1000 RPM and a 1 to 2% accuracy scale.
2. If idle mixture screw was not initially adjusted after unit rebuild, turn screw in very gently against seat, then back out specified number of turns (see SPECIFICATIONS for initial setting). Turning the idle mixture screw tight against its seat can cause severe damage to screw tip and seat.
3. Attach a vacuum gauge to engine.
4. Thoroughly warm up engine and adjust engine idle to specified speed (See SPECIFICATIONS).
5. Turn mixture screws in to obtain "lean best idle" at the specified idle speed (see SPECIFICATIONS). "Lean best idle" is the point at which intake manifold vacuum starts to drop due to leanness.
6. Install colored (service) plastic cap with tab fully counterclockwise against tab stop.

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7. Adjust idle. speed to specifications.
8. Turn idle mixture screw in (clockwise), to reduce engine speed to specified RPM. The resulting idle air/fuel ratio is optimum for exhaust emission control. To compensate for fuel and temperature variations when setting idle mixture:
   a. Do not idle for more than three minutes at one time.
   b. Increase engine speed to 2000 RPM for one minute.
   c. Continue with idle set procedure. Do not idle for more than three minutes without repeating step "b."
9. If idle speed with automatic transmission in drive range is not as shown in specifications after above adjustments have been made, readjust throttle setting to specified RPM.

Idle Speed and Fuel Mixture Adjustment--Unit Not Rebuilt. Light-Duty (Under 6000 Lbs. GVW) Exhaust Emission Controlled Engines.

Idle speed and fuel mixture settings must be made with the engine at normal operating temperature, parking brake applied, choke open, air cleaner on, air conditioning on and transmission in neutral.

1. Connect a satisfactory tachometer to the engine. A satisfactory tachometer is considered to be one with an expanded scale of 400 to 800 or 0 to 1000 RPM and a 1 to 2% accuracy scale.
2. Turn idle mixture screws out (counterclockwise) -against tab stop.
3. Attach a vacuum gauge to engine.
4. Thoroughly warm up engine and adjust idle speed to specifications.
5. Turn idle mixture screws in (clockwise) to reduce engine speed to specified RPM. The resulting idle air/fuel ratio is optimum for exhaust emission control.
6. Removal of the idle limiter cap may be necessary if either a sufficiently rich or lean idle mixture cannot be obtained. A vacuum gauge is required for the following procedure.
   a. To prevent damaging screw threads and seat during cap removal, file or grind away the side of the plastic cap -do not pry off.
   b. Turn mixture screws in to obtain "lean best idle" at the specified idle speed (see SPECIFICATIONS). "Lean best idle" is the point at which intake manifold vacuum starts to drop due to leanness.
   c. Install colored (service) plastic cap with tab fully counterclockwise against tap stop.
   d. Adjust engine idle per Steps 4 and 5 to obtain recommended setting for optimum exhaust emission control.

To compensate for fuel and temperature variations when setting idle mixture:

   a. Do not idle for more than three minutes at one time.
   b. Increase engine speed to 2000 RPM for one minute.
   c. Continue with idle set procedure. Do not idle for more than three minutes without repeating step "b".

7. If idle speed with automatic transmission in drive range is not as shown in specifications after above adjustments have been made, readjust throttle setting to specified RPM.

Idle Speed and Fuel Mixture Adjustment--After Unit Rebuild. Heavy-Duty (Over 6000 Lbs. GVW) Exhaust Emission Controlled Engines.

A. Combustion Analyzer Procedure

1. With the air cleaner installed, parking brake applied, transmission in neutral, choke open and air conditioning off, connect a satisfactory tachometer to the engine. A satisfactory tachometer is considered to be one with an expanded scale of 400 to 800 or 1 to 1000 RPM and a 1 to 2% accuracy scale.
2. Thoroughly warm up engine prior to making any final idle adjustments. Since the exhaust analyzer also requires temperature stabilization, operate the engine for a minimum of 15 minutes at high idle speed with the sample probe installed in tailpipe to circulate exhaust gas to the analyzer cell.

   During the warm-up period the ignition timing should be checked and set to specifications if necessary (vacuum advance line disconnected).

   During the following procedure, reestablish a hot idle condition at least every 3 minutes by operating the engine briefly at 2000 RPM.

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3. After 15 minutes of stabilization, calibrate combustion analyzer per equipment manufacturer's instructions. This will normally require removing the probe from the tailpipe.
   Reinstall exhaust sample probe approximately 2 feet into tailpipe immediately after calibrating the analyzer.
4. Using a vacuum gauge set idle speed to specification and adjust idle mixture screws to obtain best idle (maximum vacuum). This should be done with the normal accessory loads (i.e., headlights on high beam). Maintain a balanced mixture screw adjustment unless a rough idle condition requires otherwise.
5. Observe air/fuel ratio and adjust idle screws in 1/16 turn increments until specified air/fuel ratio is obtained (see SPECIFICATIONS).
   Wait 20 seconds for analyzer response and check for corresponding decrease in air/fuel ratio. This assures correct analyzer response to subsequent leaner adjustment. If combustion analyzer does not respond to changes in mixture quality, check for sample line leaks, restrictions and/or improper procedure in the assembly and installation of sample system. Thermal conductivity instruments are both temperature and pressure sensitive, demanding a definite sample flow rate. A high velocity exhaust evacuation system can cause a reduced sample flow rate to the instrument and/or dilution of the exhaust sample entering the probe, resulting in erroneous readings (refer to equipment manufacturer's instructions).
6. Reset idle speed if necessary and readjust mixture screws to provide specified air/fuel ratio at recommended idle speed.
7. Check combustion analyzer calibration. If calibration is required, repeat Steps 5 and 6.
8. Install colored (service) plastic caps with tabs fully counterclockwise against stops.

B. Combustion Analyzer Not Available

If combustion analyzer is not available, the following procedure should be used to establish the recommended idle setting:

1. Produce a hot engine idle condition and adjust idle speed to specification with the normal accessory loads.
2. Adjust idle mixture screws to obtain "lean best idle" -the point at which intake manifold vacuum starts to drop due to leanness.
3. Readjust idle speed to specifications.
4. Adjust mixture screws lean to reduce engine speed to specified RPM The resulting air/ fuel ratio is comparable to that achieved with the use of a combustion analyzer.
5. Install colored (service) plastic caps with tabs fully counterclockwise against stops.

If an unsatisfactory idle condition prevails after completing the above idle set procedures, a recheck of ignition system components, timing advance, crankcase ventilation valve operation and induction system should be made.

Idle Speed and Fuel Mixture Adjustments If Unit Is Not Rebuilt

A. Combustion Analyzer Procedure

1. Thoroughly warm up engine prior to making any final idle adjustments. Since the exhaust analyzer also requires temperature stabilization, operate the engine for a minimum of 15 minutes at high idle speed with the sample probe installed in tailpipe to circulate exhaust gas to the analyzer cell.
   During the warm-up period, the ignition timing should be checked and set to specifications if necessary (vacuum advance line disconnected).
   During the following procedure reestablish a hot idle condition at least every 3 minutes by operating the engine briefly at 2000 RPM.
2. After 15 minutes of stabilization, calibrate the combustion analyzer per equipment manufacturer's instruction. This will normally require removing the probe from the tailpipe. Reinstall exhaust sample probe approximately 2 feet into tailpipe immediately after calibrating the analyzer.
3. Set idle speed to specification and adjust idle mixture screws to obtain best idle (maximum vacuum). This should be done with the normal accessory loads (i.e., headlights on high beam). Maintain a balanced mixture screw adjustment unless a rough idle condition requires otherwise.
4. Observe air/fuel ratio. If mixture screws are not already fully counterclockwise with plastic limiter caps against stops, adjust 1/8 turn out to increase richness. Wait 20 seconds for analyzer response and check for corresponding decrease in air/fuel ratio. This assures correct analyzer response to subsequent leaner adjustment.

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If mixture screws were stop limited, the above check can be made by partially closing the choke plate to cause mixture enrichment. The air/fuel ratio may increase if the fast idle cam causes engine speed to increase.

If combustion analyzer does not respond to change in mixture quality, check for sample line leaks, restrictions and/or improper procedure in the assembly and installation of sample system. Thermal conductivity instruments are both temperature and pressure sensitive, demanding a definite sample flow rate. A high velocity exhaust evacuation system can cause a reduced sample flow rate to the instrument and/or dilution of the exhaust sample entering the probe, resulting in erroneous readings (refer to equipment manufacturer's instructions).

5. Adjust idle mixture screws in (clockwise) 1/16 turn increments to obtain specified air/ fuel ratio (see SPECIFICATIONS).
6. Reset idle speed if necessary and readjust mixture screws to provide the specified air/ fuel ratio at recommended idle speed.
7. Check combustion analyzer calibration. If calibration is required, repeat Steps 5 and 6.
8. If the idle mixture cannot be enriched or leaned sufficiently to obtain the specified air/ fuel ratio, it will be necessary to remove the idle limiter caps from the mixture screws.

   To prevent damaging screw threads and seat during cap removal, file or grind away the side of the plastic caps -do not pry off; In some cases it may be necessary to remove the carburetor from engine to remove limiter caps.

   After specified air/fuel ratio is obtained, install idle limiter caps with tabs counter-clockwise against stops. Recheck air/fuel ratio.

B. Combustion Analyzer Not Available

If a combustion analyzer is not available, the following procedure should be used to establish the recommended idle setting:

1. Turn idle mixture screws out (counter-clockwise) against stops.
2. Produce hot engine idle condition and adjust idle speed to specification with the normal accessory loads.
3. Adjust idle mixture screws to obtain "lean best idle" -the point at which intake manifold vacuum starts to drop due to leanness.
4. Readjust idle speed screw to specifications.
5. Adjust mixture screws lean to reduce engine speed to specified RPM. The resulting air/ fuel ratio is comparable to that achieved with the use of a combustion analyzer. Removal of idle limiter caps may be necessary if either a sufficiently rich or lean idle mixture cannot be obtained. To prevent damaging screw threads and seat during removal, file or grind away the side of the plastic caps --do not pry off. In some cases it may be necessary to remove the carburetor from engine to remover limiter caps.

If an unsatisfactory idle condition prevails after completing the above idle set procedures, a recheck of ignition system components, timing advance, crankcase ventilation valve operation and induction system should be made.

Dashpot

With engine temperature normalized and engine operating at specified curb idle speed, depress dashpot plunger and measure distance between plunger and throttle lever (see SPECIIFICATIONS). The shank of a new drill may be used to check this adjustment.

To adjust the setting, loosen locknut and screw the dashpot in or out as required. When the desired setting is obtained, tighten locknut on dashpot against the bracket. Recheck idle speed.

Throttle Modulator

With vacuum applied to throttle modulator loosen locknut and adjust modulator until engine operates at specified RPM (See SPECIFICA-TIONS).

Fuel Level

1. Check fuel pump pressure before changing fuel level.
2. With ignition off and air cleaner removed remove the fuel bowl lower mounting screw (screw farthest from fuel inlet).
3. Drain gasoline into a shallow pan to purge bowl of possible dirt.

CAUTION

Avoid gasoline spillage and guard against fire hazard at all times.

4. Reinstall bowl screw.

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5. Start engine and with engine running remove the sight plug from bowl (Fig. 36). The fuel level should be on line with the threads at bottom of sight plug hole.

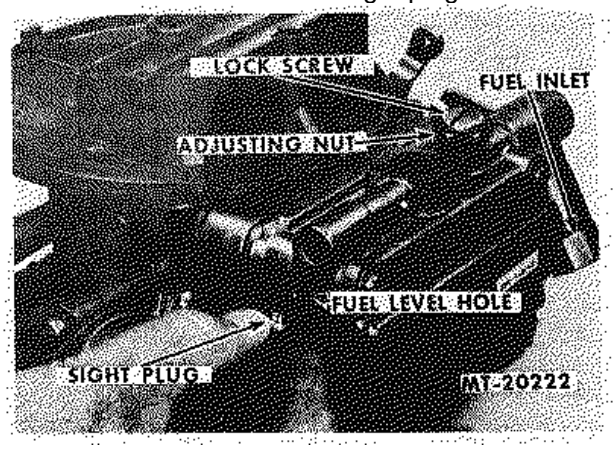


Fig. 36 Removing Fuel Level Sight Plug from Fuel Bowl

6. To adjust fuel level, loosen the lock screw slightly with a screwdriver and turn the adjusting nut with a 5/8" wrench, Turn nut clockwise to lower fuel level and counterclockwise to raise fuel level (Fig. 37).

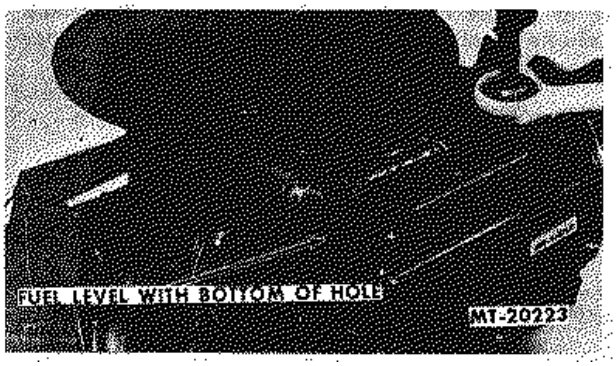


Fig. 37 Adjusting Fuel Level

7 Tighten lock screw.

8. Operate engine until fuel level is stabilized, then recheck level at sight plug. Repeat fuel level adjustment until proper fuel level is attained.

Pump Discharge

The adjustment which regulates the accelerator pump discharge is located at the override spring on the accelerator pump lever (Fig. 38).

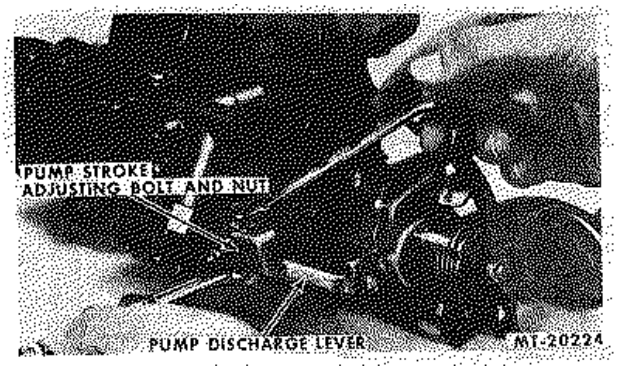


Fig. 38 Making Pump Discharge Adjustment

With choke wide open and throttle set for curb idle, lengthen or shorten adjusting bolt until the bolt touches the diaphragm lever and takes up the linkage slack. Then lengthen the adjusting bolt 1/2 turn.

Governor Adjustment

The procedure outlined below should be followed when making a governor spinner adjustment. It is necessary to use a tachometer to adjust engine RPM.

Adjust the governor spinner so that engine speed will cut off within the engine no load cutoff range (see SPECIFICATIONS).

1. Turn off ignition. Engine must be completely stopped.
2. Remove governor clamp and gasket assembly.
3. Turn engine over until adjusting screw hole plug appears in the opening.
4. Remove plug with 1/8" Allen Wrench (Fig. 39).

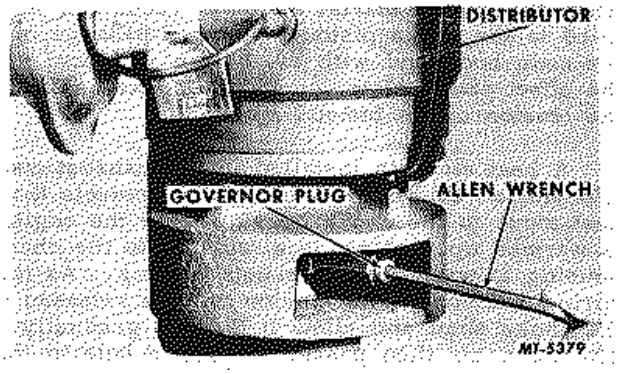


Fig. 39 Using Allen Wrench to Remove Governor Plug

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5. Insert slotted end of SE-2072-2 governor adjusting tool firmly in hole, engaging adjusting tank (Fig. 40). Turn the handle clockwise to decrease speed and counterclockwise to increase speed; 1/4 turn will change the speed approximately 100 RPM.

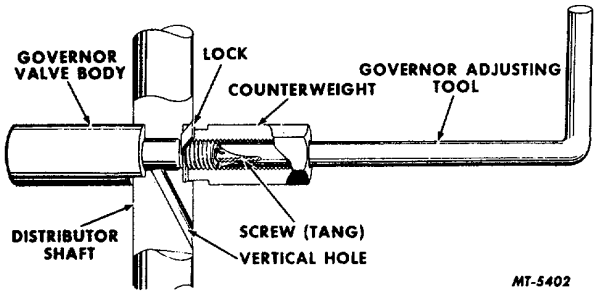


Fig. 40 Adjusting Governor Using Tool SE-2072-2

6. The adjusting screw is of a special design. The spinner cannot be adjusted with a screwdriver or by any device other than this tool.
7. Reinstall plug with 1/8" Allen Wrench before checking governor speed.
8. Reinstall governor clamp and gasket assembly.
9. Reinstall governor seal.
10. On distributors so equipped, be sure the governor spinner valve air cleaner is cleaned or replaced at regular intervals depending on severity of operation.

AUTOMATIC CHOKE

The automatic choke assembly consists of a bimetallic thermostat spring and vacuum piston. The automatic choke assembly is mounted on the carburetor main body. A passage through the main body connects the vacuum system to the manifold area. When the engine is cold, the bimetal spring closes the choke plate for starting. When the engine starts, manifold vacuum is applied to the choke piston through a passage in the main body and with the help of air flow on the offset choke plate, opens the choke against the tension of the bimetal spring.

A heat stove is installed in the exhaust manifold and an asbestos-covered tube connects the heat stove to the choke housing. As the engine is warmed up, hot air is circulated to the choke housing to warm up the bimetal spring. As the spring warms up, its tension will be released on the choke shaft and allow it to open gradually. The warm air then passes through a hole in the choke piston and down the passage in the main body to the manifold vacuum passage.

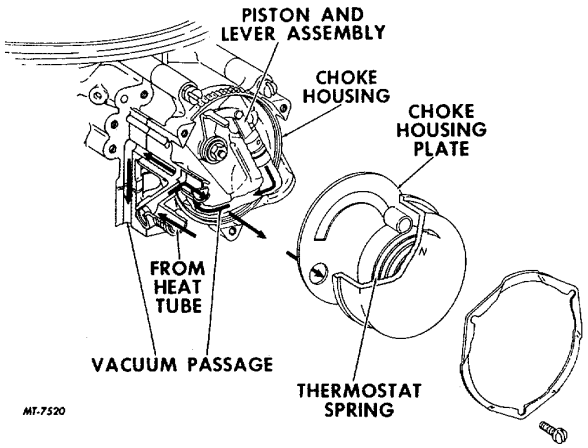


Fig. 41 Automatic Choke Assembly

A choke lever is provided on the side of the carburetor which actuates a fast idle cam during choking. The fast idle cam has a series of stops on one side which are designed to increase the engine idle RPM for smoother running when the engine is cold. As the engine is warmed up and the choke opens, each step on the fast idle cam permits the engine to run at a slower RPM.

An adjustable piston stop screw controls the / initial travel of the choke piston. The piston, in turn, controls the initial opening of the choke plate or choke qualifying dimensions. To check the choke qualifying dimension, follow the procedure outlined below:

1. Bend a paper clip as shown in insert in Fig. 42.
2. Place bent end of clip on top of piston and depress piston until it bottoms on stop screw (Fig. 42).

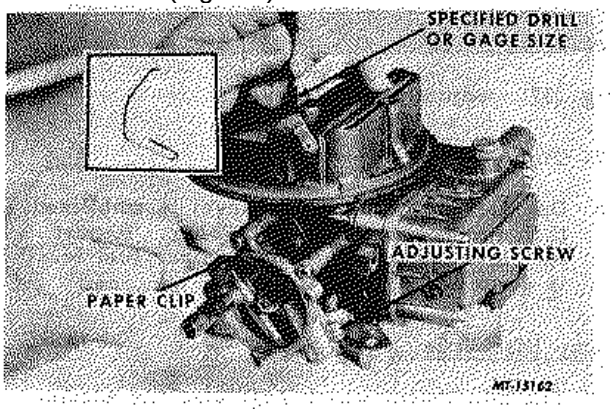


Fig. 42 Checking Choke Qualifying Dimension

3. Rotate choke lever tang counterclockwise until choke piston link touches top of piston (Fig. 42).

4. Measure clearance on lower edge of choke plate at inner wall of air horn. See SPECIFICATIONS for correct setting.

5. Adjust clearance by moving adjusting screw in or out.

6. After adjustment has been established, seal off head of adjusting screw with sealing compound.

A small unloader lever is provided on the throttle shaft which will manually open the choke plate when the throttle lever is at the wide open position. This permits the operator to relieve an over choke condition. To overcome a flooded condition, hold accelerator to floor (do not pump accelerator until engine starts).

Service of the automatic choke carburetor is identical to the hand choke model with the following exceptions:

The choke cover should not be immersed in carburetor cleaner. It can be rinsed in solvent or fuel and carefully blown out. The bimetal spring should not be bent, stretched or tampered with.

New gaskets must be installed between the carburetor body and choke housing.

If for some reason a richer or leaner mixture during the warmup period is desired, it can be obtained by rotating the thermostat cover. Never set the index mark on the cover more than two graduations off the specified settings.

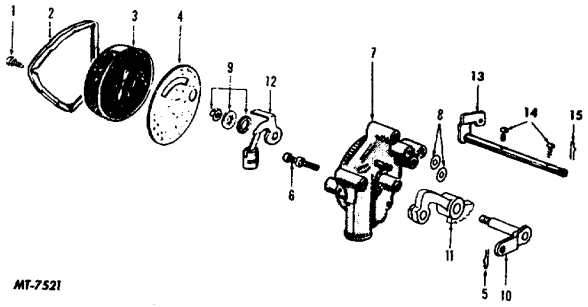


Fig. 43 Exploded View of Automatic Choke Assembly

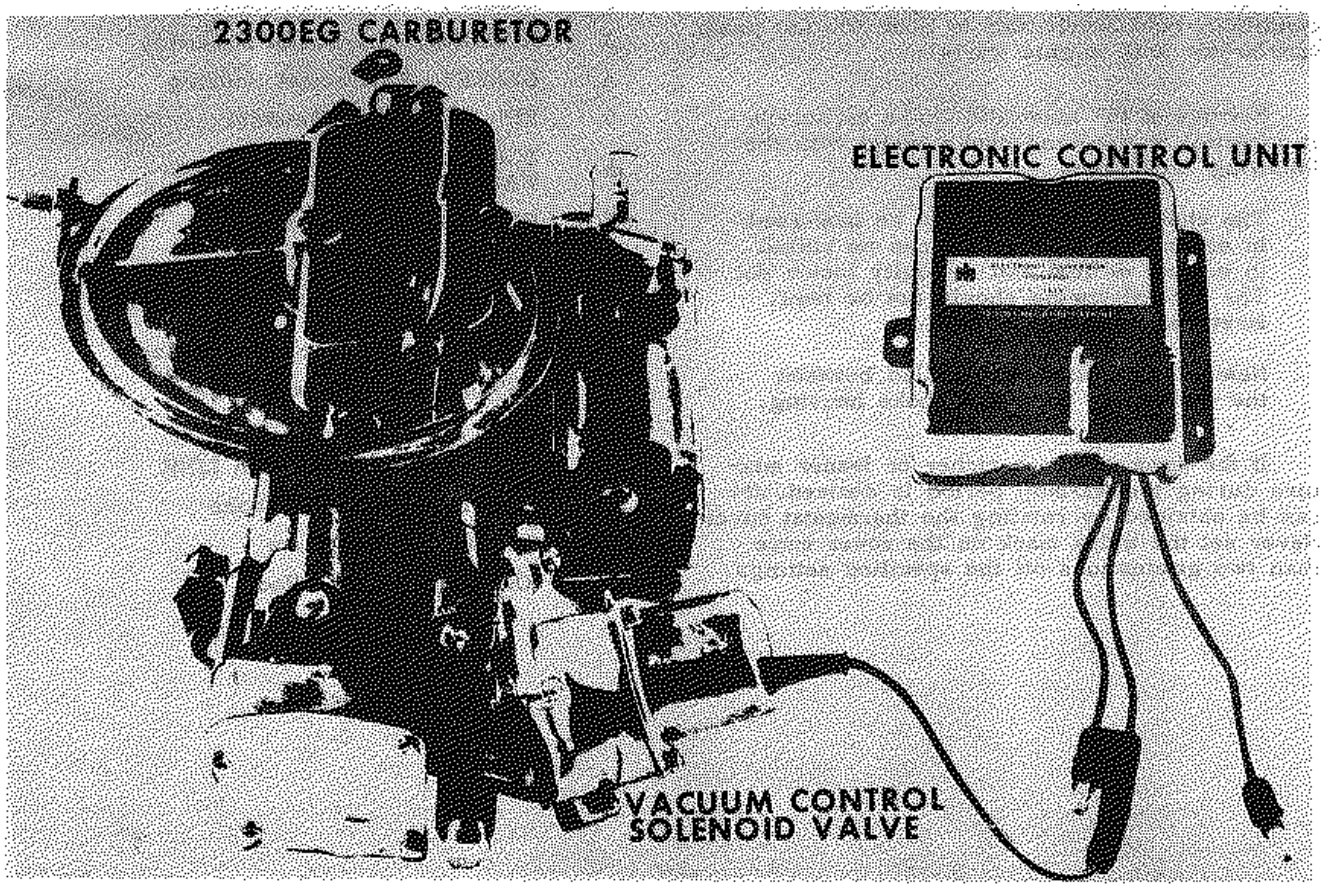
Legend for Fig. 43

Key	Description
1	SCREW, Fil. Hd. No. 8NC x 7/16
2	CLAMP, Thermostat Housing
3	HOUSING, Thermostat Assembly
4	GASKET, Thermostat Housing
5	PIN, Choke Rod Retainer
6	SCREW, Choke Housing WASHER, Lock, Choke Housing
7	HOUSING, Choke Assembly
8	GASKET, Choke Housing WASHER, Lock, Internal Tooth (#8)
9	NUT, Choke Shaft SPACER, Choke Thermostat Lever
10	ASSEMBLY, Shaft and Lever
11	CAM, Fast Idle
12	LEVER, Thermostat with LINK
13	SHAFT, Carburetor Choke
14	SCREWS, Choke Plate
15	RETAINER, Choke Rod

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ELECTRONIC VACUUM MODULATING GOVERNOR SYSTEM

OPERATION AND TROUBLESHOOTING



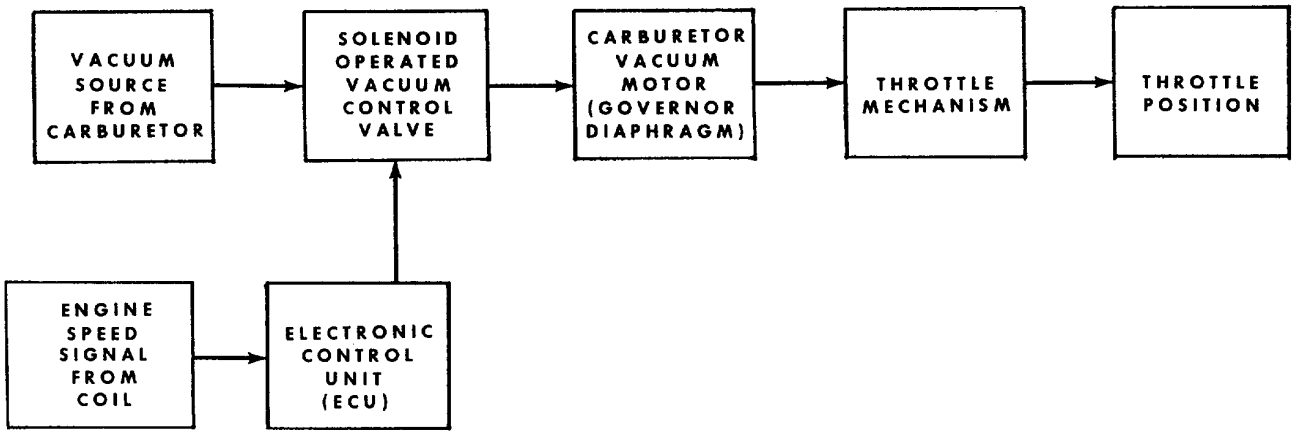
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ELECTRONIC VACUUM MODULATING GOVERNOR SYSTEM (EVM)

The electronic vacuum modulating governor system consists of a remote mounted electronic control unit (ECU), a three-way solenoid vacuum valve and a vacuum diaphragm attached to the carburetor throttle plates. The solenoid vacuum valve and vacuum diaphragm are an integral part of the carburetor. The ECU receives the engine speed signal from the negative side of the ignition coil. This engine speed signal switches the ECU (when governed engine speed is reached) to allow current to flow through the solenoid vacuum valve. The solenoid vacuum valve provides correct governor vacuum to the vacuum diaphragm. The vacuum diaphragm acting against the governor spring thereby controls the throttle position to regulate engine speed.

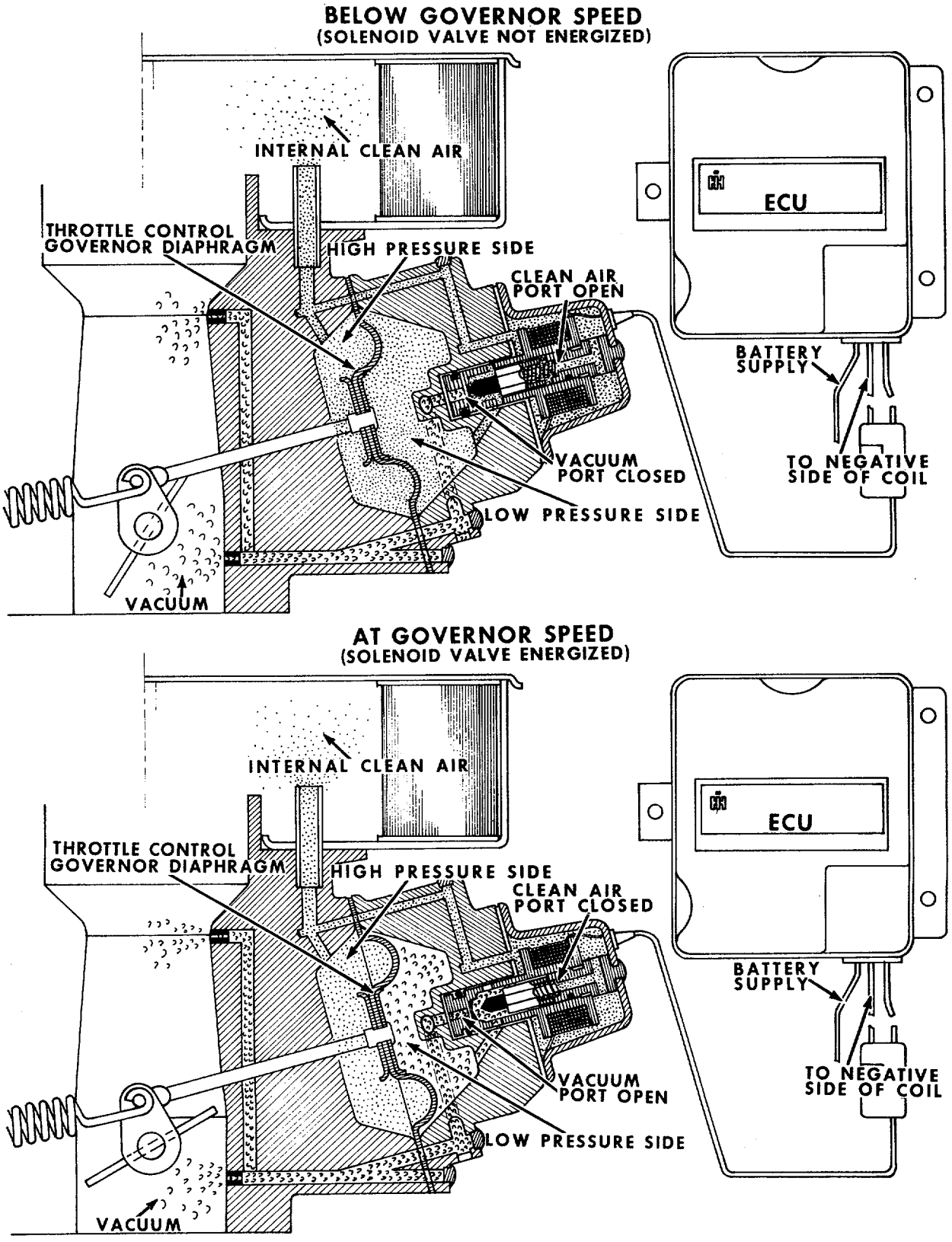
Internal clean air is supplied to both the solenoid side of the solenoid valve and to the high pressure side of the governor diaphragm. The cone-tipped side of the solenoid valve connects the venturi and intake manifold vacuum to the low pressure side of the governor diaphragm. In an underspeed or current off condition, the solenoid return spring closes the source vacuum port, thereby venting the low pressure side of the governor diaphragm directly to the clean air source. In this mode, the zero or near zero pressure differential across the governor diaphragm prevents any governing action.

As the engine approaches governed speed, current is applied to the solenoid which pulls the valve against the return spring, closes the port to clean air and connects the governor diaphragm to source vacuum. Modulation between the extremes of solenoid valve full-off and full-on is accomplished by varying the percentage on-time of the current to the solenoid. This results in an average' valve opening that is proportional to percent on-time and provides the desired governing action. The speed is factory preset within the electronic control unit.



Electronic Vacuum Modulating (EVM) Governor System Block Diagram

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EVM GOVERNOR OPERATION

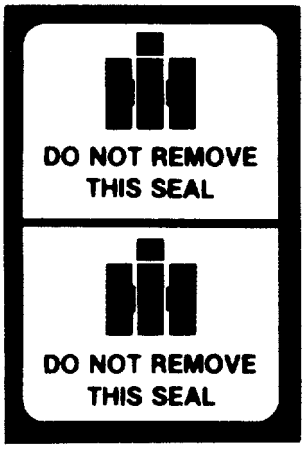
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ELECTRONIC VACUUM MODULATING (EVM) GOVERNOR SYSTEM TROUBLE SHOOTING PROCEDURE

The following procedure presents a systematic method of diagnosing and trouble shooting the Electronic Vacuum Modulating (EVM) Governor System. Each trouble shooting step has a chart to locate the component and illustrate the test. Test instruments used consist of a voltmeter and a tachometer.

It is recommended that the tachometer used for testing governor no load speed be an instrument with a high percentage of accuracy. The governed no load speed should be within a 100 RPM tolerance.

If engine speed reading is more than 100 RPM high or lower than the specified governed no load speed, make sure the tachometer being used has been properly calibrated before condemning the ECU or vacuum solenoid valve.

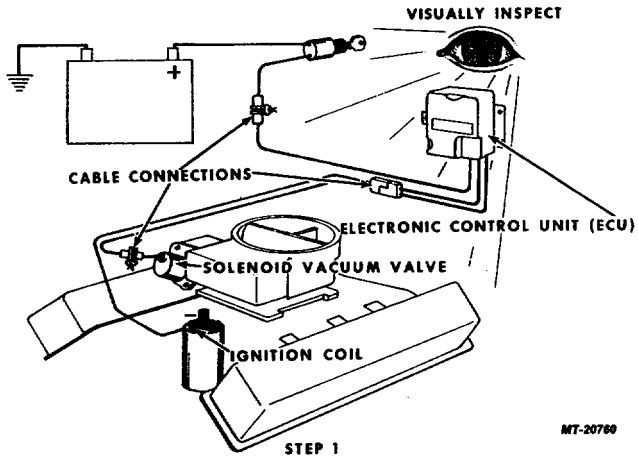


MT-20888

Anti Tamper Proof Seal

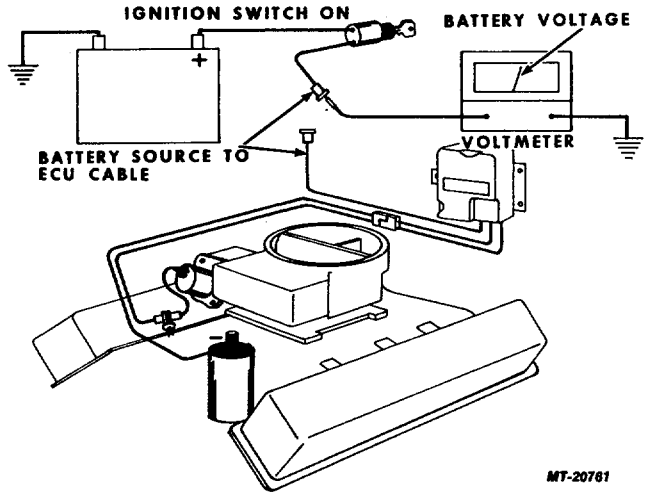
Electrical connections on the EVM system are sealed with an anti-tamper proof seal tape which is placed on the connectors at the time of assembly. The production seal tape can be identified by its white color with black print. If the connector seal tape is tampered with the word VOID will appear.

After service is performed, a service antitamper proof tape which is white in color with red print should be installed. This difference in print color will show the system has been serviced.



STEP 1

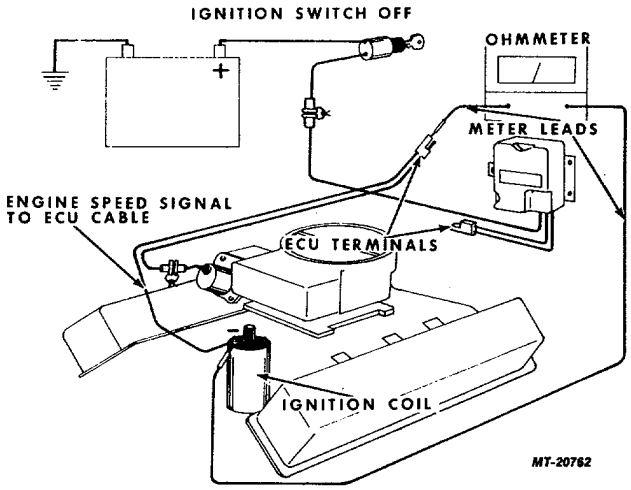
1. Visually inspect condition of wiring connections and components.



STEP 2

2. Disconnect wire at electronic control unit (ECU). Check for battery voltage with ignition turned on. If battery voltage is not found, refer to Service Manual, ELECTRICAL, for repair. If battery voltage is found, proceed to Step 3.

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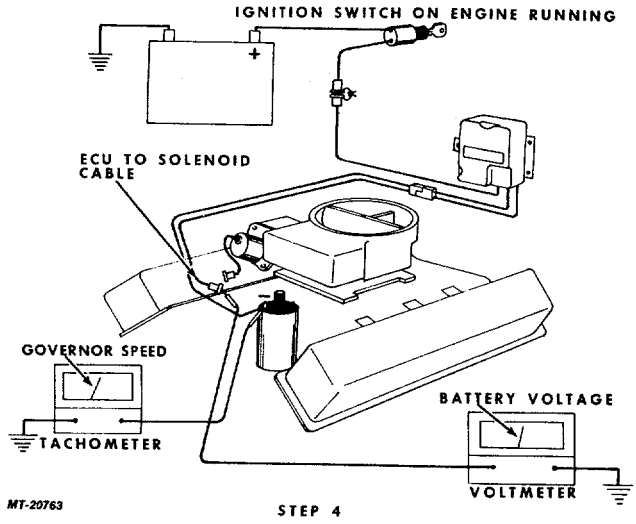


STEP 3

3. Disconnect ECU signal cable at terminal connector as shown.

   a. Check continuity of cable from negative side of coil to ECU end. If reading indicates an open circuit, replace cable.

   b. If normal, reconnect cable and proceed to next step.

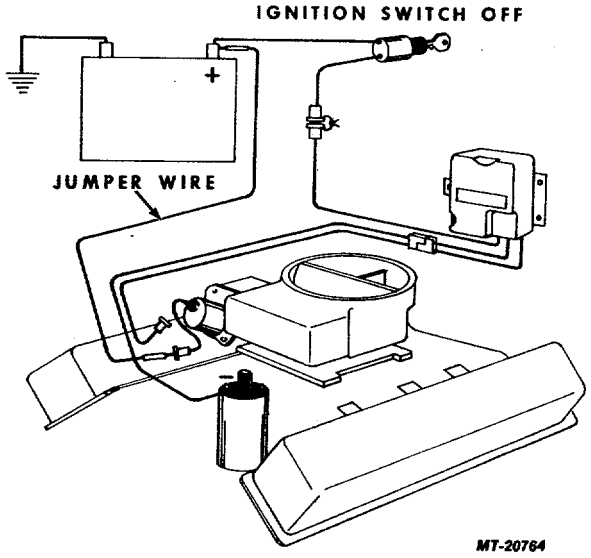


STEP 4

4. Disconnect cable terminal connector between ECU and solenoid valve (on carburetor). Connect tachometer and voltmeter. Start engine, increase speed until governor no load rpm is reached (see specifications). Battery voltage should be obtained at ECU side of connector.

   a. If battery voltage is not obtained, replace ECU.

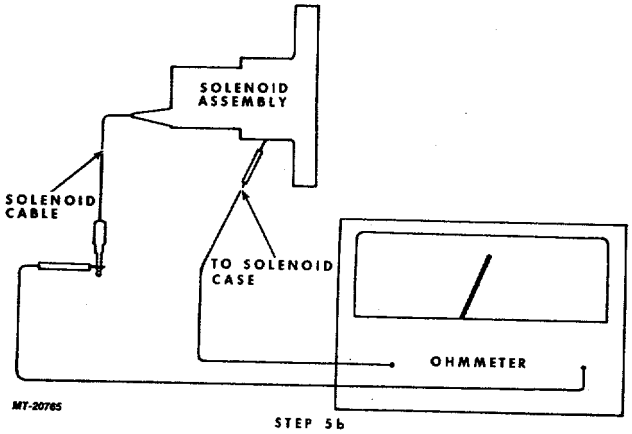
   b. If battery voltage is obtained, stop engine and proceed to next step.



STEP 5

5. Apply battery voltage to solenoid valve side of cable as shown. The solenoid valve should make a slight noise or movement felt when current is applied and released indicating the solenoid valve plunger is operating.

   a. If the solenoid is operating properly, proceed to step 6.



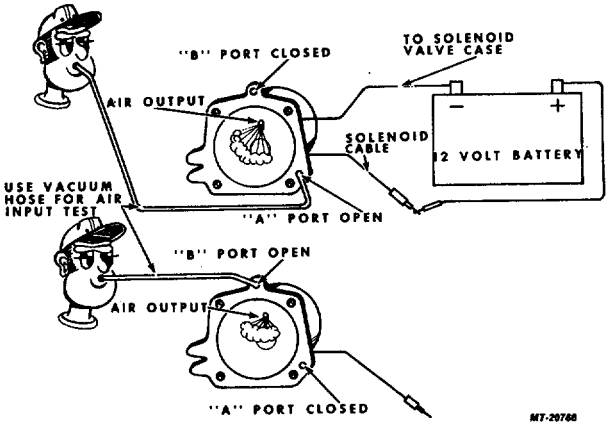
STEP 5b

   b. If the noise is not heard or movement felt, remove solenoid valve and cover assembly from carburetor. Make a resistance check with an ohmmeter from the solenoid valve cable to the valve assembly case as shown. The ohmmeter should read approximately 50 ± ohms.

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If resistance is zero or a very high reading, the solenoid valve assembly must be replaced.

c. If resistance is 50 ± 10 ohms, the solenoid valve windings are good. Remove solenoid valve from cover. Check to see if valve seat is sticking, keeping solenoid valve plunger from operating.



STEP 6

6. If Steps 1 through 5 have proved that the electrical portion of governor system is operating properly, the trouble must be in the cover vacuum passages on the carburetor.

a. With solenoid valve assembled to cover, apply air through a small diameter hose as shown to port "A," then port "B" to insure passages are clear.

With battery voltage applied:

Port "B" should be closed.

Port "A" should be open.

Without battery voltage applied:

Port "B" should be open.

Port "A" should be closed.

b. If solenoid valve plunger is not seating properly, replace solenoid valve.

c. If vacuum passages in the cover are clogged, clean (cover only) with commercial carburetor cleaning solvent.

7. Some carburetor malfunctions that are not a part of the EVM governor system may affect governor action. These malfunctions can be corrected by using the CLEANING AND INSPECTION portion of this service manual.

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SPECIFICATIONS
1969, 1970, 1971 AND 1972 VEHICLES

CARBURETOR MODEL	2300							
ENGINE MODEL	V-304, V-304E, V-345 AND V-345E							
Manual Trans., Manual Choke:								
Production No.	284545-C91	360769-C92	379475-C91	398236-C91	398238-C92	360773-C92	428090-C91	428080-C91
List No.	2977-2	3991-1	4306	4574	4594-1	4081-1	6379	6391
Service No.	151786-R94	360771-C92	379475-C91	298236-C91	----	360775-C92	----	----
List No.	1710-4	4079-1	4308	4574	----	4083-1	----	----
Auto. Trans., Manual Choke:								
Production No.	284549-C92	360771-C92	379475-C91	----	398238-C91	360775-C92	----	----
List No.	2976-2	4079-1	4308	----	4594	4083-1	----	----
Service No.	151786-R94	360771-C92	379475-C91	----	398238-C91	360775-C92	----	----
List No.	1710-4	4079-1	4308	----	4594	4083-1	----	----
Throttle Body Bore, mm (in)	38 (1-1/2)							
Fuel Level	9.52 mm @ 37.92 kPa (3/8" @ 5.5 psi)							
Venturi	29 mm (1-1/8")							
Main Jet	#53	#52	#53	#51	#51	#50	#51	#51
High Speed Bleed, mm (in)	.89 (.035)	.89 (.035)	.89 (.035)	.89 (.035)	.89 (.035)	.91 (.036)	.089 (.035)	.64 (.025)
Accelerator Jet, mm (in)	.79 (.031)	.79 (.031)	.74 (.029)	.64 (.025)	.64 (.025)	.74 (.029)	.64 (.025)	.74 (.029)
Fuel Valve Seat, mm (in)	2 (.082)						2.44 (.096)	2 (.082)
Initial Idle Needle Setting (Approx. turns off seat)	3	3	3	3	3	3	3	1-1/2 - 2
Dashpot Setting, mm (in)	2.29 - 3.0 (.090 - .120)			None	2.29 - 3.0	(.090 - .120)	1.90 - 2.67 (.075 - .105)	None
Throttle Modulator Setting	None	None	None	(1)	None	None	None	None
Fast Idle Setting, mm (in)	.000	.000	.000	1.40 (.055) (2)		.000	2.79 (.110) (3)	
Idle Speed, RPM	450-500 (4)	550 (5) 700 (6)	450-500 (4)	600 (6)	550 (5)	550 (5) 700 (6)	700 (6)	700 (6)
Air/Fuel Ratio, Idle	12 - 13	13.4-13.6 (3% CO)	13.4-13.6 (3% CO)	Not Applicable	Not Applicable	13.4-13.6 (3% CO)	Not Applicable	Not Applicable

(1) 1100-1200 RPM with vacuum applied to modulator.
(2) California vehicles
(3) Clearance - stop screw-to-fast idle cam with choke plate open and throttle plate at curb idle.
(4) Manual transmission ; also automatic transmission in Drive (D).
(5) Automatic transmission in Drive (D).
(6) Manual transmission.

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SPECIFICATIONS
1969, 1970, 1971 AND 1972 VEHICLES

CARBURETOR MODEL	2300 C										
ENGINE MODEL	V-304, V-304E, V-345 AND V-345E										
Manual Trans., Auto. Choke:											
Production No.	330556-C93	346868-C92	360770-C92	360774-C92	3794747-C91	398237-C91	398239-C92	428081-C91	----	428091-C91	----
List No.	3679-3	3937-2	4078-1	4082-1	4307	4593	4595-1	6393	----	6380	----
Service No.	324889-C93	346685-C92	360772-C92	360776-C92	379476-C91	398237-C91	----	----	----	----	----
List No.	2520-3	3936-2	4080-1	4084-1	4309	4593	----	----	----	----	----
Auto. Trans., Auto. Choke:											
Production No.	324889-C93	346685-C92	360772-C92	360776-C92	379476-C91	----	398239-C91	----	428083-C91	428091-C91	428103-C91
List No.	2520-3	3936-2	4080-1	4084-1	4309	----	4595	----	6394	6380	6386
Service No.	324889-C93	346685-C92	360770-C92	360776-C92	379476-C91	----	398239-C91	----	----	----	----
List No.	2520-3	3936-2	4080-1	4084-1	4309	----	4595	----	----	----	----
Automatic Choke Setting	One Notch Lean	Index	One Notch Lean	One Notch Lean	One Notch Lean	Index	Index	One Notch Lean	One Notch Lean	4 Notches Lean (Summer) 1 Notch Lean (Winter)	
Choke Qualifying Dimension, mm (in)	6 (.240)	6.35 (.250)	5.59 (.220)	4.70 (.185)	5.59 (.220)	7 (.280)	7 (.280)	5 (.200)	5 (.200)	5 (.200)	5 (.200)
Throttle Body Bore, mm (in)	38 (1-1/2)										
Fuel Level, mm @ kPa (in @ psi)	9.52 @ 37.92 (3/8 @ 5.5)										
Venturi, mm (in)	29 (1-1/8)										
Main Jet	#53	#54	#52	#50	#53	#51	#51	#51	#51	#51	#51
High Speed Bleed, mm (in)	.89 (.035)	.89 (.035)	.89 (.035)	.91 (.036)	.89 (.035)	.89 (.035)	.89 (.035)	.64 (.025)	.64 (.025)	.89 (.035)	.89 (.035)
Accelerator Jet, mm (in)	.79 (.031)	.79 (.031)	.79 (.031)	.74 (.029)	.79 (.031)	.64 (.025)	.64 (.025)	.74 (.029)	.74 (.029)	.64 (.025)	.64 (.025)
Fuel Valve Seat, mm (in)	2 (.082)	2 (.082)	2 (.082)	2 (.082)	2 (.082)	2 (.082)	2 (.082)	2 (.082)	2 (.082)	2.44 (.096)	2.44 (.096)
Initial Idle Needle Setting (Approx. turns off seat)	3	3	3	3	3	3	3	1-1/2 - 2	1-1/2 - 2	3	3
Dashpot Setting, mm (in)	2.29 - 3.00 (.090 - .120)					None	2.29 - 3.00 (.090 - .120)	None	2.29 - 3.00 (.090 - .120)	1.90 - 2.67 (.075 - .105)	
Throttle Modulator Setting	None					(1)	None				
Fast Idle Setting, (2)	.0000						2000 RPM Top Step (Hot)				
Idle Speed, RPM	450 - 500 (3)		550 (4) - 700 (5)		450-500 (3)	600 (5)	550 (4)	700 (6)			
Air/Fuel Ratio, Idle	12.0 - 13.0		13.4 - 13.6 (3% CO)			Not Applicable					

(1) 1100-1200 RPM with vacuum applied to modulator.
(2) Clearance - stop screw-to-fast idle cam with choke plate open and throttle plate at curb idle.
(3) Manual transmission ; also automatic transmission in Drive (D).
(4) Automatic transmission in Drive (D).
(5) Manual transmission.
(6) Transmission in Neutral, Air Conditioning ON.

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SPECIFICATIONS

1969, 1970, 1971 AND 1972 VEHICLES

CARBURETOR MODEL	2300G		
ENGINE MODEL	V-304, V-304E, V-345 AND V-345E		
Manual Trans., Manual Choke:			
Production No.	284552-C91	284546-C91	379477-C92
List No.	2979	2980	4310-1
Service No.	151724-R94	151725-R95	379477-C92
List No.	1706-2	1707-2	4310-1
Auto. Trans., Manual Choke:			
Production No.	----	292868-C91	379478-C92
List No.	----	2975	4311-1
Service No.	----	292868-C91	379478-C92
List No.	----	2975	4311-1
Throttle Body Bore, mm (in)	40 (1-9/16)		
Fuel Level, mm @ kPa (in @ psi)	9.52 @ 37.92 (3/8 @ 5.5)		
Venturi, mm (in)	32 (1-1/4)		
Main Jet	#60	#60	#56
High Speed Bleed, mm (in)	.71 (.028)	.71 (.028)	.61 (.024)
Accelerator Jet, mm (in)	.79 (.031)		
Fuel Valve Seat, mm (in)	2.46 (.097)		
Initial Idle Needle Setting (Approx. turns off seat)	3	3	1-1/2 - 2
Fast Idle Setting, mm (in) (1)	.46 - .51 (.018 - .020)		
Idle Speed, RPM (2)	450 - 500		
Air/Fuel Ratio, Idle	12.0 - 13.0	12.0 - 13.0	13.4 - 13.6 (3% CO)
Governor Upper Orifice, mm (in)	.71 (.028)		
Governor Lower Orifice, mm (in)	1.32 (.052)		
Governor Spring (Color)	Green		
Governor Post Position	#2		
Venturi Vacuum Hole, mm (in)	None	1.70 (.067)	1.70 (.067)
Governed Speed, RPM			
Full Speed - No Load	4000		
Full Speed - Full Load (On Road)	3800		

(1) Clearance - stop screw to fast idle cam with choke plate open and throttle plate at curb idle.
(2) Manual Transmission - Also Automatic Transmission in Drive (D).

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SPECIFICATIONS

1973 MEDIUM AND HEAVY DUTY VEHICLES (All States Except California)

CARBURETOR MODEL	2300	2300C	2300C	2300G
ENGINE MODEL		V-304, V-345		
Carburetor:				
Part Number	442163-C91	442164-C91	442165-C91	442168-C91
List Number	6391-1	6393-1	6394-1	4310-2
Throttle Body Bore, mm (in)	38 (1-1/2)			40 (1-9/16)
Venturi, mm (in)	29 (1-1/8)			32 (1-1/4)
Main Jet	#52			#56
Fuel Level, mm @ kPa (in @ psi)	9.52 @ 37.92 (3/8 @ 5.5)			
Idle Mixture Screw Initial Setting, mm (in) (Turns Off Seat)	38 - 50 (1-1/2 - 2)			
Automatic Choke Setting	----	One Notch Lean		----
Fast Idle Setting, mm (in) (*)	2.79 (.110)	----		.46-.51 (.018-.020)
Fast Idle Setting, RPM	----	2000 Top Step (Hot)		----
Dashpot Setting, mm (in)	----	----	2.29-3.0 (.090-.120)	----
Curb Idle Speed, RPM (**)	700			
Governor Upper Orifice, mm (in)	----			.71 (.028)
Governor Lower Orifice, mm (in)	----			1.32 (.052)
Governor Spring (Color)	----			Green
Governor Spring Post Position	----			#2
Governed Speed, RPM				
Full Speed - No Load	----			4000
Full Speed - Full Load (On Road)	----			3800

(*) Clearance between stop screw and fast idle cam with choke open and curb idle set correctly.

(**) Transmission in Neutral, Air Conditioning ON.

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SPECIFICATIONS

1973 MEDIUM AND HEAVY DUTY VEHICLES (California Only)

CARBURETOR MODEL	2300G	2300G
ENGINE MODEL	V-304	V-345
Carburetor:		
Part Number	441195-C91	441196-C91
List Number	6623	6624-1
Throttle Body Bore, mm (in)	40 (1-9/16)	40 (1-9/16)
Venturi, mm (in)	32 (1-1/4)	32 (1-1/4)
Main Jet	#56	#56
Fuel Level:		
mm @ kPa	9.52 @ 37.92	9.52 @ 37.92
(in @ psi)	(3/8 @ 5.5)	(3/8 @ 5.5)
Fast Idle Setting, mm (in) (*)	.46-.51 (.018-.020)	.46-.51 (.018-.020)
High Idle Speed, RPM (Throttle Modulator Extended)	1300 - 1400	1300 - 1400
Curb Idle Speed, RPM (**)	650 - 700	650 - 700
Idle Mixture Setting, % CO	2.0 Max.	1.5 Max.
Governor Upper Orifice, mm (in)	.71 (.028)	.71 (.028)
Governor Lower Orifice, mm (in)	1.32 (.052)	1.32 (.052)
Governor Spring (Color)	Green	Green
Governor Spring Post Position	#2	#2
Governed Speed, RPM		
Full Speed - No Load	4000	4000
Full Speed - Full Load (On Road)	3800	3800

(*) Clearance between stop screw and fast idle cam with choke open and curb idle speed set correctly.
(**) Transmission in Neutral, Air Conditioning OFF.

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SPECIFICATIONS

1974 MEDIUM AND HEAVY DUTY VEHICLES (50 States)

CARBURETOR MODEL	2300G	2300G
ENGINE MODEL	V-304	V-345
Carburetor:		
Production Part No.	451867-C92	451868-C91
List No.	6801-1	6802
Service Part No.	----	451867-C92
List No.	----	6801-1
Throttle Body Bore, mm (in)	40 (1-9/16)	40 (1-9/16)
Venturi, mm (in)	32 (1-1/4)	32 (1-1/4)
Main Jet	#56	#56
Fuel Level:		
mm @ kPa	9.52 @ 37.92	9.52 @ 37.92
(in @ psi)	(3/8 @ 5.5)	(3/8 @ 5.5)
Fast Idle Setting, mm (in)	.46-.51 (.018-.020)	.46-.51 (.018-.020)
High Idle Speed, RPM (Throttle Modulator Extended)	1300 - 1400	1300 - 1400
Curb Idle Speed, RPM (*)	650 - 700	650 - 700
Idle Mixture Setting, % CO	2.0 Max.	1.5 Max.
Governor Upper Orifice, mm (in)	.71 (.028)	.71 (.028)
Governor Lower Orifice, mm (in)	1.32 (.052)	1.32 (.052)
Governor Spring (Color)	Green	Green
Governor Spring Post Position	#2	#2
Governed Speed, RPM		
Full Speed - No Load	4000	4000
Full Speed - Full Load (On Road)	3800	3800

(*) Transmission in Neutral, Air Conditioning OFF.

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SPECIFICATI ONS

1975-1976 CALIFORNIA HEAVY DUTY ENGINES

CARBURETOR MODEL	2300G	2300G	2300G
ENGINE MODEL	V-345	MV-404	V-537
Carburetor:			
Production Part No.	461307-C91	465531-C91	465487-C91
List No.	6899	7216	7198
Throttle Body Bore, mm (in)	39.67 (1-9/16)	39.67 (1.562)	39.67 (1-9/16)
Venturi, mm (in)	30.15 (1.187)	31.75 (1.250)	30.15 (1-3/16)
Main Jet	#572	#582	#582
Fuel Level:			
mm @ kPa	9.52 @ 37.92	9.52 @ 37.92	9.52 @ 37.92
(in @ psi)	(3/8 @ 5.5)	(3/8 @ 5.5)	(3/8 @ 5.5)
Fast Idle Setting, RPM	2000	2400	2000
High Idle Speed, RPM (Throttle Modulator Extended)	1450 ± 50	1350 ± 50	1300 - 1400
Curb Idle Speed, RPM (*)	625 - 675	525 - 575	500 - 550
Idle Mixture Setting, % CO	0.5 - 1.5	0.5 - 2.5	1.0 - 2.0
Governor Upper Orifice, mm (in)	0.711 (.028)	0.711 (.028)	0.711 (.028)
Governor Lower Orifice, mm (in)	1.32 (.052)	1.32 (.052)	1.32 (.052)
Governor Spring (Color)	Green	Brown	Brown
Governor Spring Post Position	#3	#2	#3
Governed Speed, RPM			
Full Speed - No Load	4000	3800	3400
Full Speed - Full Load (On Road)	3800	3600	3200

(*) Transmission in Neutral, Air Conditioning OFF.

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SPECIFICATIONS

1975, 1976, 1977, 1978 FEDERAL (Not California) HEAVY DUTY ENGINES

CARBURETOR MODEL	2300G	2300EG	2300G	2300EG	2300G	2300EG
ENGINE MODEL	V-304	V-345	MV-404		V-537	
Carburetor: Production Part No. List No.	451867-C92 6801-1	487848-C91 8232	465528-C91 7213	487851-C91 8235	448312-C92 6908-1	487854-C91 8238
Throttle Body Bore, mm (in.)	39.67 (1-9/16)		39.67 (1-9/16)		39.67 (1-9/16)	
Venturi, mm (in.)	31.75 (1-1/4)		31.75 (1.250)		30.15 (1-3/16)	
Main Jet	#56		#582		#54	
Fuel Level: mm @ kPa (in. @ psi)	9.52 @ 37.92 (3/8 @ 5.5)		9.52 @ 37.92 (3/8 @ 5.5)		9.52 @ 37.92 (3/8 @ 5.5)	
Fast Idle Setting, RPM	2200		2400		2000	
High Idle Speed, RPM (Throttle Modulator Extended)	1300 - 1400		1350 ± 50		1350 ± 50	
Curb Idle Speed, RPM (*)	650 - 700		525 - 575		500 - 550	
Idle Mixture Setting, % CO	2.0 Max.	1.5 Max.	0.5 - 2.5		1.5 - 3.0	
Governor Upper Orifice, mm (in.)	0.711 (.028)	0.94 mm (.037)	0.711 (.028)			0.94 mm (.037)
Governor Lower Orifice, mm (in.)	1.32 (.052)	1.50 mm (.059)	1.32 (.052)		1.32 (0.52)	1.50 mm (.059)
Governor Spring (Color)	Green	Red Stripe	Brown	Red Stripe	Green	Red Stripe
Governor Spring Post Position	#2		#2		#3	#2
Governed Speed, RPM** Full Speed - No Load	4000		3800		3400	
Full Speed - Full Load (On Road)	3800		3600		3200	

(*) Transmission in Neutral, Air Conditioning OFF

(**) 2300EG Carburetor No Load Speed Should be Within a Plus (+) or Minus (-) 100 RPM.

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SPECIFICATIONS

1977, 1978 CALIFORMIA HEAVY DUTY ENGINES

CARBURETOR MODEL	2300G	2300EG	2300G	2300EG	2300G	2300EG
ENGINE MODEL	V-345		MV-404		V-537	
Carburetor: Production Part No. List No. Production Part No. List No.	467113-C91 7656	487858-C91 8242	476057-C91 7580 481872-C91 7922	487861-C91 8245	465487-C91 7198	487864-C91 8248
Throttle Body Bore, mm (in.)	39.67 (1-9/16)		39.67 (1-9/16)		39.67 (1-9/16)	
Venturi, mm (in.)	31.75 (1.250)		31.75 (1.250)		30.15 (1-3/16)	
Main Jet	#632		#591		#582	
Fuel Level: mm @ kPa (in @ psi)	9.52 @ 37.92 (3/8 @ 5.5)		9.52 @ 37.92 (3/8 @ 5.5)		9.52 @ 37.92 (3/8 @ 5.5)	
Fast Idle Setting, RPM	2000		2400		2000	
High Idle Speed, RPM (Throttle Modulator Extended)	1450 ± 50		1350 ± 50		1300 - 1400	
Curb Idle Speed, RPM (*)	625 - 675		525 - 575		500 - 550	
Idle Mixture Setting, % CO	1.0 - 3.0		0.5 - 2.0		1.0 - 2.0	
Governor Upper Orifice, mm (in)	0.711 (.028)	Blank	0.711 (.028)	0.94mm (.037)	0.711 (.028)	0.94mm (.037)
Governor Lower Orifice, mm (in)	1.32 (.052)	1.50 mm (.059)	1.32 (.052)	1.50 mm (.059)	1.32 (.052)	1.50 mm (.059)
Governor Spring (Color)	Green	Red Stripe	Brown	Red Stripe	Brown	Plain
Governor Spring Post Position	#2		#2		#3	#2
Governed Speed, RPM:** Full Speed - No Load Full Speed - Full Load (On Road)	4000 3800		3800 3600		3400 3400	

(*) Transmission in Neutral, Air Conditioning OFF.

(**) 2300EG Carburetor No Load Speed Should be Within a Plus (+) or Minus (-) 100 RPM.

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SPECIFICATIONS

1979 HEAVY DUTY ENGINES

CARBURETOR MODEL	2300EG		2300EG		2300EG	
ENGINE MODEL	V-345		MV-404		V-537	
Carburetor: Production Part No. List No. Production Part No. List No.	500175-C91 8736	487858-C91 8242	481872-C91 7922	487861-C91 8245	500182-C91 8741	487864-C91 8248
Throttle Body Bore, mm (in)	39.67 (1.562")		39.67 (1.562")		39.67 (1.562")	
Venturi, mm (in)	31.75 (1.250)		31.75 (1.250)		30.15 (1.187)	
Main Jet	#622		#591		#582	
Fuel Level: mm @ kPa (in @ psi)	9.52 @ 37.92 (.375 @ 5.5)		9.52 @ 37.92 (.375 @ 5.5)		9.52 @ 37.92 (.375 @ 5.5)	
Fast Idle Setting, RPM	2000		2400		2000	
High Idle Speed, RPM (Throttle Modulator Extended)	1450 ± 50		1350 ± 50		1300 - 1400	
Curb Idle Speed, RPM (*)	625 - 675		525 - 575		500 - 550	
Idle Mixture Setting, % CO	1.0 - 3.0		0.5 - 2.5		1.0 - 2.0	
Governor Upper Orifice, mm (in)	Blank		0.94 (.037)		0.94 (.037)	
Governor Lower Orifice, mm (in)	1.50 (.059)		1.50 (.059)		1.50 (.059)	
Governor Spring (Color)	Red Stripe		Red Stripe		Plain	
Governor Spring Post Position	#2		#2		#2	
Governed Speed, RPM:** Full Speed - No Load Full Speed - Full Load (On Road)	4000 3800		3800 3600		3400 3200	

(*) Transmission in Neutral, Air Conditioning OFF.

(**) 2300EG Carburetor No Load Speed Should be Within a Plus (+) or Minus (-) 100 RPM.

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SPECIFICATIONS

1979 (CANADIAN) HEAVY DUTY ENGINES

CARBURETOR MODEL	2300EG		2300EG	2300EG
ENGINE MODEL	V-304	V-345	MV-404	V-537
Carburetor: Production Part No. List No.	487848-C91 8232		487851-C91 8235	487854-C91 8238
Throttle Body Bore, mm (in)	39.67 (1-9/16)		39.67 (1-9/16)	39.67 (1-9/16)
Venturi, mm (in)	31.75 (1-1/4)		31.75 (1.250)	30.15 (1-3/16)
Main Jet	#56		#582	#54
Fuel Level: mm @ kPa (in @ psi)	9.52 @ 37.92 (3/8 @ 5.5)		9.52 @ 37.92 (3/8 @ 5.5)	9.52 @ 37.92 (3/8 @ 5.5)
Fast Idle Setting, RPM	2200		2400	2000
High Idle Speed, RPM (Throttle Modulator Extended)	1300 - 1400		1350 ± 50	1350 ± 50
Curb Idle Speed, RPM (*)	650-700		525-575	500-550
Idle Mixture Setting, % CO	2.0 Max.	1.5 Max.	0.5 - 2.5	1.5 - 3.0
Governor Upper Orifice, mm (in)	0.94 mm (.037)		0.711 (.028)	0.94 mm (.037)
Governor Lower Orifice, mm (in)	1.50 mm (.059)		1.32 (.052)	1.50 mm (.059)
Governor Spring (Color)	Red Stripe		Red Stripe	Red Stripe
Governor Spring Post Position	#2		#2	#2
Governed Speed, RPM** Full Speed - No Load	4000		3800	3400
Full Speed - Full Load (On Road)	3800		3600	3200

(*) Transmission in Neutral, Air Conditioning OFF

(**) 2300EG Carburetor No Load Speed Should be Within a Plus (+) or Minus (-) 100 RPM.

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FUEL SYSTEM

CARBURETOR MODELS: 4150, 4150C, 4150G & 4150EG

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DESCRIPTION

The 4-barrel carburetor model 4150, 4150C and 4150G, Figs. 1, 2, 3 and 4 are downdraft, two-stage carburetors--one stage supplying a fuel/air mixture throughout the entire range of engine operation (primary stage) and the other functioning only when a greater quantity of fuel/air mixture is required (second stage).

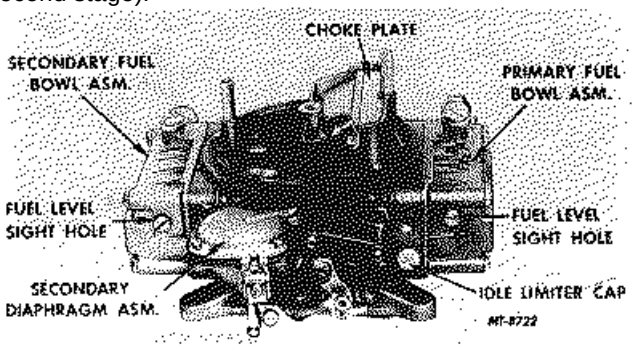


Fig. 1 4150 Carburetor

The carburetors incorporate idle limiter caps, which are an external system to limit the richness of the idle mixture. With this system the travel of the curb idle mixture screw is limited to the extent that idle mixture cannot be set so rich that emission levels do not meet requirements.

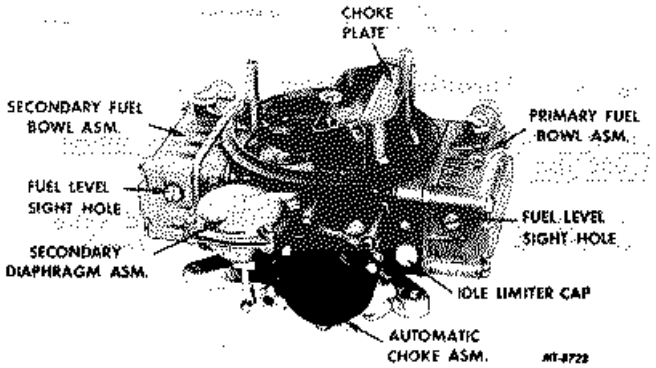


Fig. 2 4150C Carburetor

Two-Stage Power Valve

To provide the necessary emission calibration (leaner light load and light part throttle operation), a two-stage diaphragm-actuated power valve is used in some of the 4150 series carburetor models. In light load and light part throttle type operations where manifold vacuum drops to a predetermined level, the first stage of the power valve opens and enriches the mixture slightly. As manifold vacuum decreases on

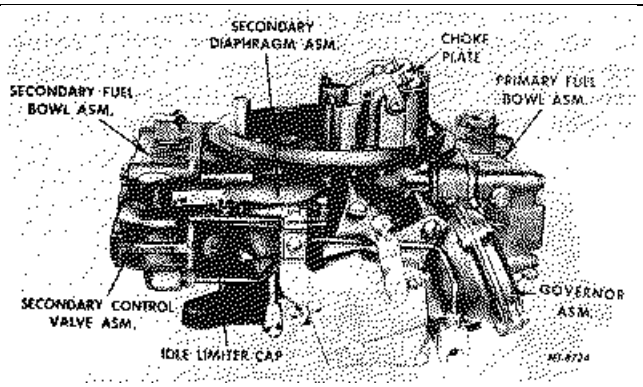


Fig. 3 4150G Carburetor (Governor View)

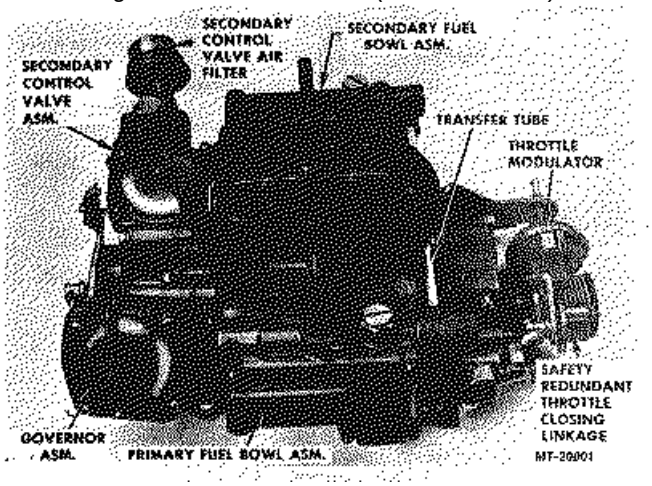


Fig. 4 4150G Carburetor (Late Production)

acceleration or steeper grades, the second stage of the power valve opens, providing full power enrichment. The two-stage power valve is serviced as an assembly and is not adjustable in the field.

POWER VALVE MODULATOR

Throttle shaft-actuated; with high vacuum type operating conditions such as deceleration, idle, low throttle openings, the power valve is normally closed.

The power valve modulator is incorporated in the power valve vacuum system to ensure fuel enrichment during high speed, WOT operation. As WOT engine speed approaches the maximum engine RPM, intake manifold vacuum may rise to a level sufficient to close the second stage of the power valve reducing fuel flow and engine power. The power valve modulator system is designed to bleed off power valve cavity vacuum when the throttle plates are opened to 50 degrees or greater. At this angle, a hole in the throttle shaft and a hole in the throttle body

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are aligned permitting a flow of clean air from the air cleaner to the power valve cavity reducing cavity vacuum and ensuring full fuel enrichment. Figs. 5 and 6 illustrate the shaft valve in open and closed positions respectively.

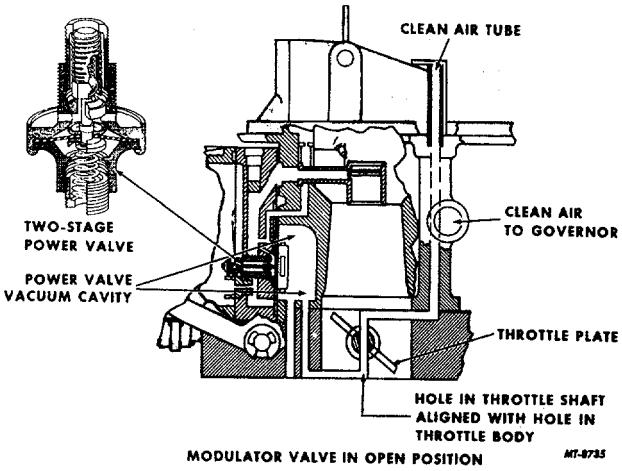


Fig. 5

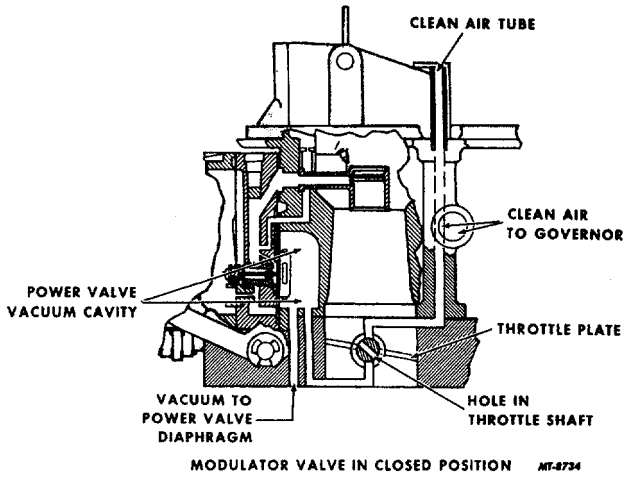


Fig. 6

Synthetic (Plastic) Accelerator Pump Inlet Valve

The primary fuel bowl assembly accelerator pump unit incorporates a synthetic type check valve in the nongoverned and most governed type carburetors. Fig. 7 illustrates the synthetic check valve. The valve uncovers the inlet hole to admit fuel from the fuel bowl and covers the inlet hole when the accelerator pump is operated to prevent fuel from returning to the bowl.

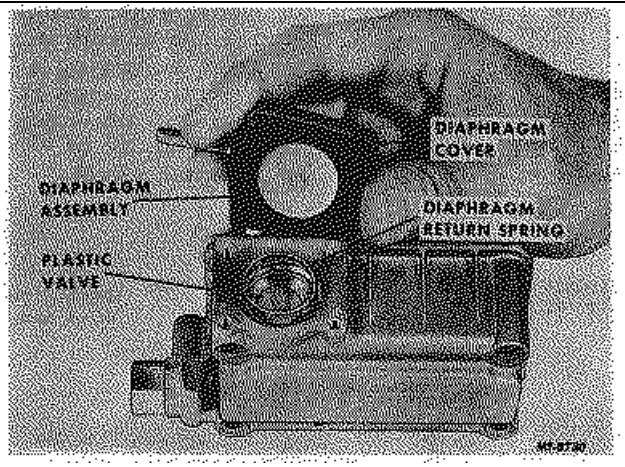


Fig. 7

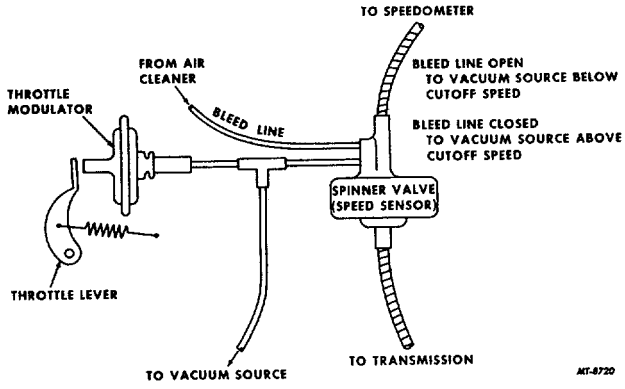


Fig. 8 Throttle Modulator

Throttle Modulator (1970-1971 vehicles under 6,000 lbs. GVW)

The throttle modulator is illustrated schematically in Fig. 8. A speed sensor (spinner valve) unit is driven by the speedometer cable. A vacuum source and bleed line are piped into the speed sensor. The sensor is designed to open the bleed line to the vacuum source when vehicle road speed is below the predetermined cutoff speed (approximately 24 m.p.h.). As long as the bleed line is open no vacuum is available to extend the modulator. When the vehicle passes the road speed cutoff point, the bleed line is closed, making vacuum available to actuate the modulator. The throttle plate is held in a partially open position during vehicle deceleration to aid combustion and provide an acceptable exhaust emission level. When the vehicle decelerates

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to the cutoff speed, the vacuum bleed line is opened by the speed sensor, causing the modulator to retract and allow the throttle lever to close the throttle plate to curb idle position. The speed sensor and throttle modulator are serviced only as a complete unit replacement.

Deceleration Throttle Modulator System (1973 California and 1974 thru 1978 Vehicles Over 6000 Lbs. GVW.

The deceleration throttle modulator system (DTM) consists basically of a vacuum operated throttle modulator unit on the carburetor, a solenoid vacuum valve and engine speed sensor unit (Fig. 9).

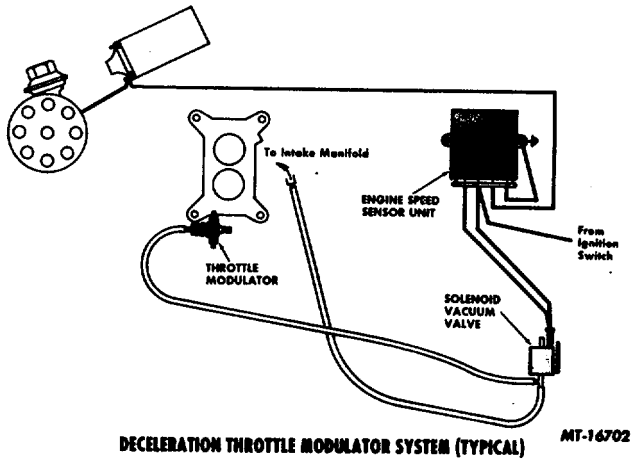


Fig. 9 Deceleration Throttle Modulator System (Typical)

Normally an engine will emit relatively high levels of unburned hydrocarbons during "closed throttle" deceleration. This is because the intake of fuel/air mixture is not sufficient to support complete combustion and the engine "misfires" resulting in fuel being passed through the engine unburned. The deceleration throttle modulator system overcomes this condition by maintaining a slightly greater throttle opening (high idle) during initial deceleration which permits intake of just enough additional fuel/air mixture to promote combustion and eliminate misfire.

The engine speed sensor is calibrated to activate or deactivate (extend or retract) the throttle modulator unit at approximately 1850 RPM engine speed.

Above 1850 RPM engine speed, the solenoid vacuum valve is activated (held open) by electrical current from the engine speed sensor unit. This permits manifold vacuum to act upon the diaphragm of the throttle modulator unit extending the modulator unit to the high idle position. Upon deceleration, the returning carburetor throttle lever contacts the extended modulator, thus holding the throttle in high idle position.

When engine speed drops below 1850 RPM, the speed sensor unit deactivates the solenoid vacuum valve allowing the valve to close and bleed the vacuum from the throttle modulator diaphragm spring to retract the modulator unit and allow the throttle lever to return to normal curb idle position.

For DTM operational test, refer to FUEL SYSTEM, Section CTS-2733, CTS-2694 or CTS-2721, Emission Control Systems for Gasoline Engines.

AUTOMATIC CHOKE OPERATION, DESCRIPTION AND SERVICING

The automatic choke assembly consists of a bimetallic thermostat spring and vacuum piston. The automatic choke assembly is mounted on the carburetor main body. A passage through the main body connects the vacuum system to the manifold area. When the engine is cold, the bimetal spring closes the choke plate for starting. When the engine starts, manifold vacuum is applied to the choke piston through a passage in the main body and with the help of air flow on the offset choke plate opens the choke against the tension of the bimetal spring. A heat stove is installed in the exhaust manifold and an asbestos-covered tube connects the heat stove to the choke housing. As the engine is warmed up hot air is circulated to the choke housing to warm up the bimetal spring. As the spring warms up, its tension will be released on the choke shaft and allow it to open gradually. The warm air then passes through an opening in the choke piston and down the passage in the main body to the manifold vacuum passage.

A choke lever is provided on the side of the carburetor which actuates a fast idle cam during choking. The fast idle cam has a series of steps on one side which are designed to increase the engine idle RPM for smoother running when the engine is cold. As the engine is warmed up and the choke opens, each step on the fast idle cam permits the engine to run at a slower RPM.

An adjustable piston stop screw controls the initial travel of the choke piston. The piston in turn controls the initial opening of the choke plate or choke qualifying dimension. To check the choke qualifying dimension, use the following procedure:

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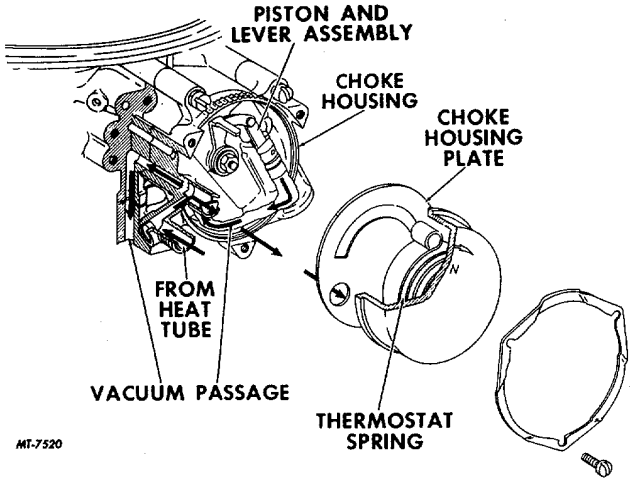


Fig. 10 Automatic Choke Assembly

1. Bend a paper clip as shown in insert in Fig. 11.
2. Place bent end of clip on top of piston and depress piston until it bottoms on stop screw (Fig. 11).
3. Rotate choke lever tang counterclockwise until choke piston link touches top of piston (Fig. 11).
4. Measure clearance on lower edge of choke plate at inner wall of air horn. See specifications for correct setting.
5. Adjust clearance by moving adjusting screw in or out.
6. After adjustment has been established, seal off head of adjusting screw with sealing compound.

A small unloader lever is provided on the throttle shaft, which will manually open choke plate when the throttle lever is at the wide-open position. This permits the operator to relieve an over-choke condition. To overcome a flooded condition, hold accelerator to floor (do not pump accelerator until engine starts).

Service of the automatic choke carburetor is identical to the hand choke model with the following exceptions:

The choke cover should not be immersed in the carburetor cleaner. It can be rinsed in solvent or fuel and carefully blown out. The bimetal spring should not be bent, stretched or tampered with.

New gaskets must be installed between the carburetor body and choke housing.

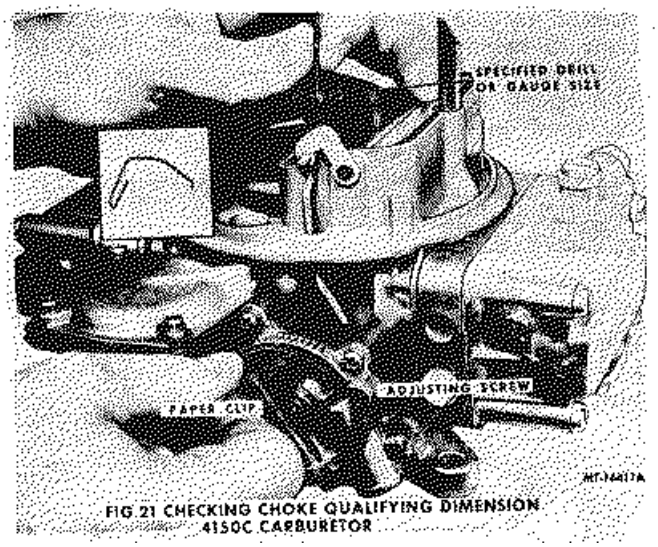


Fig. 11 Checking Choke Qualifying Dimension

If for some reason a richer or leaner mixture during the warm-up period is desired, it can be obtained by rotating the thermostat cover. Never set the index mark on the cover more than two graduations off the specified settings.

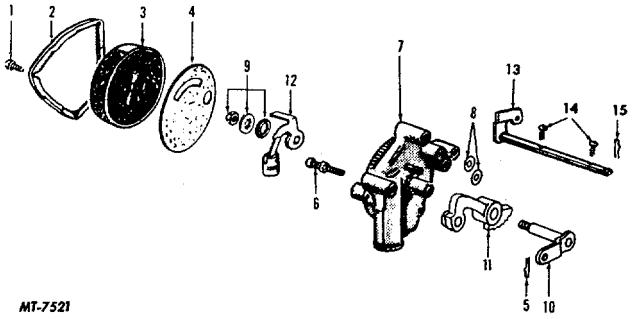


Fig. 12 Exploded View of Automatic Choke Assembly

Legend for Fig. 12

Key	Description
1	SCREW, Fil. Hd. No. BNC x 7/16
2	CLAMP, Thermostat Housing
3	HOUSING, Thermostat Assembly
4	GASKET, Thermostat Housing
5	PIN, Choke Rod Retainer
6	SCREW, Choke Housing WASHER, Lock Choke Housing
7	HOUSING, Choke Assembly
8	GASKET, Choke Housing
9	WASHER, Lock, Internal Tooth (#8)

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Legend for Fig. 12 (Continued)

Key	Description
	NUT, Choke Shaft
	SPACER, Choke Thermostat Lever
10	ASSEMBLY, Shaft and Lever
11	CAM, Fast Idle
12	LEVER, Thermostat with LINK and piston
13	SHAFT, Carburetor Choke
14	SCREWS, Choke Plate

GOVERNOR

Internal Vacuum Type 4150G

A Centri-Vac vacuum-operated engine speed governor (Fig. 13) is incorporated on the carburetor as a positive means of controlling engine speed. The governor contains a throttle-actuating mechanism attached to the primary throttle of the carburetor through an overriding clutch. The throttle-actuating mechanism consists of a diaphragm assembly, governor spring and governor lever assembly. Below governing speeds the operator, through a simple clutch arrangement on the throttle body of the carburetor, controls the throttle body of the carburetor and throttle plates in the usual manner. When governing speed is reached, a combination of venturi and manifold vacuum acts on the governor diaphragm to close the throttle plates.

Two calibrated bypass jets in the vacuum passages meter the vacuum from the venturi and the manifold to provide the correct balance for proper operation of the governor. At speeds below governing RPM this vacuum is weakened by air bleeding through the governor valve in the governor spinner so that no premature governing action will occur.

Filtered air from the carburetor air cleaner enters the governor system through a passage in the main body and then into the governor vent tube. The air flows through an air line to the housing enclosing the governor rotor or spinner valve.

A combination of low pressure from the venturi and manifold transmitted through the governor system passages draws the air past the governor valve and through another air line to the throttle-actuating unit on the carburetor.

In the controlling unit centrifugal force acting on the rotor, which has kept pace with engine speed, overcomes the tension of the valve spring and tends to close the governor valve when governing speed is reached. This greatly restricts the amount of air bleeding through to the diaphragm on the carburetor, thus allowing the combined venturi and manifold pressure differential to operate the diaphragm. As the pressure differential across the diaphragm increases, the diaphragm moves the governor lever against the tension of the governor spring to close the throttle plates.

The governed engine speed is held constant by centrifugal force on the valve balanced against the tension of the valve spring. Any slight change in engine speed due to load variation will cause the governor valve to react immediately, either increasing or decreasing the amount of air bleeding through the governor valve orifice. A change in the amount of air bleed will, in turn, cause an instant response from the diaphragm to increase or decrease the throttle plate opening.

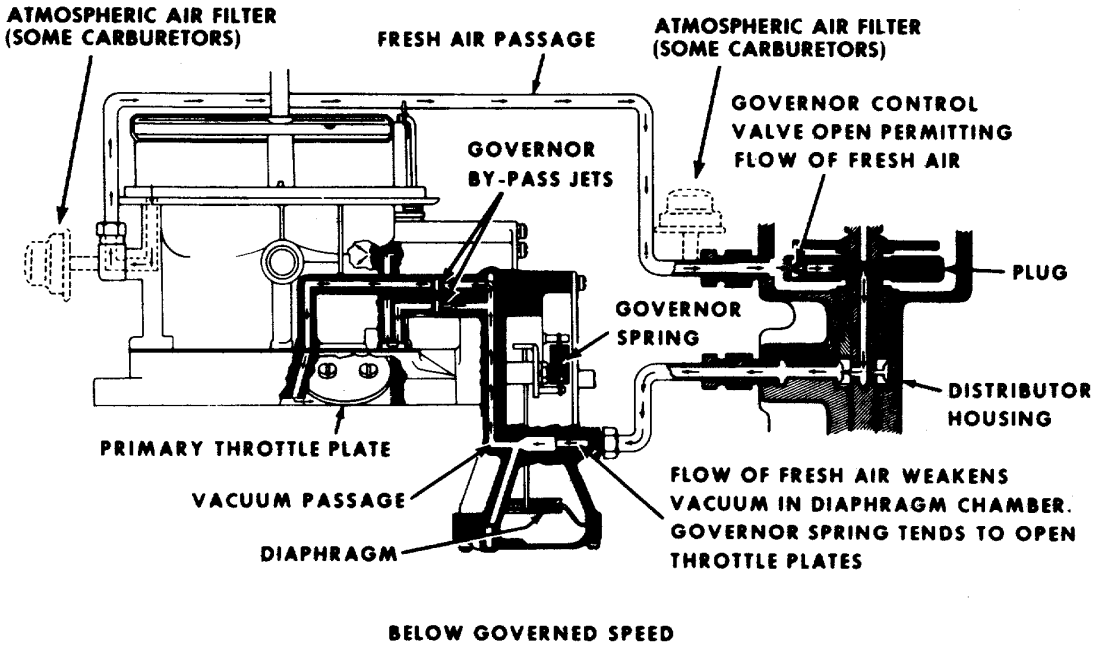
When the accelerator is released, control is taken from the governor by the external throttle lever and the return spring in the accelerator pedal linkage closes the throttle plates to bring the engine to any desired lower speed.

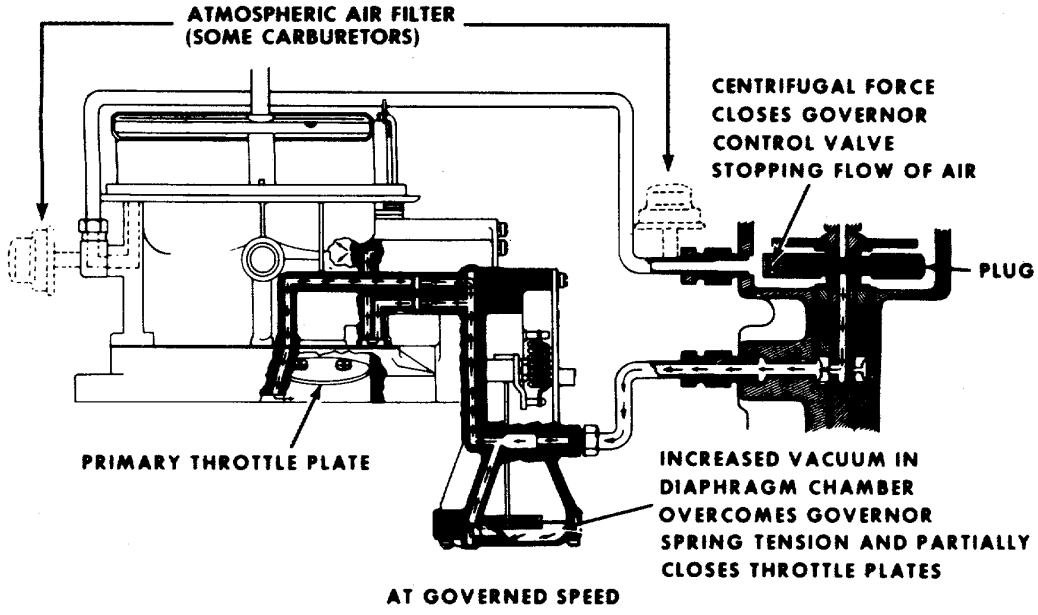
Although the entire governor system is described, only the throttle-actuating mechanism on the carburetor is included in the overhaul procedure presented in this manual. This portion of the governor can be cleaned and serviced readily; also the governor can be serviced independently.

A secondary control valve is used in conjunction with the governor. The purpose of the secondary control valve (Fig. 14) is to close the secondary throttle plates when the engine reaches full governed speed. To understand operation of the secondary control valve, let's briefly review operation of the secondary throttle system and the governor system.

The secondary throttle plates are operated by a spring-loaded diaphragm which is controlled by vacuum from the right primary venturi (Fig. 14). The secondary diaphragm spring tends to hold the secondary throttle plates closed. When engine air requirements approach the capacity of the two primary venturis, increased vacuum from the right primary venturi moves the secondary diaphragm, compressing the diaphragm spring and opening the secondary throttle plates. As the secondary throttle plates open, the secondary fuel system begins to discharge fuel and the engine is supplied by all four carburetor venturis. When engine speed is reduced, primary venturi vacuum acting upon the secondary diaphragm is lessened, and the diaphragm spring starts closing the secondary throttle plates. When the primary

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GOVERNOR OPERATION

Fig. 13

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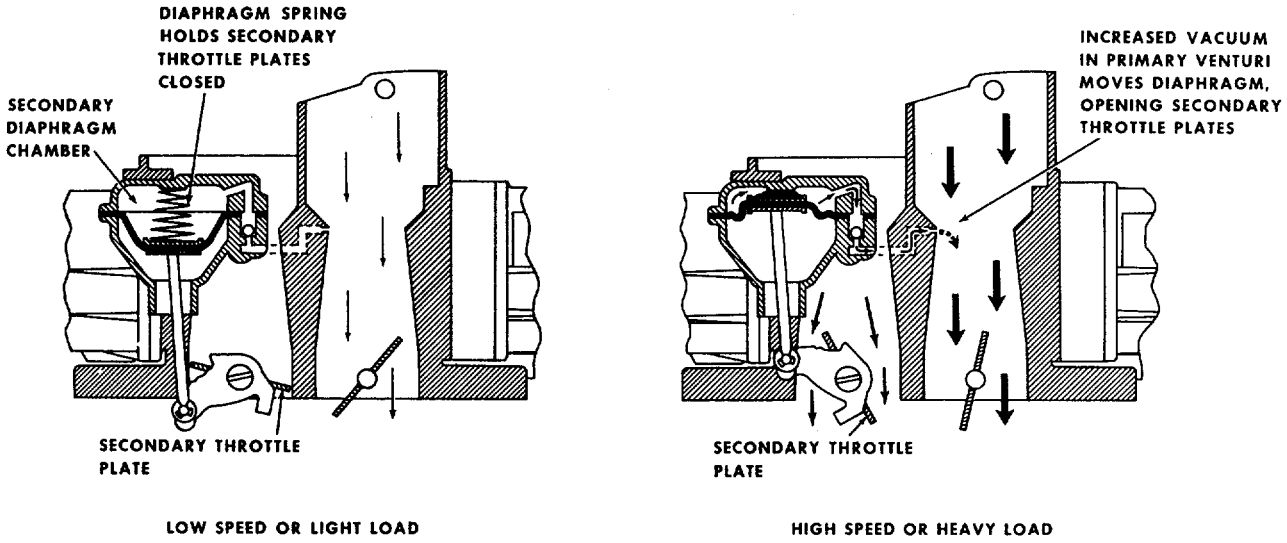


Fig. 14

throttle plates are fully closed, the secondary throttle plates are held closed mechanically by design of the secondary connecting rod.

The governor limits the maximum operating speed of the engine. The governor consists of two units: a throttle-actuating mechanism and a controlling unit. The throttle-actuating unit consists of a diaphragm assembly, governor lever and governor spring. This unit is connected to the primary throttle shaft in such a way that tension of the governor spring tends to open the throttle when the accelerator pedal is depressed. Two calibrated jets in the vacuum passages meter venturi and manifold vacuum to control the governor operating diaphragm. The control unit located in the distributor housing consists of a rotating centrifugally-operated valve which is driven by the distributor shaft at one-half engine speed. The tension of the valve spring holds the valve open. As rotation speed increases, centrifugal force acting on the valve weight overcomes spring tension closing the valve. Spring tension can be adjusted manually to regulate the speed at which the valve closes.

Below governed speed venturi and manifold vacuum draw filtered air through the open governor valve (Fig. 13). Vacuum in the diaphragm chamber, being weakened by the flow of air, is not strong enough to move the governor diaphragm. The primary throttle plates are controlled by position of the accelerator pedal.

When governed speed is reached, centrifugal force acting on the valve weight closes the valve, restricting the flow of air. The resulting increased vacuum moves the diaphragm and lever against the tension of the governor spring to partially close or prevent further opening of the primary throttle plates. Further movement of the accelerator pedal will not increase engine speed, since vacuum acting on the diaphragm holds the throttle plates in partially closed position. Governed engine speed is held constant by balance between centrifugal force on the valve weight and tension of the valve spring.

Any slight change in engine speed will cause the governor valve to react immediately either increasing or decreasing the flow of air through the valve. A change in air flow will cause an instant response from the diaphragm to increase or decrease the throttle opening. When the accelerator is released, control is taken from the governor by the throttle lever, and the accelerator return spring closes the primary throttle plates to lower the engine speed.

The secondary control valve closes the secondary throttle plates when governed speed is reached, so that the engine cruises at governed speed operating only the primary venturis. The secondary control valve is operated by governor vacuum acting upon the control valve diaphragm (Fig. 15). Below governed speed air flow through the governor ("spinner") valve weakens the vacuum acting upon the control valve diaphragm. The diaphragm spring holds

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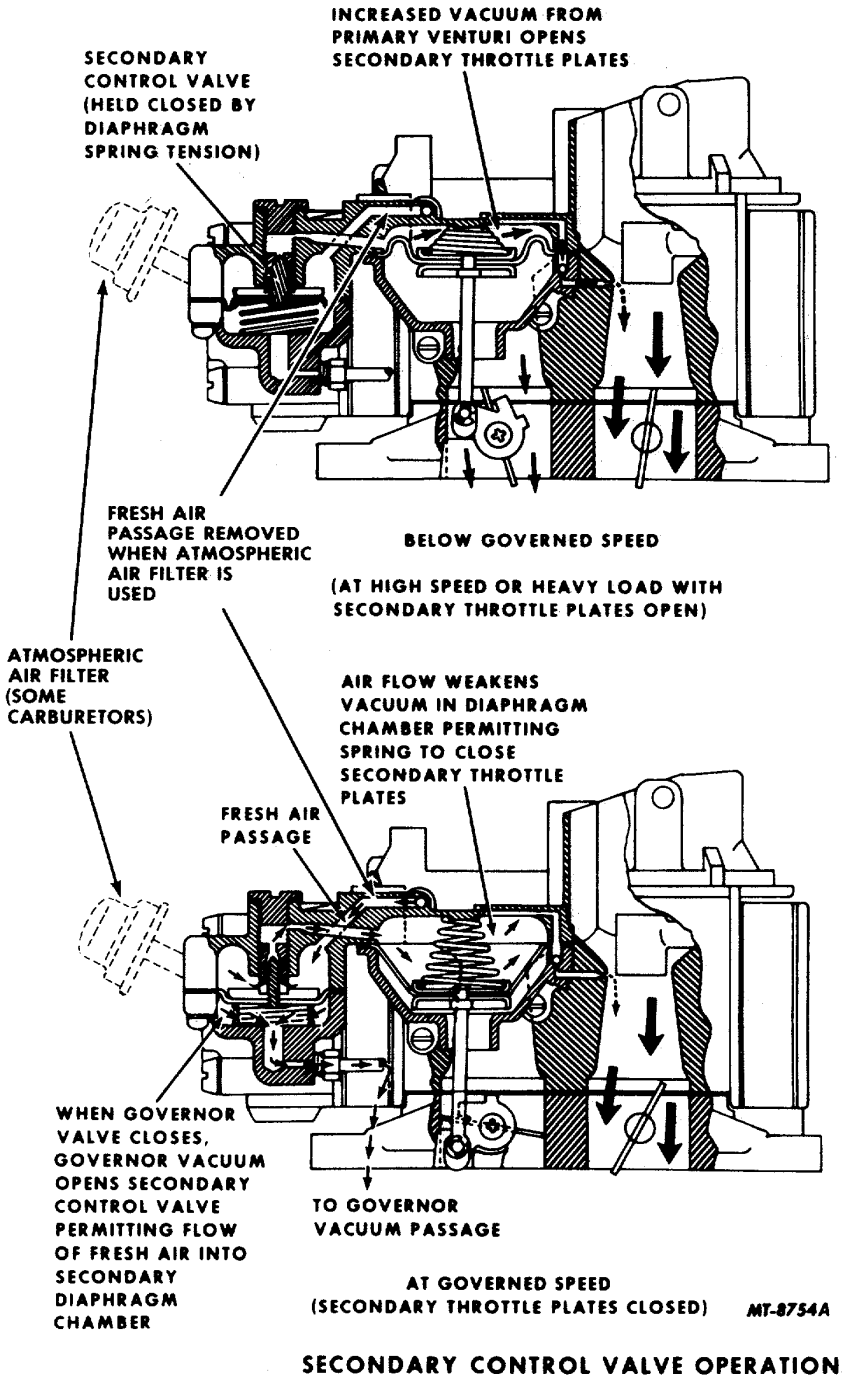


Fig. 15

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the valve closed against its seat. Primary venturi vacuum acting on the secondary diaphragm controls position of the secondary throttle plates. When governed speed is reached and the governor ("spinner") valve closes (restricting the air flow), increased vacuum moves the secondary control valve diaphragm compressing the valve spring and opens the valve. This permits a flow of fresh air through the valve into the secondary diaphragm chamber. The flow of air weakens the vacuum acting on the secondary diaphragm and allows the diaphragm spring to close the secondary throttle plates.

Malfunction of the secondary control valve can cause fluctuation of engine speed ("surging") when the governor is in effect or failure of the governor to limit engine speed. Because calibration of the control valve requires special equipment, the secondary diaphragm cover (with secondary control valve) is assembled, calibrated and sealed at the factory and furnished for service only as an assembly. Control valve components are not serviced separately.

Outlined in the following paragraphs are procedures for testing the secondary control valve. These procedures are used to determine if the control valve is satisfactory or if it should be replaced.

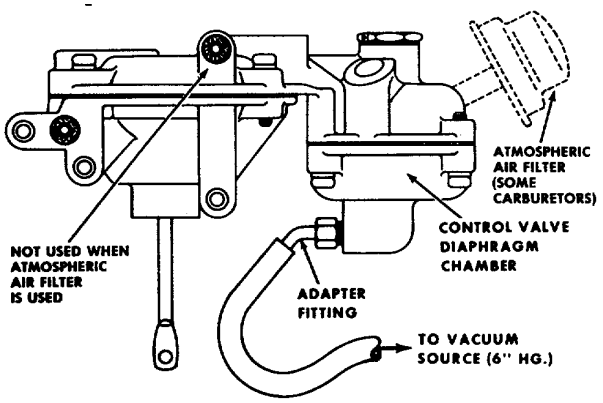
Bench Test

The following "bench" test procedure can be used to check functioning of the control valve. It is recommended that this check be made at the time of carburetor overhaul or if improper valve operation is suspected.

1. Connect a controllable vacuum source to the vacuum inlet of the control valve diaphragm chamber, as shown in Fig. 16. (Distributor tester SE-1925 or SE-1979 can be used as a vacuum source.) Apply 6 inches of vacuum to the diaphragm chamber. If vacuum holds, the control valve diaphragm is satisfactory. If vacuum cannot be maintained, diaphragm is faulty and the complete secondary diaphragm assembly should be replaced.

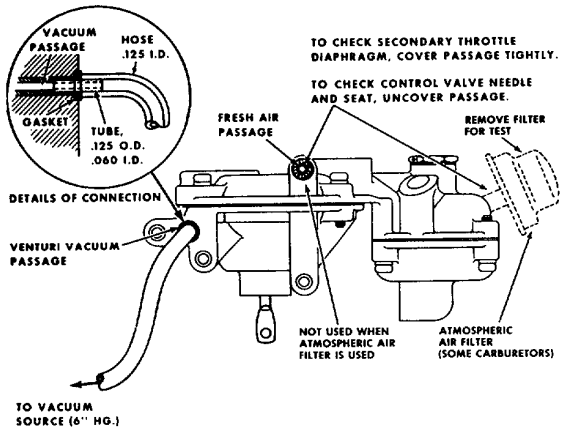
2. Connect the vacuum source to the venturi vacuum pickup passage on the back of the cover assembly, as shown in Fig. 17. Tightly cover the fresh air passage also on the back of the cover assembly. Apply 6 inches of vacuum. If secondary diaphragm moves (compresses spring) and vacuum holds, secondary diaphragm is satisfactory. If diaphragm does not move or if vacuum cannot be maintained, secondary diaphragm is faulty and should be replaced.

3. With vacuum applied as in Step 2, uncover the fresh air passage. If vacuum holds, control valve needle and seat are satisfactory. If vacuum cannot be maintained, control valve is faulty and the complete secondary diaphragm assembly should be replaced.



VACUUM CONNECTION FOR CHECKING SECONDARY CONTROL VALVE DIAPHRAGM. MT-8755A

Fig. 16



VACUUM CONNECTION FOR CHECKING SECONDARY THROTTLE DIAPHRAGM AND SECONDARY CONTROL VALVE. MT-8756A

Fig. 17

On the Vehicle Test

The "on the Vehicle" test outlined below can be used to help locate the cause for loss of governor control.

1. With the vehicle on the service floor accelerate the engine to check governor operation.

   a. Governor should limit engine speed to

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150-250 initial overrun. Adjust governor if necessary.

NOTE

Initial overrun means that under acceleration the engine will momentarily exceed governed speed by approximately 150-250 RPM and then settle to governed speed.

b. If there is no governor control, proceed with Step No. 2 below.

c. If the engine governs at light load and does not govern at wide-open throttle, the problem is probably in the secondary control valve. Proceed with Step No. 4 below.

2. Disconnect the vacuum line (distributor to governor throttle actuating unit) from the fitting at the governor unit. Leave the secondary control valve vacuum line connected. Operate the engine at 2200 RPM, wet your finger and hold it over the opening in the fitting. If the engine speed slows to approximately 1000 RPM, the governor trouble is in the governor control ("spinner") valve or the lines or connections to the governor control valve. If the engine does not slow down, proceed with Step No. 3.

3. Disconnect the secondary control valve vacuum line from the fitting and remove the fitting. Again, operate the engine at 2200 RPM and place a wet finger over the vacuum passage in the governor throttle unit. If the engine now slows to approximately 1000 RPM, the problem is in the secondary control valve or its vacuum line. If the engine does not slow down, the problem is in the governor throttle unit or the vacuum passages behind it.

4. When the problem is suspected to be in the secondary control valve, operate the vehicle on the highway and check governor operation. The governor should limit engine speed to 3600 RPM plus 150-250 RPM initial overrun. If the engine does not govern, disconnect the secondary throttle diaphragm link from the secondary throttle shaft lever. Operate the vehicle again on only the primary carburetor venturis. If the engine governs now, the problem is in the secondary control valve. Some 4150G carburetors will be equipped with a secondary throttle diaphragm assembly air filter. If the air filter becomes clogged the governor will not operate properly. To check the filter for restriction, blow through filter tube. If air does not pass freely, replace filter.

NOTE

Check air filter every 24,000 miles or 24 months whichever occurs first. In vehicles operated in dusty conditions, check for filter restrictions more frequently.

Correct operation of the secondary throttle system and the governor depends upon proper functioning of the secondary control valve. Use of the test procedures described will assist in diagnosing governor problems and checking secondary control valve operation.

Governor Final Adjustment

The step-by-step procedure outlined should be followed when making governor adjustment. NOTE: It is necessary to use a tachometer to adjust engine RPM.

Adjust the governor so that engine speed will cut off within the engine no-load cutoff range. (See specifications.)

1. Turn off ignition. Engine must be completely stopped.

2. Remove governor clamp and gasket assembly.

3. Turn engine over until adjusting screw hole plug appears in the opening.

4. Remove plug with 1/8" Allen Wrench (Fig. 18).

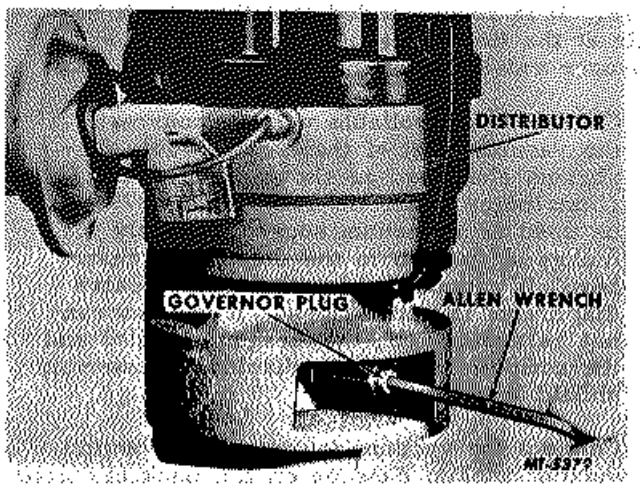


Fig. 18 Using Allen Wrench to Remove Governor Plug.

5. Insert slotted end of SE-2072-2 governor adjusting tool firmly in hole, engaging adjusting tang (Fig. 19). Turn the handle clockwise to decrease speed and counter-

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clockwise to increase the speed; 1/4 turn will change the speed approximately 100 RPM.

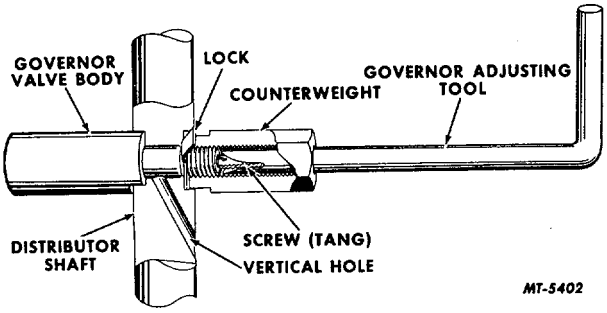


Fig. 19 Adjusting Governor Using Tool SE-2072-2.

NOTE

The adjusting screw is of a special design and cannot be adjusted with a screwdriver or by any device other than this tool.

6. Reinstall plug with 1/8" Allen Wrench. Plug must be installed when checking governor speed.

7. Reinstall governor clamp and gasket assembly.

8. Reinstall governor seal.

Redundant Throttle Closing Linkage

The model 4150G carburetors appearing on vehicles produced after September 1, 1973 are equipped with redundant throttle closing linkage as an added safety feature. The purpose of this redundant linkage is to return the throttle to the idle position in event the throttle return spring becomes disconnected or linkage breaks.

The redundant linkage consists of a safety spring, trip lever, retaining lever and throttle lever as shown in Fig. 20. Under normal operation the safety spring is held in a coiled (loaded) position by the notch in the retaining lever and tab of the trip lever. The throttle return spring supplies the force necessary to keep the notch and tab engaged. In the loaded position, the throttle lever may be operated with the usual restraining force of the throttle return spring.

In event the throttle return spring becomes disconnected, the notch and tab will become disengaged allowing the force of the loaded safety spring to snap the throttle to the idle position. Although vehicles may be driven in this condition the redundant throttle closing linkage should be reloaded as soon as possible.

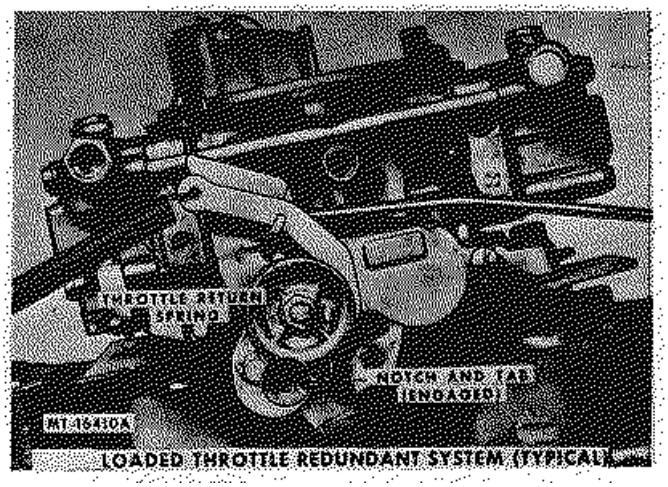


Fig. 20 Redundant Throttle Closing Linkage.

IN-TRUCK ADJUSTMENTS AND REPAIRS

Fuel Bowl and Gasket and Metering Block and Gasket Replacement

Removal:

1. Remove the fuel inlet line and vacuum line.

2. Place a suitable container under the fuel bowl and drain the bowl by loosening one of the lower fuel bowl retaining screws. Remove the container.

3. Remove the four fuel bowl retaining screws.

4. Remove the fuel bowl and gasket and metering block and gasket. Discard the gaskets.

5. If the fuel bowl or metering block is being replaced, transfer the parts.

Installation:

4150 carburetor rebuild kits have two different metering block gaskets. Fig. 21 illustrates the difference between early and late production gaskets.

1. Position the metering block gasket on the dowels on the back of the metering block.

2. Lay the metering block in place on the main body.

3. Position the fuel bowl gasket on the metering block.

4. Place the retaining screws and new compression gaskets in the fuel bowl.

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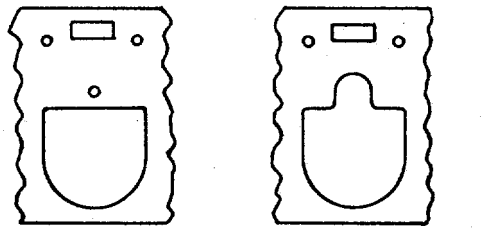


Fig. 21

5. Lay the fuel bowl in place on the metering block and tighten the retaining screws to 25-30 inch pounds.

NOTE

When positioning fuel bowl the accelerating pump lever must be slightly depressed to clear the diaphragm pump lever. When spring loaded bowl screws are used the following procedure should be used.

Tighten each spring loaded bowl screw by rotating screw head until screw assembly bottoms in main body. Bottoming of screw assembly is accomplished when screw head "springs back" about one quarter (1/4) turn when screw driver is removed from slot. Excessive rotation of screw head can destroy spring.

Power Valve or Fuel Enrichment Valve and Gasket Replacement

Removal:

1. Remove the fuel bowl and metering block.
2. Using a socket wrench, SE-1772-1, remove the power valve or fuel enrichment valve and gasket.
3. Discard the gasket.

Installation:

1. Place a new gasket on the specified power valve or fuel enrichment valve.
2. Using a socket wrench, SE-1772-1, install the power valve or fuel enrichment valve and gasket. Torque to 50 inch pounds.
3. Install the fuel bowl and metering block.

Main Jet Replacement:

1. Remove the fuel bowl and metering block.
2. Using a jet wrench, SE-1772-6, remove the jets.

Installation:

1. Using a jet wrench, SE-1772-6, install the jets.
2. Install the fuel bowl and metering block.

Accelerating Pump Diaphragm Replacement

Removal:

1. Remove the fuel bowl and metering block.
2. Remove the accelerating pump cover, diaphragm and spring.
3. If it is necessary to remove the synthetic valve, grasp it firmly and pull it out. If the valve tip broke off during removal, be sure to remove the tip from the fuel bowl. The valve must be replaced whenever it has been removed. Install valve by lubricating the tip. Insert the tip into the accelerator pump cavity center hole. Using a pair of needle nose pliers, reach into the fuel bowl and grasp the valve tip. Pull the valve in until it seats in the pump chamber.

   In some 4150 carburetor fuel pump cavities there will be a very small bleed hole from the fuel bowl. This bleed hole allows vapor pressure to escape from the fuel pump cavity into the fuel bowl. This pressure bleed off prevents fuel spill over through the fuel pump discharge nozzles. The bleed hole must be checked to make sure it is not clogged. It can be cleared with air pressure.

Installation:

1. Before accelerator pump diaphragm installation check accelerator pump inlet check ball travel (where used)(Fig. 22). Clearance between ball and retainer bar is specified at .011"-.017". (Best operation can be expected with clearance set at low end of specifications .011"-.014".) Adjustment is made by bending retainer bar. If adjustment is necessary, extreme care must be taken to prevent possible damage to ball and/or seat

NOTE

It is emphasized that the check ball

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setting mentioned above is a critical item in obtaining instant pump response to throttle movement. Ball travel in excess of .017" can easily cause a lag in fuel injection.

2. Place the spring and diaphragm in the accelerating pump chamber. The diaphragm must be positioned so that the flat head of the rivet protrudes from the fuel bowl.

3. Install the pump cover and screw.



Fig. 22

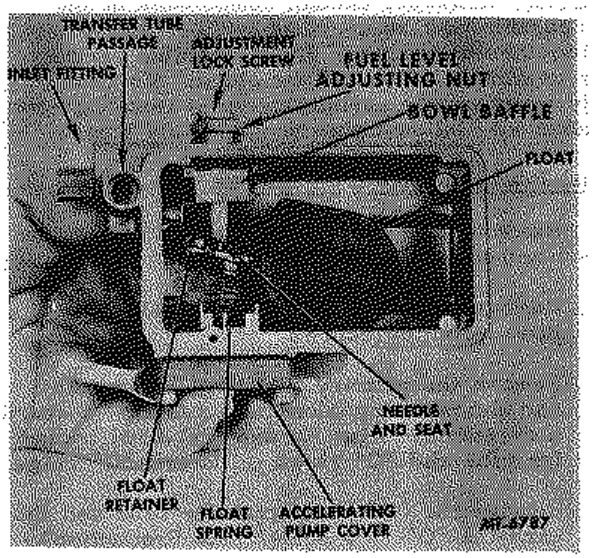


Fig. 23

Float Replacement

Replacement:

1. Using needle nose pliers, remove the float retainer.

2. Slide the float off the shaft.

3. Remove the spring from the float.

4. Note color of floats before removing.

Installation:

1. Install the float spring on the float.

2. Slide the (correct color) float on the shaft.

3. Install the float retainer.

Fuel Inlet Needle and Seat Replacement

The fuel inlet needle and seat assembly can be replaced without removing the fuel bowl.

Removal:

1. Remove the air cleaner.

2. Remove the fuel level adjustment lock screw and gasket. Turn the adjusting nut out and remove the adjusting nut and gasket. Remove the fuel inlet needle and seat assembly. Do not disassemble the fuel inlet needle and seat assembly. They are matched parts and are serviced as an assembly.

Installation:

Coat "O" ring with engine oil before installing needle and seat assembly.

1. Position the fuel inlet needle and seat assembly in the fuel bowl.

2. Position the adjusting nut gasket and nut on the fuel inlet needle and seat assembly. Align the flat on the I. D. of the nut with the flat on the 0. D. of the fuel inlet needle and seat assembly.

3. Install the fuel level adjustment lock screw and gasket.

4. Adjust the fuel level.

REMOVAL AND INSTALLATION

CAUTION

Additional care should be exercised when servicing 4150G model carburetors equipped with redundant throttle closing linkage. Whenever the throttle return spring is disconnected at either end, the throttle linkage at the carburetor will snap to a closed position under a spring force sufficient to cause personal

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injury. It is essential, to prevent personal injury, that all instructions be followed in the stated order and hands be kept clear of carburetor throttle linkage when connecting or disconnecting the throttle return spring.

Removal:

1. Remove the air cleaner.
2. Disconnect the throttle return spring.
3. Remove the throttle rod from the throttle lever. Disconnect the choke control cable and the fuel line. Disconnect the governor lines from the carburetor. If so equipped, remove automatic transmission control cable.
4. Remove the carburetor, spacer and gaskets.

Installation:

1. Clean the gasket surface of the intake manifold. Place the spacer and gasket in position on the manifold. Position the carburetor on the manifold and install the lock washers and nuts. Torque the nuts alternately to 12-15 ft.lbs.
2. Connect the throttle rod. Connect the choke control cable. Be sure the end of the choke cable is bent downward to prevent interference with the bottom of the air cleaner. This interference will restrict opening of the choke plate. Connect the fuel line, governor lines and automatic transmission control cable if so equipped.
3. Reload redundant throttle closing linkage. Loading the linkage is accomplished by rotating the throttle lever to wide open throttle (clockwise in Fig. 24) by moving accelerator control rod to the right. Do not rotate throttle lever directly, since it will snap to the closed position, then attach throttle return spring to the trip lever. Secure opposite end of throttle return spring to throttle return spring anchor bracket. Slowly return throttle lever to idle position.
4. Adjust the idle speed, the primary and secondary fuel level and idle fuel mixture.
5. Replace the air cleaner.

MAJOR REPAIR OPERATIONS

Disassembly:

To facilitate working on the carburetor and to prevent damage to the throttle plates, install bolts about 2-1/4" long of the correct diameter through the carburetor retaining bolt holes with a nut above and below the flange (or install carburetor legs).

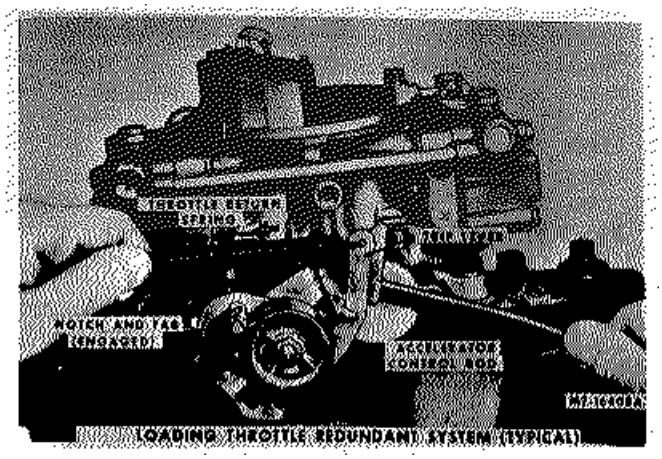


Fig. 24 Reloading Throttle Redundant Closing Linkage.

Use a separate container for the component parts of the various assemblies to facilitate cleaning, inspection and assembly.

The following is a step-by-step sequency of operations for completely overhauling the carburetor; however, certain components of the carburetor may be serviced without disassembling the entire unit. For a complete carburetor overhaul, follow all the steps. To partially overhaul the carburetor or to install a new gasket kit, follow only the applicable steps.

Fuel Bowls and Metering Blocks

Refer to Fig. 25 for the removal of the fuel bowl and metering block.

1. Remove four spring loaded primary fuel bowl mounting screws.
2. Remove the primary fuel bowl and gasket and the metering block and gasket. Discard the gaskets. Also remove fuel bowl transfer tube and "O" rings. Discard "O" rings.
3. Remove the fuel pump transfer tube and discard the "O" ring seals (Late Production)
4. Using a socket wrench, SE-1772-1, remove the power valve and gasket (Fig. 26).
5. Using a jet wrench, SE-1772-6, remove the main jets (Fig. 27).
6. Remove the distributor vacuum fitting or plug from the metering block.

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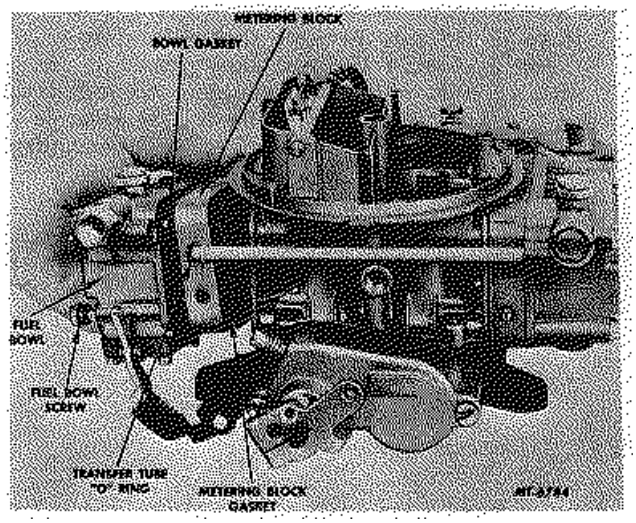


Fig. 25 Removal of the Fuel Bowl and Metering Block (Typical).

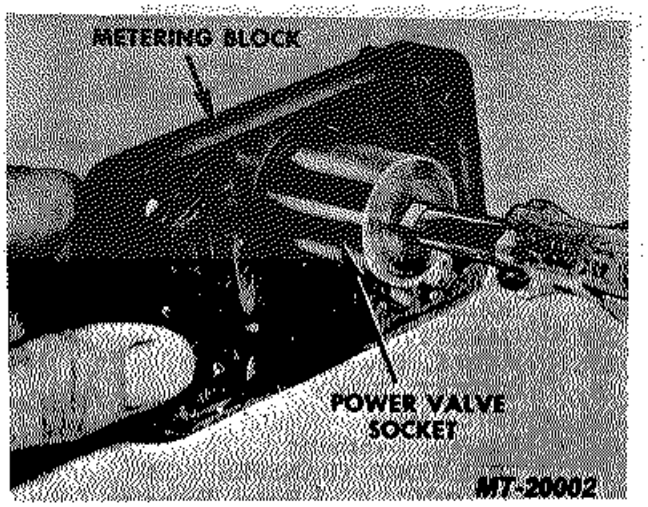


Fig. 26 Using Socket Wrench SE-1772-1 to Remove Power Valve

7. Remove the fuel level adjustment lock screw and gasket. Turn the adjusting nut counterclockwise and remove the lock nut and gasket. Remove the fuel inlet needle and seat assembly. Do not disassemble the fuel inlet needle and seat. They are matched assemblies and are replaced as an assembly (Fig. 23).

8. Using needle nose pliers, remove the float retainer (Fig. 23). Slide the float (noting color) off the shaft. Remove the spring from the float.

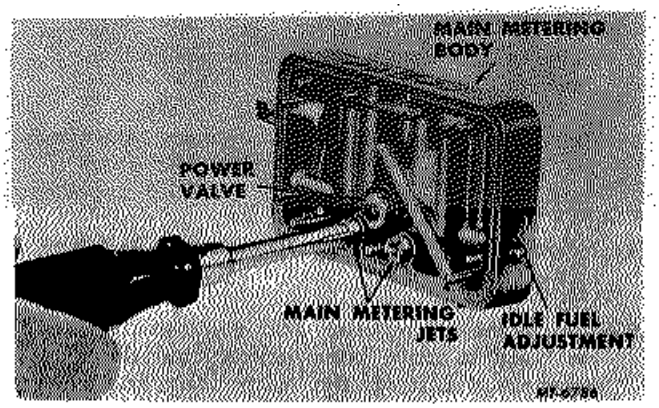


Fig. 27 Using Jet Wrench SE-1772-6 to Remove Main Jets.

9. Remove the baffle plate from the fuel bowl.

10. Remove the fuel level sight plug and gasket.

11. Remove the fuel inlet fitting, gasket and filter screen.

12. Invert the fuel bowl and remove the accelerating pump cover, diaphragm and spring. The accelerating pump inlet ball check (where used) is not removable.

    Remove synthetic valve where used) as outlined in "Accelerating Pump Diaphragm Replacement".

13. Remove the secondary fuel bowl and gasket and the metering block and gasket. Discard the gaskets.

14. Remove the following parts from the secondary metering block: Using a jet wrench, SE-1772-6, remove the main jets (Fig. 27).

    Using a socket wrench, SE-1772-1, remove the power valve and gasket (Fig. 26). Discard the gasket. Remove the idle adjusting needles and gaskets. Discard the gaskets.

15. Disassemble the secondary fuel bowl by following Steps 6, 7, 8, 9 and 10. Refer to Fig. 28 for complete disassembly of fuel bowl and metering block.

Main Body

1. Remove the air cleaner anchor stud and

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remove the secondary diaphragm link retainer.

2. Remove the choke control lever and the governor housing cover.

3. Remove the nut and lock washer retaining the governor lever to the throttle shaft, then remove the governor housing assembly.

4. Remove the secondary diaphragm link retainer.

5. Invert the carburetor and remove the throttle body to main body screws and lock washers. Lift off the main body and remove the main body gasket. Discard the gasket.

6. Remove the retainer securing the choke rod to the choke rod lever and bushing assembly, then remove the lever retainer and remove the lever and lever spring.

7. Remove the secondary diaphragm housing and gasket from the main body. The housing must be removed before the cover can be removed. Remove the diaphragm housing cover, then remove the spring, diaphragm and the secondary vacuum ball check. Remove the control valve tube. The secondary control valve is factory adjusted and should not have to be disassembled.

8. Remove the accelerating pump discharge nozzle screw, then lift the pump discharge nozzle and gasket out of the main body. Invert the main body and let the discharge needle fall into the hand.

Governor Housing

1. Remove and discard the governor housing seal.

2. Mark the governor spring pin hole to facilitate assembly. Remove the spring and pin if damaged.

3. Remove the diaphragm rod retainer and governor lever.

4. Remove the governor line fitting. Make a note of the governor bypass jet numbers and their positions. Remove the bypass jets, the diaphragm cover and the diaphragm.

5. Remove the fast idle camshaft retainer and slide the fast idle cam and shaft out of the housing.

Remove the cam plunger, spring and fast idle pin.

Throttle Body Redundent Linkage

1. If so equipped, remove the redundant throttle closing linkage safety spring retaining nut, retaining washer, spring drum and spacer washer. Unhook and remove the safety spring, trip lever and retaining lever.

2. Remove the accelerating pump lever and the throttle operating shaft housing.

Legend for Fig. 28

Key	Description
1	RETAINER, Float Shaft
2	FLOAT, Assembly
3	SPRING, Float
4	PLATE, Baffle
11	SCREW, Lock, Fuel Valve Seat
12	GASKET, Fuel Valve Seat Screw
13	NUT, Adjusting, Fuel Valve Seat
14	GASKET, Fuel Valve Seat Adjusting Nut and Gasket
15	SEAT, Fuel Valve, Assembly
16	"O" RING, Fuel Valve Seat
17	PLUG, Check, Fuel Level
18	GASKET, Fuel Level Check Plug
19	SCREW, Fuel Pump Cover
20	COVER, Accelerating Pump, Assembly
21	DIAPHRAGM, Accelerating Pump
22	SPRING, Accelerating Pump Diaphragm
23	FITTING, Fuel Inlet
24	GASKET, Fuel Inlet Fitting
25	SCREEN, Filter, Fuel Inlet
26	GASKET, Metering Body
27	VALVE, Power, Assembly
28	GASKET, Power Valve
31	JETS, Main
32	VALVE, Synthetic
33	FUEL PUMP TRANSFER TUBE
34	"O" RING, Fuel Pump Transfer Tube

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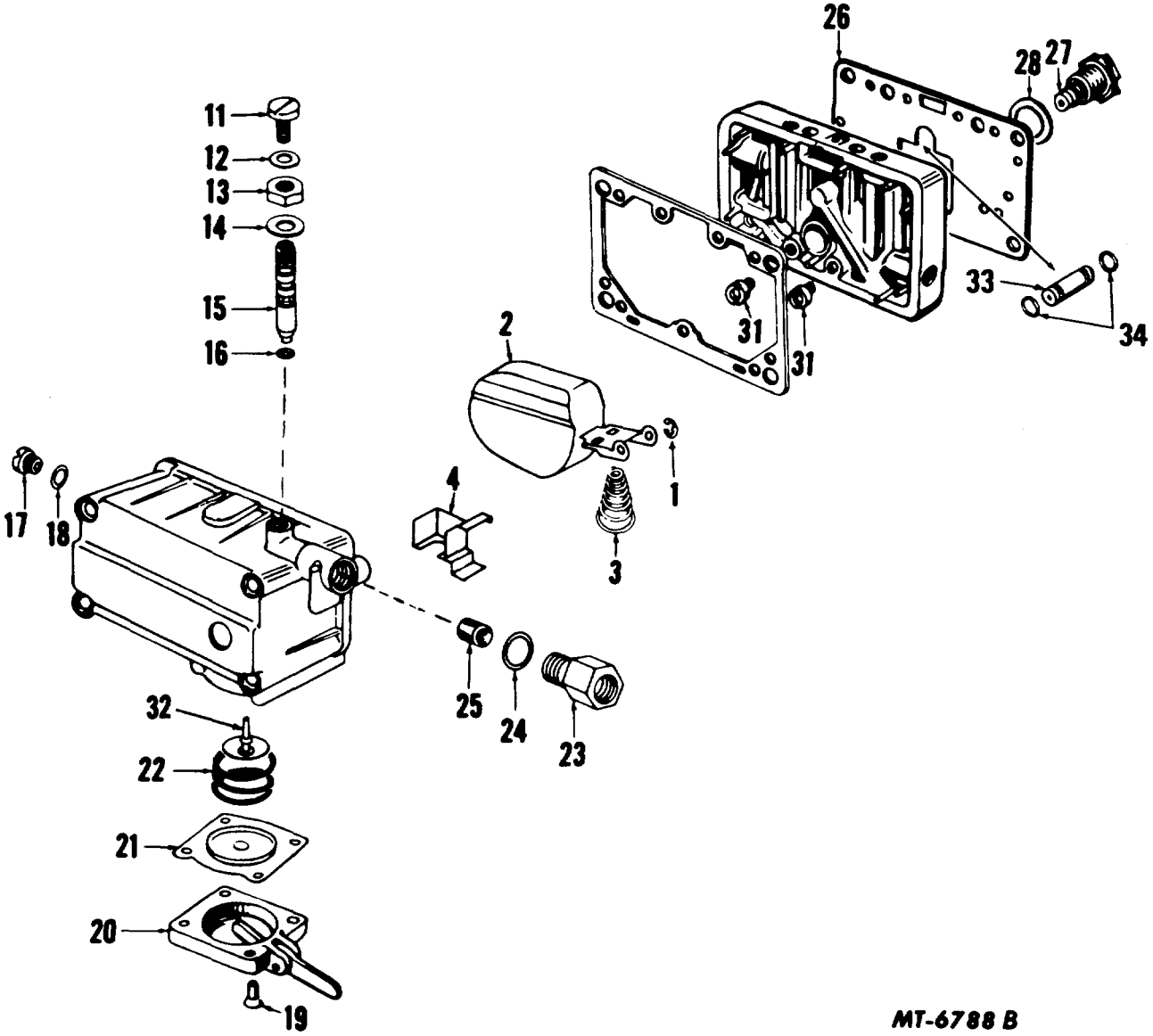


Fig. 28 Exploded View of Fuel Bowl and Metering Block.

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Throttle Operating Housing

1. Straighten lock tab on throttle operating shaft nut lock and remove nut, lock and washer.

2. Hold redundant spring concentric with throttle operating shaft and remove spring drum.

3. Remove "spacer" washer.

4. Release redundant spring from long spring perch and remove redundant spring.

5. Remove catch lever bushing and pin assembly.

6. Remove trip lever.

7. Remove accelerator pump operating lever assembly retainer.

8. Remove the two throttle operating housing screws and remove housing assembly.

9. Straighten lock tabs on throttle operating driver (inside throttle operating housing).

NOTE

Position the flats of the throttle shaft driver in relation with the idle adjusting screw.

10. Remove operating lever and shaft assembly.

11. Remove pump cam retainer screw, noting hole position and reference number on cam and lever. The cast numbers on the cam are facing toward the throttle operating housing. Then remove cam (do not put cam in carburetor cleaner).

12. Remove the (hot engine) idle screw and spring.

CLEANING AND INSPECTION

Dirt, gum, water or carbon contamination in the carburetor or the exterior moving parts of the carburetor are often responsible for unsatisfactory performance. For this reason efficient carburetion depends upon careful cleaning and inspection.

The cleaning and inspection of only those parts not included in the carburetor overhaul repair kit are covered here. All gaskets and parts included in the repair kit should be installed when the carburetor is assembled and the old gaskets and parts should be discarded.

Wash all parts except the nitrophyl carburetor float (if so equipped), the accelerating pump diaphragm, the power valve or power valve diaphragm, the secondary throttle diaphragm, the governor diaphragm, in clean commercial carburetor cleaning solvent.

Rinse the parts in hot water to remove all traces of the cleaning solvent and then dry all of them with compressed air. Wipe all parts that cannot be immersed in solvent with a clean, soft, dry cloth. Be sure all dirt, gum, carbon and other foreign matter are removed from all parts.

Replace the float if the arm needle contact point is grooved. If the float(s) is serviceable, polish the needle contact surface of the arm with crocus cloth or steel wool.

Force compressed air through all passages of the carburetor. Do not use a wire brush to clean any parts or a drill or wire to clean out any openings or passages in the carburetor. A drill or wire may enlarge the hole or passage, changing the calibration of the carburetor.

Check the choke shaft for grooves, wear, and excessive looseness or binding. Inspect the choke plate for nicked edges and for ease of operation. Free the shaft and plate if necessary.

Check the throttle shaft(s) in its bore for binding. Check the throttle plate(s) for burrs which prevent proper closure.,

Check the action of the poppet valves in the choke plate. Free them if necessary.

Inspect the main body (main body surfaces must be flat, check from corner to corner and both directions in the center), throttle body, metering block, air horn, nozzle bars, booster venturi assemblies, power valve, accelerating pump cover and the secondary diaphragm housing for cracks.

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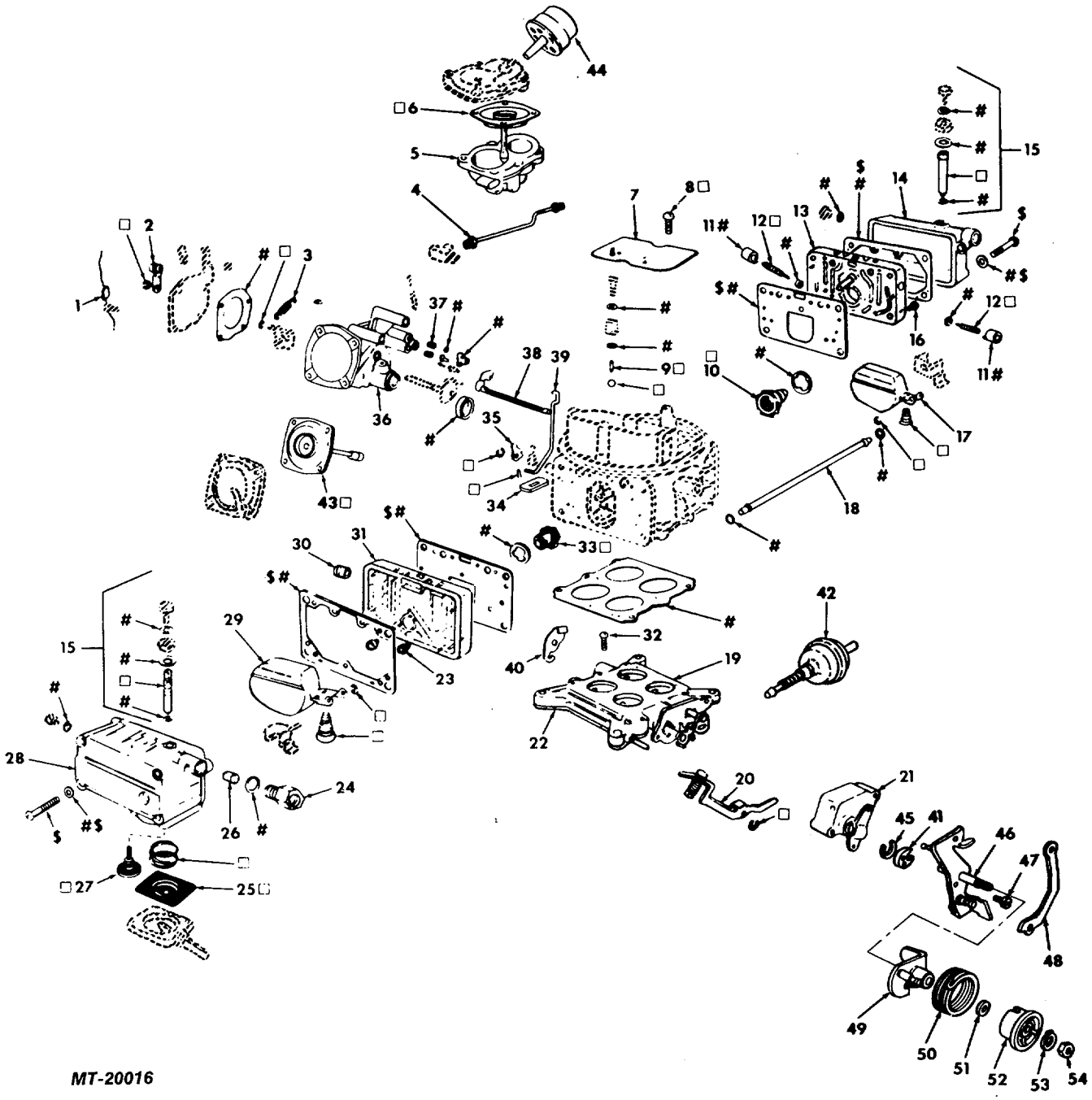


Fig. 29 Exploded View of Carburetor (Typical).

LEGEND FOR FIG. 29

Key	Description
1	WIRE, Governor Cover
2	LEVER, w/Swivel, Choke
3	SPRING, Governor
4	PIPE, Fuel Control Valve
5	PUMP, Secondary Accel.
6	DIAPHRAGM, Accel. Pump Secondary
7	PLATE, Choke
8	SCREW, Choke Plate
9	NEEDLE, Pump Discharge Nozzle
10	NOT USED
11	STOP, Adjusting Needle
12	NEEDLE, Idle Adjusting
13	BODY, Not Serviced Separately
14	BOWL, w/Plugs, Float - Secondary
15	VALVE, Carb. Fuel Inlet, Assy.
16	JET, Main Secondary
17	FLOAT, Fuel Secondary
18	TUBE, Fuel Level Secondary
19	BODY, Not Serviced Separately
20	LEVER, Accelerator Pump, Assy.
21	HOUSING, Throttle Operator Shaft Assy.
22	GASKET, Carburetor Mounting
23	JET, Main Primary
24	FITTING, Fuel Inlet
25	DIAPHRAGM, Accel. Pump Assy.
26	SCREEN, Fuel Filter
27	VALVE, Accel. Pump Check
28	BOWL, w/Plugs Float - Primary
29	FLOAT, Fuel Primary
30	ELBOW
31	BODY
32	SCREW, Throttle Plate
33	VALVE, Power Jet Primary
34	SEAL, Choke Rod
35	LEVER, w/Bushing, Choke Rod
36	GOVERNOR, w/Diaphragm Assy.
37	NOT USED
38	SHAFT, w/Lever, Choke
39	ROD, Choke
40	LEVER, Diaphragm Assy.
41	CAM, Accelerator Pump Operating
42	CHAMBER, Vacuum Throttle Modulator
43	DIAPHRAGM, Governor Assy.
44	CLEANER, Air
45	RETAINER, Throttle Operating Shot
46	LEVER, Throttle Operating
47	SCREW, Accel. Pump Cam
48	LEVER, Trip
49	LEVER, Catch
50	SPRING, Redundant
51	WASHER, (Spacer)
52	BUSHING, Spring
53	LOCK, Washer
54	NUT

Replace all damaged screws, nuts and springs. Inspect all gaskets and mating surfaces. Clear all passages with compressed air.

ASSEMBLY

Make sure all holes in the new gasket have been properly punched and that no foreign material has adhered to the gaskets. Make sure the accelerating pump diaphragm, secondary operating diaphragm and governor operating diaphragm are not cut or torn.

An exploded view of the carburetor is shown in Fig. 29.

Throttle Operating Housing

Refer to Figs. 29 and 30 for the correct location of the parts.

1. Install the engine (HOT) idle screw and spring in the throttle operating housing. Turn the screw in until spring tension is felt.

2. Install the pump cam retainer screw noting hole position and reference number on cam and lever. The cast number on the cam should face toward the throttle operating housing. Then install the cam.

3. Install the operating lever and shaft assembly. Position the flats of the throttle shaft driver in relation with the hot idle adjusting screw (see Step 9 of disassembly).

4. Bend locking tabs on throttle shaft driver lock washer.

5. Install the accelerating pump lever and the secondary throttle plate operating lever.

6. Install two throttle operating shaft housing assembly screws in throttle operating shaft housing.

7. While holding the primary throttle plate in the closed position, assemble the throttle operating shaft housing on the throttle body and tighten screws securely.

8. If the carburetor is equipped with a safety throttle redundant spring, install the catch lever assembly on the throttle operating lever shaft.

9. Install the trip lever over the shaft redundant spring perch.

10. Install throttle operating shaft spacer on throttle operating shaft.

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11. Install the curved end of the redundant spring on the short spring perch.

12. Install the short straight end of the redundant spring on the long spring perch.

13. Holding the redundant spring concentric with the throttle operating shaft, install the redundant spring bushing.

14. Install the throttle operating shaft nut lock washer on the throttle operating shaft.

15. Install the throttle operating shaft nut, tighten securely, and bend tab on lock washer to retain nut.

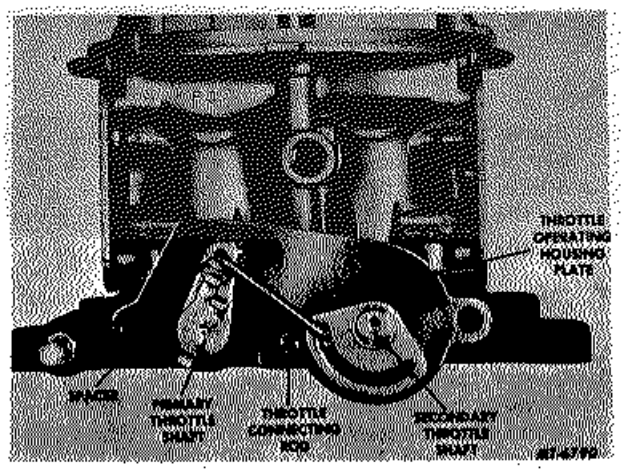


Fig. 30 Throttle Operating Housing Plate.

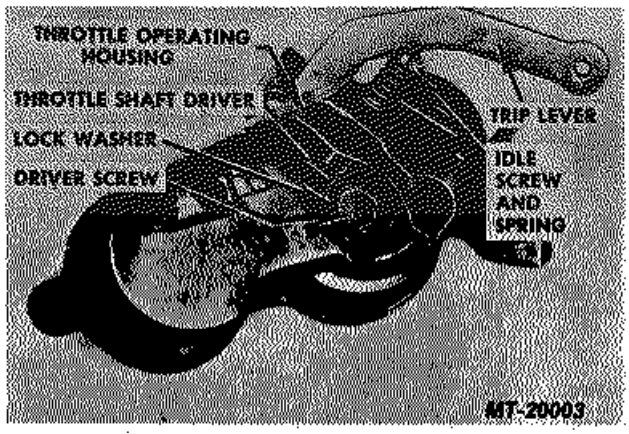


Fig. 31 Throttle Operating Housing Assembly.

Governor Housing

Refer to Figs. 29-32 for the correct location of the parts.

1. Place the fast idle pin in position in the governor housing.

2. Insert the fast idle cam plunger spring in the plunger and install the assembly in the governor housing.

3. Slide the fast idle cam assembly into position and install the retainer.

4. Install the governor bypass jets and the governor line fitting.

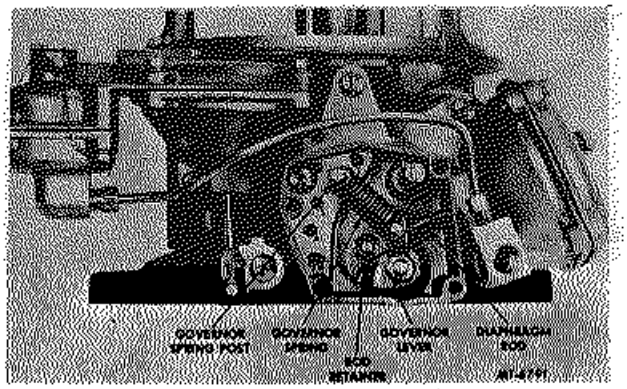


Fig. 32

5. Install the governor spring pin in the same hole from which it was removed if it were removed.

6. Position the governor diaphragm in the governor housing. Position the diaphragm properly to avoid damage by the screws. Install the cover with the screws and tighten securely. Install new safety wire and a seal.

7. Place the governor lever in the housing and insert the diaphragm rod on the stud. Install the rod retainer.

8. Housing is installed after the throttle body is assembled to the main body.

Main Body

1. Drop the accelerating pump discharge needle into its well (Fig. 33) governed carburetor.

   On nongoverned carburetors drop check ball into its well (Fig. 34) nongoverned carburetor.

2. Seat the needle with a brass drift and light hammer. Make sure the needle is free.

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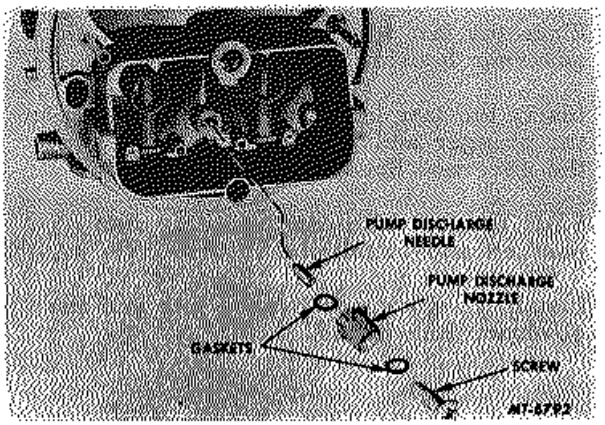
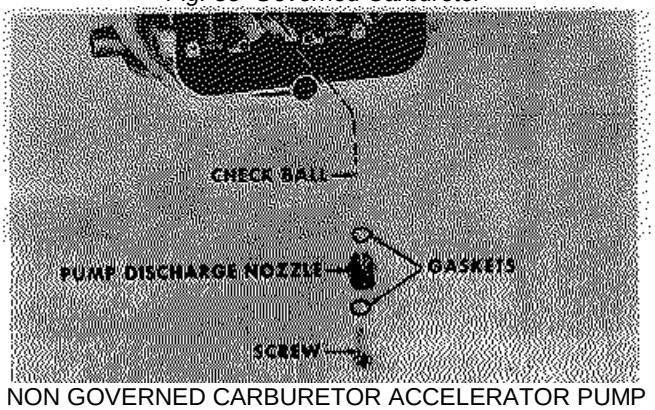


Fig. 33 Governed Carburetor



NON GOVERNED CARBURETOR ACCELERATOR PUMP DISCHARGE

MT-729

Fig. 34 Nongoverned Carburetor

3. Position the accelerating pump discharge nozzle gasket and nozzle in the main body, then install the retaining screw and gasket.

4. Drop the secondary vacuum ball check in the vacuum passage in the secondary diaphragm housing (Fig. 35).

5. Because calibration of the control valve requires special equipment, the secondary diaphragm cover (with secondary control valve) is assembled, calibrated and sealed at the factory and furnished for service only as an assembly. Control valve components are not serviced separately.

6. Place the gasket on the secondary vacuum and clean air passage openings on the main body (Fig. 36). Lay the diaphragm housing in position on the main body and install the lock washers and retaining screws.

7. Place the choke rod lever spring on the lever with the end of the spring with largest hook on the lever (Fig. 36).

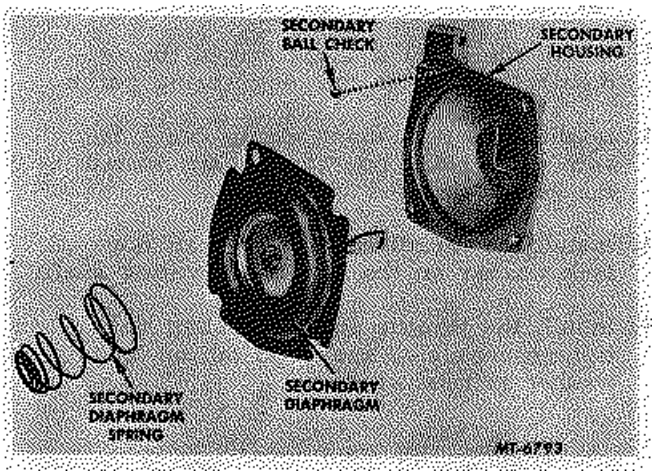


Fig. 35

8. Place the choke rod lever and spring assembly in position on the main body with the other end of the spring fitting in the groove in the main body. Install the choke lever retainer (Fig. 36).

9. Secure the choke rod to the lever with a pin retainer (Fig. 36).

10. Invert the main body and position the throttle body gasket on the main body. Slide the secondary diaphragm rod onto the operating lever as the throttle body is placed into position. Install the diaphragm operating rod retainer.

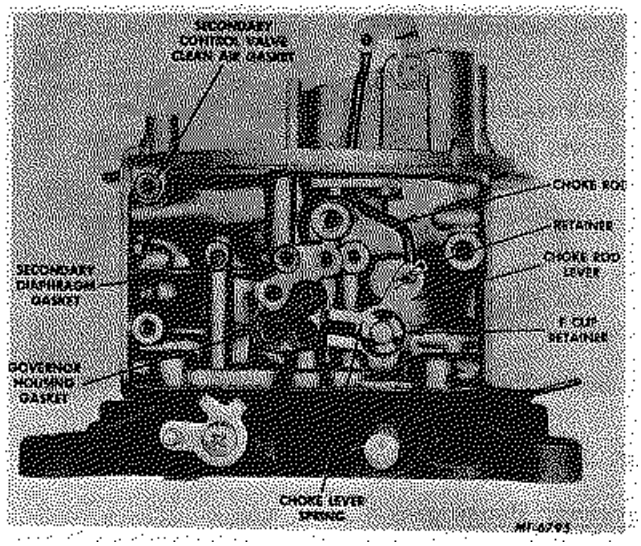


Fig. 36

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11. Install the throttle body to main body screws and lock washers.

12. Install the air cleaner anchor stud.

13. Position the governor housing gaskets on the main body. Install the governor body seal on the governor housing, then slide the housing on the throttle shaft so that with the choke plate closed the protruding stud on the fast idle cam lever is in the slot of the choke rod lever tang. As the governor body is placed into position, insert the end of the throttle shaft into the governor (Fig. 36).

14. Install the governor housing retaining screws and the governor lever lock washer and nut. The governor lever should hold the primary throttle plates wide open.

15. Be sure the primary throttle plates are closed and the choke plate is open. Adjust fast idle screw to the correct specification. See fast idle procedure setting.

16. Install the governor housing cover and the choke swivel. The choke swivel should open and close the choke plate.

17. Install seal wire through opposite screws on cover insert seal and crimp.

Fuel Bowls and Metering Blocks

Refer to Fig. 28 for the correct location of the fuel bowl parts.

The primary and secondary fuel bowls and metering blocks are installed on the main body in the same sequence (Fig. 29).

1. Place the accelerating pump diaphragm spring and diaphragm in the accelerating pump chamber of the primary fuel bowl. The diaphragm must be positioned so that the flat end of the rivet will be against the pump lever. Install the cover screws and tighten securely.

2. Install the fuel level sight plug and gasket.

3. Slide the baffle plate on the ridges in the fuel bowl (Fig. 23).

4. Install the float spring on the float and slide the float on the shaft. Be sure the float spring is between the ridges and the boss on the floor of the fuel bowl. Using needle nose pliers, install the float retainer.

5. Apply Vaseline to a new "0" ring seal and slide it on the fuel inlet needle and seat assembly.

6. Position the fuel inlet needle and seat assembly in the fuel bowl through the top of the bowl. Position the adjusting nut gasket and nut on the fuel inlet needle and seat assembly. Align the flat on the I.D. of the nut with the flat on the O.D. of the fuel inlet needle and seat assembly. Install the fuel level adjustment lock screw and gasket.

7. As a preliminary primary float adjustment, adjust the float so that the top of the float or horizontal line in the center of the float is parallel to the bowl floor with the bowl in an inverted position (Fig. 37).

8. Using a socket wrench, SE-1772-1, install the power valve and gasket in the metering block (Fig. 26). Be sure to install the correct power valve. Refer to specifications for the correct identification number. The number is stamped on a flat on the base of the valve.

9. Install two "O" rings to fuel pump transfer tube and position in primary metering block (Fig. 28) (Late Production).

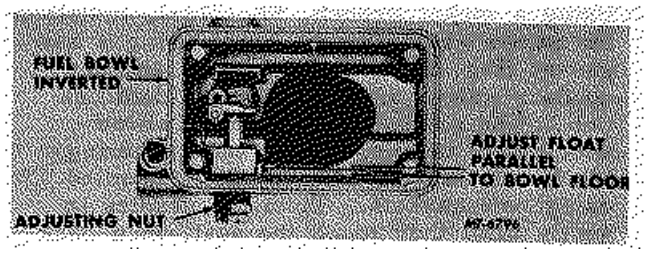


Fig. 37

Using a jet wrench, SE-1772-6, install the main jets in the metering block (Fig. 27).

10. Position the primary metering block gasket on the dowels on the back of the metering block. Lay the metering block in position on the main body.

    Position the fuel bowl gasket on the metering block (Fig. 25). Place the retaining screws with the new compression gaskets in the fuel bowl. Lay the bowl in place on the metering block (Fig. 25). Tighten the retaining screws to 25-30 inch pounds.

NOTE

When positioning fuel bowl the accelerating pump lever must be slightly depress

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ed to clear the diaphragm pump lever. When spring loaded bowl screws are used the following procedure should be used.

Tighten each spring loaded bowl screw by rotating screw head until screw assembly bottoms in main body. Bottoming of screw assembly is accomplished when screw head "springs back" about one quarter (1/4) turn when screw driver is removed from slot. Excessive rotation of screw head can destroy spring.

11. Install the fuel inlet fitting and gasket.

12. Apply Vaseline to the fuel transfer tube "O" ring seal and place the seal against the flange on one end of the fuel transfer tube and install this end of the tube in the primary fuel bowl.

13. Assemble the secondary fuel bowl by following Steps 2 through 6. As a preliminary secondary float adjustment, adjust the float so that the top of the float is parallel to the bowl floor with the bowl in an inverted position (Fig. 37).

14. Install the following parts in the secondary metering block.

    Using a jet wrench, SE-1772-6, install the secondary main jets (Fig. 27).

    Using a socket wrench, SE-1772-1, install the power valve (where used) using a new gasket (Fig. 26). Both primary and secondary valves are stamped for identification. The proper power valve (where used) must be installed in each metering block. Install the idle adjusting needles using new gaskets. Turn the needles in gently until they touch the seat, then back them out the correct amount of turns (Fig. 32). (See SPECIFICATIONS.) Do not force the needles against their seats. If a needle is damaged, it must be replaced before a proper idle mixture adjustment can be obtained.

15. Refer to Step 9 and install the metering block, fuel bowl, gaskets and spring loaded bowl screws.

16. When the proceeding steps have been completed, the carburetor is ready for installation. Refer to the Removal and Installation section of this manual for the installation procedure.

Adjustments

Any adjustments made during the assembly will have to be rechecked and final adjustments made after carburetor is mounted on the engine.

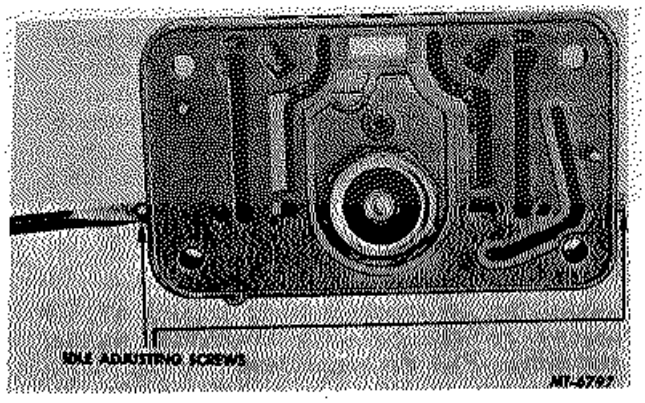


Fig. 38

FUEL LEVEL

Position the truck on a level floor. Be sure the fuel pump pressure is within specifications. Operate the engine until the normal, stabilized operating temperature has been reached. Place a suitable container below the fuel level sight plug to collect any spill-over of fuel. Check each fuel bowl separately.

With the engine stopped remove the air cleaner assembly, fuel level sight plug and gasket and check the fuel level (Fig. 39). The fuel level within the bowl should be at the lower edge of the sight plug opening + 1/32". If the fuel level is satisfactory, install the sight plug.

If the fuel level is too high or low, install the sight plug, drain the fuel bowl by loosening one lower retaining bolt from the fuel bowl and drain the fuel into a suitable container. Install the bolt and the fuel level sight plug and start the engine to fill the fuel bowl. Check the fuel level again before altering the float setting. This will eliminate the possibility of foreign material causing a temporary flooding condition.

If the fuel level is still high or low, loosen the lock screw on the top of the fuel inlet seat and turn the adjusting nut in or out to correct the fuel level. 1/6 turn of the adjusting nut equals approximately 3/64" in fuel level. Remove the sight plug and recheck the fuel level. Repeat the foregoing procedure until the correct fuel level is obtained.

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CAUTION: Do not loosen the lock screw or attempt to adjust the fuel level with the sight plug removed and the engine running, as this creates a fire hazard.

NOTE: It is important that the fuel level be maintained to specifications, as the fuel level is a part of the carburetor calibration.

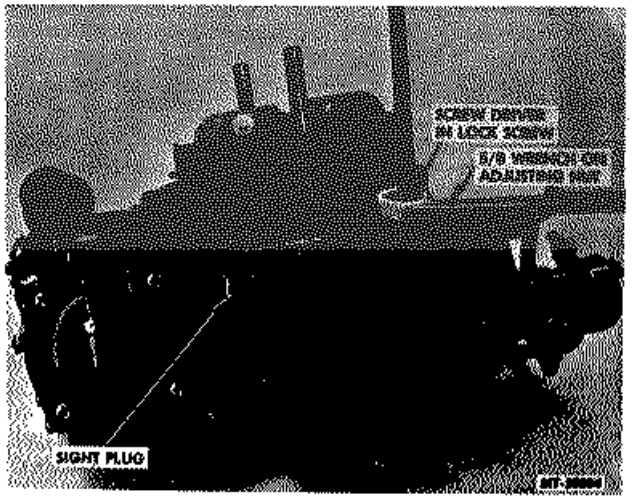


Fig. 39

IDLE SPEED AND FUEL MIXTURE ADJUSTMENTS

Idle speed and fuel mixture settings must be made with the engine at normal operating temperature, parking brake applied, choke open and air cleaner in place. See "Specifications" for transmission shift selector position and air conditioner switch settings.

When making carburetor adjustments, disconnect vacuum hose from vapor storage canister and plug end of hose. After idle adjustments have been made, remove plug and reconnect hose to canister.

To compensate for fuel and temperature variations when setting idle mixture, observe these precautions:

1. Do not idle engine continuously for more than three minutes at one time.

2. After each three minutes of idling increase engine speed to 2000 RPM for one minute.

3. Continue with idle adjustment procedure. Do not idle engine for more than three minutes without repeating Step "b".

It is imperative that the precautions outlined above be followed on engines equipped with road speed controlled spark advance systems where extended idling could permit sufficient increase in engine coolant temperature to activate high temperature vacuum control valve and thereby affect engine timing and idle speed.

Adjustment Procedure without Exhaust Analyzer (Speed Drop Method)

1. Connect tachometer to engine (Tachometer should have expanded scale of 400-800 RPM or 0-1000 RPM and 1%-2% accuracy.)

2. Turn idle mixture screw(s) "out" (counterclockwise) against tab stop.

NOTE: If working with a unit rebuild which has not had the idle limiter caps installed, refer to specification for the initial idle setting.

3. Operate engine until thoroughly warmed up.

4. Adjust idle speed screw to give engine speed higher then specified idle speed. (See "Specifications.)

5. Turn idle mixture screws "in" (clockwise) slowly and equally until specified idle speed is obtained. The resulting idle fuel mixture is optimum for exhaust emission control.

NOTE: If working with unit rebuild, install idle limiter caps at this time.

6. If engine runs rough after obtaining specified idle speed or if specified idle speed cannot be obtained (per Steps 4 and 5), it will be necessary to remove the idle limiter caps and establish proper mixture screw setting as follows:

a. Remove limiter caps. To prevent damaging screw threads or seat, file or grind away the side of the cap. Do not pry cap off.

b. With engine operating, adjust mixture screws to obtain "lean best idle" at the specified idle speed. ("Lean best idle" is the point at which engine speed drops approximately 10 RPM due to leanness.)

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c. Install new idle limiter caps with tab fully counterclockwise against stop.

d. Make idle speed adjustment per Step 4 and 5 to obtain recommended setting for optimum exhaust emission control.

7. If idle speed with automatic transmission in "DRIVE" is less than 550 RPM after the above adjustments have been made, readjust idle speed screw to obtain 550 RPM in "DRIVE. "

8. Disconnect tachometer from engine.

Adjustment Procedure With Exhaust Analyzer

If exhaust analysis equipment is available, the following procedure can be used to establish the recommended idle settings. Exhaust analysis equipment must have a "Percent of Carbon Monoxide" meter which gives accurate readings in the 0-5% CO range.

NOTE: Exhaust analysis equipment is not recommended for use with winter grade gasolines. These fuels, being more volatile, yield vapors which can cause excessively rich analyzer meter readings. Where winter grade fuels are used, it is recommended that the Speed Drop Method be utilized to obtain correct idle mixture settings.

1. Connect test tachometer to engine. (Tachometer should have an expanded scale of 400-800 or 1-1000 RPM and 1% to 2% accuracy.)

2. On engines equipped with air injection system, disconnect air injection hoses from air manifold check valves.

3. Adjust idle mixture screws full rich against tab stop by turning screws counterclockwise "out."

NOTE: If working with a unit rebuild which has not had idle limiter caps installed, refer to specifications for the initial idle setting.

4. Operate engine until it reaches normal operating temperature.

5. Adjust idle speed screw to obtain specified idle speed.

6. Prepare exhaust analyzer and insert exhaust sample probe into vehicle's tail pipe. (Refer to test equipment manufacturer's instructions for preparation and hook-up procedures.)

7. Observe percent of carbon monoxide (% CO) indicated on analyzer dial.

a. Adjust idle mixture screws "in" (clockwise) by 1/16 turn increments to obtain specified CO setting. (See Carburetor Specifications.)

b. Readjust idle speed if necessary and readjust mixture screws to provide the specified CO setting at specified curb idle speed.

NOTE: If working with unit rebuild, install idle limiter caps at this time.

8. If specified CO setting cannot be obtained per Step 7, it will be necessary to remove the plastic idle limiter caps and establish proper mixture screw setting as follows:

a. Remove limiter caps. To prevent damage to screw threads or seat, file or grind away the side of the cap. Do not pry cap off.

b. With engine operating, adjust mixture screws to obtain "lean best idle" at specified curb idle speed. (Lean best idle" is the point at which engine speed drops approximately 10 RPM due to leanness.)

c. Install new idle limiter caps with tab fully counterclockwise against stop.

d. Make idle mixture adjustment per Step 7 to tin recommended CO setting.

9. If idle speed with automatic transmission in "DRIVE" is less than 550 RPM after the above adjustments have been made, readjust idle speed screw to obtain 550 RPM in "DRIVE."

10. Disconnect test equipment from engine. Reconnect air injection hose to air manifold check valves where equipped.

If unsatisfactory idle operation persists after completing idle adjustment per the above procedures, recheck ignition system components, timing advance, crankcase ventilation system and air induction system.

Preliminary Fast (Cold Engine) Idle Adjustment

If the carburetor was removed from the truck for replacement or overhaul procedures, it is recommended that a preliminary fast idle adjustment be performed as follows.

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Off-Engine Adjustment

1. Completely reassemble carburetor.

2. Close choke plate.

3. Invert carburetor. Insert gauge (from gauge set SE-2425 or drill of same diameter) upstream between throttle plate and throttle body of the primary bore (see Fig. 39).

4. With gauge or drill held in place (see Fig. 40) by the primary throttle plate against the bore, adjust the fast idle screw until the screw touches the cam lightly (see Fig. 41).

5. The gauge or drill size dimension for the throttle plate clearance and fast idle speed are given below:

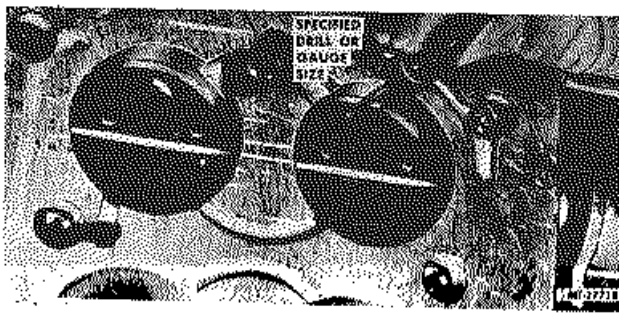


Fig. 40

Engine	Fast Idle Speed	Throttle Plate Clearance (Gauge or Drill Sizes)
V-392	2000 RPM	.040
MV-404	2400 RPM	.045
MV-446	2400 RPM	.045
V-537	2000 RPM	.045
V-605	2000 RPM	.045

6. After the carburetor is installed on the engine warm engine to operating temperature, connect tachometer and check fast idle reading with above specifications.

On-Engine Adjustment

1. Thoroughly warm up engine before performing adjustment.

2. Shut off engine, remove air cleaner, connect tachometer.

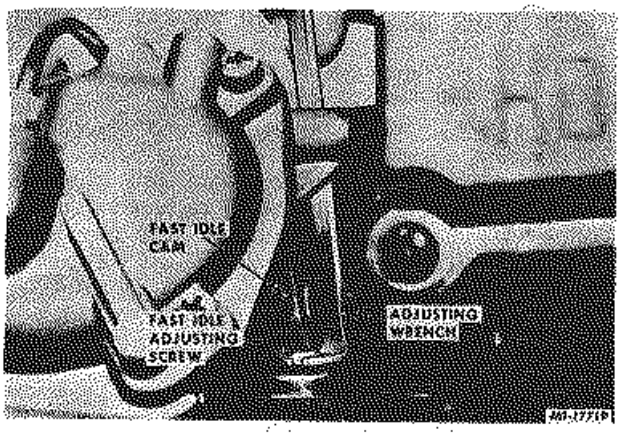


Fig. 41 Adjusting Fast Idle Screw With SE-1772-18 Wrench

3. Depress accelerator pedal to floor. Close choke and release accelerator pedal.

4. Remove idle stop screw and spring, reinstall idle stop screw without spring (See Fig. 42).

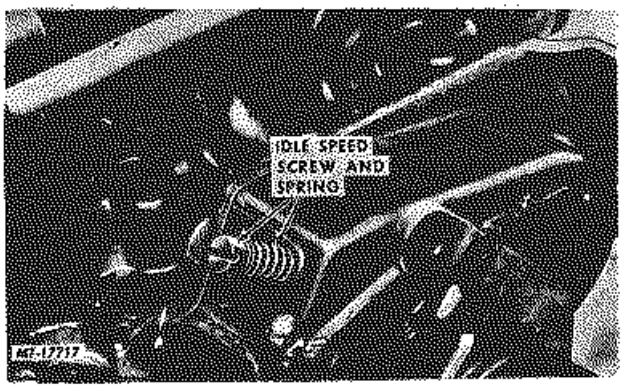


Fig. 42

5. Run the idle stop screw in until it contacts the internal stop.

6. Release choke as it opens completely.

7. Start engine, observe and record (RPM) tachometer reading. If RPM reading does not correspond with fast idle speed specification chart, an adjustment should be made.

8. To increase RPM, continue to turn the idle screw until proper fast idle speed is reached (See Fig. 42).

NOTE: Record the number of turns it takes to increase or decrease the engine

RPM to the specified speed shown:

V-392	2000 RPM
MV-404, 446	2400 RPM
V-537, 605	2000 RPM

9. Before shutting off engine back out idle screw until engine speed is reduced to curb idle speed to prevent engine dieseling. Shut off engine (See Fig. 42).

10. Depress accelerator pedal to floor. Close choke and release accelerator pedal.

11. Reset the idle screw until it lightly contacts the inner stop. Turn the idle screw in the number of additional turns recorded (in Step 8) to reach proper fast idle speed setting.

12. Adjust fast idle screw with special wrench SE-1772-18 until the screw just contacts the fast idle cam (See Fig. 41). Contact is established when visual clearance between the screw and the cam is eliminated or when the throttle lever starts to move.

13. To recheck adjustment, choke closed, back out idle screw two turns and then reset screw until lightly contacting internal stop.

14. Open choke, start engine, proper engine RPM should now be obtained.

15. Repeat Step No. 9.

16. Reinstall spring on idle speed screw and install screw with spring.

17. Reinstall air cleaner and adjust proper curb idle speed (See Specifications).

Accelerating Pump Lever Adjustment

1. Using a feeler gauge and with the throttle plates in the wide-open position, there should be the specified clearance of .015" minimum between the accelerating pump operating lever adjustment screw and the pump arm when the pump arm is depressed manually (Fig. 43).

2. If adjustment is required, loosen the adjusting screw lock nut and turn the adjusting screw in to increase the clearance and out to decrease the clearance. One-half turn of the adjusting screw is equal to approximately .015".

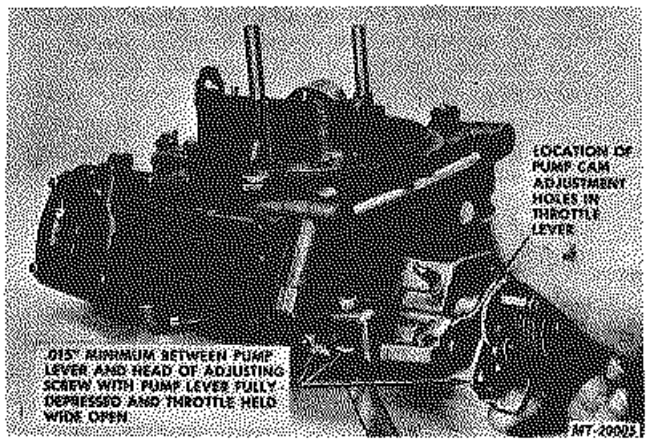


Fig. 43

Accelerating Pump Stroke Adjustments

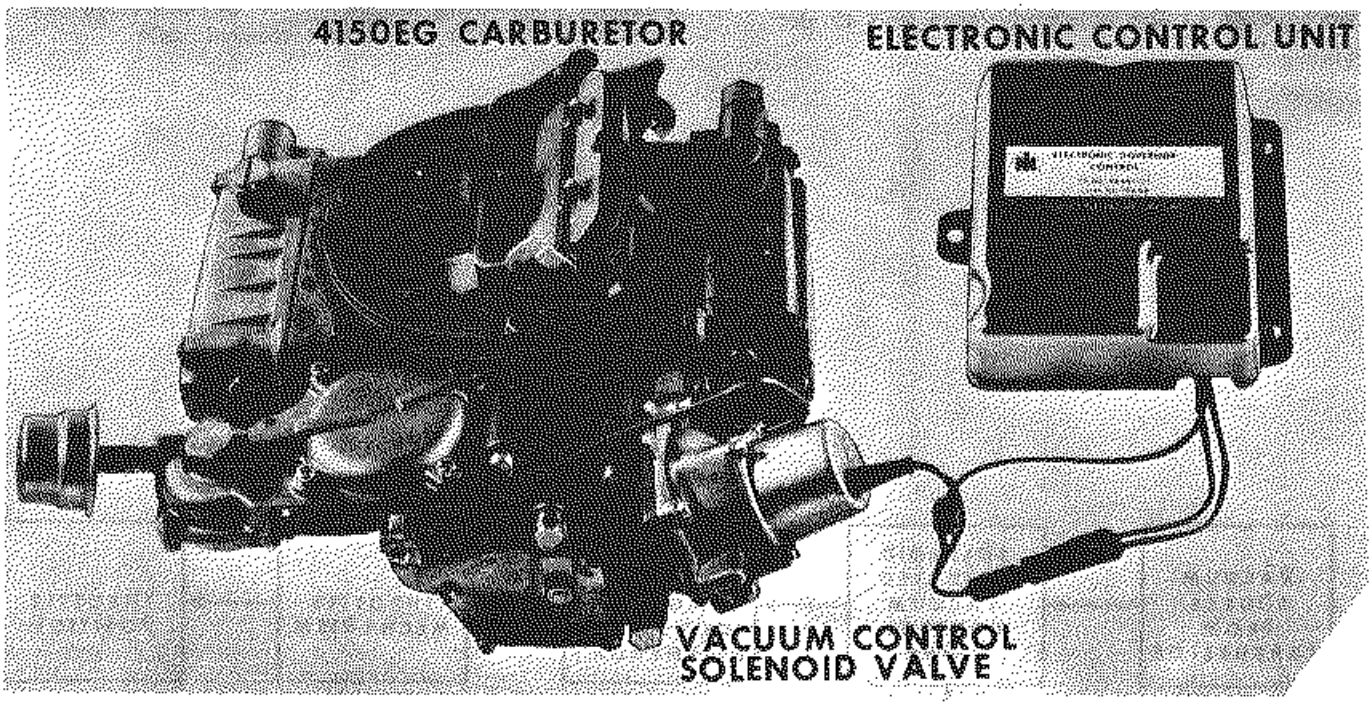
To satisfy acceleration requirements in various climates, the accelerating pump discharge can be adjusted (Fig. 43).

The bottom hole (No. 2) in the acceleration pump cam and the throttle lever provides the maximum pump discharge for extreme cold weather and the top hole (No. 1) provides the minimum pump discharge for warm weather operation. If a change in the adjustment is required, make certain the proper hole (top or bottom) in plastic accelerating pump cam, located behind the throttle lever, is properly aligned (indexed) with the numbered hole (top or bottom) in the throttle lever before installing the retaining screw.

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ELECTRONIC VACUUM MODULATING GOVERNOR SYSTEM

OPERATION AND TROUBLESHOOTING



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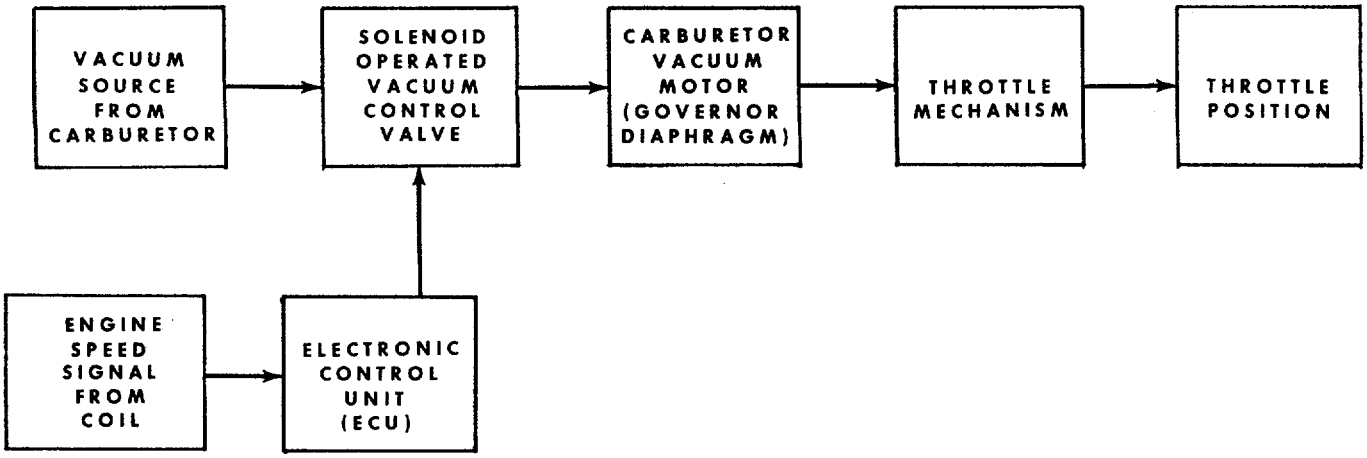
A

ELECTRONIC VACUUM MODULATING GOVERNOR SYSTEM

The electronic vacuum modulating governor system consists of a remote mounted electronic control unit (ECU), a three-way solenoid vacuum valve and a vacuum diaphragm attached to the carburetor throttle plates. The solenoid vacuum valve and vacuum diaphragm are an integral part of the carburetor. The ECU receives the engine speed signal from the negative side of the ignition coil. This engine speed signal switches the ECU (when governed engine speed is reached) to allow current to flow through the solenoid vacuum valve. The solenoid vacuum valve provides correct governor vacuum to the vacuum diaphragm. The vacuum diaphragm acting against the governor spring thereby controls the throttle position to regulate engine speed.

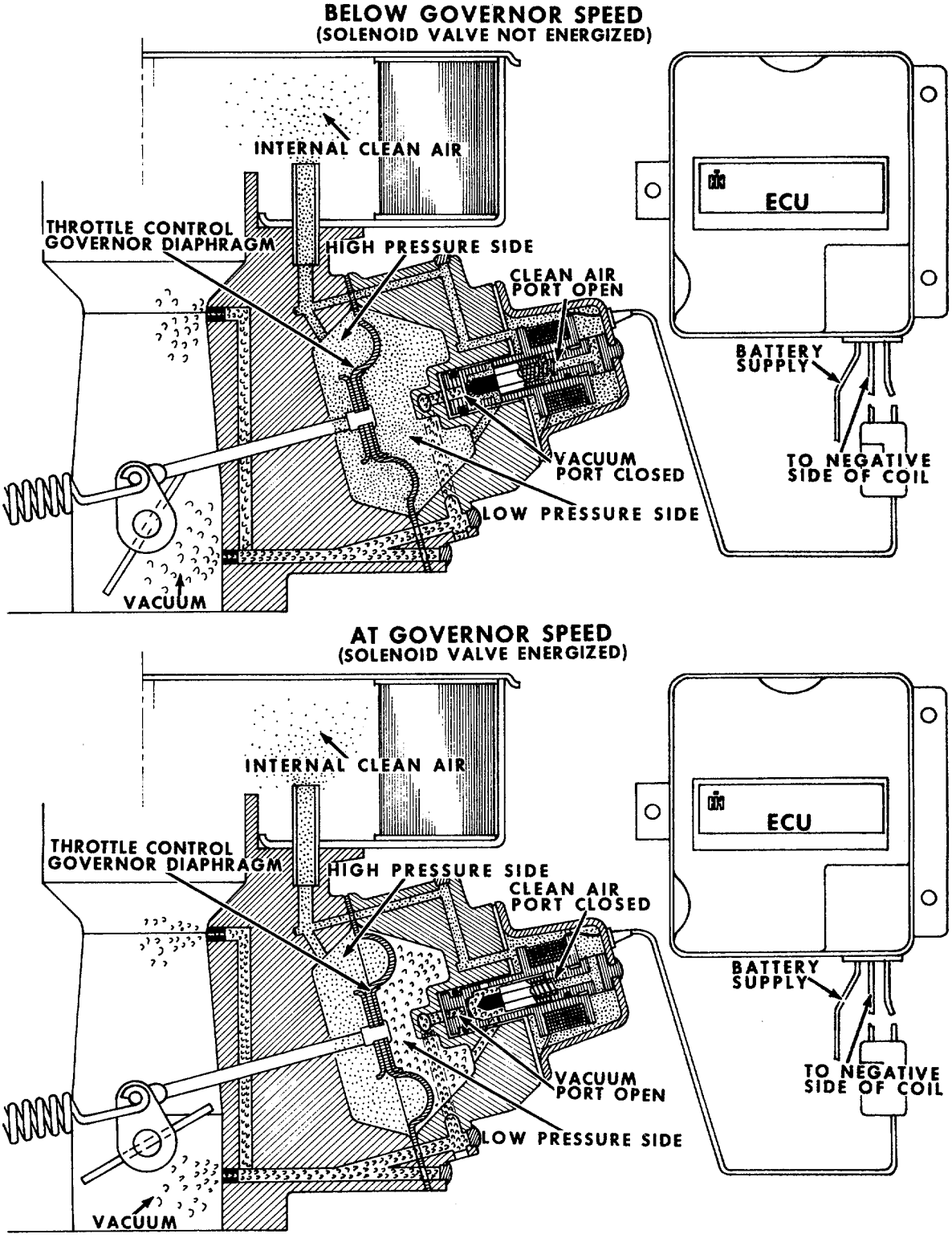
Internal clean air is supplied to both the solenoid side of governor the solenoid valve and to the high pressure side of the diaphragm. The cone-tipped side of the solenoid valve connects the venturi and intake manifold vacuum to the low pressure side of the governor diaphragm. In an underspeed or current off condition, the solenoid return spring closes the source vacuum port, thereby venting the low pressure side of the governor diaphragm directly to the clean air source. In this mode, the zero or near zero pressure differential across the governor diaphragm prevents any governing action.

As the engine approaches governed speed, current is applied to the solenoid which pulls the valve against the return spring, closes the port to clean air and connects the governor diaphragm to source vacuum. Modulation between the extremes of solenoid valve full-off and full-on is accomplished by varying the percentage on-time of the current to the solenoid. This results in an average valve opening that is proportional to percent on-time and provides the desired governing action. The speed is factory preset within the electronic control unit.



ELECTRONIC VACUUM MODULATING (EVM) GOVERNOR SYSTEM BLOCK DIAGRAM

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EVM GOVERNOR OPERATION

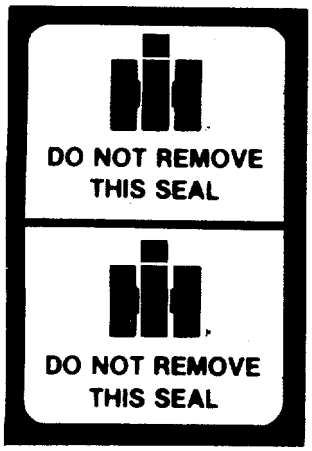
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ELECTRONIC VACUUM MODULATING (EVM) GOVERNOR SYSTEM TROUBLE SHOOTING PROCEDURE

The following procedure presents a systematic method of diagnosing and trouble shooting the Electronic Vacuum Modulating (EVM) Governor System. Each trouble shooting step has a chart to locate the component and illustrate the test. Test instruments used consist of a voltmeter and a tachometer.

It is recommended that the tachometer used for testing governor no load speed be an instrument with a high percentage of accuracy. The governed no load speed should be within a 100 RPM tolerance.

If engine speed reading is more than 100 RPM higher or lower than the specified governed no load speed, make sure the tachometer being used has been properly calibrated before condemning the ECU or vacuum solenoid valve.

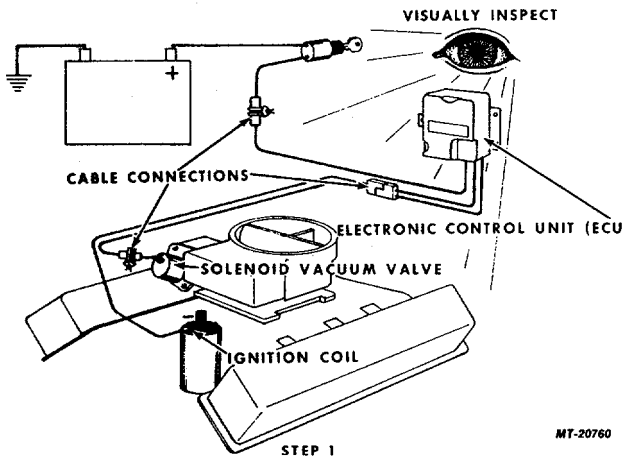


MT-20888

Anti-Tamper Proof Seal

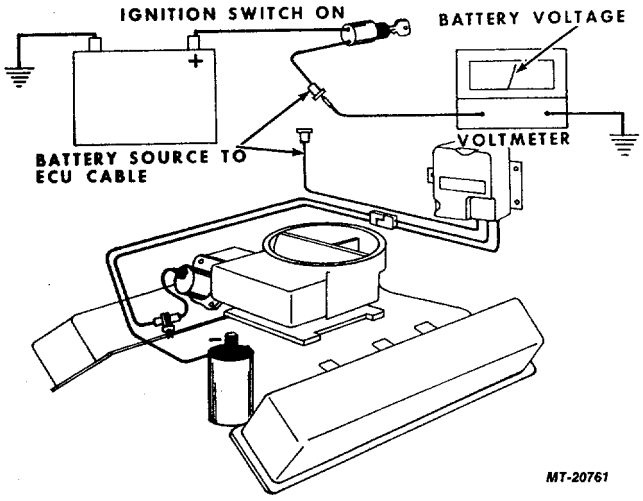
Electrical connections on the EVM system are sealed with an anti-tamper proof seal tape which is placed on the connectors at the time of assembly. The production seal tape can be identified by its white color with black print. If the connector seal tape is tampered with the word VOID will appear.

After service is performed, a service anti-tamper proof tape which is white in color with red print should be in installed. This difference in print color will show the system has been serviced.



STEP 1

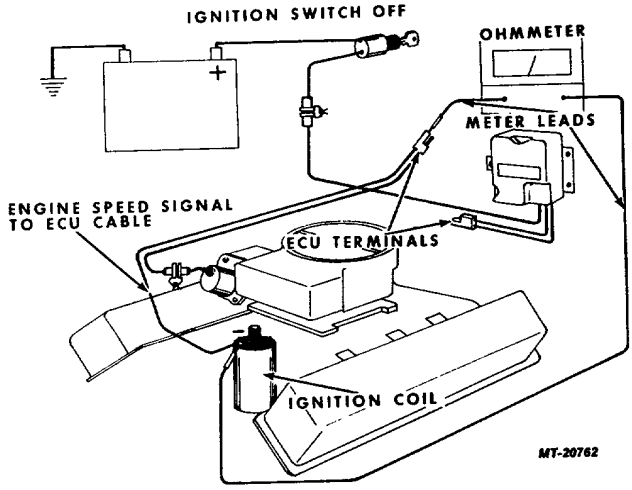
1. Visually inspect condition of writing connections and components.



STEP 2

2. Disconnect wire at electronic control unit (ECU). Check for battery voltage with ignition turned on. If battery voltage is not found, refer to Service Manual, ELECTRICAL, for repair. If battery voltage is found, proceed to Step 3.

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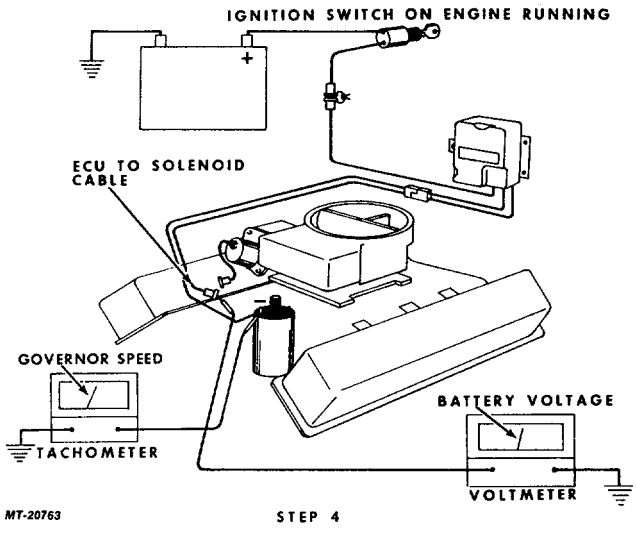


STEP 3

3. Disconnect ECU signal cable at terminal connector as shown.

a. Check continuity of cable from negative side of coil to ECU end. If reading indicates an open circuit, replace cable.

b. If normal, reconnect cable and proceed to next step.

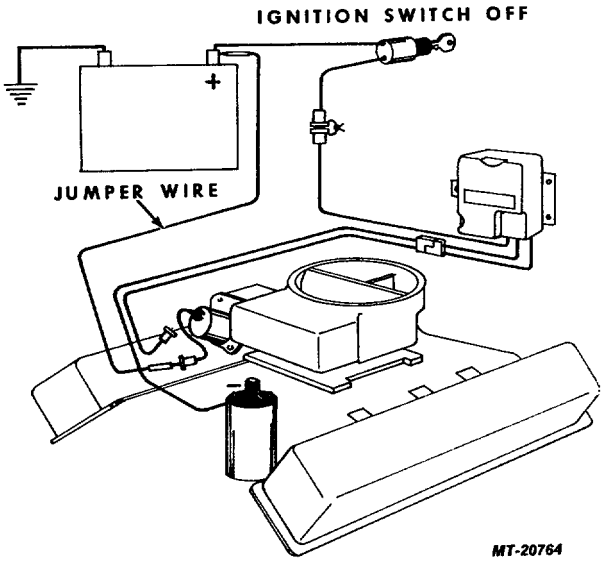


STEP 4

4. Disconnect cable terminal connector between ECU and solenoid valve (on carburetor). Connect tachometer and voltmeter. Start engine, increase speed until governor no load rpm is reached (see specifications). Battery voltage should be obtained at ECU side of connector.

a. If battery voltage is not obtained, replace ECU.

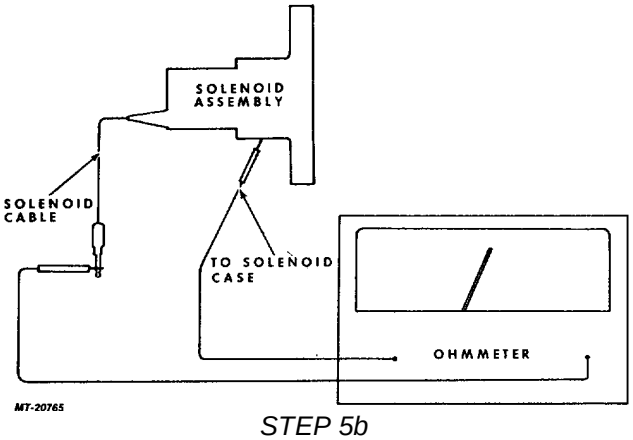
b. If battery voltage is obtained, stop engine and proceed to next step.



STEP 5

5. Apply battery voltage to solenoid valve side of cable as shown. The solenoid valve should make a slight noise or movement felt when current is applied and released indicating the solenoid valve plunger is operating.

a. If the solenoid is operating properly, proceed to step 6.



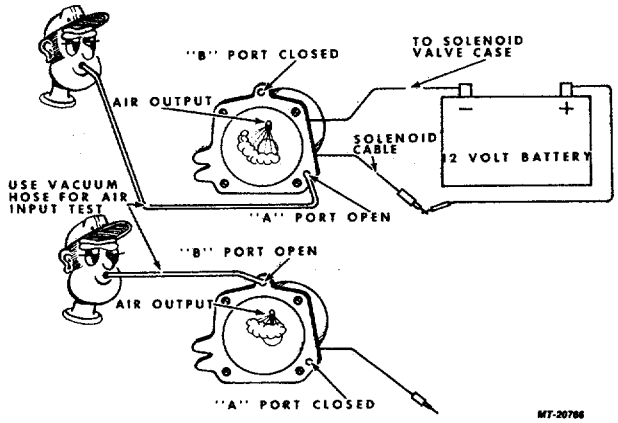
STEP 5b

b. If the noise is not heard or movement felt, remove solenoid valve and cover assembly from carburetor. Make a resistance check with an ohmmeter from the solenoid valve cable to the valve assembly case as shown. The ohmmeter should read approximately 50 ñ 10 ohms.

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If resistance is zero or a very high reading, the solenoid valve assembly must be replaced.

c. If resistance is 50 + 10 ohms, the solenoid valve windings are good. Remove solenoid valve from cover. Check to see if valve seat is sticking, keeping solenoid valve plunger from operating.



STEP 6

6. If Steps 1 through 5 have proved that the electrical portion of governor system is operating properly, the trouble must be in the cover vacuum passages.

a. With solenoid valve assembled to cover, apply air through a small diameter hose as shown to port "A," then port "B" to insure passages are clear.

With battery voltage applied:

Port "B" should be closed. Port "A" should be open.

Without battery voltage applied:

Port "B" should be open. Port "A" should be closed.

b. If solenoid valve plunger is not seating properly, replace solenoid valve.

c. If vacuum passages in the cover are clogged, clean (cover only) with commercial carburetor cleaning solvent.

7. Some carburetor malfunctions that are not a part of the EVM governor system may affect governor action. These malfunctions can be corrected by using the CLEANING AND INSPECTION portion of this service manual.

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1969 SPECIFICATIONS (MANUAL CHOKE) (Exhaust Emission Controlled and Non-Emission Controlled Engines)							
Engine Model	V-392						
Carburetor Model	4150				4150G		
Manual Trans., Manual Choke:							
Production Number	379283-C91	--	379287-C91	--	379483-C91	--	
List Number	4237	--	4318	--	4323	--	
Service Number	379283-C92	--	443281-C91	--	379483-C92	--	
List Number	4237	--	4318-1	--	4323-4	--	
Service Number	443279-C91	--	--	--	442170-C91	--	
List Number	4237-1	--	--	--	4323-5	--	
Service Number	454605-C91	--	--	--	454603-C91	--	
List Number	4237-2	--	--	--	4323-7	--	
Auto. Trans., Manual Choke:							
Production Number	--	379284-C91	--	379288-C91	--	379484-C91	
List Number	--	4264	--	4320	--	4324	
Service Number	--	379284-C92	--	443282-C91	--	379484-C92	
List Number	--	4264-1	--	4320-1	--	4324-4	
Service Number	--	443280-C91	--	--	--	442171-C91	
List Number	--	4264-1	--	--	--	4324-5	
Service Number	--	--	--	--	--	454604-C91	
List Number	--	--	--	--	--	4324-7	
Fuel Level: Primary	12.7 mm @ 34.47 kPa (1/2" @ 5 psi)		9.53 mm @ 34.47 kPa (3/8" @ 5 psi)		9.53 mm @ 34.47 kPa (3/8" @ 5 psi)		
Fuel Level: Secondary	15.9 mm @ 34.47 kPa (5/8" @ 5 psi)		15.9 mm @ 34.47 kPa (5/8" @ 5 psi)		15.9 mm @ 34.47 kPa (5/8" @ 5 psi)		
Main Jet: Primary	#51		#53		#58		
Main Jet: Secondary	#53		#53		#57		
Accelerator Jet	.635 mm (.025")				.635 mm (.025")		
Fuel Valve Seat: Primary	2.464 mm (.097")				2.464 mm (.097")		
Fuel Valve Seat: Secondary	2.464 mm (.097")				2.464 mm (.097")		
Initial Idle Needle Setting (Approx. turns off seat)	1-1/2		4		1-1/2		
Dashpot Setting	None	1.52 - 2.29mm	None	1.52 - 2.29mm	None		
Fast Idle Setting	.635 mm (.025") Clearance Between Stop Screw & Cam						
Idle Speed, RPM	700	* 550	450 - 500		450 - 500		
Air/Fuel Ratio (Idle)	13.4 - 13.6 (3% CO)		12.0 - 13.0		13.4 - 13.6 (3% CO)		
Upper Orifice, mm (in.)	None				.914 (.036)		
Lower Orifice, mm (in.)	None				1.10 (.043)		
Governor Spring	None				Black		
Post Position	None				#1		
Governed Speed, RPM							
Full Speed - No Load	None				3800		
Full Speed - Full Load	None				3600		
Power Valve: ** Primary	Stamped 8	Stamped 8	Stamped 65	Stamped 65	Stamped 5	Stamped 5	
Power Valve: ** Secondary	Stamped 35	Stamped 35	Stamped 85	Stamped 85	Stamped 25	Stamped 25	

* Automatic transmission in gear.

** Power valve identification number is stamped on a flat on the base of the valve.

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1969 SPECIFICATIONS (AUTOMATIC CHOKE) (Exhaust Emission Controlled and Non-Emission Controlled Engines)					
Engine Model		V-392			
Carburetor Model		4150C			
Manual Trans., Auto. Choke:					
Production Number		379285-C91	379289-C91	379290-C91	--
List Number		4312	4319	4321	--
Service Number		379286-C92	--	443283-C91	
List Number		4313-1	--	4321-1	--
Service Number		442167-C91	--	--	--
List Number		4313-2	--	--	--
Service Number		454584-C92	--	--	--
List Number		4313-3	--	--	--
Auto. Trans., Auto. Choke:					
Production Number		--	--	379290-C91	379286-C91
List Number		--	--	4321	4313
Service Number		--	--	443283-C91	379286-C92
List Number		--	--	4321-1	4313-1
Service Number		--	--	--	442167-C91
List Number		--	--	--	4313-2
Service Number		--	--	--	454584-C92
List Number		--	--	--	4313-3
Automatic Choke Setting		1st Notch Lean	3rd Notch Lean	3rd Notch Lean	1st Notch Lean
Fuel Level:	Primary	12.7mm @ 34.47 kPa (1/2" @ 5 psi)	9.53 mm @ 34.47 kPa (3/8" @ 5 psi)		12.7mm @ 34.47 kPa (1/2" @ 5 psi)
	Secondary	15.9mm @ 34.47 kPa (5/8" @ 5 psi)	15.9 mm @ 34.47 kPa (5/8" @ 5 psi)		15.9mm @ 34.47 kPa (5/8" @ 5 psi)
Main Jet:	Primary	#51	#53	#53	#51
	Secondary	#53	#53	#53	#53
Accelerator Jet		.635 mm (.025")			
Fuel Valve Seat:	Primary	2.464 mm (.097")			
	Secondary	2.464 mm (.097")			
Initial Idle Needle Setting (Approx. turns off seat)		1-1/2	4	4	1-1/2
Dashpot Setting		None	None	1.52 - 2.29 mm (.060" - .090")	
Fast Idle Setting		.635 mm (.025") Clearance between Stop Screw & Cam			
Idle Speed		700	450 - 500	450 - 500	* 550
Air/Fuel Ratio (Idle)		13.4 - 13.6 (3% CO)	12.0 - 13.0	12.0 - 13.0	13.4 - 13.6 (3% CO)
Choke Qualification Setting		4.70 - 5.46 mm (.185" - .215") Measured on Downstream Side of Choke Plate			
Power Valve: **	Primary	Stamped 8	Stamped 65	Stamped 65	Stamped 8
	Secondary	Stamped 35	Stamped 85	Stamped 85	Stamped 35

* Transmission in Drive range, Air Conditioning "OFF"
** Power valve identification number is stamped on a flat on base of valve.

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CARBURETOR SPECIFICATIONS

1970 - 1971 Exhaust Emission Controlled and Non-Emission Controlled Engines

Engine Model	V-392				
Carburetor Model	4150C				
Manual Trans., Auto. Choke:					
Production No.	398245-C91	----	379285-C91	----	----
List No.	4599	----	4312	----	----
Service No.	398247-C92	----	279286-C92	----	----
List No.	4602-1	----	4313-1	----	----
Service No.	443285-C91	----	442167-C91	----	----
List No.	4602-2	----	4313-2	----	----
Service No.	----	----	454584-C92	----	----
List No.	----	----	4313-3	----	----
Auto. Trans., Auto. Choke:					
Production No.	----	398247-C92	379286-C92	398247-C91	379286-C91
List No.	----	4602-1	4313-1	4602	4313
Service No.	----	443285-C91	442167-C91	----	----
List No.	----	4602-2	4313-2	----	----
Service No.	----	----	454584-C92	----	----
List No.	----	----	4313-3	----	----
Automatic Choke Setting	Index	Index	2nd notch lean	Index	2nd notch lean
Fuel Level:					
Primary	12.7 mm @ 34.47 kPa (1/2" @ 5 psi)				
Secondary	15.9 mm @ 34.47 kPa (5/8" @ 5 psi)				
Main Jet:					
Primary	#50	#50	#51	#50	#51
Secondary	#51	#51	#53	#51	#53
Accelerator Jet	.625 mm (.025")				
Fuel Valve Seat:					
Primary	2.464 mm (.097")				
Secondary	2.464 mm (.097")				
Initial Idle Needle Setting (approx. turns off seat)	3	3	3	3	1-1/2
Dashpot Setting	None	2.3-3.0 mm (.090-.120")	1.5-2.3 mm (.060-.090")	2.3-3.0 mm (.090-.120")	1.5-2.3 mm (.060-.090")
Throttle Modulator Setting	1150-1250	None	None	None	None
Fast Idle Setting - *	2000 RPM - Top Step (Hot)				
Idle Speed - *	700 RPM				
Air/Fuel Ratio (Idle)	14.4 - 14.6	14.4 - 14.6	13.4 - 13.6 (3% CO)	14.4 - 14.6	13.4 - 13.6 (3% CO)
Choke Qualification Setting	4.7 - 5.46 mm (.185 - .215") Measured on downstream side of choke plate.				
Power Valve - **					
Primary	Stamped 16	Stamped 16	Stamped 8	Stamped 16	Stamped 8
Secondary	Stamped 85	Stamped 85	Stamped 35	Stamped 85	Stamped 35

* Transmission in neutral, air conditioning off.
** Power valve identification number is stamped on a flat on the base of the valve.

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CARBURETOR SPECIFICATIONS
1970 - 1971 Exhaust Emission Controlled and Non-Emission Controlled Engines

Engine Model	V-392					V-392
Carburetor Model	4150					4150G
Manual Trans. Manual Choke:						
Production No.	398244-C92	----	379283-C91	----	----	379483-C91
List No.	4572-1	----	4237	----	----	4323
Service No.	398246-C92	----	379283-C92	----	----	379483-C92
List No.	4601-1	----	4237	----	----	4323-4
Service No.	443284-C91	----	443279-C91	----	----	442170-C91
List No.	4601-2	----	4237-1	----	----	4323-5
Service No.	----	----	454605-C91	----	----	454603-C91
List No.	----	----	4237-2	----	----	4323-7
Auto. Trans., Manual Choke:						
Production No.	----	398246-C92	----	398246-C91	379284-C91	379484-C91
List No.	----	4601-1	----	4601	4264	4324
Service No.	----	443284-C91	----	----	379284-C92	379484-C92
List No.	----	4601-2	----	----	4264-1	4324-4
Service No.	----	----	----	----	443280-C91	442171-C91
List No.	----	----	----	----	4264-1	4324-5
Service No.	----	----	----	----	----	454604-C91
List No.	----	----	----	----	----	4324-7
Fuel Level:						
Primary	12.7 mm @ 34.47 kPa (1/2" @ 5 psi)					
Secondary	15.9 mm @ 34.47 kPa (5/8" @ 5 psi)					
Main Jet:						
Primary	#50	#50	#51	#50	#51	#59
Secondary	#51	#51	#53	#51	#53	#56
Accelerator Jet	.635 mm (.025")					
Fuel Valve Seat:						
Primary	2.464 mm (.097")					
Secondary	2.464 mm (.097")					
Initial Idle Needle Setting (approx. turns off seat)	3	3	3	3	3	3
Dashpot Setting, mm Dashpot Setting, (in)	None	2.3 - 3.0 (.090-.120)	None	2.3 - 3.0 (.090-.120)	1.5 - 2.3 (.060-.090)	None
Throttle Modulator Setting	1150-1250	None	None	None	None	None
Fast Idle Setting	1.75 mm (.070") Clearance	1.75 mm (.070")* Clearance	.625 mm (.025") Clearance	2000 RPM Top Step Hot	2000 RPM Top Step Hot	**
Idle Speed, RPM ***	700	700	700	700	700	450 - 500
Air/Fuel Ratio (Idle)	14.4-14.6	14.4-14.6	13.4-13.6 (3% CO)	14.4-14.6	13.4-13.6 (3% CO)	13.4-13.6 (3% CO)
Upper Orifice, mm (in.)	None					.914 (.036)
Lower Ofifice, mm (in.)	None					1.10 (.043)
Governor Spring	None					Black
Post Position	None					#1
Governed Speed, RPM						
Full Speed - No Load	None					3800
Full Speed - Full Load	None					3600
Power Valve ****						
Primary	Stamped 14	Stamped 14	Stamped 8	Stamped 14	Stamped 8	Stamped 5
Secondary	Stamped 36	Stamped 35	Stamped 35	Stamped 35	Stamped 35	Stamped 25

* 1.016 mm (.040") clearance between stop screw and cam (California one).
** .25 - .375 mm (.010 - .015") clearance between stop screw and cam.
*** Transmission in neutral, air conditioning off.
**** Power valve identification number is stamped on a flat on the base of valve.

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1972 SPECIFICATIONS *(Exhaust Emission Controlled and Non-Emission Controlled Engines)*			
Engine Model	V-392	V-392	
Carburetor Model	4150G	4150C	
Manual Trans., Manual Choke			
Production (List) Numbers	379483-C92 (4323-3,4)	---	---
Service (List) Numbers	442170-C91 (4323-5)	---	---
Service (List) Numbers	454603-C91 (4323-7)	---	---
Auto. Trans., Manual Choke			
Production (List) Numbers	379484-C92 (4324-3,4)	---	---
Service (List) Numbers	442171-C91 (4324-5)	---	---
Service (List) Numbers	454604-C91 (4324-7)	---	---
Manual Trans., Auto. Choke			
Production (List) Numbers	---	428113-C91 (6390-1)	*379285-C92 (4312-1)
Service (List) Numbers	---	442162-C91 (6390-2S)	*379286-C91 (4313-1)
Service (List) Numbers	---	454602-C91 (6390-3)	*442167-C91 (4313-2)
Service (List) Numbers	---	---	*454584-C92 (4313-3)
Auto. Trans., Auto. Choke			
Production (List) Numbers	---	428113-C91 (6390-1)	379286-C92 (4313-1)
Service (List) Numbers	---	442162-C91 (6390-2S)	442167-C91 (4313-2)
Service (List) Numbers	---	454602-C91 (6390-3)	454584-C92 (6313-3)
Automatic Choke Setting:			
Summer	---	4 Notches Lean	2nd Notch Lean
Winter	---	1 Notch Lean	
Fuel Level: Primary	9.53 mm @ 34.47 kPa (3/8" @ 5 psi)	12.7 mm @ 34.47 kPa (1/2" @ 5 psi)	
Fuel Level: Secondary	15.9 mm @ 34.47 kPa (5/8" @ 5 psi)	15.9 mm @ 34.47 kPa (5/8" @ 5 psi)	
Main Jet: Primary	#59	#50	#51
Main Jet: Secondary	#56	#51	#53
Accelerator Jet	.635 mm (.025")	.635 mm (.025")	
Fuel Valve Seat: Primary	2.464 mm (.097")	2.464 mm (.097")	
Fuel Valve Seat: Secondary	2.464 mm (.097")	2.464 mm (.097")	
Initial Idle Needle Setting (Approx. turns off seat)	3	3	3
Dashpot Setting	---	1.91-2.67 mm (.075-.105")	1.52-2.29 mm (.060-.090")
Fast Idle Setting	.254 - .381 mm (.010 - .015")	2000 RPM Top Step (Hot)	
Idle Speed, RPM	700 **	700 **	700 **
Air/Fuel Ratio (Idle)	1.0 - 2.0% CO	1.0 - 1.5% CO	1.0 - 2.0% CO
Choke Qualification Setting		4.70 - 5.46 mm (.185" - .215") Measured on Downstream Side of Choke Plate	
Governor Upper Orifice	.914 mm (.036")	---	---
Governor Lower Orifice	1.10 mm (.043")	---	---
Governor Spring	Black	---	---
Post Position	#1	---	---
Governed Speed, RPM			
Full Speed - No Load	3800	---	---
Full Speed - Full Load	3600	---	---
Power Valve: *** Primary	Stamped 5	Stamped 16	Stamped 8
Power Valve: *** Secondary	Stamped 25	Stamped 85	Stamped 35

* Dashpot Setting = None

** Automatic Transmission in Neutral with Air Conditioning On.

*** Power Valve Identification Number is stamped on a flat on the base of the valve.

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1973 SPECIFICATIONS (Exhaust Emission Controlled and Non-Emission Controlled)		
Engine Model	V-392	V-392
Carburetor Model	4150G	4150C
Manual or Automatic Trans. W/Manual Choke:		
Production (List) Numbers	442170-C91 (4323-5,6)	---
Service (List) Numbers	454603-C91 (4323-7)	---
Service (List) Numbers	451869-C91 (6803)	---
Service (List) Numbers	451869-C92 (6803-1)	---
Manual Transmission W/Automatic Choke:		
Production (List) Numbers	---	442166-C91 (4312-2)
Service (List) Numbers	---	442167-C91 (4313-2)
Automatic Transmission W/Automatic Choke:		
Production (List) Numbers	---	442167-C91 (4313-2)
Service (List) Numbers	---	454584-C92 (4313-3)
Automatic Choke Setting	---	2nd Notch Lean
Fuel Level: Primary	9.53 mm @ 34.47 kPa (3/8" @ 5 psi)	12.7 mm @ 34.47 kPa (1/2" @ 5 psi)
Fuel Level: Secondary	15.9 mm @ 34.47 kPa (5/8" @ 5 psi)	15.9 mm @ 34.47 kPa (5/8" @ 5 psi)
Main Jet: Primary	#59	#51
Main Jet: Secondary	#56	#53
Accelerator Jet	.635 mm (.025")	.635 mm (.025")
Fuel Valve Seat: Primary	2.464 mm (.097")	2.464 mm (.097")
Fuel Valve Seat: Secondary	2.464 mm (.097")	2.464 mm (.097")
Initial Idle Needle Setting (Approx. turns off seat)	3	3
Dashpot Setting	---	1.52 - 2.29 mm (.060" - .090")
Fast Idle Setting	.254 - .381 mm (.010 - .015)	2000 RPM Top Step (Hot)
Idle Speed, RPM	700 *	700 *
Air/Fuel Ratio (Idle)	2.0% CO Max.	2.0% CO Max.
Choke Qualification Setting		4.70 - 5.46 mm (.185" - .215") Measured on Downstream Side of Choke Plate
Governor Upper Orifice	.914 mm (.036")	---
Governor Lower Orifice	1.10 mm (.043")	---
Governor Spring	Black	---
Post Position	#1	---
Governor Speed, RPM (On Road) Full Speed - No Load	3800	---
Full Speed - Full Load	3600	---
Power Valve: ** Primary	Stamped 5	Stamped 8
Power Valve: ** Secondary	Stamped 25	Stamped 35

* Automatic Transmission in Neutral with Air Conditioning On.

** Power valve identification number is stamped on a flat on the base of the valve.

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1974 SPECIFICATIONS
(Exhaust Emission Controlled and Non-Emission Controlled)

Engine Model		V-392	V-392
Carburetor Model		4150G	4150C
Manual or Automatic Trans. W/Manual Choke:			
Production Number		451869-C91	- - -
List Number		6803	- - -
Service Number		451869-C92	- - -
List Number		6803-1	- - -
Manual Transmission W/Automatic Choke:			
Production Number		- - -	454583-C92
List Number		- - -	4312-3
Service Number		- - -	461291-C91
List Number		- - -	7035
Automatic Transmission W/Automatic Choke:			
Production Number		- - -	454584-C92
List Number		- - -	4313-3
Service Number		- - -	461291-C91
List Number		- - -	7035
Automatic Choke Setting		- - -	2nd Notch Lean
Fuel Level:	Primary	9.53 mm @34.47 kPa (3/8" @5 psi)	12.7 mm @34.47 kPa (½" @5 psi)
	Secondary	15.9 mm @34.47 kPa (5/8" @5 psi)	15.9 mm @34.47 kPa (5/8" @5 psi)
Main Jet:	Primary	#59	#51
	Secondary	#56	#53
Accelerator Jet		.635 mm (.025")	.635 mm (.025")
Fuel Valve Seat:	Primary	2.464 mm (.097")	2.464 mm (.097")
	Secondary	2.464 mm (.097")	2.464 mm (.097")
Initial Idle Needle Setting (Approx. turns off seat)		3	3
Dashpot Setting		- - -	1.52-2.29 mm(.060"-.090")
Fast Idle Setting		.254-.381mm (.010-.015)	2000 RPM Top Step (Hot)
Idle Speed, RPM		700*	700*
Air/Fuel Ratio (Idle)		2.0% Max.	2.0% Max.
Choke Qualification Setting			4.70-5.46 mm (.185"-.215") Measured on Downstream Side of Choke Plate
Governor Upper Orifice		.914 mm (.036")	- - -
Governor Lower Orifice		1.10 mm (.043")	- - -
Governor Spring		Black	- - -
Post Position		#1	- - -
Governed Speed, RPM (On Road)			
Full Speed - No Load		3800	
Full Speed - Full Load		3600	
Power Valve: **	Primary	Stamped 8	Stamped 8
	Secondary	Stamped 35	Stamped 35

* Automatic Transmission in Neutral with Air Conditioning On.
** Power Valve identification number is stamped on a flat on the base of the valve.

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CARBURETOR SPECIFICATIONS

1975, 1976, 1977, 1978 Federal (Not California) Heavy Duty Engines

Carburetor Model		4150G	4150EG	4150G	4150G
Engine Model		V-392		MV-404	MV-446
Carburetor:	Part Number List Number	461292-C92, 6803-3	487849-C91 8233	465530-C91 7215	467026-C91 7251
Throttle Body Bore:	Primary Secondary	36.51 mm (1-7/16") 36.51 mm (1-7/16")			
Venturi:	Primary Secondary	30.16 mm (1-3/16") 26.99 mm (1-1/16")			
Main Jet:	Primary Secondary	#581 #562		#572 #572	#572 #572
Fuel Level:	Primary Secondary	9.53 mm @ 34.47 kPa (3/8" @ 5 psi) 15.90 mm @ 34.47 kPa (5/8" @ 5 psi)			
Fast Idle Setting, RPM		2000		2400	2400
High Idle Speed, RPM (Throttle Modulator Extended)		N/A		1350 ±50	1300 ± 50
Curb Idle Speed, RPM - *		650-700		525-575	525-575
Idle Mixture Setting, % CO		2.0 Max.		0.5 - 2.5	0.5 - 2.5
Governor Upper Orifice		.914 mm (.036")	0.94mm (.037")	.711mm (.028")	.711mm (.028")
Governor Lower Orifice		1.09mm (.043")	1.32mm (.052")	1.09mm (.043")	1.09mm (.043")
Governor Spring (Color)		Black	Plain	Black	Black
Governor Spring Post Position		#1	#2	#3	#3
Governed Speed, RPM*** Full Speed, No Load		3800		3800	3800
Full Speed, Full Load		3600		3600	3600
**Power Valve:	Primary Secondary	Stamped 5 Stamped 25		Stamped 13 ---	Stamped 11 ---

*Transmission in Neutral, Air Conditioning OFF.

**Power valve identification number is stamped on a flat on the base of the valve.

***4150 EG carburetor no load speed should be within a plus (+) or minus (-) 100 RPM.
N/A - Not Available

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CARBURETOR SPECIFICATIONS 1975, 1976, 1977, 1978 Federal (Not California) Heavy Duty Engines			
Carburetor Model		4150G	4150G
Engine Model		V-537	
Carburetor:	Part Number List Number	448314-C91 6911	487895-C91 8139
Throttle Body Bore:	Primary Secondary	36.50 mm (1-7/16") 36.50 mm (1-7/16")	
Venturi:	Primary Secondary	30.15 mm (1-3/16") 26.97 mm (1-1/16")	
Main Jet:	Primary Secondary	#58 #58	
Fuel Level:	Primary Secondary	9.53 mm @ 37.92 kPa (3/8" @ 5.5 psi) 15.90 mm @ 37.92 kPa (5/8 @ 5.5 psi)	
Fast Idle Setting		2000 RPM	
High Idle Speed, RPM (Throttle Modulator Extended)		1300 - 1400	
Curb Idle Speed, RPM - *		500 - 550	
Idle Mixture Setting, % CO		1.5 - 3.0	
Governor Upper Orifice		.914 mm (.036")	
Governor Lower Orifice		1.10 mm (.043")	
Governor Spring Post Position		#3	
Governed Speed, RPM*** Full Speed, No Load Full Speed, Full Load		 3400 3200	
**Power Valve (Primary)		Stamped 9	

* Transmission in Neutral, Air Conditioning OFF.

** Power valve identification number is stamped on a flat on the base of the valve.

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CARBURETOR SPECIFICATIONS

1975, 1976, 1977, 1978 California Heavy Duty Engines

Carburetor Model		4150G		4150EG
Engine Model		V-392		
Carburetor:	Part Number List Number	461310-C91 7028	476056-C91 7579	487859-C92 8243/8243-1
Throttle Body Bore: mm (in.)	Primary Secondary	36.51 (1-7/16) 36.51 (1-7/16)		
Venturi: mm (in.)	Primary Secondary	30.23 (1-3/16) 16.99 (1-1/16)		
Main Jet:	Primary Secondary	#581 #512		
Fuel Level: mm (in.)	Primary Secondary	9.52 @ 34.34 kPa (3/8 @ 5 psi) 15.88 @ 34.45 kPa (5/8 @ 5 psi)		
Fast Idle Setting, mm (in.)		.38 - .51 (.015 - .020)*		
High Idle Speed, RPM		1400 ± 50 RPM		
**Curb Idle Speed, RPM		625 - 675		
Idle Mixture Setting, % CO		0.5 - 1.5%		
Governor Upper Orifice, mm (in.)		.91 (.036)		0.94 (.037)
Governor Lower Orifice, mm (in.)		1.09 (.043)		1.32 (.052)
Governor Spring (Color)		Brown		Plain
Governor Spring Post Position		#2		
Governed Speed, RPM: **** Full Speed, No Load Full Speed, Full Load		3800 3600		
***Power Valve	Primary Secondary	Stamped 13 Stamped 25		Stamped 11 Stamped 25

* Clearance between stop screw and fast idle cam with choke open and curb idle speed set correctly.
** Transmission in Neutral, Air Conditioning OFF.
*** Power valve identification number is stamped on a flat on the base of the valve.
**** 4150EG carburetor no load speed should be within a plus (+) or minus (-) 100 RPM.

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CARBURETOR SPECIFICATIONS

1975, 1976, 1977, 1978 (California) Heavy Duty Engines

Carburetor Model	4150G			4150EG
Engine Model	MV-404			MV-404
Carburetor: Part Number List Number Part Number List Number	465533-C91 7218	465533-C92 7218-1	476058-C91 7581	481873-C91 7921 487862-C91 8246
Throttle Body Bore Primary Secondary	36.51 mm (1-7/16") 36.51 mm (1-7/16")			
Venturi Primary Secondary	30.16 mm (1-3/16") 26.99 mm (1-1/16")			
Main Jet Primary Secondary	#612 #572	#603 #572	#601 #572	#603 #572
Fuel Level Primary Secondary	9.52 mm @ 34.45 kPa (3/8" @ 5 psi) 15.88 mm @ 34.45 kPa (5/8" @ 5 psi)			
Fast Idle Setting	2400 RPM			
High Idle Speed, RPM (Throttle Modulator Extended)	1350 ± 50			
Curb Idle Speed, RPM	525 - 575			
Idle Mixture Setting	.5 - 2.5% CO			
Governor Upper Orifice	.711 mm (.028")			0.94 mm (.037")
Governor Lower Orifice	1.09 mm (.043")			1.32 mm (.052")
Governor Spring (Color)	Black			Plain
Governor Spring Post Position	#3			#2
Governed Speed, RPM** Full Speed - No Load Full Speed - Full Load	3800 3600			3800 ± 50 -----
Power Valve - Primary*	Stamped 10			

* Power valve identification number is stamped on a flat on the base of the valve.

** 4150EG carburetor no load speed should be within a plus (+) or minus (-) 100 RPM.

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CARBURETOR SPECIFICATIONS

1975, 1976, 1977, 1978 California Heavy Duty Engines

Carburetor Model		4150G		4150EG
Engine Model		MV-446		
Carburetor:	Part Number List Number	461313-C91 7029	461313-C92 7029-1	487863-C91 8247
Throttle Body Bore: mm (in.)	Primary Secondary	36.51 (1-7/16) 36.51 (1-7/16)		
Venturi: mm (in.)	Primary Secondary	30.23 (1-3/16) 26.99 (1-1/16)		
Main Jet:	Primary Secondary	#602 #572	#593 #572	
Fuel Level: mm (in.)	Primary Secondary	9.52 @ 34.45 kPa (3/8 @ 5.0 psi) 15.88 @ 34.45 kPa (5/8 @ 5.0 psi)		
Fast Idle Setting, RPM		2400		
High Idle Speed, RPM (Throttle Modulator Extended)		1350 ± 50		
Curb Idle Speed, RPM		525-575		
Idle Mixture Setting, % CO		.5 - 2.5%		
Fuel Bowl Vent Adj. Clearance		-----		
Pump Piston Stroke Adjustment		-----		
Governor Upper Orifice, mm (in.)		.711 (.028)		.037
Governor Lower Orifice, mm (in.)		1.09 (.043)		.052
Governor Spring (Color)		Black		Red Stripe
Governor Spring Post Position		#3		#2
Governed Speed, RPM** Full Speed, No Load Full Speed, Full Load		3800 3600		
*Power Valve	Primary	Stamped 10		

* Power valve identification number is stamped on a flat on the base of the valve.

** 4150EG carburetor no load speed should be within a plus (+) or minus (-) 100 RPM.

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CARBURETOR SPECIFICATIONS

1975, 1976 California Heavy Duty Engines

CARBURETOR SPECIFICATIONS 1975, 1976 California Heavy Duty Engines		
Carburetor Model		4150G
Engine Model		V-537
Carburetor: Production Part No. List No.		448315-C91 6974
Throttle Body Bore: mm (in.)	Primary Secondary	36.51 (1-7/16) 36.51 (1-7/16)
Venturi: mm (in.)	Primary Secondary	30.23 (1-3/16) 26.99 (1-1/16)
Main Jet:	Primary Secondary	602 592
Fuel Level: mm (in.)	Primary Secondary	9.52 @ 37.92 kPa (3/8 @ 5.5 psi) 15.88 @ 37.92 kPa (5/8 @ 5.5 psi)
Automatic Choke Setting		----
Automatic Choke Qualification		----
Choke Unloader Setting		----
Dashpot Setting		----
Fast Idle Setting		2000 RPM
High Idle Speed, RPM (Throttle Modulator Extended)		1300 - 1400
*Curb Idle Speed, RPM		500-550
Idle Mixture Setting, % CO		1.0-2.0%
Governor Upper Orifice, mm (in.)		.91 (.036)
Governor Lower Orifice, mm (in.)		1.09 (.043)
Governor Spring (Color)		Brown
Governor Spring Post Position		#3
Governed Speed, RPM: Full Speed, No Load Full Speed, Full Load (On Road)		 3400 3200
**Power Valve	Primary	Stamped 13

* Transmission in Neutral, Air Conditioning OFF
** Power valve identification number is stamped on a flat on the base of the valve.

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CARBURETOR SPECIFICATIONS 1979 Heavy Duty Engines			
Carburetor Model		4150EG	
Engine Model		V-392	
Carburetor:	Part Number List Number	500176-C91 8737	487859-C92 8243-1
Throttle Body Bore: mm (in.)	Primary Secondary	36.51 (1-7/16) 36.51 (1-7/16)	
Venturi: mm (in.)	Primary Secondary	30.23 (1-3/16) 16.99 (1-1/16)	
Main Jet:	Primary Secondary	#581 #512	
Fuel Level: mm (in.)	Primary Secondary	9.52 @ 34.34 kPa (3/8 @ 5 psi) 15.88 @ 34.45 kPa (5/8 @ 5 psi)	
Fast Idle Setting, mm (in.)		.38 - .51 (.015 - .020)*	
High Idle Speed, RPM		1400 ± 50 RPM	
**Curb Idle Speed, RPM		625 -675	
Idle Mixture Setting, % CO		0.5 - 1.5%	
Governor Upper Orifice, mm (in.)		0.94 (.037)	
Governor Lower Orifice, mm (in.)		1.32 (.052)	
Governor Spring (Color)		plain	
Governor Spring Post Position		#2	
Governed Speed, RPM: **** Full Speed, No Load Full Speed, Full Load		 3800 3600	
***Power Valve	Primary Secondary	Stamped 13 Stamped 25	Stamped 11 Stamped 25

* Clearance between stop screw and fast idle cam with choke open and curb idle speed set correctly.

** Transmission in Neutral, Air Conditioning OFF.

*** Power valve identification number is stamped on a flat on the base of the valve.

****4150EG carburetor no load speed should be within a plus (+) or minus (-) 100 RPM.

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CARBURETOR SPECIFICATIONS

1979 Heavy Duty Engines

Carburetor Model	4150EG
Engine Model	MV-404
Carburetor: Part Number List Number Part Number List Number	481873-C91 7921 487862-C91 8246
Throttle Body Bore Primary Secondary	 36.51 mm (1.437) 36.51 mm (1.437)
Venturi Primary Secondary	 30.16 mm (1.187) 26.99 mm (1.062)
Main Jet Primary Secondary	 #601 #572
Fuel Level Primary Secondary	 9.52 mm @ 34.45 kPa (.375 @ 5 psi) 15.88 mm @ 34.45 kPa (.625 @ 5 psi)
Fast Idle Setting	2400 RPM
High Idle Speed, RPM (Throttle Modulator Extended)	1350 ± 50
Curb Idle Speed, RPM	525 - 575
Idle Mixture Setting	.5 - 2.5% CO
Governor Upper Orifice mm (in.)	0.94 (.037)
Governor Lower Orifice mm (in.)	1.32 (.052)
Governor Spring (Color)	plain
Governor Spring Post Position	#2
Governed Speed, RPM** Full Speed - No Load Full Speed - Full Load	 3800 3600
Power Valve - Primary *	Stamped 10

* Power valve identification number is stamped on a flat on the base of the valve.

** 4150EG carburetor no load speed should be within a plus (+) or minus (-) 100 RPM.

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CARBURETOR SPECIFICATIONS

1979 Heavy Duty Engines

Carburetor Model		4150EG	
Engine Model		MV-446	
Carburetor:	Part Number List Number	500180-C91 8740	487863-C91 8247
Throttle Body Bore: mm (in.)	Primary Secondary	36.51 (1.437) 36.51 (1.437)	
Venturi: mm (in.)	Primary Secondary	30.23 (1.187) 26.99 (1.062)	
Main Jet:	Primary Secondary	#593 #572	
Fuel Level: mm (in.)	Primary Secondary	9.52 @ 34.45 kPa (.375 @ 5.0 psi) 15.88 @ 34.45 kPa (.625 @ 5.0 psi)	
Fast Idle Setting, RPM		2400	
High Idle Speed, RPM (Throttle Modulator Extended)		1300 ± 50	
Curb Idle Speed, RPM		525-575	
Idle Mixture Setting, % CO		.5 - 2.5%	
Fuel Bowl Vent Adj. Clearance		----	
Pump Piston Stroke Adjustment		----	
Governor Upper Orifice, mm (in.)		0.94 (.037)	
Governor Lower Orifice, mm (in.)		1.32 (.052)	
Governor Spring (Color)		Red Stripe	
Governor Spring Post Position		#2	
Governed Speed, RPM** Full Speed, No Load Full Speed, Full Load		 3800 3600	
*Power Valve	Primary	Stamped 10	

* Power valve identification number is stamped on a flat on the base of the valve.

** 4150EG carburetor no load speed should be within a plus (+) or minus (-) 100 RPM.

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CARBURETOR SPECIFICATIONS

1979 Canadian Heavy Duty Engines

Carburetor Model		4150EG	4150EG	4150EG	4150EG
Engine Model		V-392	MV-404	MV-446	V-537
Carburetor:	Part Number List Number	487849-C92 8233-1	1700161-C91 8922	1700162-C91 8923	1700163-C91 8924
Throttle Body Bore:	Primary Secondary	36.51 mm (1-7/16") 36.51 mm (1-7/16")			
Venturi:	Primary Secondary	30.16 mm (1-3/16") 26.99 mm (1-1/16")			
Main Jet:	Primary Secondary	#581 #562	#572 #572	#572 #572	#573 #542
Fuel Level:	Primary Secondary	9.53 mm @ 34.47 kPa (3/8" @ 5 psi) 15.90 mm @ 34.47 kPa (5/8" @ 5 psi)			
Fast Idle Setting, RPM		2000	2400	2400	2000
High Idle Speed, RPM (Throttle Modulator Extended)		N/A	1350 ± 50	1300 ± 50	1350 ± 50
Curb Idle Speed, RPM - *		650-700	525-575	525-575	500-550
Idle Mixture Setting, % CO		2.0 Max.	0.5 - 2.5	0.5 - 2.5	1.5 - 3.0
Governor Upper Orifice		0.94 mm (.37")	0.94 mm (.037")	0.94 mm (.037")	0.94 mm (0.37")
Governor Lower Orifice		1.32 mm (.052")	1.32 mm (.052")	1.32 mm (.052")	1.39 mm (.055")
Governor Spring (Color)		Plain	Plain	Plain	Red Stripe
Governor Spring Post Position		#2	#2	#2	#2
Governed Speed, RPM*** Full Speed, No Load Full Speed, Full Load		 3800 3600	 3800 3600	 3800 3600	 3400 3200
**Power Valve:	Primary Secondary	Stamped 5 Stamped 25	Stamped 13	Stamped 11	Stamped 9

* Transmission in Neutral, Air Conditioning OFF.

** Power valve identification number is stamped on a flat on the base of the valve.

*** 4150EG carburetor no load speed should be within a plus (+) or minus (-) 100 RPM.

N/A-Not Available

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1978

EMISSION CONTROL SYSTEMS

FOR

GASOLINE ENGINES

This service manual contains 1978 Emission Control Systems used on International gasoline engines. Part I includes exhaust emission effects and maintenance interval charts along with complete tune-up specifications. Part II is a trouble shooting guide with reference (IH Truck Service Manual) CTS-numbers for individual engine accessory servicing.

The Illustrations and specifications In this service manual are based on the latest information available at the time of publication approval.

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PART I

EMISSION CONTROL SYSTEMS

AND

SERVICE OPERATIONS

To function effectively, emission control systems must be properly maintained. Because satisfactory emission limits depend upon proper engine operation, the engine must be kept correctly tuned and adjusted.

It is important that maintenance operations be performed at specified intervals as indicated on the following pages.

Service intervals given are based upon average operating conditions. Where dusty, frequent start and stop or heavily laden operations ate encountered, more frequent servicing will be required.

The required maintenance operations should be performed by an International Harvester dealer, or other service outlet equipped and qualified to perform such services. Any replacement parts used for required maintenance services or repairs of emission control systems should be equivalent in quality and performance to genuine IH parts. Use of interior replacement parts may result In improper operation of emission control systems.

As indicated on the exhaust emission effects chart some California engines are equipped with additional emission controls than the Federal engines. This is because of more stringent air pollution standards in California than the other 49 States. In this service manual, Federal refers to engines sold in all States except California.

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The following chart shows the exhaust emission effects for 1978 International gasoline engines.

EXHAUST EMISSION EFFECTS

Vehicle Model	Engine	Carburetor	Electronic Ignition	Decel Throttle Modulator	Electric Choke	Integral Choke	Remote Choke	Evap. Canister	Air Pump	Exhaust Gas Recirculation	Ported Spark	Modulated Air Cleaner
FEDERAL												
	4-196	1940	Yes	Yes	Yes	Yes	No	No	No	No	Yes	Yes
SCOUT	V-304	2210	Yes	Yes	No	No	Yes	No	No	Yes	Yes	Yes
	V-345	2210	Yes	Yes	No	No	Yes	No	No	Yes	Yes	Yes
CALIFORNIA												
	4-196	1940	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
SCOUT	V-345	2210	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes
FEDERAL												
	V-345	2300EG	Optional	Yes	No	No	Manual	No	No	Yes	Yes	Modulated or Non-Modulated
	V-345	2210	Optional	Yes	No	No	Yes	No	No	Yes	Yes	Modulated or Non-Modulated
LOADSTAR	V-392	4150G	Optional	No	No	No	Manual	No	No	No	Yes	Modulated or Non-Modulated
CARGOSTAR	MV-404	2210	Yes	Yes	No	No	Yes	No	No	No	No	Modulated
S-SERIES	MV-404	2300EG	Yes	Yes	No	No	Manual	No	No	No	No	Modulated
	MV-404	4150G	Yes	Yes	No	No	Manual	No	No	No	No	Modulated
	MV-404	4360EG	Yes	Yes	No	No	Manual	No	No	No	No	Modulated
	MV-446	4150G	Yes	Yes	No	No	Manual	No	No	No	No	Modulated
	MV-446	4360EG	Yes	Yes	No	No	Manual	No	No	No	No	Modulated
FLEETSTAR	V-537	2300EG	Yes	Yes	No	No	Manual	No	No	No	No	Modulated Dry
S-SERIES	V-537	4150G	Yes	Yes	No	No	Manual	No	No	No	No	Modulated Dry
	V-537	4360EG	Yes	Yes	No	No	Manual	No	No	No	No	Modulated Dry
CALIFORNIA												
	V-345	2300EG	Yes	Yes	No	No	Manual	Yes	Yes	Yes	No	Modulated or Non-Modulated
	V-345	2210	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Modulated or Non-Modulated
LOADSTAR	V-392	4150EG	Yes	Yes	No	No	Yes	Yes	Yes	Yes	*No	Modulated or Non-Modulated
CARGOSTAR	MV-404	2210	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Modulated
	MV-404	2300EG	Yes	Yes	No	No	Manual	Yes	Yes	Yes	Yes	Modulated
	MV-404	4150EG	Yes	Yes	No	No	Manual	Yes	Yes	Yes	Yes	Modulated
	MV-446	4150EG	Yes	Yes	No	No	Manual	Yes	Yes	Yes	No	Modulated
FLEETSTAR S-SERIES	V-537	2300EG	Yes	Yes	No	No	Manual	Yes	Yes	Yes	No	Modulated Dry

*Spark vacuum common with EGR signal vacuum.

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Each numbered maintenance step under Maintenance Operations on the Chart is completely explained under the corresponding number in the following text.

MAINTENANCE INTERVALS

MAINTENANCE OPERATIONS	(Mileage, Months or Operation Hours, Whichever Occurs First)														
Km	6400	12800	19200	25600	32000	38400	44800	51200	57600	64000	70400	76800	83200	89600	96000
Miles	4000	8000	12000	16000	20000	24000	28000	32000	36000	40000	44000	48000	52000	56000	60000
Mos.	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75
Hours	125	250	375	500	625	750	875	1000	1125	1250	1375	1500	1625	1750	1875
1. Change Engine Oil and Oil Filter.	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
2. Check and clean Dist. Cap & Rotor or replace, if necessary. Replace Breaker Points & Condenser, where used.			I			I			I			I			I
3. Check Ignition Cables and Measure Resistance and Replace if necessary.			I			I			I			I			I
4. Replace all Spark Plugs, Check Required Voltage, Replace any Defective Plugs.			R			R			R			R			R
5. Replace Fuel Filter.			R			R			R			R			R
6. Clean or Replace Air Cleaner Filter.			I			I			I			I			I
7. Replace Filter at Bottom of Evaporative Vapor Storage Canister.			R			R			R			R			R
8. Check Engine Bolt Torque and Tighten if necessary.			I			I			I			I			I
9. Check Exhaust Gas Control Valve for Free Operation & Service or Replace if necessary.			I			I			I			I			I
10. Check Coil Output Voltage & Replace Coil if necessary.			I			I			I			I			I
11. Check Initial Advance and Adjust if necessary.			I			I			I			I			I
12. Check Operation of Inlet Air System Valve and Service or Replace if necessary.			I			I			I			I			I
13. Check PCV System Hoses & Replace if necessary; Clean PCV Valve if necessary.			I			I			I			I			I
14. Check Deceleration Throttle Modulator (DTM) Systems & Adjust or Replace if necessary.			I			I			I			I			I
15. Remove and Check EGR Valve and Clean or Replace if necessary (California Engines Only).			I			I			I			I			I
16. Check EGR System with Functional Test & Clean or Replace if necessary (Federal and California Engines).			I			I			I			I			I
17. Check Air Injection System and Replace if necessary (California Engines Only).			I			I			I			I			I
18. Check Curb Idle Speed and Air/Fuel Mixture and Adjust as necessary.			I			I			I			I			I
19. Check Automatic Choke (where used) for Proper Setting and Free Operation.			I			I			I			I			I

R = Replace I = Inspect, Correct, Replace if necessary.

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1. Change Engine Oil and Filter

a. Remove oil drain plug from bottom of oil pan and drain oil.

b. Service oil filter.

Procedure for servicing the replaceable element type oil filter is as follows

(1) Remove drain plug in bottom oil filter and drain oil from filter, reinstall drain plug.

(2) Loosen filter body retaining bolt and remove filter body and element. Check condition of filter body to base gasket, replace if necessary.

(3) Wash filter body in cleaning fluid making sure all the sediment is removed from inside of filter body.

(4) Position new filter element to oil filter base with large hole end of element toward filter base. Filter element must be seated on pilot on filter base to avoid damage to element when filter body is installed.

(5) Install filter body and bolt with spring assembly to filter, make sure filter body seats on seal In filter base. Tighten filter body retaining bolt to 41-47 N•m (30 to 35 ft lbs.) torque.

Procedure for servicing the spin-on type oil filter is as follows:

(1) Remove oil filter assembly by turning counterclockwise with the hands or a suitable tool. Clean filter mounting pad.

(2) Coat the gasket on the new filter with a film of grease.

(3) Place the new filter m position on the center tube. Hand tighten 1/2 to 3/4 of a turn after gasket first contacts base of mounting pad.

c. Add sufficient oil to bring the oil level between "ADD" and "FULL" marks on oil dipstick (Fig. 2).

Oil types and grades recommended for engines used on IH truck applications are as follows:

GASOLINE ENGINES

Temperature	Straight Viscosity Grade	Multi-Viscosity Grade
20 to 120 F (-7 to 49C)	SAE 30	SAE 10W-30, 10W-40, 20W-40, 20W-30
0 to 90 F (-18 to 32 C)	SAE 20W	SAE 10W-30, 10W-40, 20W-40, 20W-30
-10 to 70 F (-23 to 21 C)	SAE 10W	SAE 10W-30, 10W-40
Below -10 F (23 C)	--------	SAE 5W-20, 5W-30

Use engine oils meeting service classification "SE" or "CC" (MIL-L-46152).

IMPORTANT

When a universal engine oil (SE-CD) is preferred, the engine oil must have passed the Volvo B-20 cam and tappet test and contain a minimum 0.1% alkyl zinc. IH #1 engine oil now meets this requirement.

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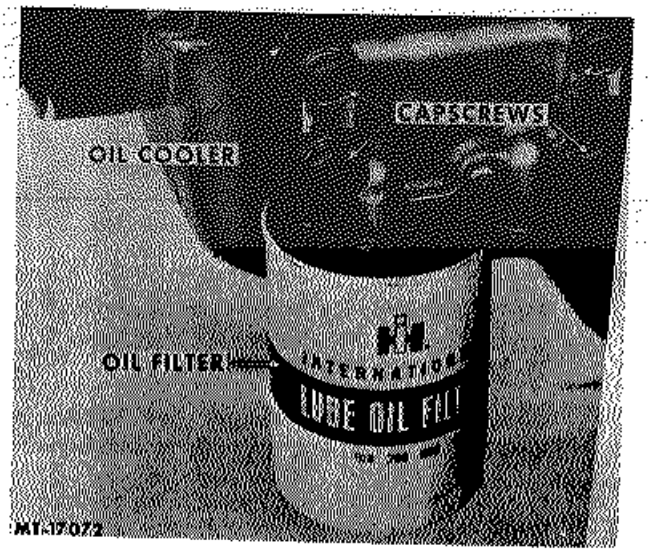


Fig. 1 Typical Spin-on Type Oil Filter

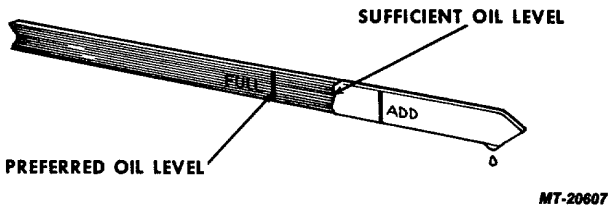


Fig. 2 Proper Oil Level

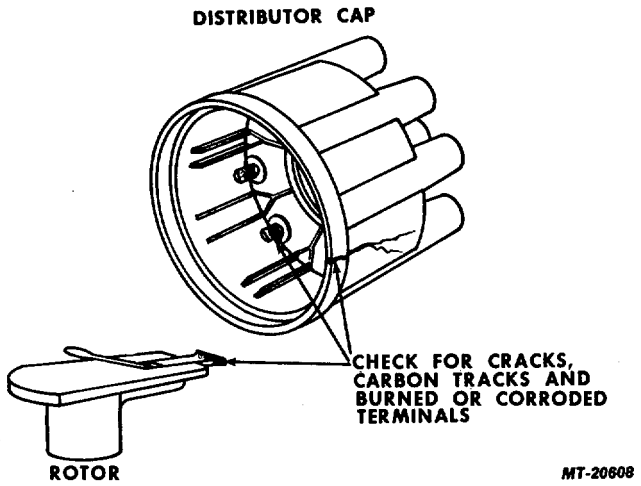


Fig. 3 Inspect Distributor Cap and Rotor

d. Start engine and run for at least five minutes to warm oil and check for leaks. Recheck and add sufficient oil.

2. Check and Clean Distributor Cap and Rotor or replace, if necessary. Replace Breaker Points and Condenser, where used.

a. Remove distributor cap and rotor.

b. Clean and inspect distributor cap and rotor for cracks, carbon tracks and burned or corroded terminals.

c. Replace breaker points, where used. See Tun-Up Specifications for gap or dwell. Lubricate distributor cam.

d. Replace rotor, if defective, and install in distributor.

e. Replace cap, it detective, and connect high tension cables to cap.

3. Check Ignition Cable and Measure Resistance and Replace, if necessary.

a. Remove high tension cables from spat k plugs.

b. Using Engine Performance Tester No. SE-2576 or equivalent, measure resistance of each cable by connecting ohmmeter leads to spark plug end of cable and terminal inside distributor cap.

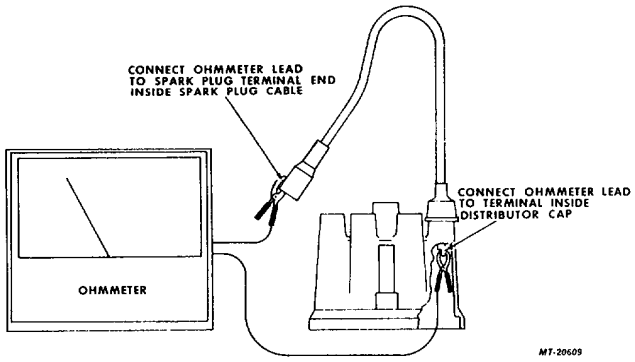


Fig. 4 Checking Ignition Cables with Ohmmeter.

c. It resistance exceeds specifications (see Emission Control System Tune-Up Specifications), replace high tension cable(s).

d. Reinstall cap onto distributor.

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e. Inspect high tension ignition cables for cracks or deterioration and replace detective cables.

4. Replace all Spark Plugs, Check Required Voltage and Replace any Defective Plugs

a. Remove used spark plugs.

b. Check gap of new spark plugs (see Emission Control System Tune-Up Specifications) and adjust gap, if necessary.

Continuous light load operation may produce spark plug fouling, necessitating more frequent spark plug changes than are indicated in the Maintenance Intervals. A change in plug heat range will not correct fouling under these conditions.

To change spark plug gap, bend the outer electrode, never bend the center electrode. Be accurate-use a round wire gauge to check the electrode gap. Check the gap of new spark plugs before installation and tighten to specified torque.

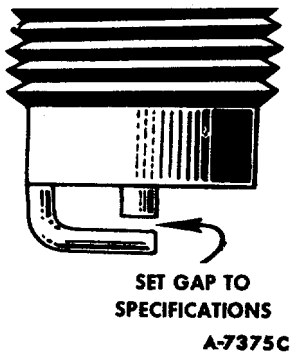


Fig. 5

IH Branches and Dealers are equipped with spark plug cleaning and testing equipment which renders dependable service.

c. Install new spark plugs and torque to specifications (see Emission Control System Tune-Up Specifications).

d. Install high tension spark plug cables onto spark plug terminal.

IMPORTANT

When replacing high tension spark plug cables, be sure cables are routed to proper spark plugs (refer to firing order cast into intake manifold).

e. Connect Tune-Up Scope Tester No. SE-2440, or equivalent.

f. Start and operate engine until normal operating temperatures are reached. Then operate engine at 1000 RPM.

g. Observe required voltage (see Emission Control System Tune-Up Specifications).

h. If required voltage is out of specifications on any cylinder, replace spark plug and repeat Steps a through g

5. Replace Fuel Filler.

Inline fuel filters are used on most IH engines (Fig. 6). This type of filter is inexpensive and easy to replace when needed.

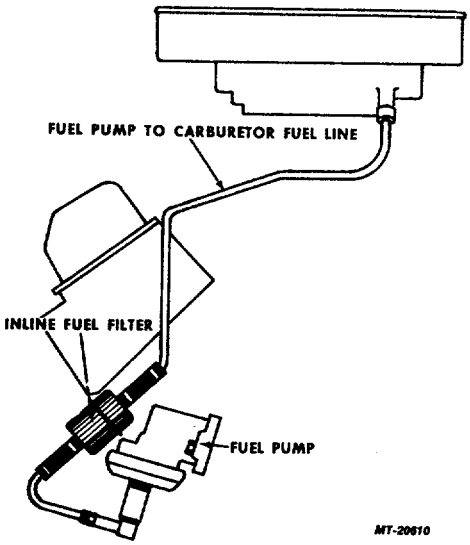


Fig. 6 Inline Fuel Filter Typical on Most Gasoline Engines

The V-537 engine used In a Fleetstar model vehicle will have a rail mounted spin-on type fuel filter (Fig 7).

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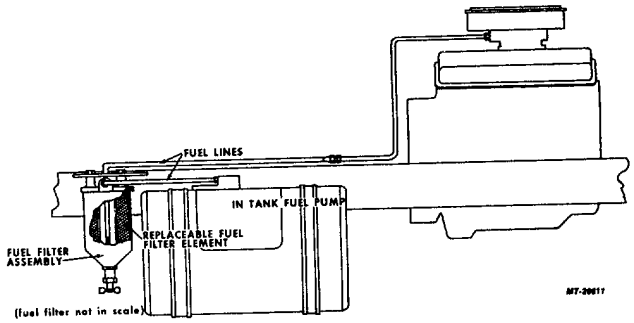


Fig. 7 Rail Mounted Fuel Filter Used on Fleetstar Model with V-537 Engine

6. Clean or Replace Air Cleaner Filter.

a. Dry Type-Remove air cleaner element, clean any accumulation of dirt from air cleaner housing. Tap element lightly on a flat surface or use low air pressure to remote dirt particles. Blow air from inside filter element to outside. Check element for punctures or splits by looking through filter paper toward light held in center of element. Do not wash element. Replace with new element, if necessary.

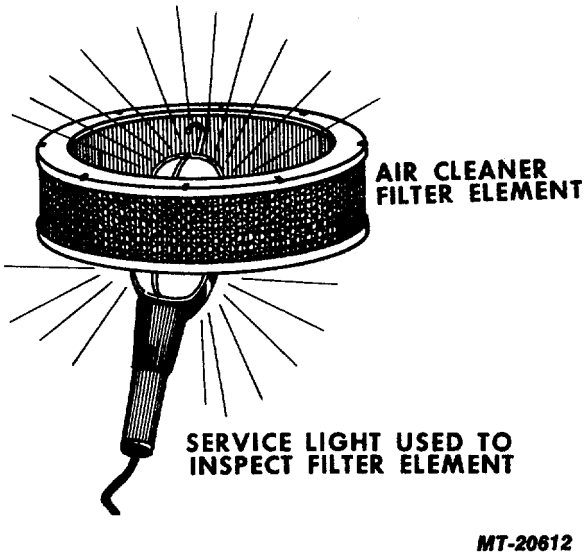


Fig. 8 Dry Type Air Cleaner Filter

b Oil Bath Type-Remove air cleaner from engine. Remove oil sump and drain oil. Wash sump and mesh filter element In solvent and dry with compressed air. Refill sump and oil mesh element with engine oil of same viscosity used in the engine. Allow excess oil to drip from element before reassembly. Reinstall air cleaner.

7. Replace Filter at Bottom of Evaporative Vapor Storage Canister.

The air filter located at the bottom of the vapor storage canister (Fig. 9) should be replaced at the interval shown on the Maintenance Intervals Chart, or more frequently under severe dusty conditions.

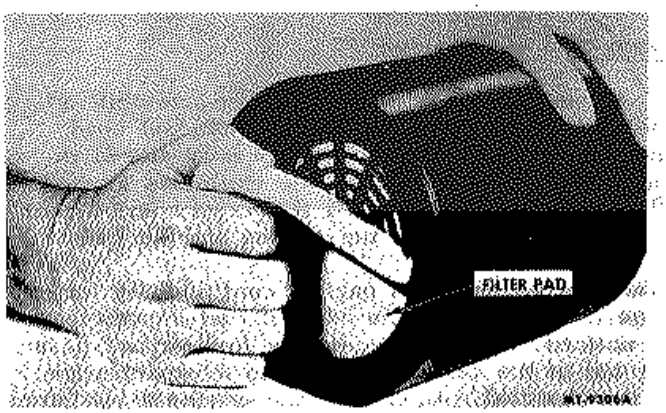


Fig. 9 Vapor Storage Canister Air Filter Location

7A. Gasoline Evaporative Loss Control System (California Only)

In compliance with California air pollution control regulations, all IH gasoline powered vehicles sold in California will utilize gasoline evaporative loss control system which reduces the amount of gasoline vapors entering the atmosphere from the vehicle's fuel system. Below is a schematic view of a typical gasoline evaporative loss control system.

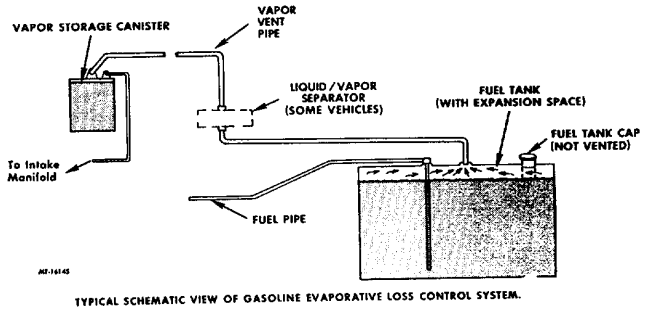


Fig. 10 Typical Schematic View of Fuel Tank Gasoline Evaporative Loss Control System

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To accomplish evaporative control the system must perform three basic functions:

1. Provide space for gasoline expansion due to temperature rise.

2. Limit escape of gasoline vapors to the atmosphere by collecting and storing vapors generated while vehicle is parked with engine shut off.

3. Burn off stored gasoline vapors when engine is operating.

Vapor Storage Canister

When vehicle is parked and engine shut off. gasoline vapors from the carburetor fuel bowl and the fuel tank will be temporarily stored in the charcoal canister until the engine is started. When the engine is started the vapors ,are drawn from the canister into the engine and burned.

When a vehicle is parked continuously for more than one day, the odor of fuel vapors may be noticed. This is caused by fuel vapors passing out of the canisters due to over saturation of the charcoal. Operating the engine a few minutes will purge the canister(s) of fuel vapors and restore its holding capacity.

Three types of vapor storage canister systems are used in 1978 California vehicles.

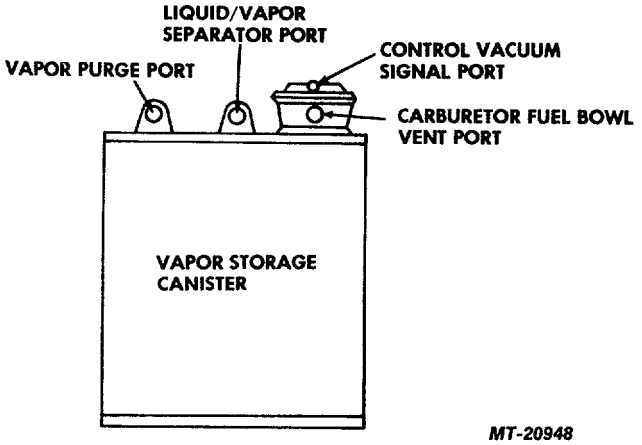


Fig. 11 Scout Vapor Storage Canister

1. The vapor storage canister used on Scout vehicles (Fig. 11) stores both carburetor fuel bowl vapors and fuel tank vapors. Fig 11 shows the canister ports for proper hose connections.

The operation of the canister used on Scout vehicles is shown in Figure 14.

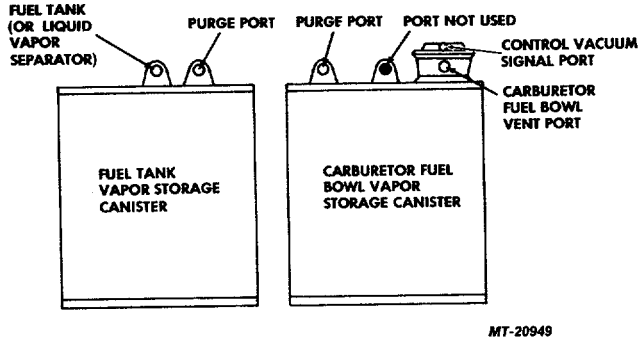


Fig. 12 Vapor Storage Canisters Used on Medium-Heavy Duty Vehicles with Single Tank of 35 Gallon Capacity And Less

2. Two vapor storage canisters are used on medium-heavy duty vehicles with single fuel tanks of 35 gallon capacity or less. One canister is used for storing fuel tank vapors only. This canister has two ports, one port for liquid vapor separator connection and one for canister purge to engine.

   The other canister is used for carburetor fuel bowl vapors only. This vapor storage canister is the same as used on the Scout vehicles and Its operation is shown in Fig 14.

3. Three vapor storage canisters are used on medium-heavy duty vehicles with single fuel tank greater than 35 gallon capacity and all multi-tank vehicles. As shown in Figure the fuel tank vapor storage canisters consist of one canister with a vacuum controlled purge valve and one two-port canister which is connected to the bottom of the vacuum controlled purge canister. The two port canister adds vapor storage capacity for large fuel tank(s) systems. The operation of the vacuum controlled purge canister is shown in Figure 15.

   The function of the third vapor storage canister (shown in Fig 13) is to store carburetor fuel bowl vapors only. Its operation is the same as explained for Scout vehicles except the fuel tank port is not used. The opera- ton of this canister is shown in Fig. 14.

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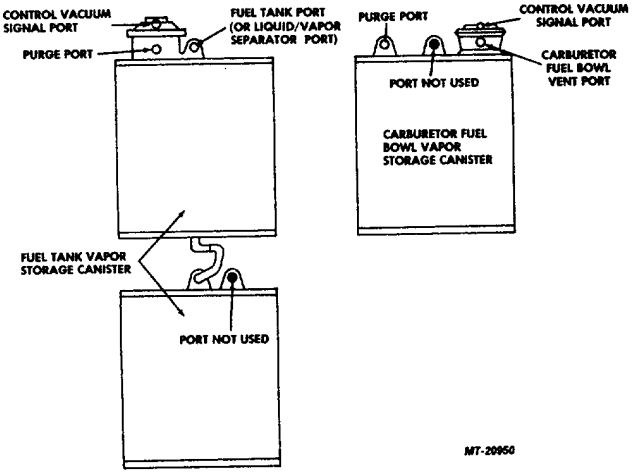


Fig. 13 Vapor Storage Canisters Used on Medium-Heavy Duty Vehicles with Single Fuel Tank Greater Than 35 Gallon Capacity and All Multitank Installations

Canister Operation Test

Disconnect control vacuum and purge hoses from canister(s). With engine running at high idle speed and normal operating temperature. a vacuum pull should be felt at each hose end. If no vacuum is felt, reconnect hoses to the proper port on the canister(s) and disconnect at vacuum source on engine. Inspect for obstruction in hoses and hose connecting fittings. Also inspect hoses for cracks, damage or deterioration and replace if necessary.

It is important that canister hoses be connected to the proper manifold fitting.

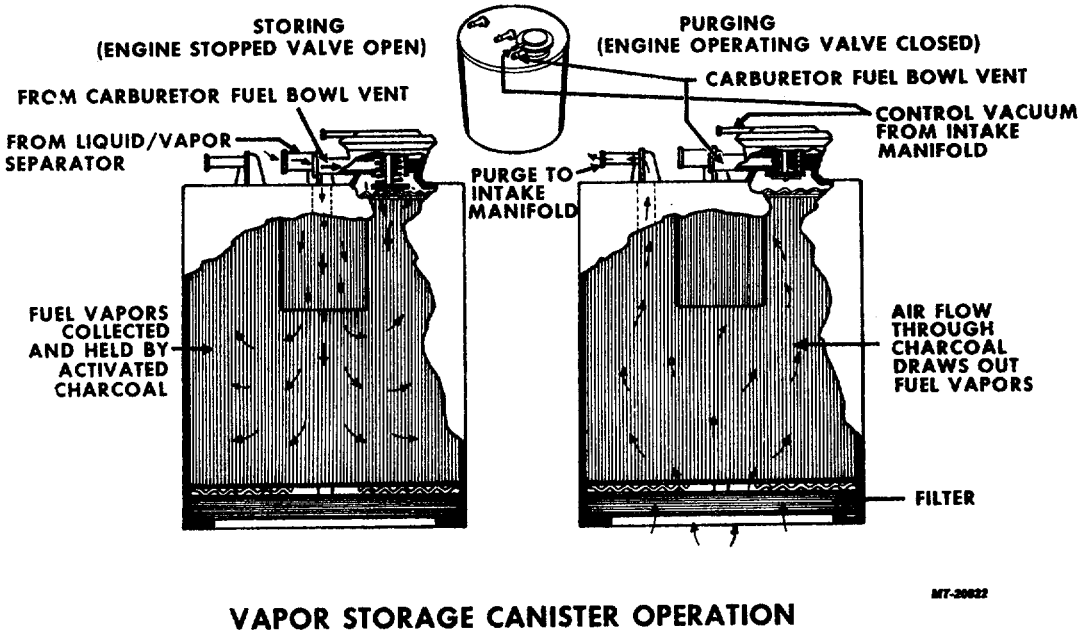


Fig. 14 Vapor Storage Canister with Vacuum Controlled Carburetor Fuel Bowl Vent Valve

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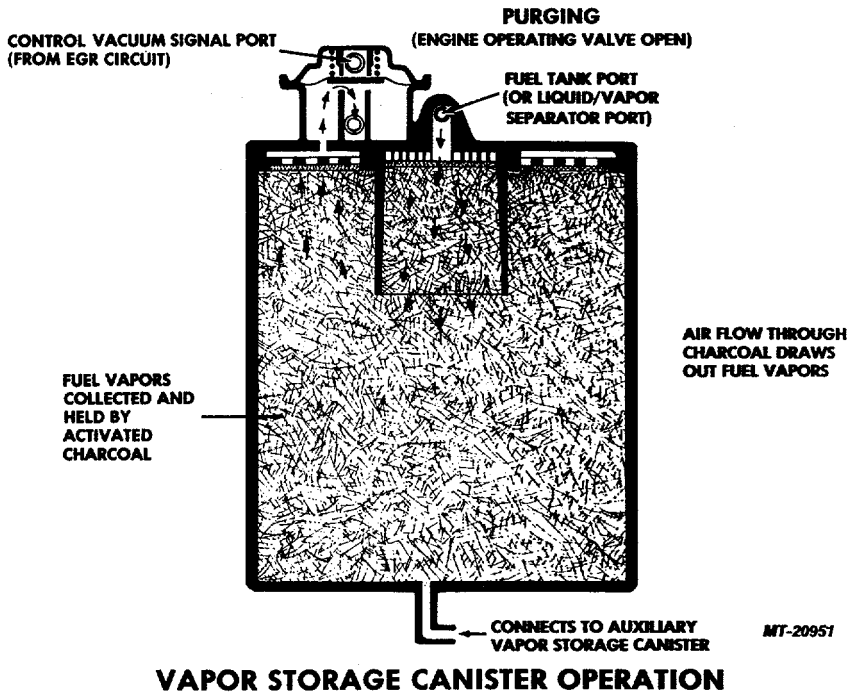


Fig. 15 Vapor Storage Canister with vacuum Controlled Purge Valve

Canister Control Valve Test

Before starting the following test with hand operated vacuum pump (SE-2499), check pump for leakage (Fig. 16) by placing a finger over the vacuum port and pump until full or near full scale is reached. Watch pump gauge. If vacuum drops rapidly pump is leaking and should not be used for test. If a very slow leak is indicated the pump may be used if the degree of pump leakage is kept in mind.

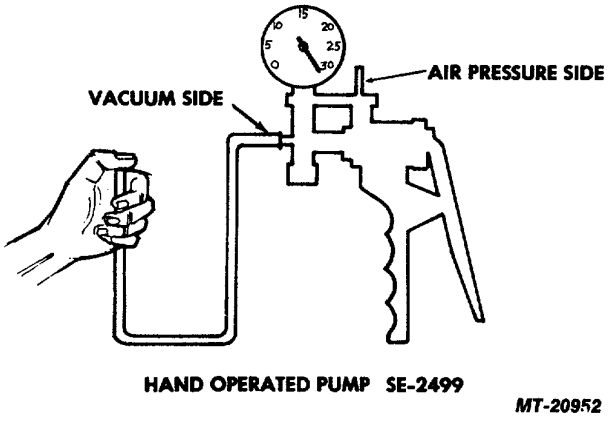


Fig. 16 Check Hand Operated Vacuum Pump SE-2499 for Leakage

1. Test canister fuel bowl .vent control valve diaphragm by applying vacuum to the control valve port (smaller top port valve assembly) with hand operated vacuum pump (SE-2499). Observe vacuum pump gauge (Fig. 17). If vacuum drops rapidly the control valve diaphragm is leaking and the canister must be replaced.

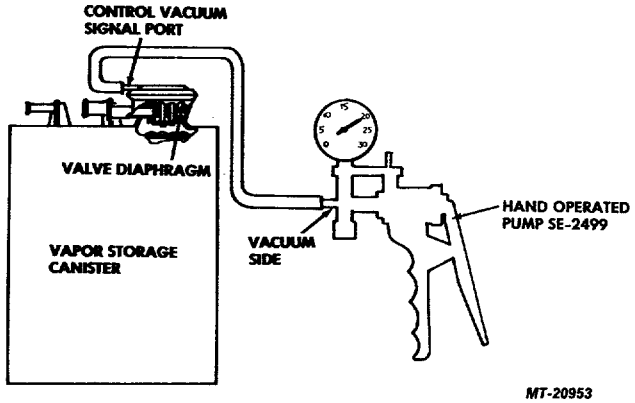


Fig. 17 Canister Fuel Bowl Vent Control Valve Diaphragm Test

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2. The valve seat portion of the fuel bowl vent control valve can be tested by applying vacuum to the control valve (same as diaphragm test Fig. 17) and at the same time (with another hand operated pump SE-2499 using all pressure side of pump) apply air pressure to the valve (Fig 18) until pressure buildup is felt. If pressure buildup is not felt the valve seat is leaking and the canister must be replaced.
3. Test purge control valve diaphragm and valve seat by applying vacuum with hand operated vacuum pump (SE-1499) simultaneously to both vacuum signal port and purge port (see Fig 19). If vacuum of either pump drops rapidly the value is faulty and the canister must be replaced.

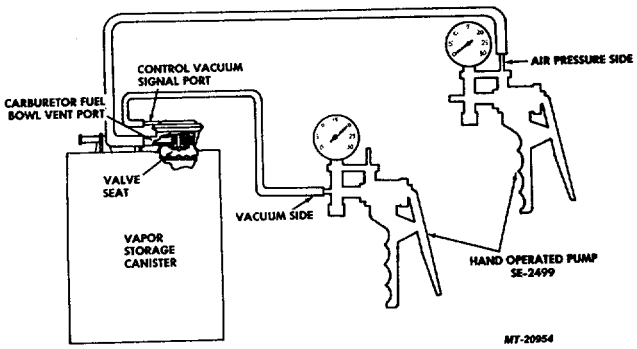


Fig. 18. Canister Fuel Bowl Vent Control Vale Seat Test

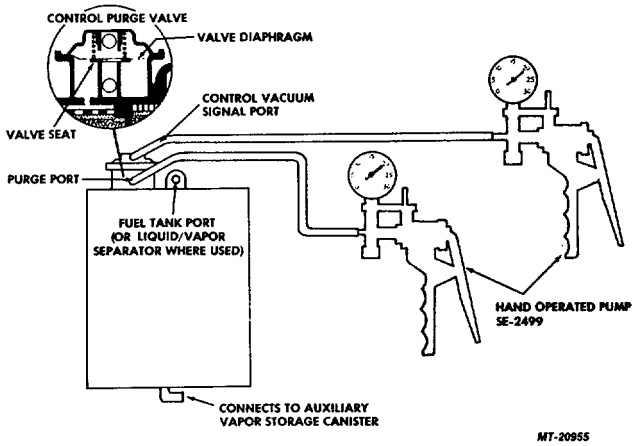


Fig. 19. Canister Purge Control Valve Diaphragm And Valve Seat Test

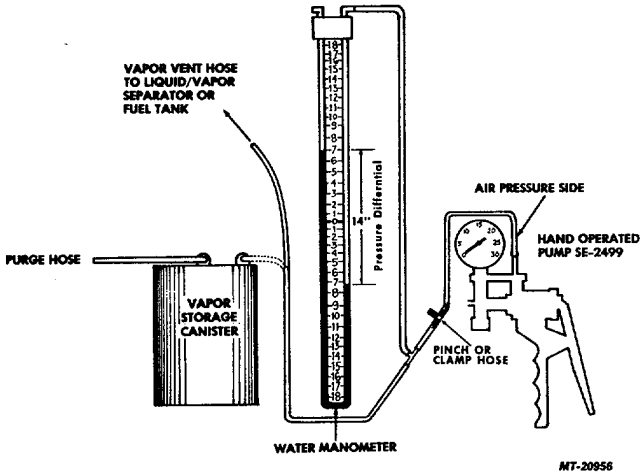


Fig. 20. Method of Pressurizing Vapor Vent System to Check for Leakage

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Pressure test fuel tank vapor vent system by disconnecting the hose on canister leading to separator and connect water manometer (SE-2217 or equivalent) and the air pressure side of hand operated vacuum pump (SE-2499) as shown in Figure 20.

Place sufficient water in manometer to allow 356 mm (14") differential in height. Pump the hand operated air pump until a pressure of 356 mm (14") of water is applied to the system (indicated on the manometer). Pinch or clamp hose between tee and air pump to keep system pressurized. Observe manometer. If pressure drops more than 51 mm (2") of water in five (5) minutes, an excessive leak is indicated.

On a warm day it is possible to observe pressure rise due to hot fuel. This indicates that system is tight.

If excessive leakage is indicated, first check fuel tank cap for a loose fit on tank tiller neck or a damaged cap gasket. If either of these conditions are found, replace cap. If cap-to-tiller neck tit and cap gasket are satisfactory, cover relief valve opening in cap (small hole in portion of cap which enters filler neck) securely with tape. Reinstall cap and again pressurize system and check for leakage. If excessive leakage persists, check all connections in fuel supply and vapor vent system with soap suds solution to locate leaks. Inspect for cracked or damaged liquid vapor separator, fuel supply or vapor vent tubes or connecting hoses. If no leaks are found and system holds pressure with valve opening in cap covered but loses pressure with valve opening uncovered, it can be assumed that relief valve in cap is faulty. Replace cap.

When pressure testing system following installation of a new fuel tank, it will be necessary to disconnect and plug fuel system line at fuel pump to prevent air leakage through fuel pump and carburetor

Fuel Tank Cap

Fuel tank caps are nonvented to prevent passing of gasoline vapors directly into the atmosphere.

Some caps incorporate a vacuum relief valve set to open at approximately 178 to 356 mm of water (7" to 14" H2O) and a pressure relief valve set to open at approximately 508 to 1524 mm of water (20" to ho" H2O).

The vacuum valve provides an air intake opening to the fuel tank. As fuel is consumed or contracts due to cooling, causing low pressure (vacuum) in fuel tank, atmospheric pressure opens the vacuum relief valve permitting air to enter the fuel tank. The pressure relief valve acts as a pressure release in case the vapor vent system becomes plugged. Operation of fuel tank cap vacuum relief valve and pressure relief valve, is illustrated in Fig. 21.

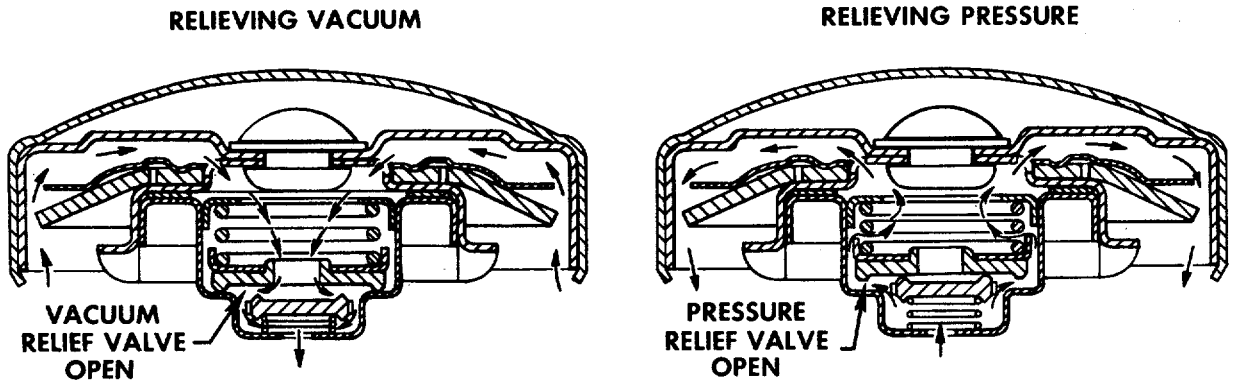


Fig. 21. Fuel Tank Cap Relief Valve Operation

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Fig. 22. Illustrates a typical nonvented fuel tank cap for vehicles with large side mounted fuel tanks.

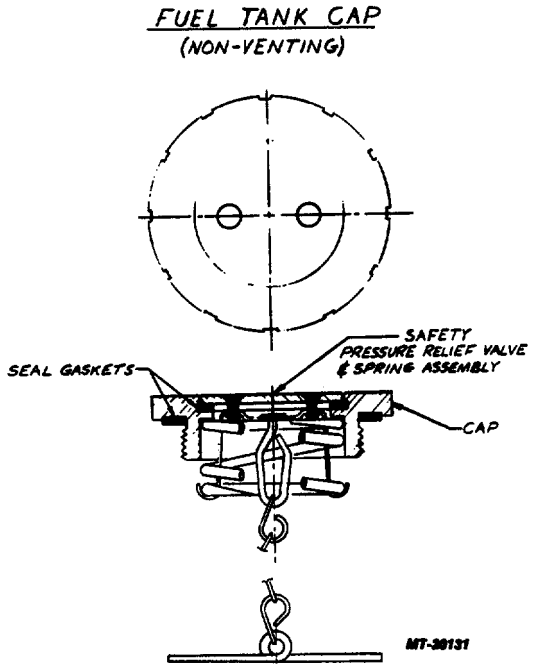


Fig. 22 Fuel Tank Cap (Nonvented Type)

Fuel Tank Cap Relief Valve Test

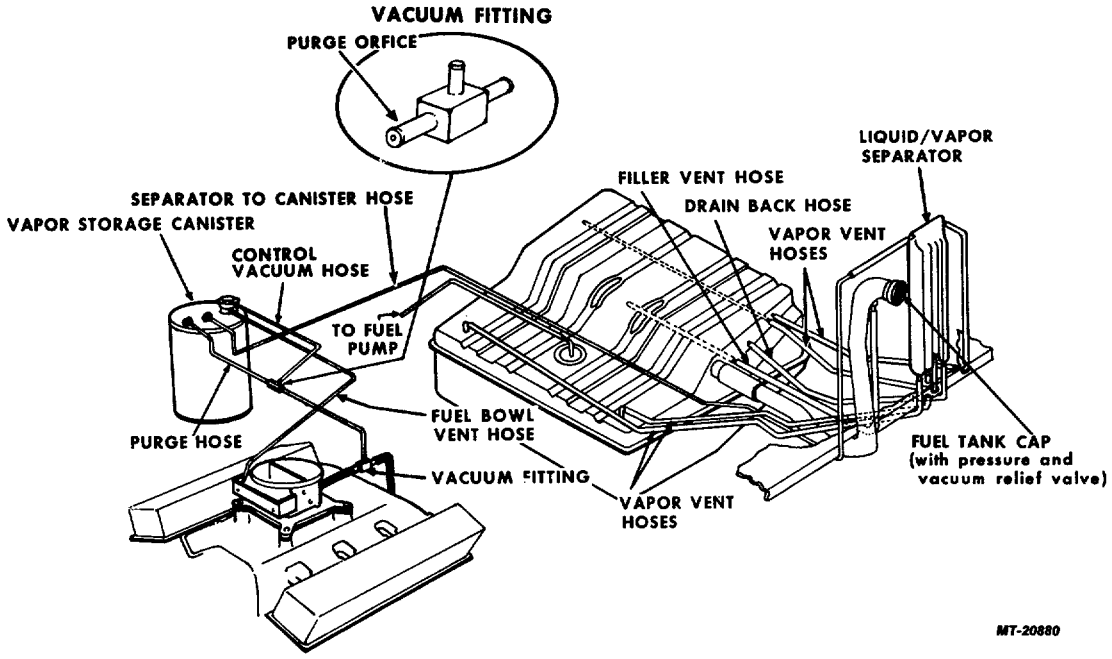
A quick check of the vacuum and pressure relief valves in the fuel tank cap may be made as follows:

Check vacuum relief valve by applying high suction to hole In relief valve housing (portion of cap which enters filler neck) If vacuum relief value falls to open (no air flow through valve), cap should be replaced.

To check pressure relief valve, force air lightly into hole in relief valve housing. An immediate leak (air flow) or failure to release (no air flow) indicates that pressure relief valve is faulty and that the cap should be replaced.

Liquid/Vapor Separator

Some vehicles are equipped with a liquid/ vapor separator. The purpose of the liquid/vapor separator is to receive any liquid fuel which may enter the fuel tank vapor vent lines due to thermal expansion of fuel or vehicle maneuvering and allow, it (liquid fuel) to drain back to the fuel tank permitting only fuel vapors to flow to the vapor storage canister.



GASOLINE EVAPORATION LOSS CONTROL SYSTEM SCOUT SERIES VEHICLES

Fig. 23. Gasoline Evaporative Loss Control System - Scout Series Vehicles

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Fuel Tanks

Fuel tanks are designed to provide space to permit expansion of gasoline without overflowing. The tanks incorporate vapor vent outlets which permit passage of gasoline vapors fiom the tank. Some fuel tanks have multiple vapor vent outlets located such that under any sloping attitude of the vehicle at least one of the vent outlets will be above the level of the gasoline in the tank.

Evaporative loss control systems vary between vehicle models, types of fuel tanks and fuel tank installations. Systems used on various vehicle models ale illustrated in Figs. 23 thru 68.

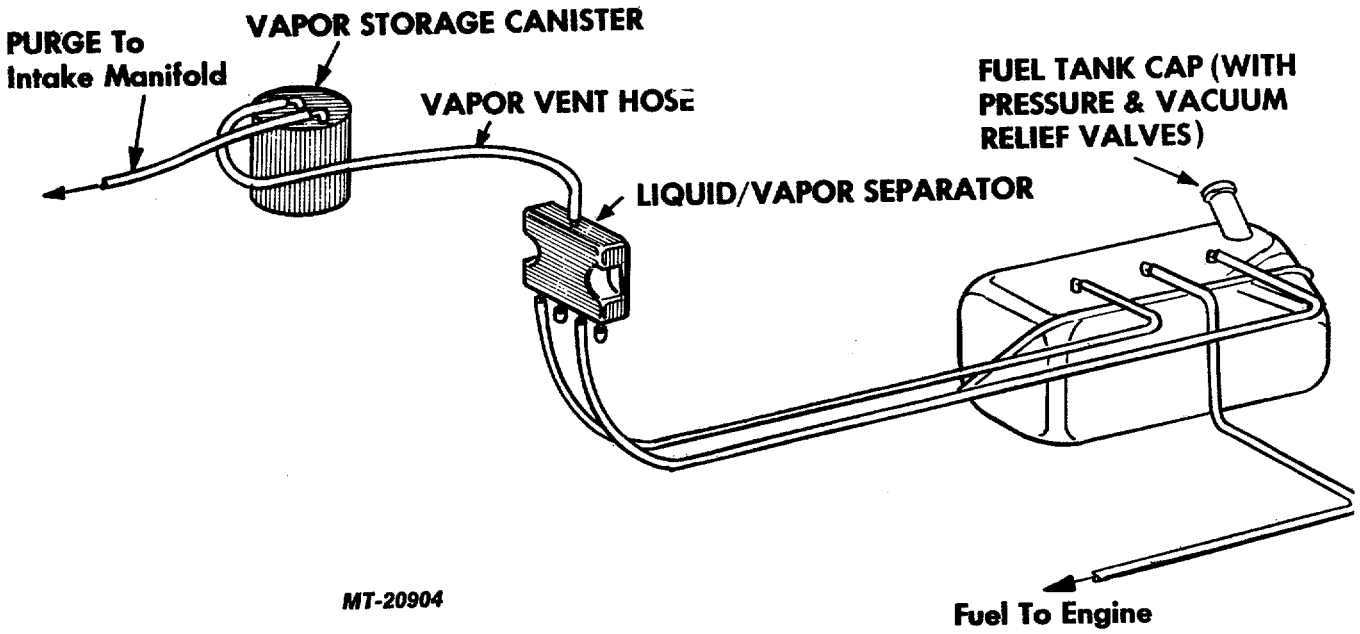


Fig. 24. 1600 - 1800 Loadstar Vehicles with 21 Gallon Under Cab Fuel Tank

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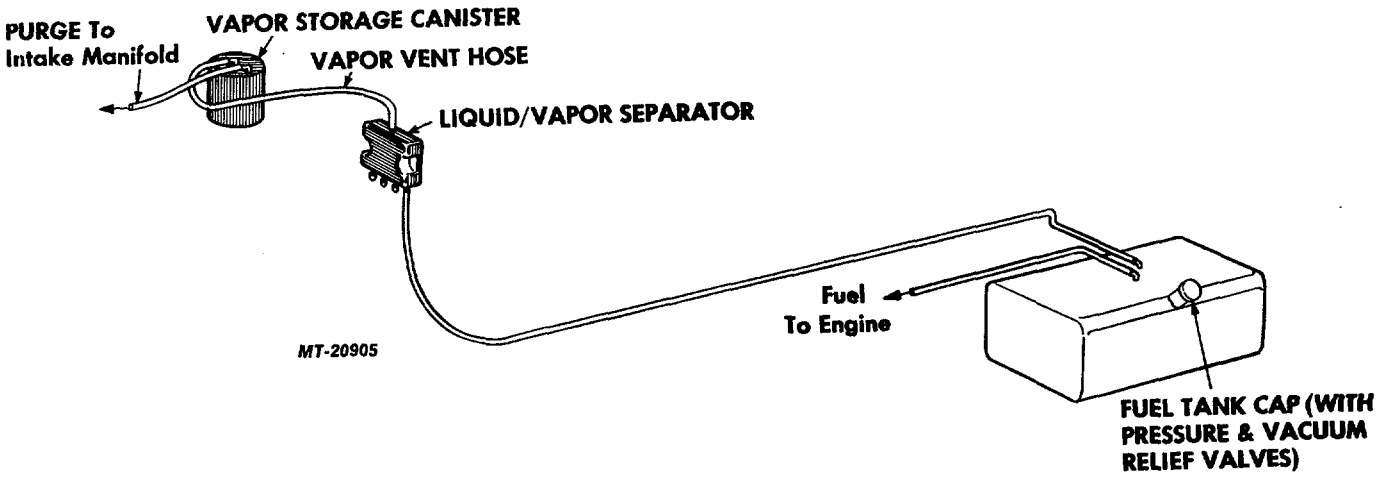


Fig. 25. 1600-1800 Loadstar Vehicles with 31 Gallon Single Left Fuel Tank

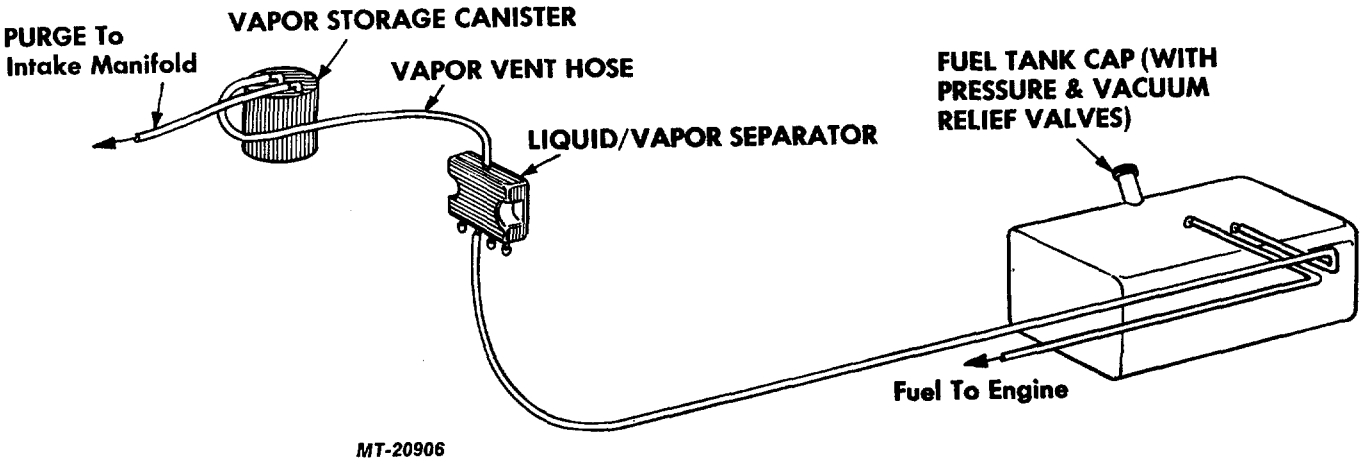


Fig. 26. 1600-1800 Loadstar Vehicles with 31 Gallon Single Right Fuel Tank

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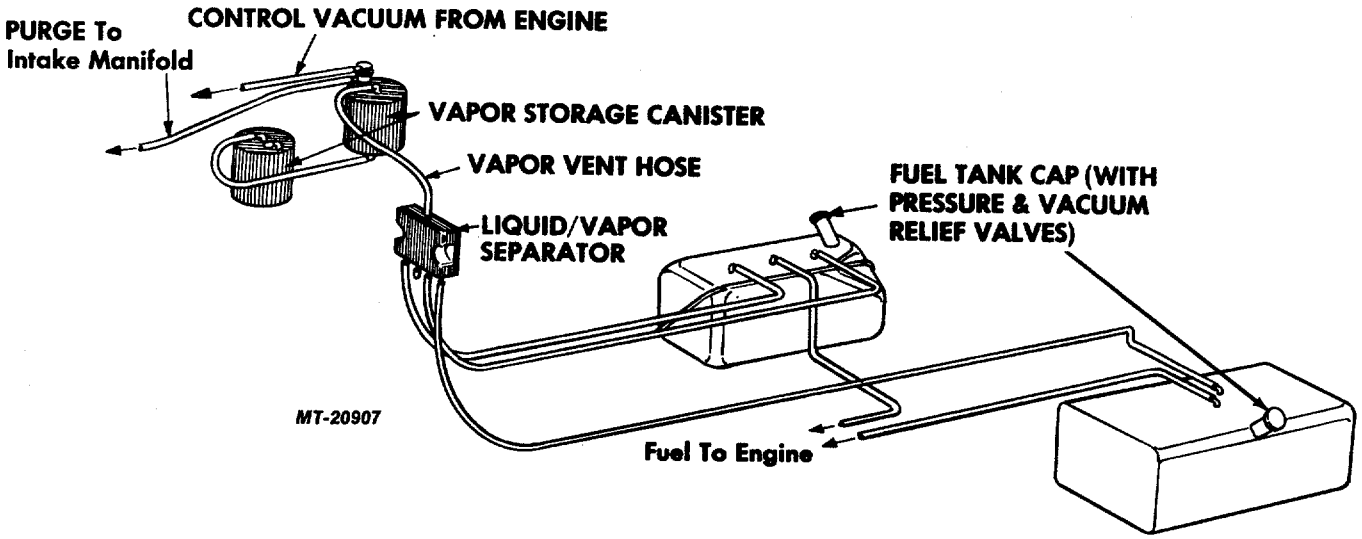


Fig. 27. 1600-1800 Loadstar Vehicles with 21 Gallon Under Cab Fuel Tank And 31 Gallon Single Left Fuel Tank

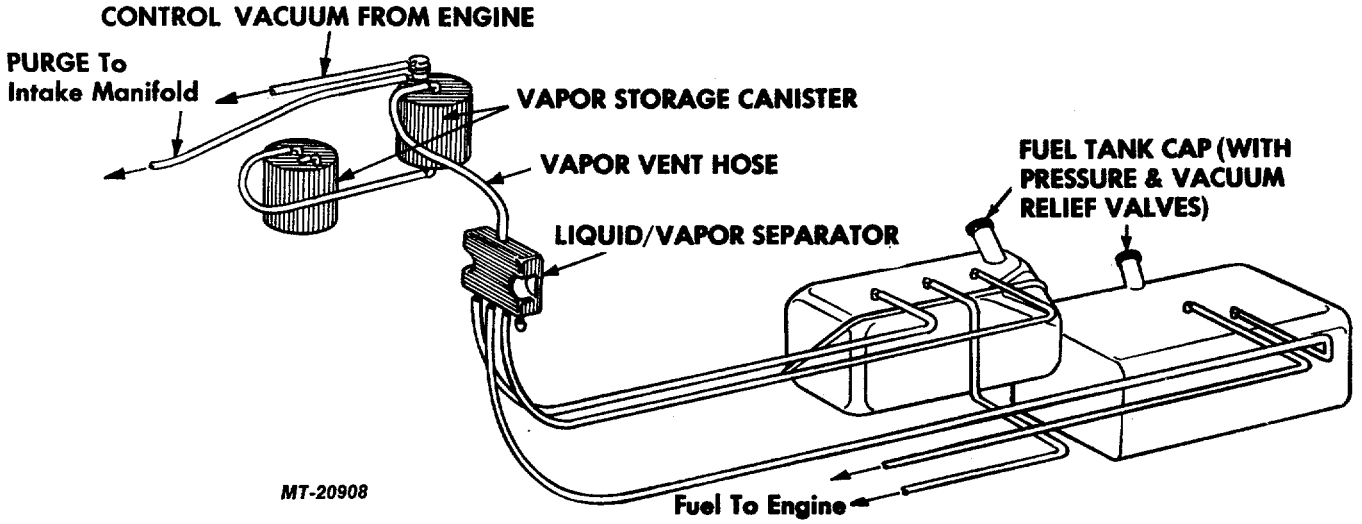


Fig. 28. 1600-1800 Loadstar Vehicles with 21 Gallon Under Cab Fuel Tank And 31 Gallon Single Right Fuel Tank

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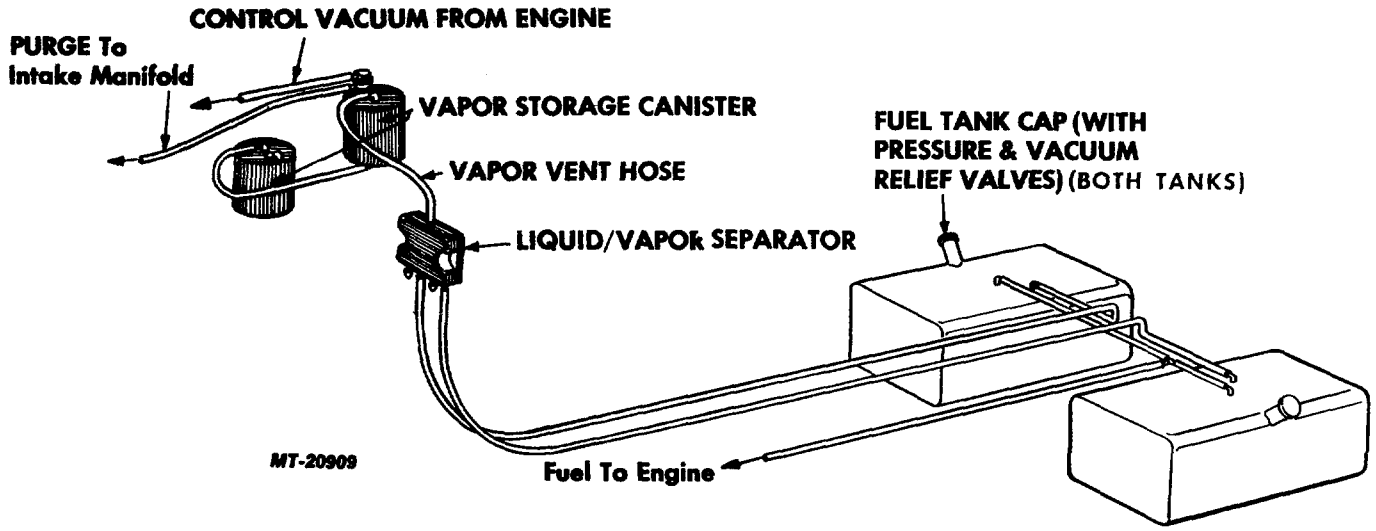


Fig. 29. 1600-1800 Loadstar Vehicles with 31 Gallon Dual Fuel Tanks

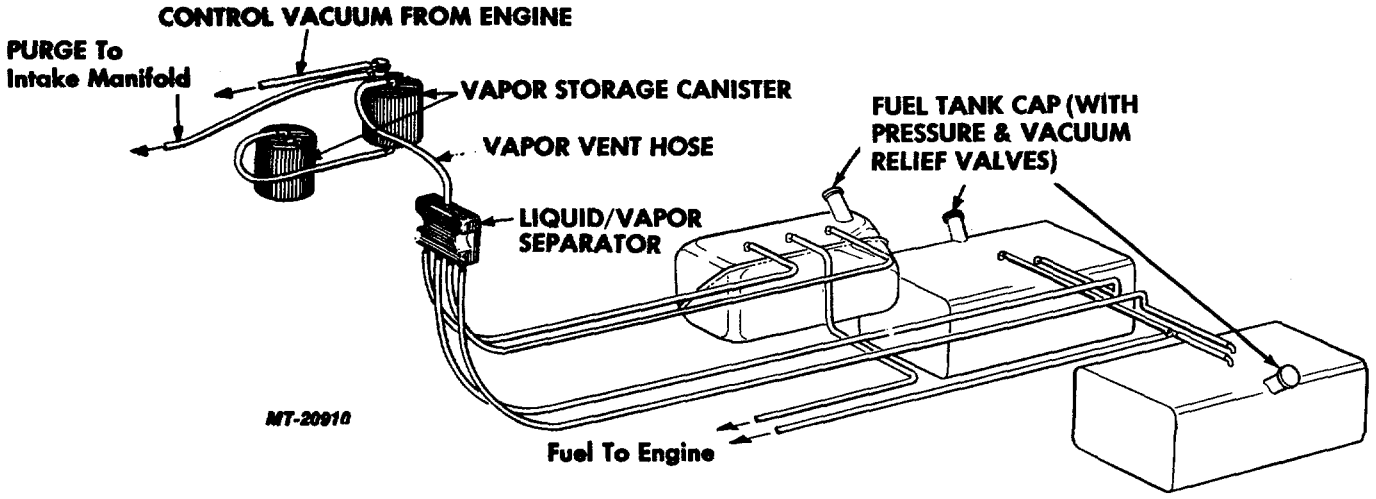


Fig. 30. 1600-1800 Loadstar Vehicles with 21 Gallon Under, Cab Tank And 31 Gallon Dual Tanks

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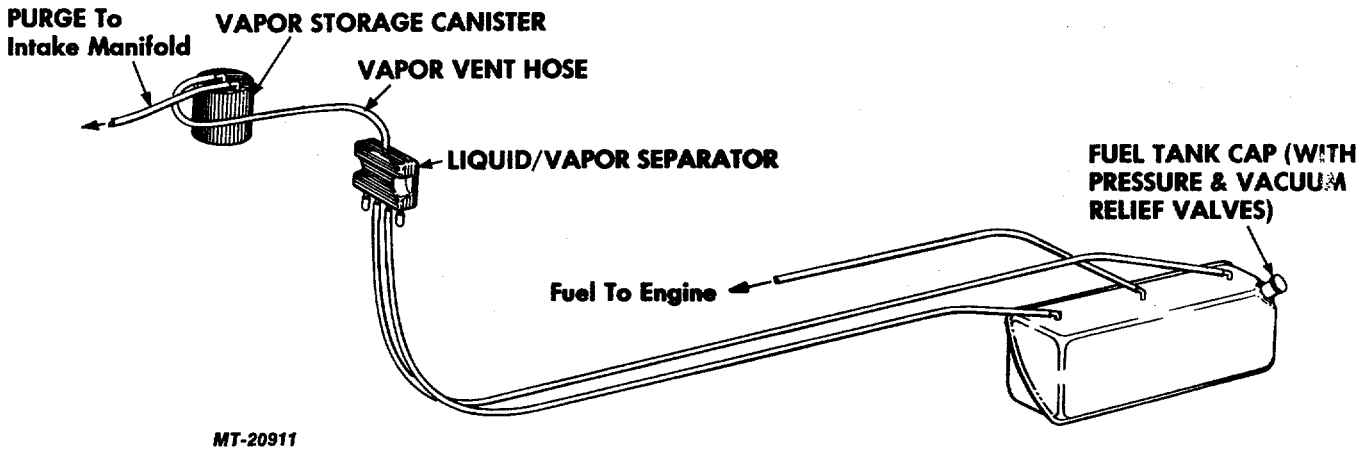


Fig. 31. 1600-1800 Loadstar Travelcrew Cab Vehicle With 21 Gallon Under Cab Fuel Tank

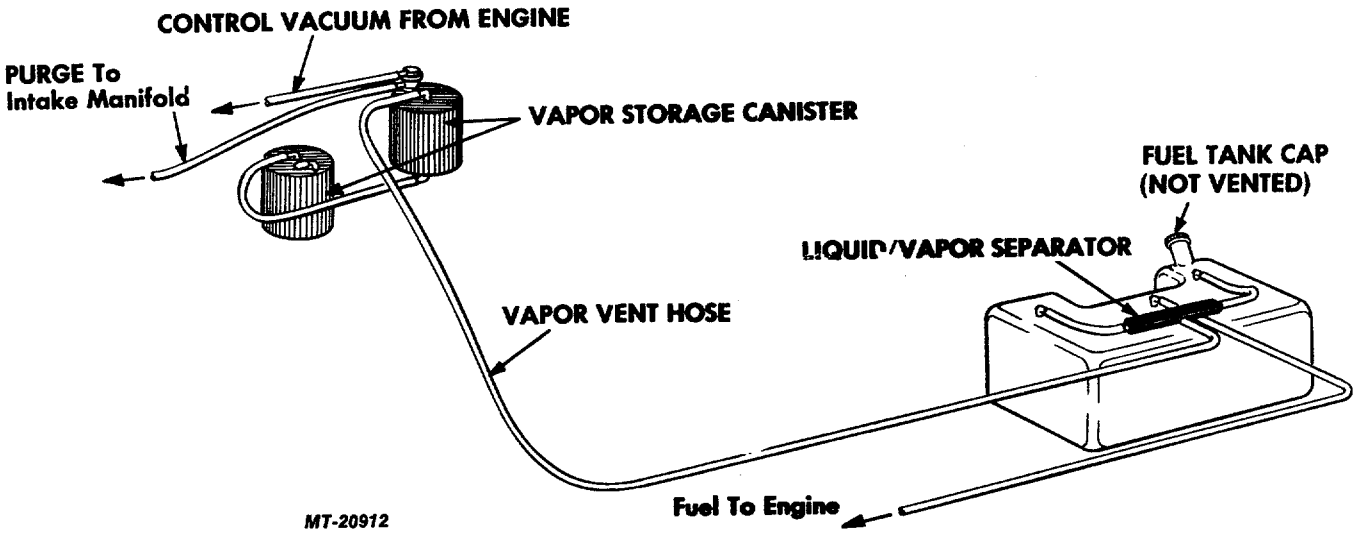


Fig. 32. 1600-1800 Loadstar Vehicles with 50 Gallon Single Right Fuel Tank.

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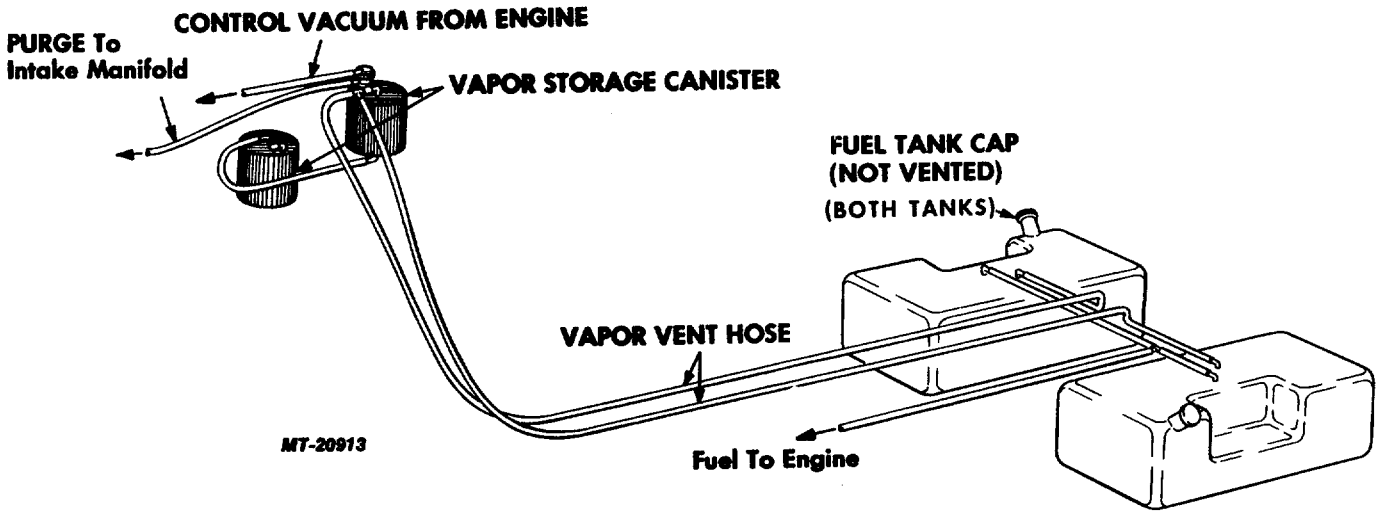


Fig. 33. 1600-1800 Loadstar Vehicles with 53 Gallon Dual Fuel Tanks

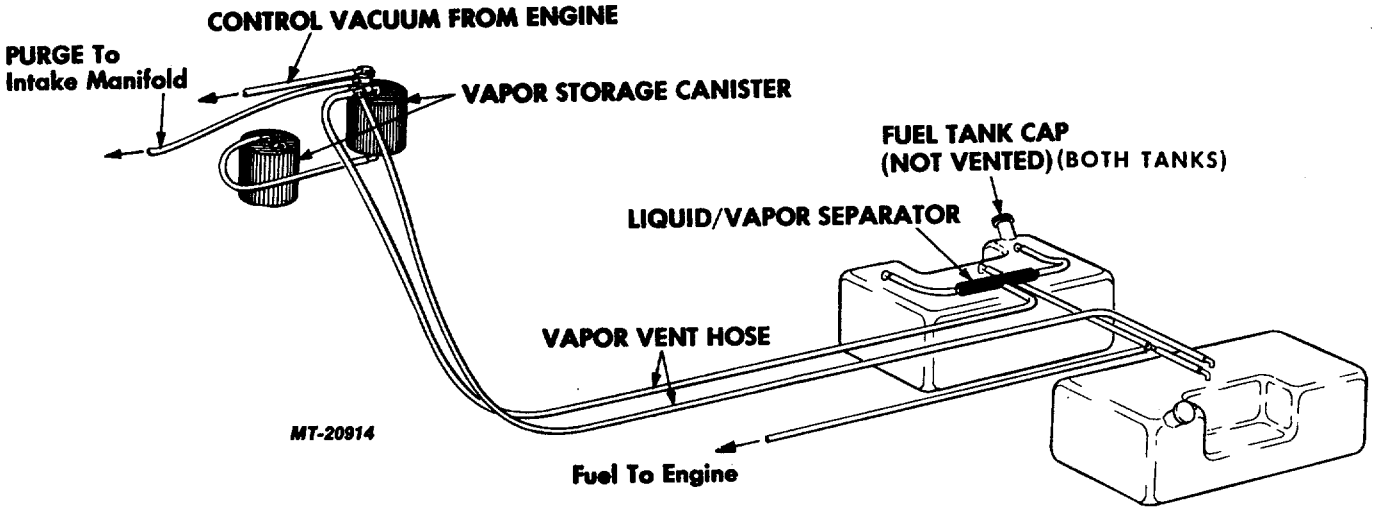


Fig. 34. 1600-1800 Loadstar Vehicles with 50 Gallon Right Fuel Tank And 53 Gallon Left Fuel Tank

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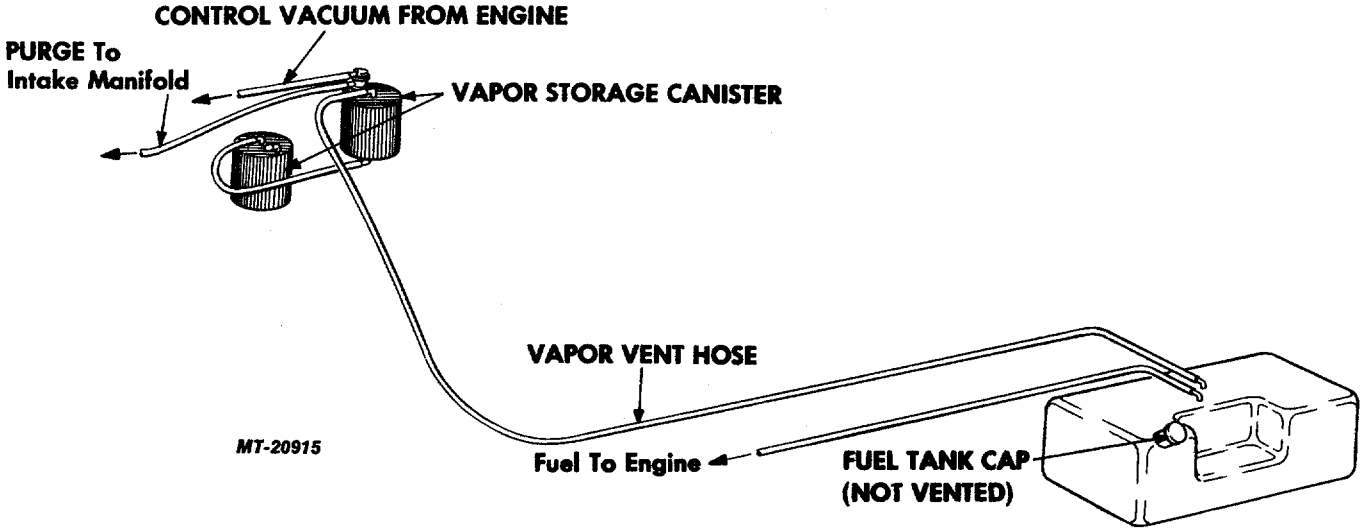


Fig. 35. 1600-1800 Loadstar Vehicles with 53 Gallon Single Left Fuel Tank

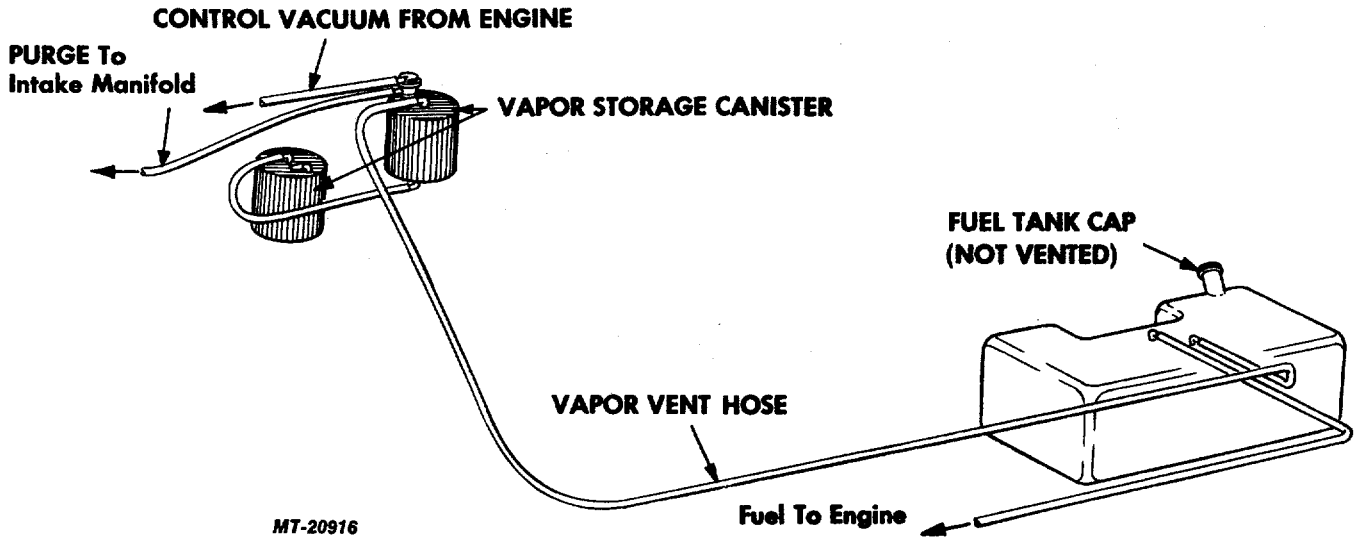


Fig. 36. 1600-1800 Loadstar Vehicles with 53 Gallon Single Right Fuel Tank

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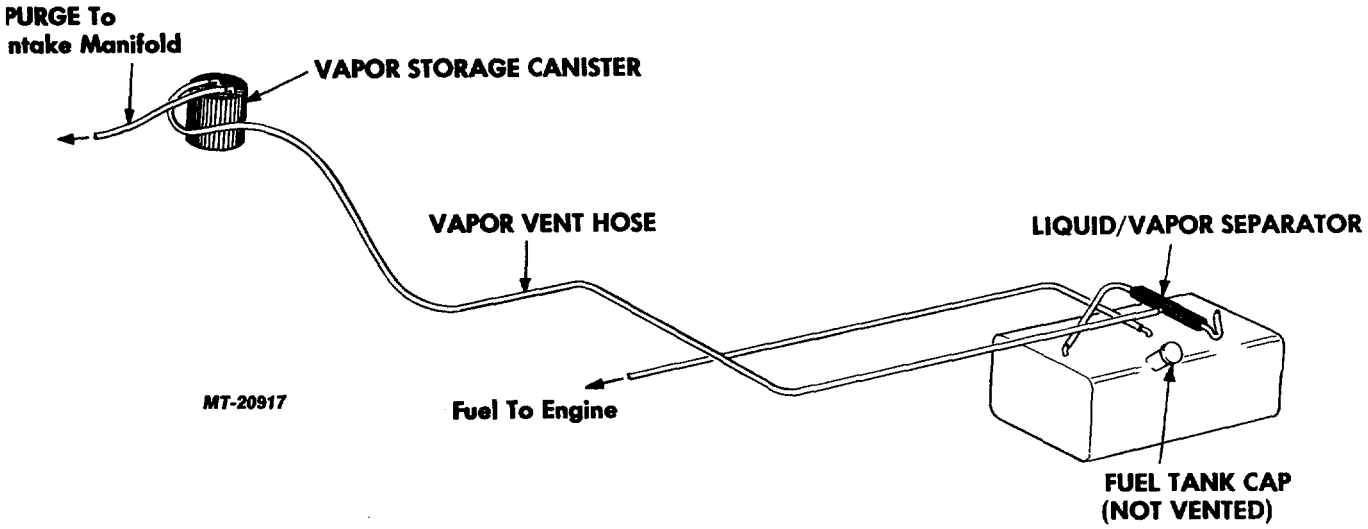


Fig. 37. 1603, 1703 and 1803 Loadstar Vehicles with 30 Gallon Single Left Fuel Tank

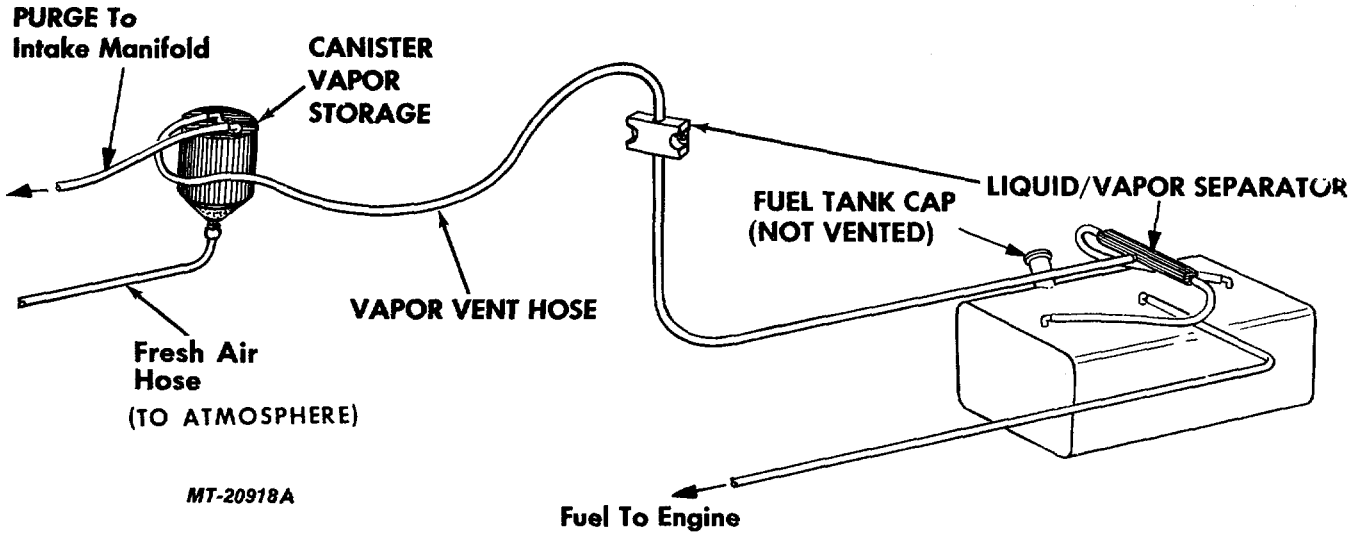


Fig. 38. 1603, 1703 and 1803 Loadstar Vehicles with 30 Gallon Single Right Fuel Tank

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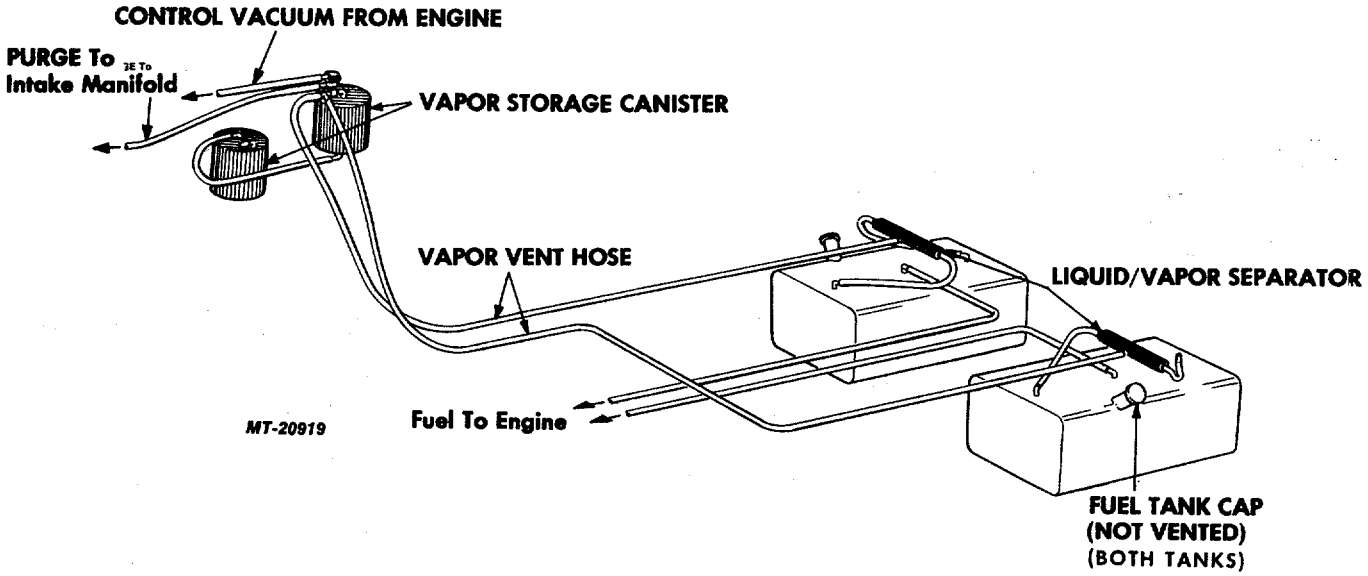


Fig. 39 1603, 1703 and 1803 Loadstar Vehicles with 30 Gallon Dual Fuel Tanks

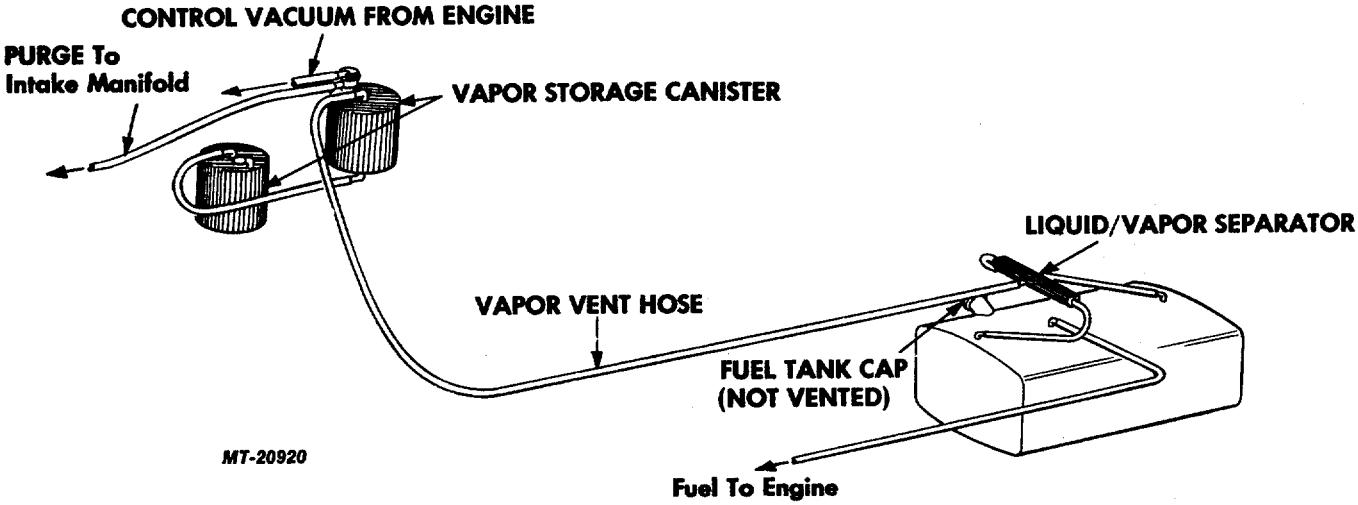


Fig. 40 1603, 1703 and 1803 Loadstar Vehicles with 40 Gallon Right Fuel Tank

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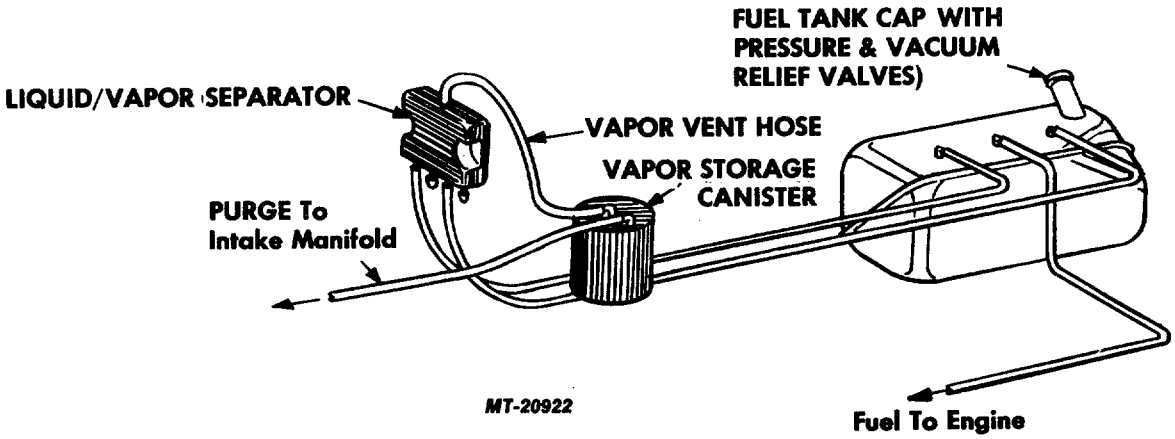


Fig. 41 1600-1800 Loadstar Right Hand Drive Vehicles With 50 Gallon Single Fuel Tank Right and 53 Gallon Dual Tanks

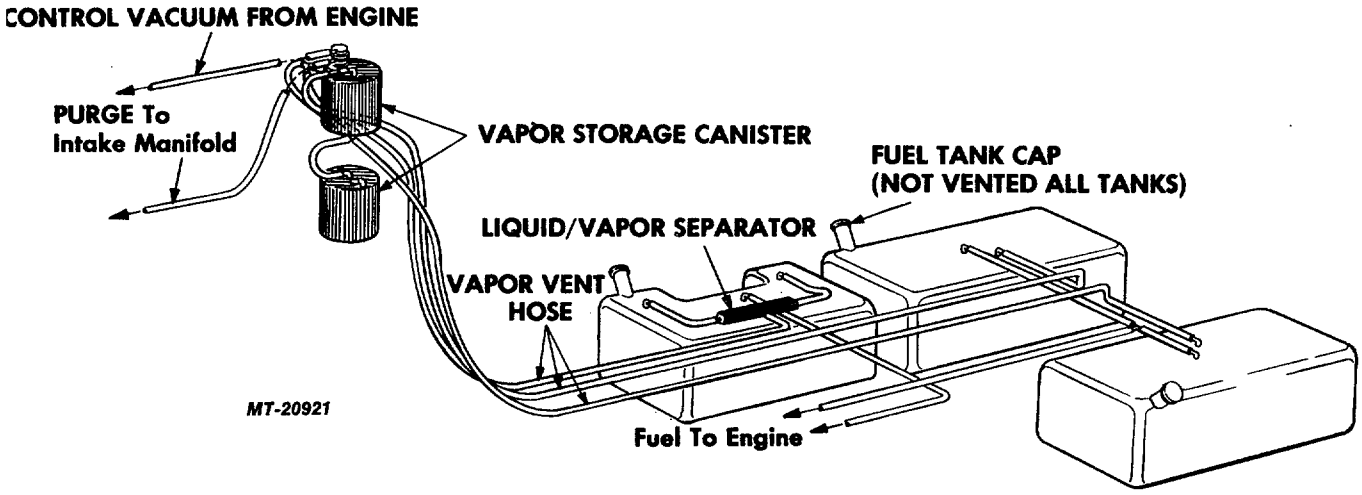


Fig. 42 1600-1800 Loadstar Right Hand Drive Vehicles With 21 Gallon Under Cab Fuel Tank

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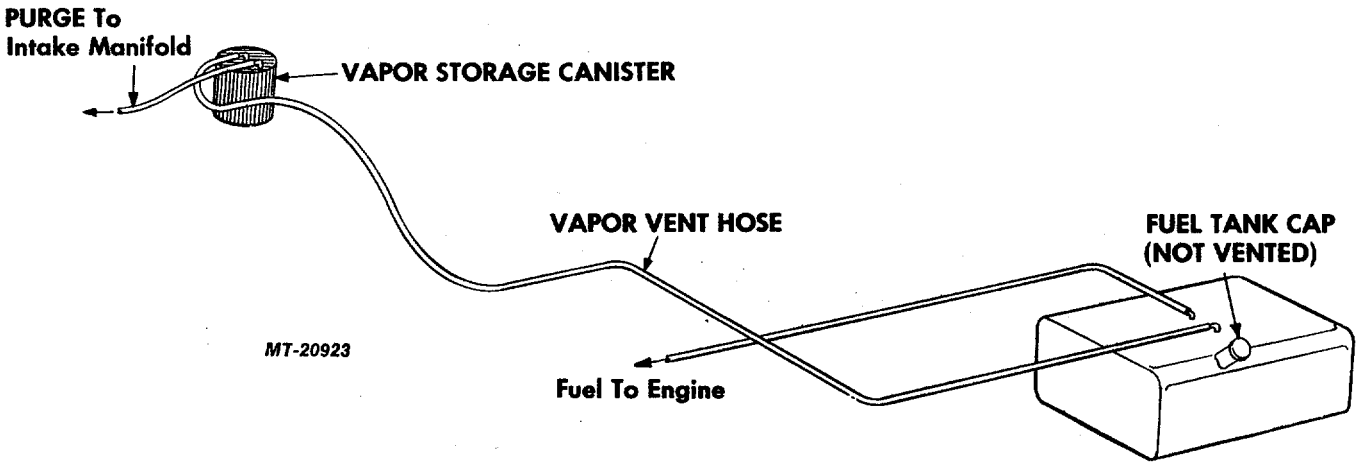


Fig. 43 1703 Loadstar Vehicle with 30 Gallon Left Fuel Tank

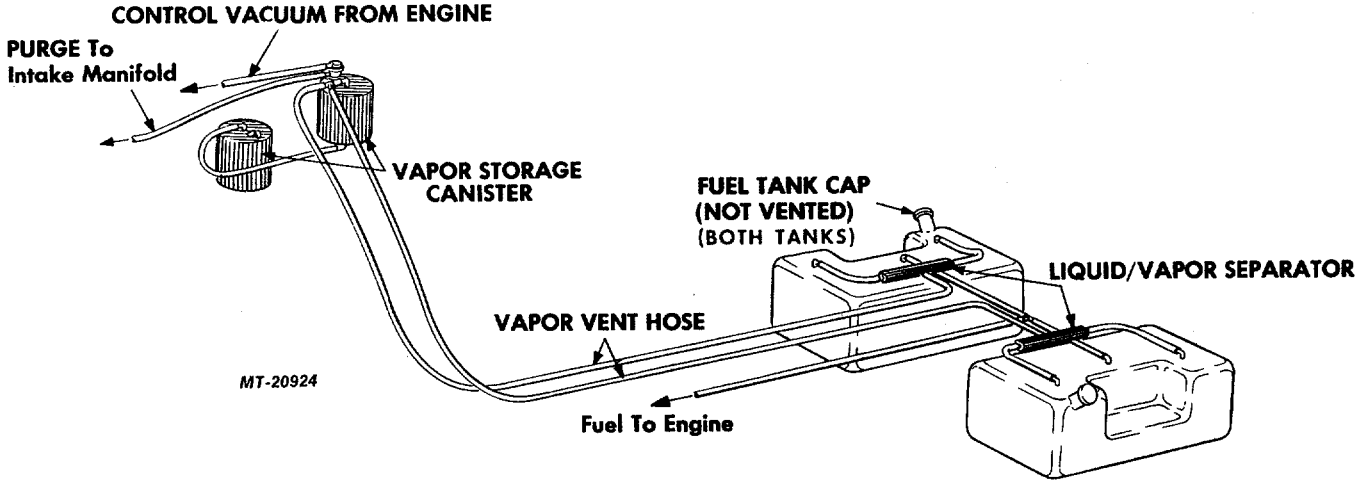


Fig. 44 1703 Loadstar with 50 Gallon Dual Fuel Tanks

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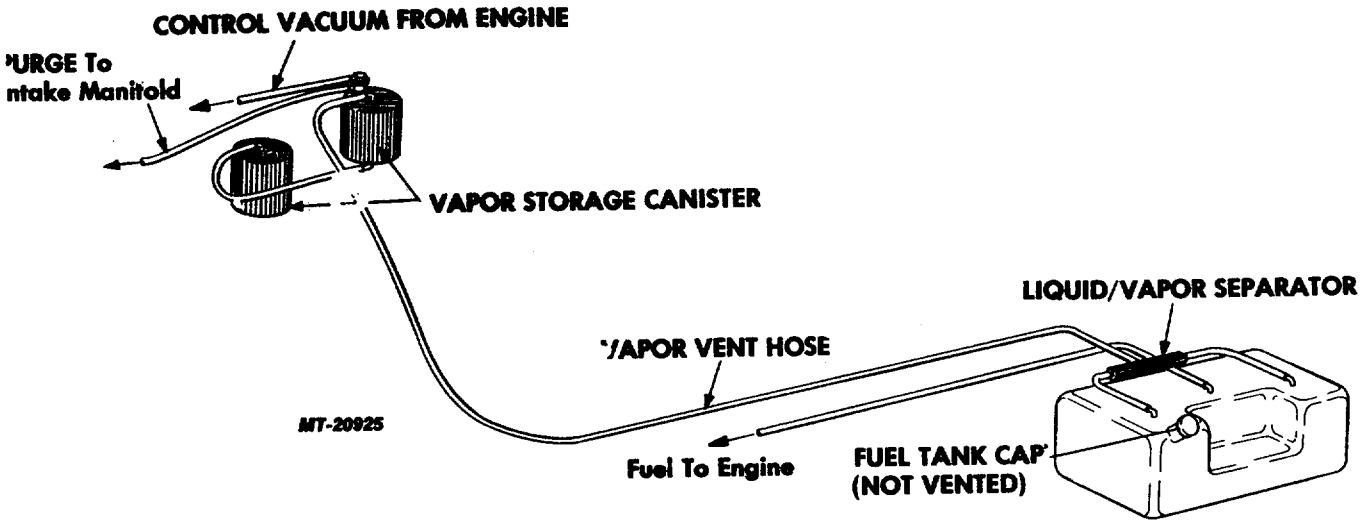


Fig. 45 1703 Loadstar Vehicles with 50 Gallon Left Fuel Tank

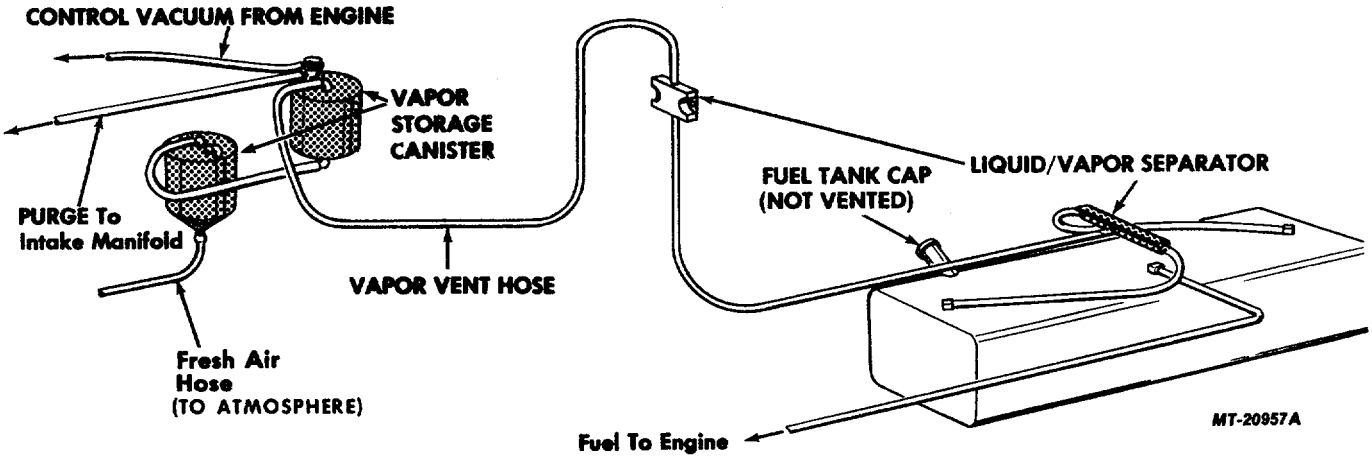


Fig. 46 1603, 1703 and 1803 Loadstar Vehicles with Single 60 Gallon Right Fuel Tank

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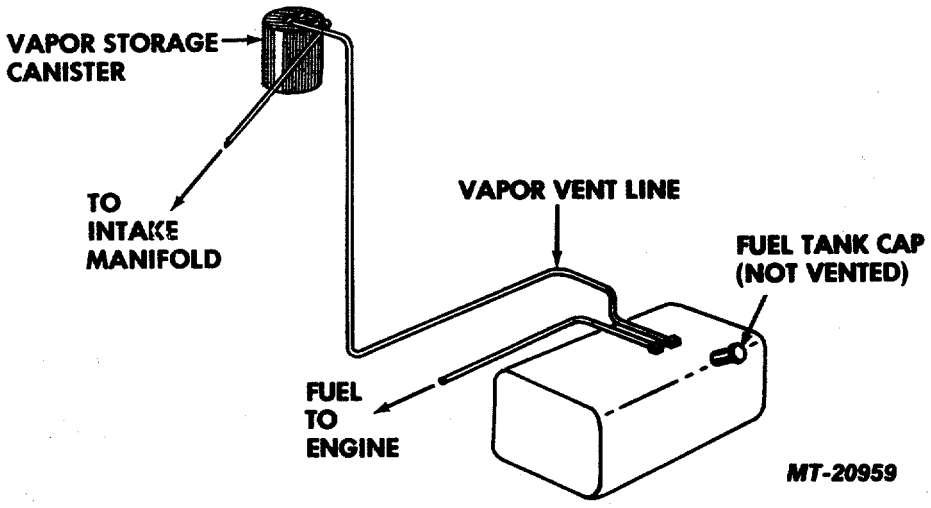


Fig. 47 CO-1610B and COF-1810B Cargostar Vehicles with 30 Gallon Left Fuel Tank

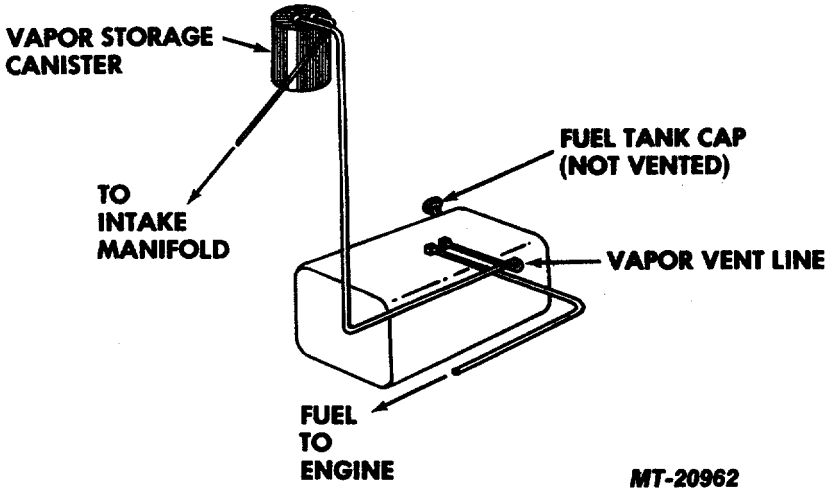


Fig. 48 CO-1610B and COF-1810B Cargostar Vehicles with 30 Gallon Right Fuel Tank

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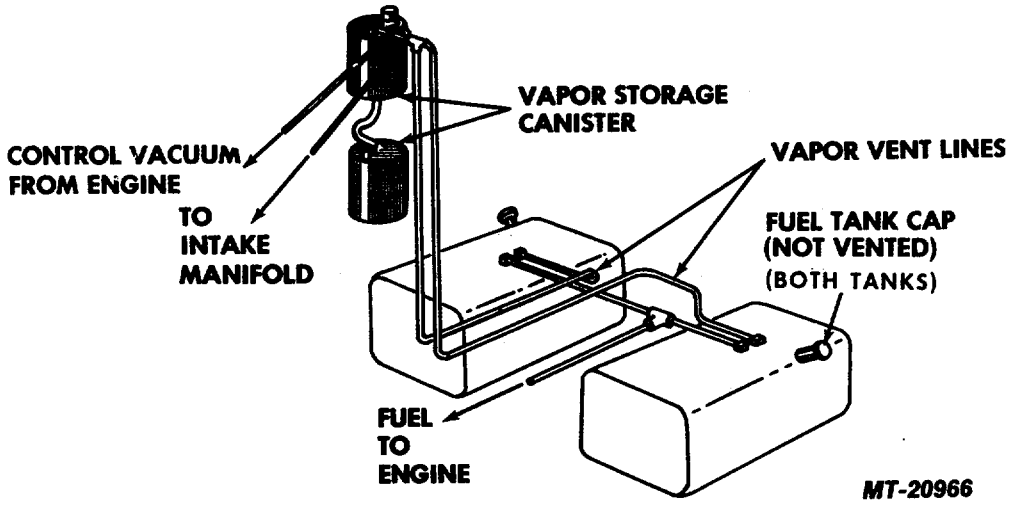


Fig. 49 CO-1610B and COF-1810B Cargostar Vehicles with 30 Gallon Dual Fuel Tanks

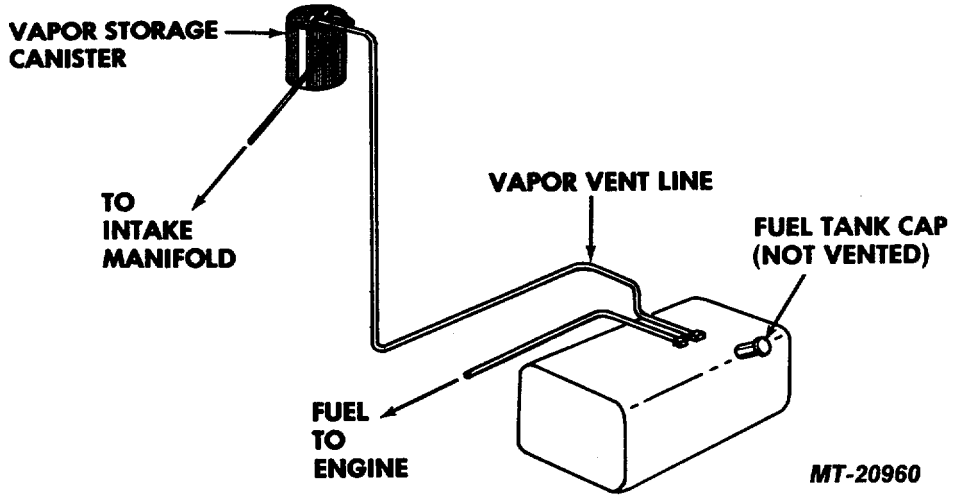


Fig. 50 CO-1610B and COF-1910B Cargostar Vehicles with 33 Gallon Left Fuel Tank

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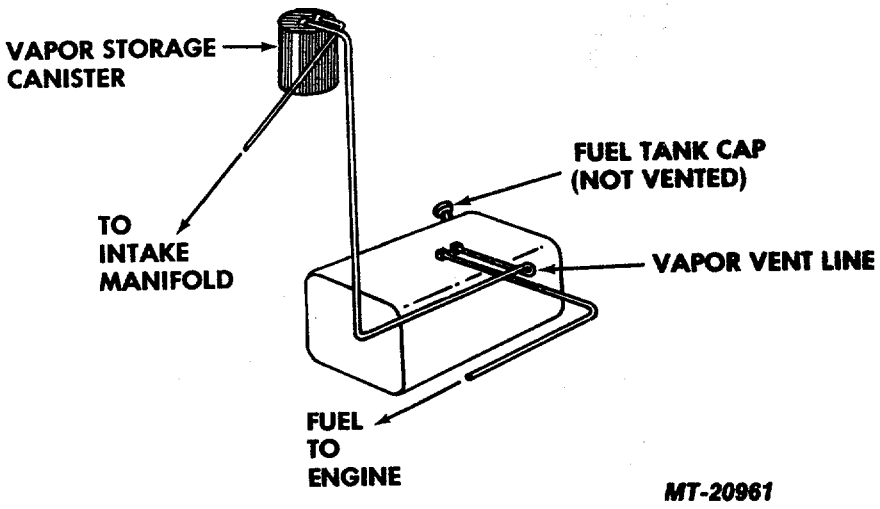


Fig. 51 CO-1610B and COF-1910B Cargostar Vehicles with 33 Gallon Right Fuel Tank

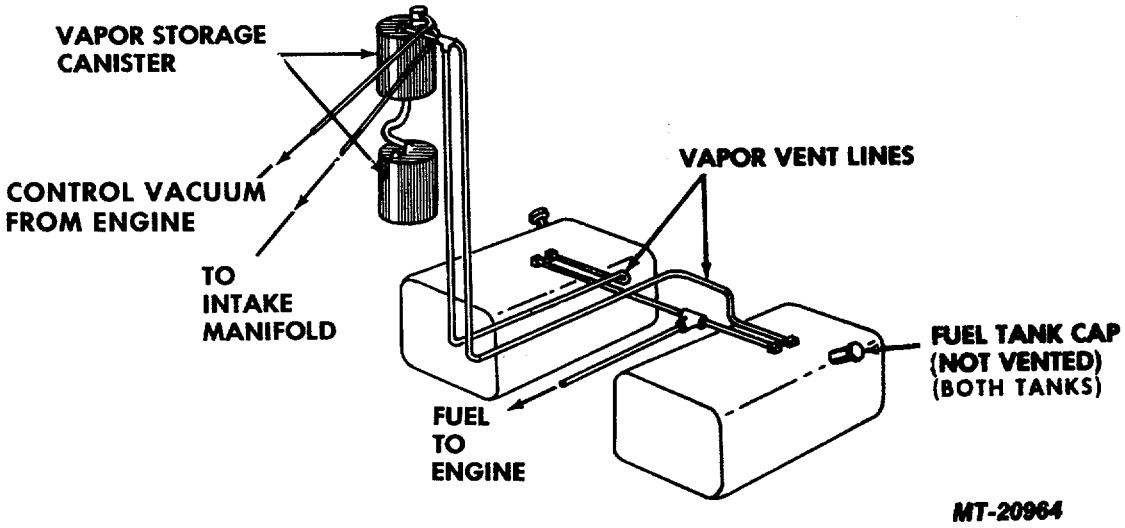


Fig. 52 CO-1610B and COF-1910B Cargostar Vehicles with 33 Gallon Dual Fuel Tanks

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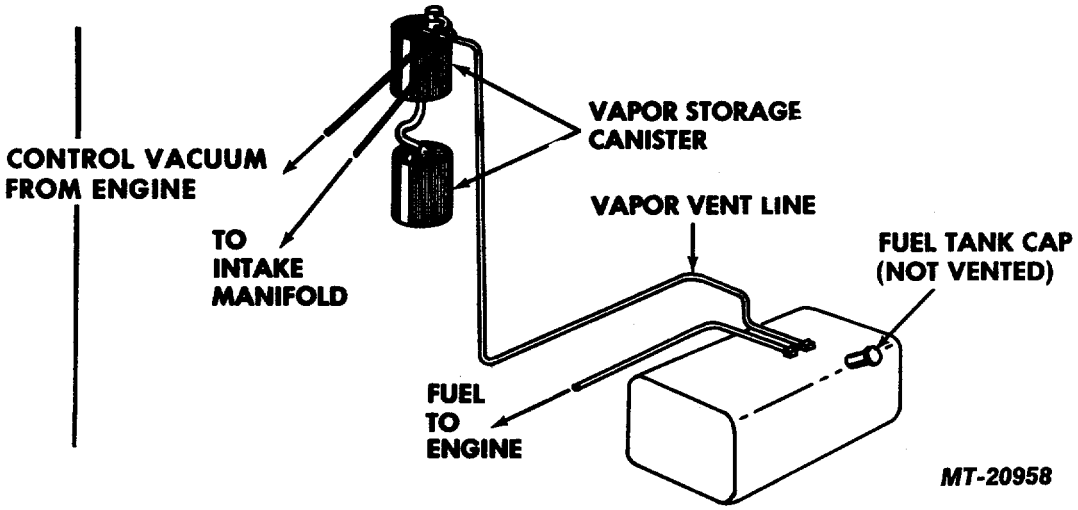


Fig. 53 CO-1610B and COF-1910B Cargostar Vehicles with 50 Gallon Left Fuel Tank

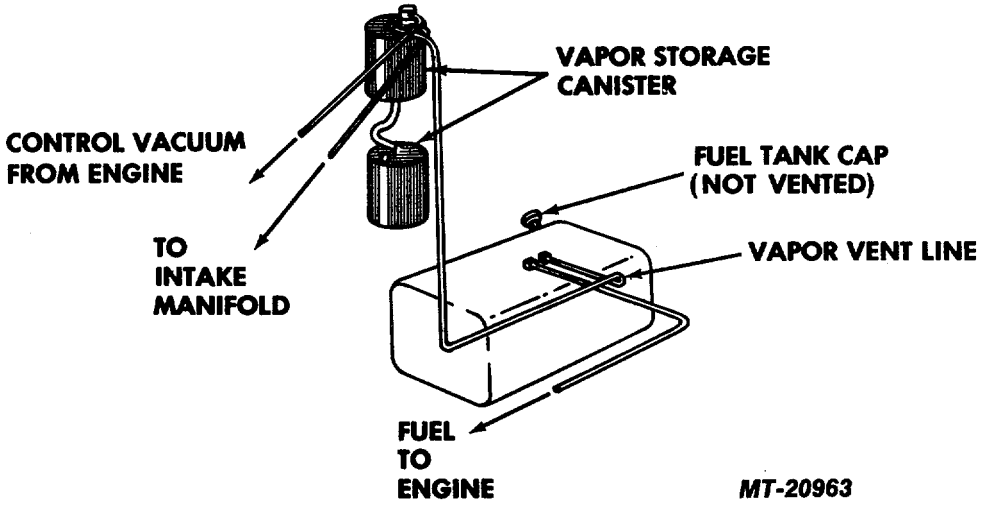


Fig. 54 CO-1610B and COF-1910B Cargostar Vehicles with 50 Gallon Right Fuel Tank

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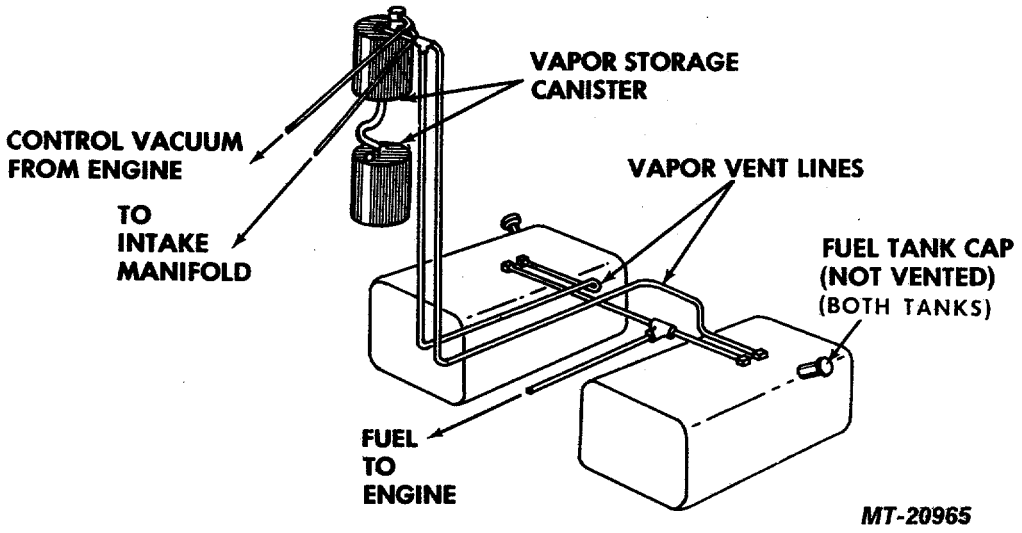


Fig. 55 CO-1610B and COF-1910B Cargostar vehicles with 50 Gallon Dual Fuel Tanks

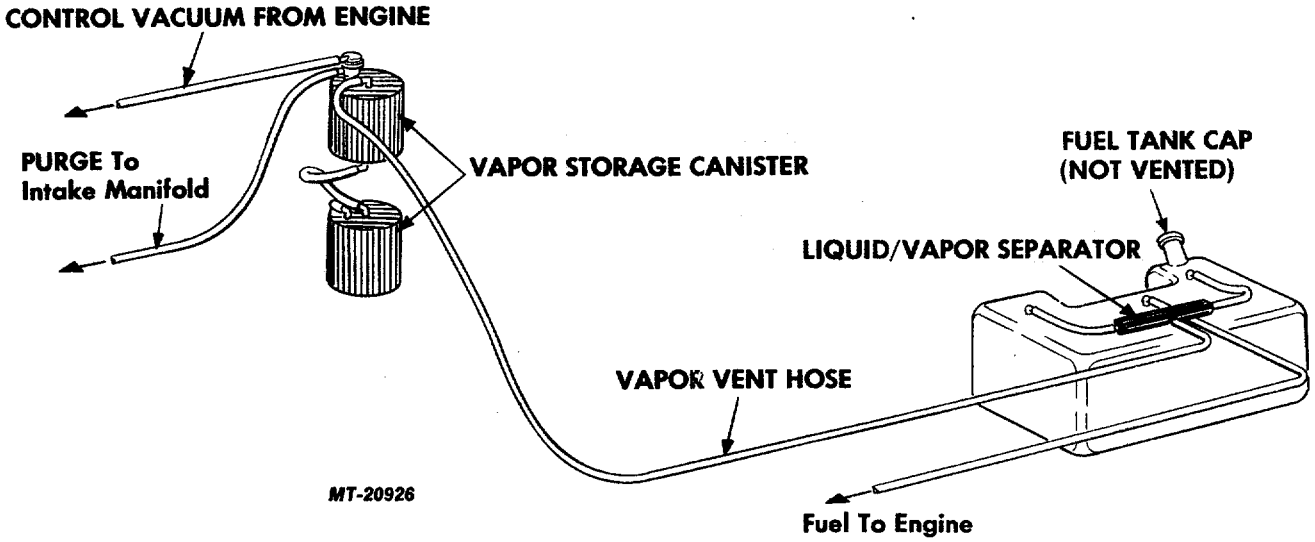


Fig. 56 2010 Fleetstar Vehicle with 50 Gallon Right Fuel Tank

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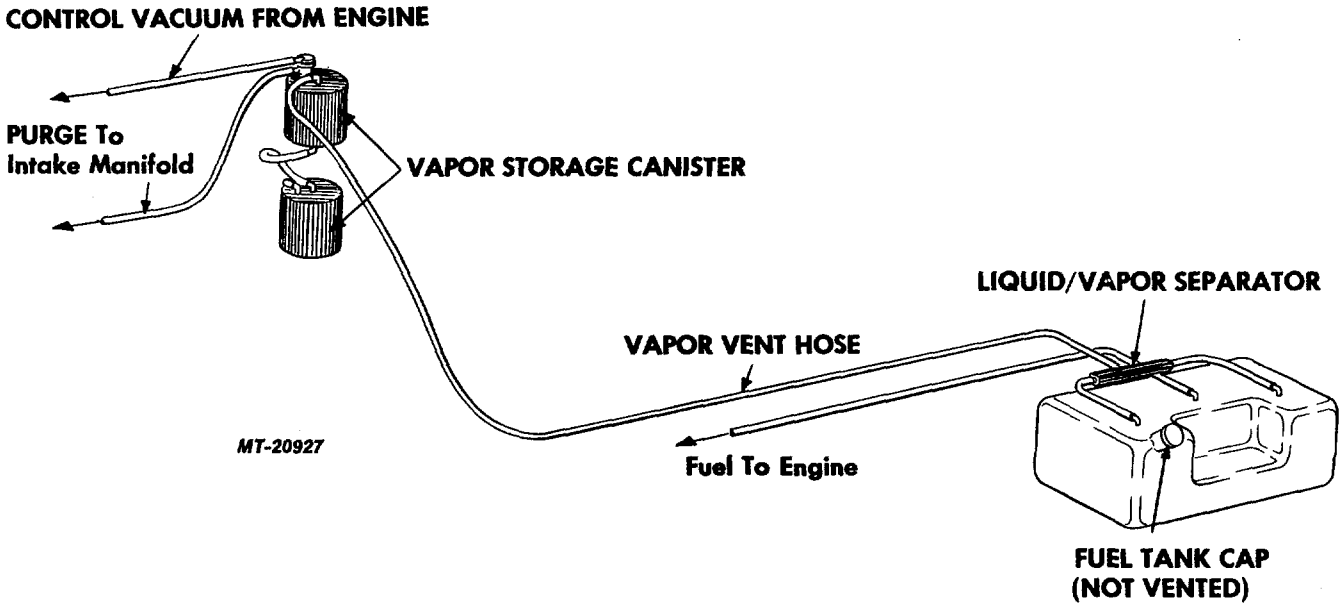


Fig. 57 2010 Fleetstar Vehicle with 50 Gallon Left Fuel Tank

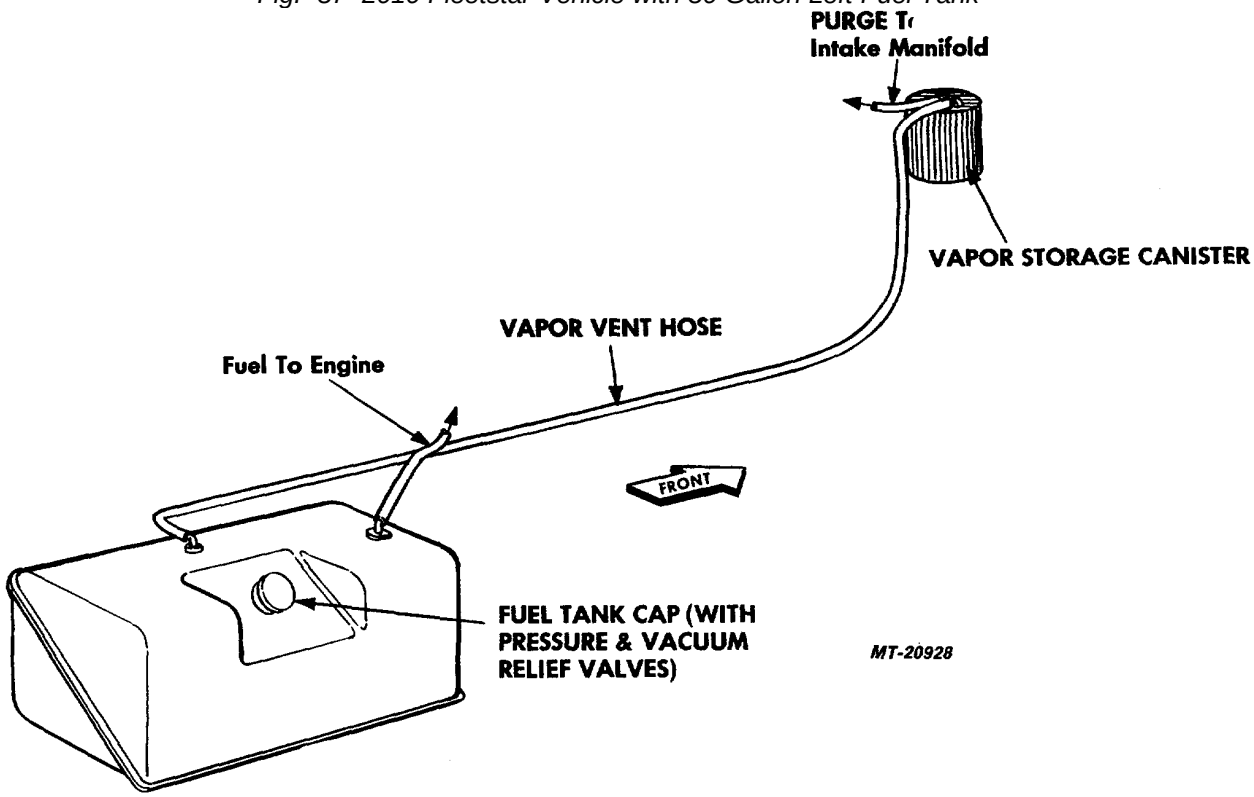


Fig. 58 S-Series 1624, 1724, 1824, 1824 4x4, 1924, 1924 6x6, F1924 And F-1925 Vehicles with 30 Gallon Fuel Tank

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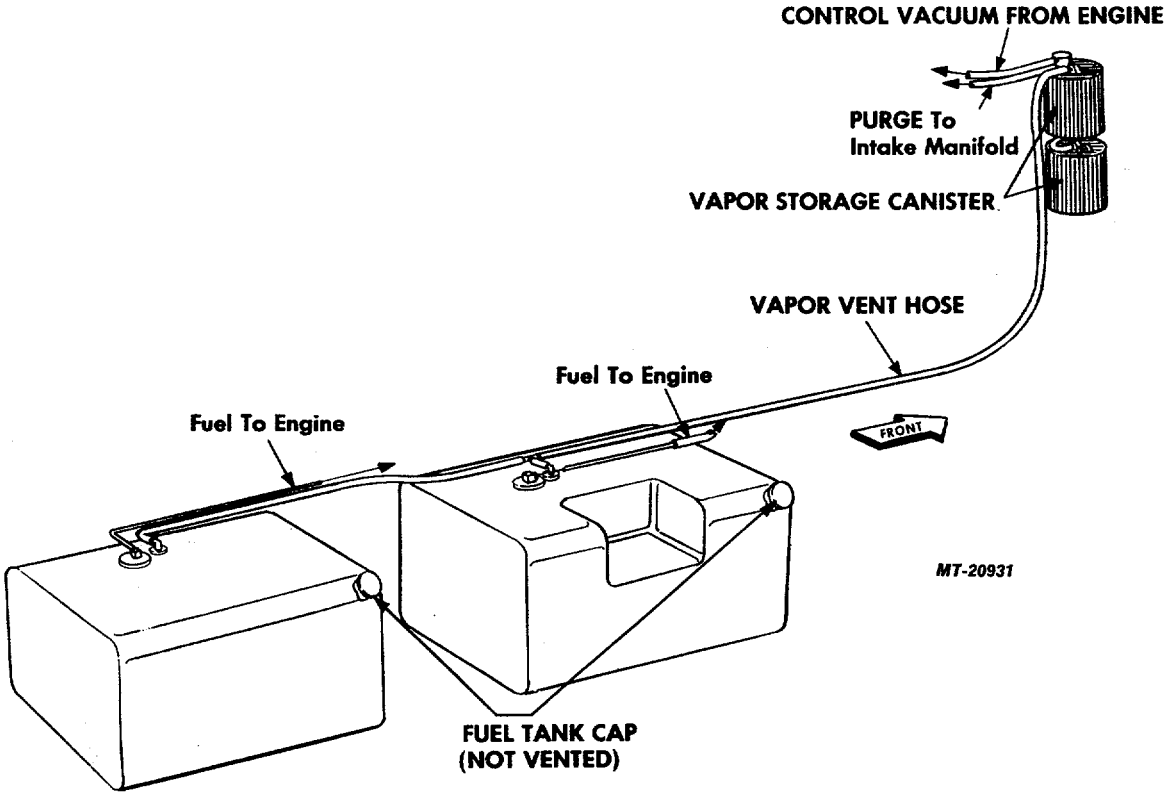


Fig. 59 S-Series 1624, 1724, 1824, 1824 4x4, 1924, 1924 6x6, F1924 And F-1925 Vehicles with 45 and 48 Gallon Dual Fuel Tanks

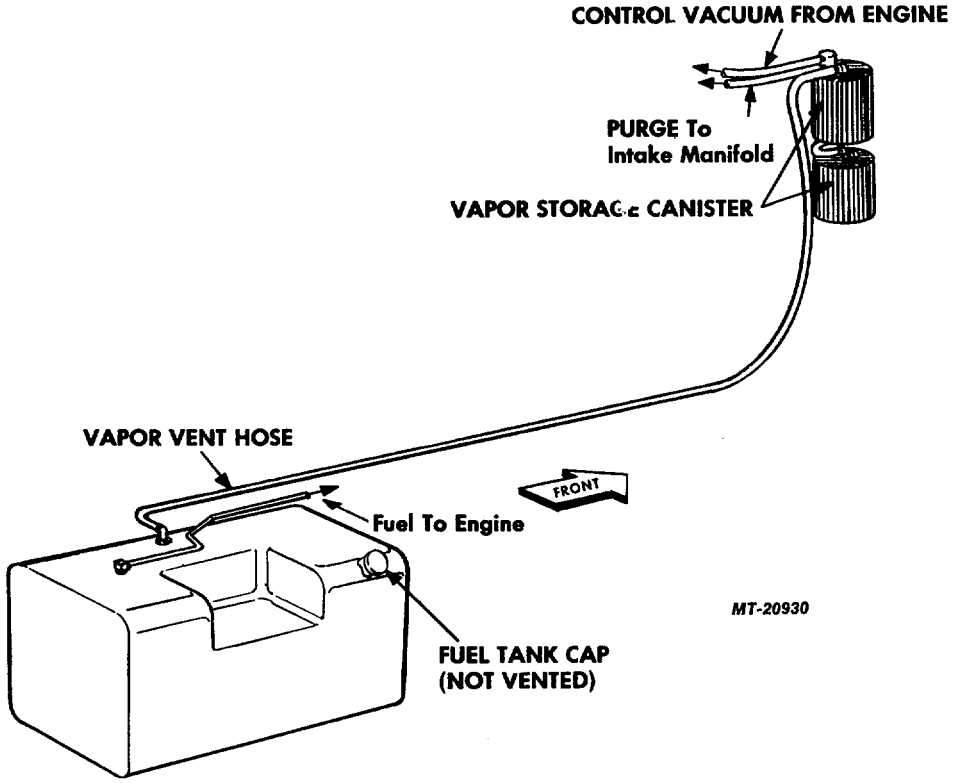


Fig. 60 S-Series 2524 and F2524 Vehicles with 57 Gallon Fuel Tank

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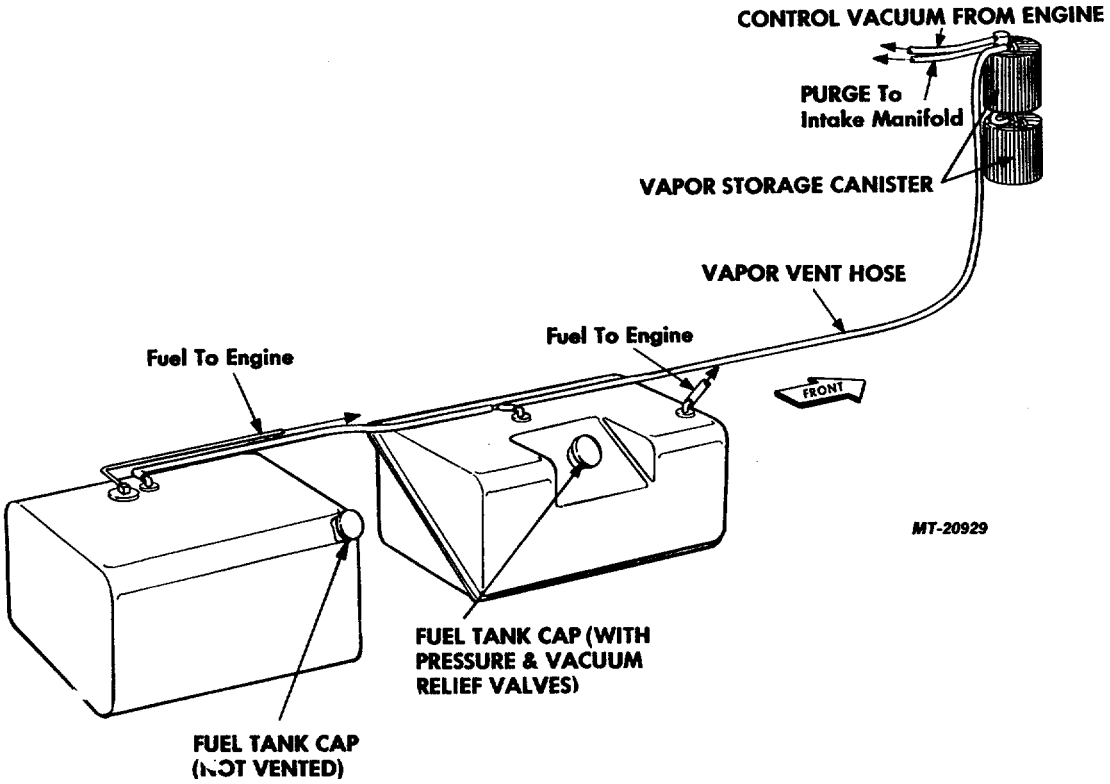


Fig. 61 S-Series 1624, 1724, 1824, 1824 4x4, 1924, 1924 6x6, F1924 And F1925 Vehicles with 30 and 48 Gallon Fuel Tanks

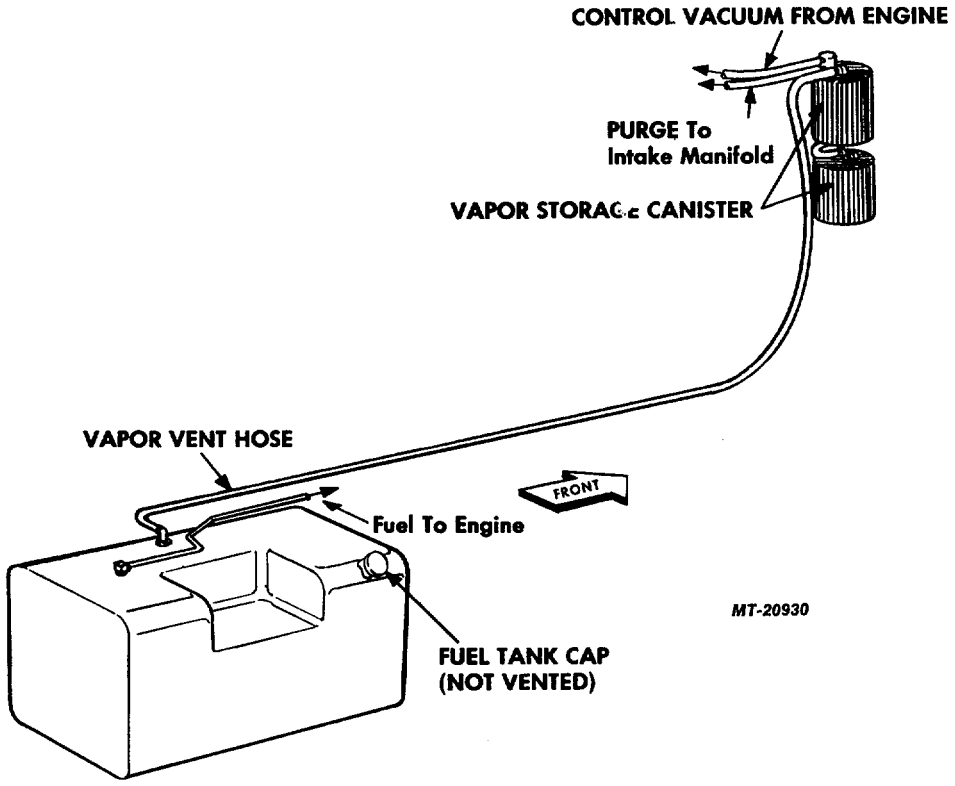


Fig. 62 S-Series 1624, 1724, 1824, 1824 4x4, 1924, 1924 6x6, F-1924 And F1925 Vehicles with 45 Gallon Fuel Tanks

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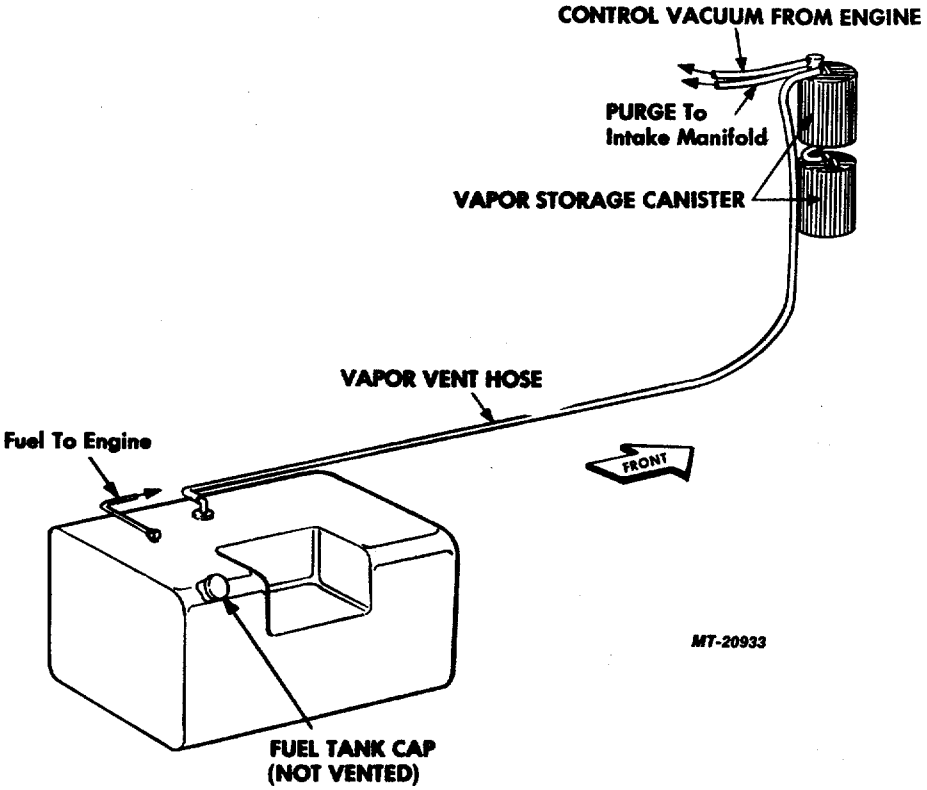


Fig. 63 S-Series 2125 and F2125 Vehicles with 57 Gallon Fuel Tank

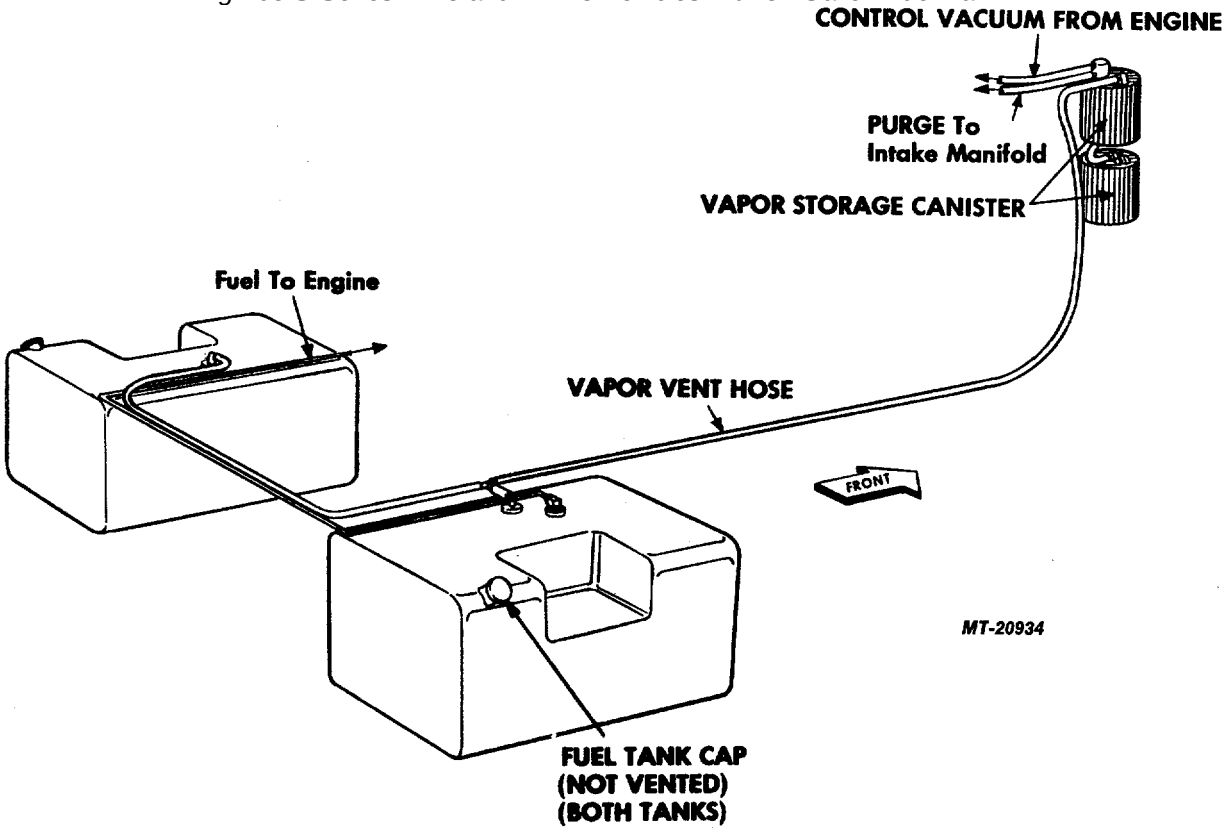


Fig. 64 S-Series 2125 and F2125 Vehicles with 57 Gallon Dual Fuel Tanks

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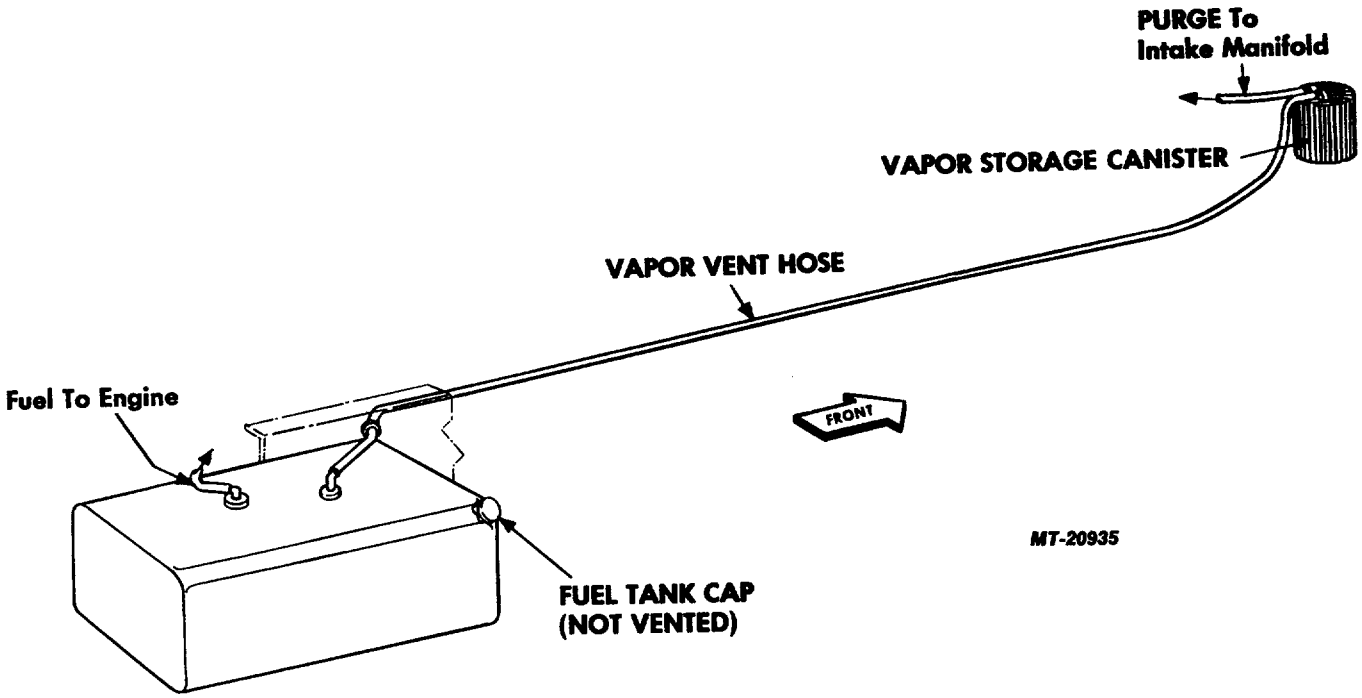


Fig. 65 S-Series 1723 and 1823 Bus with 32 Gallon Fuel Tank

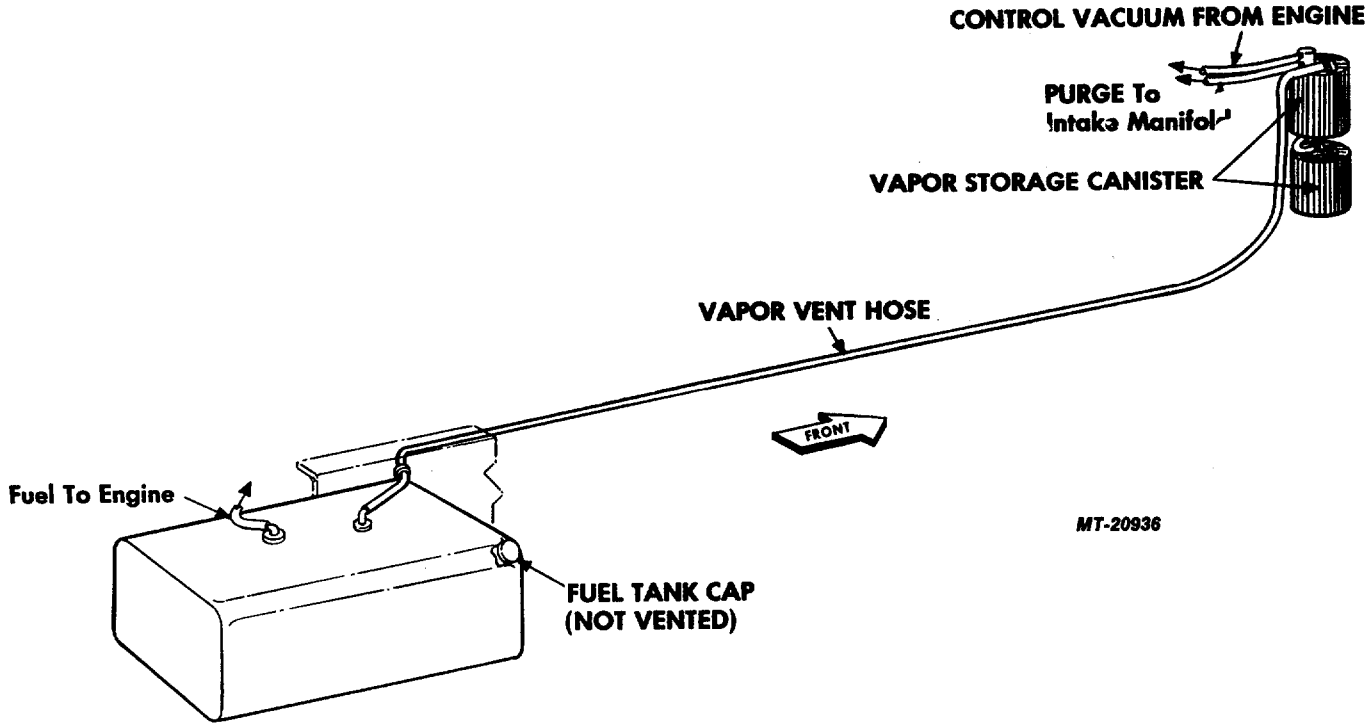


Fig. 66 S-Series 1723 and 1823 Bus with 52 Gallon Fuel Tank

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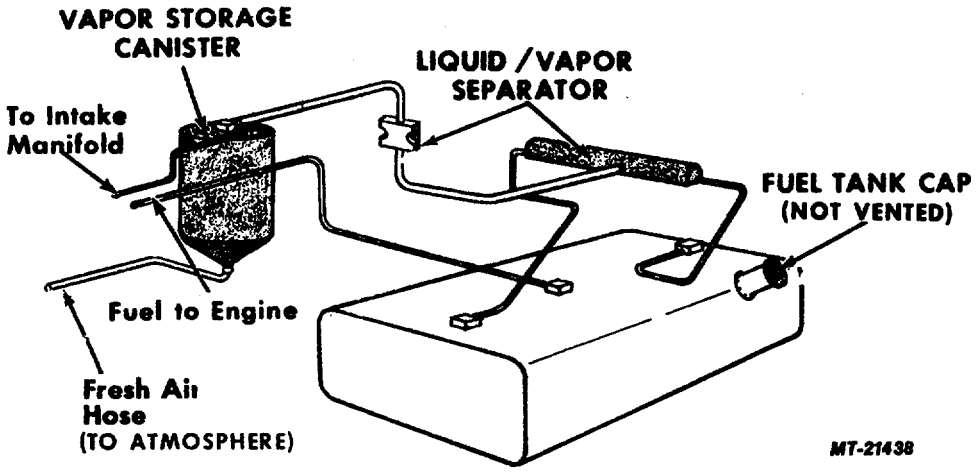


Fig. 67 1610-FC Vehicles with Single 30 Gallon Fuel Tank

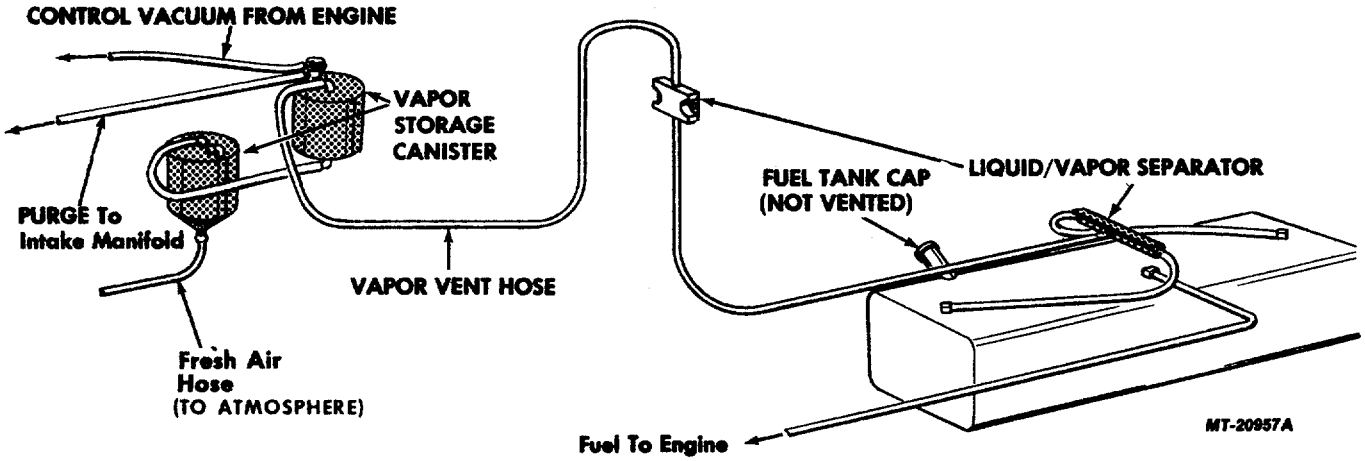


Fig. 68 1610-FC Vehicles with Single 60 Gallon Fuel Tank

8. Check Engine Bolt Torque and Tighten if necessary.

Torque carburetor, intake manifold and exhaust manifold mounting bolts (see Tune-Up Specifications).

9. Check Exhaust Gas Control Valve for free operation and service or replace, if necessary.

a. Inspect exhaust heat riser valve for free operation (Fig. 69).

b. Free up with solvent, if necessary, while turning valve by hand (valve should turn to closed position when at ambient temperature).

c. If valve cannot be freed with solvent, replace with new valve.

10. Check Coil Output Voltage and Replace Coil, if necessary.

a. Connect SE-2576, or equivalent, test equipment.

b. Start and operate engine until normal operating temperatures are reached. Then, increase engine speed to 2500 RPM.

c. Record coil output voltage. If coil output voltage is not within specifications (see Tune-Up Specifications), proceed as follows:

d. Measure the D.C. voltage at the positive terminal of the ignition coil with the engine at idle speed and record.

e. Measure battery terminal D.C. voltage with engine at idle speed and record.

f. If coil positive terminal voltage is less than battery terminal voltage by more than .5 volts, replace or repair primary wiring, ignition switch or firewall connector as required. Recheck coil output voltage. If not satisfactory, proceed as follows:

g. Measure ignition coil primary resistance. The resistance from positive terminal to negative terminal with ignition switch off should measure between 1.2 and 1.4 limits, replace coil.

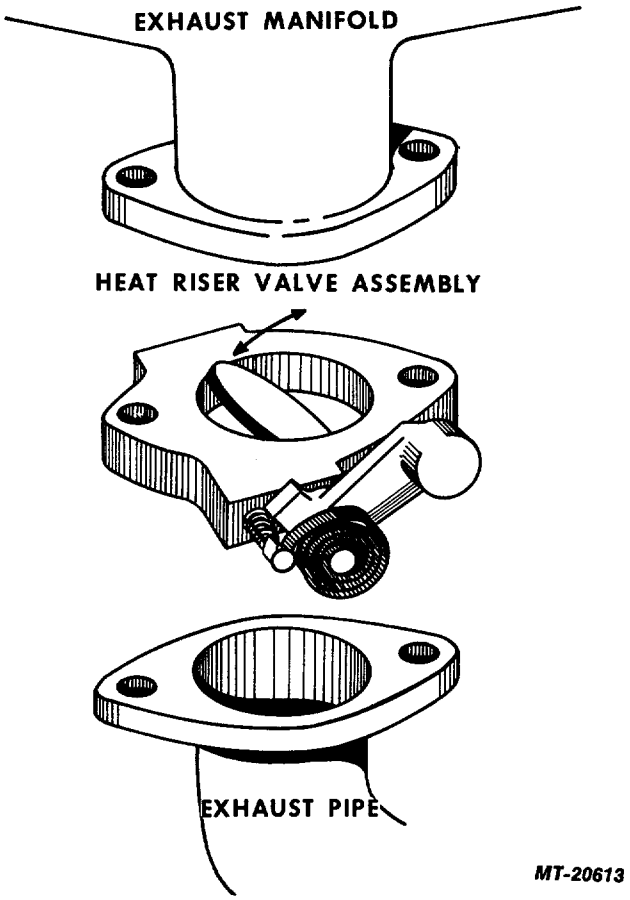


Fig. 69

h. Measure secondary resistance of ignition coil by measuring between the positive terminal and the secondary tower connector. The resistance should measure between 9.4 and 11.1 thousand ohms. If the resistance is outside these limits, replace coil.

i. Off-Engine Coil Check: The ignition coil can be removed from the engine and checked with SE-2576 or equivalent test equipment.

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11. Check Initial Advance and Adjust if necessary.

a. Connect timing light.

b. Disconnect and plug vacuum advance hose.

c. Start engine and operate until normal operating temperatures are reached.

d. Observe engine idle speed. Speed must be within specifications (see Tune-Up Specifications); adjust speed to specifications, if necessary.

e. Observe initial advance with timing light.

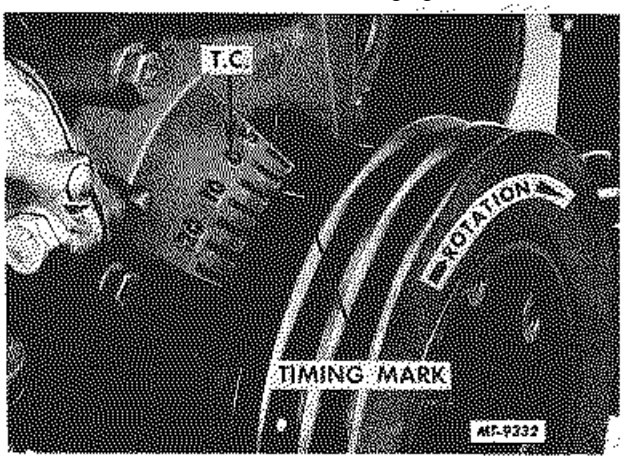


Fig. 70 Typical Location of Timing Marks (Small V-8 Shown)

f. Loosen distributor clamp and adjust to specifications, if necessary (see Emission Control System Tune-Up Specifications). Tighten distributor clamp and recheck initial advance.

g. Stop engine.

h. Reconnect vacuum advance hose and remove timing light.

12. Check Operation of Inlet Air System Valve and Service or Replace, if necessary.

Procedure for servicing the sensor controlled vacuum chamber type air cleaner is as follows:

a. Test should be conducted when ambient temperature of the vehicle are less than 24 deg. C (75 deg. F) and engine started cold. Air cleaner must have all hoses, piping and cover in place. No leaks permitted.

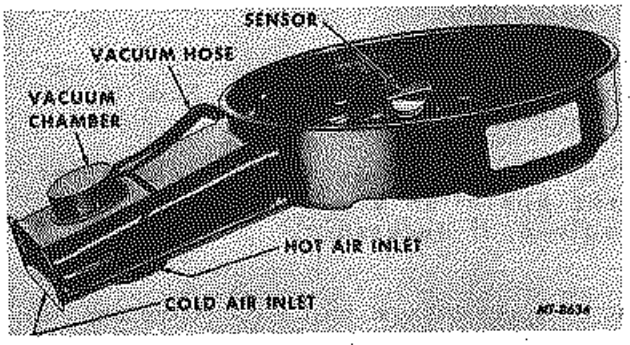


Fig. 71 Sensor Controlled Vacuum Chamber Type Air Cleaner

b. With engine off, inlet tube damper should be in full down position to close heat tube inlet pipe from exhaust manifold stove. Damper position can be determined by looking in end of inlet tube.

If damper assembly is not in the correct position, vacuum chamber should be removed and damper movement loosened. Replace vacuum chamber (located on top of inlet tube) and recheck damper position.

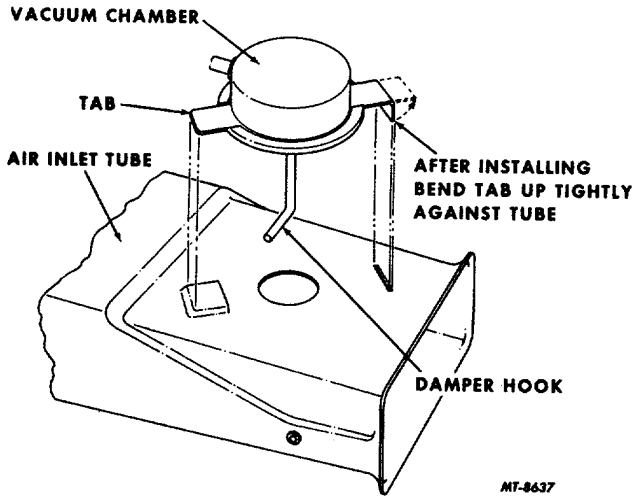


Fig. 72 Vacuum Chamber Details

To replace vacuum chamber (Fig. 72) (cannot be replaced on air cleaners used on 4-196 engines) bend tab nearest inlet tube entrance down from inside tube. Disconnect vacuum hose and lift vacuum chamber, sliding the rear tab out of its slot disengaging damper hook from damper. Attach new chamber by engaging hook in damper, sliding rear tab into its slot and fitting front tab

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into place. A spring preload should be felt when vacuum chamber is pressed firmly against top of inlet tube. If no preload is felt, check the installation or be sure parts are not faulty. Press front vacuum chamber tab firmly against tube inside surface. Connect vacuum hose.

c. Start engine and note that damper has rotated up to close off cold air inlet. Observe damper position by looking in the inlet tube. If damper did not immediately close cold air inlet, proceed as follows:

(1) Shut off engine and disconnect the two hoses from sensor.

(2) Connect the two hose ends together using suitable tubing.

(3) Restart engine and again check damper location. If damper fully closes cold air inlet, temperature sensor is defective and must be replaced (located inside air cleaner body).

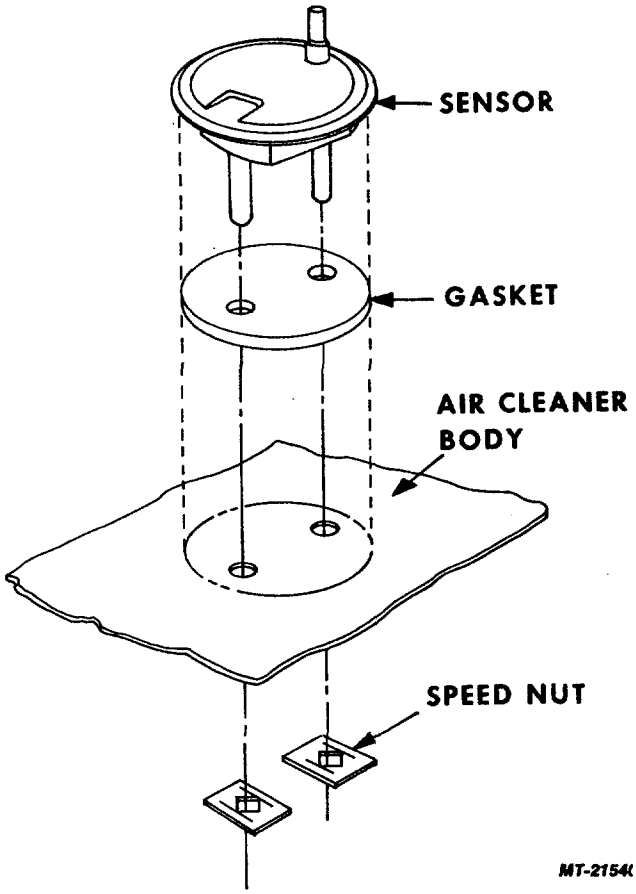


Fig. 73 Sensor Installation

To replace temperature sensor, disconnect two vacuum hoses attached to sensor inlet and outlet tubes on underside of air cleaner body. Remove clamps or speed nuts from tubes and lift sensor from body. Position new sensor and gasket inside air cleaner body. Firmly press two new speed nuts or- clamps on tubes to hold sensor in place. Attach vacuum hoses to sensor tubes. If damper does not close cold air inlet, sensor is okay, but damper has bind or vacuum chamber is defective. Remove vacuum chamber and check damper for free movement. If damper moves freely, replace vacuum chamber.

d. After cold start, operate engine for 10 minutes at medium RPM. When engine is at normal operating temperature, slow engine to idle and observe position of inlet tube damper. If damper has not rotated all or part way down to allow some cold air to enter inlet tube, replace temperature sensor.

Procedure for servicing the thermal pellet type air cleaner is as follows:

a. With the engine cold and ambient under hood temperature below 32 deg. C (90 deg. F), the damper should be closed to the cold air inlet (open to the hot air inlet). This closed to cold air inlet can be checked by looking in the end of the inlet.

b. With the engine at operating temperature and the ambient under hood temperature above 57 deg. C (135 deg. F), the thermal pellet should open the damper allowing cold air to enter the air cleaner and at the same time shut off the hot air inlet.

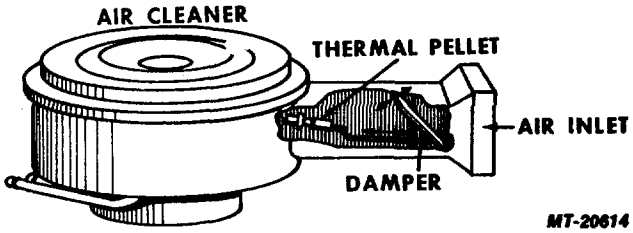


Fig. 74 Pellet Type Controlled Air Cleaner

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c. If the damper does not operate as described above, reach in the inlet, move the damper open and check to see if it is sticking. If damper is moving freely and the linkage is connected, then the thermal pellet must be at fault and should be replaced.

When replacing the thermal pellet do not tighten the pellet assembly with a tool. Tighten finger tight only. Use locking compound on the threads to secure in place. If a tool is used, too much pressure may be applied changing the calibration of the thermal pellet and linkage assembly.

13. Check PCV System Hoses and Replace, if necessary, Clean PCV Valve, if necessary.

a. Remove valve from crankcase side. Leaving the other end of valve in hose and connected to intake manifold.

b. With the engine operating, a vacuum should be felt at the end of the valve. If no vacuum is present, the valve, hose and fitting should be removed and cause of restriction determined.

c. Check the inner chamber of the valve to see that it can be moved freely. This may be accomplished by inserting a stiff wire into the valve body and observing whether or not the plunger can be readily moved, or shake the valve and listen for rattle. If the plunger does not move, soak in carburetor.

13A. Positive Crankcase Ventilation Valve (PCV) Operation.

Since the vacuum supply for the PCV system is from the intake manifold, the flow through this system into the manifold must be controlled in such a manner that it varies in proportion to the air-fuel ratio being drawn into the intake manifold.

The PCV valve varies the amount of flow through the system according to the various modes of operation (i.e. idle, cruise, acceleration, etc.). The valve itself consists of a coil spring, valve and a two-piece outer body which is crimped together. The valve dimensions, spring and internal dimensions are such to produce the desired air flow requirements.

During the periods of deceleration and idle, manifold vacuum is high. The high vacuum overcomes the force of the valve spring and the valve bottoms in the manifold end of the valve housing. This does not completely stop the flow but it does restrict (Fig. 76).

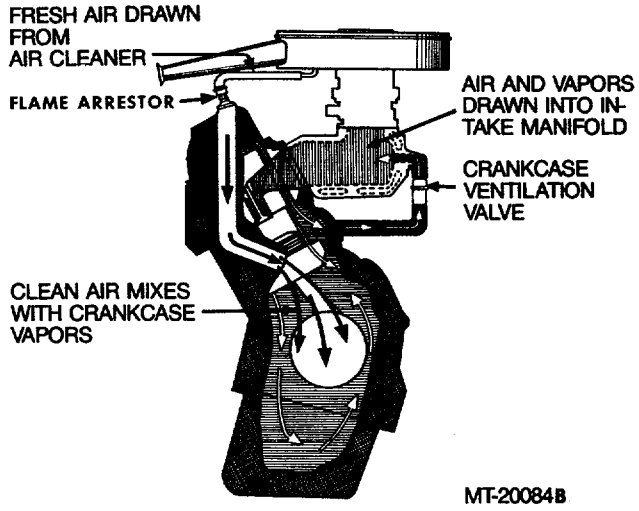


Fig. 75 Typical Air and Vapor Flow Through the System

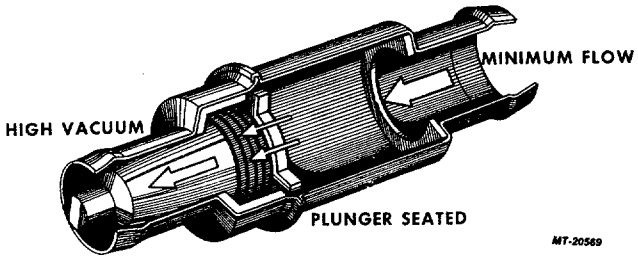


Fig. 76 Plunger Position During Idle or Low Engine Speed

When the engine is accelerated or operated at constant speed, intake manifold vacuum is less than at idle or during deceleration. The spring force is stronger than vacuum pull during this mode so the valve is forced toward the crankcase end of the valve housing. With the valve in this position, move crankcase vapors flow into the intake manifold (Fig. 77).

In the event of a backfire, the valve plunger is forced back and seated against the inlet of the valve body. This prevents the backfire from traveling through the valve and connecting hose into the crankcase (Fig. 78). If the backfire was allowed to enter the crankcase, it could ignite the volatile crankcase blow-by gases.

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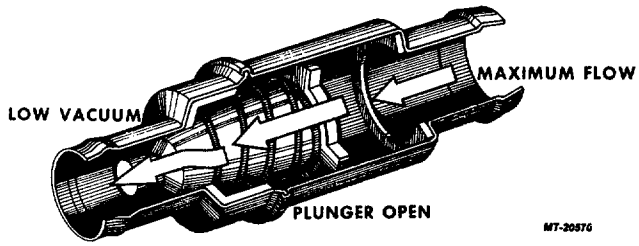


Fig. 77 Plunger Position During High Engine Speed

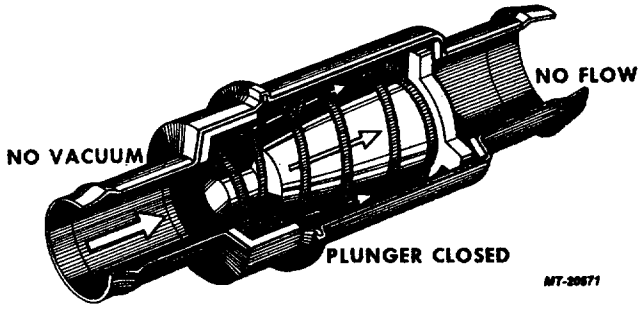


Fig. 78 Plunger Position During Backfire or When Engine is "OFF"

14. Check Deceleration Throttle Modulator (DTM) System and, if Adjust or Replace necessary.

a. Check modulator for free operation by grasping modulator by large diameter of the plastic housing and pulling (without twisting) toward throttle lever. Plastic housing should move freely against internal spring force for about 6.35 mm (1/4"). Modulator should be replaced if it does not move freely or does not return rapidly to fully retracted position (Fig.79).

b. Check throttle modulator speed setting and adjust, if necessary.

(1) Connect tachometer to engine.

(2) Start and operate engine until normal operating temperatures are reached.

(3) Disconnect vacuum hose from modulator and manually apply vacuum to modulator (Fig. 80). If modulator does not extend, unit is faulty and must be replaced. Allow throttle to close against extended modulator.

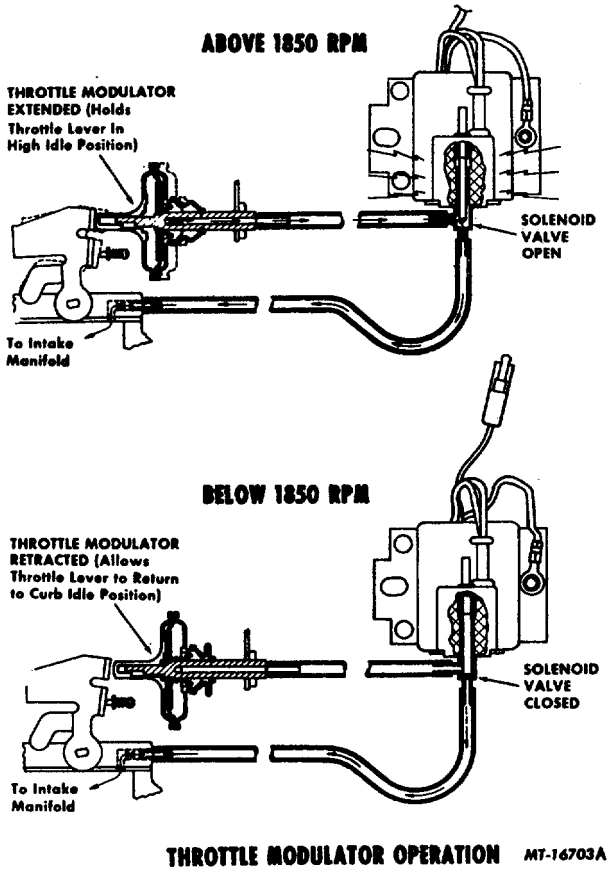


Fig. 79 Throttle Modulator Operation

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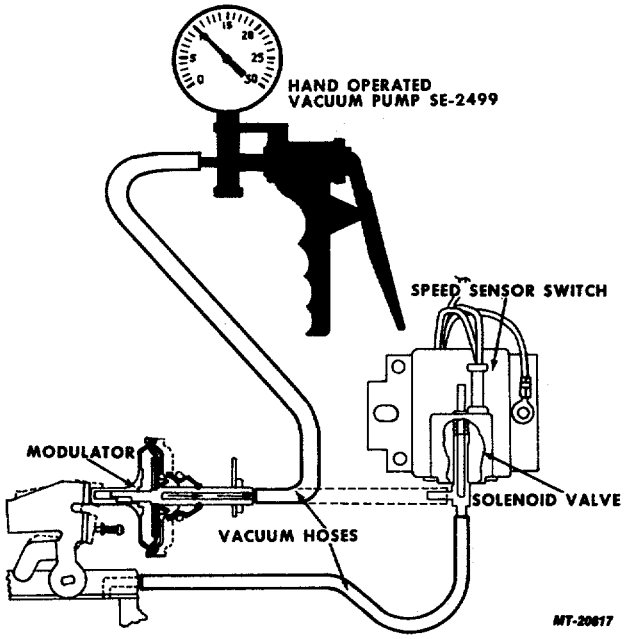


Fig. 80 Modulator Test

(4) Observe engine speed. For proper speed, see Emission Control Tune-Up Specifications.
(5) If modulator is improperly adjusted, loosen lock nut and adjust position of modulator.
(6) Repeat Steps (3) thru (5) until proper speed is achieved; then tighten lock nut.
(7) Reconnect proper vacuum hose to modulator.

c. Perform DTM operational test as follows:

(1) Verify modulator is retracted at idle.

(2) Slowly accelerate the engine and observe the speed at which the modulator extends. Modulator should extend at 1850 ± 5 RPM (Fig. 79).
(3) Slowly decelerate the engine and observe the speed at which the modulator retracts. Modulator should retract at 1850 ñ 50 RPM (Fig. 79).
d. Verify solenoid valve functions properly.

(1) Operate engine at any condition.

(2) With wiring harness disconnected from solenoid valve, modulator must be in retracted position.

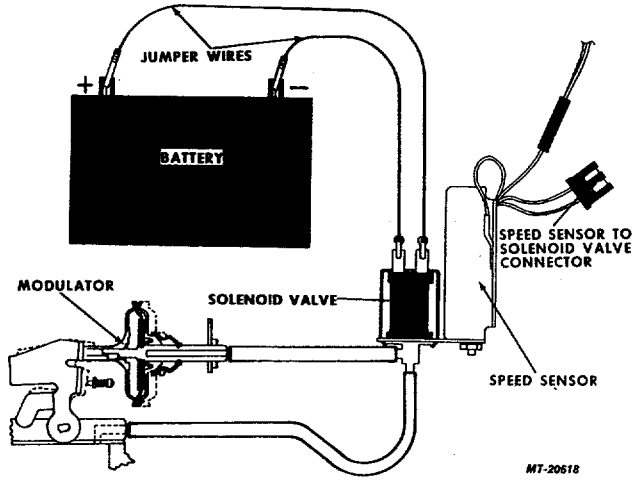


Fig. 81 Jumper Wires From Battery to Solenoid Valve Terminals

(3) With jumper wires from positive terminal of battery and from ground connected to solenoid valve terminals (Fig. 81), modulator must be in extended position.

(4) If modulator does not function properly, solenoid valve is faulty and must be replaced. (The solenoid valve and speed sensor are sold as one assembly.)

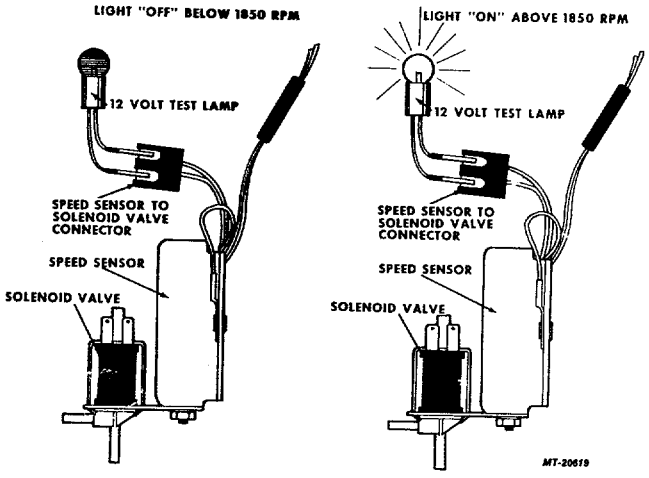


Fig. 82 Speed Sensor Switch Test

e. Verify speed sensor functions properly.

(1) Disconnect wiring harness from solenoid valve and connect a 12-volt test lamp between the two terminals of the harness connector.

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(2) Slowly accelerate the engine and observe the speed at which the test lamp lights. Test lamp should light above 1850 • 50 RPM.

(3) Slowly decelerate the engine and observe speed at which the test lamp goes out. Test lamp should go out below 1850 • 50 RPM.

(4) If test lamp does not function properly, check speed sensor wiring for proper routing and for clean and tight connections. If wiring is correct, speed sensor is faulty and must be replaced. (The speed sensor and solenoid valve are sold as one assembly.)

14A. Deceleration Throttle Modulator System (DTM) Operation.

The deceleration throttle modulator system consists basically of a vacuum operated throttle modulator unit on the carburetor, a solenoid vacuum valve and engine speed sensor unit (Fig. 79).

Normally an engine will emit relatively high levels of unburned hydrocarbons during "closed throttle" deceleration. This is because the intake of fuel/air mixture is not sufficient to support complete combustion and the engine "misfires" resulting in fuel being passed through the engine unburned. The deceleration throttle modulator system overcomes this condition by maintaining a slightly greater throttle opening (high idle) during initial deceleration which permits intake of just enough additional fuel/air mixture to promote combustion and eliminate misfire.

The engine speed sensor is calibrated to activate or deactivate (extend or retract) the throttle modulator unit at approximately 1850 RPM engine speed. Operation of the throttle modulator is illustrated in Fig.79.

Above 1850 RPM engine speed, the solenoid vacuum valve is activated (held open) by electrical current from the engine speed sensor unit. This permits manifold vacuum to act upon the diaphragm of the throttle modulator unit extending the modulator unit to the high idle position. Upon deceleration, the returning carburetor throttle lever contacts the extended modulator, thus holding the throttle in high idle position.

When engine speed drops below 1850 RPM, the speed sensor unit deactivates the solenoid vacuum valve allowing the valve to close and bleed the vacuum from the throttle modulator diaphragm chamber. This permits the diaphragm spring to retract the modulator unit and allow the throttle lever to return to normal curb idle position.

15. Remove and Check GOR Valve and Clean or Replace, if necessary.

For California Engines Only.

a. Remove EGR valve from engine.

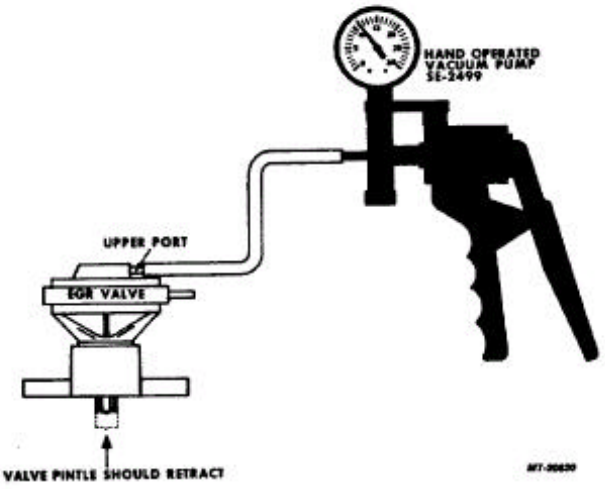


Fig. 83 EGR Valve Test

b. Apply 10-12" vacuum to EGR valve vacuum port (upper port of dual diaphragm valve). As vacuum is applied, valve pintle should move off seat and retract into valve housing (Fig. 83). IF valve does not operate when vacuum is applied, valve is faulty and should be replaced.

c. Visually inspect valve for evidence of valve pintle (plunger) not seating or deposit accumulation on pintle or seat. Clean deposits from pintle and seat, if necessary.

To clean deposits from pintle and seat of EGR valve, use a sand blast type spark plug cleaner and the following procedure:

(1) Prepare spark plug cleaner by installing rubber adapter with 22 mm (7/8") hole over cleaning (blast) port. Do not install metal adapter clamp (Fig. 84).

(2) Insert pintle of EGR valve through hole in rubber plug cleaner adapter.

(3) Holding EGR valve tightly down against adapter, apply sand blast to clean pintle.

CAUTION

Safety goggles should be worn while performing cleaning operation.

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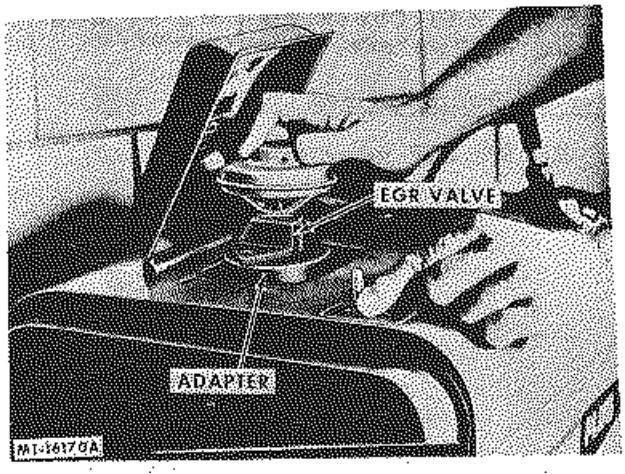


Fig. 84 Cleaning EGR Valve

(4) After cleaning exposed pintle, hold EGR valve in both hands and press in diaphragm to retract valve pintle into valve housing. Use a 25 mm (1") long bolt (3/4" long bottom dual diaphragm valves) to hold pintle in retracted position. Apply masking tape to cover outlet port of valve.

(5) With pintle opening of valve aligned with hole in cleaning adapter, hold EGR valve down tightly against adapter and apply sand blast to clean interior of valve housing and valve seat.

d. After cleaning, blow all excess sand from interior of valve housing and remove bolt.

e. Recheck valve for proper operation and seating.

f. Replace with new valve, if necessary.

16. Check EGR System with Functional Test and Clean or Replace, if necessary.

For California Engines Only.

Perform EGR System Functional Test as follows:

a. Operate engine until it reaches normal operating temperature.

b. Shut off engine. Connect tachometer. Connect vacuum pump with vacuum gauge to EGR system vacuum hose at carburetor.

c. Plug fitting at carburetor.

d. With tachometer installed, operate all engines at 2000 RPM.

e. Apply specified vacuum (see Emission Control System Tune-Up Specifications)

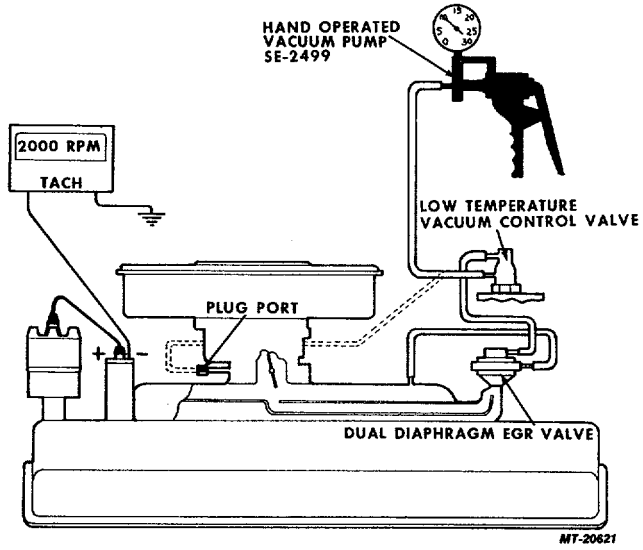


Fig. 85 Complete EGR System Test

f. See Emission Control System Tune-Up Specifications for engine speed drop when vacuum is applied. This procedure checks not only the EGR valve but the intake manifold and related passages as well.

If minimum speed drop specification is not achieved, verify applied vacuum signal acts on valve.

a. Tee vacuum gauge into vacuum hose at EGR valve (upper port on dual diaphragm valves).

b. With engine shut off and normal operating temperature (EGR low temperature vacuum control valve), any vacuum magnitude applied at carburetor end of vacuum hose should be observed at EGR valve end of hose (Fig. 86).

c. If same vacuum is not observed, inspect vacuum hoses for leaks and replace as necessary.

d. Repeat Step b. If same vacuum is not observed, replace EGR low temperature vacuum control valve.

e. Repeat EGR System Functional Test.

If minimum speed drop specification is still not achieved, check for plugged exhaust gas passages and clean as required.

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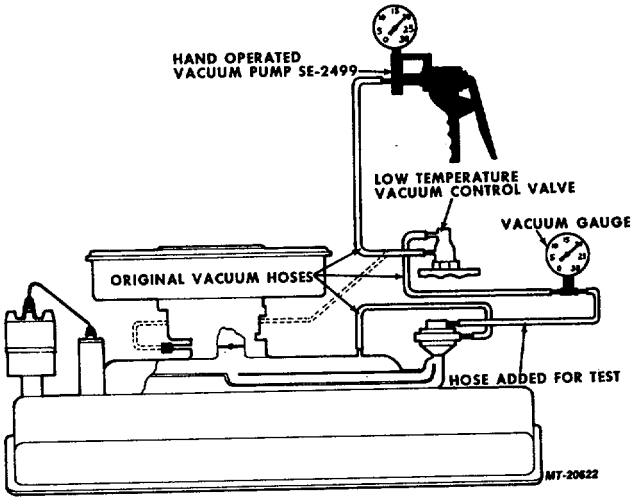


Fig. 86 Low Temperature Vacuum Control Valve and Connecting Hose Test

a. For V-304/345/392 engines, open carburetor throttle plates and examine exhaust ,gas ports located in floor of intake manifold directly below carburetor. If ports are plugged with deposits, remove carburetor and clean ports as needed.

b. For 4-196, remove EGR valve from intake manifold. If ports are plugged with deposits, clean deposits from ports.

For Federal V-304/345 Engines Only.

a. Operate engine until it reaches normal operating temperature.
b. Shut off engine. Connect tachometer and vacuum gauge to engine.
c. Start engine and block throttle open to give 3000 RPM. Observe and record tachometer reading.

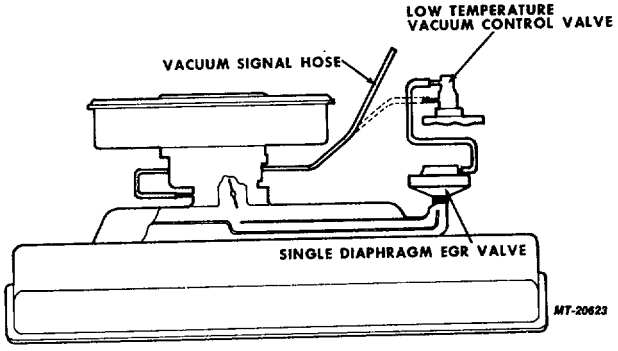


Fig. 87 Single Diaphragm EGR Valve System

d. Disconnect EGR vacuum signal hose (Fig. 87) and again record tachometer reading. If EGR system is functioning properly the minimum speed increase should be 50 rpm for the V-304 and 150 rpm for the V-345. If rpm increase is less than shown above, EGR system is not functioning properly and should be checked per the following steps.

Check low temperature vacuum control valve as follows:

a. With engine operating at fast idle, disconnect vacuum signal hose from low temperature vacuum control valve. A vacuum signal should be felt at the open end of hose. If vacuum is felt, reconnect hose and proceed. If vacuum is not felt, stop engine and check for leaking or restricted vacuum hose or restricted vacuum port in carburetor.

b. With engine operating at fast idle, disconnect vacuum signal hose from EGR valve. A vacuum signal should be felt at the open end of the hose. If vacuum is felt, vacuum supply and low temperature valve are satisfactory (Fig. 87).

If vacuum is not felt:

a. Check for leaking or restricted vacuum hose.

b. Be sure hoses are connected properly to low temperature vacuum control valve.

c. If hoses are satisfactory and vacuum does not pass through low temperature vacuum control valve, valve is faulty and must be replaced.

After correcting any problem and obtaining a vacuum signal at EGR valve, repeat System Operation Test per c and d above.

Check operation of EGR valve as follows:

a. Remove EGR valve from engine.

b. Visually inspect valve for evidence of valve pintle (plunger) not seating. If pintle does not seat due to deposits, clean valve pintle and seat (see EGR Valve Cleaning Procedure). If pintle does not seat properly after cleaning, replace EGR valve.

c. Apply 10-12" Hg vacuum to EGR valve vacuum port (Fig. 85). As vacuum is applied, valve pintle should move off seat and retract into valve housing until end of pintle is approximately flush with surface of valve housing. If valve

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does not operate when vacuum is applied, valve is faulty and should be replaced.

16A. Replace EGR Valve (Federal and California Engine).

Because EGR valve metering varies between engines, it is important that the correct EGR valve be used in order to obtain optimum engine performance and emission control (see EGR Valve Application Chart).

To assist in identification, EGR valves are coded by a colored disk attached to the center of the vacuum diaphragm housing. The valve may also be identified by the manufacturer's part number stamped on the valve (Fig. 88).



Fig. 88 EGR Valve Identification Marking

16B. Exhaust Gas Recirculation System Operation

The exhaust gas recirculation (EGR) system introduces a metered amount of exhaust gas into the intake manifold where it mixes with the air/fuel mixture entering the combustion chambers. Dilution of the air/fuel mixture with exhaust gas lowers combustion temperature and pressure, thereby reducing formation of oxides of nitrogen.

The EGR valve regulates the amount of exhaust gas entering the intake manifold. The EGR valve is controlled by ported vacuum, which is determined by position of the carburetor throttle plate(s). Operation of the exhaust gas circulation system is illustrated in Figures 89 and 90.

While the engine is stopped or operating at idle speed (negligible port vacuum), the EGR valve is held closed by spring pressure.

A low temperature vacuum control valve is

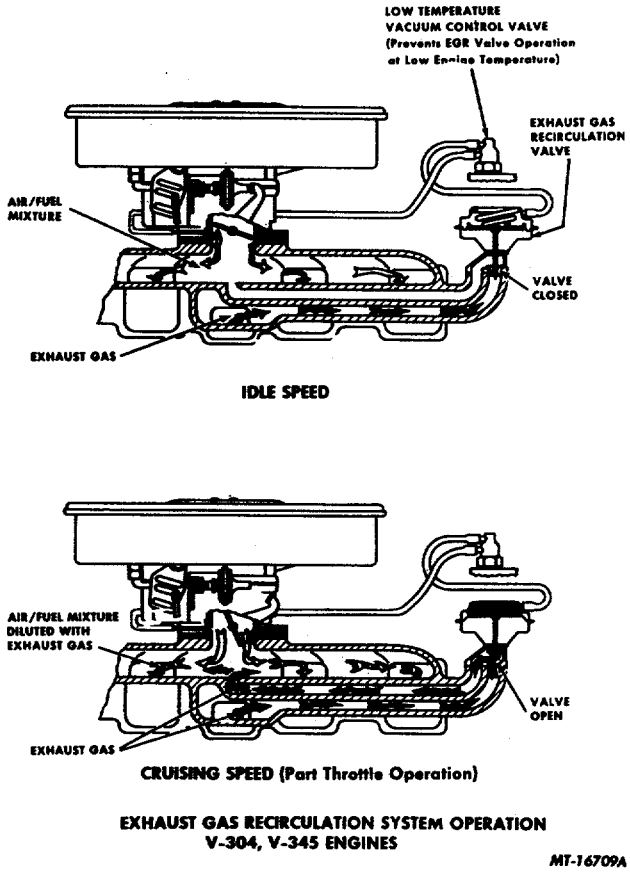


Fig. 89 Exhaust Gas Recirculation System (Single Diaphragm EGR Valve)

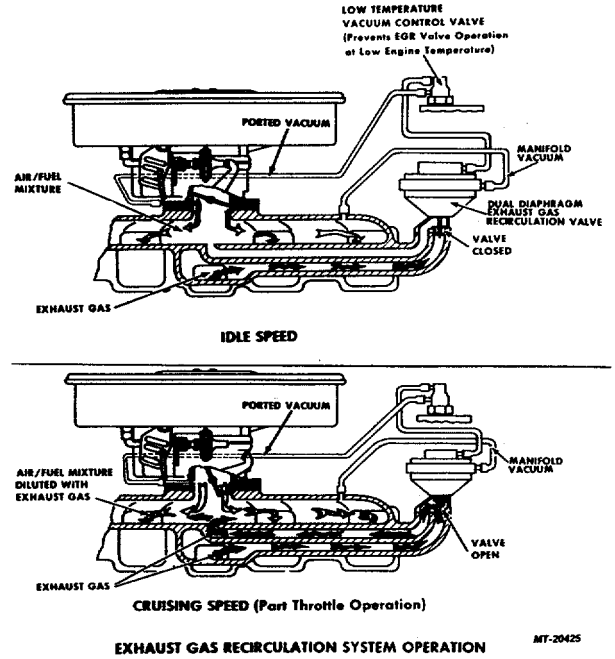


Fig. 90 Exhaust Gas Recirculation System (Dual Diaphragm EGR Valve)

used in the exhaust gas recirculation system. The purpose of this valve is to prevent exhaust gas recirculation when the engine is cold. The low temperature control valve senses engine coolant temperature and is located in the coolant passage of the intake manifold. Whenever engine coolant temperature is below 46 deg. C (115 deg. F), the low temperature control valve is closed blocking vacuum from the EGR valve diaphragm, thus preventing EGR valve operation. When engine warms up and coolant temperature exceeds 46 deg. C (115 deg. F), the low temperature control valve opens permitting vacuum to actuate the EGR valve and establish exhaust gas recirculation in response to throttle plate position. The low temperature control valve can be identified by a purple exterior color.

EGR VALVE APPLICATION CHART

(For 1978 Model Engines)

CALIFORNIA

Engine	Carburetor	IH No.	Mfr. No.	Color Code
4-196	1940C	472207C1	17051786	Black/White
V-345	2210C	480825C1	17057905	Red/White
V-345	2300G	472207C1	17051786	Black/White
V-392	4150G	480824C1	7044409	Green/Black
MV-404	2210C	446981C1	17056690	Green/Yellow
MV-404	2300G	446981C1	17056690	Green/Yellow
MV-404	4150G	440312C1	17053177	White
MV-446	4150G	440312C1	17053177	White
V-537	2300G	440310C1	17053031	Blue/White

FEDERAL

(Not California)

V-304	2210C	440308C1	7040435	None
V-304	2300G	440306C1	7030983	Black
V-345	2210C	440308C1	7040435	None
V-345	2300G	440306C1	7030983	Black

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17. Check Air Injection System and Replace, if necessary.

For California Engines Only.

a. Check air injection pump drive belt. Air injection pump drive belt tension can be checked with belt tension gauge SE-2312 (Fig. 91). Check tension at mid-point between the pulleys. Apply gauge to the longest belt span. Instructions for checking are as follows:

(1) Grasp gauge and depress ball handle all the way down. Make certain hook extends beyond legs to pick up the belt.
(2) Apply gauge to belt. Be sure belt is positioned between nose piece and hook and that the nose piece is centered on belt.
(3) Release ball handle quickly. A slow release may present full return of hook, thus giving a false reading.

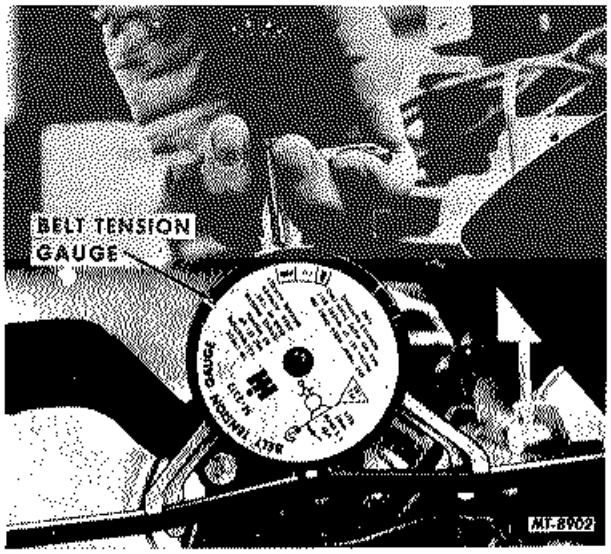


Fig. 91 Checking Belt Tension With SE-2312 Gauge

(4) Observe the area of gauge face indicated at the index mark. If index mark does not indicate a NEW reading on a new belt or a USED reading on a used belt, it will be necessary to increase or decrease belt tension as required.
(5) Before changing belt tension, repeat Step (3) several times to become familiar with gauge operation. Observe gauge reading each time operation is repeated. Check tension of both belts when so equipped.

To establish tension of a loose belt apply SE-2312 gauge to belt and make the adjustment. Tighten belt until proper area for belt is indicated at index mark on gauge. Lock adjustment and recheck belt tension. Readjust as necessary.

When using SE-2312 belt tension gauge, remember to set new belts (belt with less than two minutes running time) to the NEW area on gauge face and used belts (more than two minutes running time) to USED area on gauge.

b. Inspect air pump centrifugal air filter; if clogged or damaged, air pump centrifugal filter can be replaced as follows:

(1) Hold pump pulley from turning and remove pulley mounting bolts.

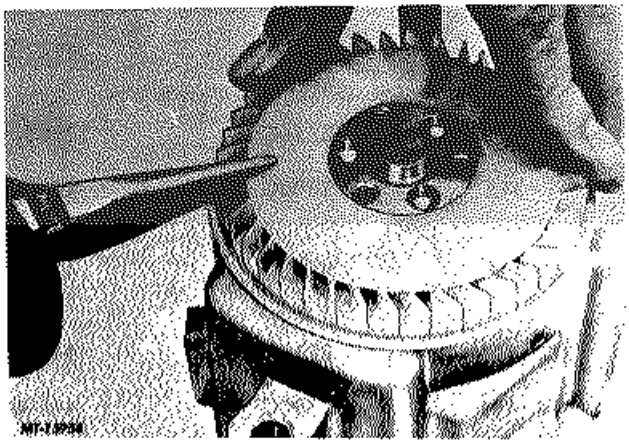


Fig. 92 Removing Centrifugal Air Filter Fan

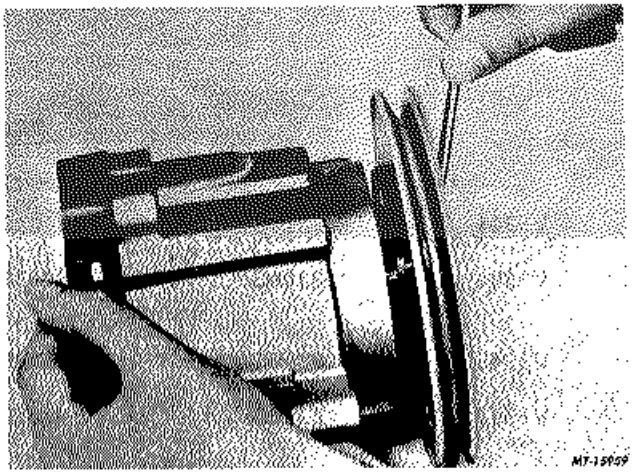


Fig. 93 Installing Centrifugal Air Filter Fan

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(2) Insert needle nose pliers and pull filter fan from hub (Fig. 92). Care should be taken to prevent fragments of the fan from entering the air intake hole.

(3) Install new filter fan by drawing it on with the pulley and pulley bolts (Fig. 94). Do not attempt to install the filter by hammering or pressing it on.

(4) Draw filter fan down evenly by alternately tightening the pulley mounting bolts. Make certain that the outer edge of the filter slips into the pump housing. A slight amount of interference with housing bore is normal.

(5) Hold pulley from turning and torque pulley bolts to 111 N.m (25 ft.lbs.). The new filter may squeal up on initial operation until its outside diameter sealing lip has worn in.

c. Perform air injection system functional test as follows:

(1) Disconnect one air injection hose from check valve and plug end of hose (V8's only).

(2) Disconnect other air injection hose from check valve and connect air pump tester SE-2498, or equivalent, to end of hose.

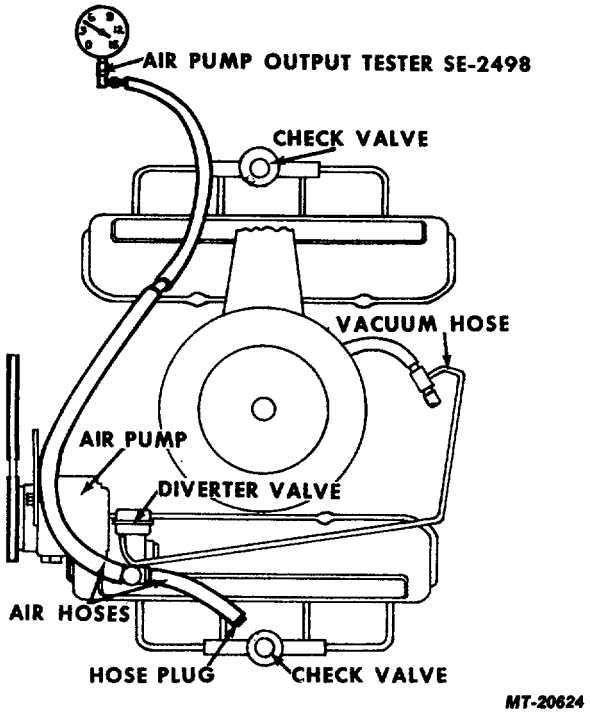


Fig. 94 Checking Air Injection System Output (Small V-8 Engine Shown)

(3) Connect tachometer to engine.

(4) Operate engine at speed specified (see Emission Control System Tune-Up Specifications), perform the following.

d. Check air hoses for leaks. If leaks are found, replace hose(s) and repeat Step c.

e. With engine at steady speed specified (see Emission Control System Tune-Up Specifications), check for flow of air through diverter valve external exhaust ports (Fig. 97).

(1) If air flows through diverter valve external exhaust ports, valve is faulty and must be replaced. After replacing diverter valve, repeat Step c.

(2) If air does not flow through diverter valve external exhaust ports, pump output is low and the pump must be replaced. When installing a new pump or adjusting the air pump belt tension, do not pry on the pump housing.

f. Check diverter valve divert function as follows:

(1) Operate engine at speed specified (see Emission Control System Tune-Up Specifications).

(2) Remove vacuum hose from diverter valve (Fig. 94) and check for a vacuum pull at the end of hose. If no vacuum is felt, replace hose.

(3) Reconnect vacuum hose from diverter valve and check for momentary flow of air through the diverter valve exhaust ports (Fig. 97). After a few seconds, flow of air through the diverter valve exhaust ports should be restored. If divert valve does not function properly, valve is faulty and must be replaced.

17A. Air Injection System Operation.

The air injection system forces air into the cylinder head exhaust ports to promote "after-burning" of any combustibles remaining in the exhaust gases flowing from the combustion chamber. The components of the air injection system are illustrated in Figure 95.

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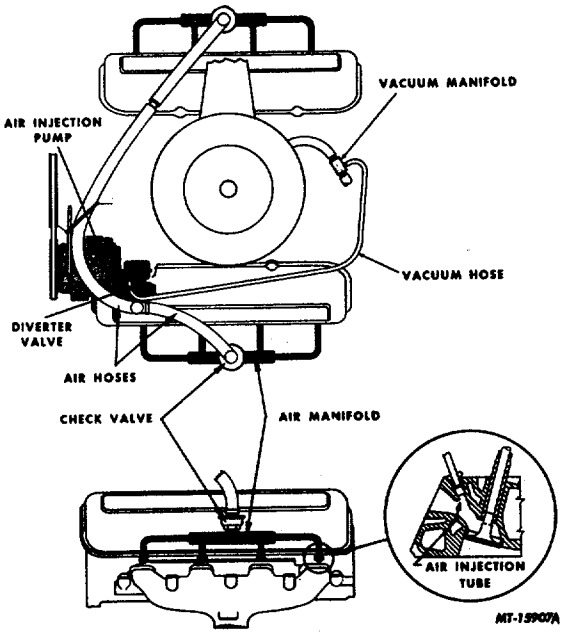


Fig. 95 Air Injection System Used on Small V8 Engine

The air pump used in the air injection system is a rotary vane type which is belt driven from the engine. A centrifugal type air filter located behind the pump pulley filters the air entering the pump to prevent entrance of dirt and abrasives (Fig. 50).

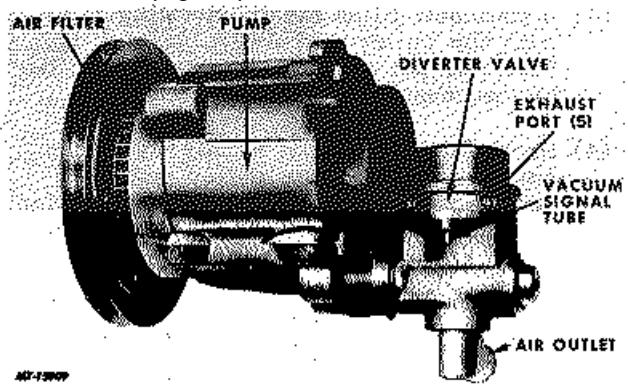


Fig. 96 Air Injection Pump With Diverter Valve

The air manifold distributes air under pressure from the pump to the individual exhaust ports in the cylinder heads. Figure 95 shows the location of the air manifolds on the small V8 engines. The air manifold is an integral part of the MV and large V8 engine cylinder heads. A one-way check valve is used on each air manifold to protect the pump from a back flow of high temperature exhaust gases. Stainless steel air injection tubes are used in small V8 cylinder

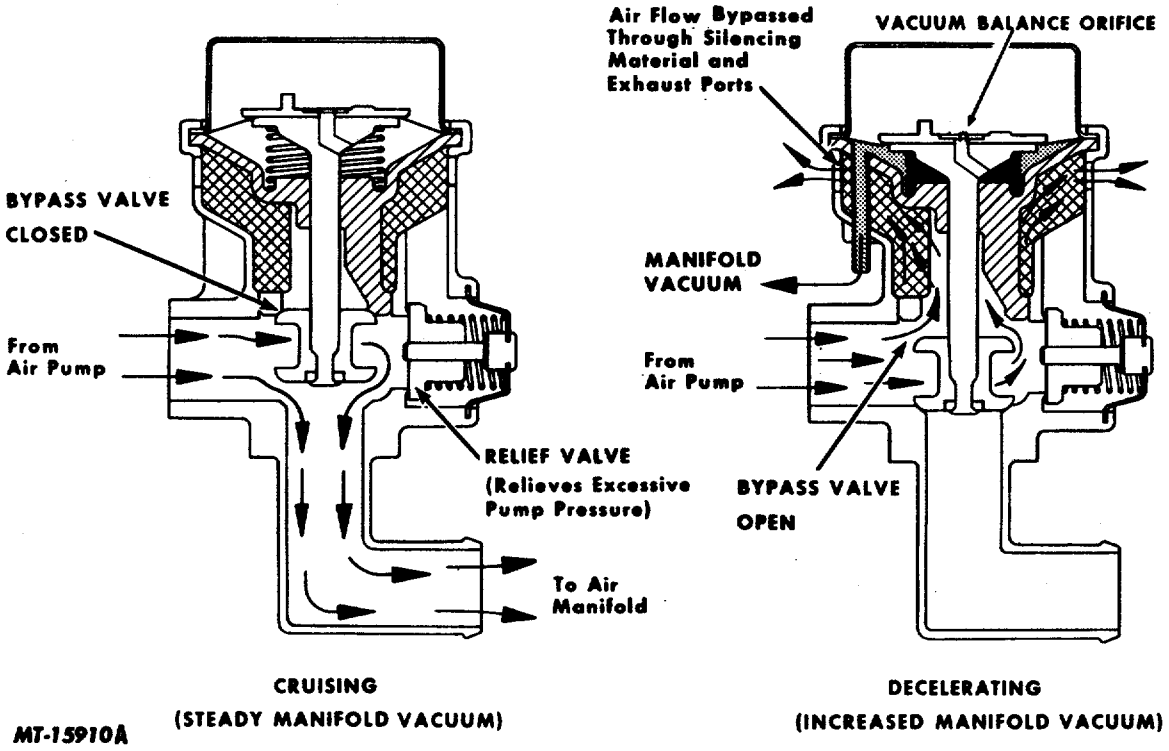


Fig. 97 Diverter Valve Operation

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heads to direct the air flow from the air manifold to a point just "downstream" of the exhaust valves. The diverter valve attached to the air pump (Fig. 50) prevents backfire in the exhaust system by shutting off air flow during the first few seconds of deceleration. The diverter valve also incorporates a pressure relief valve which exhausts excessive pump outlet air pressure during high speed operation. Operation of the diverter valve is illustrated in Figure 97.

In normal operation (cruising) the air pump delivers air through the air manifolds into the cylinder head exhaust ports. With the addition of air from the air injection system, an over rich mixture can cause backfire in the exhaust system. To prevent backfire, the diverter valve momentarily stops the flow of air to the cylinder head exhaust ports during deceleration.

The diverter valve is controlled by intake manifold vacuum. At constant manifold vacuum spring pressure holds the valve in normal delivery position. This permits air to flow from the air pump to the air manifolds. During deceleration high manifold vacuum overcomes spring pressure and moves the valve to bypass position. This closes the outlet port and bypasses the air flow through the internal silencer to the atmosphere. The valve returns to normal delivery position when the vacuum being applied to the diaphragm is balanced through the orifice to the chamber on the other side of the diaphragm. Operating cycle time for the valve is approximately six seconds. In cases of high pump output air pressure (due to high engine speed etc.), the pressure relief valve opens and exhausts excessive air flow through the internal silencer to the atmosphere.

18. Check Curb Idle Speed and Air/Fuel Mixture and Adjust, as necessary.

For Federal and California Engines.

Idle speed and fuel mixture adjustments must be made with parking brake applied, air cleaner in place, transmission in neutral and air conditioning "OFF"

When making idle adjustments, disconnect vacuum hose from --vapor storage canister and plug end of hose. After idle adjustments have been made, remove plug and reconnect hose to canister.

To compensate for fuel and temperature variations when setting idle mixture, observe these precautions:

a. Do not idle engine continuously for more than three minutes at one time.

b. After each three minutes of idling, increase engine speed to 2000 rpm for one minute.

c. Continue with idle adjustment procedure. Do not idle engine for more than three minutes without repeating Step b.

Winter grade gasolines, being more volatile than summer grade, can yield vapors which result in excessively rich or erratic air/fuel mixtures, particularly at high engine temperatures. Because of this, care must be taken when making carburetor idle mixture adjustments with the exhaust analyzer. Attempts to adjust the idle mixture screw(s) leaner to overcome a rich mixture caused by evaporation of winter grade fuel at high engine temperatures can result in an extremely lean mixture and associated

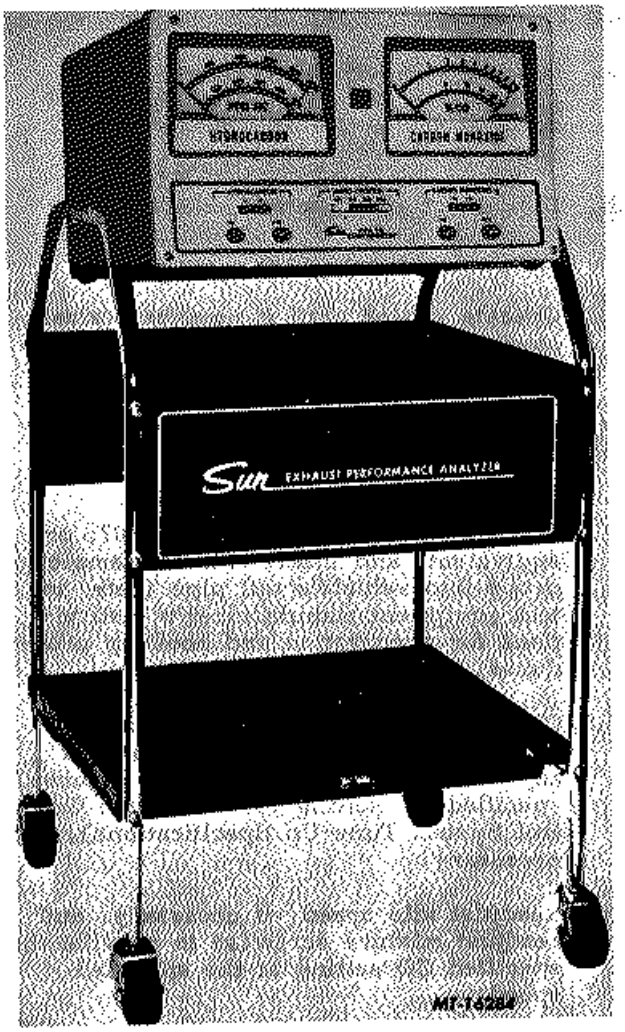


Fig. 98 Exhaust Analyzer - SE-2507

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starting and driveability problems when vehicle is cold. Therefore, with winter grade gasolines, observe the following additional precaution:

Idle mixture adjustments must be made as soon as possible after engine will run without choke (choke plate fully open) -before engine temperature becomes sufficiently high to cause evaporation of winter grade gasolines. Enrichment of the idle mixture by fuel evaporation can be detected by observing test meter readings. Readings should remain stable. A gradual increase in engine idle speed (RPM) or a tendency for the CO meter to climb toward the rich side without any adjustments being made indicates a richening of the mixture due to fuel evaporation. When this condition occurs, engine should be allowed to cool before making final mixture adjustments.

Setting Procedure:

a. Connect test tachometer to engine. (Tachometer should have an expanded scale of 400 to 800 or 0 to 1000 RPM and 1 to 2% accuracy.)

b. Disconnect air injection hose(s) at air manifold check valve(s) and plug air manifold check valve(s .

c. Operate engine until it reaches normal operating temperature (unless winter grade gasoline is used).

d. Adjust curb idle speed to specifications (see Emission Control System Tune-Up Specifications) .

e. Prepare Exhaust Analyzer SE-2507, or equivalent, and insert exhaust sample probe into vehicle's tail pipe (refer to test equipment manufacturer's instructions for preparation and hook-up procedures.

f. Observe percent of carbon monoxide (%CO) indicated on analyzer dial and adjust idle mixture screw(s) to obtain specified CO setting (see Emission Control System Tune-Up Specifications), if necessary.

g. Readjust idle speed, if necessary, and readjust mixture screw(s) to provide the specified CO setting at the specified speed.

h. If specified CO setting cannot be obtained, establish proper mixture screw(s) setting as follows:

(1) Remove limiter cap(s). To prevent damage to screw threads or seat, file or grind away the side of the cap. Do not pry cap off.

(2) Gently seat idle mixture screws (not required on 4-196 engine).

(3) Adjust idle speed and mixture screw(s) (equal number of turns) to provide the specified CO setting at the specified speed.

(4) Install new plastic (service) limiter cap(s) with tab in the mid position.

i. Disconnect test equipment from engine and reconnect air injection hose(s) to air manifold check valve(s).

For Federal Engines Only.

Idle speed and fuel mixture adjustments must be made with parking brake applied, air cleaner in place, transmission in neutral and air conditioning "OFF".

To compensate for fuel and temperature variations when setting idle mixture, observe these precautions:

a. Do not idle engine continuously for more than three minutes at one time.

b. After each three minutes of idling, increase engine speed to 2000 rpm for one minute.

c. Continue with idle adjustment procedure. Do not idle engine for more than three minutes without repeating Step b.

Adjustment Procedure Without Exhaust Analyzer:

a. Connect tachometer to engine. (Tachometer should have an expanded scale of 400 to 800 or 0 to 1000 rpm and 1 to 2% accuracy.

b. Remove limiter cap(s). To prevent damage to screw threads or seat, file or grind away the side of the cap. Do not pry cap off.

c. Operate engine until it reaches normal operating temperature.

d. Gently seat idle mixture screws (not required on 4-196 engine).

e.Carefully, adjust idle mixture screws (equal number of turns) to produce maximum idle speed.

f. Carefully adjust curb idle speed screw to give engine speed higher than mid point of idle speed range per specifications (see Emission Control System Tune-Up Specifications). Then carefully adjust curb idle mixture screw(s) (equal number of turns) in until mid point of idle speed range specification is obtained (see Emission Control System Tune-Up Specifications) .

g. Install new plastic (service) limiter cap(s) with tab in mid position.

19. Check Automatic Choke (where used) for proper setting and free operation.

a. See Carburetor Service Manual (FUEL SYSTEMS) for proper choke setting procedure.

b. Check choke valve for free operation by opening and closing choke valve manually.

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VACUUM HOSE ROUTING

Vacuum Hose Identification Legend

Key Letter	Location	Color Code
A	Carburetor Port-to-Solenoid Valve	Yellow Stripe
B	Solenoid Valve-to-Throttle Modulator	Blue Stripe
C	Carburetor Port or Intake Manifold Fitting to Distributor Vacuum Advance Unit	Red Stripe
D	Carburetor Port-to-High Temperature Vacuum Valve	White Stripe
E	High Temperature Vacuum Valve-to-Distributor Vacuum Advance Unit	Red Stripe
F	High Temperature Vacuum Valve-to-Vacuum Manifold	Purple Stripe
G	Carburetor Port-to-Vacuum Manifold	(Plain)
H	Carburetor Port-to-Low Temperature Vacuum Valve (EGR System)	Green Stripe
I	Low Temperature Vacuum Valve (EGR System) to EGR Valve	Green Stripe
J	Canister-to-Tee	(Plain)
K	Air Cleaner Temperature Sensor-to-Vacuum Manifold	(Plain)
L	Intake Manifold Vacuum Port-to-Tee	(Plain)
O	Diverter Valve-to-Tee or Intake Manifold Fitting	Purple Stripe

Use the following eight (8) vacuum hose location charts for engines sold in all States, except California.

The Federal Version (49 States, not California) of the V-392 engine with the 4150G carburetor is not shown because it does not have any external emission controls.

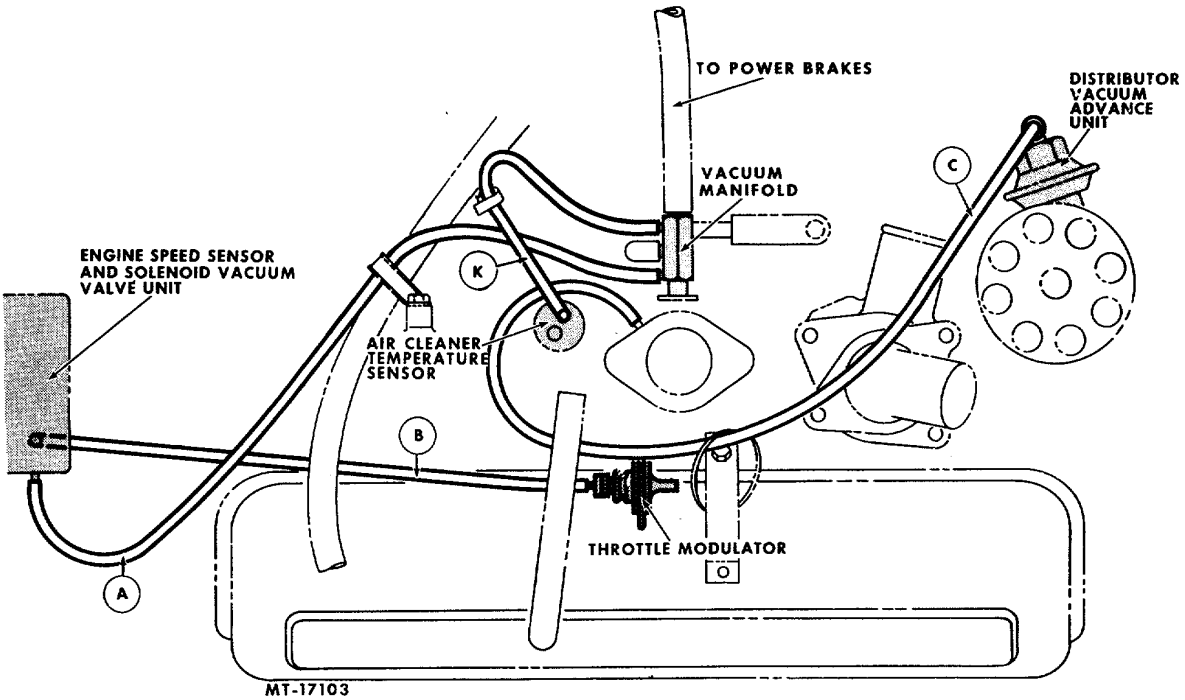


Fig. 99 Vacuum Hose Locations on 4-196 Engine with]940C Carburetor In Scout Vehicles (Not Sold in California)

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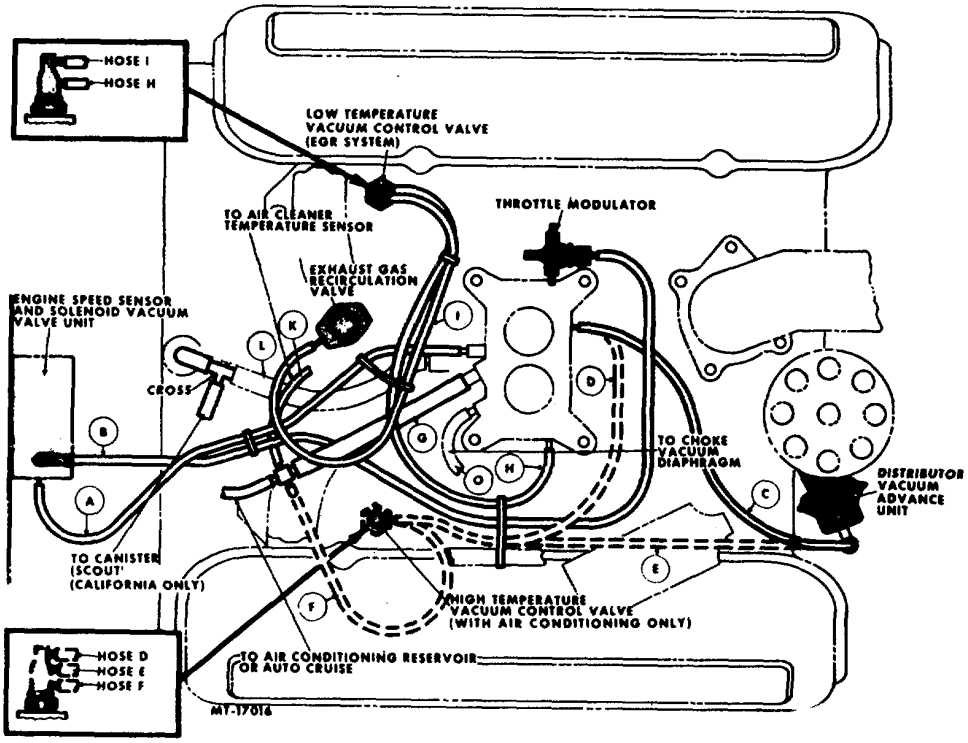


Fig. 100 Vacuum Hose Locations on V-304/345 Engine with 2210C Carburetor In scout vehicles (Not Sold in California.

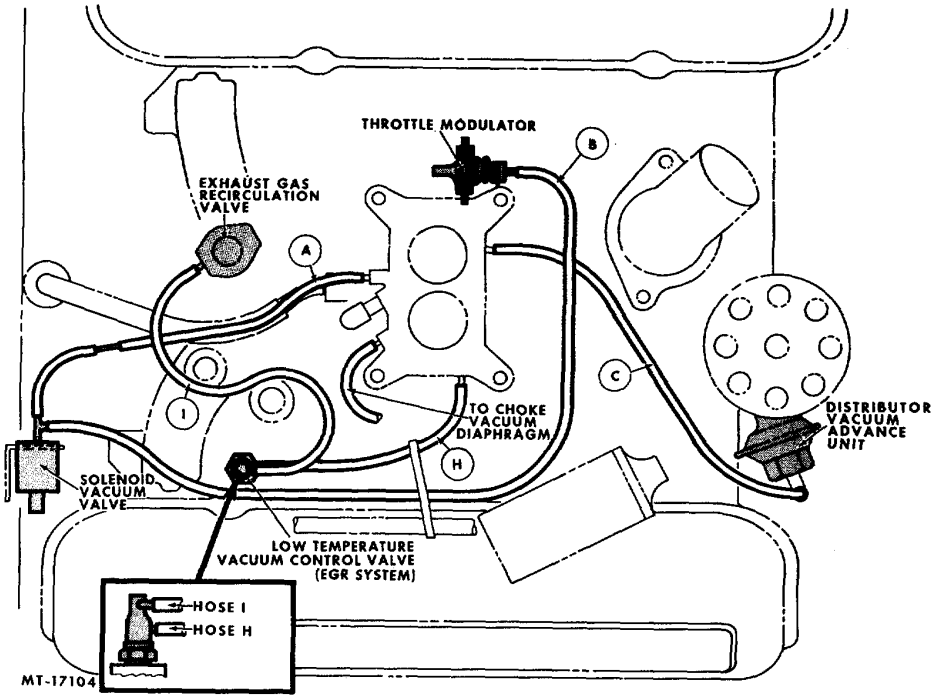


Fig. 101 Vacuum Hose Locations on V-345 Engine with 2210C Carburetor in Loadstar, Cargostar and S-Series Vehicles (Not Sold in California)

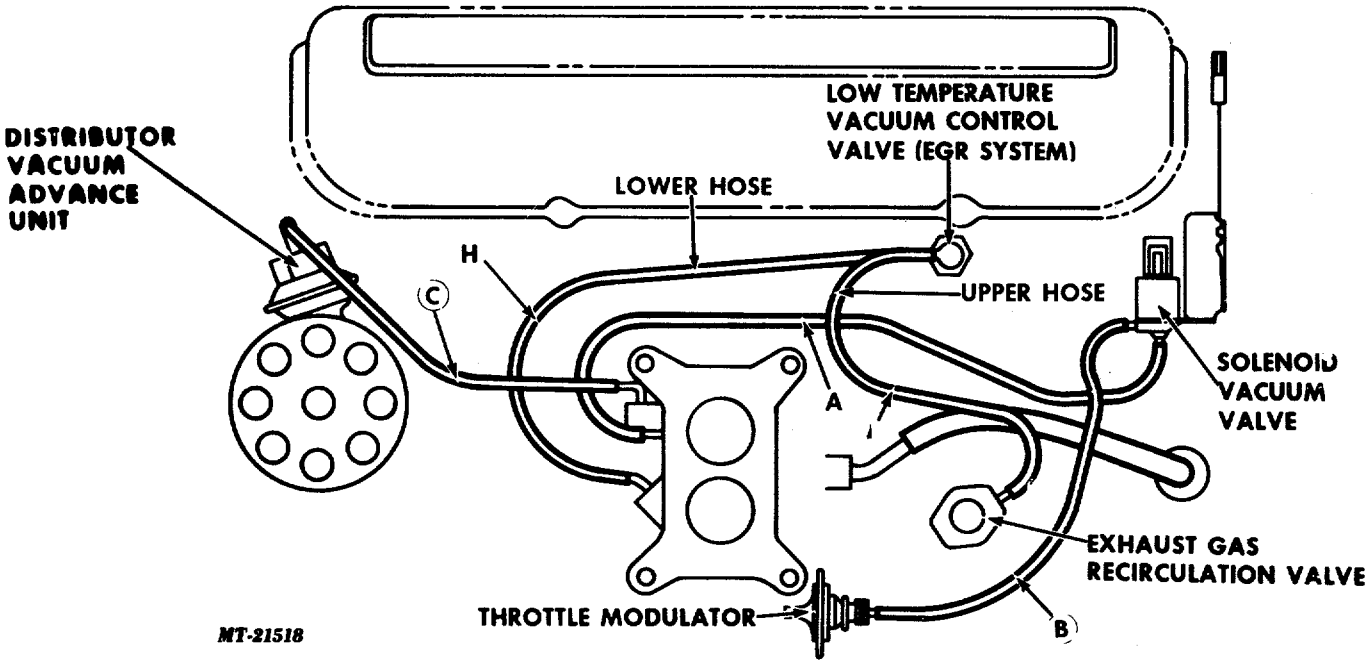


Fig. 102 Vacuum Hose Locations on V-345 Engine with 2300EG Carburetor in Loadstar, Cargostar and S-Series Vehicles (Not Sold in California)

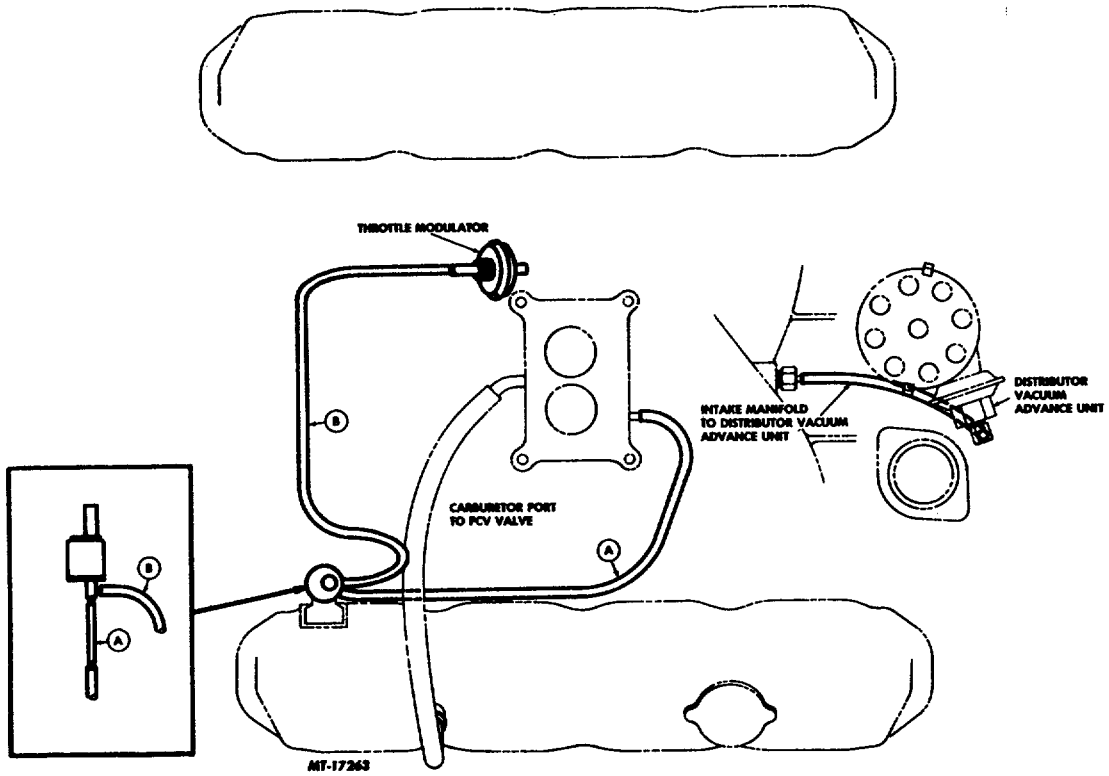


Fig. 103 Vacuum Hose Locations on MV-404 Engine with 2210C Carburetor in Loadstar, Cargostar and S-Series Vehicles (Not Sold in California)

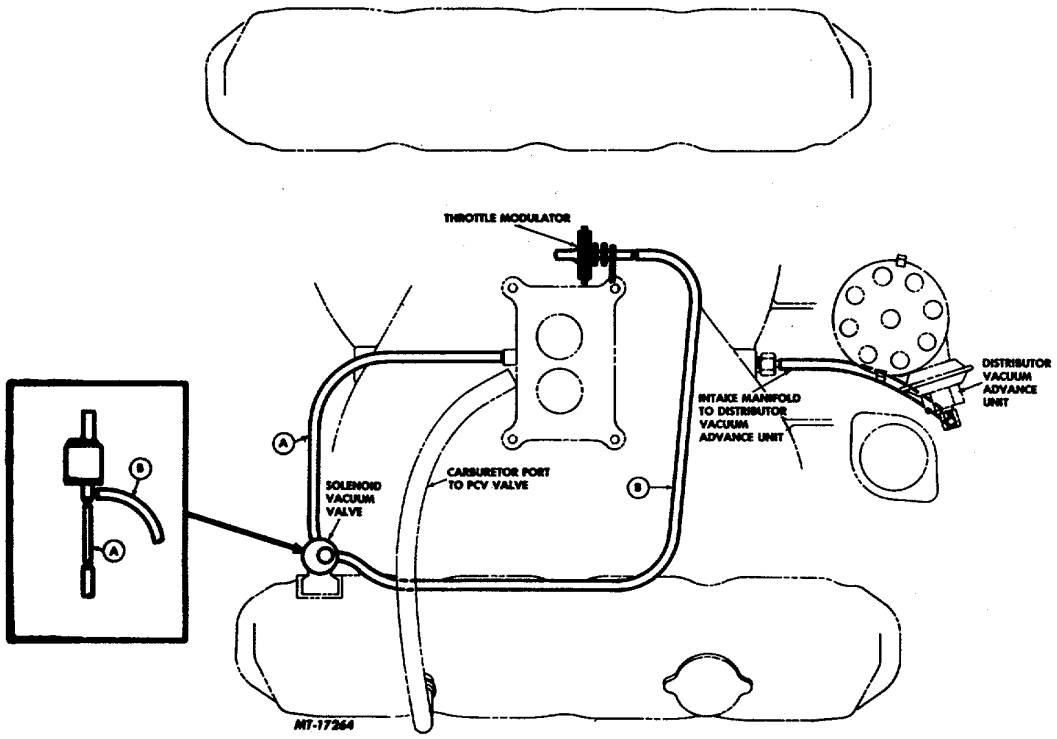


Fig. 104 Vacuum Hose Locations on MV-404 Engine with 2300EG Carburetor in Loadstar, Cargostar and S-Series Vehicles (Not Sold in California)

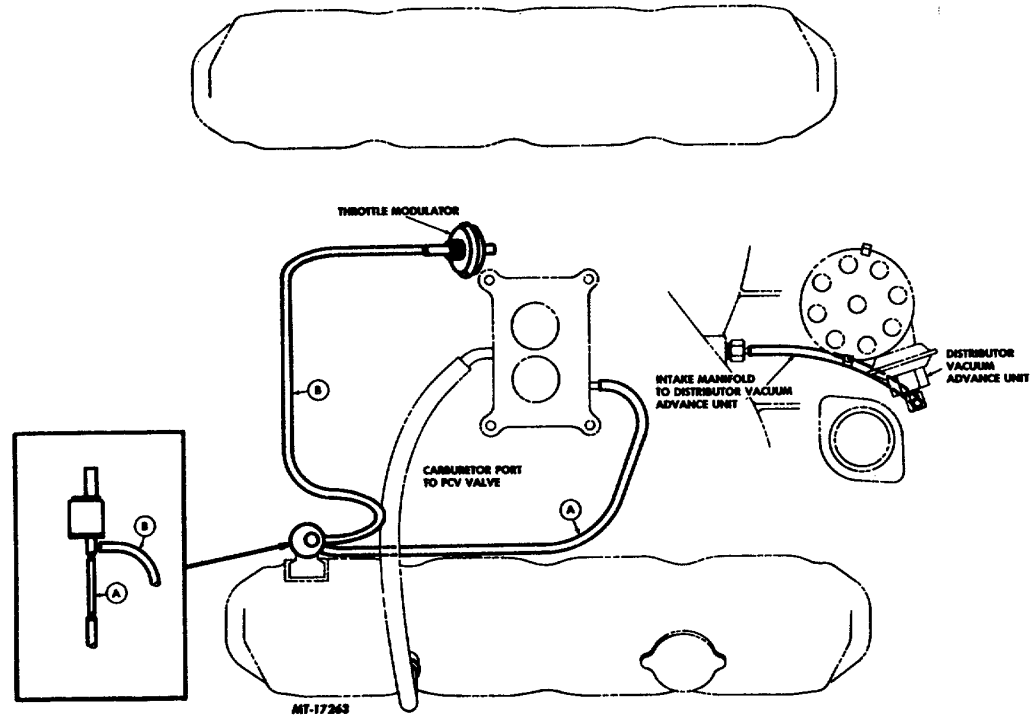


Fig. 105 Vacuum Hose Locations on MV-404/446 Engines with 4150G or 4360EG Carburetors in Loadstar, Cargostar and S-Series Vehicles (Not Sold in California)

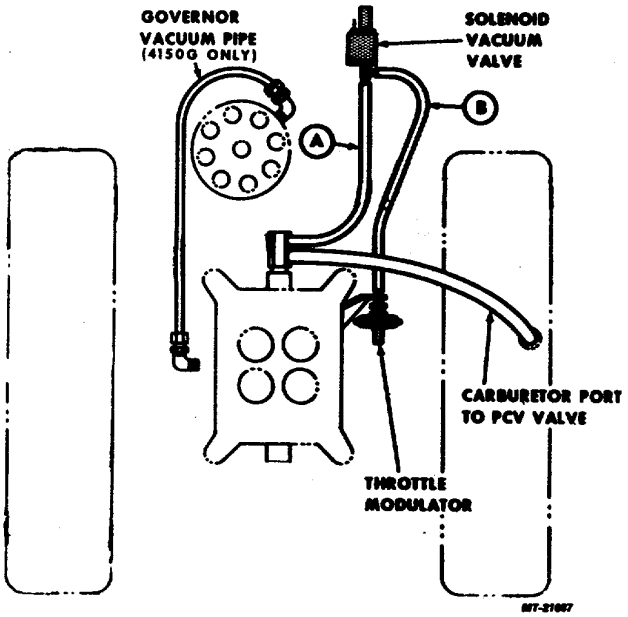


Fig. 106 Vacuum Hose locations on V-537 Engine With 4150G or 4360EG Carburetor in Fleetstar or S-Series Vehicles (Not Sold in California)

Use the following eighteen (18) vacuum hose location charts for engines sold in California.

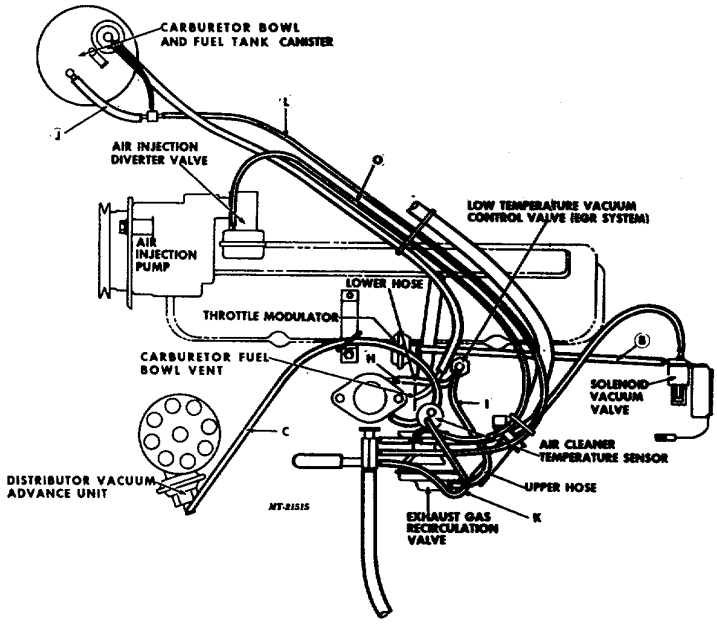


Fig. 107 Vacuum Hose Locations on 4-196 Engine with 1940C Carburetor in Scout Vehicles (Sold in California)

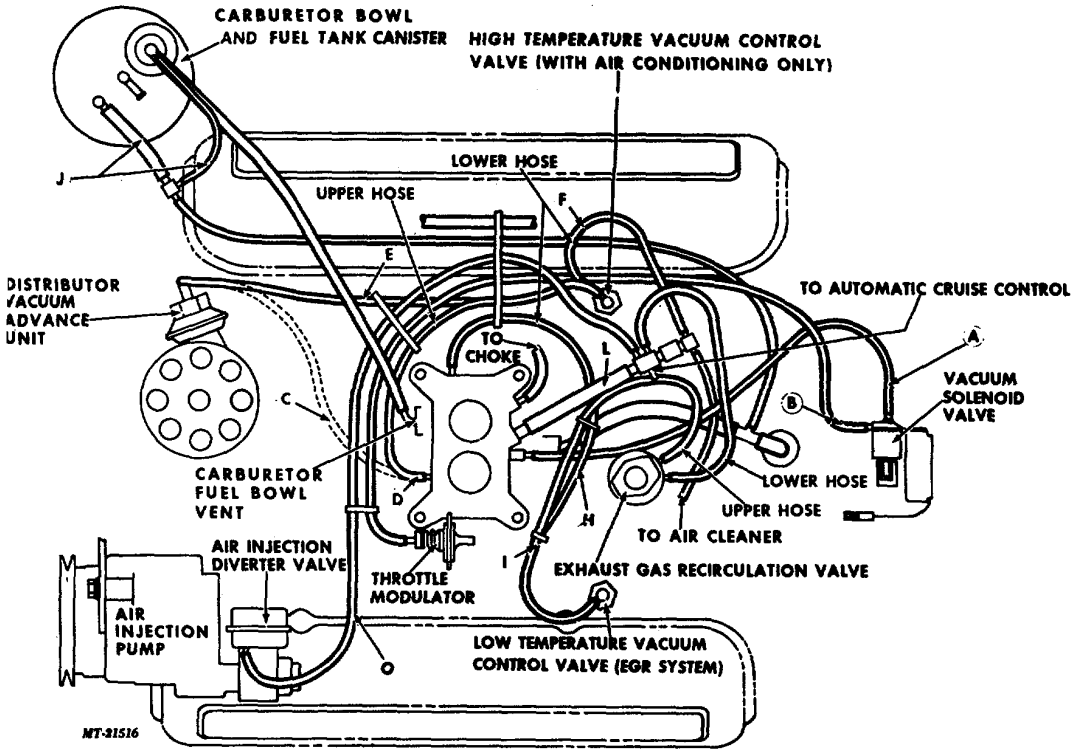


Fig. 108 Vacuum Hose Locations on V-345 Engine with 2210C Carburetor in Scout Vehicles (Sold in California)

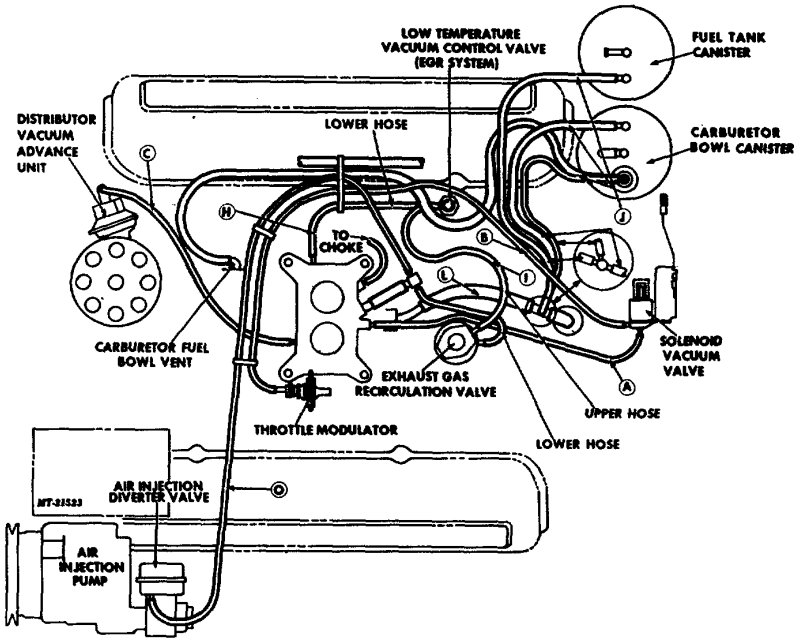


Fig. 109 Vacuum Hose Locations on V-345 Engine with 2210C Carburetor in Loadstar, Cargostar and S-Series with Two Vapor Storage Canisters(Sold in California)

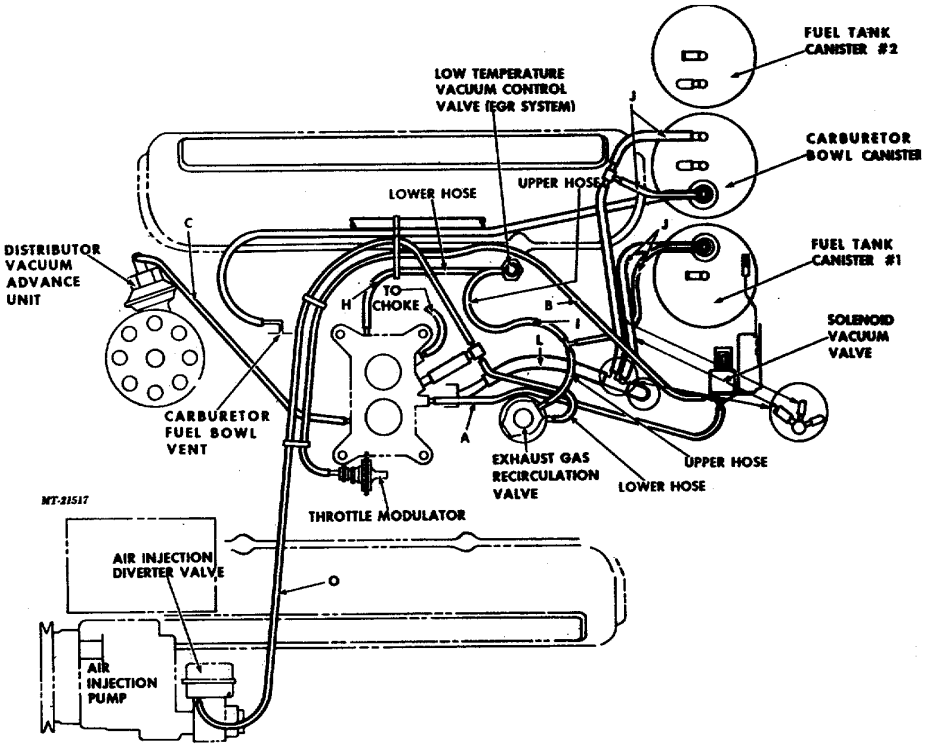


Fig. 110 Vacuum Hose Locations on V-345 Engine with 2210C Carburetor in Loadstar, Cargostar and S-Series Vehicles with Three Vapor Storage Canisters(Sold in California)

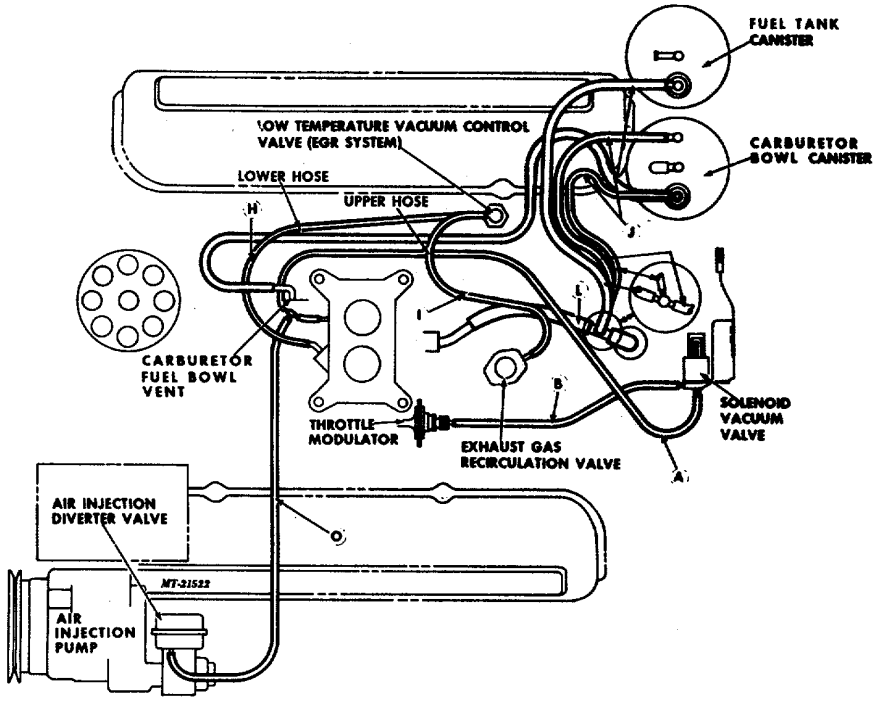


Fig. 111 Vacuum Hose Locations on V-345 Engine with 2300EG Carburetor in Loadstar, Cargostar and S-Series Vehicles with Two Vapor Storage Canisters(Sold in California)

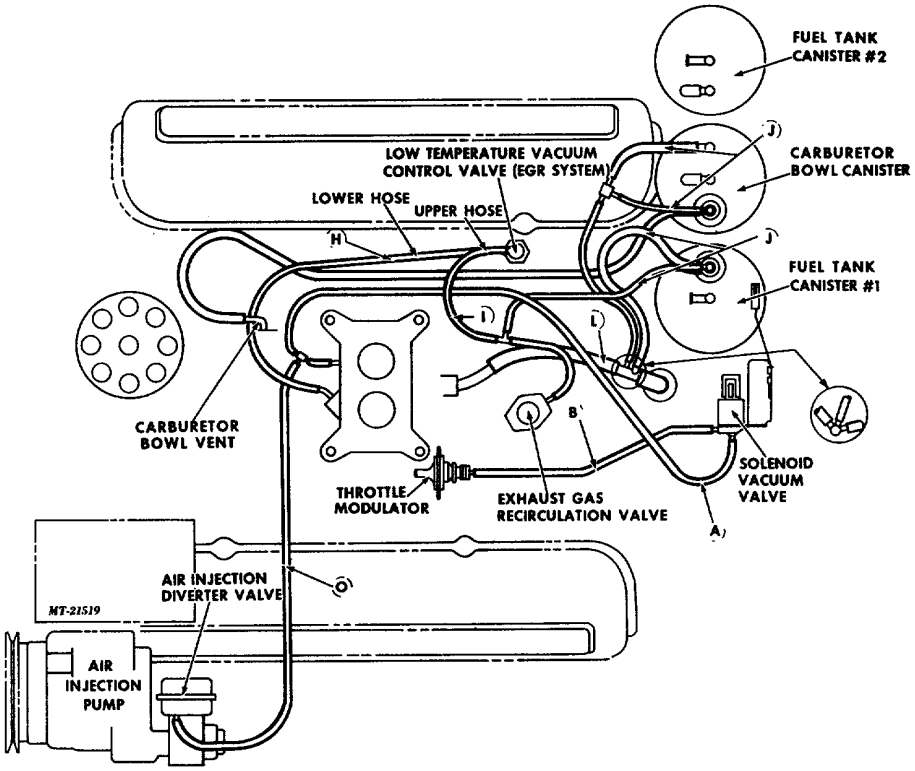


Fig. 112 Vacuum Hose Locations on V-345 Engine with 2300EG Carburetor in Loadstar, Cargostar and S-Series Vehicles with Three Vapor Storage Canisters (Sold in California)

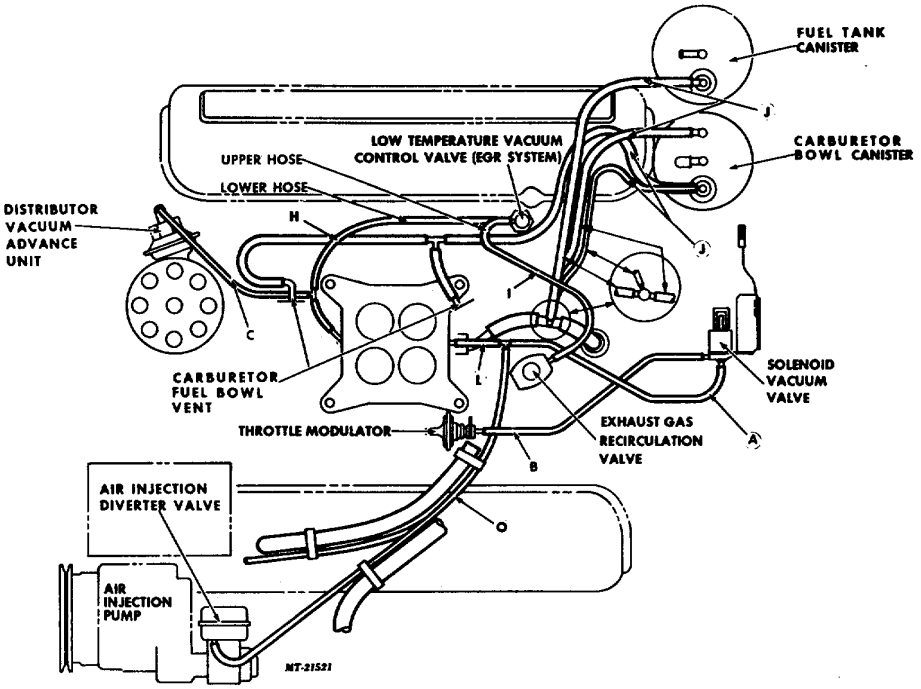


Fig. 113 Vacuum Hose Locations on V-392 Engine with 4150EG Carburetor in Loadstar, Cargostar Vehicles with Two Vapor Storage Canisters(Sold in California)

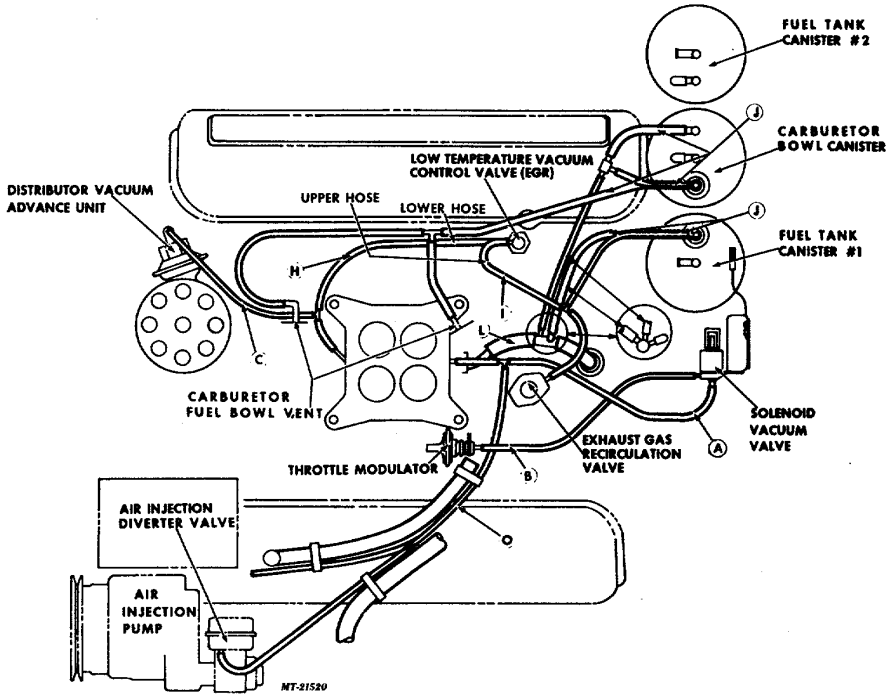


Fig. 114 Vacuum Hose Locations on V-392 Engine with 4150EG Carburetor in Loadstar, Cargostar and S-Series Vehicles with Three Vapor Storage Canisters (Sold in California)

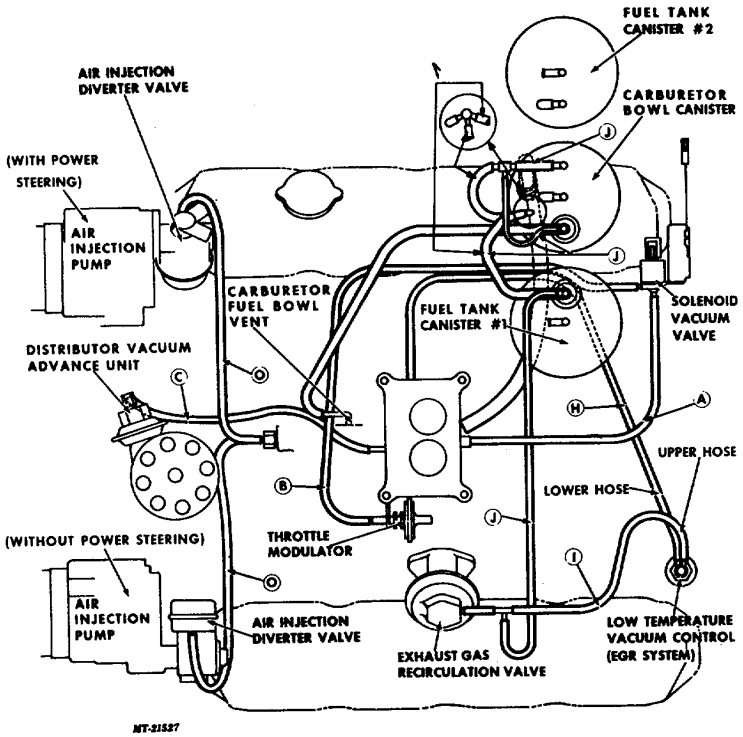


Fig. 115 Vacuum Hose Locations on MV-404 Engine with 2210C Carburetor in Loadstar, Cargostar and S-Series Vehicles with Two Vapor Storage Canisters (Sold in California)

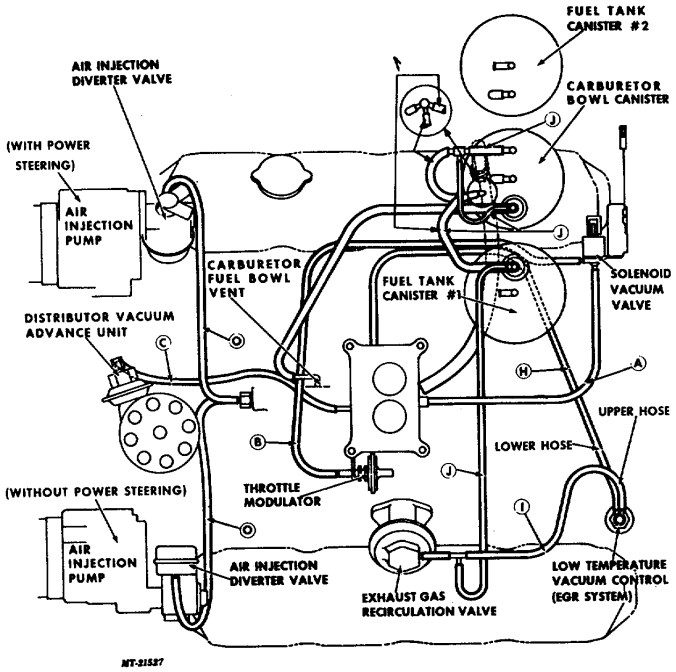


Fig. 116. Vacuum Hose Locations on MV-404 Engine with 2200EG Carburetor in Loadstar, Cargostar and S-Series Vehicles with Three Vapor Storage Canisters (Sold in California)

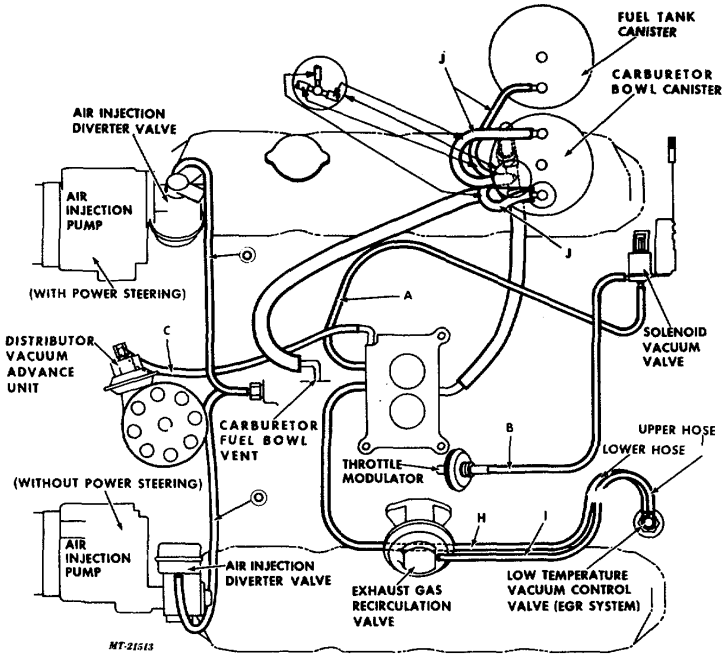


Fig. 117 Vacuum Hose Locations on MV-404 Engine with 2300EG Carburetor in Loadstar, Cargostar and S-Series Vehicles (Sold in California)

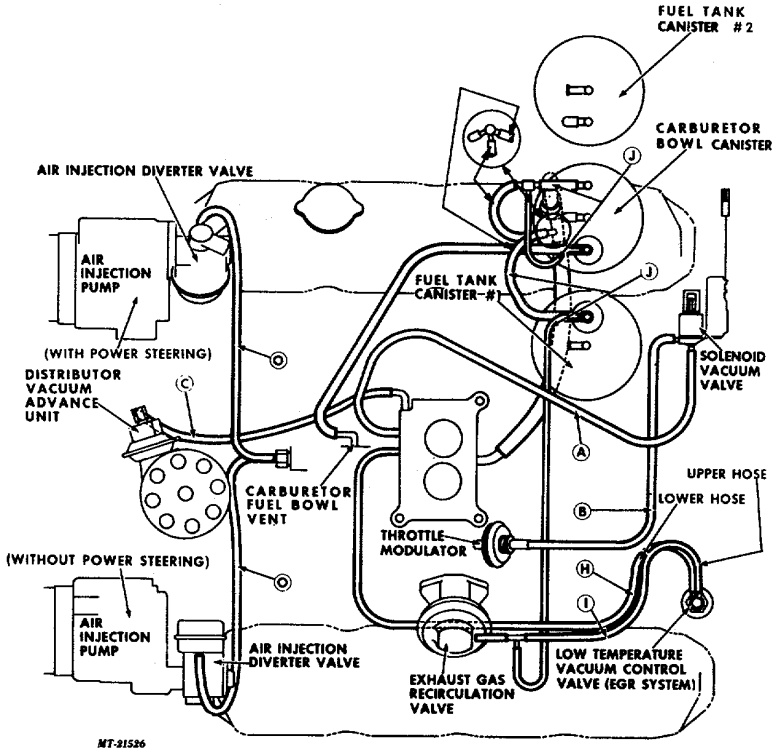


Fig. 118 Vacuum Hose Locations on MV-404 Engine with 2300EG Carburetor in Loadstar, Cargostar and S-Series Vehicles with Three Vapor Storage Canisters (Sold in California)

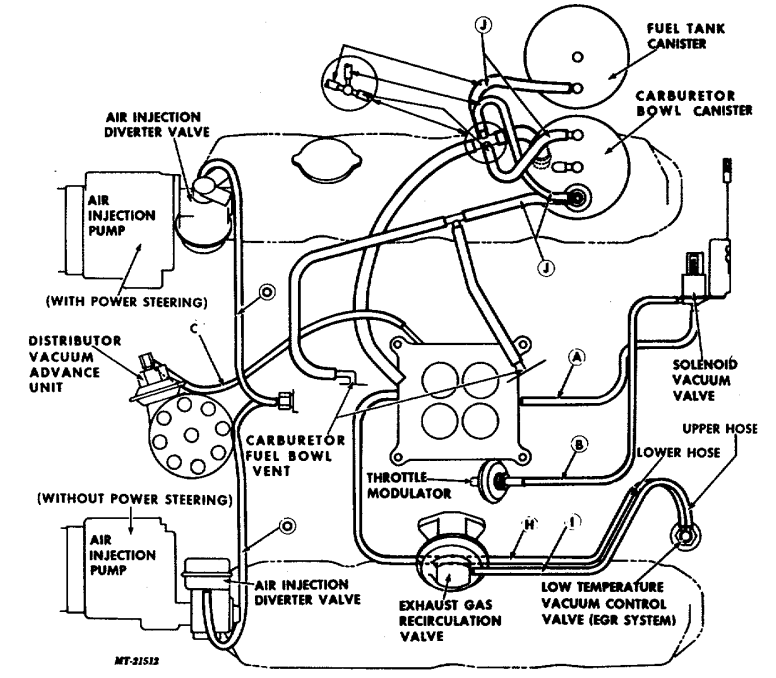


Fig. 119 Vacuum Hose Locations on MV-404 Engine with 4150EG Carburetor in Loadstar, Cargostar and S-Series Vehicles with Two Vapor Storage Canisters (Sold in California)

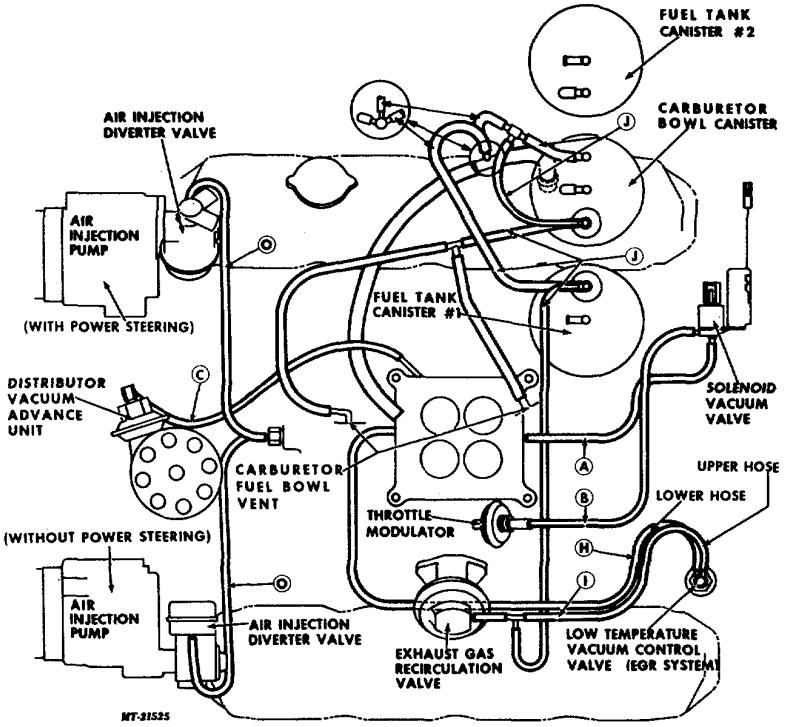


Fig. 120 Vacuum Hose Locations on MV-404 Engine with 4150EG Carburetor in Loadstar, Cargostar and S-Series Vehicles with Three Vapor Storage Canisters (Sold in California)

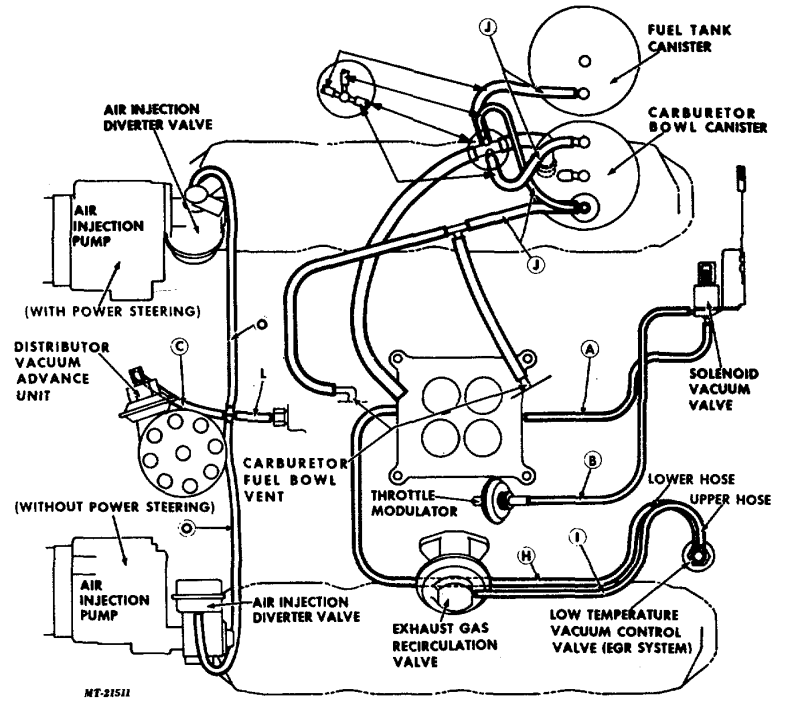


Fig. 121 Vacuum Hose Locations on MV-446 Engine with 4150EG Carburetor in Loadstar, Cargostar and S-Series Vehicles with Two Vapor Storage Canisters (Sold in California)

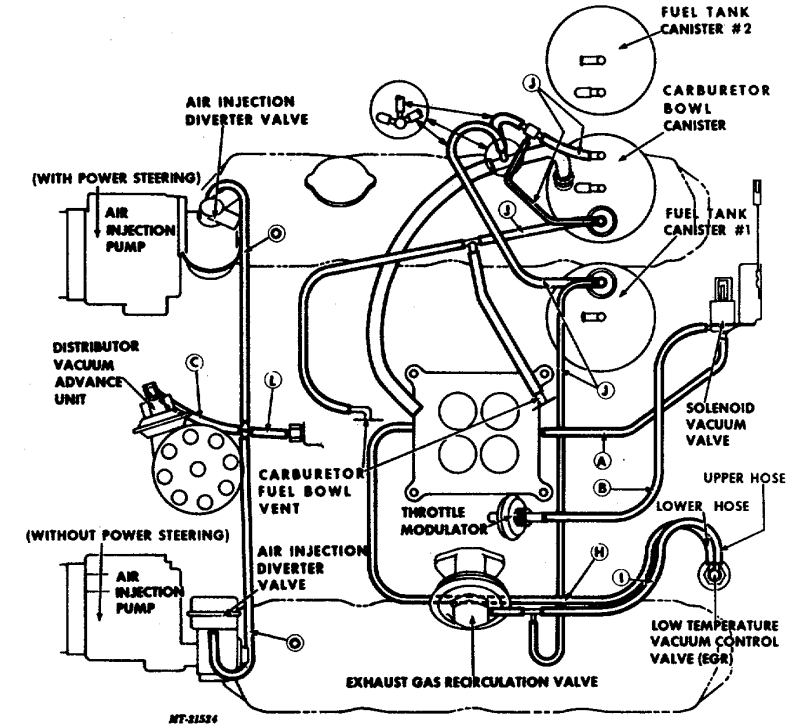


Fig. 122 Vacuum Hose Locations on MV-446 Engine with 4150EG Carburetor in Loadstar, Cargostar and S-Series Vehicles with Three Vapor Storage Canisters(Sold in California)

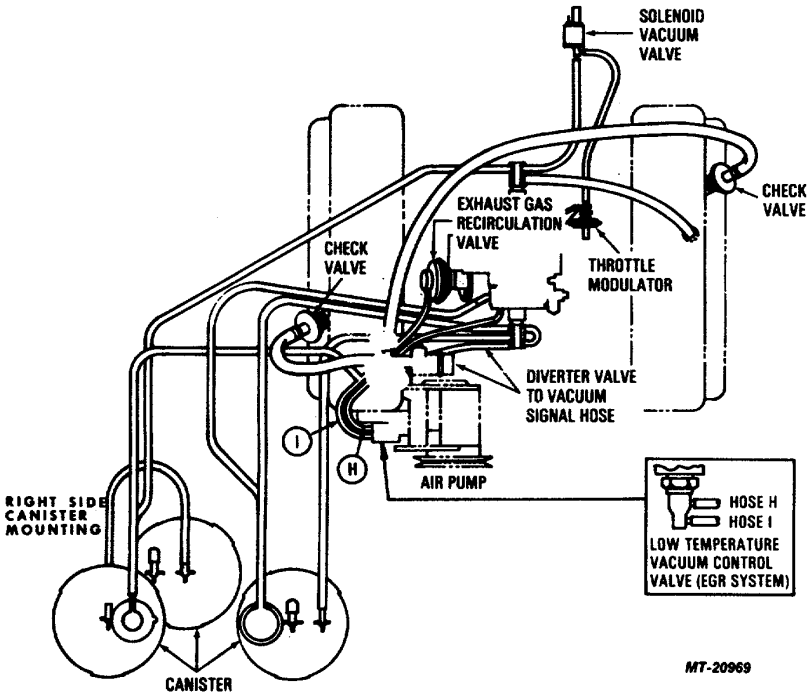


Fig. 123 Vacuum Hose Locations on V-537 Engine with 2300EG Carburetor in Cargostar and S-Series Vehicles with Three Vapor Storage Canisters Mounted on Right Side (Sold in California)

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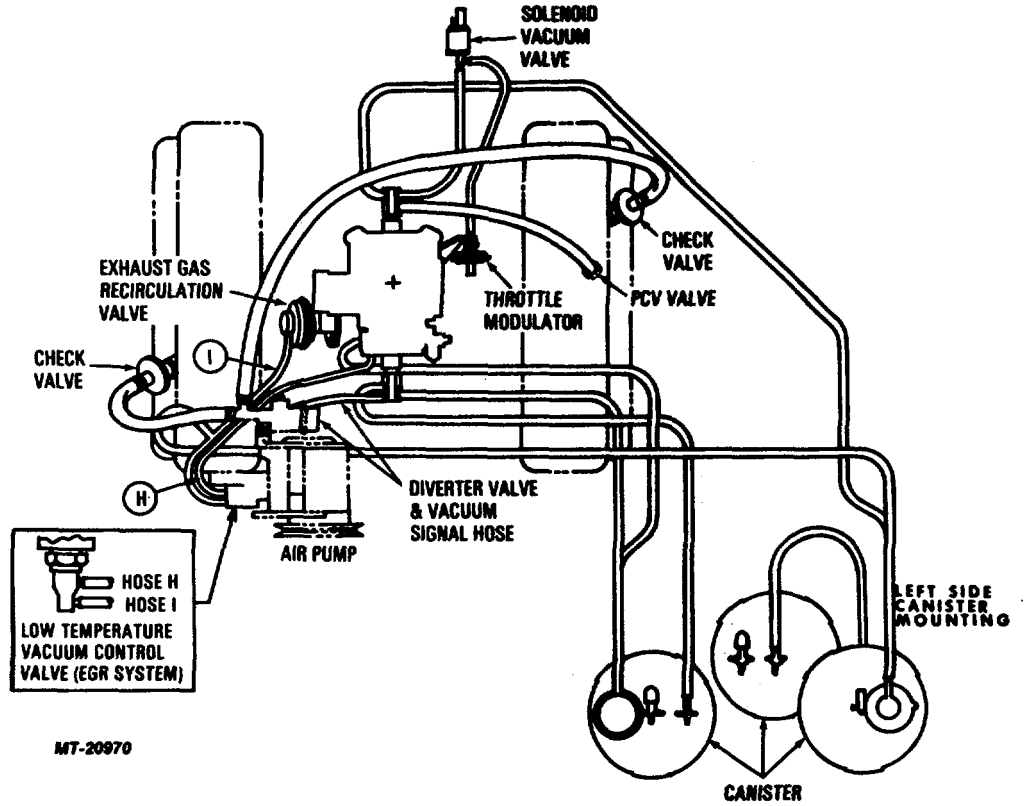


Fig. 124 Vacuum Hose Locations on V-537 Engine with 2300EG Carburetor in Cargostar and S-Series Vehicles with Three Vapor Storage Canisters Mounted on the Left Side (Sold in California)

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Gasoline for IH Engines.

Your engine is designed to operate efficiently in normal operations on "Regular" grade fuels of at least 91 RON (Research Octane Number) or 86.5 anti-knock index designation. (The latter figure is now generally posted on fuel dispensing pumps.) It is recommended that the maximum octane rating used be no more than four octane numbers above the minimum of 91 octane. "Low Lead" fuel containing at least .13 gpl (0.5 gpg) lead, or the equivalent additive, per liter (gallon) may be used.

Continuous use of gasoline which is completely free of lead, or other lubricating additives such as phosphorous, is not recommended. Prolonged use of such fuel can cause excessive exhaust valve seat wear resulting in loss of emission control, poor performance and possible engine failure. Use of a fuel which is too low in anti-knock quality will result in "spark knock". Since anti-knock quality of all "regular" grade gasolines is not the same and factors such as altitude, terrain and air temperature affect operating efficiency, knocking may result even though you are using the grade of fuel recommended for your engine.

Emission Certification Label

The engine exhaust emission control information label attached to the engine valve cover is very valuable to the tune-up technician. It gives him ready information: engine model, cubic inch displacement, timing, idle speeds and idle mixture settings.

Tuning IH Engines Equipped with Emission Controls.

Tune-up on engines with emission controls is performed in the conventional manner. It is extremely important that the IH tune-up specifications found in this manual be used. It is necessary to become completely familiar with all types of emission controls, how they operate and how they are serviced. Using the recommended specifications and procedures will provide good performance and idling characteristics as well as allow the engine to operate within government regulations.

Owners have the responsibility to see that their engine is properly maintained on a regular schedule, or at any hint of an engine malfunction. The service technician has the responsibility to obtain the knowledge and skills to continuously perform each maintenance job completely and without fault.

Emission Control Tune-Up Specifications.

The following tune-up specifications cover both Federal (49 States, not California) and California sold engines.

These specifications should be used in conjunction with the scheduled maintenance intervals and the explanation of each maintenance step given on the previous pages.

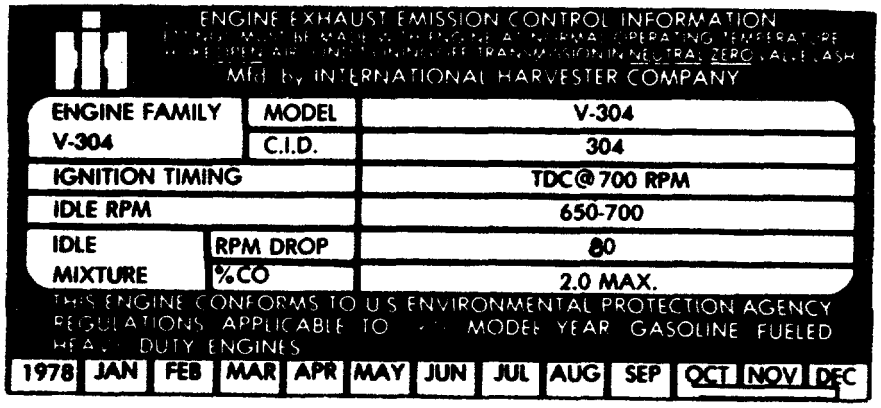


Fig. 125 Typical Engine Exhaust Emission Control Information Label

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EMISSION CONTROL SYSTEM TUNE-UP SPECIFICATION-1978
(49 STATE SYSTEMS- NOT CALIFORNIA)

ENGINE	4-1961	V-304	V-345		V-392	MV-404				MV-446	V-537		
CARBURETOR MODEL	1940C	2210C	2210C	2300EG	4150G	2210C	2300EG	4150G		4150G	2300EG	4150G	
Ignition System Dwell, Degrees: Breaker Point	N/A	28 - 32				N/A							
Breakerless	24 - 34												
Gap, Inches: Points - Reset	N/A	.406 - .508 mm (.016"-.020")				N/A N/A							
Air Gap, Trigger Wheel-to-Sensor	.2 mm (.008")												
Coil Output Voltage @ 2500 RPM	20 KV Min.												
Ignition Timing Without Vacuum Advance, Degrees (Engine at Specified Idle RPM)	TDC					9°BTDC				5°BTDC	7°BTDC		
Ignition Cable Resistance (Max.): Up to 36" Long Over 36" Long	30K Ohms 45K Ohms												
Cold Starting Enrichment System Fast Idle Speed, RPM	2000	2200			2000	1800	2400				2000		
Curb Idle Speed & Air/Fuel Mix. Curb Idle Speed, RPM (In Neutral)	525-575	650 - 700				525-575 *					500-550 *		
Mixture, % CO	0.5-2.0	2.0max.	1.5 max.		2.0max	0.5-2.5				0.5-2.5	1.5-3.0		
Speed Drop RPM	30	80	60	110	40	50					40		
Spark Plugs Standard	RJ-10Y(CR43S)**	RJ-6(CR43)**				RBN-13Y (R446TS)**					RN-11Y		
Plug Gap	.88mm(.035")	.76 mm (.030")											
Optional for Light Service	N/A	RJ-10Y(CR43S)**				N/A					RN-12Y		
Plug Gap	N/A	.88mm(.035")				N/A					.76mm (.030")		
Optional for Severe Service	N/A					RBN-4 (R44LT)**					N/A		
Plug Gap	N/A					.76 mm (.030")					N/A		
Torque	38.0-40.7N.m(28-30ft.lb.)					16.3-24.4 N.m(12-18ft.lbs.)					34.0-40.7N.m (25-30ft.lbs.)		
Required Voltage @ 1000 RPM	8 - 15 KV												
Exhaust Gas Recirculation System Functional Test @ 300 RPM Minimum Speed Increase by Removing Signal Vacuum	N/A	50 rpm	150 rpm		N/A								
Decel Throttle Modulator System Speed at which Modulator Functions, RPM	1800 - 1900				N/A	1800 - 1900							
DTM Speed (No Load) W/Mod. Extended, RPM	1300 - 1400				N/A	1300 - 1400				1250-1350	1300 - 1400		
Bolt Torque Intake Manifold-to-Cylinder Head	34.0 - 40.7 N.m (25-30 ft. lbs.)					36.6-50.2 N.m (27-37 ft. lbs.)					40.7-51.5N.m(30-38 ft. lbs.)		
Exhaust Manifold-to-Cylinder Head	34.0 - 40.7 N.m (25-30 ft. lbs.)					36.6-44.7 N.m (27-33 ft. lbs.)					40.7-51.5 N.m(30-38 ft. lbs.)		
Carburetor-to-Intake Manifold	8.1 - 10.8 N.m (6-8 ft. lbs.)												

N/A = Not applicable
* = Range 100 rpm higher with Allison Automatic Transmission
** = Approved corresponding spark plug

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EMISSION CONTROL SYSTEM TUNE-UP SPECIFICATION-1978 (CALIFORNIA SYSTEMS)

ENGINE	4-196	V-345		V-392	MV-404			MV-446	V-537
CARBURETOR MODEL	1940C	2210C	2300EG	4150EG	2210C	2300EG	4150EG	4150EG	2300EG
Ignition System									
Dwell, Degrees: Breakerless Only	24 - 34								
Air Gap, Trigger Wheel-to-Sensor	.2 mm (.008")								
Coil Out Voltage @ 2500 RPM	20 KV Min.								
Ignition Timing W/O Vacuum Advance Degrees (Engine at Specified Idle RPM)	TDC	5^0 BTDC	TDC		9^o BTDC			5^o BTDC	7^o BTDC
Ignition Cable Resistance (Maximum) Up to 36" Long	30K Ohms								
Over 36" Long	45K Ohms								
Cold Starting Enrichment System									
Fast Idle Speed, RPM	2000	2200	2000		1800	2400			2000
Curb Idle Speed & Air/Fuel Mixt.									
Curb Idle Speed, RPM (In Neutral)	525-575	625-675			525-575 *				500-550 *
Mixture, %CO	0.5-2.0	0.5 - 1.5	1.0-3.0	0.5-1.5	0.5 - 2.5				1.0-2.0
Spark Plugs									
Standard:	RJ-10Y (CR-43S)**	RJ-6 (CR-43)**			RBN-13Y (R44LTS) **				RN-11Y
Plug Gap	.88 mm (.035")	.76 mm (.030")							
Optional for Light Service:	N/A	RJ-10Y (CR43S) **			N/A				RN-12Y
Plug Gap	N/A	.88 mm (.035")			N/A				.76 mm(.030")
Optional for Severe Service:	N/A				RBN-4 (R44LT)**				
Plug Gap	N/A				.76 mm (.030")				
Torque	38.0 - 40.7 Nm (28-30 ft. lbs.)				16.3-24.4 Nm(12-18 ft. lbs.)				34.0-40.7 Nm (25-30 ft.lb.)
Required Voltage @ 100 RPM	8 - 15 KV								
Exhaust Gas Recirculation System									
Functional Test @ 2000 RPM Vacuum to be Applied	254 mm Hg (10.0" Hg) Min.								
Minimum Speed Drop, RPM	275	400		485	350				375
Air Injection System									
Engine Speed for Test, RPM	1000	1500	1000						
Minimum Pressure	27.58 kPa (4 psi)								
Decel Throttle Modulator System									
Speed at which Mod. Funct., RPM	1800 - 1900								
DTM Speed (no load) w/Mod. Extended, RPM	1350-1450	1300 - 1400	1400-1500	1350-1450	1300 - 1400			1250 - 1350	1300 - 1400
Bolt Torque									
Intake Manifold-to-Cylinder Head	34. - 40 N.m (25 - 30 ft. lb.)				36.6 - 50.2 N.m (27-37 ft.lb.)				40.7-51.5 N.m (30-38 ft.lb.)
Exhaust Manifold-to-Cylinder Head	34. - 40 N.m (25 - 30 ft. lb.)				36.6 - 44.7 N.m (27-33 ft. lb.)				40.7-51.5 N.m (30-38 ft. lb.)
Carburetor-to-Intake Manifold	8.1 - 10.8 N.m (6 - 8 ft. lb.)								

N/A = Not applicable
* = Range 100 rpm higher with Allison Automatic Transmission
** = Approved corresponding spark plug

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PART II

TROUBLE-SHOOTING

GUIDE

FOR

INTERNATIONAL

GASOLINE ENGINES

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The following trouble shooting guide can used for all 1978 International gasoline engines.

It each step is followed, a particular problem can be found and corrected without any difficulty.

To use the guide first diagnose the problem; engine will not start, engine idle speed varies, spark knock or pinging, etc. Check the engine diagnostic chart page for the chart number showing the problem. The engine diagnostic chart page shows a chart number for each diagram in the guide.

When the problem is isolated to a particular component and more information is needed for repair or replacement, find the appropriate IH Truck Service Manual for the faulty component by referring to the chart below.

IH TRUCK SERVICE MANUAL CTS NUMBERS AND SUBJECTS

FOR USE WITH ENGINE DIAGNOSTIC CHARTS

CTS No.	Description
COOLING	
2019	General Information
ELECTRICAL	
2024	Battery
2013	Ignition Coils
2016	Spark Plugs
2481	Distributor, Model 1510 Holley (Breaker Point System)
2665	Electronic Ignition System
2740	Electronic Ignition System With Integral Module
2258	Starter Motor (Standard)
2259	Starter Motor (Heavy Duty)
ENGINE	
2145	Failure Analysis-All Engines
2523	Diagnosing Excessive Oil Consumption
2130	V-304/345/392 (8-Cylinder)
2682	4-196 (4-Cylinder)
2664	MV-404/446 (8-Cylinder)
2683	V-537
FUEL SYSTEM	
2142	Carburetor, Model 2300G
2454	Carburetor, Model 4150G
2609	Carburetor, Model 1940C
2612	Carburetor, Model 2210C
2050	Fuel Pump
2056	Air Cleaner
PROPELLER SHAFT	
2045	General Information
2046	Universal Joints and Center Bearings
COMPLETE IH TRUCK SERVICE MIANUALS (1978)	
2310	Scout
2307	Loadstar, Cargostar (Medium Duty)
2309	Fleetstar, Paystar, Transtar (Heavy Duty)
2311	S-Series
2001	Complete Service Manual for all IH Vehicles

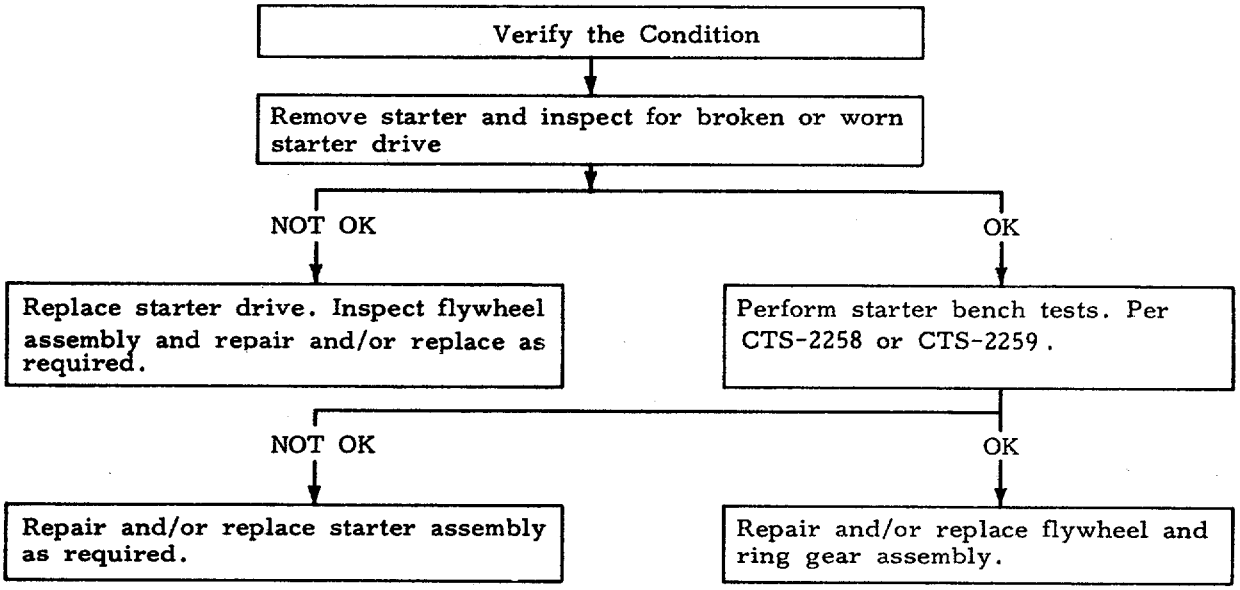
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ENGINE DIAGNOSTIC CHARTS

CONDITION	PAGE
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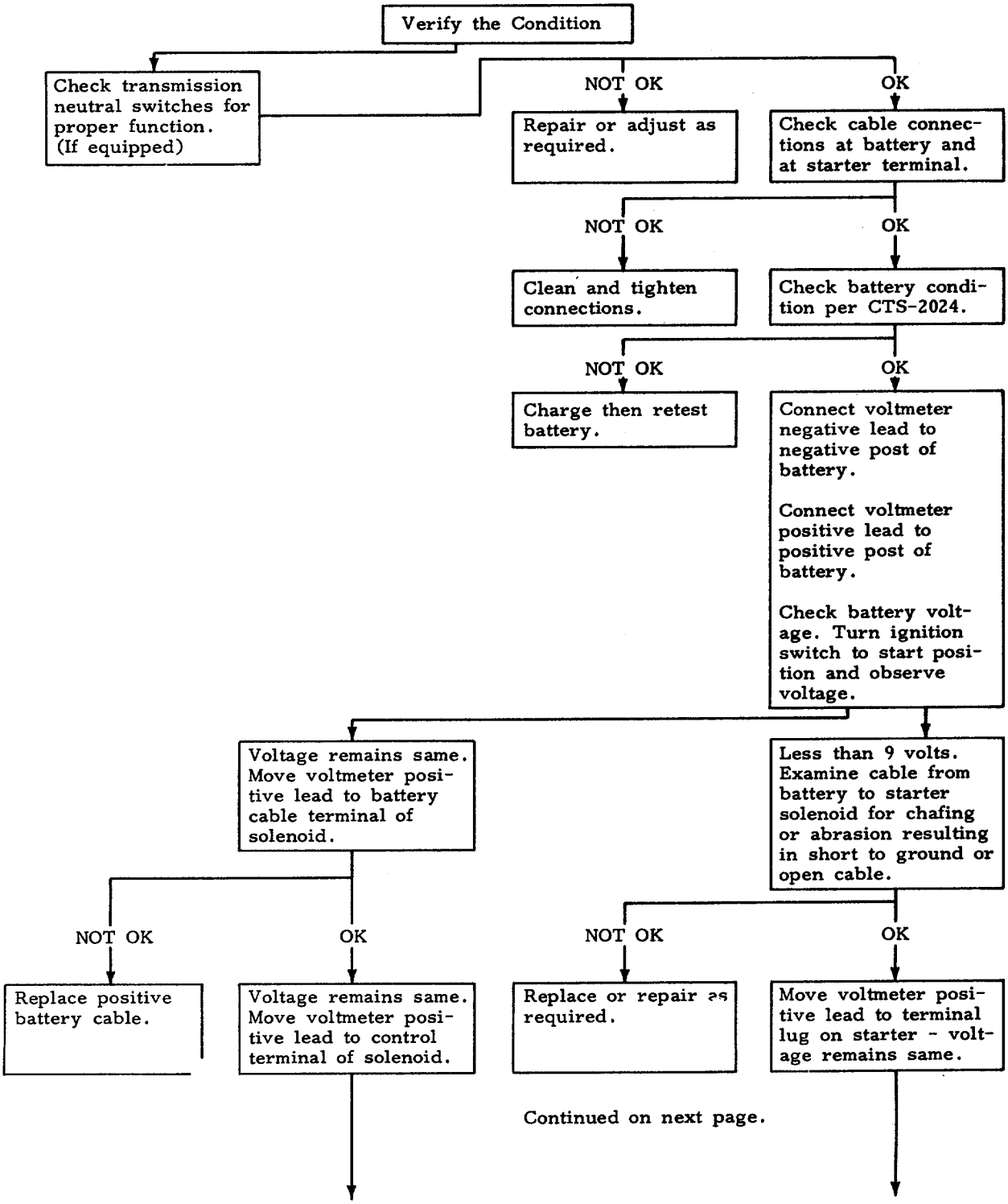
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CHART NO. 01
ENGINE WILL NOT CRANK-STARTER SPINS



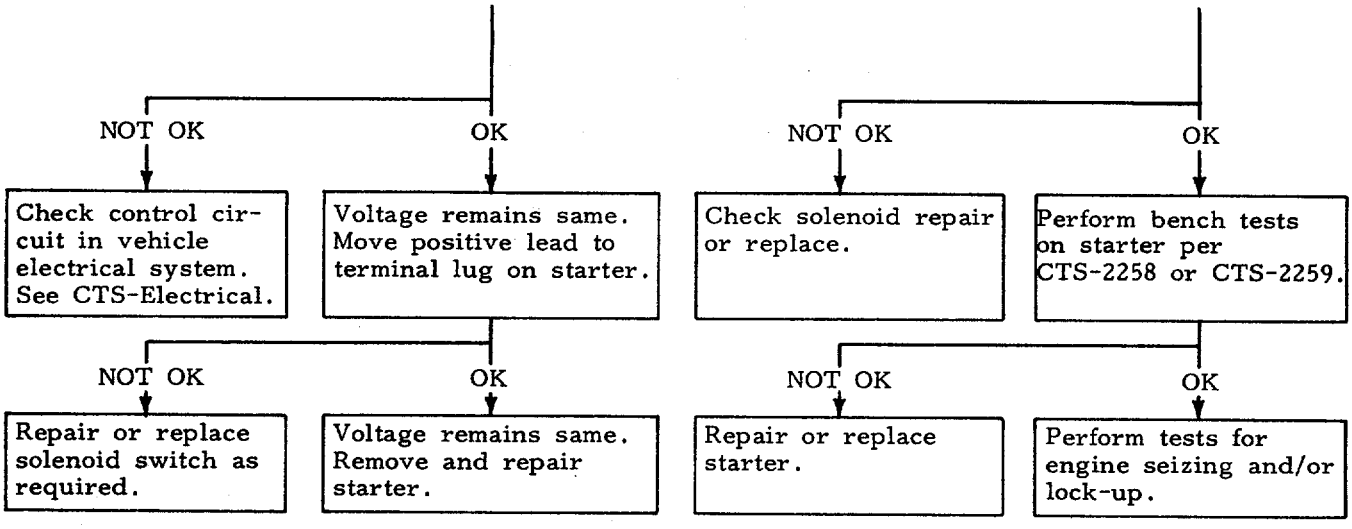
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CHART NO. 02
ENGINE WILL NOT CRANK



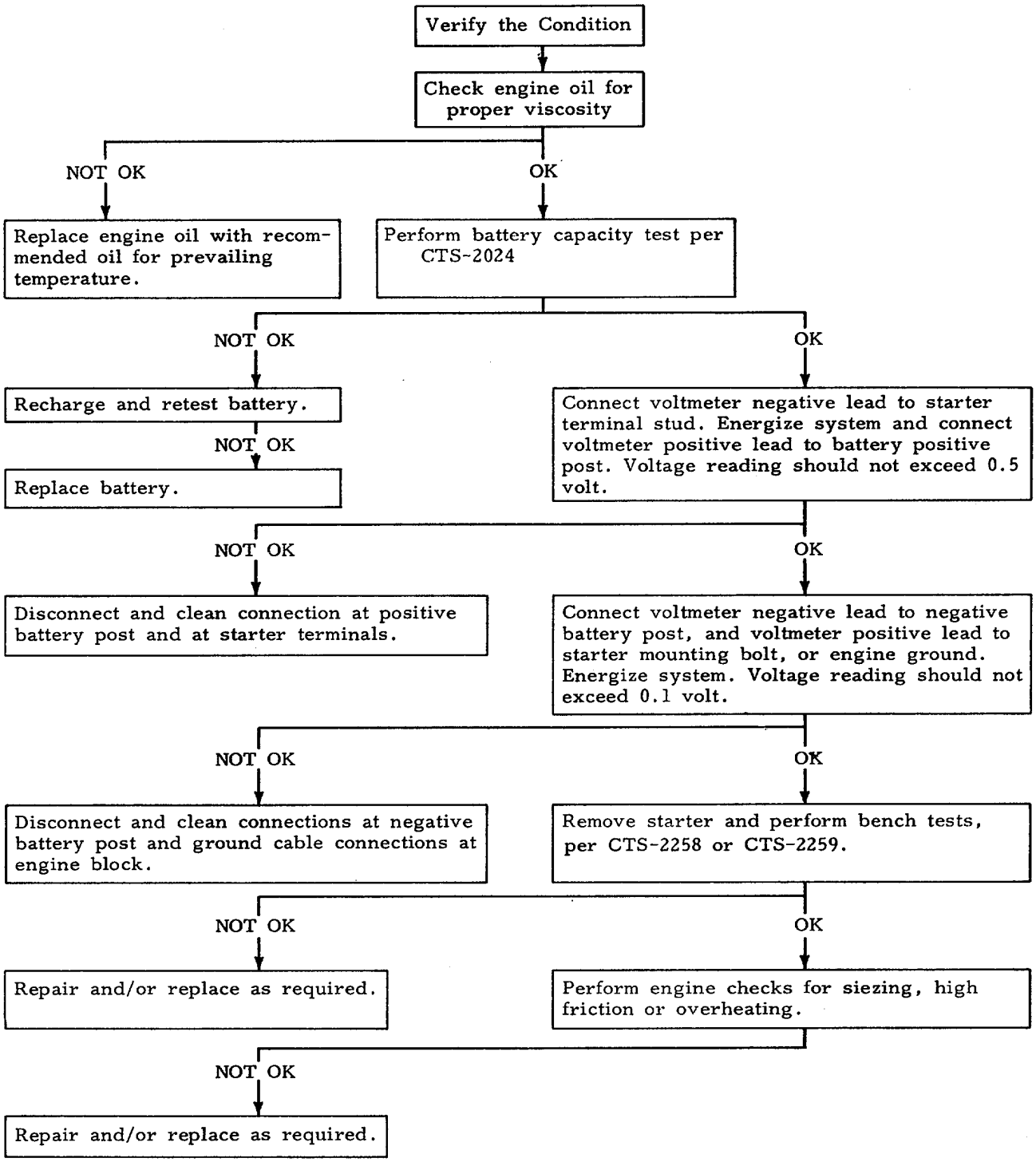
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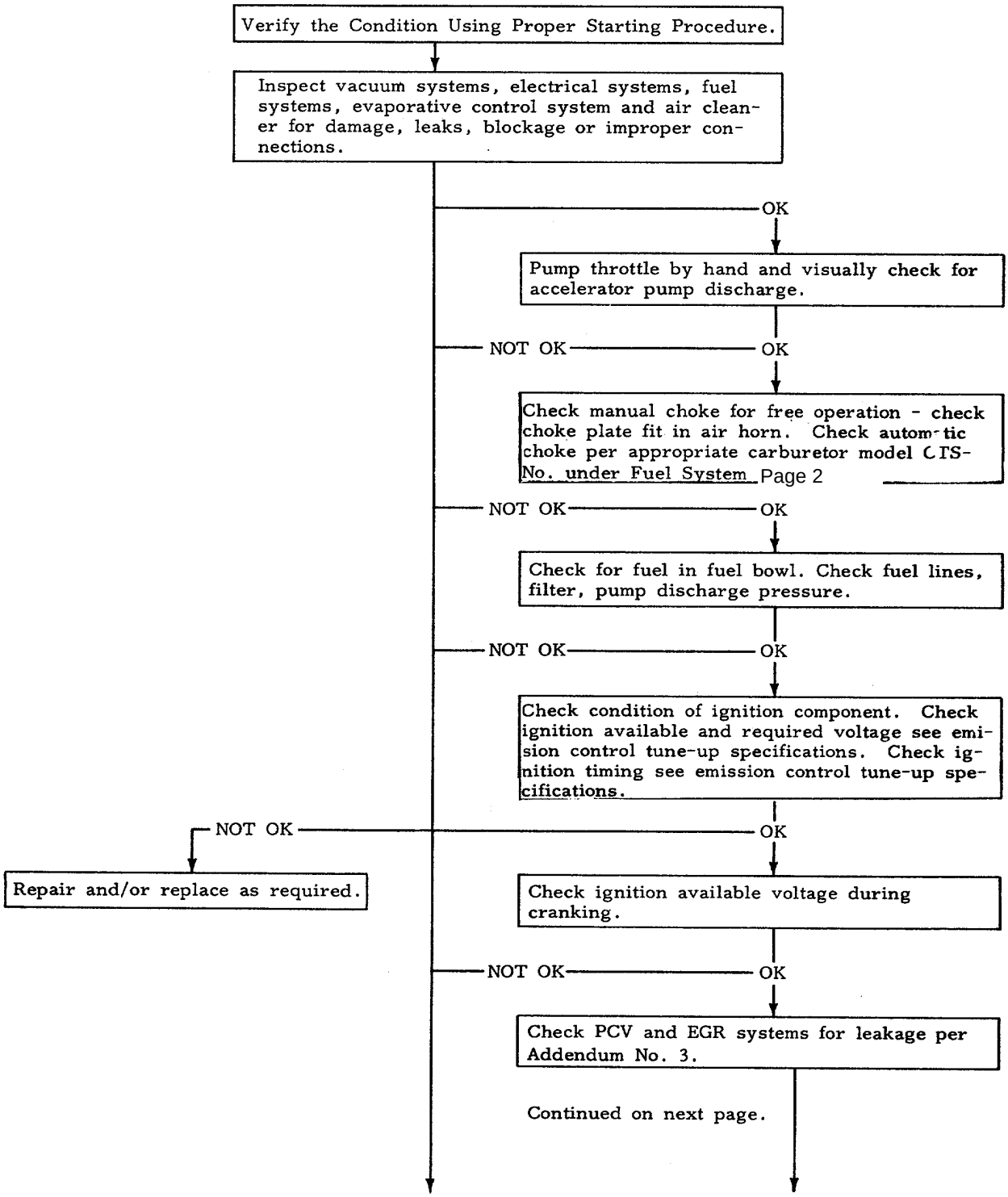
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CHART NO. 03
ENGINE CRANKS SLOWLY

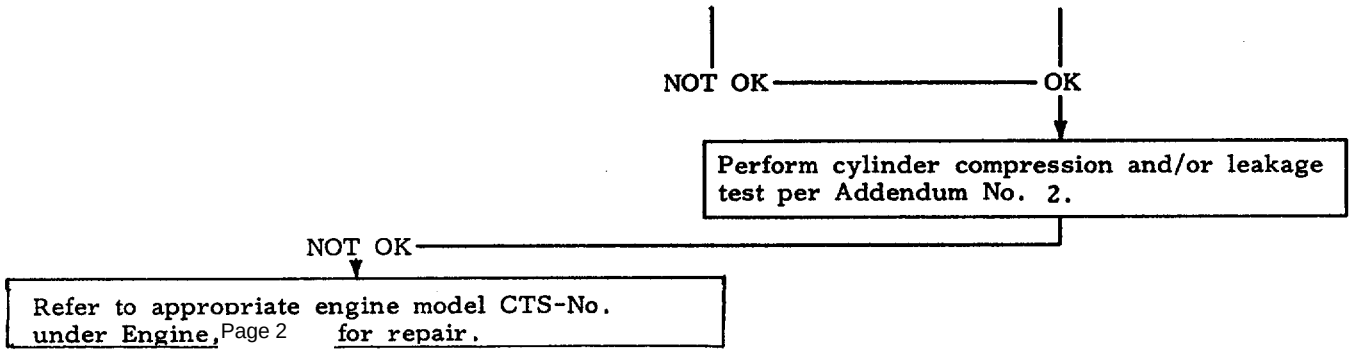


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CHART NO. 04
ENGINE CRANKS NORMALLY-STARTS HARD WHEN COLD

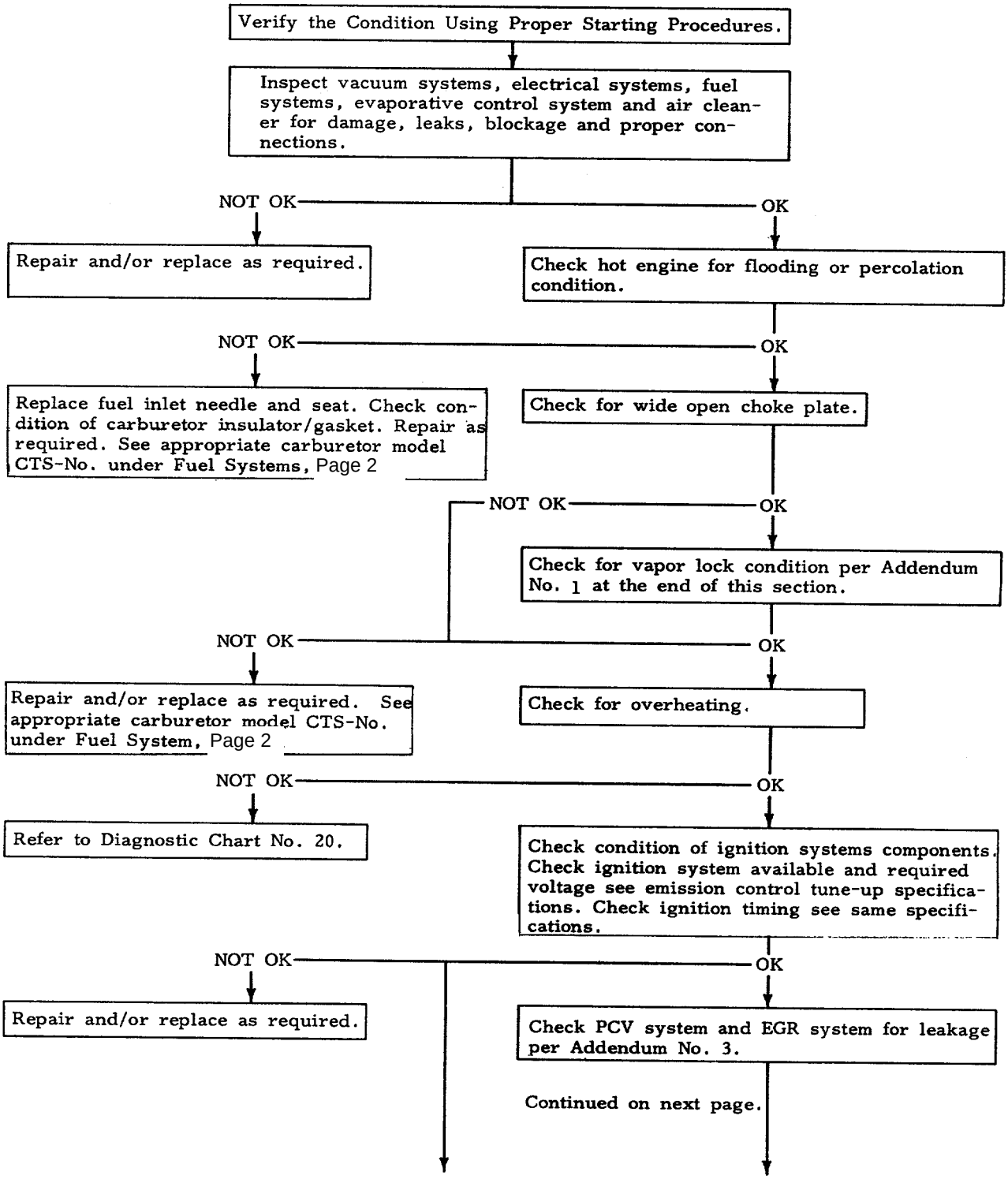


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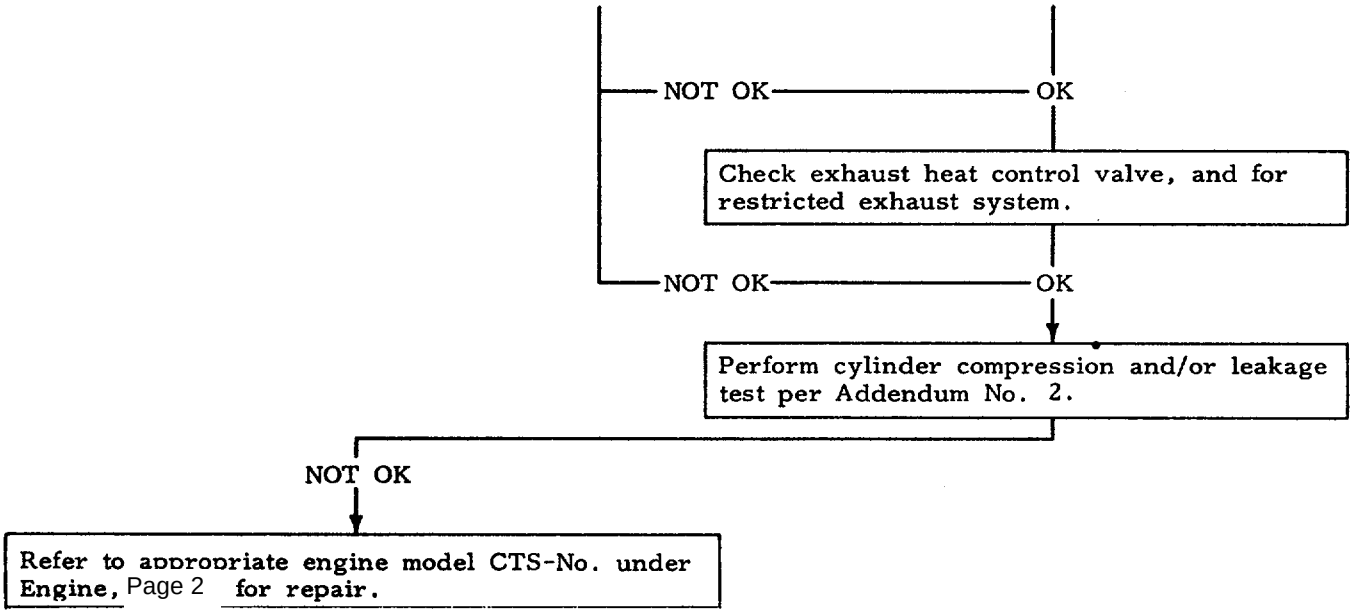


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CHART NO. 05
ENGINE CRANKS NORMALLY-STARTS HARD WHEN HOT

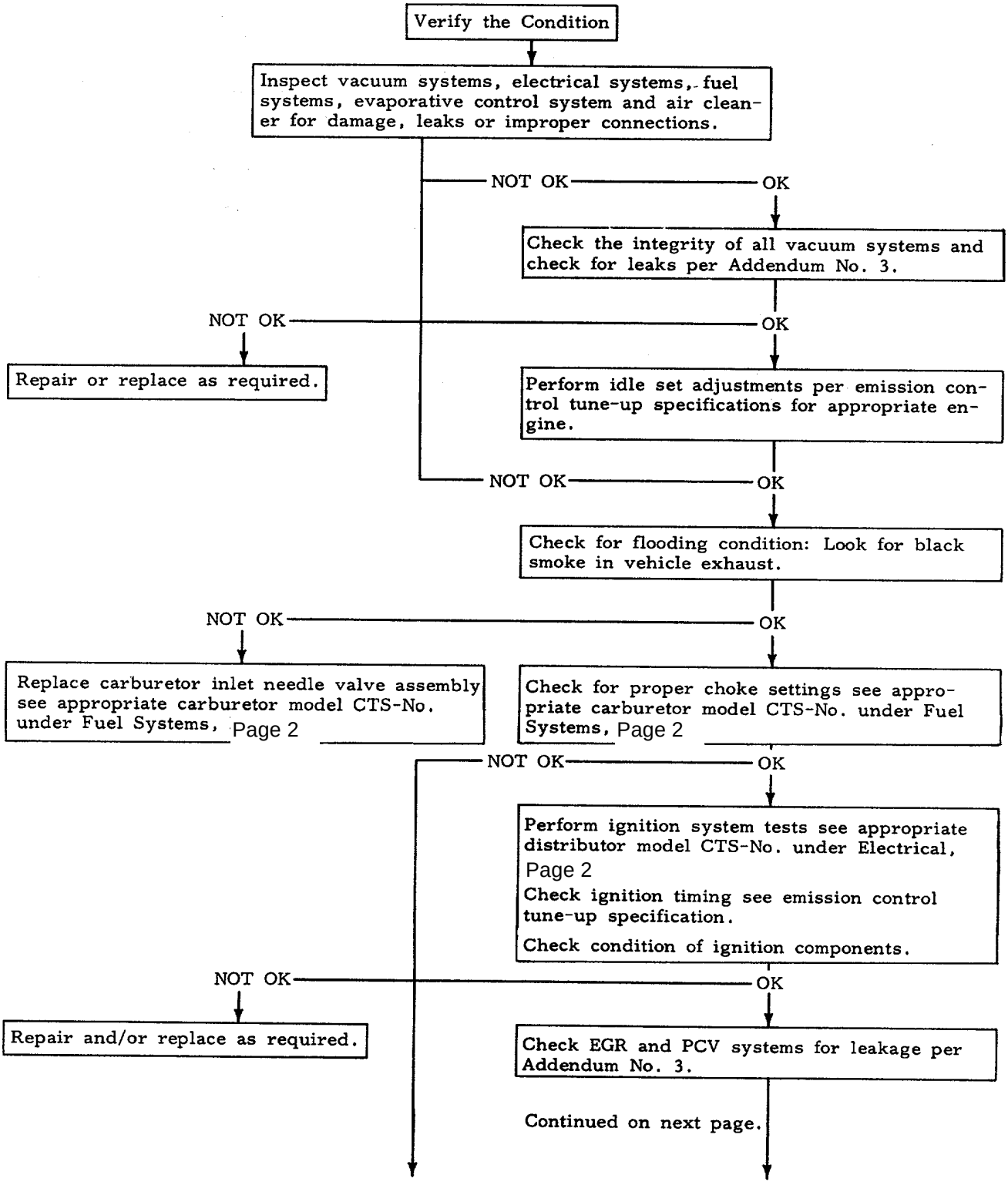


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CHART NO. 06
ENGINE IDLES ROUGH-MISSES (WARM OR COLD ENGINE)



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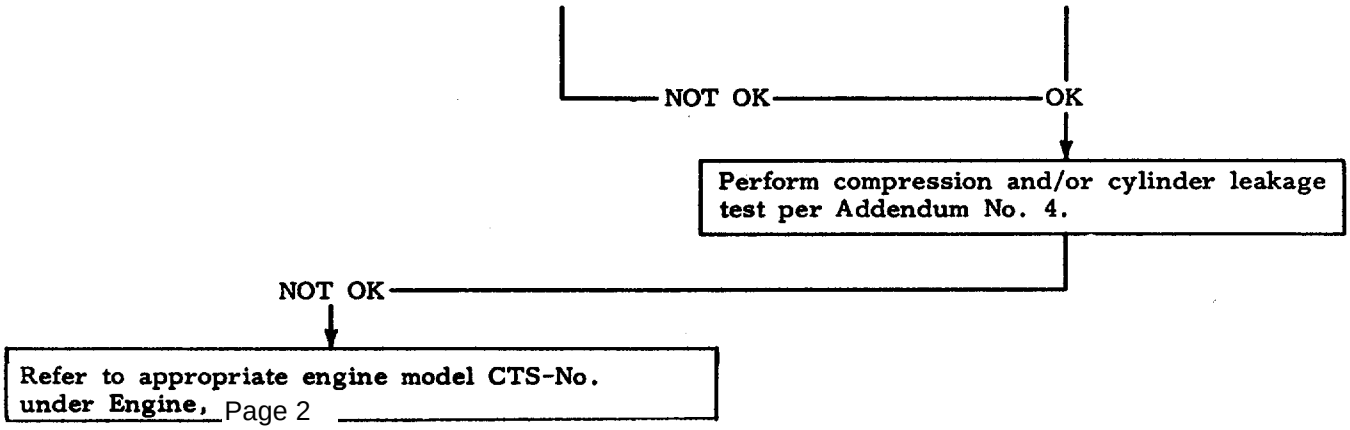
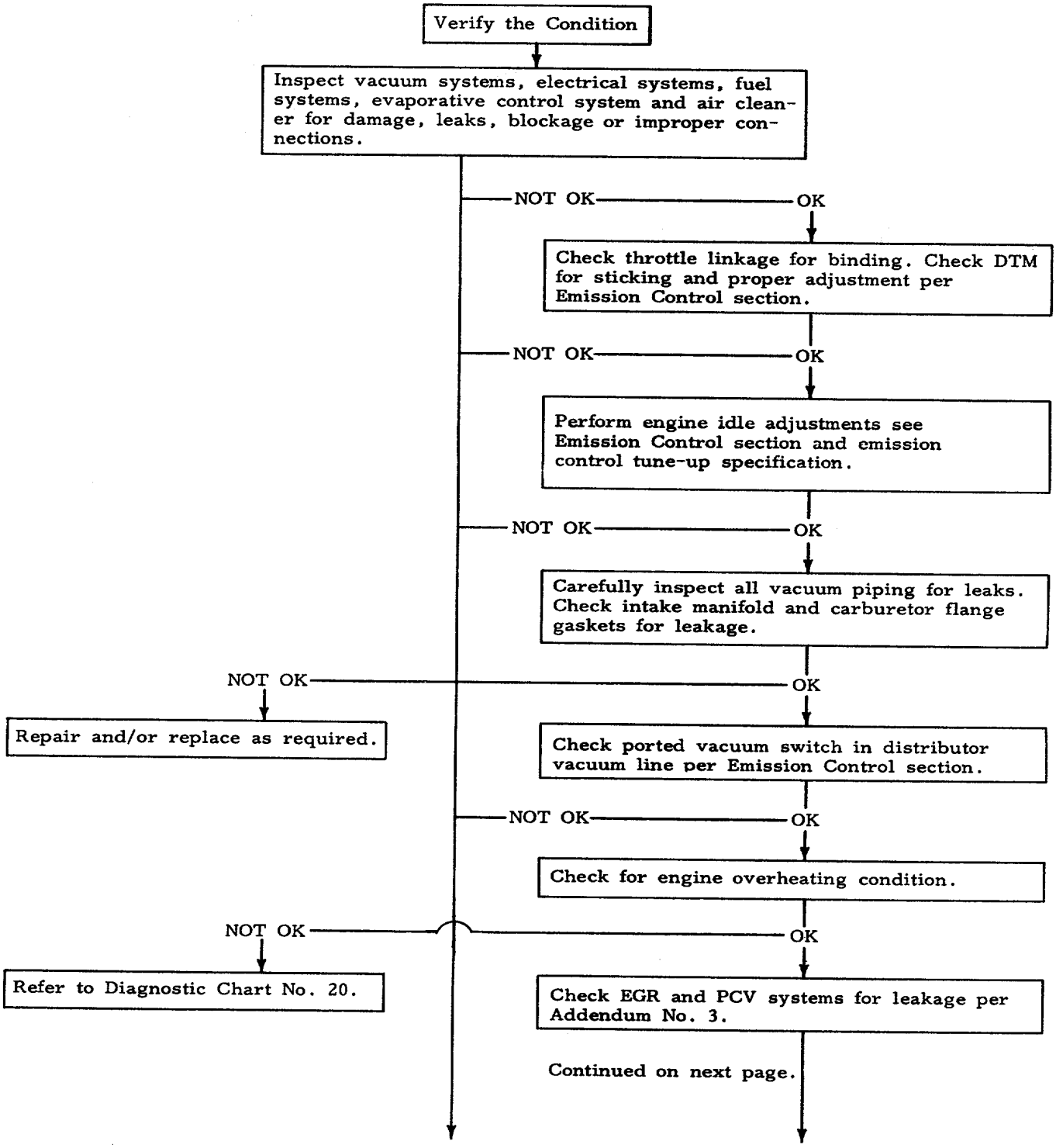
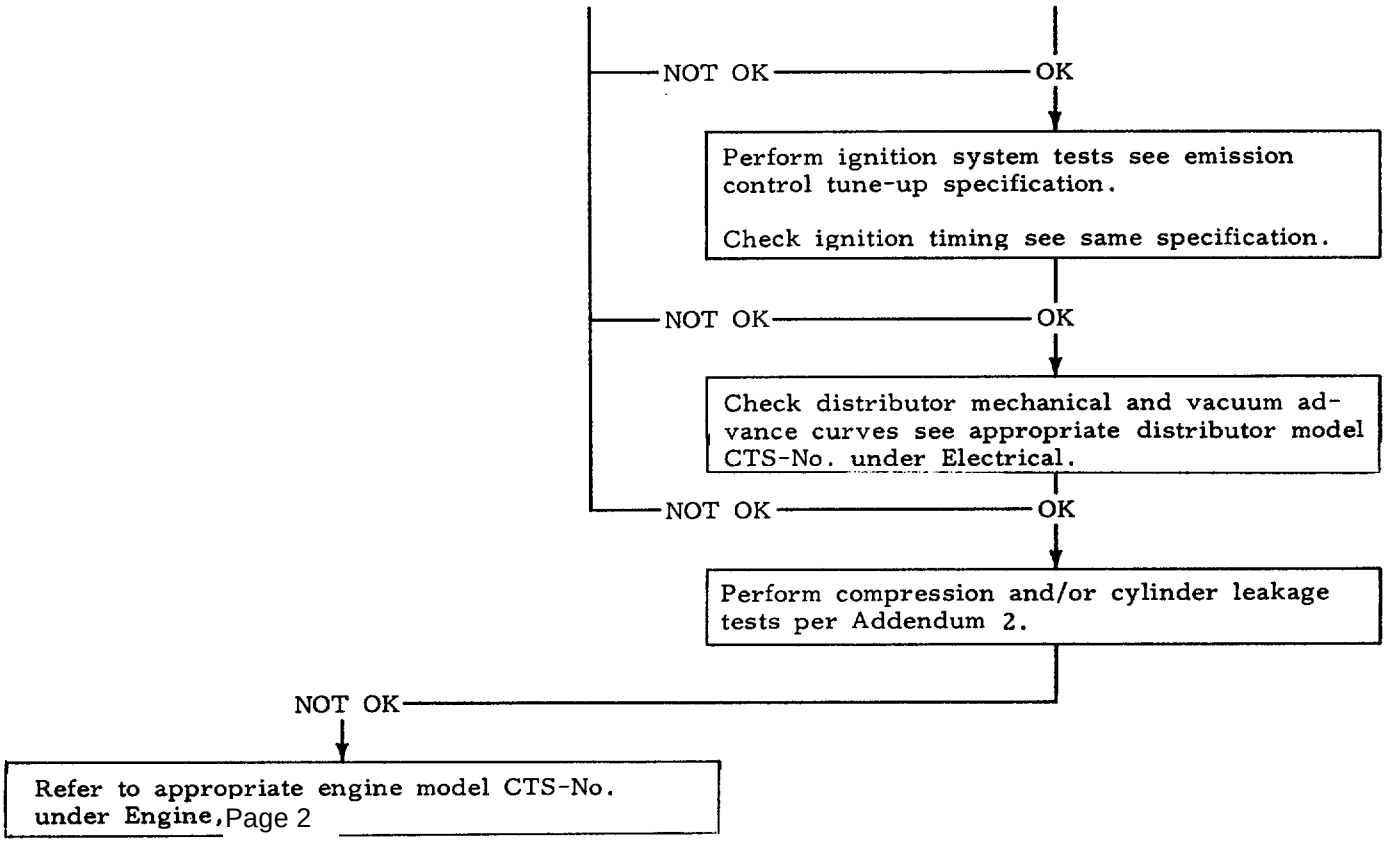

NOT OK
OK
Perform compression and/or cylinder leakage test per Addendum No. 4.
NOT OK
Refer to appropriate engine model CTS-No. under Engine, Page 2

CHART NO. 07
ENGINE IDLE SPEED VARIES

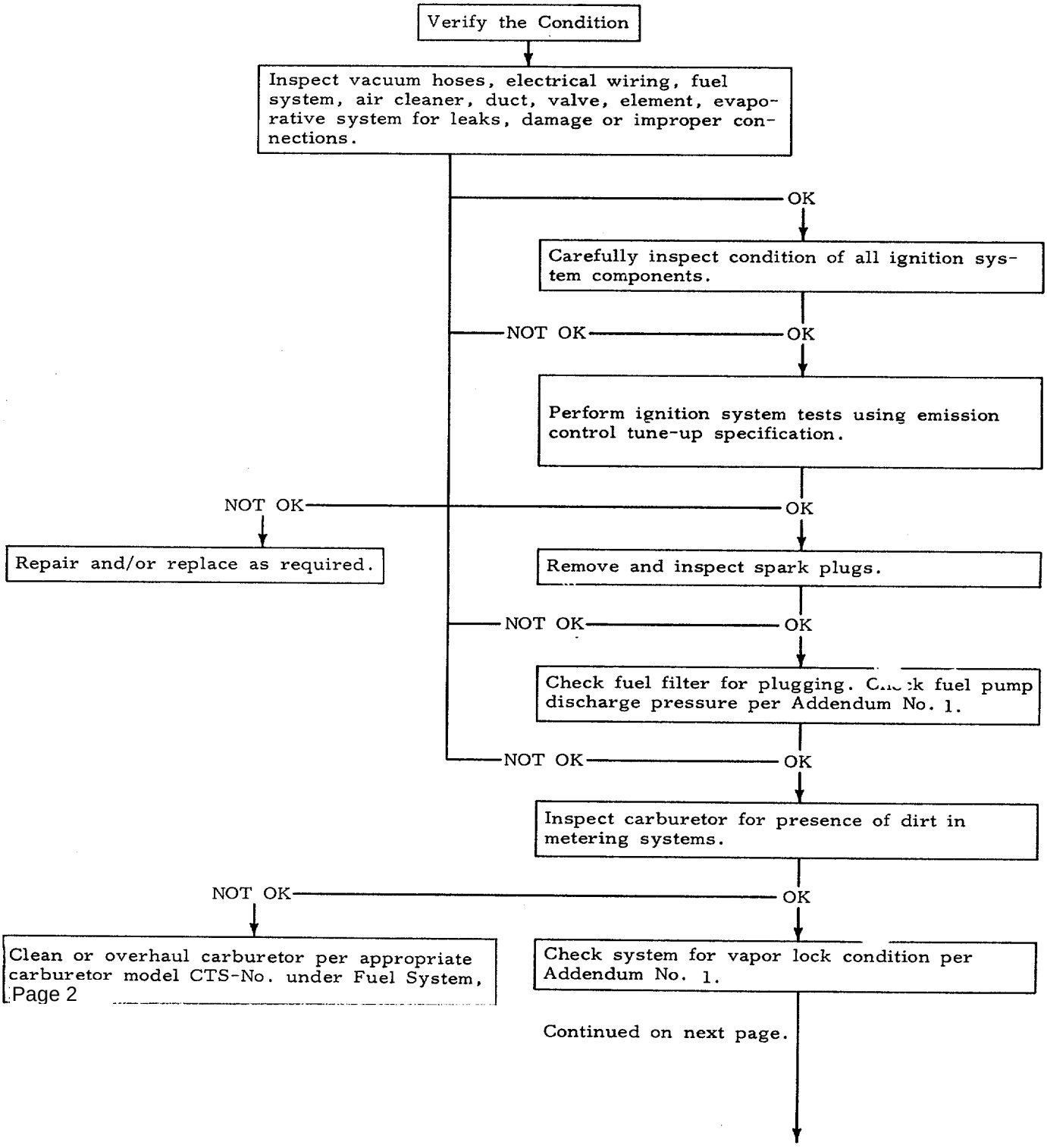


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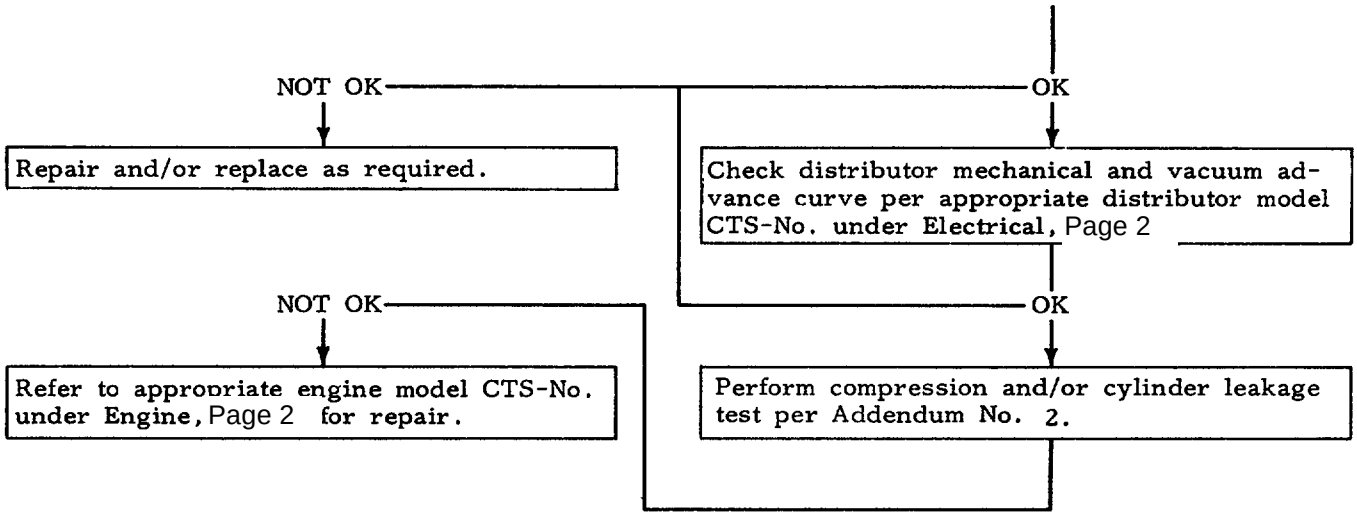


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CHART NO. 08
ENGINE MISSES AT HIGH SPEED

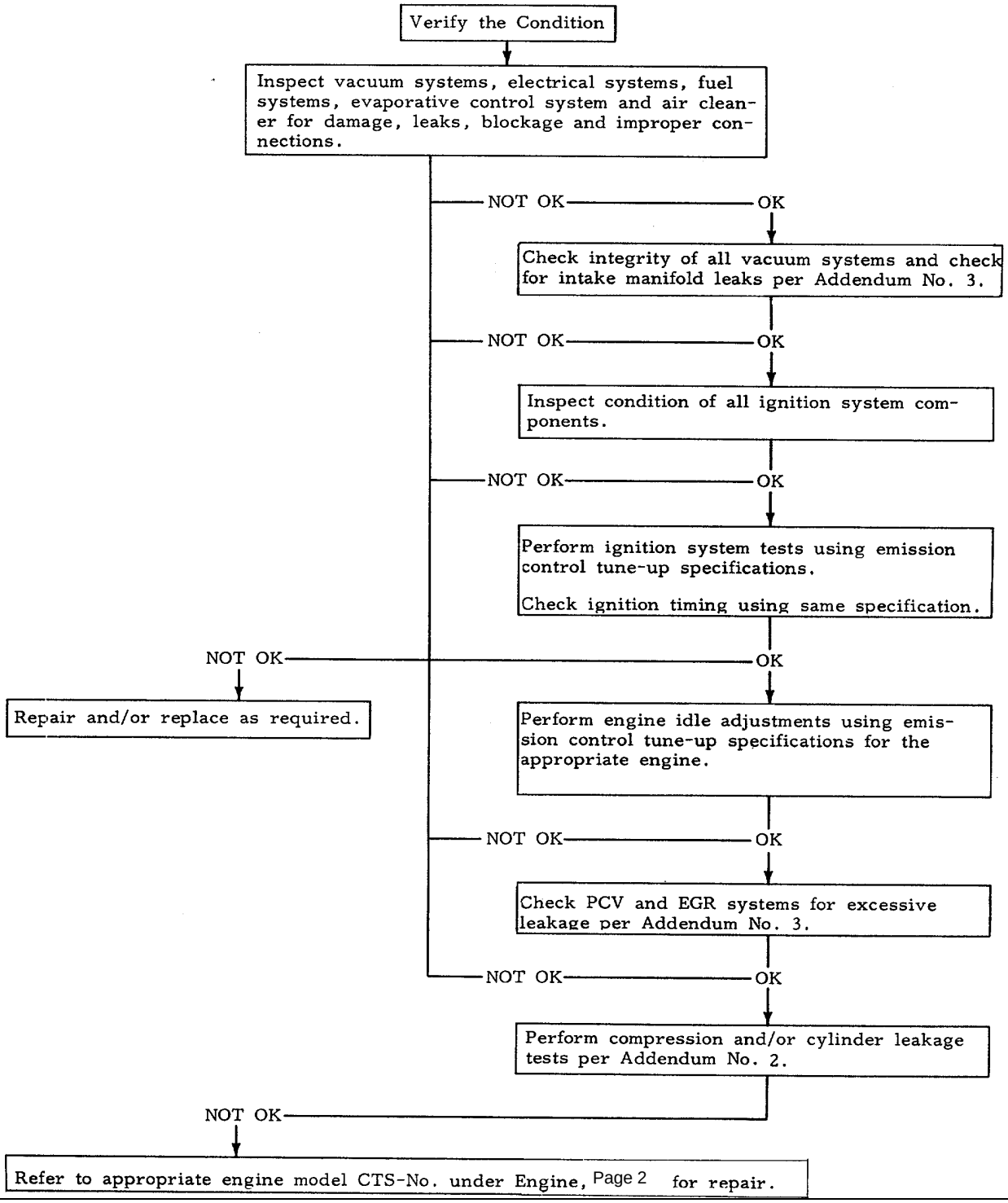


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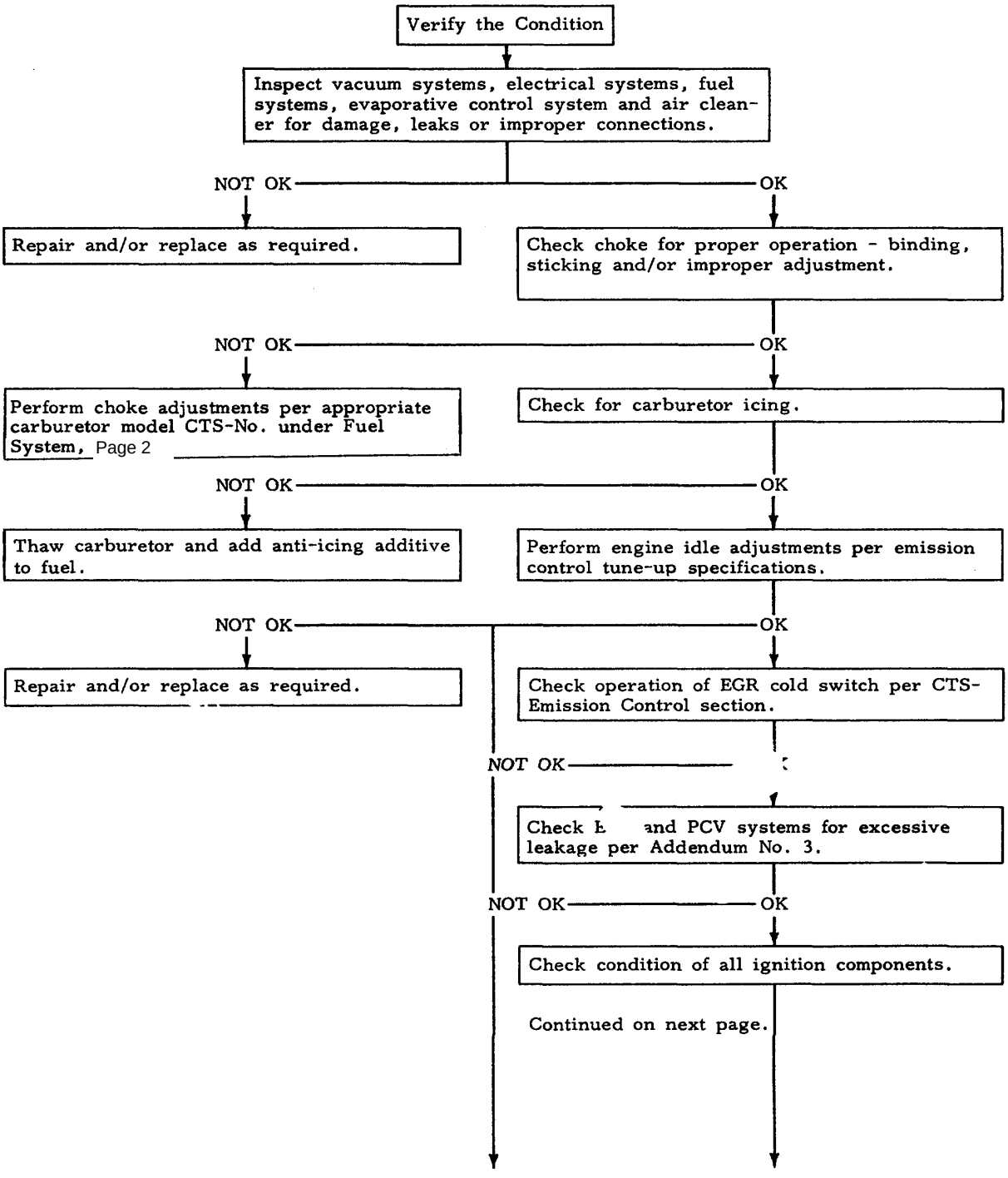
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CHART NO. 09
ENGINE MISSES AT LOW SPEED

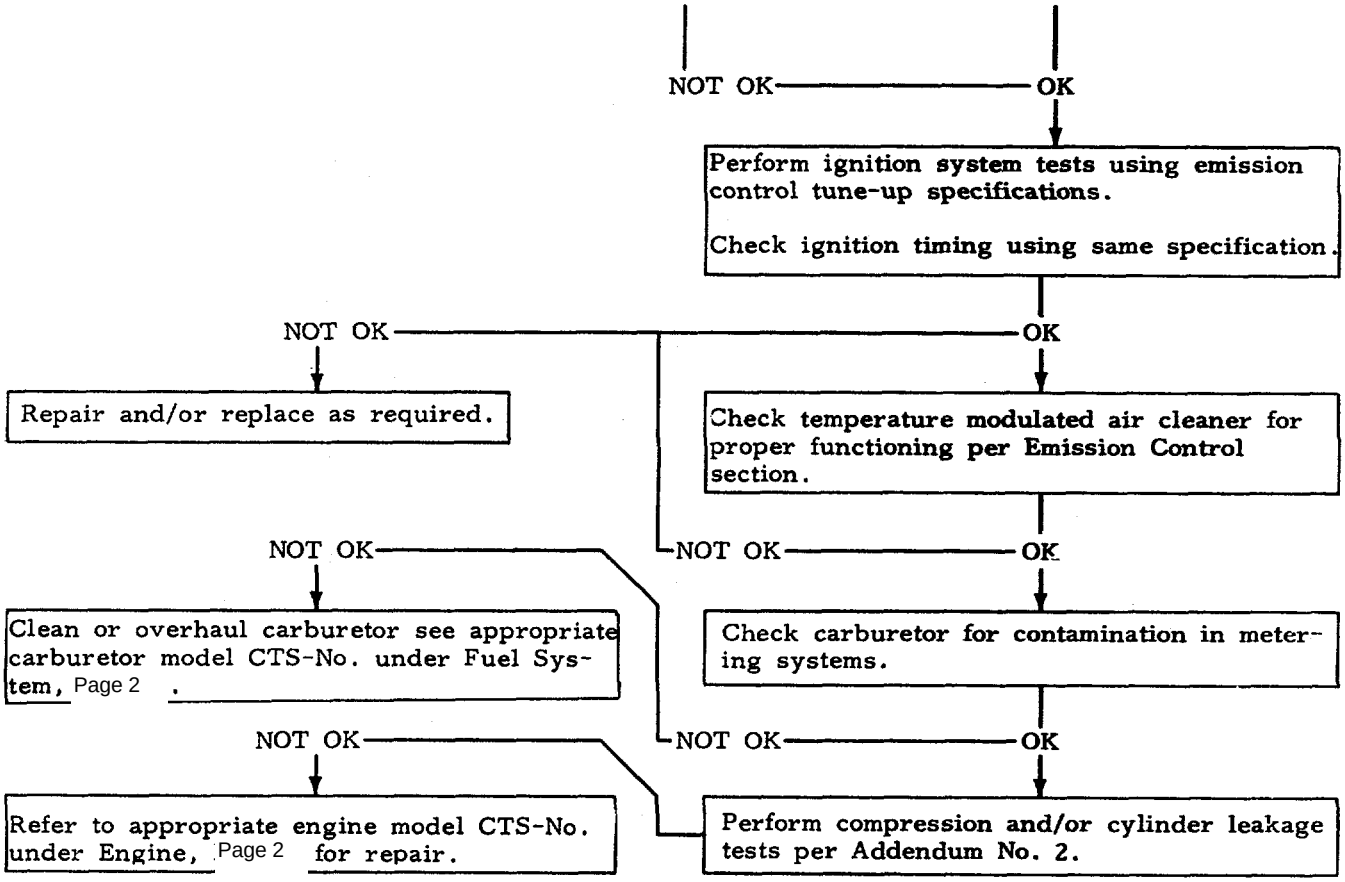


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CHART NO. 10
ENGINE STALLS AT IDLE-ENGINE COLD



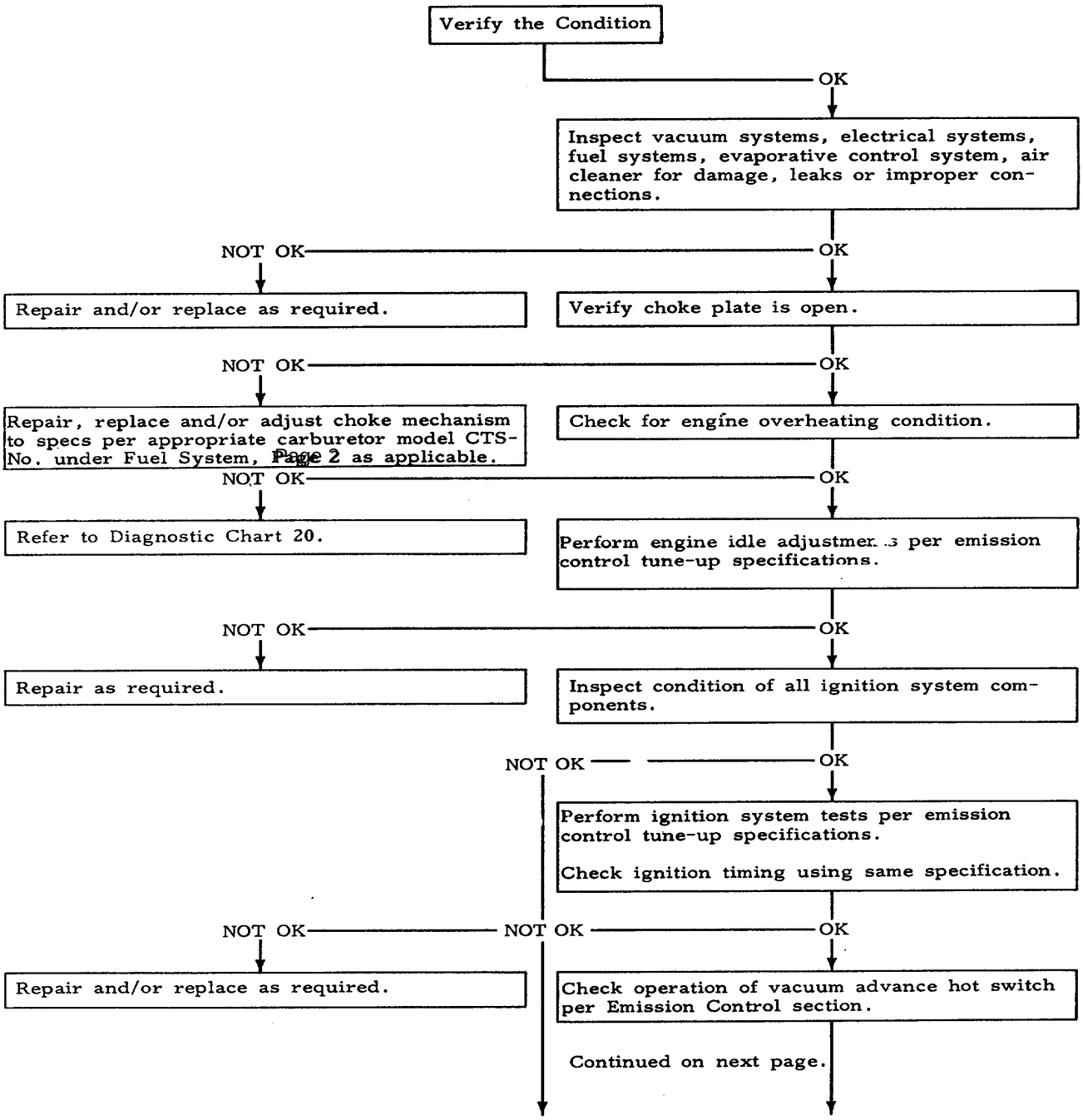
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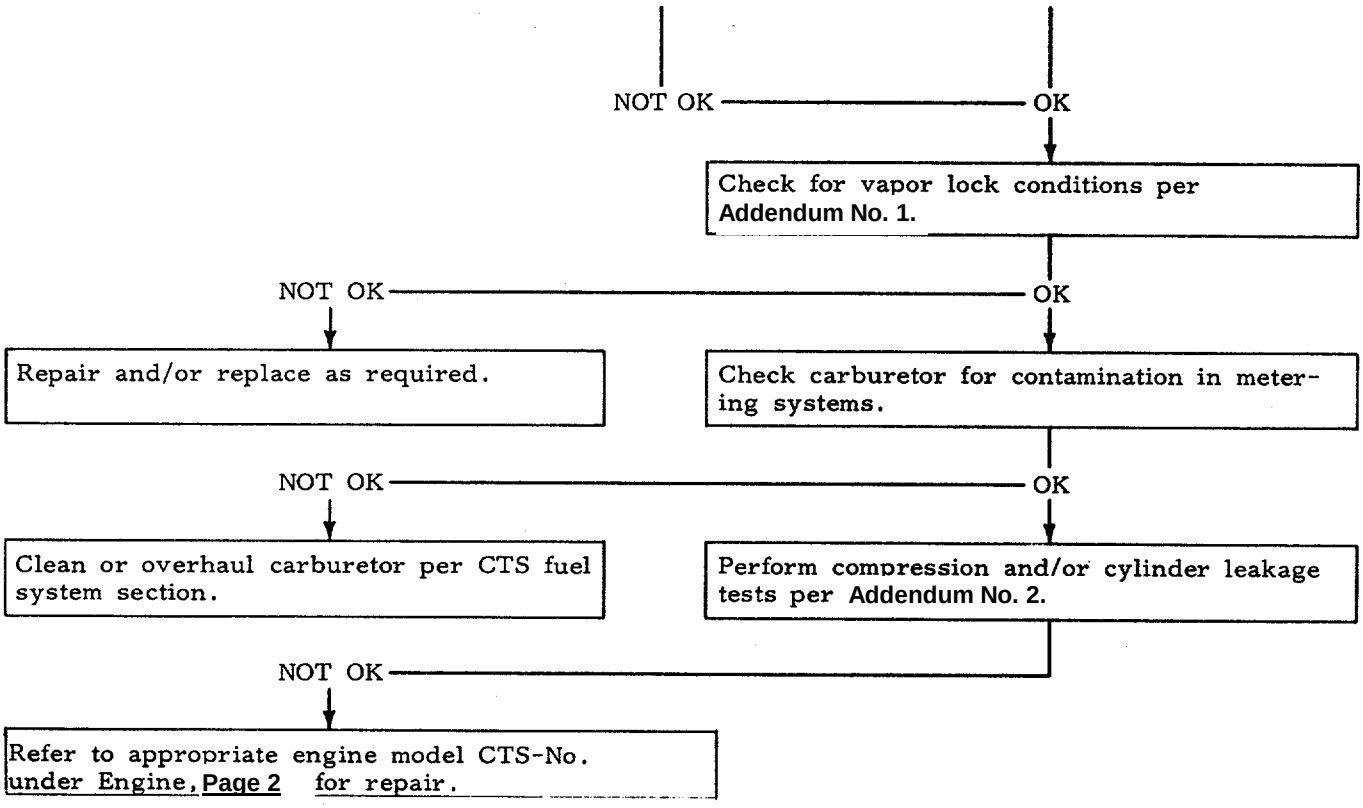
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CHART NO. 11

ENGINE STALLS AT IDLE - ENGINE HOT



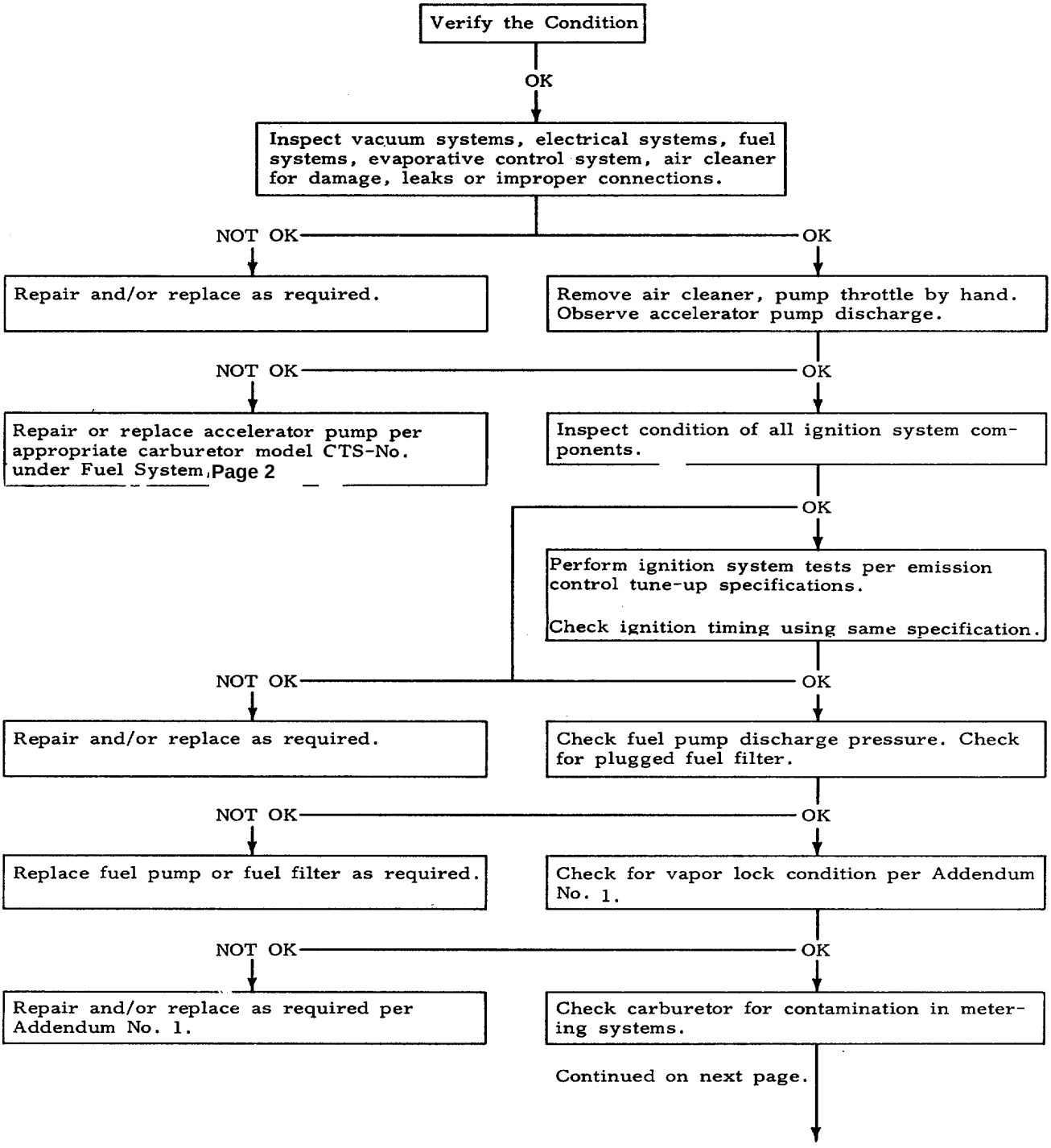
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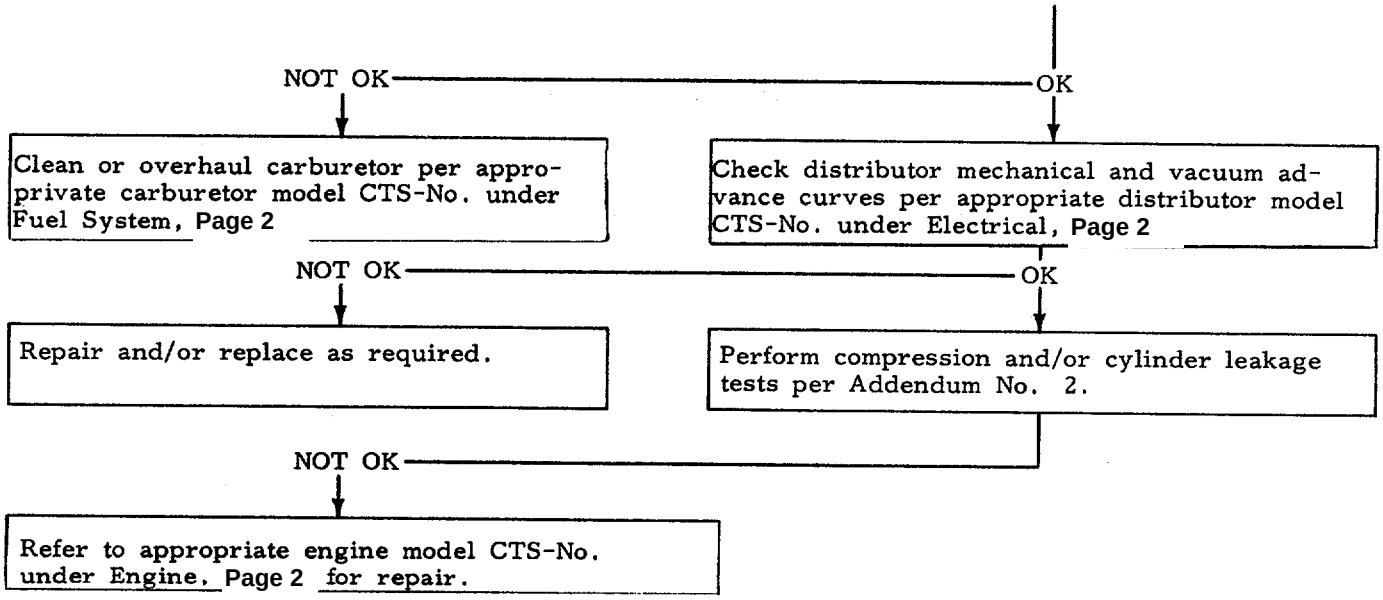
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CHART NO. 12

ENGINE HESITATES - STALLS DURING ACCELERATIONS



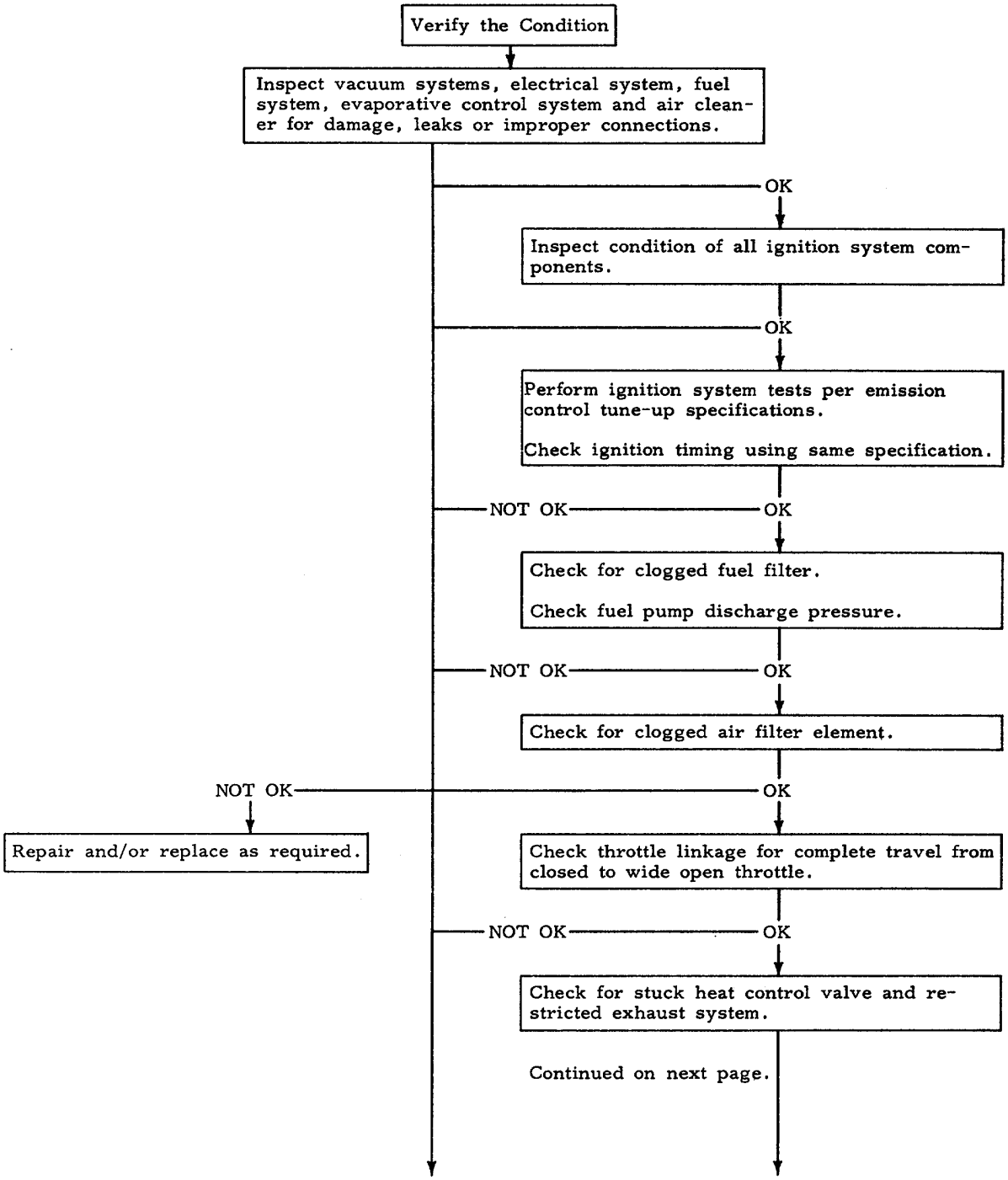
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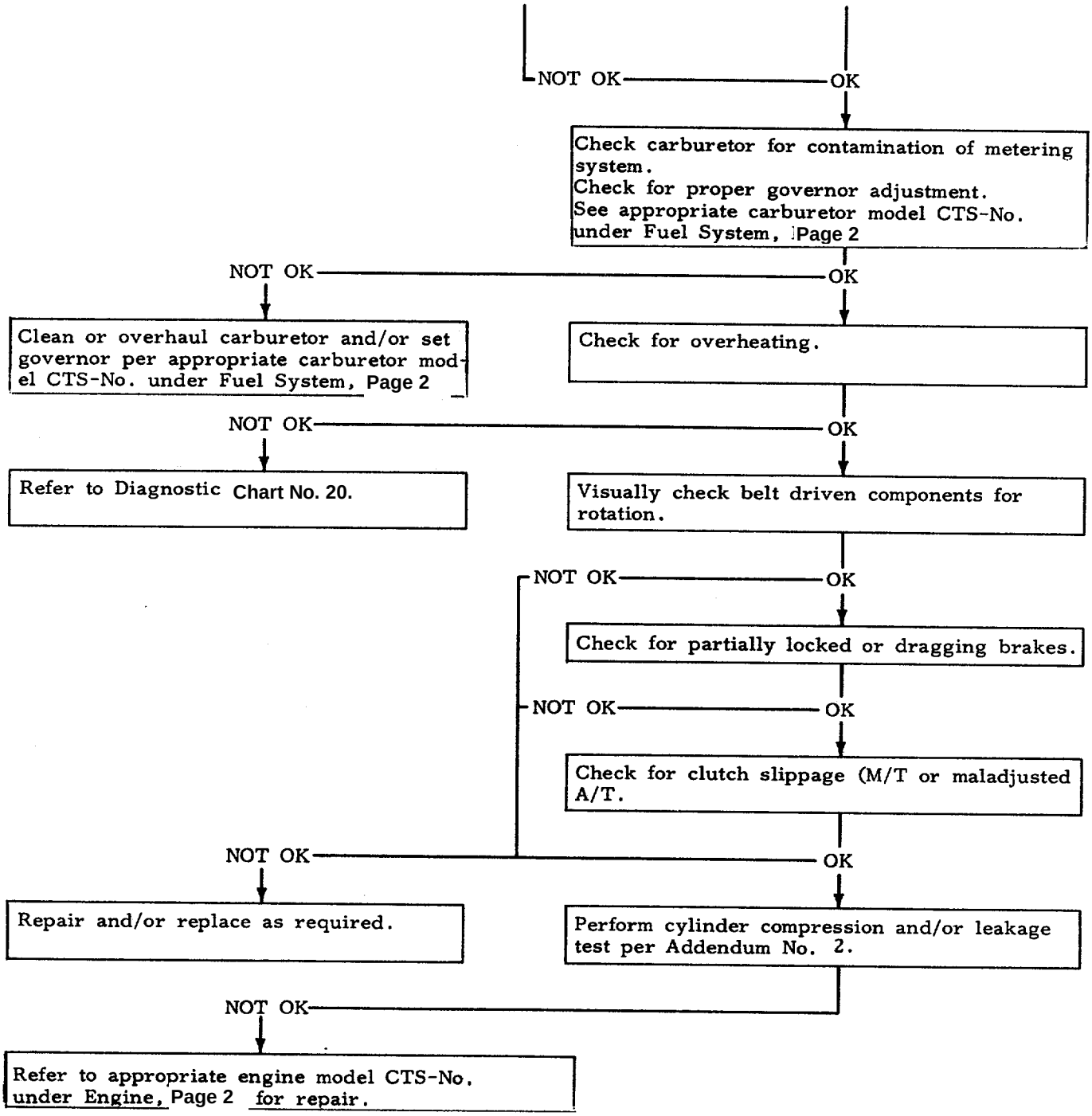


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CHART NO. 13

ENGINE HAS POOR ACCELERATION
(LESS THAN NORMAL POWER)

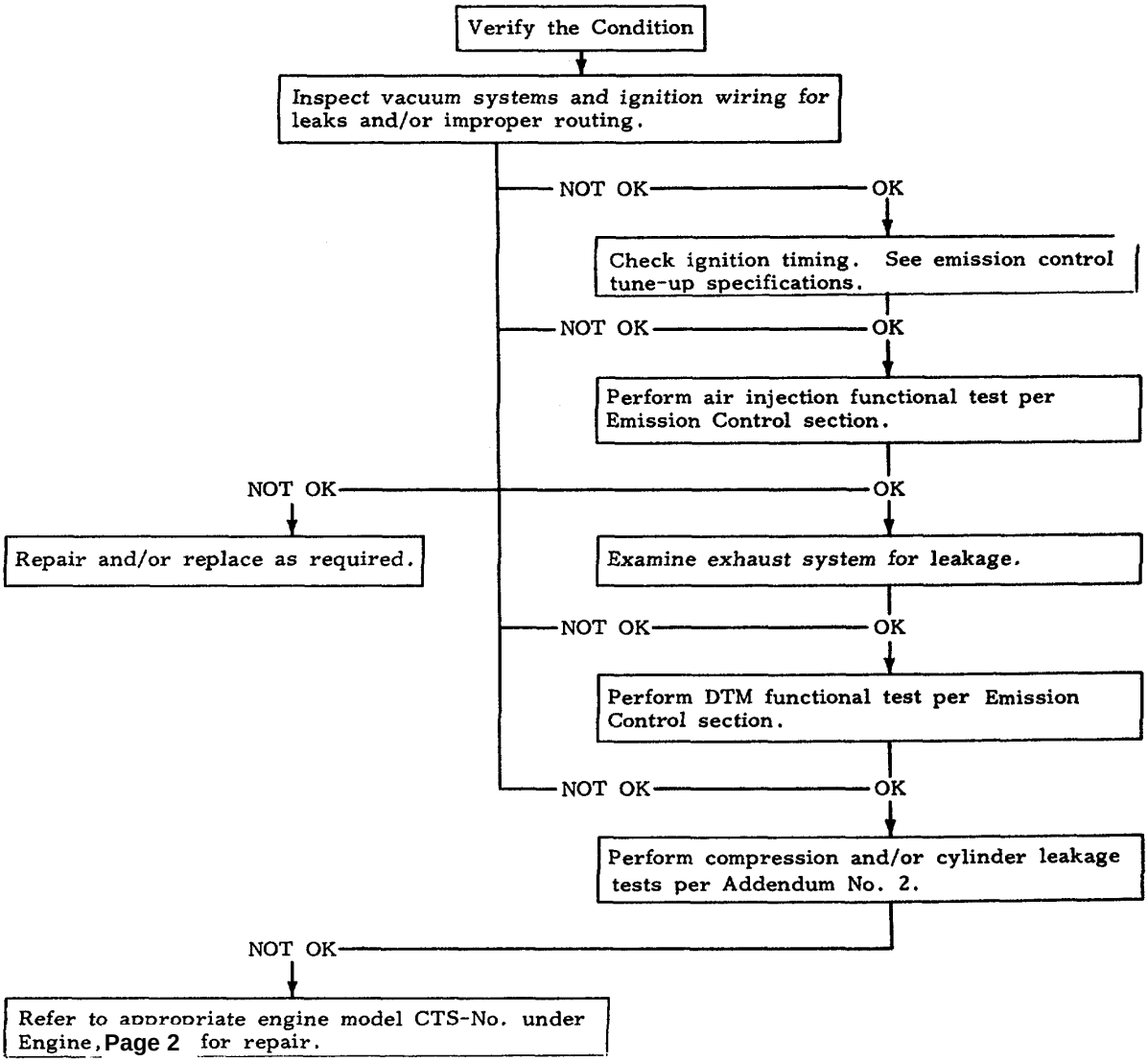




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CHART NO. 14

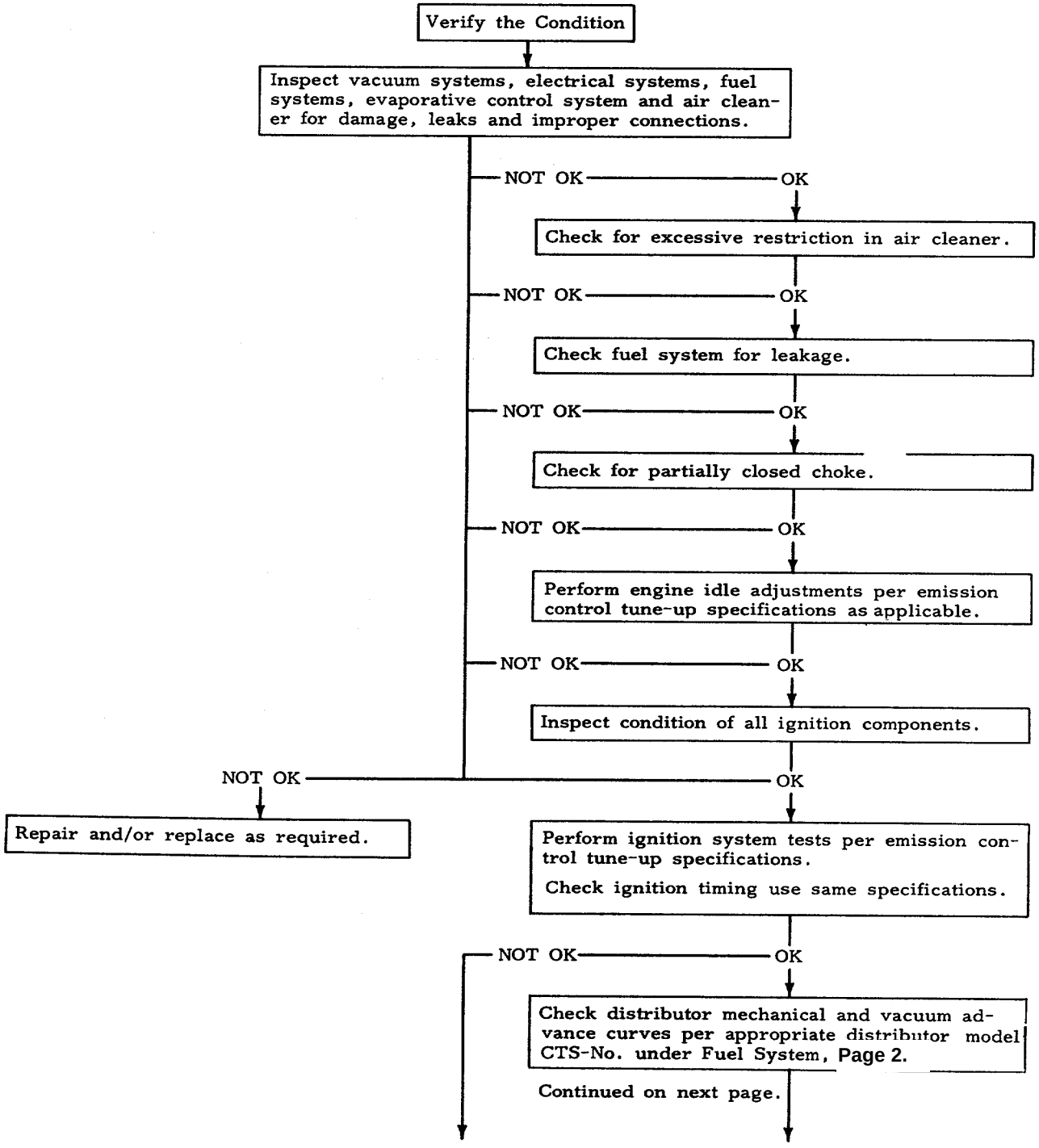
EXHAUST SYSTEM BACKFIRE



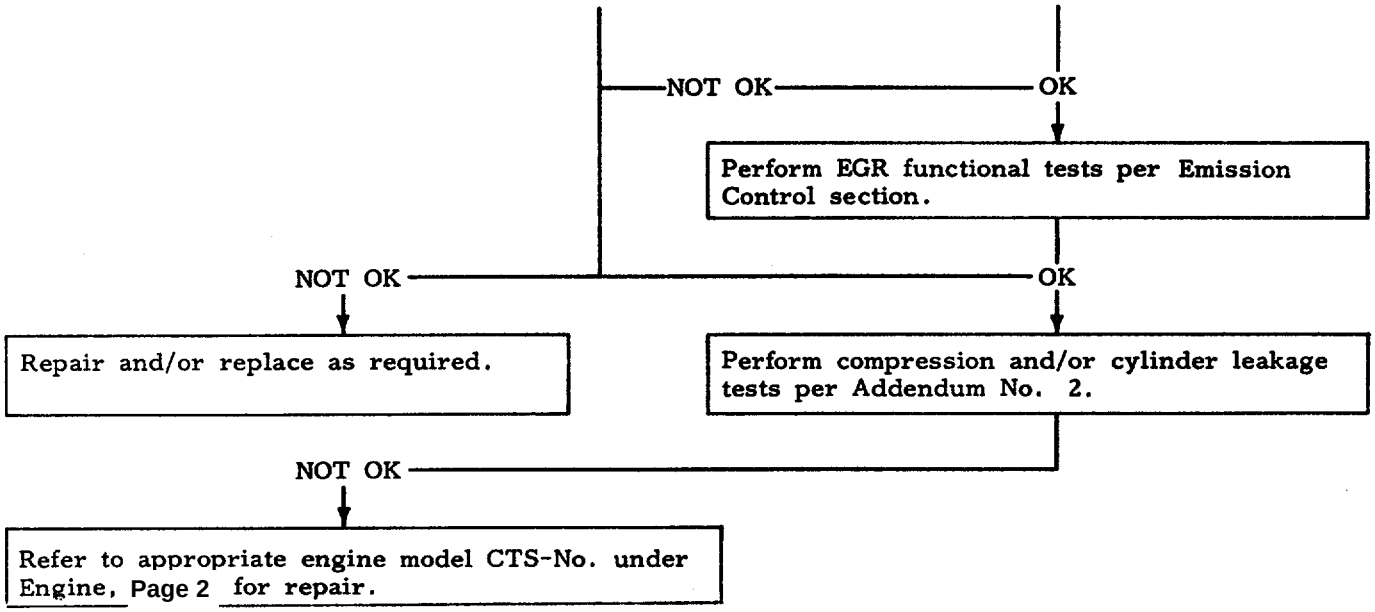
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CHART NO. 15

EXCESSIVE FUEL CONSUMPTION



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CHART NO. 16
EXCESSIVE OIL CONSUMPTION

↓

Verify the Condition

The most common cause of oil loss is leakage. To verify an excessive oil consumption complaint, it is necessary that a thorough inspection be made to insure that leakage does not exist. The following steps should be followed to verify an excessive oil consumption complaint.

A. Steam clean the engine (if necessary) to remove accumulated dirt and/or oil.

B. Drain engine oil and change the oil filter.

C. Fill the crankcase with the specified amount of the recommended grade of oil. (Check to be sure the correct dipstick has been installed.)

D. Check positive crankcase ventilation system for excessive oil pullover into air cleaner.

E. Drive the vehicle under normal conditions until the engine is at normal operating temperature. With the vehicle parked on a level surface, place a clean paper under the engine (to aid in detecting leakage).

F. Shut off engine and check for leakage at:

1. Valve rocker arm cover gaskets.
2. Oil pan gasket.
3. Cylinder block front cover gasket.
4. Cylinder block-to-fuel pump gasket and fuel pump air vent.
5. Intake manifold seals or valley cover gasket.
6. Crankshaft seals.
7. Distributor housing gasket.
8. Oil filter.
9. Oil pressure sending unit.
10. Oil Cooler.

G. When all causes of leakage (if any) have been repaired, check the oil level and adjust oil level to full mark on dipstick.

H. Record the odometer reading. Have the customer operate the engine for the approximate number of miles indicated by the complaint and then return it to you for examination.

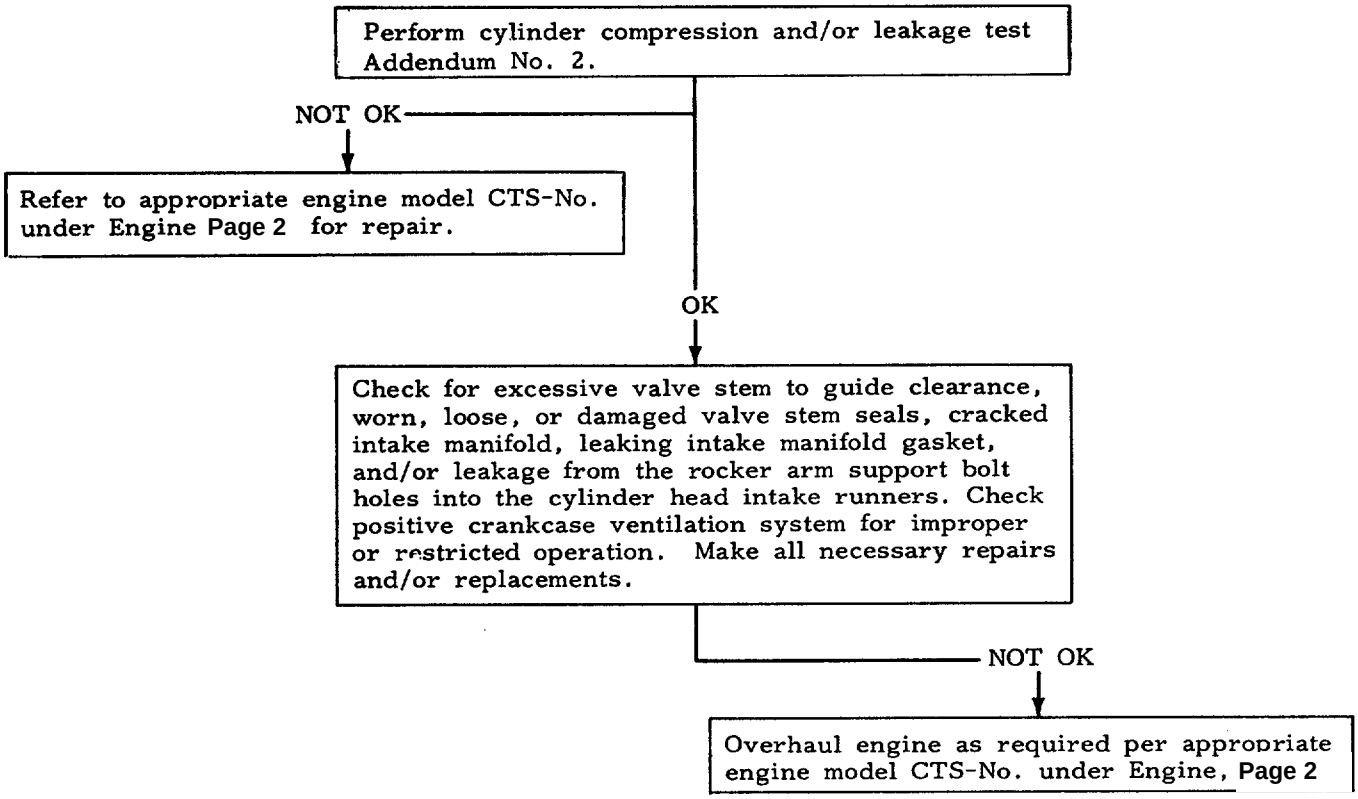
I. When customer returns the vehicle, verify the odometer reading. Check the oil level and reinspect the engine for signs of oil leakage.

J. Add a measured amount of oil as necessary to bring the oil level to the full mark.

K. If oil consumption is not within specified limits (400-500 miles per quart), proceed with oil consumption diagnosis as outlined below.

NOTE: A new engine may require up to 6000 miles of operation in order to properly seat (break in) the piston rings. For this reason, the engine should not be condemned as long as oil economy is improving with mileage accumulation. If oil economy ceases to improve with mileage accumulation, corrective action should be taken.

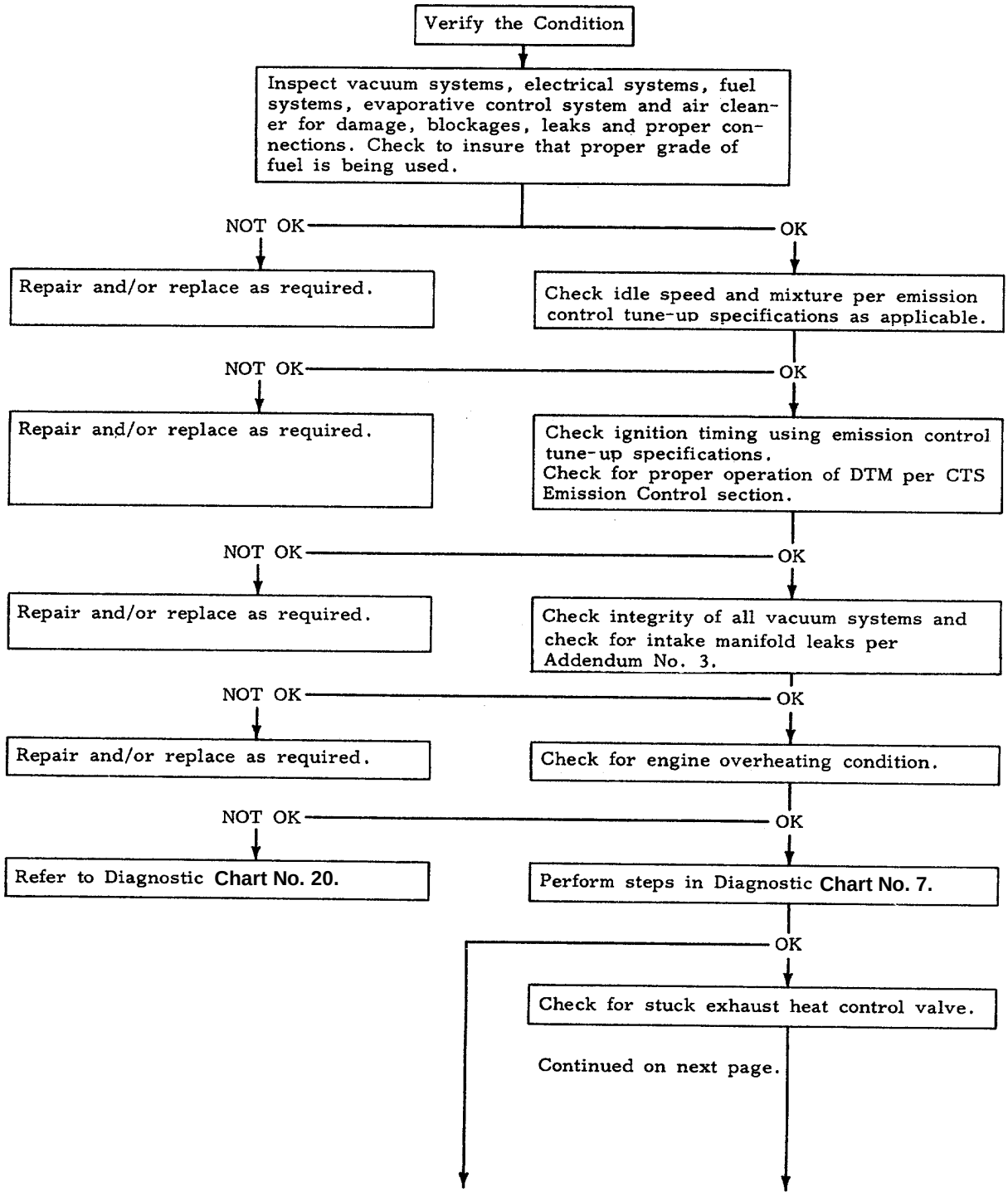
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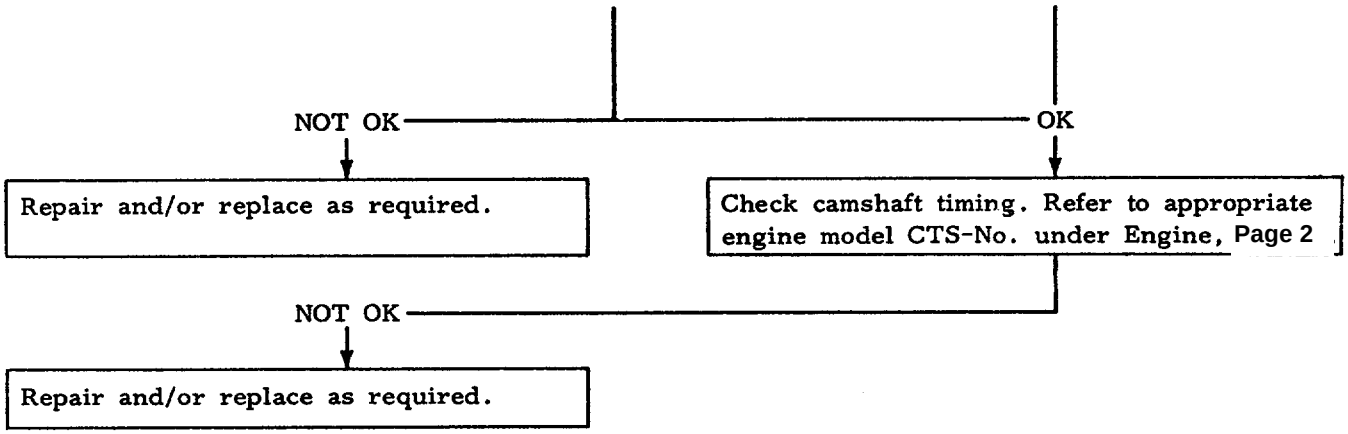
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CHART NO. 17

ENGINE DIESELS - CONTINUES TO RUN AFTER SHUT OFF



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CHART NO. 18
ENGINE NOISE

Noisy engine operation covers a wide range of conditions; therefore, to make the most efficient use of diagnostic aids to correct the condition, an accurate verification of the symptoms must be made. When the symptom is identified as to the type and general location of the noise, proceed to the applicable step outlined below. It can be seen that many of the steps are based on similar symptoms and, indeed, may be a matter of individual interpretation. Therefore, if the most likely step fails to correct the condition, proceed to the next most likely step, and so on until the condition is corrected.

A. Spark Knock or Pinging

This condition is characterized as being increasingly more noticeable as engine load increases. That is, at a given vehicle speed and throttle opening the problem would generally be more noticeable on a steep grade than on a level surface. The condition is due to low octane fuel, excessive spark advance or engine overheating.

If any discrepancies are noted in the following checks, repair and/or replace as required. Advise owner of proper octane fuel and verify correct spark plug heat range. If engine overheating is indicated, perform steps in CHART 20, check ignition timing and check distributor mechanical and vacuum advance curve per CTS ELECTRICAL section.

B. Light Clicking (Varies with Engine Speed)

This condition is usually caused by improperly adjusted, failed or malfunctioning valve train components. Insert feeler gauge between rocker arm and valve stem tip and/or exert pressure on rocker arm. If noise is eliminated, adjust valve clearance to specifications. If condition persists, inspect for worn or malfunctioning valve train components. If no failure is detected, check for excessive valve stem-to-valve guide wear by exerting side pressure on valve stem. If noise is corrected excessive wear is indicated. If valve is eliminated as a possible cause, check for accessory component noise by loosening and/ or removing drive belts, one at a time, until noise stops. Investigate fuel pump and/or pump drive as possible cause.

C. Sharp Rapping (Varies with Engine Speed)

This condition is usually caused by malfunctioning hydraulic lifter and may be located with the aid of a stethoscope. If the problem is not corrected, perform Step B.

D. Hissing

Inspect vacuum systems for leakage due to loose or broken connections and/or failed parts. Inspect manifolds for leaks. Perform cylinder compression and/or leakage tests to identify and isolate cylinder head gasket leaks. Inspect for carburetor gasket leaks.

E. Sharp Snapping Noise During Acceleration

Look for arcing from high tension ignition cables.

F. Squeaks and/or Squeals

Loosen drive belts, one at a time, to determine if accessory component or water pump is at fault.

G. Heavy Squeal During Acceleration

Check for accessory drive belt slippage and adjust tension or replace as required.

H. Ringing, Grinding or Combination of Both

Check for loose, bent or improper pulleys. Check for front end bracket interference between rotating parts and surrounding components caused by misalignment of engine, engine components or surrounding components. Check for worn or damaged water pump or accessory components by loosening drive belts, one at a time, until noise stops.

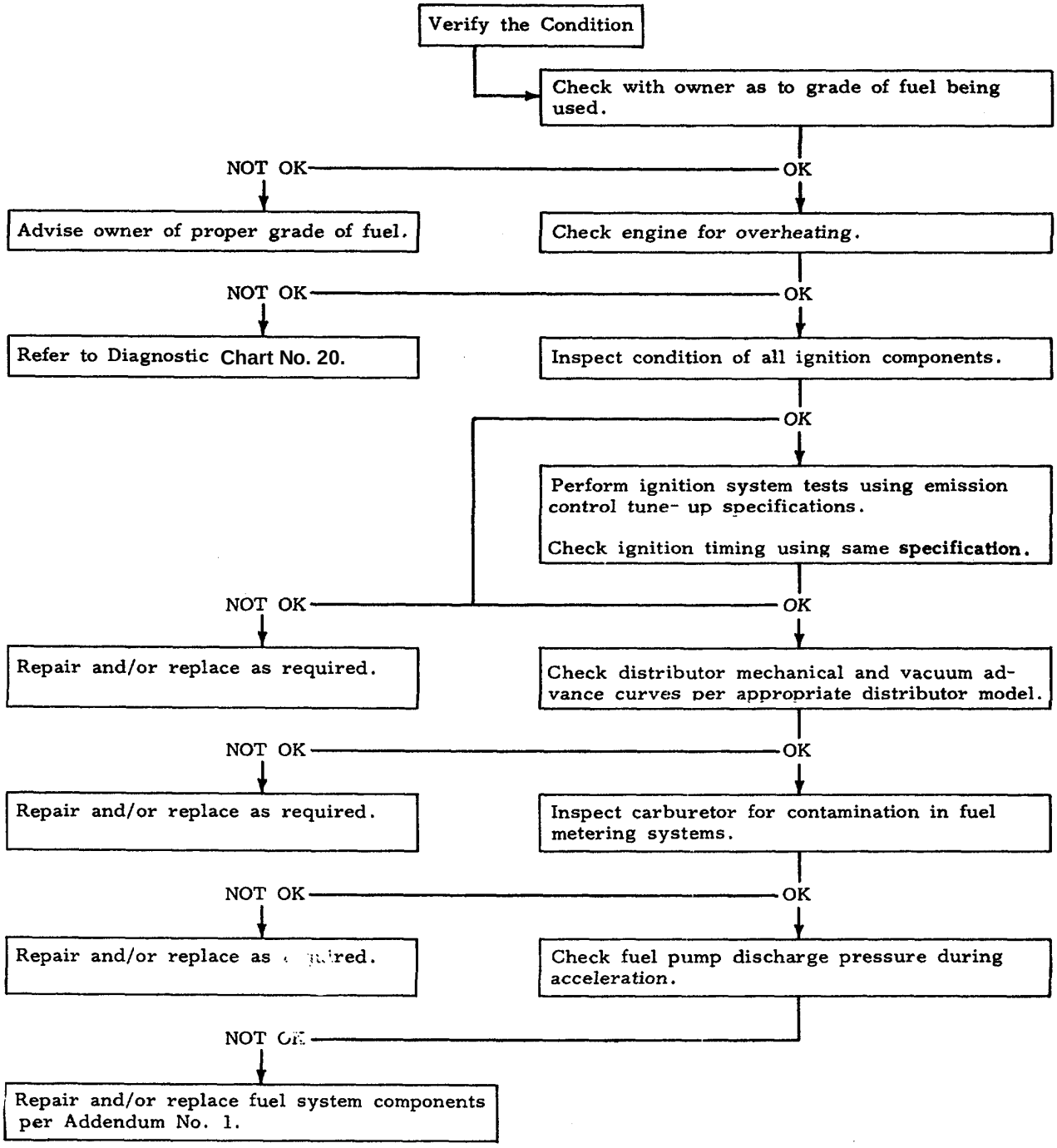
I. Buzzing or Whistling During Engine Operation

Perform radiator cap functional check and verify proper cap sealing. If engine overheating is indicated, perform engine overheating routine. Check for interference with the fan or front end drive components by foreign material, loose or broken surrounding parts. Check for loose carburetor mounting. Check for vacuum leaks. Check power steering.

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CHART NO. 18A

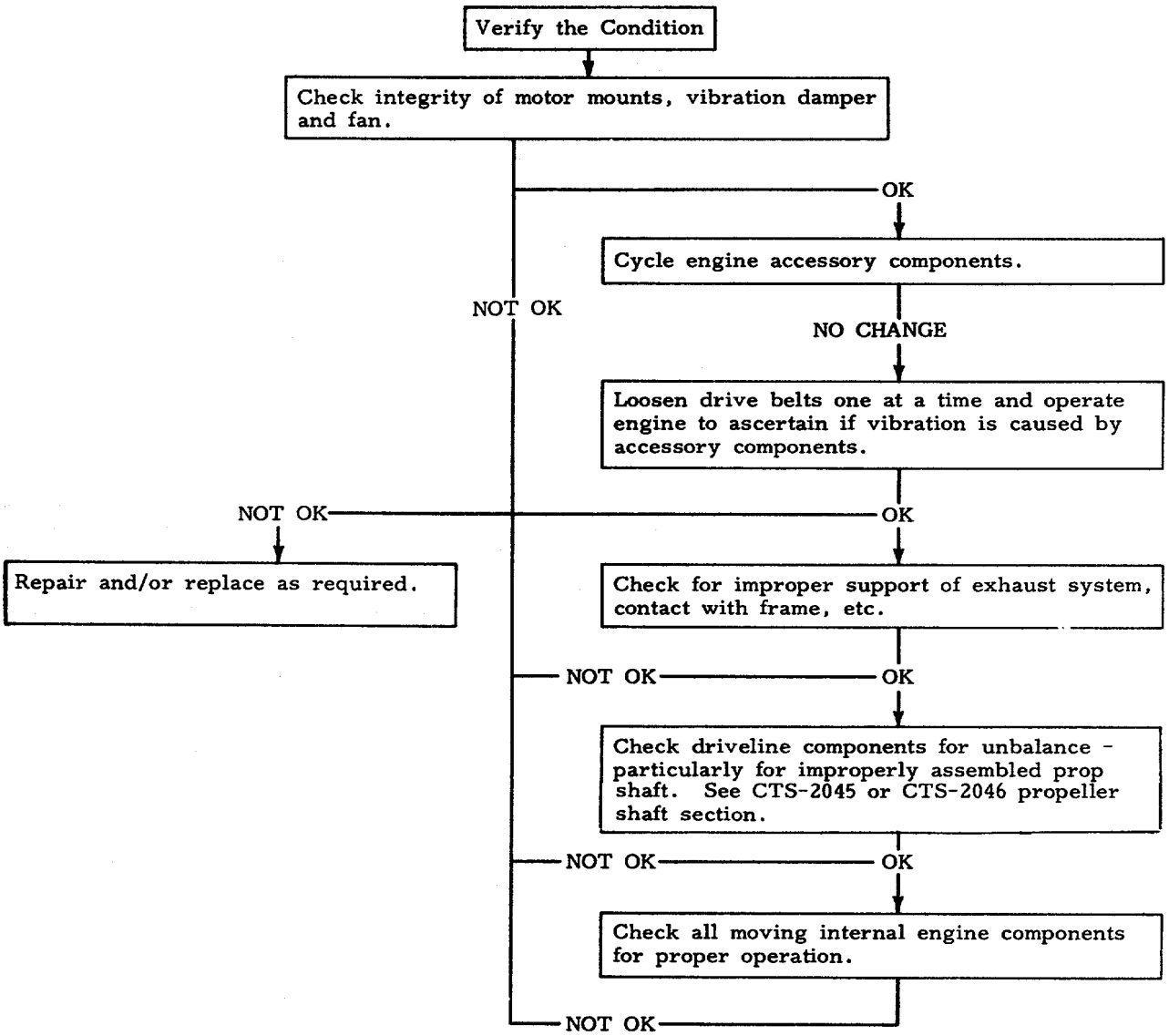
SPARK KNOCK OR PINGING



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CHART NO. 19

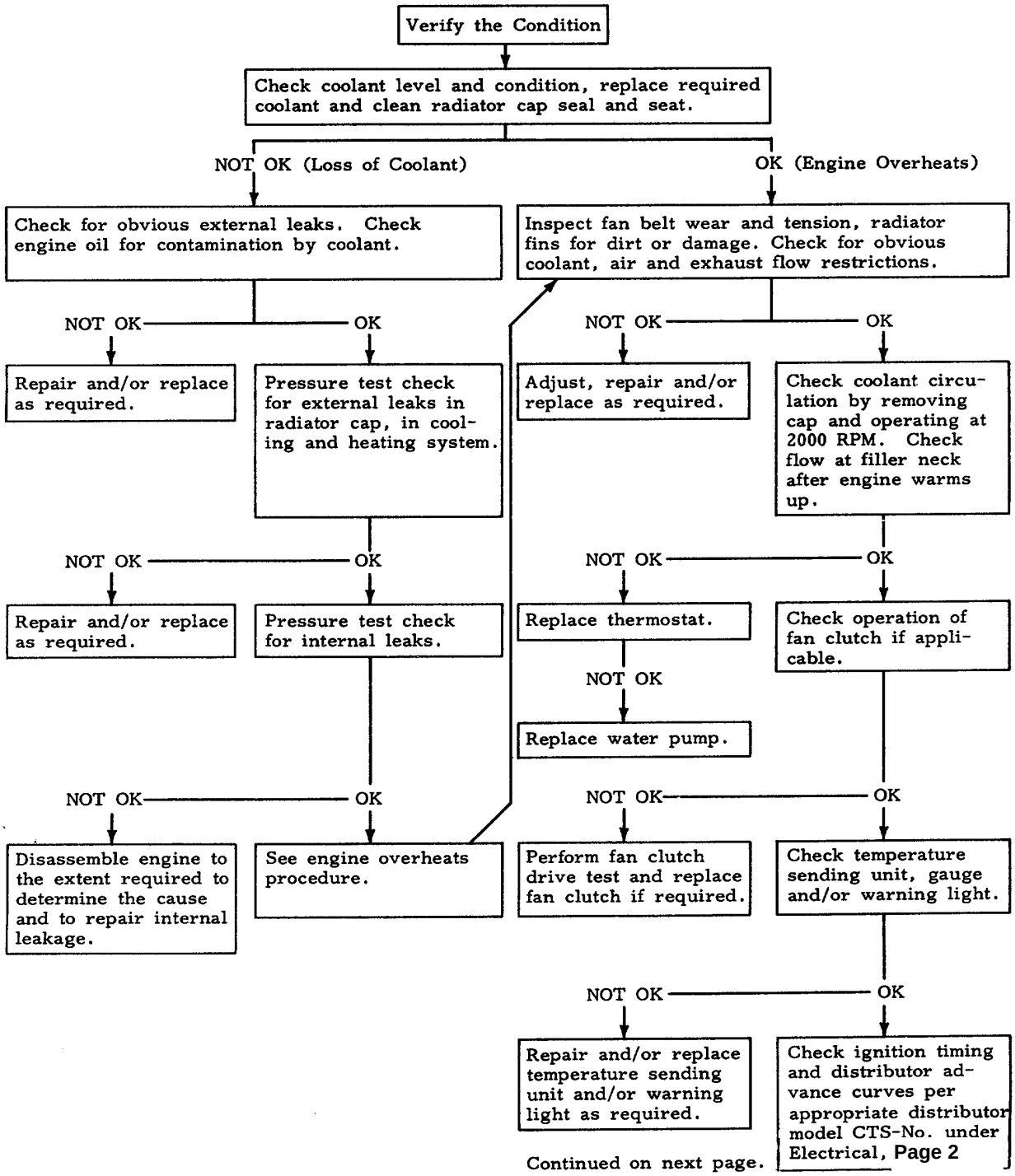
ENGINE VIBRATION



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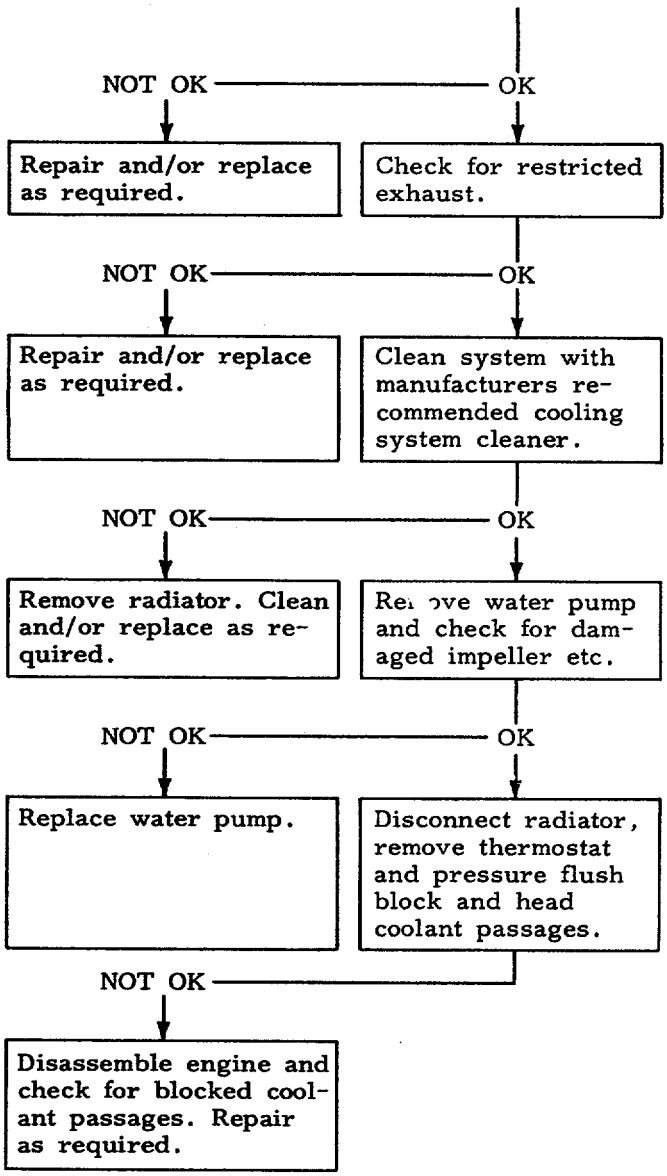
CHART NO. 20

LOSS OF COOLANT OR ENGINE OVERHEATING



Continued on next page.

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CHART NO. 21
SMOKE FROM VEHICLE EXHAUST SYSTEM

The color or type of visible smoke from vehicle exhaust can provide clues as to the source of the problem. Three types of "smoke" are generally common to gasoline engines:

White Smoke

Visible white "smoke" in exhaust results from coolant entering the combustion chambers or exhaust system. Check for failed cylinder head gasket or cracked cylinder head casting. If OK, check for cracked crankcase.

Black Smoke

Results from over-rich fuel mixture. Check for partially closed choke, or carburetor flooding condition. An over-rich mixture usually causes rough engine operation. Perform steps covered in Diagnostic Chart No. 15.

Blue or Blue-gray Smoke

Results from oil entering the combustion chambers or exhaust system. Check PCV system per CTS Emission Control section.

1. Blue smoke noted during wide open throttle operation indicates worn or stuck piston rings.

2. Blue smoke noted during deceleration (high vacuum) indicates failed or worn valve stem seals or worn valve guides.

Refer to appropriate CTS engine section for repair of above difficulties.

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CHART NO. 22

ENGINE GOVERNOR DOES NOT OPERATE - NO ENGINE SPEED CONTROL

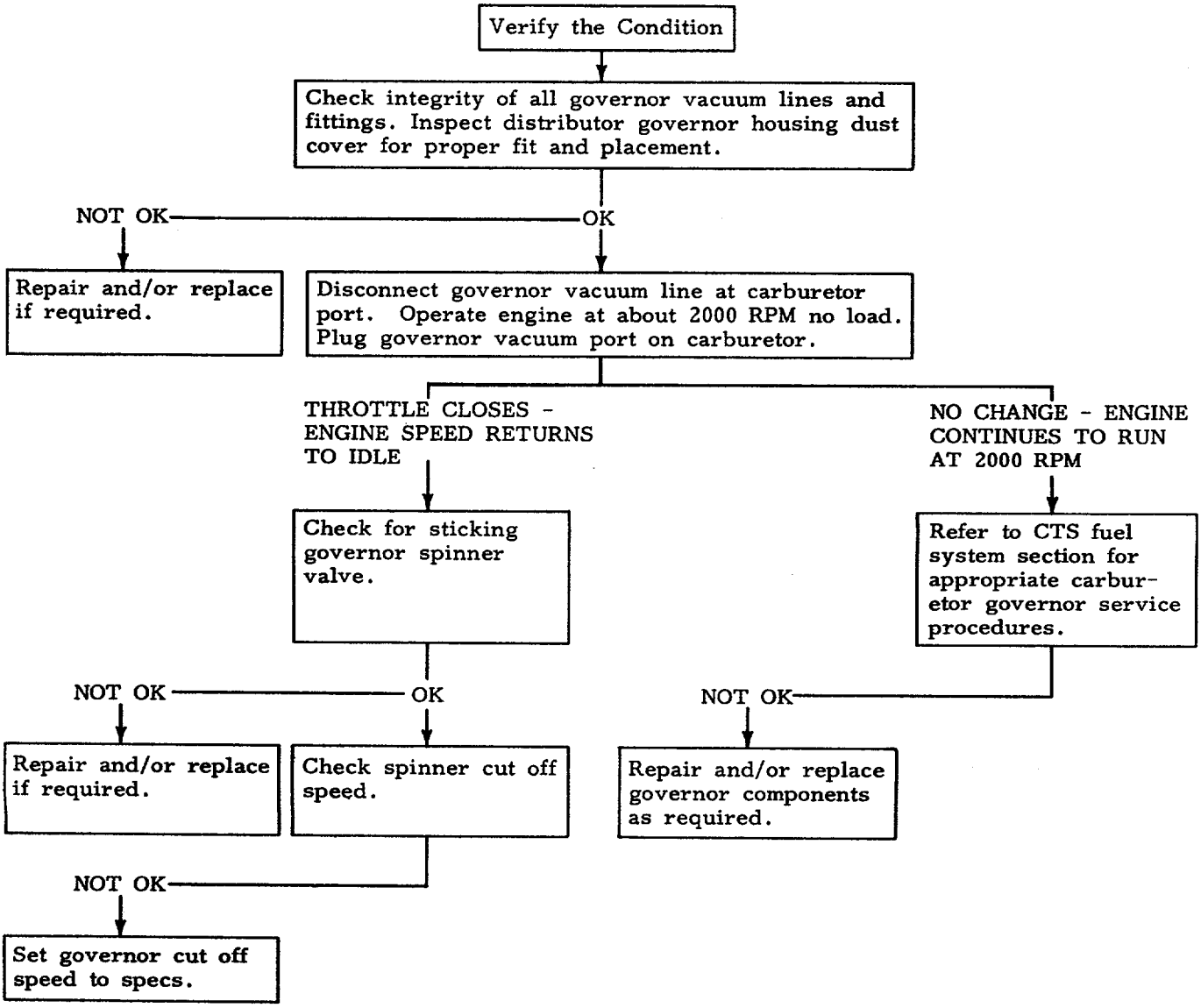
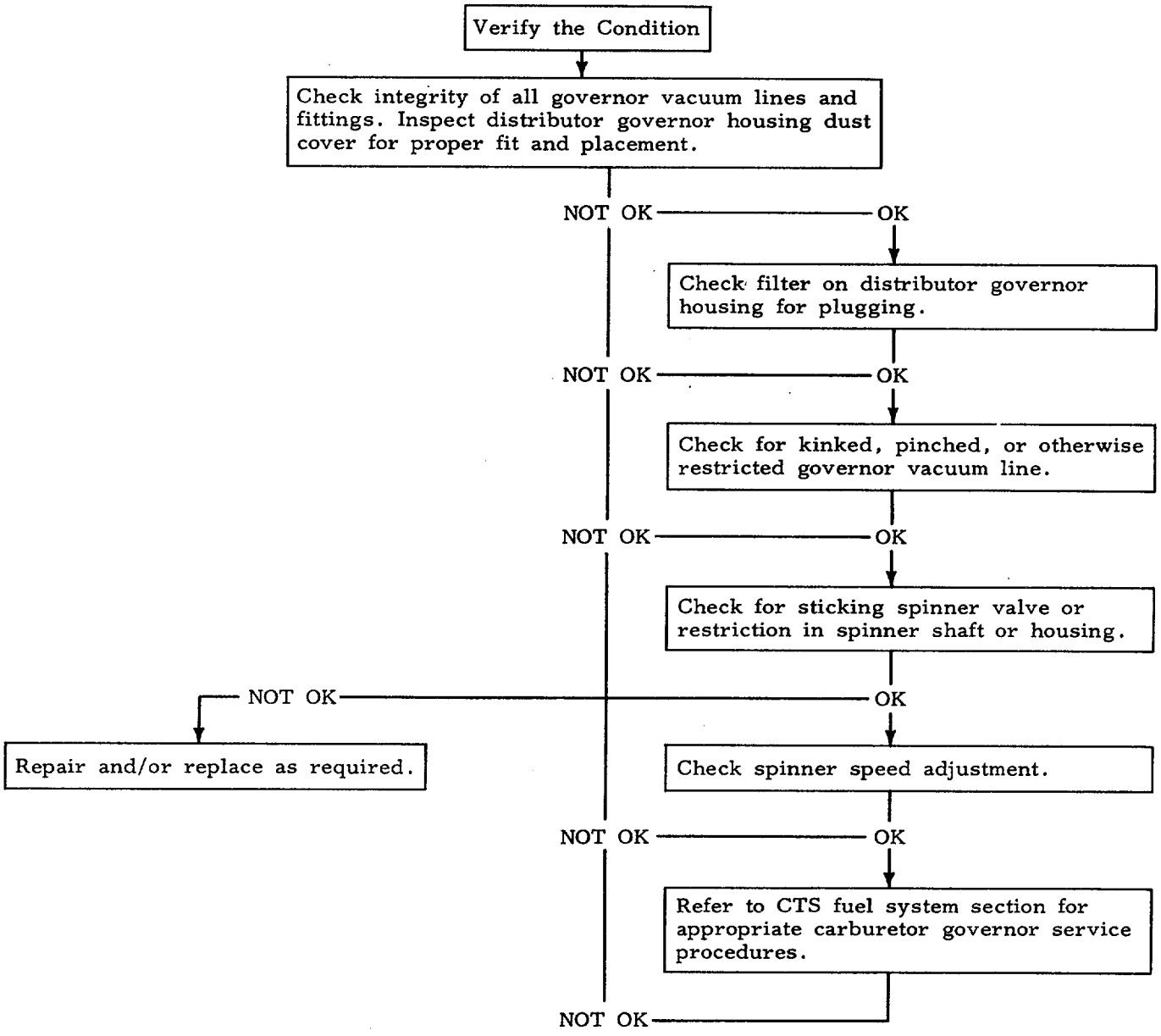


CHART NO. 23

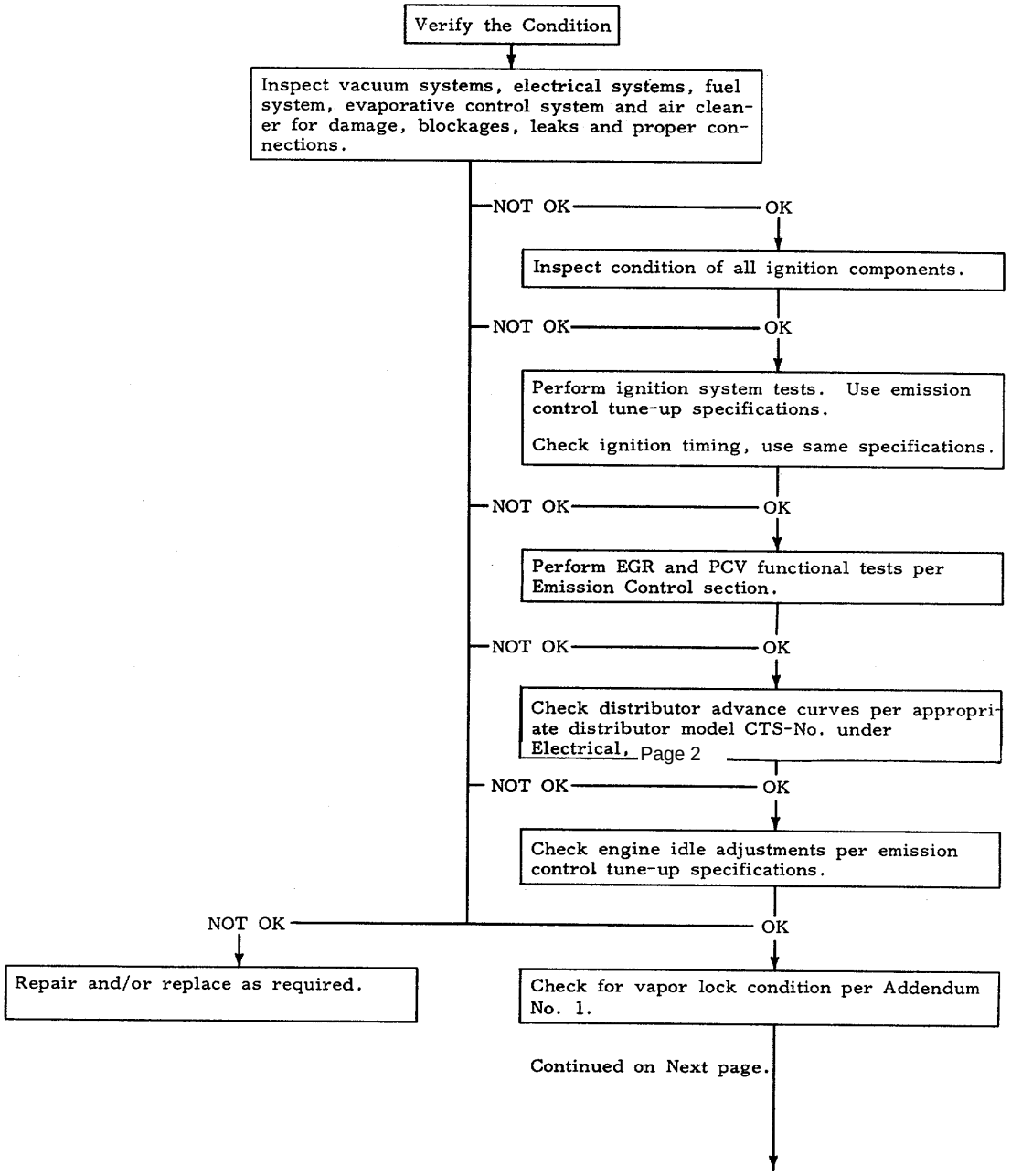
GOVERNOR CUTS OFF AT LOW SPEED - ERRATIC OPERATION



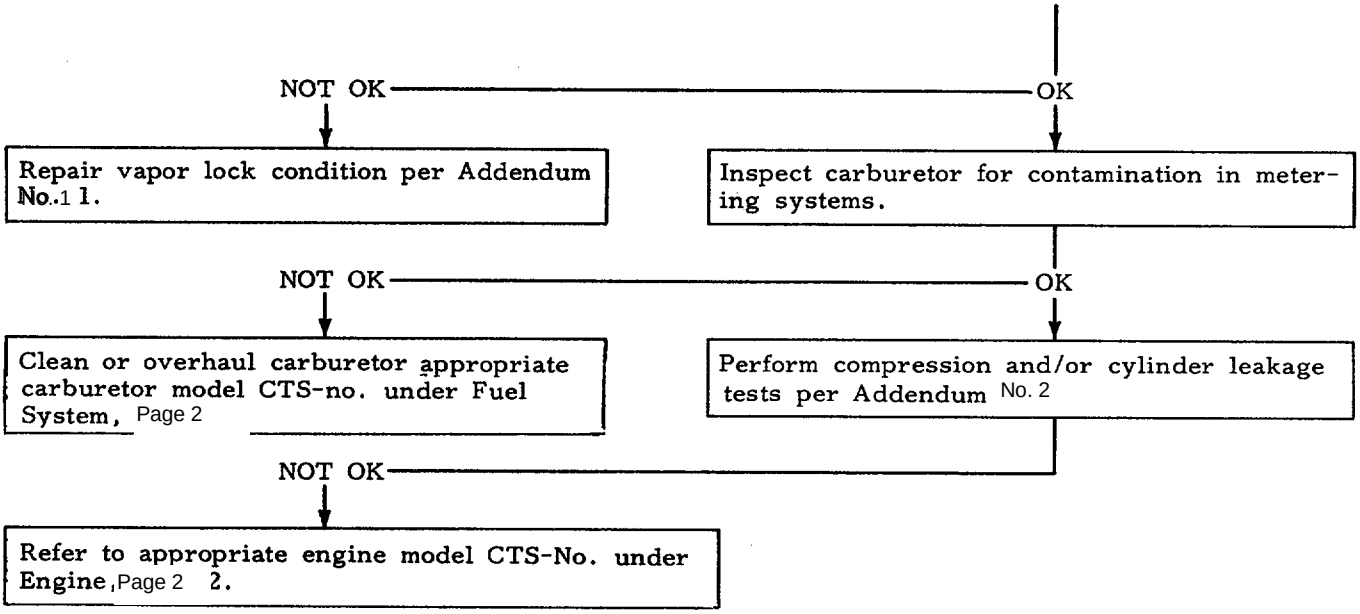
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CHART NO. 24

ENGINE SURGES BELOW GOVERNOR CUT OFF SPEED



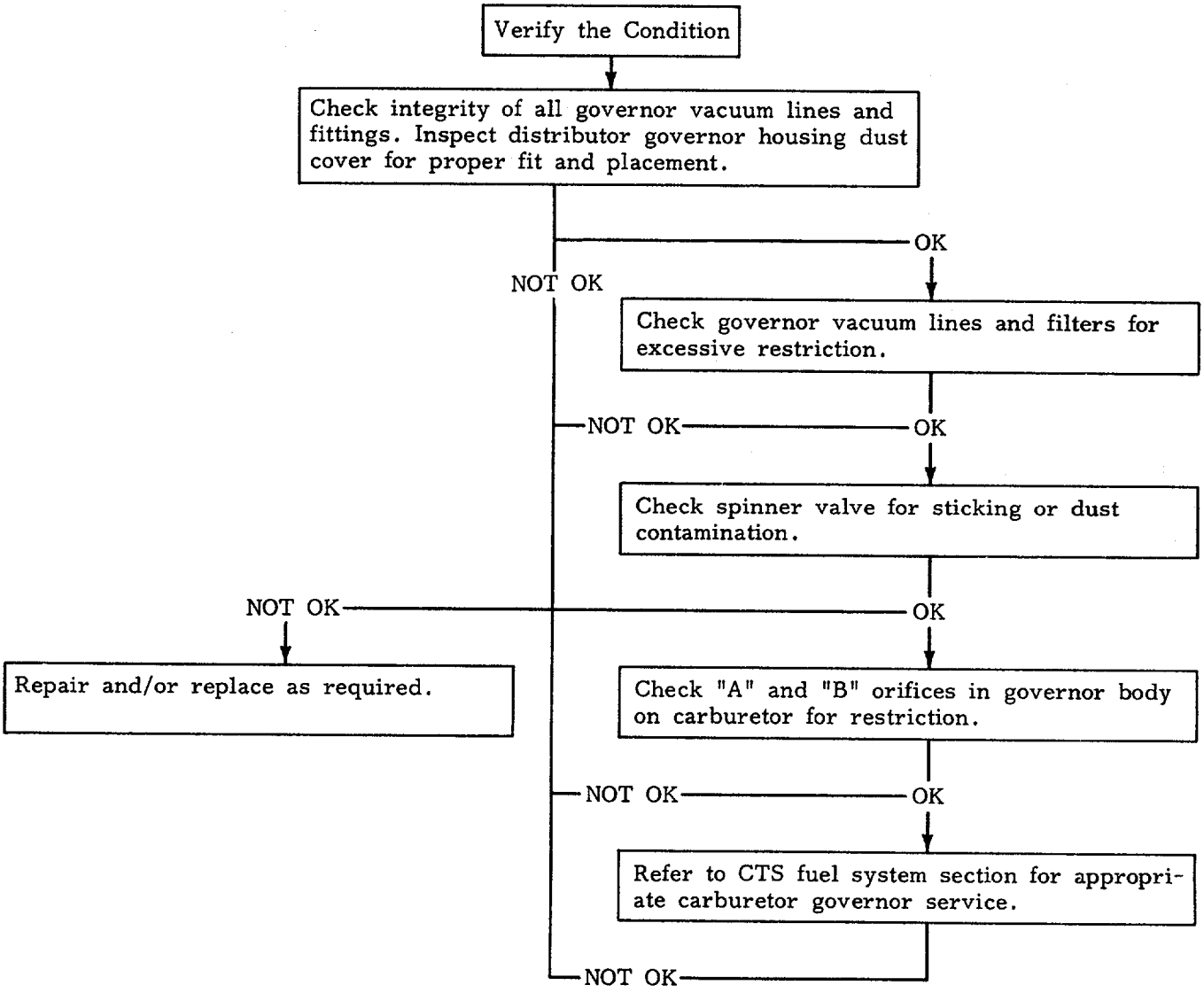
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CHART NO. 25

ENGINE SURGES AT GOVERNED SPEED



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ADDENDUM NO. 1
FUEL SYSTEM VAPOR LOCK

Vapor lock occurs when fuel system components become sufficiently heated to cause fuel to vaporize within fuel lines, filter, or fuel pump at a rate which prevents liquid fuel from reaching the carburetor. Vapor lock is generally associated with hot ambient conditions but can still occur in cooler climates when vehicle or engine is operated under heavy load. Vapor lock conditions are aggravated at higher altitudes.

To trouble shoot a suspected vapor lock condition, proceed as follows:

1. Do vapor lock conditions prevail? Look for hot fuel system components. Does engine run OK when cool?

2. Remove carburetor air cleaner and pump throttle by hand. Observe accelerator pump discharge. Absence of pump shot or weak discharge may indicate vapor lock. Check for presence of fuel in tank. Check for fuel system obstructions.

3. Check fuel pump discharge pressure by removing fuel line from carburetor inlet, connect fuel pressure tester to open end of fuel line (*) and crank engine. A vapor locked fuel pump will produce some pressure, although not necessarily specified pressure. Observed pump pressure as low as 1 to 2 psig indicates that the pump is probably OK but should be checked again when engine is running normally.

(*) NOTE

For this test, do not "tee" pressure tester into fuel line between fuel pump and carburetor. No pump discharge pressure would be observed because fuel vapor would be vented to the carburetor bowl through the open needle valve.

If fuel pump has measurable discharge pressure but does not pump liquid fuel when system is very hot, vapor lock is a likely cause.

4. If vapor lock is suspected as the cause for rough engine operation during cruise or acceleration it may be checked as follows.

"Tee" fuel pressure tester fitting into fuel line between fuel pump and carburetor. Place test gauge in vehicle within view of driver or passenger. Connect to fitting with flexible fuel line. Operate vehicle on highway until rough operation occurs.

Note fuel pressure during rough operation. If pressure drops to zero, vapor lock may be the cause. (Check fuel lines and filter for obstructions.)

Remove fuel pressure tester and fitting from fuel line and allow fuel system components to cool; then check to see that normal engine operation has been restored. If engine does not run, refer to Trouble Shooting Charts 4 or 5.

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ADDENDUM NO. 2
COMPRESSION AND CYLINDER LEAKAGE TESTS

Compression Test

The compression test is performed to measure cylinder compression pressure. The absolute value of compression pressure is significant but cylinder to cylinder variation is even more important. Allowable variation from cylinder to cylinder is:

Lowest cylinder pressure must not be less than 75% of the highest cylinder pressure. Greater variation from cylinder to cylinder indicates need for mechanical repair which should be carried out in accordance with the appropriate CTS ENGINE section. Perform engine compression test as follows:

1. Run engine until normal operating temperature is reached.
2. Remove all spark plugs and install compression gauge in No. 1 cylinder.
3. Remove coil secondary wire from distributor cap and ground it to prevent arcing. Block carburetor throttle open.
4. Connect remote starter switch to starter solenoid or have an assistant available to crank engine.
5. Crank the engine for at least 5 compression strokes or until compression gauge reaches its highest value. Note the number of compression strokes required to reach highest value. Record compression pressure and number of strokes.
6. Repeat the test for each of the other cylinders 7. If one or more cylinders produce a low reading, squirt about a tablespoon of engine oil into low reading cylinders. Repeat compression test on those cylinders.
   a. If compression pressure improves significantly, worn or broken piston rings are at fault.
   b. If compression pressure does not improve, valves are at fault or if two adjacent cylinders have low compression, a leaking cylinder head gasket may be the cause.

Cylinder Leakage Test (CLT)

The cylinder leakage test is supplemental to the compression test and can provide diagnostic information as to the cause for loss of compression. The CLT can identify leakage past intake or exhaust valves, leaking cylinder head gasket, worn or broken piston rings, or other cause for loss of compression.

Perform cylinder leakage test as follows:

1. Run engine until normal operating temperature is reached.
2. Remove spark plugs from engine.
3. Remove air cleaner and block carburetor throttle open.
4. Remove oil filler cap.
5. Remove radiator cap. If coolant is low, fill to prescribed level.
6. Turn crankshaft until No. 1 cylinder is at top dead center on compression stroke.
7. Connect and calibrate cylinder leakage tester in accordance with manufacturer's instructions.
8. Record cylinder leakage (usually in percent) and determine source of leakage by listening for air escaping through carburetor, exhaust system, or crankcase (oil filler tube). Look for air bubbles in coolant (radiator top tank).
9. Carefully turn crankshaft in normal direction of rotation until the next cylinder in firing order sequence is at top dead center. Connect CLT to that cylinder and repeat test.
10. Repeat test for each consecutive cylinder in firing order sequence.

When the cause for loss of compression has been identified, repair engine in accordance with the appropriate CTS ENGINE section.

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ADDENDUM NO. 3

VACUUM SYSTEM HOSE LEAKAGE TEST

Perform engine vacuum system hose leakage test as follows:

1. Install vacuum gauge and tachometer. Care should be taken to insure that vacuum gauge is connected to manifold vacuum and not to some other vacuum such as ported spark or EGR signal vacuum.

2. Start and run engine until normal operating temperature is reached. Then, with engine running at curb idle speed, record vacuum gauge and tachometer reading (baseline).

3. With engine running at curb idle speed, remove each vacuum hose (one at a time) from vacuum source and plug source. When removing vacuum hose to distributor on engines which have straight manifold vacuum advance, apply at least 15 In. Hg. vacuum to vacuum advance using hand vacuum pump SE-2499 to prevent change in spark timing during test.

   As each vacuum circuit is checked, record vacuum gauge and tachometer reading. If no change in reading is observed (from baseline), no vacuum leak exists in that particular vacuum hose circuit. If a change in reading is observed, a vacuum leak does exist in that particular vacuum hose circuit and can be located as follows:

   a. Remove plug and reinstall vacuum hose.

   b. Remove other end of same vacuum hose at next downstream connection and plug.

   c. Record vacuum gauge and tachometer readings.

   d. Repeat steps 4a through 4c at each hose connection until leak is isolated. Leak is isolated to last component checked when reading returns to baseline value. Replace leaking hose(s) or component(s) identified.

5. Continue procedure until the integrity of all vacuum circuits is verified or restored.

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TRUCK SERVICE MANUAL

FUEL SYSTEM
1979
EMISSION CONTROL SYSTEMS
FOR U.S.A.
LIGHT DUTY GASOLINE ENGINES
AND
U.S.A.-CANADA-AUSTRALIA
IH-633 DIESEL ENGINE

This service manual contains 1979 Emission Control Systems used on International Gasoline and diesel engines. Part I includes exhaust emission effects and maintenance intervals charts along with complete tune-up specifications for gasoline engines. Part II is a trouble shooting guide for gasoline engines with reference (IH Truck Service Manual) numbers for individual engine accessory servicing. Part III covers IH diesel exhaust emission effects and maintenance interval chart. Part IV covers trouble shooting guide for diesel engine.

The illustrations and specifications in this service manual are based on the latest information available at the time of publication approval.

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PART 1
EMISSION CONTROL SYSTEMS
AND
SERVICE OPERATIONS

INTRODUCTION

To function effectively, emission control systems must be properly maintained. Because satisfactory emission limits depend upon proper engine operation, the engine must be kept correctly tuned and adjusted.

It is important that maintenance operations be performed at specified intervals as indicated on the following pages.

Service intervals given are based upon **average** operating conditions. Where dusty, frequent start and stop or heavily laden operations are encountered, more frequent servicing will be required.

The required maintenance operations should be performed by an International Harvester dealer, or other service outlet equipped and qualified to perform such services. Any replacement parts used for required maintenance services or repairs of emission control systems should be equivalent in quality and performance to genuine IH parts. Use of inferior replacement parts may result in improper operation of emission control systems.

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EXHAUST EMISSION EFFECTS FOR ALL 1979
INTERNATIONAL ENGINES USED IN SCOUT

		GASOLINE		DIESEL
ENGINE	**4-196**	**V-304**	**V-345**	**IH-633**
Carburetor	1940	2245C	TQ	N/A
Electronic Ignition	Yes	Yes	Yes	N/A
Vacuum Pull-Off Choke	No	Yes	[1]Yes	N/A
Electric Choke	Yes	No	No	N/A
Intergral Choke	Yes	No	No	N/A
Remote Choke	No	Yes	Yes	N/A
Evaporative Canister	Yes	Yes	Yes	N/A
Air Pump	Yes	Yes	Yes	N/A
Exhaust Gas Recirculation	Yes	Yes	Yes	Yes
Ported Spark	Yes	Yes	Yes	N/A
Modulated Air Cleaner	Yes	Yes	Yes	No
Catalytic Converter	Yes	Yes	Yes	No

(1) Used only with automatic transmissions.

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		MAINTENANCE INTERVALS (Kilometers, Miles or Months, Whichever Occurs First)		
DESCRIPTION	OPERATION	Kilometers (Every)	Miles (Every)	Months (Every)
1. Engine Oil and Oil Filter	Change	8000	5000	6
2. Engine Idle Speed (Curb and Fast Idle)	Check - Adjust if Necessary	At 8000	At 5000	At 6
3. Air Cleaner Filter	Replace	24000	15000	18
4. Hot Air Tube to Air Cleaner	Inspect - Replace if Necessary	24000	15000	18
5. Fuel Filter	Replace	24000	15000	18
6. Evaporative Emission Canister, Separator and Hoses	Inspect for Damage or Deterioration Replace if Necessary	24000	15000	18
7. Filter - At Bottom of Evaporative Vapor Storage Canister	Replace	24000	15000	18
8. Fuel Tank and Fuel Lines	Inspect for Damage or Deterioration That Could Cause Leaks - Replace if Necessary	24000	15000	18
9. Fuel Tank Cap and Filler Neck	Remove Fuel Cap and Inspect for Even Imprint from Filler Neck. Check for Indications of Damage to Cap or Filler Neck. Replace if Necessary	24000	15000	18
10. Automatic Choke	Check Operation. Adjust if Necessary	24000	15000	18
11. Exhaust Heat Control Valve (V/8 Only)	Lubricate if Required	24000	15000	18
12. Crankcase Vent Hoses	Inspect for Damage or Deterioration. Replace if Necessary	24000	15000	18
13. PCV Valve	Clean Replace	24000 48000	15000 30000	18 36
14. Flame Arrestor	Clean	24000	15000	18
15. Spark Plugs	Replace - Check Required Voltage	24000	15000	18
16. Air Injection System	Check - Replace Defective Parts	24000	15000	18
17. Ignition Timing	Check - Adjust if Necessary	24000	15000	18
18. Idle Speed and Mixture	Check - Adjust if Necessary	24000	15000	18
19. Drive Belt Tension	Check - Adjust if Necessary	48000	30000	36
20. Distributor Cap and Rotor	Check - Replace if Necessary	48000	30000	36
21. Engine Bolt Torque	Check - Tighten if Necessary	48000	30000	36
22. Ignition Cables	Check Resistance - Replace if Necessary	48000	30000	36
23. Ignition Available Voltage	Check - Replace Coil if Necessary	48000	30000	36

Each numbered maintenance step under Maintenance Description Operations on the Chart is completely explained under the corresponding number in the following text.

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1. CHANGE ENGINE OIL AND FILTER

a. Remove oil drain plug from bottom of oil pan and drain oil.

b. Service oil filter.

Procedure for servicing the spin-on type oil filter is as follows:

(1) Remove oil filter assembly by turning counterclockwise with the hands or a suitable tool Fig. 1. Clean filter mounting pad.

(2) Coat the gasket on the new filter with a film of grease.

(3) Place the new filter in position on the center tube. Hand tighten 1/2 to 3/4 of a turn after gasket first contacts base of mounting pad.

c. Add sufficient oil to bring the oil level between "ADD" and "FULL" marks on oil dipstick (Fig.2).

d. Start engine and run for at least five minutes to warm oil and check for leaks. Recheck and add sufficient oil to bring oil level between "ADD" and "FULL" marks on the oil dipstick.

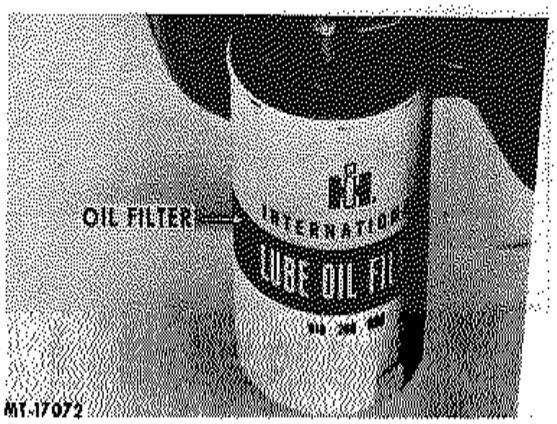


Fig. 1 Typical Spin on Type Oil Filter

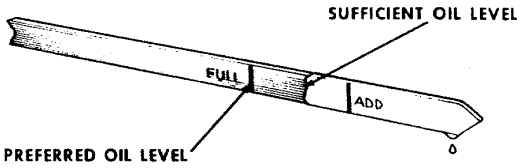


Fig. 2 Proper Oil Level.

Oil types and grades recommended for engines used on IH truck applications are as follows:

GASOLINE ENGINES

Temperature	Straight Viscosity Grade	Multi-Viscosity Grade
20 to 120 F (-7 to 49 C)	SAE 30	SAE 10W-30, 10W-40, 20W-40, 20W-30
0 to 90 F (-18 to 32 C)	SAE 20W	SAE 10W-30, 10W-40, 20W-40, 20W-30
-10 to 70 F (-23 to 21 C)	SAE 10W	SAE 10W-30, 10W-40
Below -10 F (23 C)	----------	SAE 5W-20, 5W-30

Use engine oils meeting service classification "SE" or "CC" (MIL-L-46152).

IMPORTANT

When a universal engine oil (SE-CD) is preferred, the engine oil must have passed the Volvo B-20 cam and tappet test and contain a minimum 0.1% alkyl zinc. IH #1 engine oil now meets this requirement.

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2. CHECK ENGINE IDLE SPEED. CURB AND FAST IDLE ADJUST IF NECESSARY.

A. CURB IDLE SPEED ADJUSTMENT PROCEDURE

Idle speed adjustment must be made with parking brake applied, air cleaner in place, transmission in neutral and air conditioning "OFF".

(1) Warm up the engine to normal operating temperature and connect a tachometer.

(2) With engine running (*solenoid energized), rotate the curb idle adjusting screw in or out against the solenoid plunger to secure specified RPM (see specifications for correct engine RPM).

(3) After the specified RPM has been obtained and with engine still running (solenoid energized), adjusting the low curb idle speed screw until end of screw just touches the stop. Now back off one half turn of the screw to obtain the correct low curb idle speed setting. Test by disconnecting the solenoid wire at the connector. (Do not allow the lead to short circuit on the engine). The solenoid will not advance throttle with the wire disconnected. It will be necessary to manually advance the throttle to obtain a curb idle speed.

(4) Reconnect the solenoid wire after the test

- The V-345 engine does not use a throttle solenoid. Disregard steps (3) & (4) with V-345 engine application.

B. Fast Idle Adjustment (Automatic Chokes)

The following procedure should be used to obtain the correct fast idle setting:

(1) Operate engine until it reaches normal operating temperature.

(2) Shut off engine. Remove air cleaner. Disconnect and plug vacuum signal hose at EGR valve, (hose "1").

(3) Connect tachometer to engine.

(4) With engine stopped, open throttle and move choke plate to full choke (closed) position.

(5) Holding choke plate closed, close throttle. This will hold fast idle cam in full choke position and throttle plate(s) in fast idle position. Fast idle stop screw should rest on top step of fast idle cam with the 4-196 (1 bbl. carburetor) and V-304 (2 bbl. carburetor) engine and on second step of fast idle cam with the V-345 (4 bbl. carburetor) engine.

Verify the fast idle screw location on the fast idle cam for correct position before proceeding to step 6.

(6) Without touching accelerator, start engine. Allow engine speed to stabilize and observe tachometer. Engine speed should be specified fast idle speed. (See Carburetor Specifications.). If necessary, adjust fast idle stop screw to obtain specified fast idle speed.

Throttle linkage (accelerator pedal) must not be moved between Steps (5) and (6). If linkage is disturbed, fast idle cam will not remain in fast idle position and it will be necessary to repeat Steps (4) and (5).

(7) Reinstall air cleaner. Unplug and connect vacuum signal hose. (Hose "1").

3. REPLACE AIR CLEANER FILTER.

Remove air cleaner element, clean any accumulation of dirt from air cleaner housing and carburetor air horn. Replace the element at intervals shown on Maintenance Interval Chart.

If element requires cleaning between replacement intervals, tap element lightly on a flat surface or use low air pressure to remove dirt particles. Blow air from inside filter to outside. Check element for punctures or splits by looking through filter paper toward light held in center of element. Do not wash element.



Fig. 3 Dry Type Air Cleaner Filter.

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4. INSPECT HOT AIR TUBE TO AIR CLEANER; REPLACE IF NECESSARY.

Inspect hot air tube Fig. 4 for proper fit at both the air cleaner and exhaust manifold stove ends. Also, inspect for cracks or holes. If defective, replace with new tube.

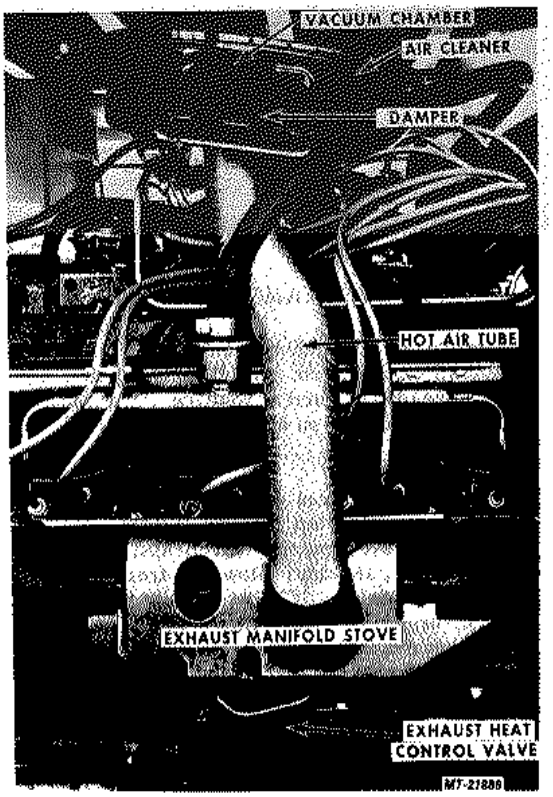


Fig. 4 - Hot Air Tube

4A. Check Operation of Inlet Air System Valve and Service or Replace, if necessary.

Procedure for servicing the sensor controlled vacuum chamber type air cleaner is as follows:

a. Test should be conducted when ambient temperature of the vehicle are less than 24 deg. C. (75 deg. F) and engine started cold. Air cleaner must have all hoses, piping and cover in place. No leakes permitted.

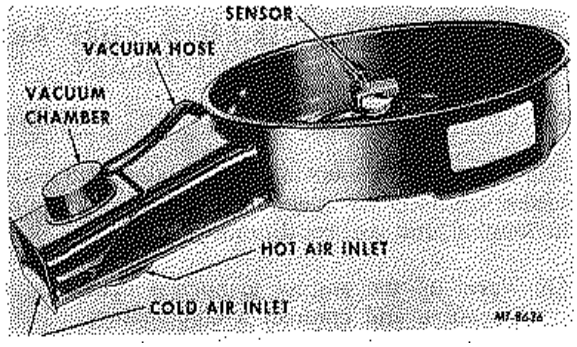


Fig. 5 - Sensor Controlled Vacuum Chamber. Type Air Cleaner

b. With engine off, inlet tube damper should be in full down position (cold air in open) to close heat tube inlet pipe from exhaust manifold stove. Damper position can be determined by looking in end of inlet tube. If damper assembly is not in the correct position, vacuum chamber should be removed and damper movement loosened. Replace vacuum chamber (located on top of inlet tube) and recheck damper position.

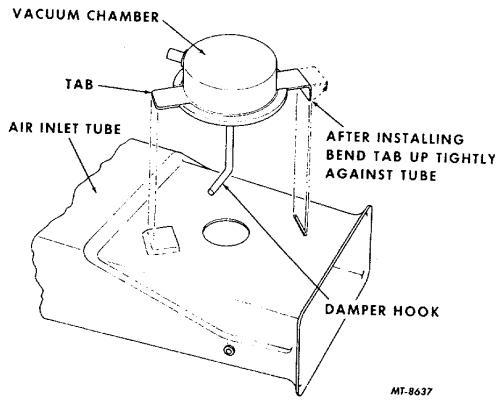


Fig. 6 - Vacuum Chamber Details

To replace vacuum chamber (Fig. 6) (cannot be replaced on air cleaners used on 4-196 engines) bend tab nearest inlet tube entrance down from inside tube. Disconnect vacuum hose and lift vacuum chamber, sliding the rear tab out of its slot disengaging damper hook from damper. Attach new chamber by engaging hook in damper, sliding rear tab into its slot and fitting front tab into place. A spring preload should

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be felt when vacuum chamber is pressed firmly against top of inlet tube. If no preload is felt, check the installation or be sure parts are not faulty. Press front vacuum chamber tab firmly against tube inside surface. Connect vacuum hose.

c. Start engine and note that damper has rotated up to close off cold air inlet. Observe damper position by looking in the inlet tube. If damper did not immediately close cold air inlet, proceed as follows:

(1) Shut off engine and disconnect the two hoses from sensor.

(2) Connect the two hose ends together using suitable tubing.

(3) Restart engine and again check damper location. If damper fully closes cold air inlet, temperature sensor is defective and must be replaced (located inside air cleaner body).

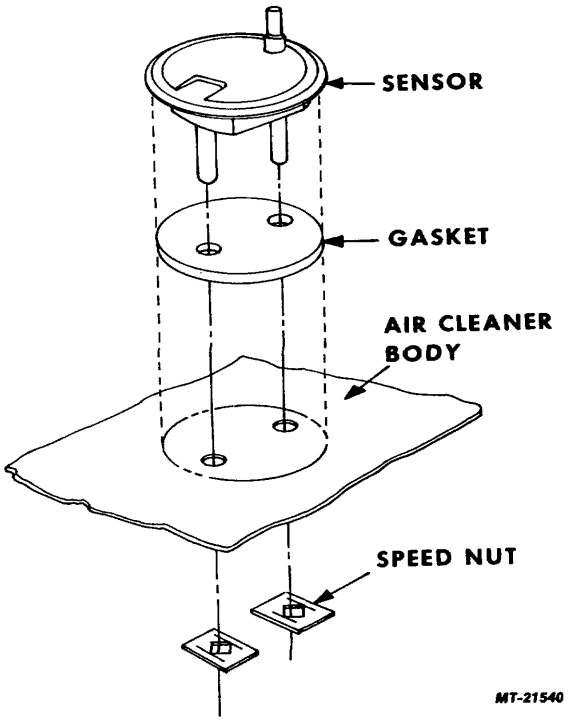


Fig. 4 Hot Air Tube.

To replace temperature sensor, disconnect two vacuum hoses attached to sensor inlet and outlet tubes on underside of air cleaner body. Remove clamps or speed nuts from tubes and life sensor from body. Position new sensor and gasket inside air cleaner body. Firmly press two new speed nuts or clamps on tubes to hold sensor in place. Attach vacuum hoses to sensor tubes. If damper does not close cold air inlet, sensor is okay, but damper has bind or vacuum chamber is defective. Remove vacuum chamber and check damper for free movement. If damper moves freely, replace vacuum chamber.

d. After cold start, operate engine for 10 minutes at medium RPM. When engine is at normal operating temperature, slow engine to idle and observe position of inlet tube damper. If damper has not rotated all or part way down to allow some cold air to enter inlet tube, replace temperature sensor.

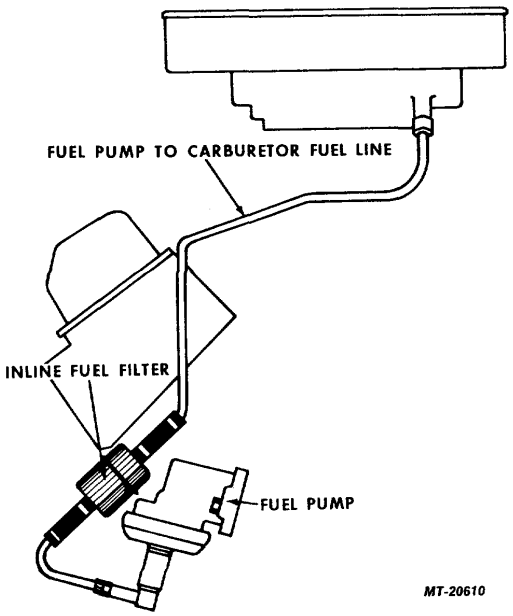


Fig. 8 Inline Fuel Filter Typical on Most Gasoline Engines.

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5. REPLACE FUEL FILTER.

Inline fuel filters are used on most IH engines (Fig. 8). This type of filter is inexpensive and easy to replace when needed. The filter should be replaced at the interval shown on the maintenance chart. Be sure that arrows on filter point in the direction of fuel flow.

6. INSPECT EVAPORATIVE EMISSION CANISTER, SEPARATOR AND HOSES FOR DAMAGE OR DETERIORATION; REPLACE AS NECESSARY.

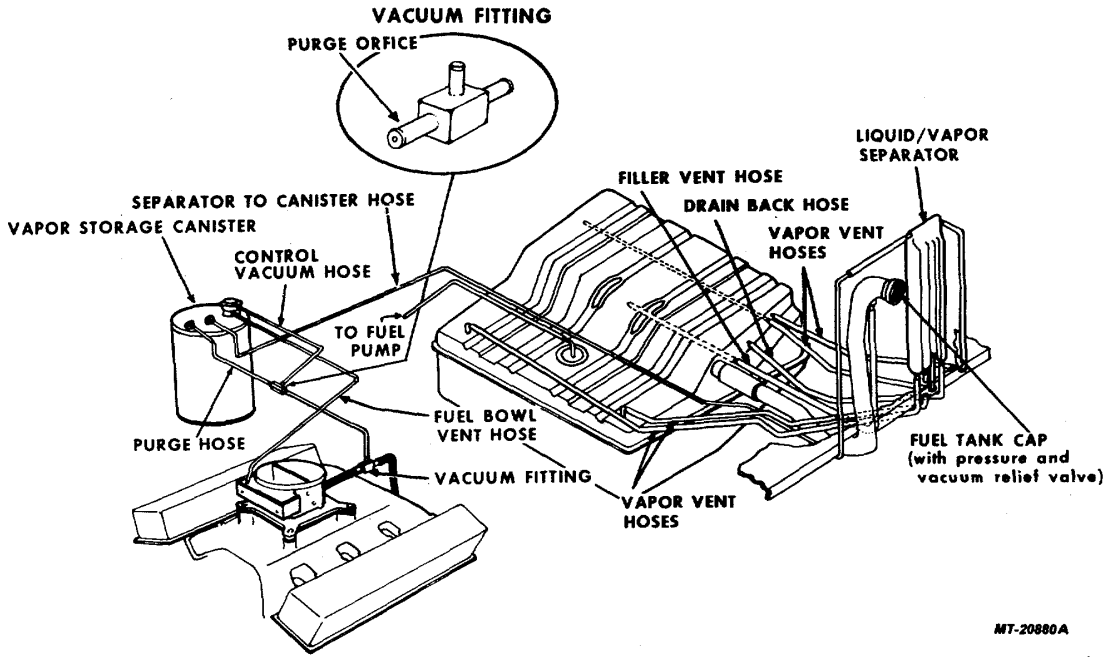
In compliance with air pollution control regulations, all SCOUTS except with diesel engines will utilize gasoline evaporative loss control system which reduces the amount of gasoline vapors entering the atmosphere from the vehicle fuel system see Figures 9 and 10 Evaporative Systems Configurations.

To accomplish evaporative control, the system must perform three basic functions:

(1) Provide space for gasoline expansion due to temperature rise.

(2) Limit escape of gasoline vapors to the atmosphere by collecting and storing vapors generated while vehicle is parked with engine shut off.

(3) Burn off stored gasoline vapors when engine is operating.



GASOLINE EVAPORATION LOSS CONTROL SYSTEM SCOUT SERIES VEHICLES (TYPICAL)

Fig. 9 Gasoline Evaporative Loss Control System - Scout Series Vehicles with 4-196 and V-304 Engines

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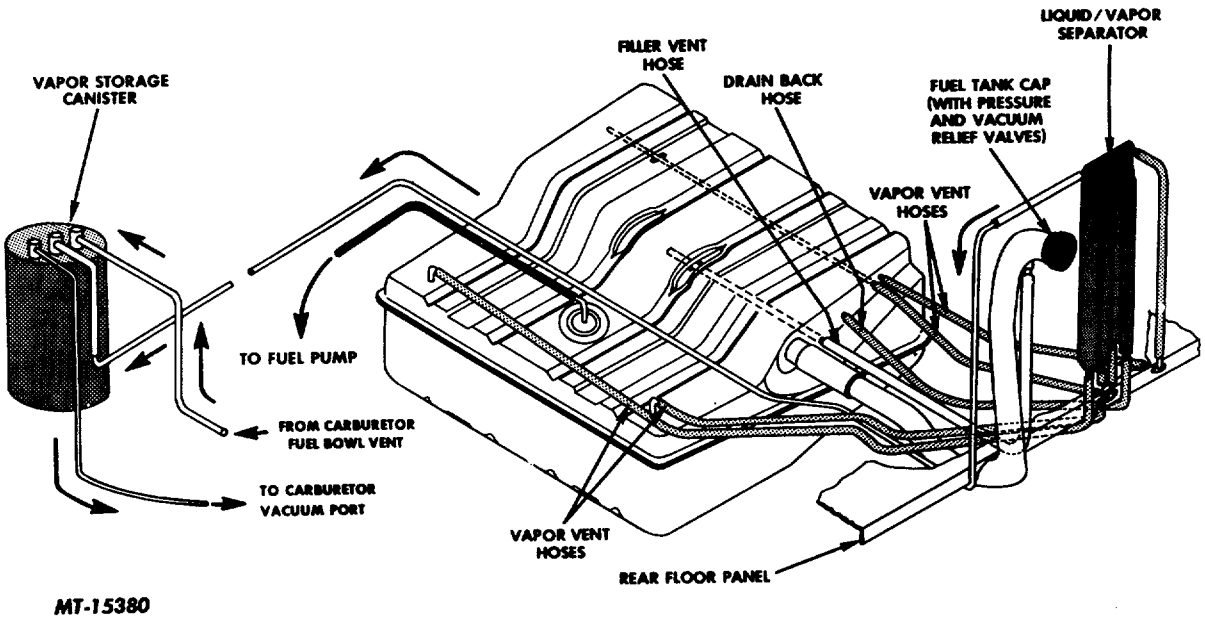


Fig. 10 - Gasoline Evaporative Loss Control Systems with V-345 Engine and TQ Carburetor

General Maintenance

As specified by the maintenance intervals chart, inspect evaporative loss control system (and fuel system) for obvious sources of liquid or vaporous fuel leaking from vehicle.

a. Inspect canister in engine compartment for any cracks or damage to the case, especially in the hose connecting area. Be sure hoses are tightly connected to the correct canister fittings. Replace defective canister or hoses.

b. Inspect vapor separator inside left near quarter panel for any cracks or damage which could cause vapor leakage. Be sure hoses are tightly connected to the separator. Replace defective separator or hoses.

Vapor Storage Canister

When vehicle is parked and engine shut off, gasoline vapors from the carburetor fuel bowl and the fuel tank will be temporarily stored in the charcoal canister until the engine is started. When the engine is started the vapors are drawn from the canister into the engine and burned.

c. Inspect hoses from engine to canister, canister to separator, and separator to tank where visible. Replace hoses which are cracked, damaged or deteriorated.

The vapor storage canister used on Scout vehicles (Fig. 11 and 12) stores both carburetor fuel bowl vapors and fuel tank vapors. Fig. 11 and 12 show the canister ports for proper hose connections.

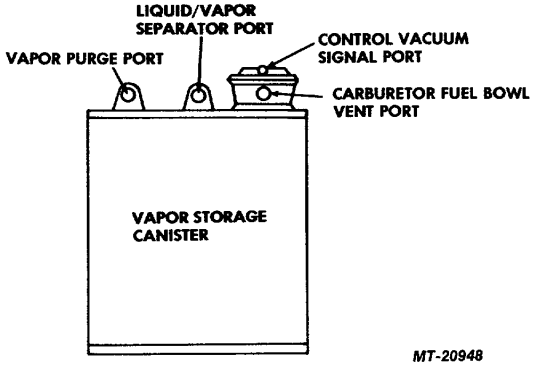


Fig. 11 - Scout Vapor Storage Canister 4-196 and V-304.

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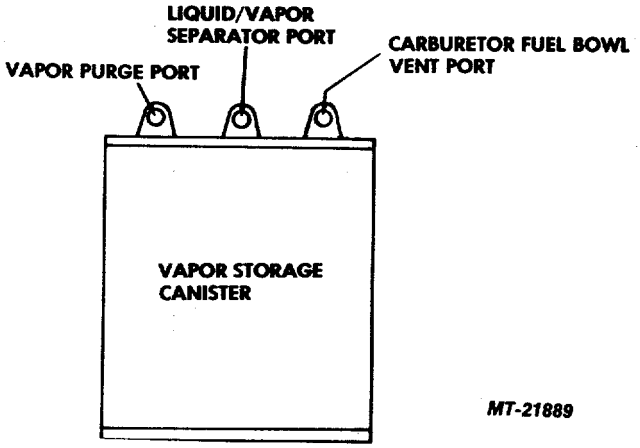


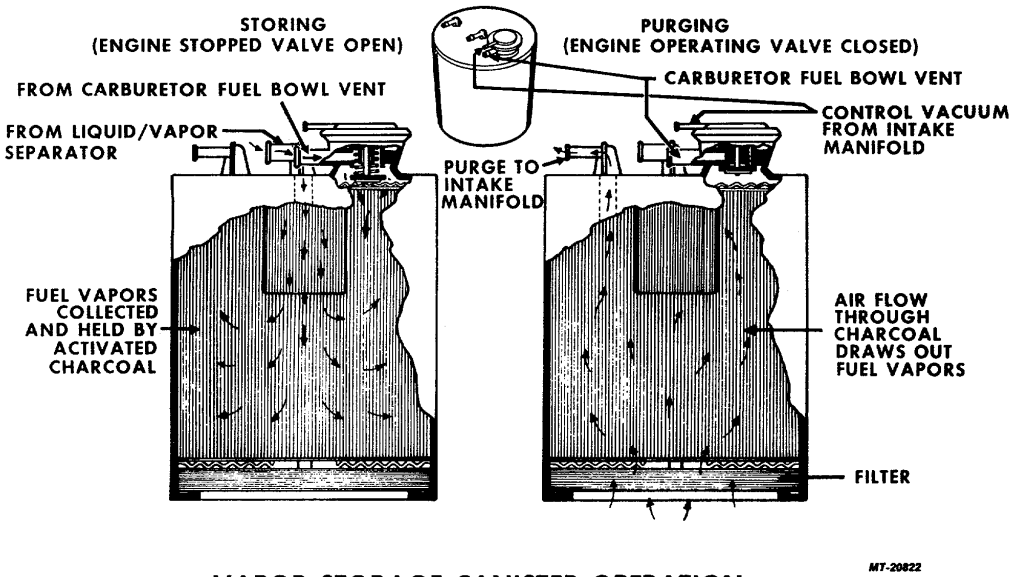
Fig. 12 - Scout Vapor Storage Canister V-345.

The operation of the canister used on Scout vehicles is shown in Figure 13 for 4-196 and V-304 Engines.

Canister Operation Test--4-196 and V-304 Engines

Disconnect control vacuum and purge hoses from canister. With engine running at high idle speed and normal operating temperature, a pull should be felt at each hose end. If no vacuum is felt, reconnect hoses to the proper port on the canister(s) and disconnect at vacuum source on engine. Inspect for obstruction in hoses and hose connecting fittings. Also inspect hoses for cracks, damage or deterioration and replace if necessary.

It is important that canister hoses be connected to the proper manifold fitting.



VAPOR STORAGE CANISTER OPERATION

Fig. 13 - Vapor Storage Canister with Vacuum Controlled Carburetor Fuel Bowl Vent Valve 4-196 and V-304 Engines

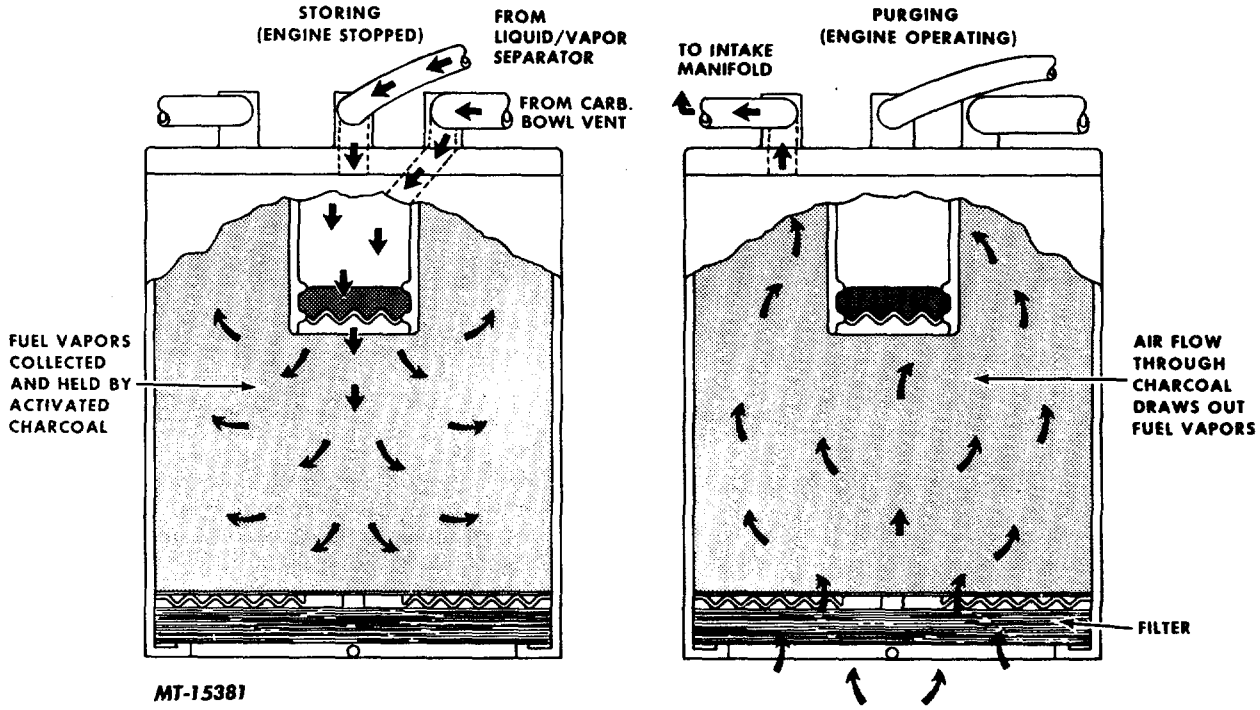


Fig. 14. Vapor Storage Canister for V-345 Engine

Liquid/Vapor Separator

The liquid/vapor separator is located between the inner and outer body side panels behind the fuel tank filler pipe. The liquid/ vapor separator serves to receive any liquid fuel flowing from the fuel tank (due to vehicle maneuvering) and to allow it (liquid fuel) to drain back to the fuel tank, permitting only fuel vapors to flow out the tope of the liquid/ vapor separator to the vapor storage canister.

Canister Control Valve Test

Before starting the following test with hand operated vacuum pump (SE-2499), check pump for leakage (Fig. 15) by placing a finger over the vacuum port and pump until full or near full scale is reached. Watch pump gauge. If vacuum drops rapidly pump is leaking and should not be used for test. If a very slow leak is indicated, the pump may be used if the degree of pump leakage is kept in mind.

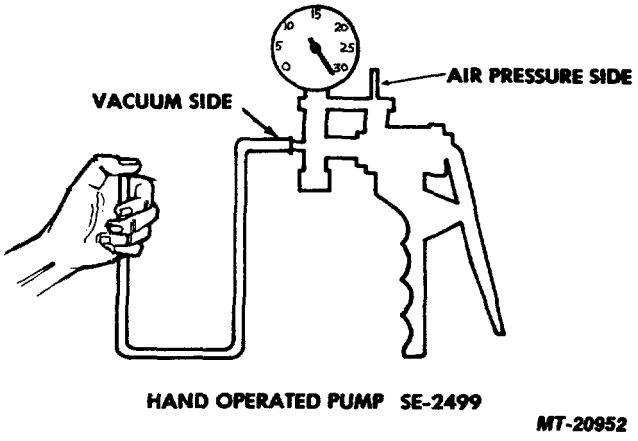


Fig. 15 Check Hand Operated Vacuum Pump SE-2499 for Leakage

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(1) Test canister fuel bowl vent control valve diaphragm by applying vacuum to the control valve port (smaller top port valve assembly) with hand operated vacuum pump gauge (Fig. 16). If vacuum drops rapidly the control valve diaphragm is leaking and the canister must be replaced.

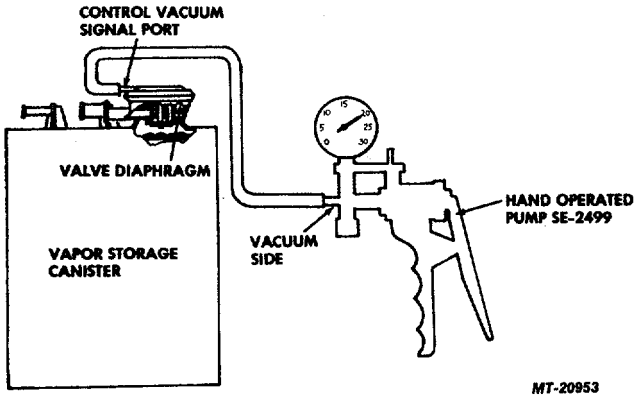


Fig. 16 Canister Fuel Bowl Vent Control Valve Diaphragm Test

(2) The valve seat portion of the fuel bowl vent control valve can be tested by applying vacuum to the control valve (same as diaphragm test Fig. 16) and at the same time (with another hand operated pump SE-2499 using air pressure side of pump) apply air pressure to the valve (Fig. 17) until pressure buildup is felt. If pressure buildup is not felt the valve seat is leaking and the canister must be replaced.

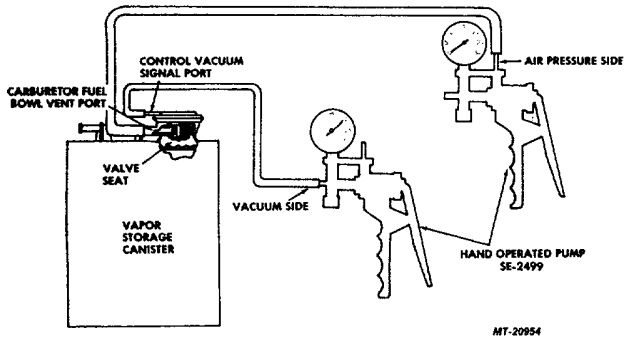


Fig. 17 Canister Fuel Bowl Vent Control Valve Seat Test

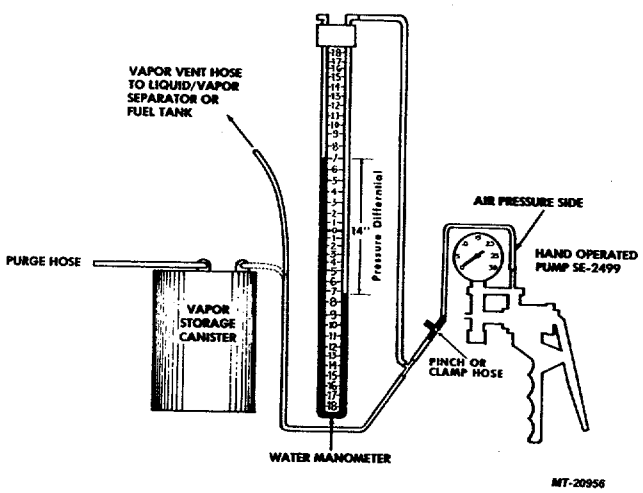


Fig. 18 Method of Pressurizing Vapor Vent System to Check for Leakage

Pressure Test of Vapor Vent System for Leaks Valve Diaphragm Type and Less Diaphragm Type Vapor Canisters

Pressure test fuel tank vapor vent system by disconnecting the center hose on canister leading to separator and connect water manometer (SE-2217 or equivalent) and the air pressure side of hand operated vacuum pump (SE-2499) as shown in Figure 18.

Place sufficient water in manometer to allow 356 mm (14") differential in height. Pump the hand operated air pump until a pressure of 356 mm (14") of water is applied to the system (indicated on the manometer). Pinch or clamp hose between tee and air pump to keep system pressurized. Observe manometer. If pressure drops more than 51 mm (2") of water in five (5) minutes, an excessive leak is indicated.

On a warm day it is possible to observe a pressure rise due to evaporation of fuel. This indicates that system is tight.

If excessive leakage is indicated, first check fuel tank cap for a loose fit on tank filler neck or a damaged cap gasket. If either of these conditions are found, replace cap. If cap-to-filler neck fit and cap gasket are satisfactory, cover relief valve opening in cap (small hole in portion of cap which enters filler neck) securely with tape. Reinstall cap and again pressurize system and check for leakage. If excessive leakage persists,

check all connections in fuel supply and vapor vent system with soap suds solution to locate leaks. Inspect for cracked or damaged liquid/vapor separator, fuel supply or vapor vent tubes or connecting hoses. If no leaks are found and system holds pressure with valve opening in cap covered but loses pressure with valve opening uncovered, it can be assumed that relief valve in cap is faulty. Replace cap.

When pressure testing system following installation of a new fuel tank, it will be necessary to disconnect and plug fuel system line at fuel pump to prevent air leakage through fuel pump and carburetor.

Fuel Tank Cap

Fuel tank caps are nonvented to prevent passing of gasoline vapors directly into the atmosphere.

Scout fuel caps incorporate a vacuum relief valve set to open at approximately 178 to 356 mm of water (7" to 14" H20) and a pressure relief valve set to open at approximately 508 to 1524 mm of water (45" to 60" H20).

The vacuum valve provides an air intake opening to the fuel tank. As fuel is consumed or contracts due to cooling, causing low pressure (vacuum) in fuel tank, atmospheric pressure opens the vacuum relief valve, permitting air to enter the fuel tank. The pressure relief valve acts as a pressure release in case the vapor vent system becomes plugged. Operation of fuel tank cap vacuum relief valve and pressure relief valves is illustrated in Figure 19.

7. REPLACE FILTER AT BOTTOM OF EVAPORATIVE VAPOR STORAGE CANISTER.

The air filter located at the bottom of the vapor storage canister (Figure 20) should be replaced at the interval shown on the Maintenance Intervals Chart, or more frequently under severe dusty conditions.

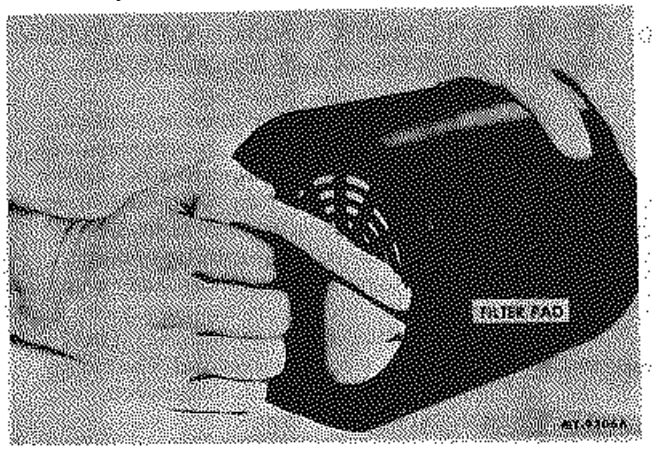


Fig. 20 Vapor Storage Canister Air Filter Location

8. INSPECT FUEL TANK AND LINES FOR DAMAGE OR DETERIORATION THAT COULD CAUSE LEAKS, REPLACE AS NECESSARY.

Inspect fuel tank, fuel lines and connections from the tank to the carburetor for damage, deterioration or leakage. Replace or repair defective or deteriorated components.

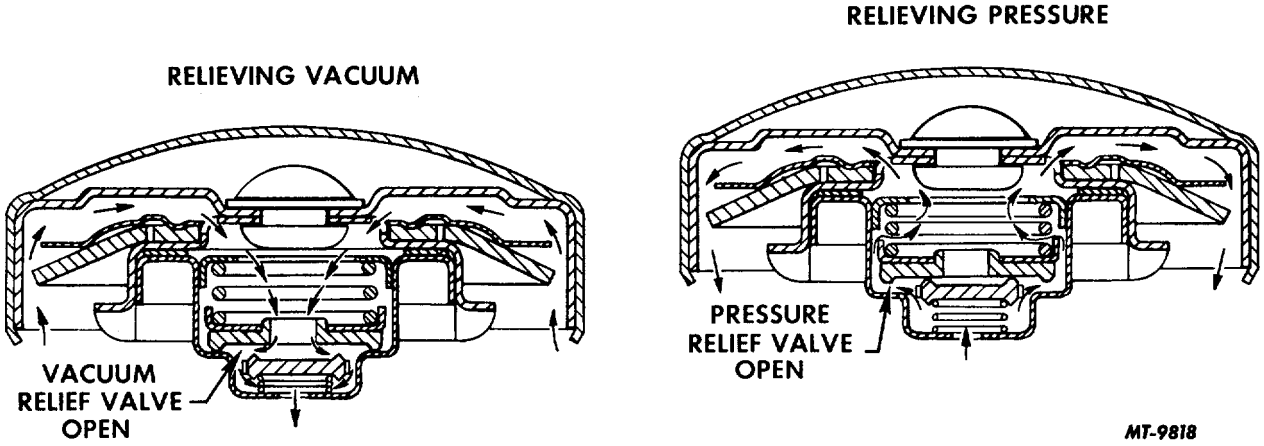


Fig. 19 Fuel Tank Cap Relief Valve Operation

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9. REMOVE FUEL TANK CAP AND INSPECT GASKET FOR AN EVEN IMPRINT FROM THE FILLER NECK. CHECK FOR INDICATIONS OF PHYSICAL DAMAGE TO CAP OR FILLER NECK. REPLACE IF DAMAGED.

If fuel odor is a problem and the cause is not evident from general maintenance inspections, proceed to the Canister Control Valve Test.

10. CHECK AUTOMATIC CHOKE OPERATION; ADJUST OR REPLACE IF REQUIRED.

a. Check choke valve for free operation by opening and closing valve manually. If the choke plate or carburetor choke linkage is sticky, clean with carburetor cleaner. If the choke control doesn't operate freely due to corrosion or distorted parts, replace with new control.

b. See Carburetor Service Manual (fuel systems) for proper preload checking and setting procedures. Service Manuals are as follow:

4-196-Engine Carburetor
1940-CGES110

V-304 Engine Carburetor
2245C-CGES-165

V-345 Engine Carburetor
TQ-CGES130

11. CHECK EXHAUST HEAT CONTROL VALVE V-8 ONLY. LUBRICATE IF REQUIRED. REPLACE, IF NECESSARY.

a. Inspect exhaust heat riser valve for free operation (Figure 21).

b. Free up with solvent, if necessary, while turning valve by hand (valve should turn to closed position when at ambient temperature).

c. If valve cannot be freed with solvent, replace with new valve.

12. INSPECT CRANKCASE VENT HOSES.

Inspect hose from carburetor to flame arrestor on valve cover (Figure 22). Inspect hose from intake manifold to crankcase ventilation valve. Check for cracks or leakage. Replace as required.

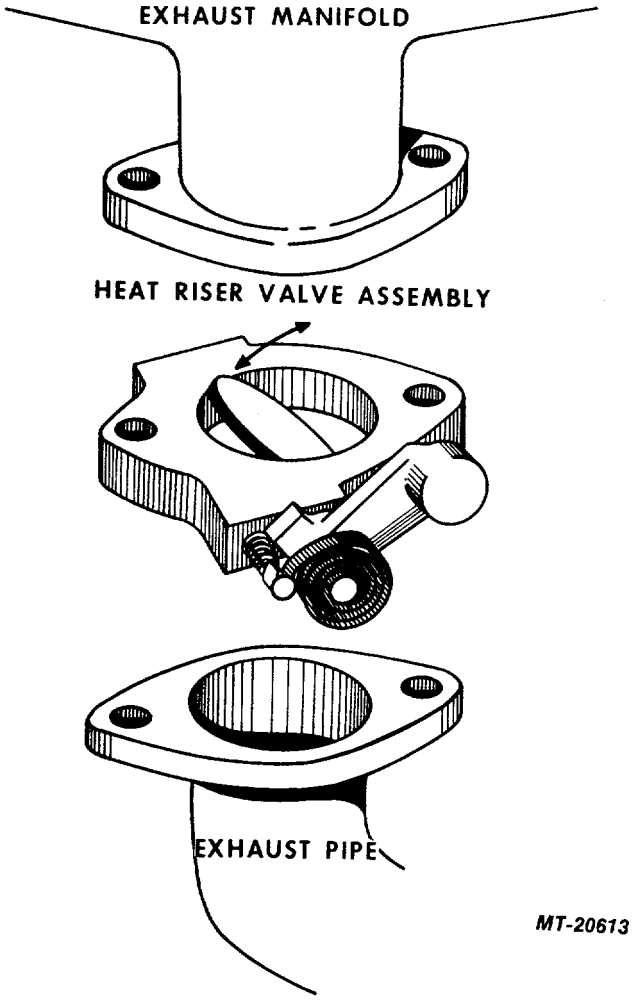


Fig. 21

13. CLEAN PCV VALVE AND CHECK SYSTEM OPERATION.

a. Remove valve from crankcase side, leaving the other end of valve in hose and connected to intake manifold.

b. With the engine operating. a vacuum should be felt at the end of the valve. If no vacuum is present, the valve, hose and fitting should be removed and cause of restriction determined.

c. Check the inner chamber of the valve to see that it can be moved freely. This may be accomplished by inserting a stiff wire into the valve body and observing whether or not the plunger can be readily moved, or shake the valve and listen for rattle.

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If the plunger does not move, soak in carburetor cleaner.

d. Replace PCV valve at every 48000 kilometer, 30000 miles or 36 months.

13A. POSITIVE CRANKCASE VENTILATION VALVE (PCV) OPERATION.

Since the vacuum supply for the PCV system is from the intake manifold, the flow through this system into the manifold must be controlled in such a manner that it varies in proportion to the air-fuel being drawn into the intake manifold.

The PCV valve varies the amount of flow through the system according to the various modes of operation (i.e. idle, cruise, acceleration, etc.). The valve itself consists of a coil spring, valve and a two-piece outer body which is crimped together. The valve dimensions, spring and internal dimensions are such to produce the desired air flow requirements.

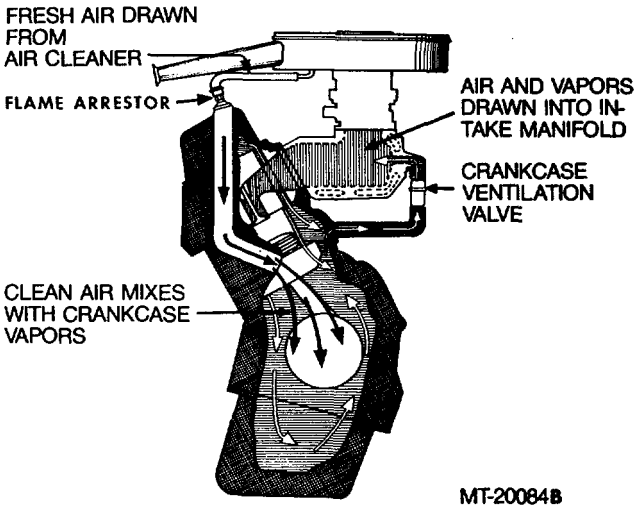


Fig. 22 Typical Air and Vapor Flow Through the System

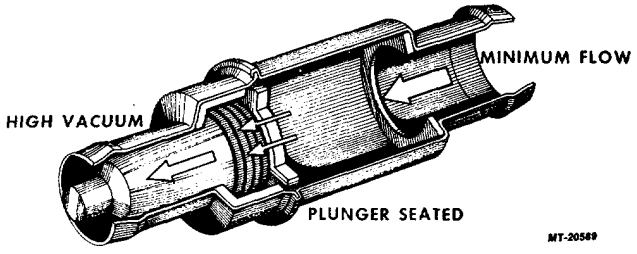


Fig. 23 Plunger Position During Idle or Low Engine Speed

During the periods of deceleration and idle, manifold vacuum is high. The high vacuum overcomes the force of the valve spring and the valve bottoms in the manifold end of the valve housing. This does not completely stop the flow but it does restrict (Figure 23).

When the engine is accelerated or operated at constant speed, intake manifold vacuum is less than at idle or during deceleration. The spring force is stronger than vacuum pull during this mode so the valve is forced toward the crankcase end of the valve housing With the valve in this position, move crankcase vapors flow into the intake manifold (Figure 24).

In the event of a backfire, the valve plunger is forced back and seated against the inlet of the valve body. This prevents the backfire from traveling through the valve and connecting hose into the crankcase (Figure 25). If the backfire was allowed to enter the crankcase, it could ignite the volatile crankcase blow-by gases.

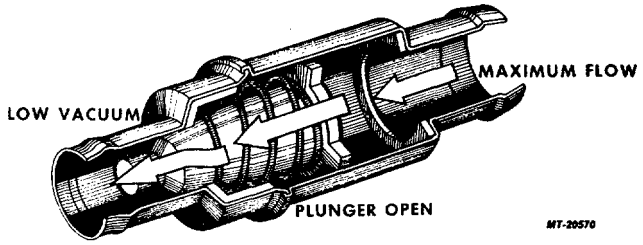


Fig. 24 Plunger Position During High Engine Speed

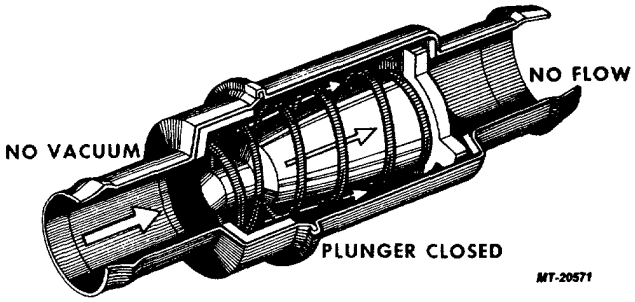


Fig. 25 Plunger Position During Backfire or When Engine is "OFF"

14. CLEAN FLAME ARRESTOR.

a. Remove flame arrestor from engine and soak in carburetor cleaner (Figure 22). blow cleaner from arrestor with compressed air and be sure air does flow freely thru the unit. If okay, reinstall on the engine. If plugged, replace with new.

b. Inspect hose connecting arrestor with air cleaner. Replace hose if cracked or plugged.

15. REPLACE SPARK PLUGS; CHECK REQUIRED VOLTAGE.

a. Remove used spark plugs.

b. Check gap of new spark plugs (see Emission Control System Tune-Up Specifications and adjust gap, if necessary.

To change spark plug gap, bend the outer electrode, never bend the center electrode. Be accurate use a round wire gauge to check the electrode gap.

c. Install new spark plugs and torque to specifications (see Emission Control System Tune-Up Specifications).

d. Install high tension spark plug cables onto spark plug terminal.

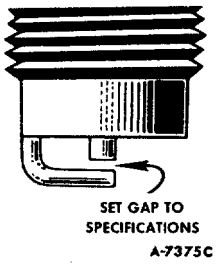


Fig. 26

IMPORTANT

When replacing high tension spark plug cables, be sure cables are routed to proper spark plugs (refer to firing order cast into intake manifold).

e. Connect Tune-Up Scope Tester No. SE-2440, or equivalent.

f. Start and operate engine until normal operating temperatures are reached. Then operate engine at 1000 RPM.

g. Observe required voltage (see Emission Control System Tune-Up Specifications).

h. If required voltage is out of specifications on any cylinder, replace spark plug and repeat steps a through g.

i. If replacing the spark plug doesn't result in acceptable required voltage check ignition cable resistance and condition (see Emission Manual CTS2751 item 22) and check distributor cap and rotor condition (see Emission Manual CTS-2751 item 20).

j. Factors such as compression pressure, ignition timing and fuel air ratio will also have some effect on required voltage.

If none of the preceding tests result in the correct voltage, determine if these factors are to specifications.

16. CHECK AIR INJECTION SYSTEM; REPLACE DEFECTIVE PARTS.

Inspect air pump centrifugal air filter; if clogged or damaged, air pump centrifugal filter can be replaced as follows:

(1) Hold pump pulley from turning and remove pulley mounting bolts.

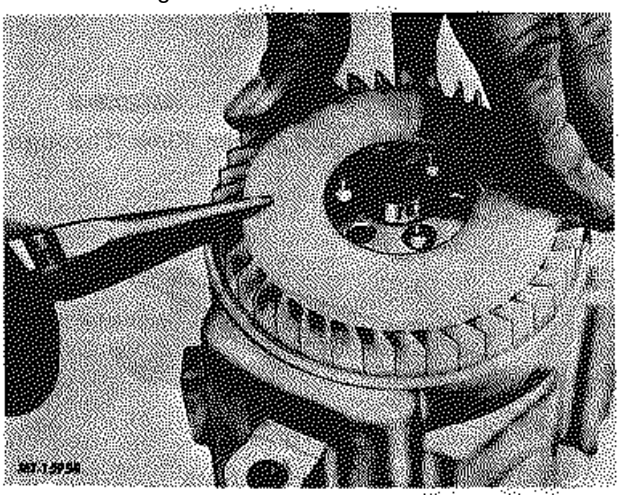


Fig. 27 Removing Centrifugal Air Filter Fan

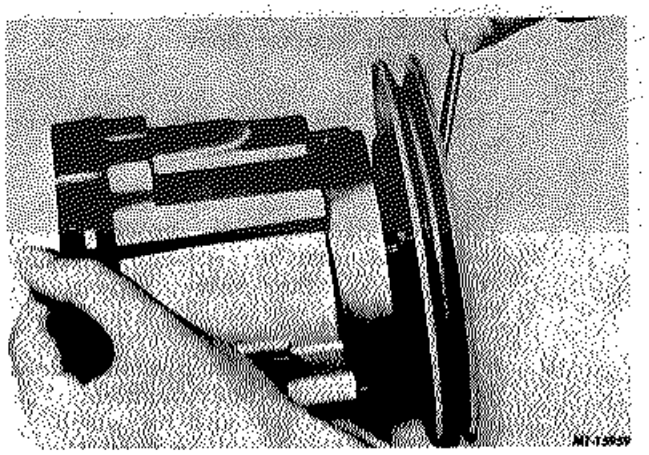


Fig. 28 Installing Centrifugal Air Filter Fan

(2) Insert needle nose pliers and pull filter fan from hub (Figure 27). Care should be taken to prevent fragments of the fan from entering the air intake hole.

(3) Install new filter fan by drawing it on with the pulley and pulley bolts (Figure 28). Do not attempt to install the filter by hammering or pressing it on.

(4) Draw filter fan down evenly by alternately tightening the pulley mounting bolts. Make certain that the outer edge of the filter slips into the pump housing. A slight amount of interference with housing bore is normal.

(5) Hold pulley from turning and torque pulley bolts to 111 N.m (25 ft. lbs.). The new filter may squeal up on initial operation until its outside diameter sealing lip has worn in.

4-196-Engine Air Injection System Functional Test As Follows:

(1) Disconnect Air injection hose from check valve and connect air pump tester SE-2398 or equivalent to end of hose. (The 4-196 engine for MY 1979 uses a 3/4" hose and will require a hose clamp to prevent air leakage at tester connection.)

(2) Connect tachometer to engine.

(3) Remove air hose from intake manifold vacuum tree and plug vacuum tree with 5/8" rubber plug or equivalent.

(4) Operate engine at speeds specified (see Emission Control System Tune Up Specifications CTS-2751) perform the following:

a. Check air hose for leaks, if leaks are found replace hose(s) and repeat system functional test.

b. With engine at steady speed specified (see Emission Control System Tune-Up Specifications) (CTS-2751) check for flow of air from 5/8" hose normally connected to intake manifold. If air flow exists the air by-pass valve ("Gulp" valve) is faulty and must be replaced. After replacement, repeat system functional test.

c. At speed specified in step (4) measure pump output pressure and compare to specification (see Emission Control System Tune-Up Specifications-CTS-2751). If pump output pressure is below the specification and hoses and air bypass valve ("Gulp" valve) are okay, replace pump.

d. Check air bypass valve ("Gulp" valve) function as follows:

(1) Operate engine at speed specified (see Emission Control System Tune Up Specifications).

(2) Remove 3/16 control vacuum from valve and check for a vacuum pull at the end of the hose. If no vacuum is felt, replace hose.

(3) Reconnect control vacuum hose to air by-pass valve ("Gulp" valve) and check for momentary flow of air from 5/8" hose, usually connected to the intake manifold vacuum tree. After a few seconds, flow of air from the 5/8"1 hose should cease. If air by-pass valve ("Gulp" valve) does not function properly, the valve is faulty and must be replaced.

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V-8 Engines

A. Perform air injection system functional test as follows:

(1) Disconnect one air injection hose from check valve and plug end of hose.

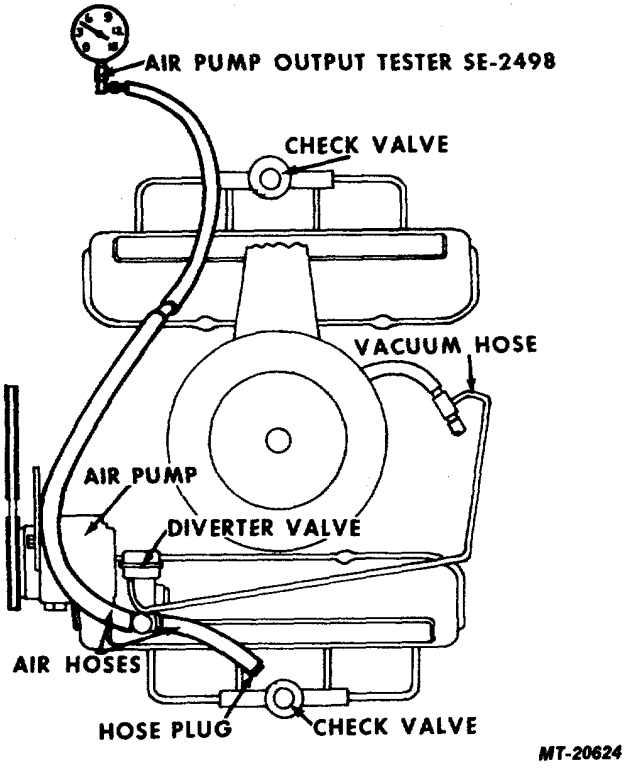


Fig. 29 Checking Air Injection System Output (Small V-8 Engine Shown)

(2) Disconnect other air injection hose from check valve and connect air pump tester SE-2498, or equivalent, to end of hose.

(3) Connect tachometer to engine.

(4) Operate engine at speed specified (see Emission Control System Tune-Up Specifications).

(5) Observe air pressure indicated. If air pressure does not exceed minimum specification (see CTS-2751 Emission Control System Tune-Up Specifications) perform the following steps, B, C and D.

B. Check air hoses for leaks. If leaks are found, replace hose(s) and repeat step A.

C. Check for flow of air through diverter valve external exhaust ports.

If air flows through diverter valve external exhaust ports, valve is faulty and must be replaced. After replacing diverter valve, repeat step C.

D. If the air pump output pressure does not meet minimum specifications, pump output is low and the pump must be replaced. When installing a new pump or adjusting the air pump belt tension, do not pry on the pump housing.

E. Check diverter valve divert function as follows:

(1) Operate engine at speed specified (see Emission Control System Tune-Up Specifications).

(2) Remove vacuum hose from diverter valve and check for a vacuum pull at the end of hose. If no vacuum is felt, replace hose.

(3) Reconnect vacuum hose from diverter valve and check for momentary flow of air through the diverter valve exhaust ports. After a few seconds flow of air through the diverter valve exhaust ports should cease. If divert valve does not function properly, valve is faulty and must be replaced.

16A. AIR INJECTION SYSTEM OPERATION.

The air injection system forces air into the cylinder head exhaust ports to promote "after-burning" of any combustibles remaining in the exhaust gases flowing from the combustion chamber. The components of the air injection system are illustrated in Figure 30 for V8's and Figure 33 for the 4 cylinder engines.

The air pump used in the air injection system is a rotary vane type which is belt driven from the engine. A centrifugal type air filter located behind the pump pulley filters the air entering the pump to prevent entrance of dirt and abrasives (Figure 31).

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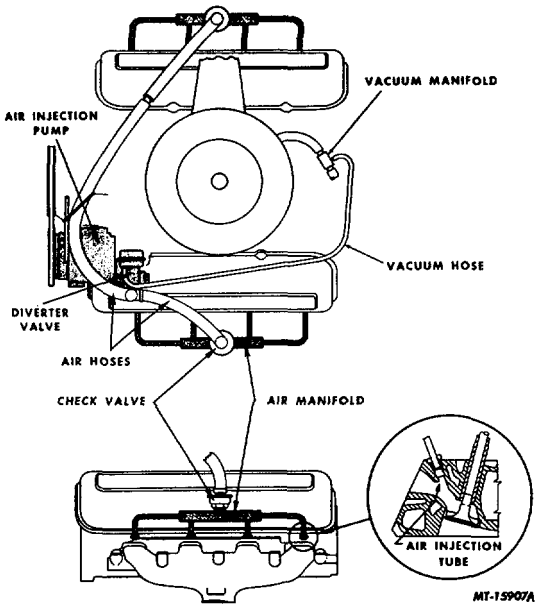


Fig. 30 Air Injection System Used on Small V-8 Engine

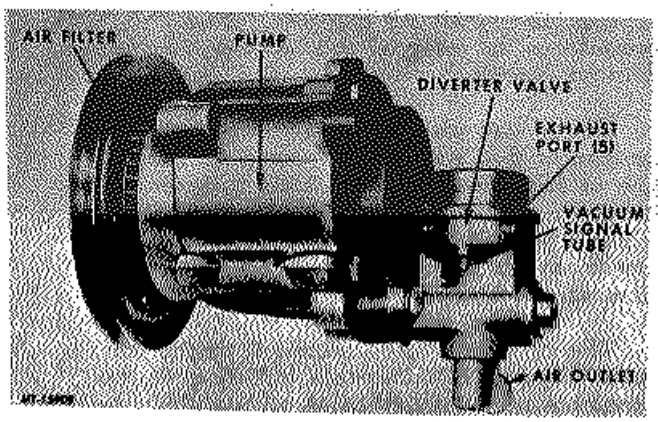


Fig. 31 Air Injection Pump With Diverter Valve

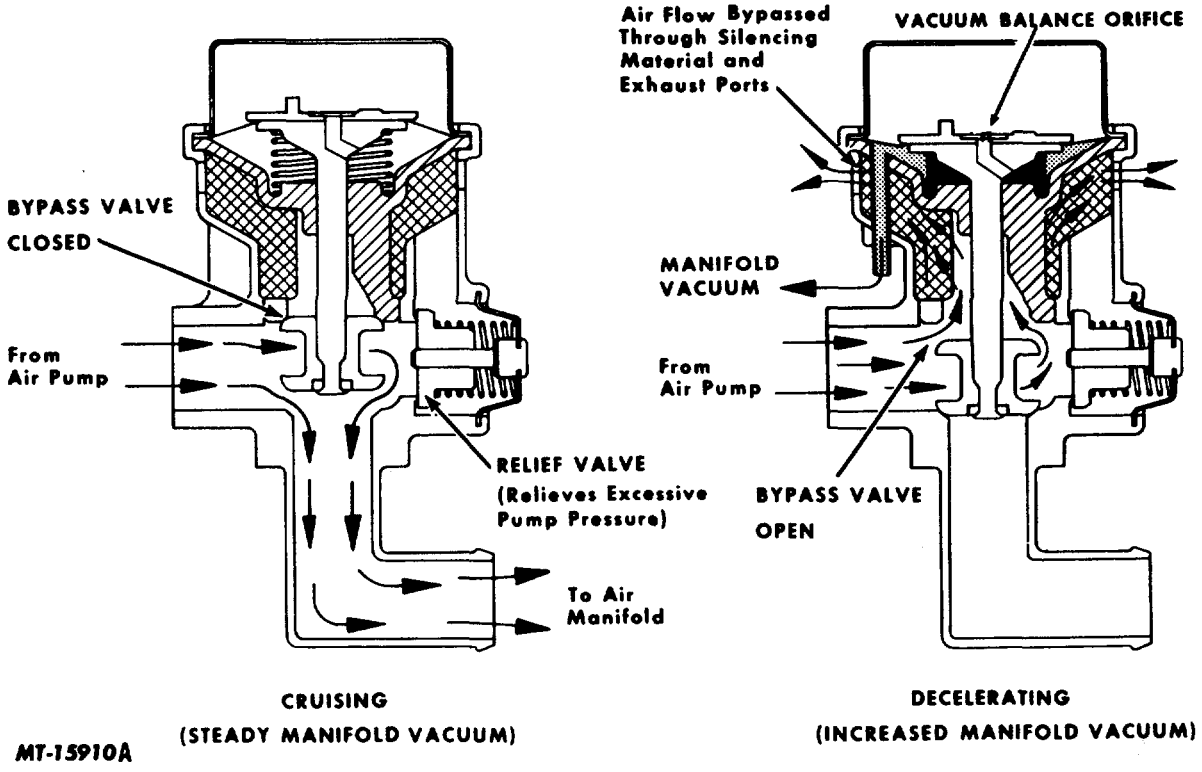


Fig. 32 Diverter Valve Operation

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The air manifold distributes air under pressure from the pump to the individual exhaust ports in the cylinder heads. Figure 30 shows the location of the air manifolds on the small V8 engines. The air manifold is an integral part of the V8 engine cylinder heads.

A one-way check valve is used on each air manifold to protect the pump from a back flow of high temperature exhaust gases. Stainless steel air injection tubes are used in small V8 cylinder heads to direct the air flow from the air manifold to a p6int just "downstream" of the exhaust valves.

The diverter valve attached to the air pump (Figure 31) prevents backfire in the exhaust system by shutting off air flow during the first few seconds of deceleration. The diverter valve also incorporates a pressure relief valve which exhausts excessive pump outlet air pressure during high speed operation. Operation of the diverter valve is illustrated in Figure 32.

In normal operation (cruising) the air pump delivers air through the air manifolds into the cylinder head exhaust ports. With the addition of air from the air injection system, an overrich mixture can cause backfire in the exhaust system. To prevent backfire, the diverter valve momentarily stops the flow of air to the cylinder head exhaust ports during deceleration.

The diverter valve is controlled by intake manifold vacuum. At constant manifold vacuum spring pressure holds the valve in normal delivery position. This permits air to flow from the air pump to the air manifolds. During deceleration high manifold vacuum overcomes spring pressure and moves the valve to bypass position. This closes the outlet port and bypasses the air flow through the internal silencer to the atmosphere. The valve returns to normal delivery position when the vacuum being applied to the diaphragm is balanced through the orifice to the chamber on the other side of the diaphragm. Operating cycle time for the valve is approximately six seconds. In cases of high pump output air pressure (due to high engine speed, etc.), the pressure relief valve opens and exhausts excessive air flow through the internal silencer to the atmosphere.

The 4-196 model year 1979 Scout engine does not use a diverter valve as described for the V-8 engine. In order to control excessive hydrocarbon emission on upshifts the 4-196 emission system incorporates an air by-pass valve ("Gulp" valve), Figure 33, which diverts air flow during the first few seconds of deceleration from exhaust ports to the intake manifold. This prevents backfire in the exhaust system and also reduces emissions, due to leaning the intake mixture.

The "Gulp" valve is controlled by intake manifold vacuum. At constant manifold vacuum spring pressure holds the valve in normal delivery position. This permits air to flow from the air pump to the air distribution manifold and into the exhaust ports. During deceleration high manifold vacuum overcomes spring pressure and moves the valve to by-pass position. This closes the normal outlet port and by-passes the air flow to the intake manifold vacuum "toll". The valve returns to normal delivery position when the control vacuum being applied to the diaphragm is balanced through an internal orifice to a chamber on the other side of the diaphragm operating cycle time for the "Gulp" valve is less than 3 seconds. Since the "Gulp" valve does not incorporate an internal pressure relief feature the air pump used with the "Gulp" valve system is equipped with a calibrated relief valve and silencer. In cases of high pump output pressure (due to high engine speed, etc.) the pressure relief valve opens and exhausts excessive air flow through the air pump mounted silencer to the atmosphere.

AIR INJECTION SYSTEM

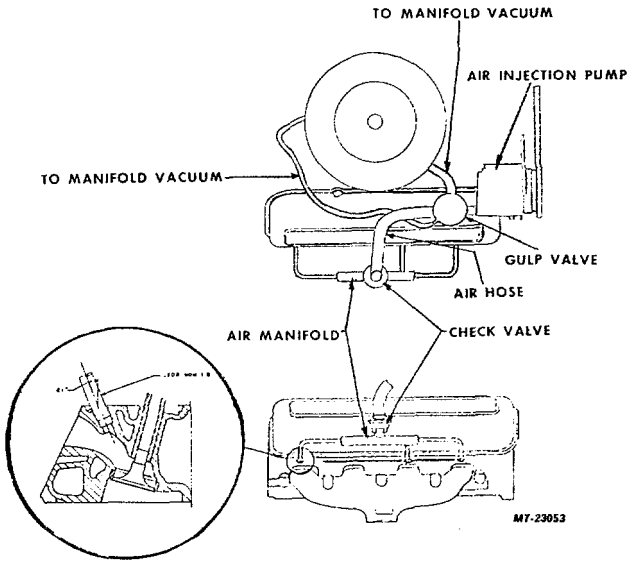


Fig. 33 Air Injection Used on 4-Cylinder Engine

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17. CHECK IGNITION TIMING AND ADJUST IF NECESSARY.

a. Connect timing light.

b. Disconnect and plug vacuum advance hose.

c. Start engine and operate until normal operating temperatures are reached.

d. Observe engine idle speed. Speed must be within specifications (see Tune-Up Specifications); adjust speed to specifications, if necessary.

e. Observe initial advance with timing light.

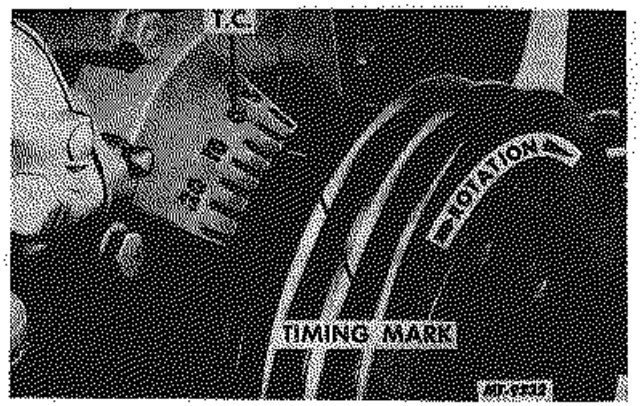


Fig. 34 Typical Location of Timing Marks (Small V-8 Shown)

f. Loosen distributor clamp and adjust to specifications, if necessary (see Emission Control System Tune-Up Specifications). Tighten distributor clamp and recheck initial advance.

g. Stop engine.

h. Reconnect vacuum advance hose and remove timing light.

18. CHECK CARBURETOR AIR/FUEL MIXTURE ADJUST, IF NECESSARY.

Idle speed and fuel mixture adjustments must be made with parking brake applied, air cleaner in place, transmission in neutral and air conditioning "OFF".

When making idle adjustments, disconnect vacuum purge hose from charcoal canister and plug hose. It is important that the vacuum supply hose to the vacuum controlled bowl vent switch remains connected for idle adjustment on vehicles using charcoal canisters with vacuum controlled bowl vent switches.

To compensate for fuel and temperature variations when setting idle mixture, observe these precautions:

a. Do not idle engine continuously for more than three minutes at one time.

b. After each three minutes of idling, increase engine speed to 2000 rpm for one minute.

c. Continue with idle adjustment procedure. Do not idle engine for more than three minutes without repeating Step b.

Winter grade gasolines, being more volatile than summer grade, can yield vapors which result in excessively rich or erratic air/fuel mixtures, particularly at high engine temperatures. Because of this, care must be taken when making carburetor idle mixture adjustments with the exhaust analyzer. Attempts to adjust the idle mixture screw(s) leaner to overcome a rich mixture caused by evaporation of winter grade fuel at high engine temperatures can result in an extremely lean mixture and associated starting and driveability problems when vehicle is restarted when the engine is cold. Therefore, with winter grade gasolines, observe the following additional precaution:

> Idle mixture adjustments must be made as soon as possible after engine will run without choke (choke plate fully open) -before engine temperature becomes sufficiently high to cause evaporation of winter grade gasolines.

Enrichment of the idle mixture by fuel evaporation can be detected by observing test meter readings. Reading should remain stable. A gradual increase in engine idle speed (RPM) or a tendency for the CO meter to climb toward the rich side without any adjustments being made indicates a richening of the mixture due to fuel evaporation. When this condition occurs engine should be allowed to cool before making final mixture adjustments.

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Fig. 35 Exhaust Analyzer -- SE-2507

Setting Procedure: With Exhaust Analyzer

a. Connect test tachometer to engine. (Tachometer should have an expanded scale of 400 to 800 or 0 to 1000 RPM and 1 to 2% accuracy.)

b. Disconnect air injection hose(s) at air manifold check valve(s) and plug air manifold check valve(s)

c. Operate engine until it reaches normal operating temperature (unless winter grade gasoline is used).

d. Adjust curb idle speed to specifications (see Tune-Up Specifications).

e. Prepare Exhaust Analyzer SE-2507, or equivalent, and insert exhaust sample probe into vehicle's tailpipe (refer to test equipment manufacturer's instructions for preparation and hookup procedures).

It is necessary to connect a tailpipe extension to vehicles equipped with V-345 engines in order to obtain a correct idle mixture reading since these vehicles incorporate a tailpipe diffuser which prevents insertion of the exhaust sample probe -into the vehicle's tailpipe.

f. Observe percent of carbon monoxide (% CO) indicated on analyzer dial and adjust idle mixture screw(s) to obtain specified CO setting (see Emission Control system Tune-Up Specifications), if necessary.

g. Readjust idle speed, if necessary, and readjust mixture screw(s) to provide the specified CO setting at the specified speed.

h. If specified CO setting cannot be obtained, establish proper mixture screw(s) setting as follows:

(1) Remove limiter cap(s). To prevent damage to screw threads or seat, file or grind away the side of the cap. Do not pry cap off.

(2) Gently seat idle mixture screws (not required on 4-196 engine).

(3) Adjust idle speed and mixture screw(s) (equal number of turns) to provide the specified CO setting at the specified speed.

(4) Install new plastic (service) limiter cap(s) with tab in the mid position.

i. Disconnect test equipment from engine and reconnect air injection hose(s) to air manifold check valve(s).

Setting Procedure: Without Exhaust Analyzer

a. Connect tachometer to engine. (Tachometer should have an expanded scale of 400 to 800 or 0 to 1000 rpm and 0 to 2% accuracy.

b. Remove limiter cap(s). To prevent damage to screw threads or seat, file or grind away the side of the cap. Do not pry cap off.

c. Set idle screw(s) to position noted before removal of caps if screw position changed while removing limiter cap (s).

d. Operate engine until it reaches normal operating temperature.

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e. Adjust idle speed to curb idle speed specification.

f. Gently seat idle mixture screws (not required on 4-196 engine).

g. Carefully, adjust idle mixture screws counterclockwise (equal number of turns) to provide maximum idle speed. Do not turn screw(s) any further than point at which highest RPM is first obtained. This is referred to as lean best idle.

h. Carefully adjust curb idle speed screw to give engine speed per specifications (see Emission Control System Tune-Up Specifications).

i. As final adjustment, turn mixture screw(s) clockwise (equal number of turns) to obtain specified drop in engine RPM. Final idle speed should correspond to specified curb idle speed.

j. Install new plastic (service) limiter cap(s) with tab in mid position.

19. CHECK DRIVE BELT TENSION.

Check air injection pump drive belt. Air injection pump drive belt tension can be checked with belt tension gauge SE-2312 (Figure 36) or by the deflection method (Figure 37). Check tension or deflection at mid-point between the pulleys. Apply gauge to the longest belt span. Instructions for checking with gauge are as follows:

(1) Grasp gauge and depress ball handle all the way down. Make certain hook extends beyond legs to pick up the belt.

(2) Apply gauge to belt. Be sure belt is positioned between nose piece and hook and that the nose piece is centered on belt.

(3) Release ball handle quickly. A slow release may prevent full return of hook, thus giving a false reading.

(4) Observe the area of gauge face indicated at the index mark. If index mark does not indicate a NEW reading on a new belt or a USED reading on a used belt, it will be necessary to increase or decrease belt tension as required.

(5) Before changing belt tension, repeat Step (3) several times to become familiar with gauge operation. Observe gauge reading each time operation is repeated. Check tension of both belts when so equipped.

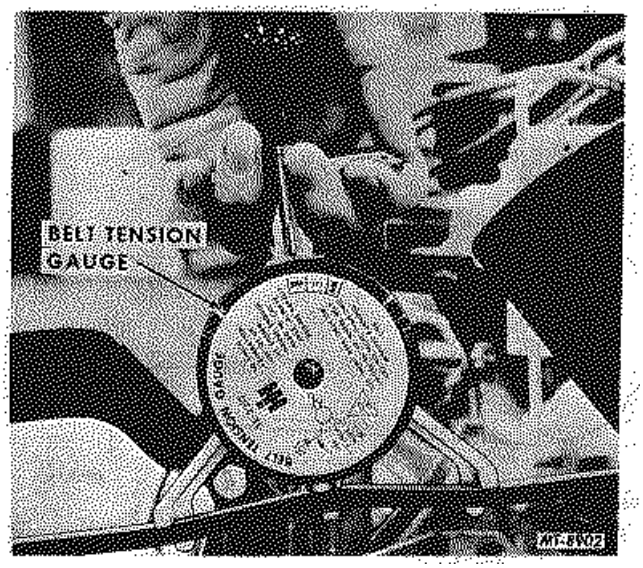


Fig. 36 Checking Belt Tension With SE-2312 Gauge

To establish tension of a loose belt, apply SE-2312 gauge to belt and make the adjustment. Tighten belt until proper area for belt is indicated at index mark on gauge. Lock adjustment and recheck belt tension. Readjust as necessary.

When using SE-2312 belt tension gauge, remember to set new belts (belt with less than two minutes running time) to the NEW area on gauge face and used belts (more than two minutes running time) to USED area on gauge.

Fan and Accessory Belt Adjustment

Conventional "V" belts are used on the engine to drive the various accessories. Belt tensions are as follows:

BELT WIDTH	DEFLECTION PER .3 METER (1 Ft.) OF SPAN
9.5 mm (3/8")	12.7 mm (1/2")
12.7 mm (1/2")	10.3 mm (13/32")
17.5 mm (11/16")	10.3 mm (13/32")
19.1 mm (3/4")	11.2 mm (7/16")
22.2 mm (7/8")	12.7 mm (1/2")
25.4 mm (1")	14.3 mm (9/16")

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IMPORTANT

When tightening the alternator belt tension, apply pressure only to the laminations centered between the end frames.

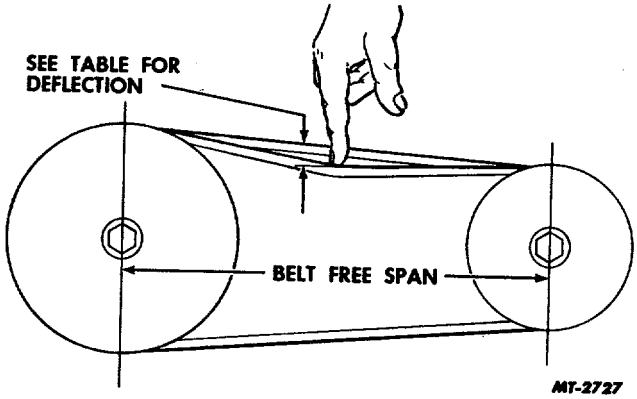


Fig. 37 Checking Belt Tension Deflection Method

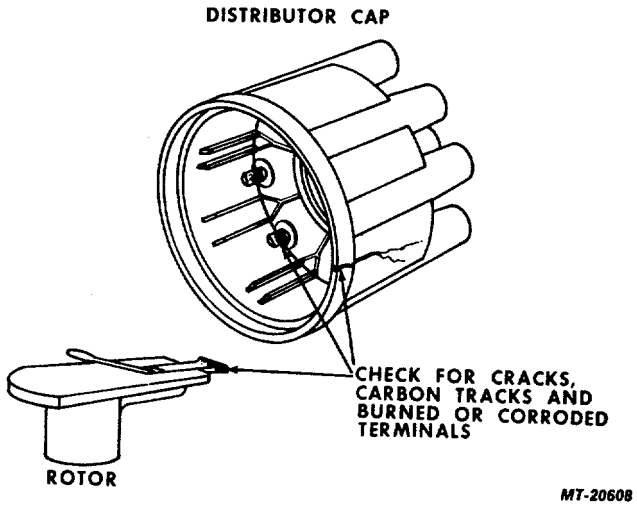


Fig. 38 Inspect Distributor Cap and Rotor

20. CHECK DISTRIBUTOR CAP AND ROTOR; REPLACE, IF NECESSARY.

a. Remove distributor cap and rotor.

b. Clean and inspect distributor cap and rotor for cracks, carbon tracks and burned or corroded terminals. Figure 38.

c. Check rotor blade and spring for tightness. Check fit of rotor on distributor shaft. Check resistance type rotor with ohmmeter (Figure 39). If resistance exceeds 6000 ohms, replace rotor.

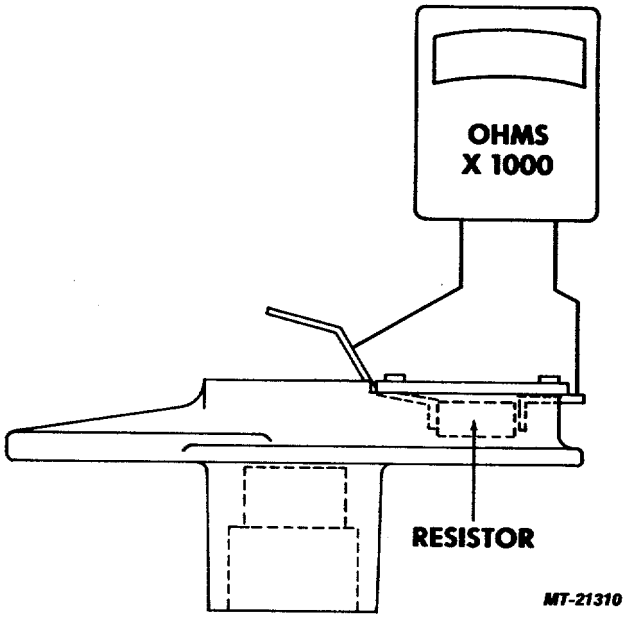


Fig. 39 Rotor Resistance Test

d. Replace rotor, if defective, and install in distributor.

e. Replace cap, if defective, and connect high tension cables to cap.

21. ENGINE BOLT TORQUE.

Check and tighten, if necessary. Torque carburetor, intake manifold and exhaust manifold mounting bolts (see Tune-Up Specifications).

22. CHECK IGNITION CABLES, CHECK RESISTANCE REPLACE, AS REQUIRED.

a. Remove high tension cables from spark plugs.

b. Using Engine Performance Tester No. SE-2576 or equivalent, measure resistance of each cable by connecting ohmmeter leads to spark plug end of cable and terminal inside distributor cap.

c. If resistance exceeds specifications (see Emission Control System TuneUp Specifications), replace high tension cable(s).

d. Reinstall cap onto distributor.

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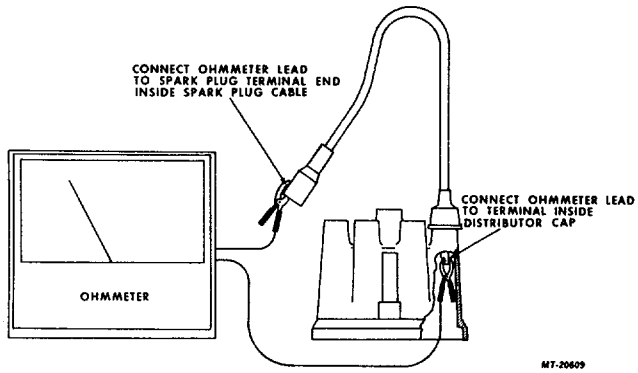


Fig. 40 Checking Ignition Cables With Ohmmeter

e. Inspect high tension ignition cables for cracks or deterioration and replace defective cables.

23. CHECK IGNITION AVAILABLE VOLTAGE; REPLACE COIL, IF NECESSARY.

a. Connect SE-2576, or equivalent, testequipment.

b. Start and operate engine until normal operating temperatures are reached. Then, increase engine speed to 2500 RPM.

c. Record coil output voltage, longest plug wire should be disconnected for this test. Keep engine running time with the longest plug wire disconnected to a minimum when checking coil output voltage. If coil output voltage is not within specifications (see Tune-Up Specifications), proceed as follows:

d. Measure the D.C. voltage at the positive terminal of the ignition coil with the engine at idle speed and record.

e. Measure battery terminal D.C. voltage with engine at idle speed and record.

f. If coil positive terminal voltage is less than battery terminal voltage by more than .5 volts, replace or repair primary wiring, ignition switch or firewall connector as required. Recheck coil output voltage. If not satisfactory, proceed as follows:

g. Measure ignition coil primary resistance. The resistance from positive terminal to negative terminal with ignition switch off should measure between 1.2 and 1.4 ohm limits, if not, replace coil. h. Measure secondary resistance coil by measuring between the positive terminal and the secondary tower connector. The resistance should measure between 9.4 and 11.1 thousand ohms. If the resistance is outside these limits, replace coil.

i. Off-Engine Coil Check: The ignition coil can be removed from the engine and checked with SE-2576 or equivalent test equipment.

j. Distributor dwell also has an effect on coil output voltage. If coil replacement doesn't result in adequate voltage be sure dwell is set to specifications. See Service Manual -CGES-145 Electrical.

EXHAUST GAS RECIRCULATION (EGR)

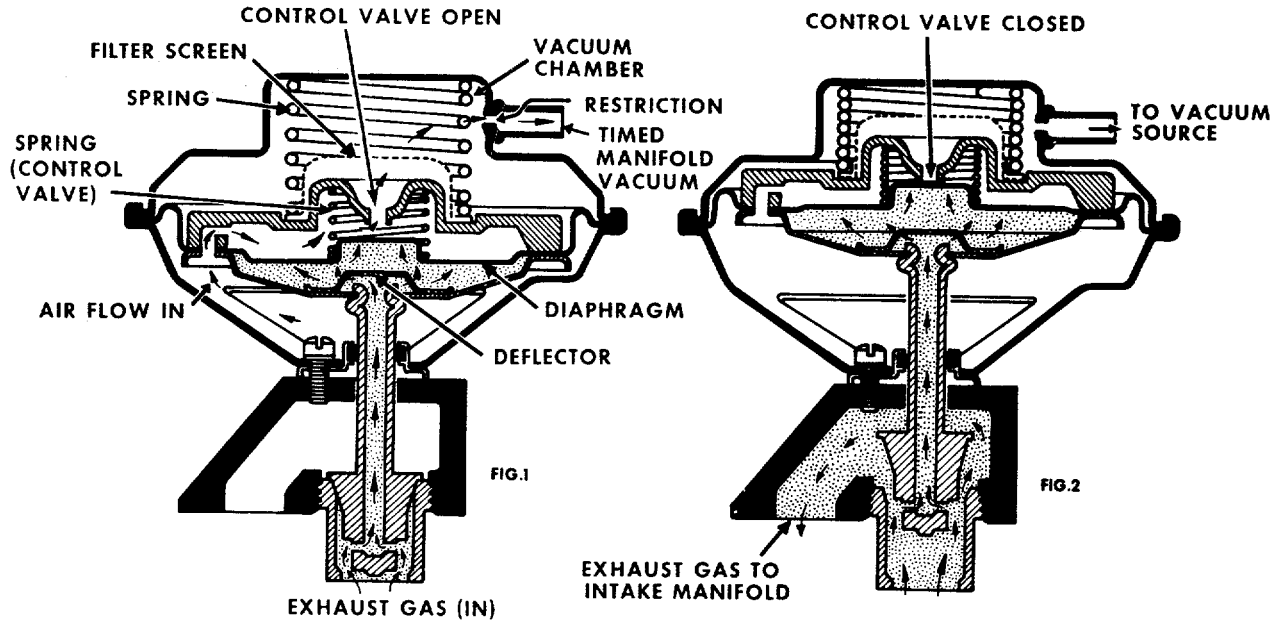
POSITIVE BACK PRESSURE EGR VALVE

A positive back pressure EGR valve (Figure 41) is being used on 4 and 8 cylinder gasoline engines.

A small diaphragm control valve inside the EGR valve assembly acts as a pressure regulator. The control valve receives an exhaust back pressure signal through the hollow shaft which exerts a force on the bottom of the control valve diaphragm, opposed by a light spring. A metal deflector plate prevents hot exhaust gases from flowing directly on the diaphragm.

Vacuum is applied to the EGR valve assembly from the carburetor spark port, to assure no exhaust gas recirculation at idle. During off-idle operation, manifold vacuum is applied to the vacuum chamber through a restruction in the signal tube. When engine load is light, and back pressure is low, the control valve is open, allowing air to flow from the 6 bleeds in the diaphragm plate, through the control valve orifice, into the vacuum chamber. The air bleeds off vacuum, decreasing the signal trying to open the EGR valve. Therefore, if back

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BACKPRESSURE EGR VALVE

Fig. 41 Positive Back Pressure EGR Valve

pressure does not close the control valve, sealing off the air flow, there will not be any vacuum built up to open the EGR valve for exhaust gas recirculation.

When power demands are made on the engine, and exhaust gas recirculation is needed exhaust back pressure increases, closing the control valve, thereby shutting off air flow through the valve. Vacuum builds up in the vacuum chamber until the spring force holding the EGR valve closed is overcome.

Once the EGR valve opens, the exhaust pressure decreases because some of the exhaust gas is flowing into the intake manifold through the EGR passage. In actual operation, the system will reach a balanced condition providing optimum EGR operation.

Any increase in engine load will momentarily increase the exhaust signal, causing the control valve to close, allowing a stronger vacuum signal. The system will then stabilize at a greater EGR flow.

At maximum engine load, when manifold vacuum is nearly zero, momentarily, there will be no EGR operation. This is because of insufficient vacuum to pull the valve open, even though high exhaust back pressure has closed the control valve.

VALVE FUNCTIONAL TEST ON THE VEHICLE

1. Connect a tachometer and warm-up engine.

2. When throttle is opened part way, valve should open slightly. When throttle is closed, valve should be closed. Detect valve movement by feeling diaphragm under upper cover.

3. Remove EGR hose from EGR valve and plug hose.

4. Refer to the section on idle speed adjustment and adjust the fast idle speed to specifications (Section 2). Then place fast idle screw on the top step of the cam (if not already there).

5. Apply at least 12" hg engine vacuum to the EGR valve and note speed drop. If the EGR valve is operating satisfactorily, the speed must drop at least the amount specified in the specification table. If the valve diaphragm moved in step 2, but the speed didn't drop at least the specified amount, see the following sections on maintenance of the EGR valve and intake manifold EGR ports (V-304 and V-345 engines only).

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VALVE FUNCTIONAL TEST OFF THE VEHICLE

1. Remove valve from engine and discard gasket.

2. Apply vacuum to signal port. Valve should not open. If it does, control valve is stuck closed. See valve cleaning section.

3. If valve passes test (2) and with at least 12" hg engine vacuum applied to the port, direct a stream of low pressure air into the valve exhaust gas intake. Valve should be open.

4. If valve does not open in step (3), the control valve is stuck open or exhaust passages are plugged. Clean valve.

5. If the EGR valve is functioning properly, clean the mating surfaces and install on engine with a new gasket. Connect vacuum hose.

EGR VALVE CLEANING

CAUTION

To avoid damaging the valve diaphragm, do not use solvents or degreasers. Permanent damage can also result from sand blasting the valve.

1. Remove valve from engine and discard old gasket.

2. Lightly tap on the sides and end of the valve to remove exhaust deposits. Tap lightly on the pintle with a small wood dowel and hammer to remove seat deposits. Empty loose particles. Do not clamp valve in a vise.

3. Use a wire wheel to remove external deposits from mounting surface and intake port.

4. Remove deposits from outlet with a screwdriver.

5. Clean the mating surfaces and install on engine with a new gasket, connect vacuum hose.

INTAKE MANIFOLD EGR PORTS
(V-304 and V-345 Engines Only)

During step (5) of the "Valve Functional Test on Vehicle", if the engine doesn't pass the speed drop test, the intake manifold EGR ports should be inspected. These ports are located under the carburetor in the intake manifold runners directly below the intake risers (V-304) or below the two primary risers (V-345). They serve to control the distribution of EGR to the runners.

To inspect the ports, remove air cleaner top and open throttle plates wide open. With a light, find the ports below the throttle shaft. If the ports are at all clogged with exhaust deposits, remove carburetor and clean ports taking care to remove all loose particles. DO NOT USE A POWER DRILL OR FILE.

THERMAL VACUUM SWITCH

All engines are equipped with a vacuum switch which delays vacuum to the EGR valve until engine water temperature reaches 85 $\pm$ 3° F. This greatly improves cold engine starting and drive ability characteristics.

In addition to this engine switch, V-304 and V-345 engines are equipped with a similar switch in the left radiator tank. This switch is plumbed in series with the engine .witch and serves to further improve cold engine performance at very cold ambients by delaying EGR vacuum until the engine thermostat opens. The switch at 45 $\pm$ 5° F opens. However the switch doesn't close until the radiator coolant temperature decreases to less than 35° F.

Hot Engine Functional Check

1. Warm-up engine until thermostat opens and radiator is also warmed.

2. Disconnect vacuum hose from EGR valve and install vacuum gauge. (On V-304 engines, EGR vacuum is also applied to the vacuum diaphragm on the carburetor.) Remove hose from diaphragm., and plug.

3. Disconnect EGR vacuum source hose from carburetor and connect to a vacuum pump or an engine manifold vacuum source. (If EGR vacuum source at the carburetor also operates other devises, apply vacuum at a point away from the carburetor to eliminate all but EGR system).

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4. With a warm engine and radiator, vacuum applied to the carburetor source hose should be seen on the vacuum gauge.

5. If vacuum doesn't reach the gauge, inspect all hoses for proper connections or leaks.

6. If hoses are okay, disconnect vacuum line from the opposite port of the engine vacuum switch and test for vacuum. If vacuum exists here, replace the engine vacuum switch.

7. If no vacuum exists in step (6) perform the same test at the hose to the opposite port of the radiator cold switch. If vacuum exists here replace radiator cold switch and repeat steps (2) through (6) as required. (Radiator coolant temperature for this step (7) test must be greater than 50°F.)

Cold Engine Functional Check

If EGR vacuum switches do not close properly at lower ambients, very poor starting and cold engines operation will result.

The engine vacuum switch should be closed below 820 F coolant temperature. The radiator switch should be closed below 350 F coolant temperature.

Functional tests of switches can be made on or off vehicle. Replace defective vacuum switches.

EGR Valve

Because EGR valve metering varies between engines, it is important that the correct EGR valve be used in order to obtain optimum engine performance and emission control (see EGR Valve Application Chart).

To assist in identification, EGR valves are coded by a colored disk attached to the center of the vacuum diaphragm housing. The valve may also be identified by the manufacturer's part number stamped on the valve (Figure 42).

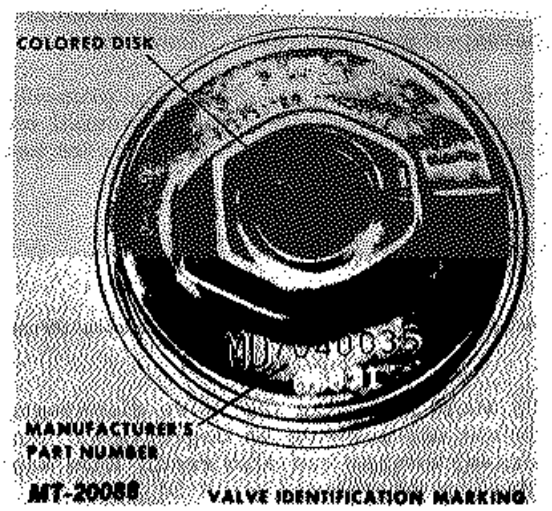


Fig. 42. EGR Valve Identification Marking

EGR VALVE APPLICATION CHART
(For 1979 Model Engines)

Test Engine	Carb.	TRANSMISSION Manual IH Number	Manual Color Code	Manual Mfr. Number	Automatic IH Number	Automatic Color Code	Automatic Mfr. Number	Functional Eng Speed Drop
4-196	1940C	496021-C1	Blue	17061715	N/A	N/A	N/A	RPM
V-304	2245C	496024-C1	Red	17061717	496022-C1	Green	17061716	RPM
V-345	T.Q.	496025-C1	Pink	17061719	496023-C1	Yellow	17061718	RPM
IH-633	N/A	499949-C1	N/A	14100-90000	N/A	N/A	N/A	RPM

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CATALYTIC CONVERTER

A catalytic converter is a muffler like canister located in the exhaust system. The catalytic converter requires the use of unleaded fuel only. Leaded gasoline will destroy the effectiveness of the catalyst as an emission control device.

All vehicles equipped with converters have labels located on the instrument panel and adjacent to the fuel filler cap that state "unleaded gasoline only". These vehicles also have fuel filler tubes specially designed to accept only the smaller diameter unleaded gasoline dispensing nozzles.

CAUTION

Damage to the catalytic converter can result if your vehicle is not kept in proper operating condition. In the event of engine malfunction, particularly involving engine misfire or other apparent loss of performance, have your vehicle serviced promptly. Continued operation of your vehicle with a severe malfunction could cause the converter to overheat, resulting in possible damage to the converter and vehicle.

As with any vehicle, do not park or operate this vehicle in areas where combustible materials such as grass or leaves can come in contact with a hot exhaust system.

In unusual situations invoicing grossly malfunctioning engine operation, a scorching odor may indicate severe and abnormal catalyst overheating. If this occurs, the vehicle should be stopped, the engine shut off and the vehicle allowed to cool. Thereafter, service, including a tune-up to manufacturer's specifications, should be obtained immediately.

To minimize the possibility of catalyst damage:

Do not shut off the engine or interrupt the ignition when the transmission is in gear and the vehicle is in motion.

Do not try to start the engine by pushing or towing the vehicle.

Catalytic converters used in scout vehicles are illustrated in Figures 43 and 44.

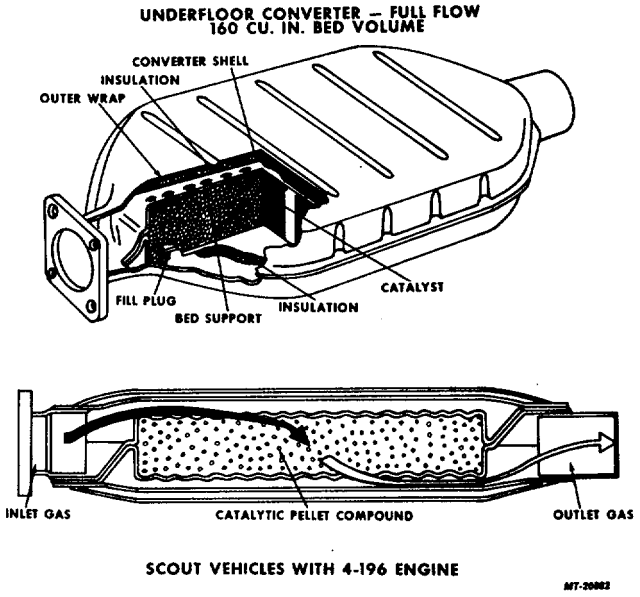


Fig. 43. Scout Vehicles with 4-196 Engine

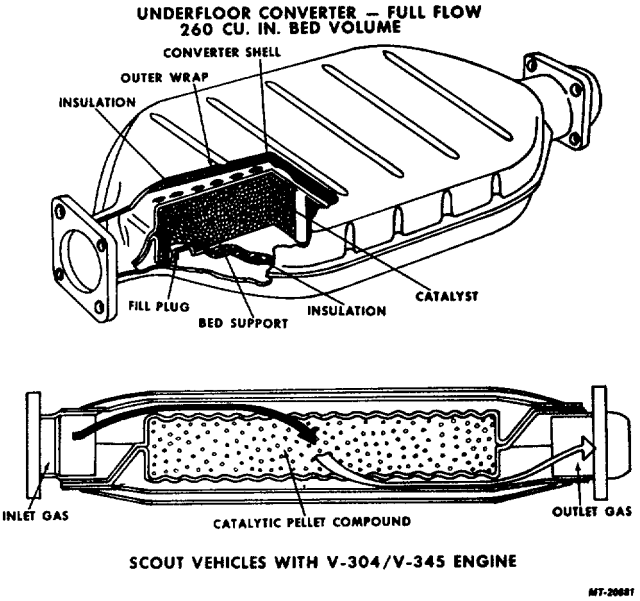


Fig. 44 Scout Vehicles with V-304/V-345 Engine

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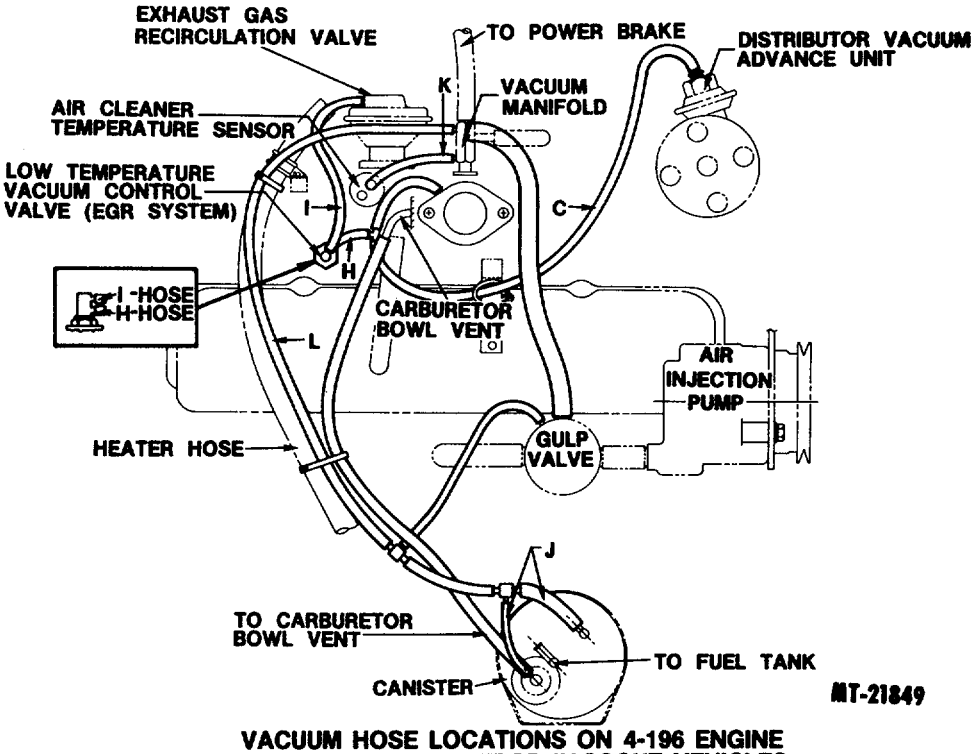
VACUUM HOSE ROUTING

Vacuum Hose Identification Legend

Key Letter	Location	Color Code
A	Carburetor Port-to-Solenoid Valve	Yellow Stripe
B	Solenoid Valve-to-Vacuum Pull-Off Diaphragm	Blue Stripe
C	Carburetor Port or Intake Manifold Fitting to Distributor Vacuum Advance Unit	Red Stripe
D	Carburetor Port-to-High Temperature Vacuum Valve	White Stripe
E	High Temperature Vacuum Valve-to-Distributor Vacuum Advance Unit	Red Stripe
F	High Temperature Vacuum Valve-to-Vacuum Manifold	Purple Stripe
H	Carburetor Port-to-Low Temperature Vacuum Valve (EGR System)	Green Stripe
I	Low Temperature Vacuum Valve (EGR System) ro EGR Valve	Green Stripe
J	Canister-to-Tee	(Plain)
K	Air Cleaner Temperature Sensor-to-Vacuum Manifold	(Plain)
L	Intake Manifold Vacuum Port-to-Tee	(Plain)
O	Diverter Valve-to-Tee or Intake Manifold Fitting	Purple Stripe
P	Low Temperature Vacuum Control Valve Engine to Radiator Low Temperature Vacuum Control Valve	(Plain)
Q	Radiator Low Temperature Vacuum Control Valve to Carburetor Port	(Green)

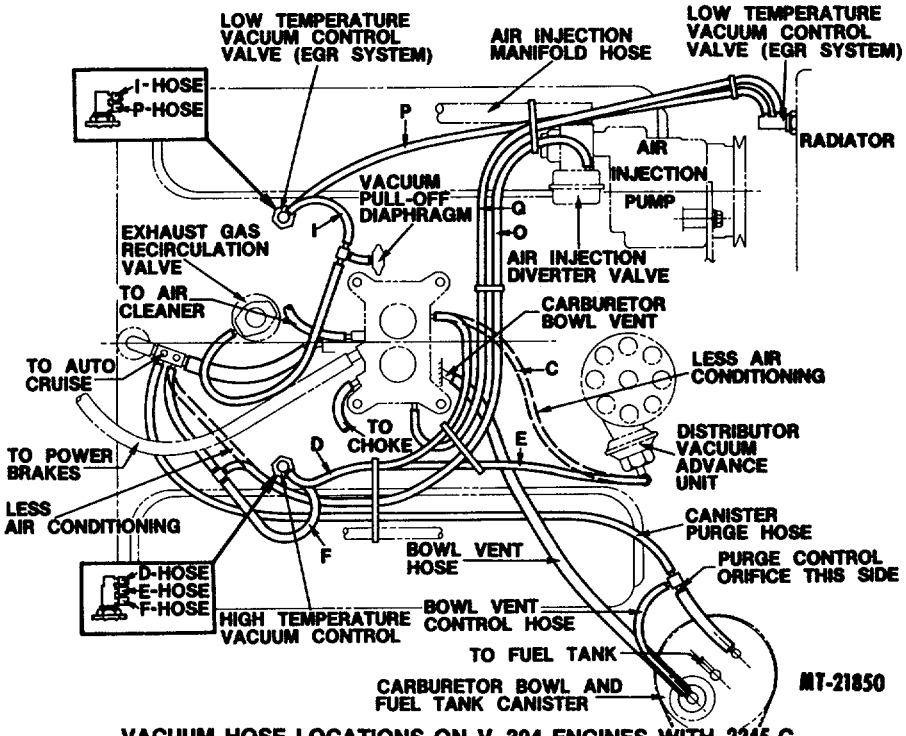
Use the following vacuum hose location charts for engines sold in all States.

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VACUUM HOSE LOCATIONS ON 4-196 ENGINE WITH 1940C CARBURETOR IN SCOUT VEHICLES.

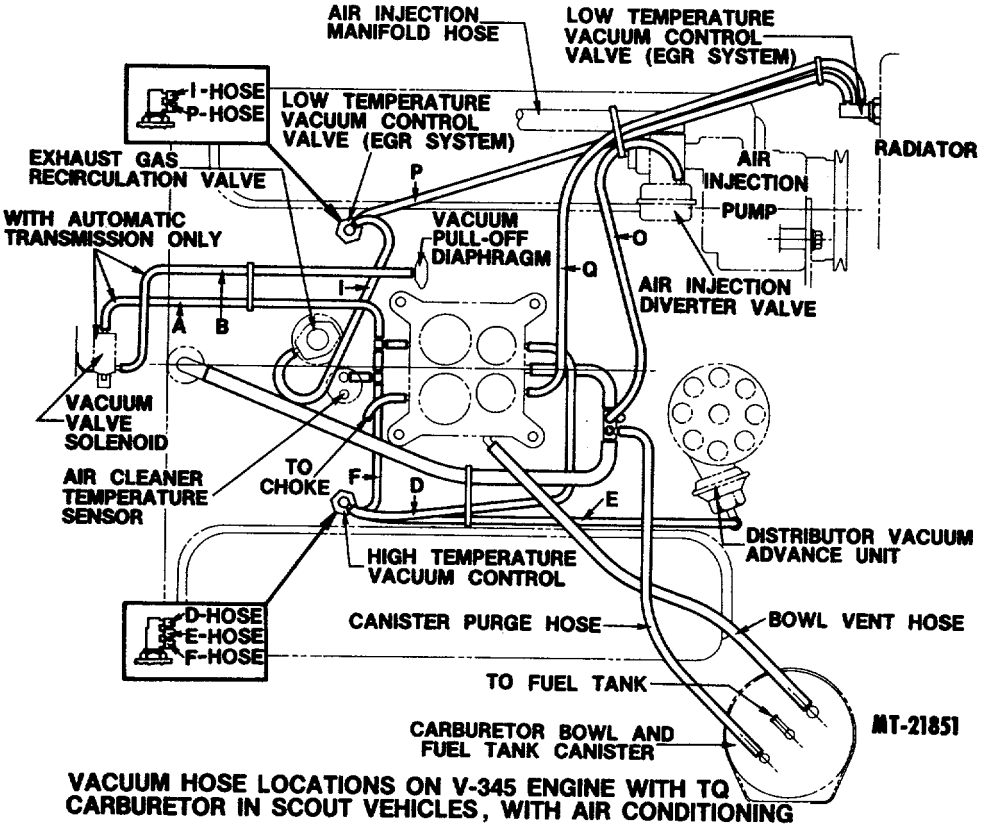
Fig. 45



VACUUM HOSE LOCATIONS ON V-304 ENGINES WITH 2245 C CARBURETOR IN SCOUT VEHICLES

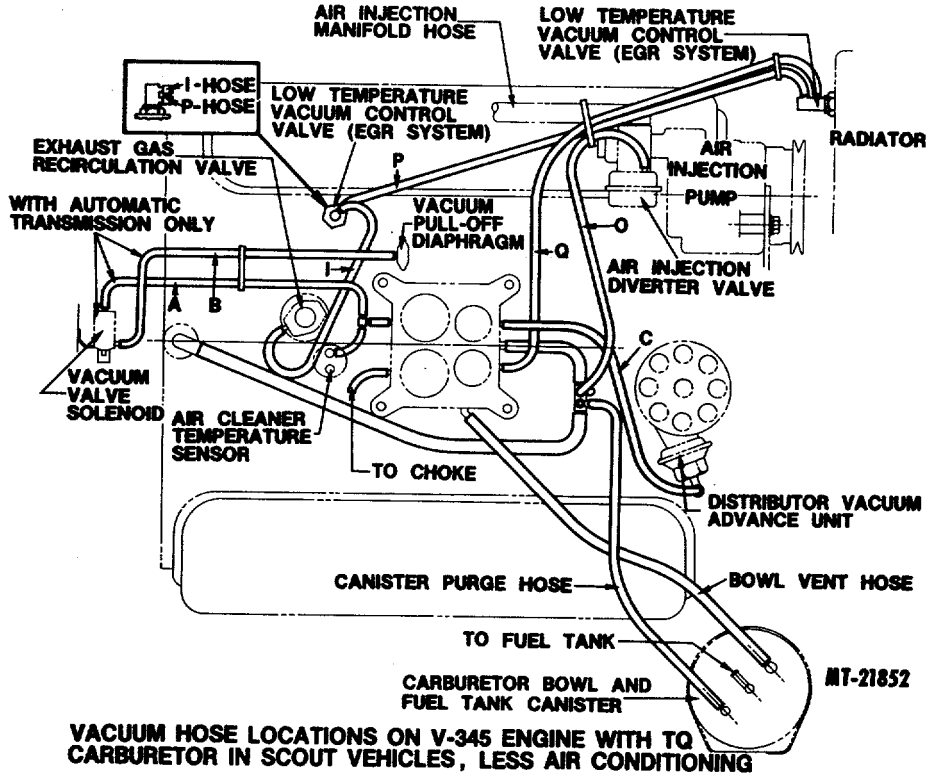
Fig. 46

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VACUUM HOSE LOCATIONS ON V-345 ENGINE WITH TQ CARBURETOR IN SCOUT VEHICLES, WITH AIR CONDITIONING

Fig. 47



VACUUM HOSE LOCATIONS ON V-345 ENGINE WITH TQ CARBURETOR IN SCOUT VEHICLES, LESS AIR CONDITIONING

Fig. 48

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EMISSION CERTIFICATION LABEL

The vehicle emission control information label attached to under the hood air duct -right side rear cover is very valuable to the tune-up technician. It gives him ready information: engine model, cubic inch displacement, timing idle speeds and idle mixture settings.

TUNING IH ENGINES EQUIPPED WITH EMISSION CONTROLS

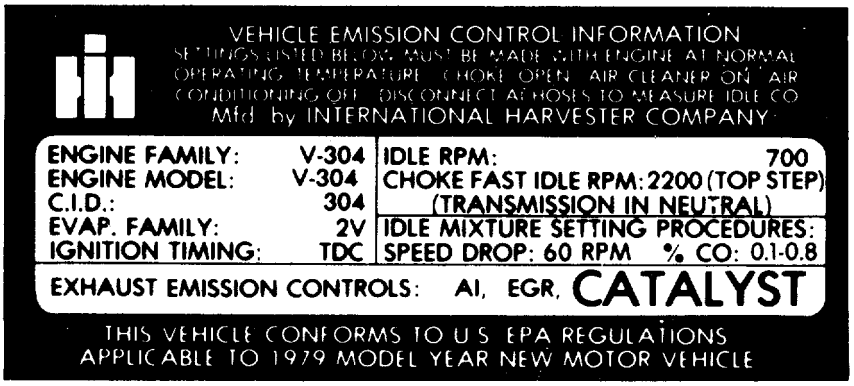
Tune-up on engines with emission controls is performed in the conventional manner. It is extremely important that the IH tune-up specifications found in this manual be used. It is necessary to become completely familiar with all types of emission controls, how they operate and how they are serviced. Using the recommended specifications and procedures will provide good performance and idling characteristics as well as allow the engine to operate within government regulations.

Owners have the responsibility to see that their engine is properly maintained on a regular schedule, or at any hint of an engine malfunction. The service technician has the responsibility to obtain the knowledge and skills to continuously perform each maintenance job completely and without fault.

EMISSION CONTROL TUNE-UP SPECIFICATIONS

The following tune-up specifications cover the light duty engines in the 50 state systems.

These specifications should be used in conjunction with the scheduled maintenance intervals and the explanation of each maintenance step given on the previous pages.



MT-21892

Fig. 49 Typical Engine Exhaust Emission Control Information Label

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EMISSION CONTROL SYSTEM TUNE-UP SPECIFICATION - 1979
50 STATE SYSTEMS

ENGINE	4-196	V-304	V-345
CARBURETOR MODEL	1940C	2245C	TQ
Ignition System			
Dwell, Degrees: Breakerless	28-34	26-32	26-32
Air Gap, Trigger Wheel-to-Sensor		.2mm (.008")	
Coil Output Voltage @ 2500 RPM		20KV Min.	
Ignition Timing Without Vacuum Advance, Degrees (Engine at Specified Idle RPM)		TDC	
Ignition Cable Resistance (Max.):		8K Ohms/Ft.	
Cold Starting Enrichment System	2200	2200	1600
Fast Idle Speed, RPM	Top Step	Top Step	2nd Step
Curb Idle Speed & Air/Fuel Mix.			
Curb Idle Speed, RPM (In Neutral)		700	
Mixture, % CO	.3-1.5	.1-.8	.1-.8
Speed Drop RPM	40	60	60
Spark Plugs			
Standard	RJ-10Y	RJ-10Y	RJ-10Y
Plug Gap		.88mm (.035)	
Torque		38.0-40.7N.m (29-30 ft. lb.)	
Required Voltage @ 1000 RPM		8-15 KV	
Bolt Torque			
Intake Manifold-to-Cylinder Head		34-40N.m (25-30 ft. lb.)	
Exhaust Manifold-to-Cylinder Head		34-40N.m (25-30 ft. lb.)	
Carburetor-to-Intake Manifold		8.1-10.8N.m (6-8 ft. lb.)	
Exhaust Gas Recirculation System			
Functional Test @ Top Step of Fast Idle Cam Vacuum to be Applied		304.8mm HG. (12.0" HG) Min.	
Minimum Speed Drop, RPM		150	
Air Injection System			
Functional Test @ 1200 RPM Minimum Pressure		27.58 kPa (4psi)	

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PART II

TROUBLE-SHOOTING

GUIDE

FOR

INTERNATIONAL

GASOLINE ENGINES

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The following trouble shooting guide can be used for all 1979 International gasoline engines.

If each step is followed a particular problem can be found and corrected without any difficulty.

To use the guide first diagnose the problem; engine will not start, engine idle speed varies, spark knock or pinging, etc.

Check the engine diagnostic chart page for the chart number showing the problem. The engine diagnostic chart page shows a chart number for each diagram in the guide.

When the problem is isolated to a particular component and more information is needed for repair or replacement, find the appropriate IH Truck Service Manual for the faulty component by referring to the chart below.

IH TRUCK SERVICE MANUAL NUMBERS AND SUBJECTS

FOR USE WITH ENGINE DIAGNOSTIC CHARTS

CTS No.	Description
COOLING	
2019	General Information
ELECTRICAL	
2024	Battery
2710	Battery
2013	Ignition Coils
2016	Spark Plugs
CGES-145	Electronic Ignition System With Integral Module
2258	Starter Motor (Standard)
ENGINE	
2145	Failure Analysis - All Engines
2523	Diagnosing Excessive Oil Consumption
CGES-160	V-304/345 (8-Cylinder)
2682	4-196 (4-Cylinder)
2711	IH-633 - Diesel Engine
FUEL SYSTEM	
CGES-130	Thermo-Quad
CGES-165	Carburetor - Model 2245-C
CGES-110	Carburetor - Model 1940-C
2050	Fuel Pump
2056	Air Cleaner
PROPELLER SHAFT	
2730	Propeller Shaft
COMPLETE IH TRUCK SERVICE MANUALS (1979)	
2313	Scout

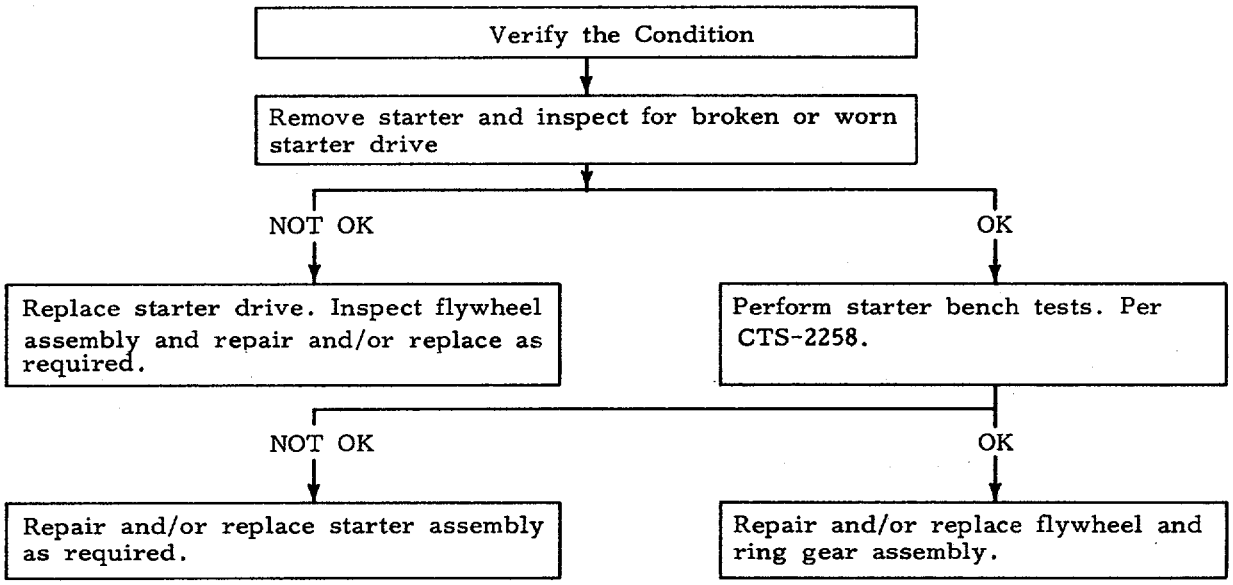
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ENGINE DIAGNOSTIC CHARTS

CONDITION	PAGE
CHART	
01 - Engine will not crank - starter spins	4
02 - Engine Will Not Crank	5
03 - Engine Cranks Slowly	7
04 - Engine Cranks Normally - Starts Hard When Cold	8
05 - Engine Cranks Normally - Starts Hard When Hot	10
06 - Engine Idles Rough - Misses	12
07 - Engine Idle Speed Varies	14
08 - Engine Misses at High Speed	16
09 - Engine Misses at Low Speed	18
10 - Engine Stalls at Idle - Engine Cold	19
11 - Engine Stalls at Idle - Engine Hot	21
12 - Engine Hesitates - Stalls During Acceleration	23
13 - Engine Has Poor Acceleration	25
14 - Exhaust System Backfire	27
15 - Excessive Fuel Consumption	28
16 - Excessive Oil Consumption	30
17 - Engine Diesels - Continues to Run After Shut Off	32
18 - Engine Noise	34
18A - Spark Knock or Pinging	35
19 - Engine Vibration	36
20 - Loss of Coolant or Engine Overheating	37
21 - Smoke from Vehicle Exhaust System	39
22 - Engine Governor does not Operate - No Engine Speed Control	40
23 - Governor Cuts Off at Low Speed - Erratic Operation	41
24 - Engine Surges below Governor Cutoff Speed	42
25 - Engine Surges at Governed Speed	44
Fuel System Vapor Lock	45
Compression and Cylinder Leakage Tests	46
Vacuum System Hose Leakage Test	47

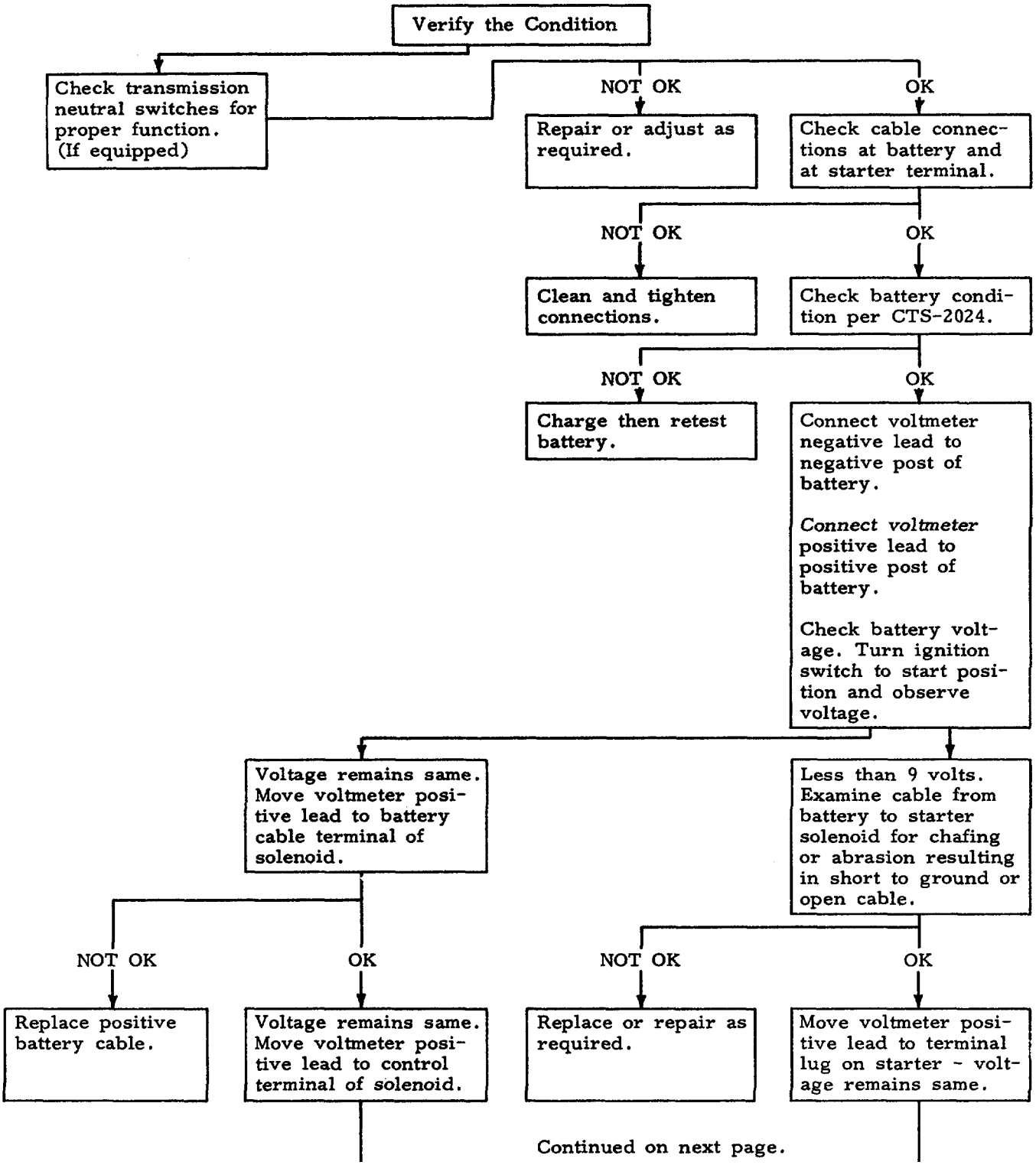
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CHART NO. 01
ENGINE WILL NOT CRANK - STARTER SPINS



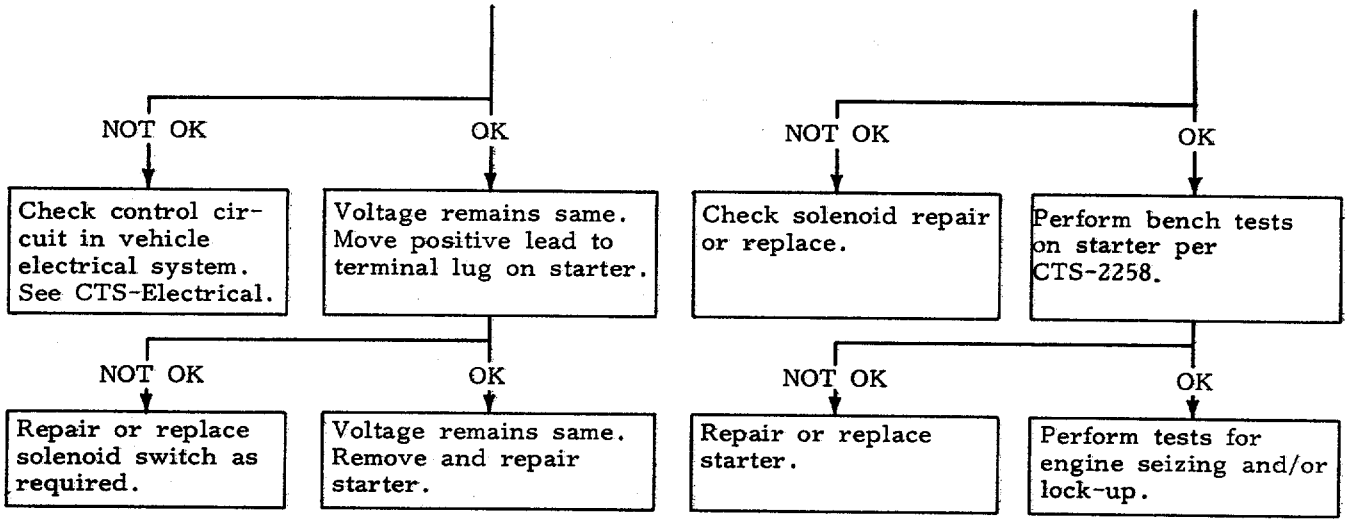
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CHART NO. 02
ENGINE WILL NOT CRANK



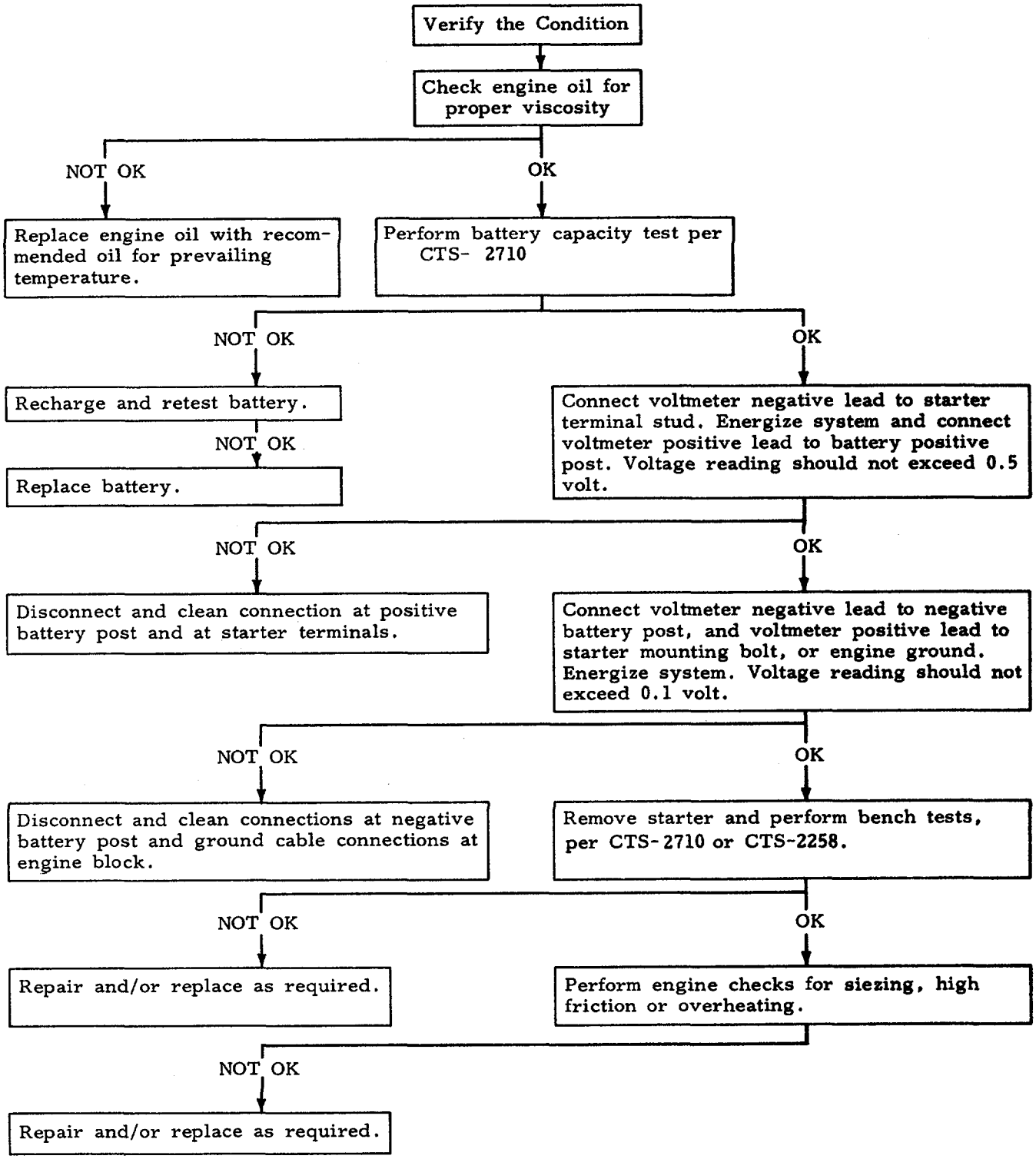
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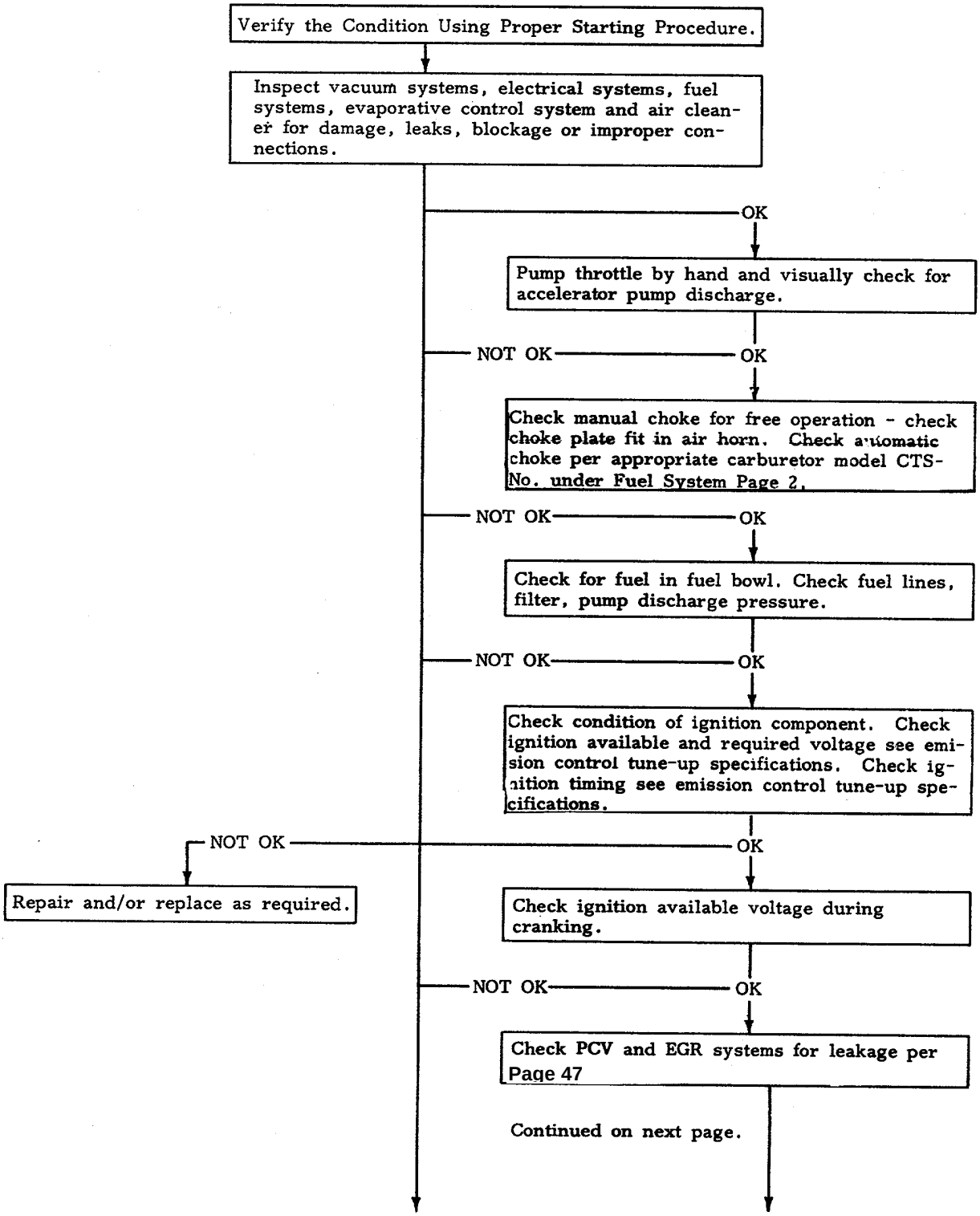
CHART NO. 03
ENGINE CRANKS SLOWLY



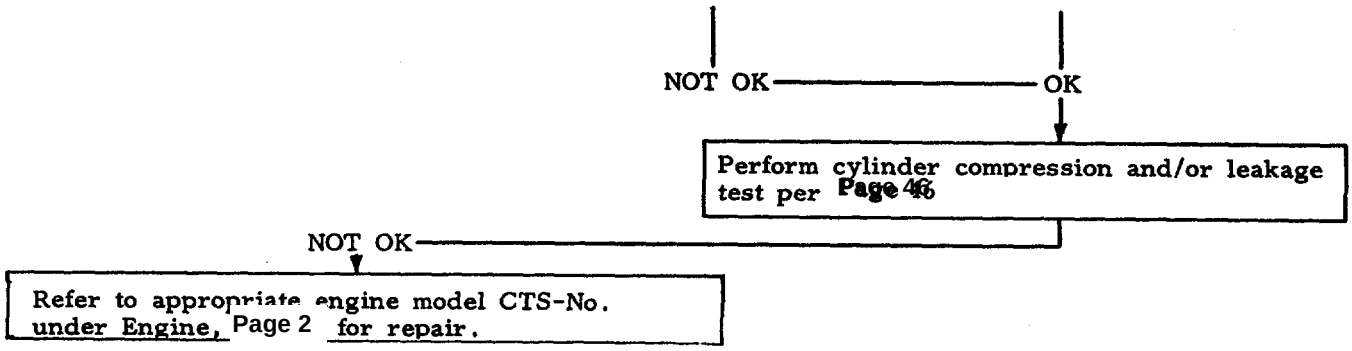
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CHART NO. 04

ENGINE CRANKS NORMALLY - STARTS HARD WHEN COLD



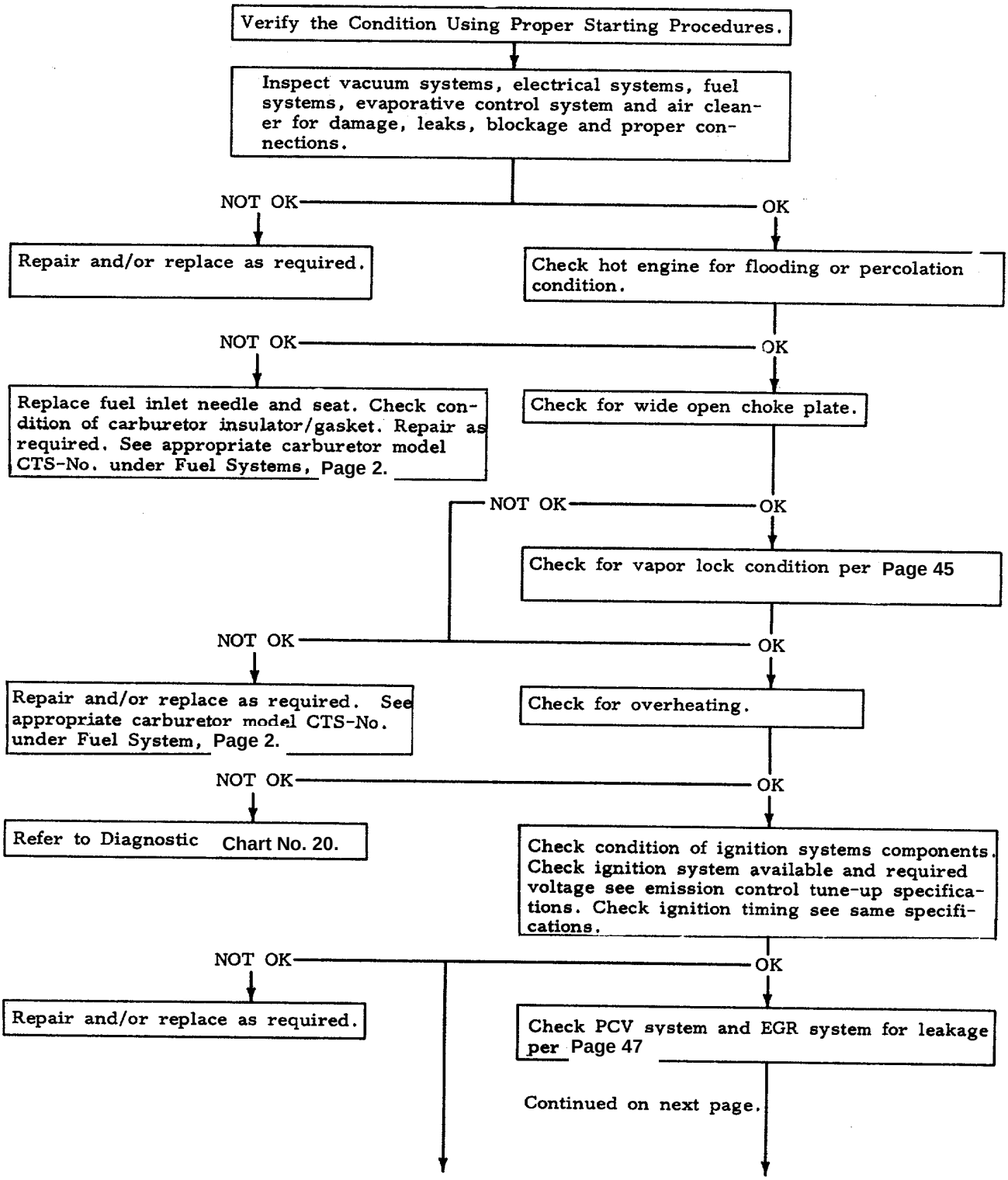
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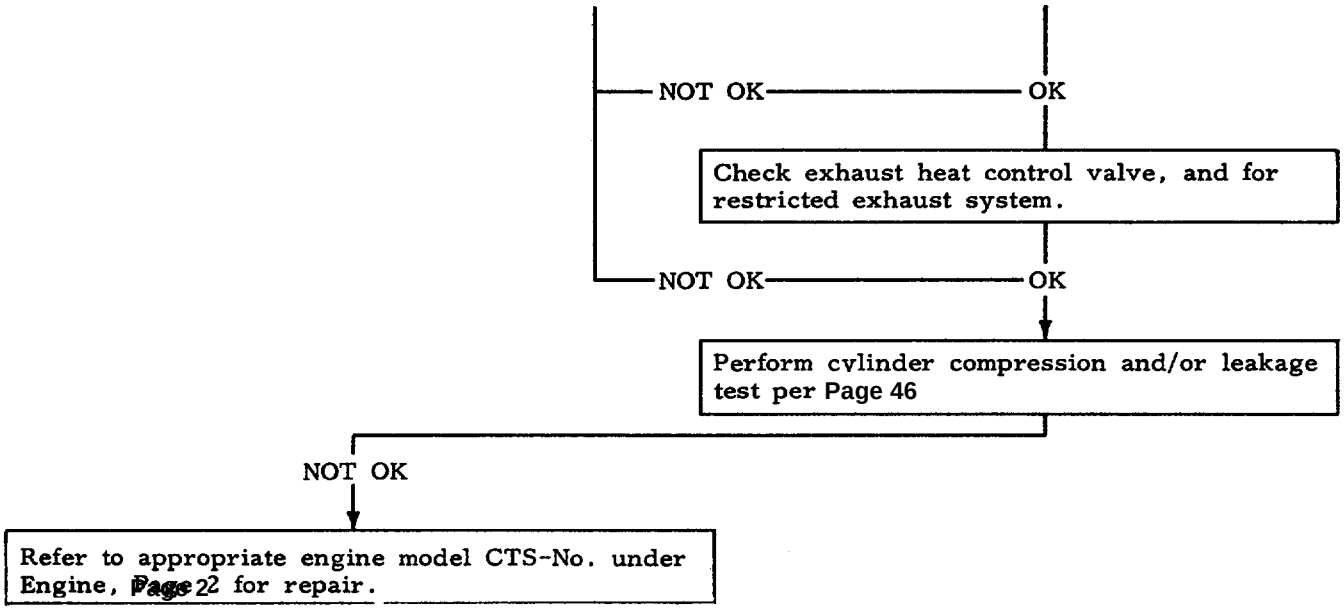
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CHART NO. 05

ENGINE CRANKS NORMALLY - STARTS HARD WHEN HOT



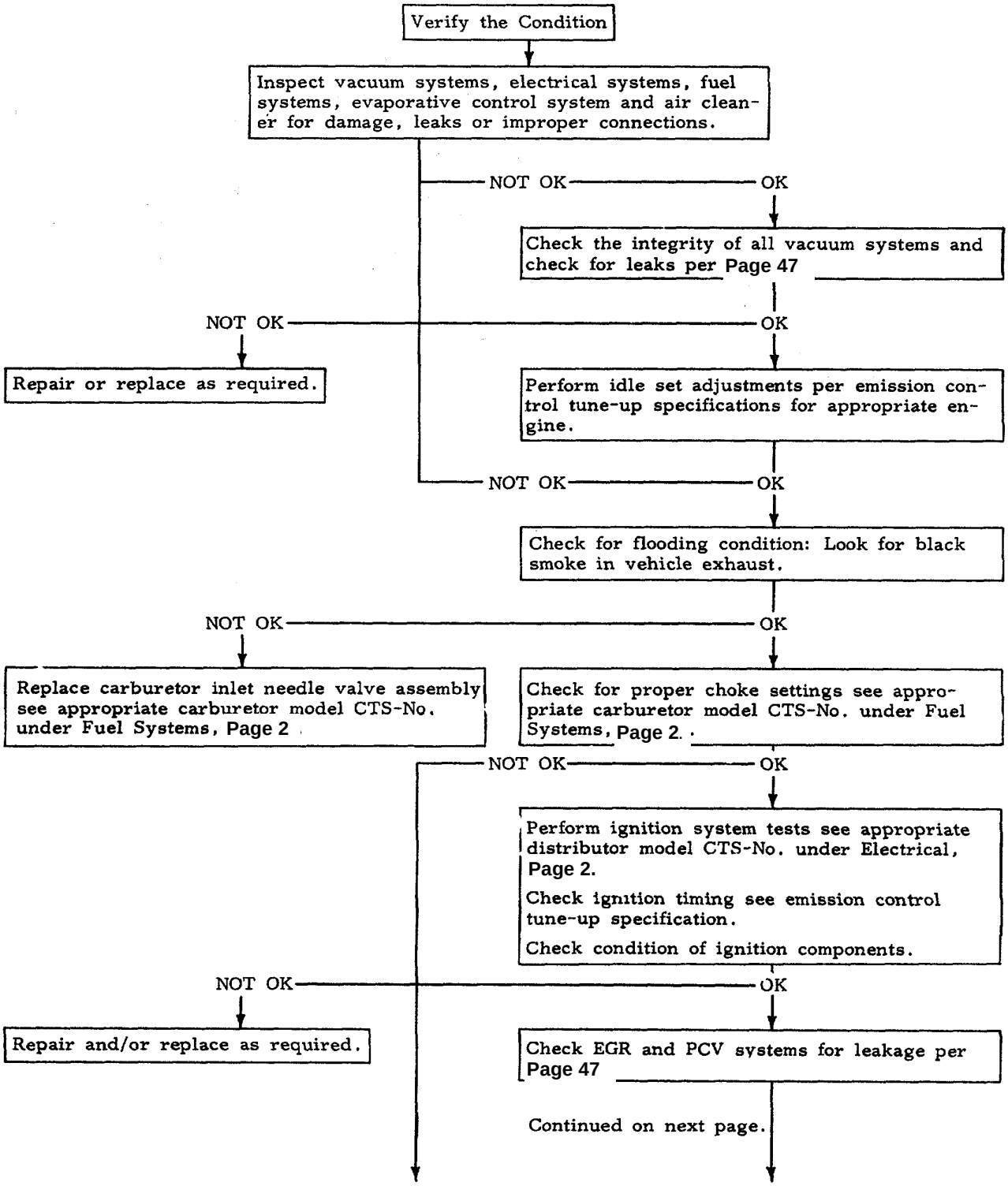
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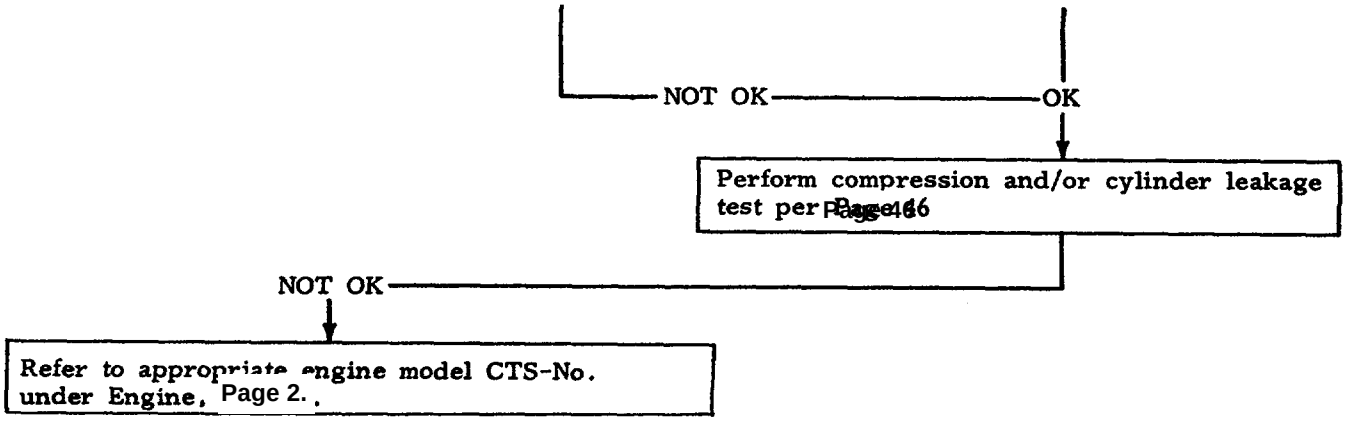
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CHART NO. 06

ENGINE IDLES ROUGH - MISSES (WARM OR COLD ENGINE)

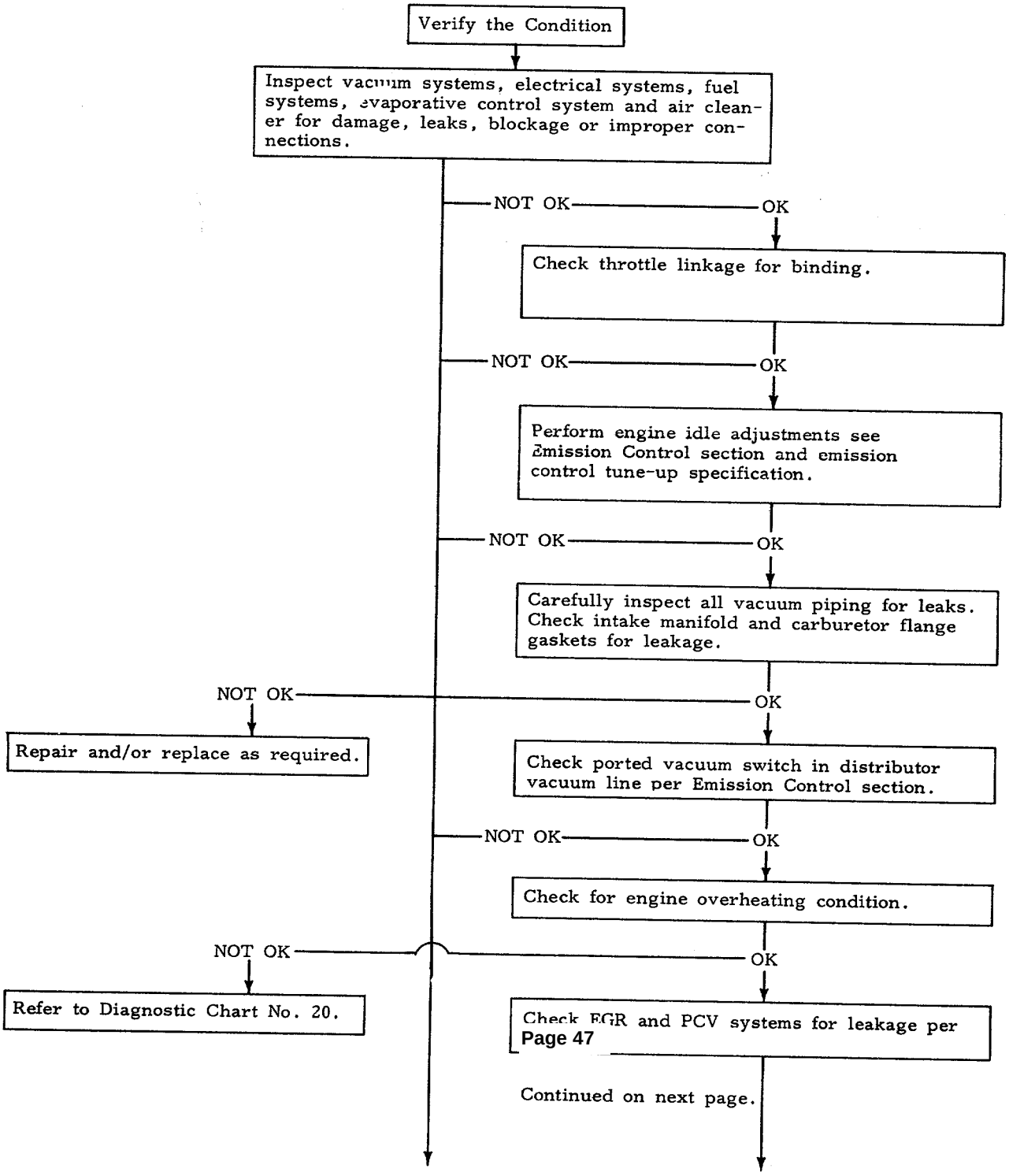


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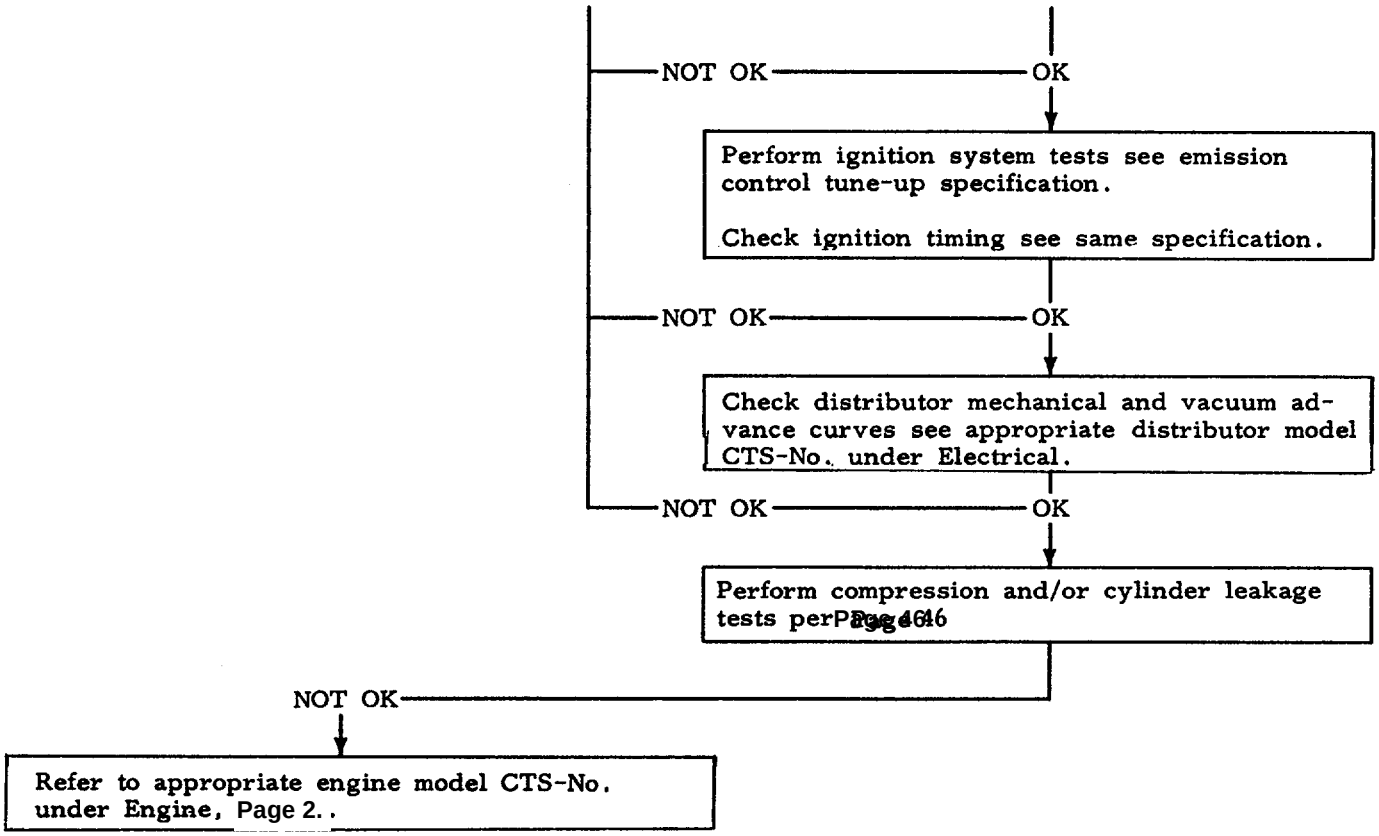


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CHART NO. 07
ENGINE IDLE SPEED VARIES

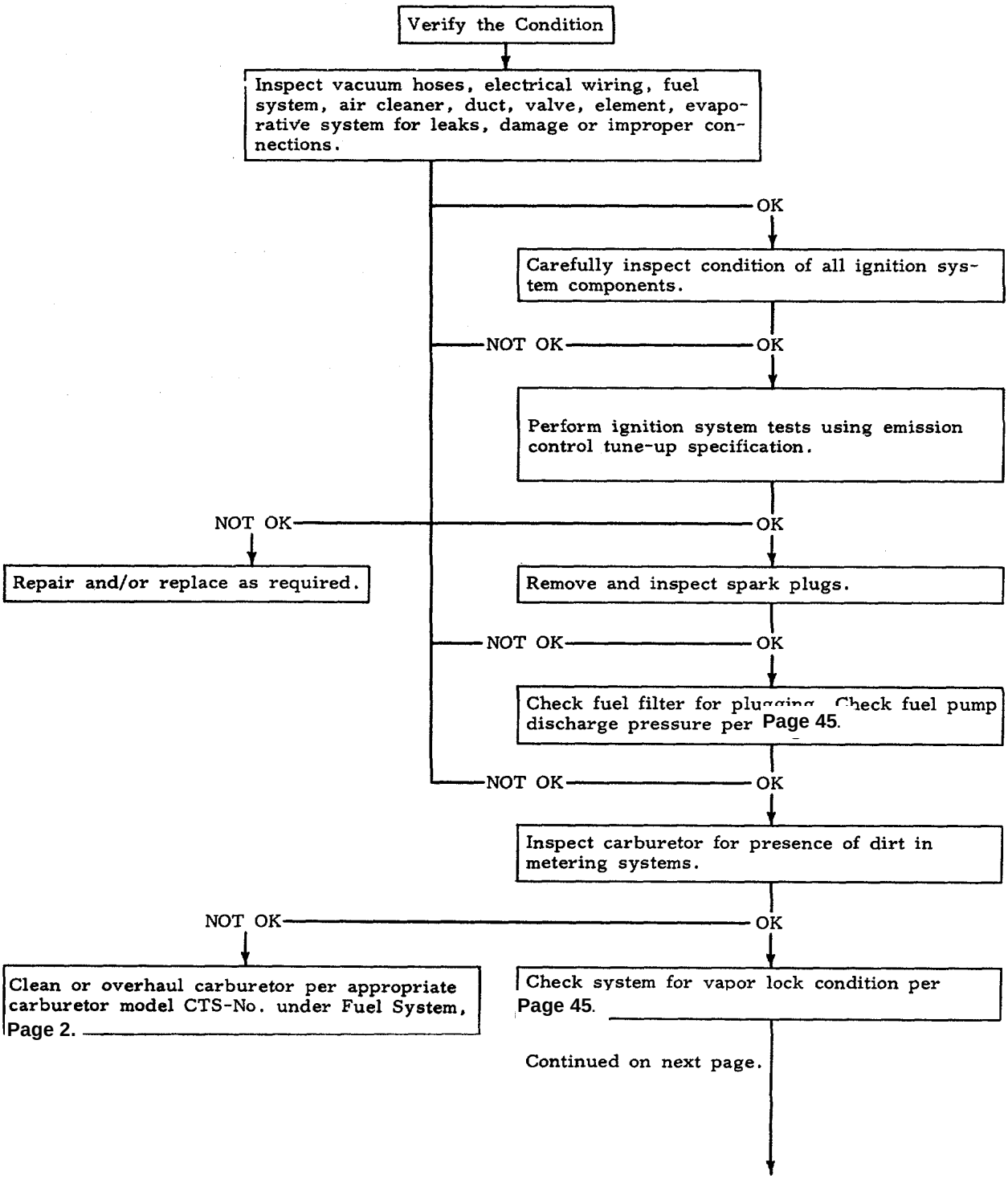


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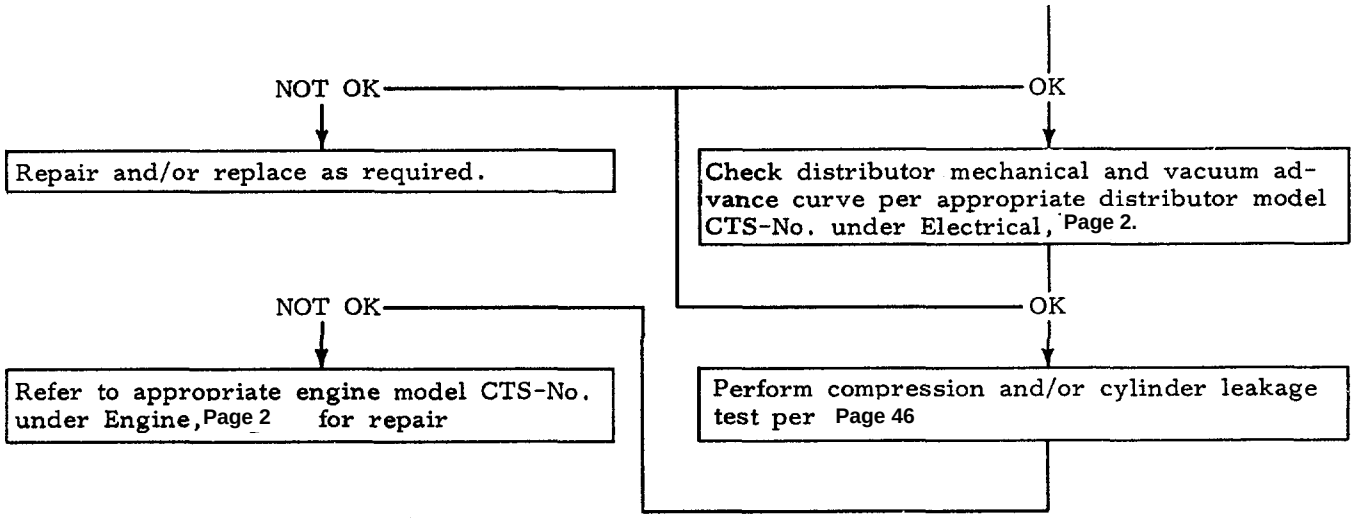


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CHART NO. 08
ENGINE MISSES AT HIGH SPEED



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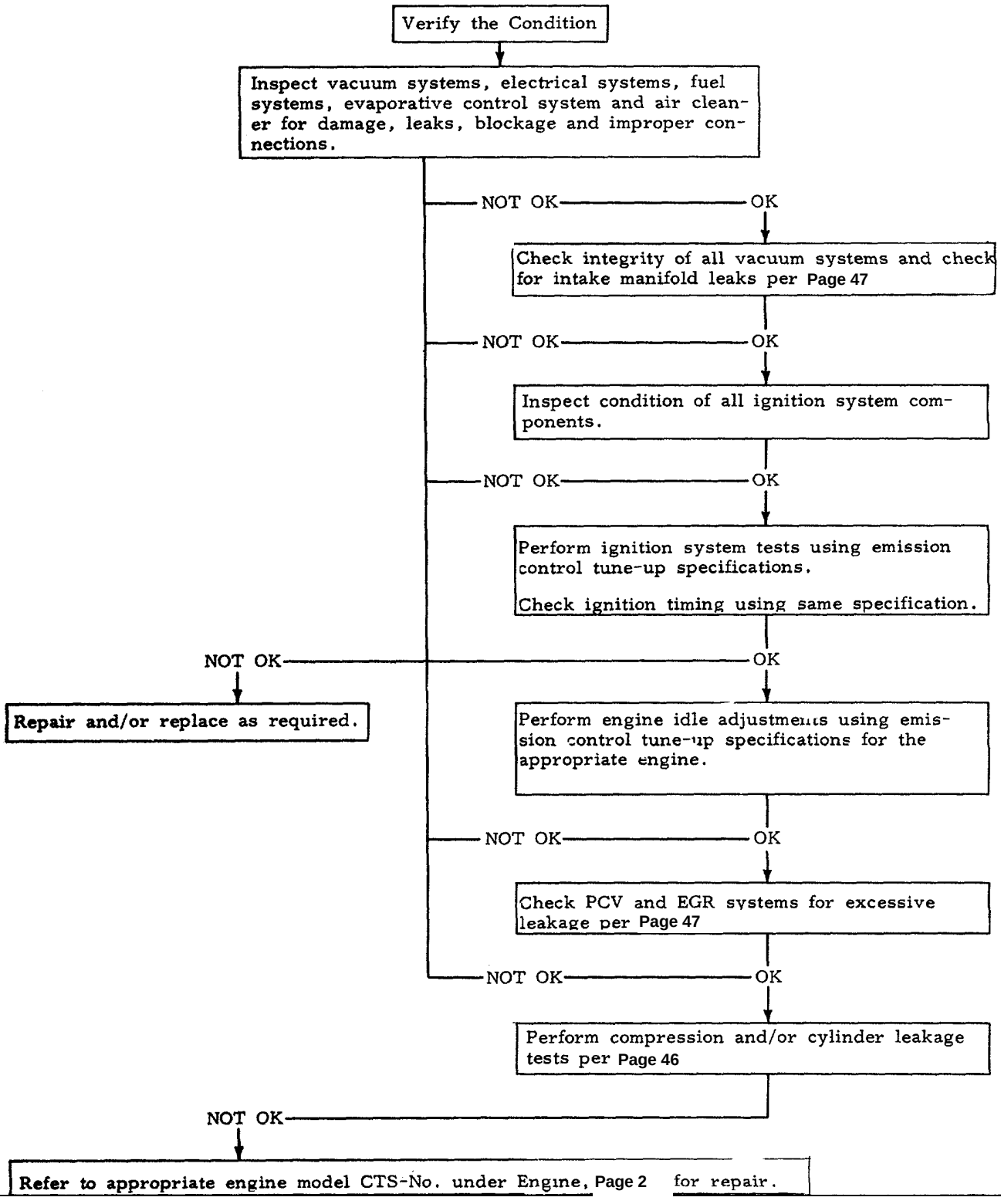


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TRUCK SERVICE MANUAL
FUEL SYSTEM
TM 5-4210-228-14&P-5

CHART NO. 09

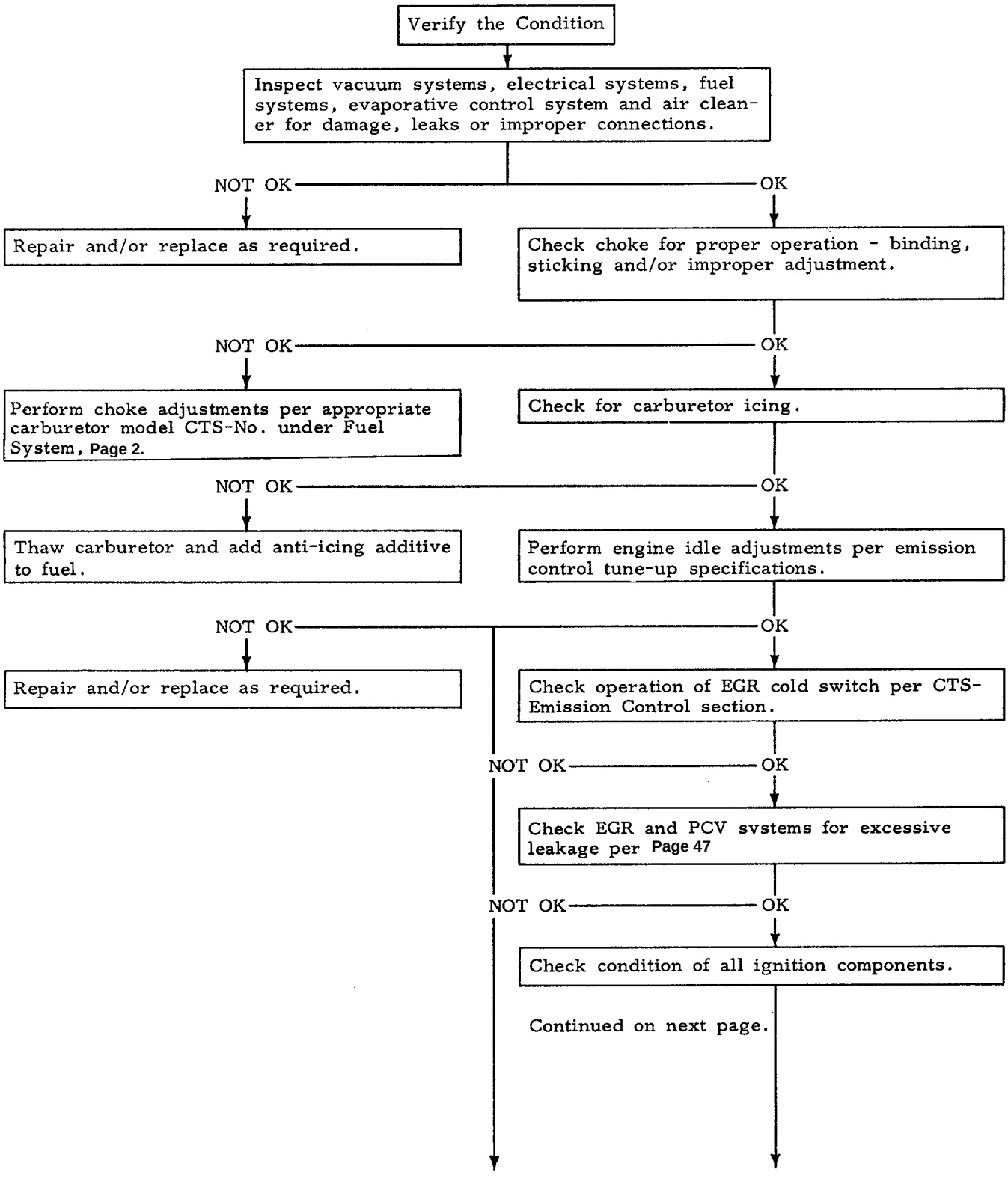
ENGINE MISSES AT LOW SPEED



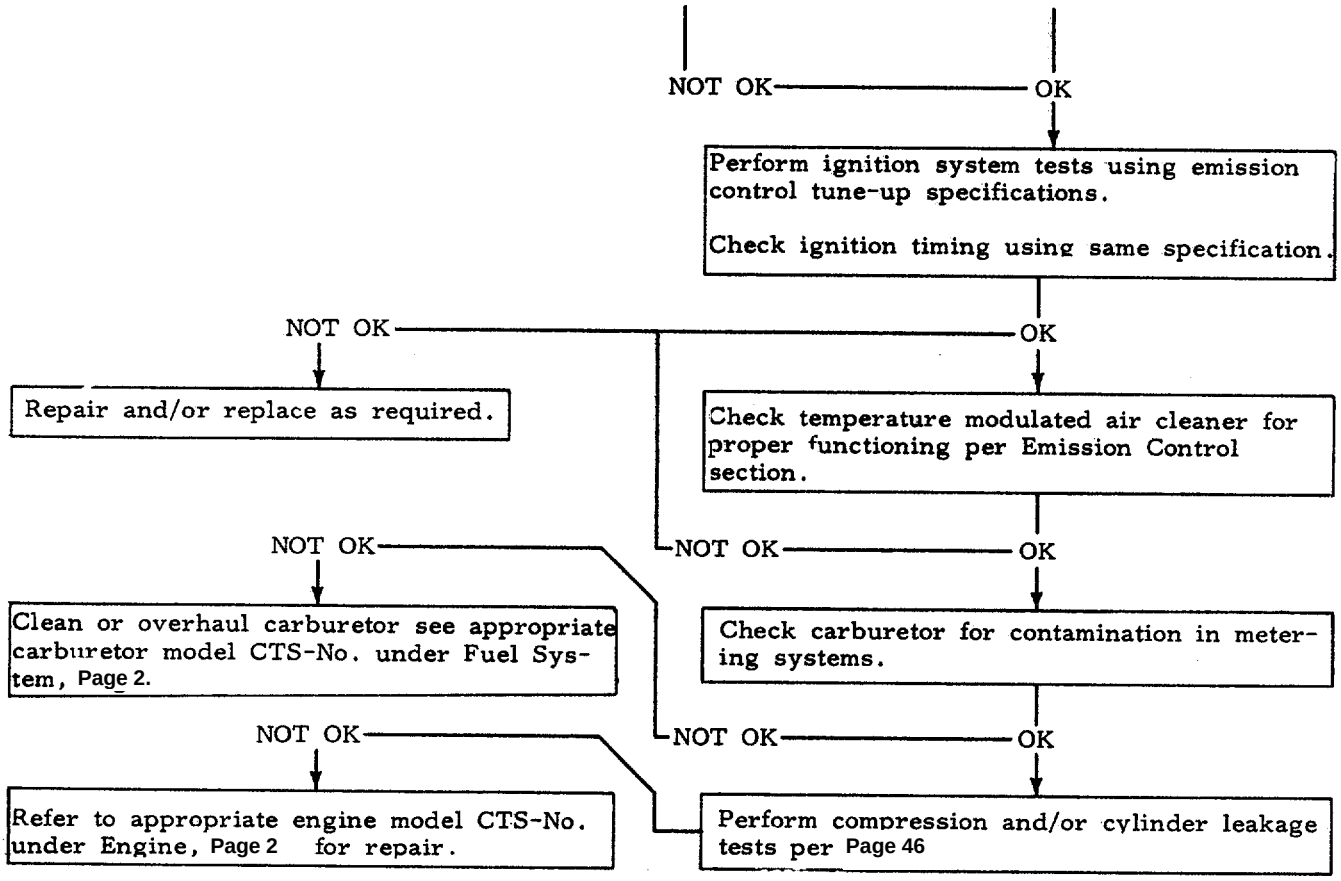
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CHART NO. 10

ENGINE STALLS AT IDLE - ENGINE COLD



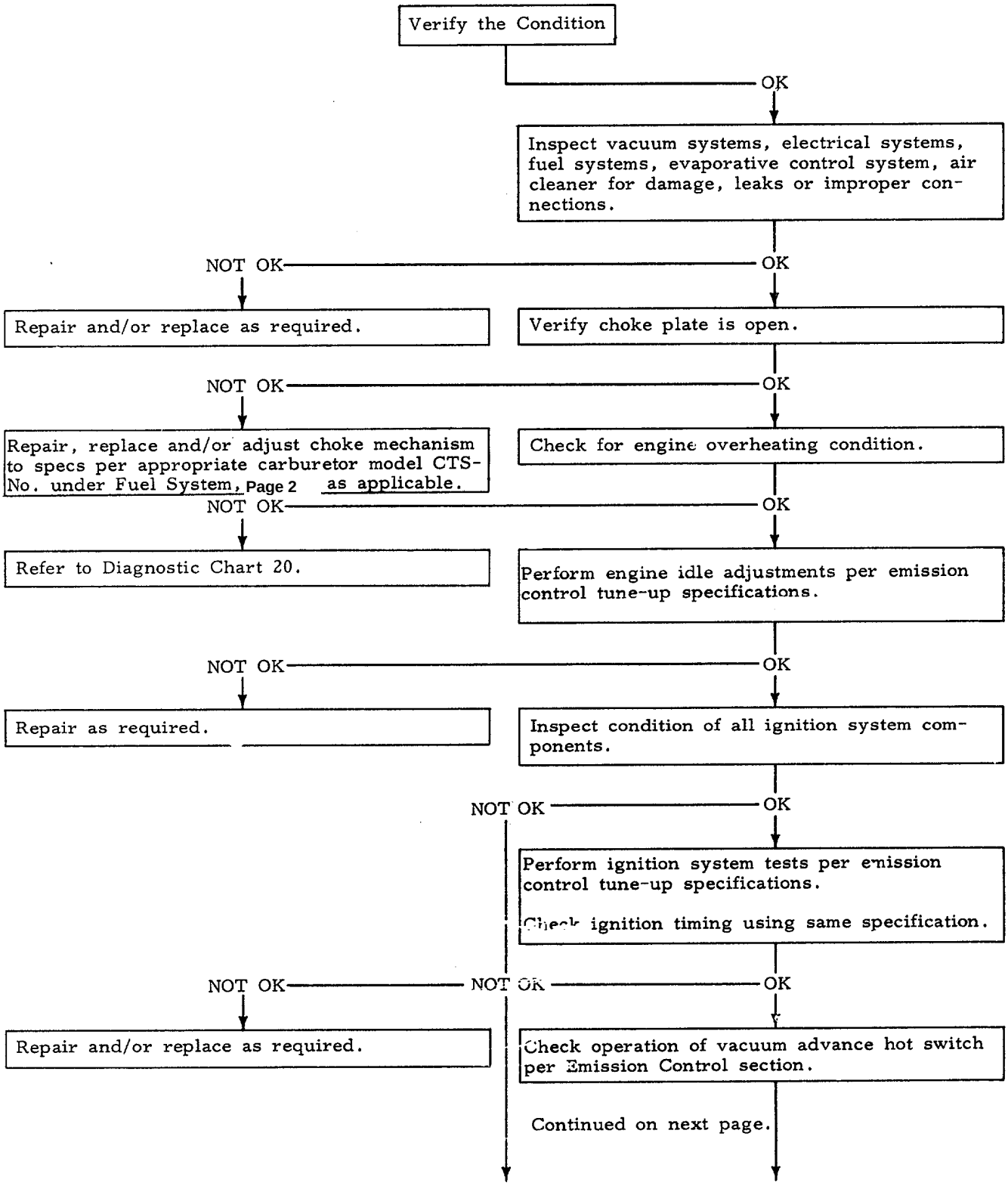
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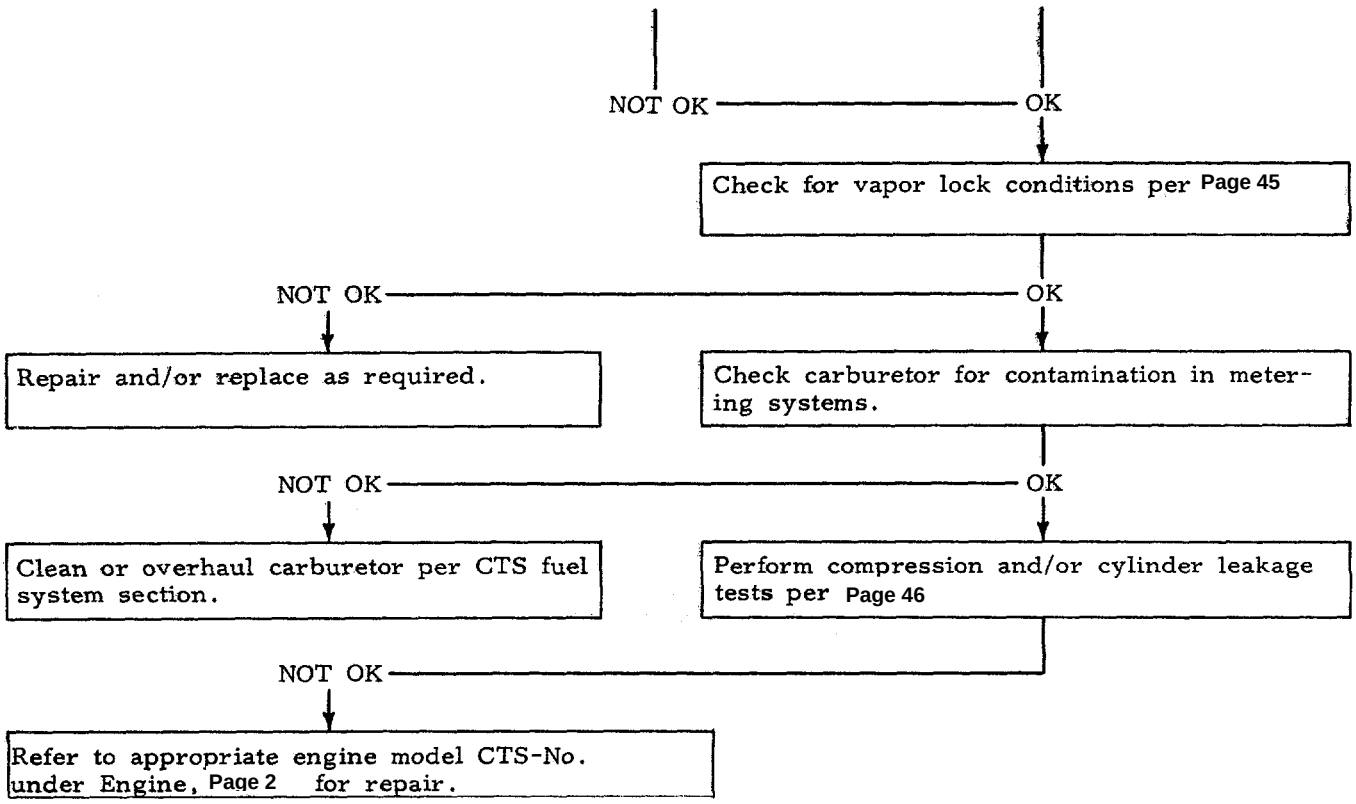
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CHART 11

ENGINE STALLS AT IDLE - ENGINE HOT



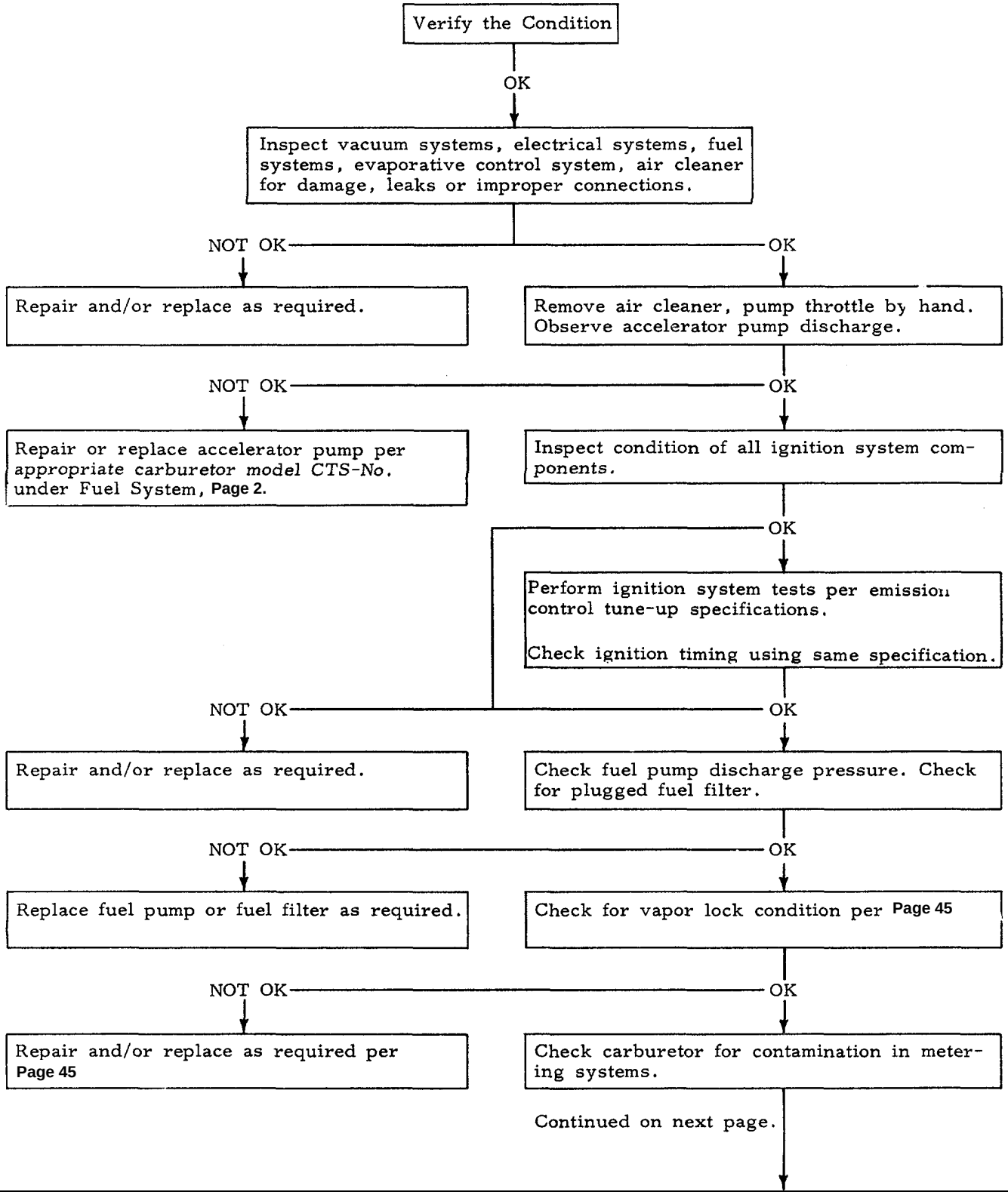
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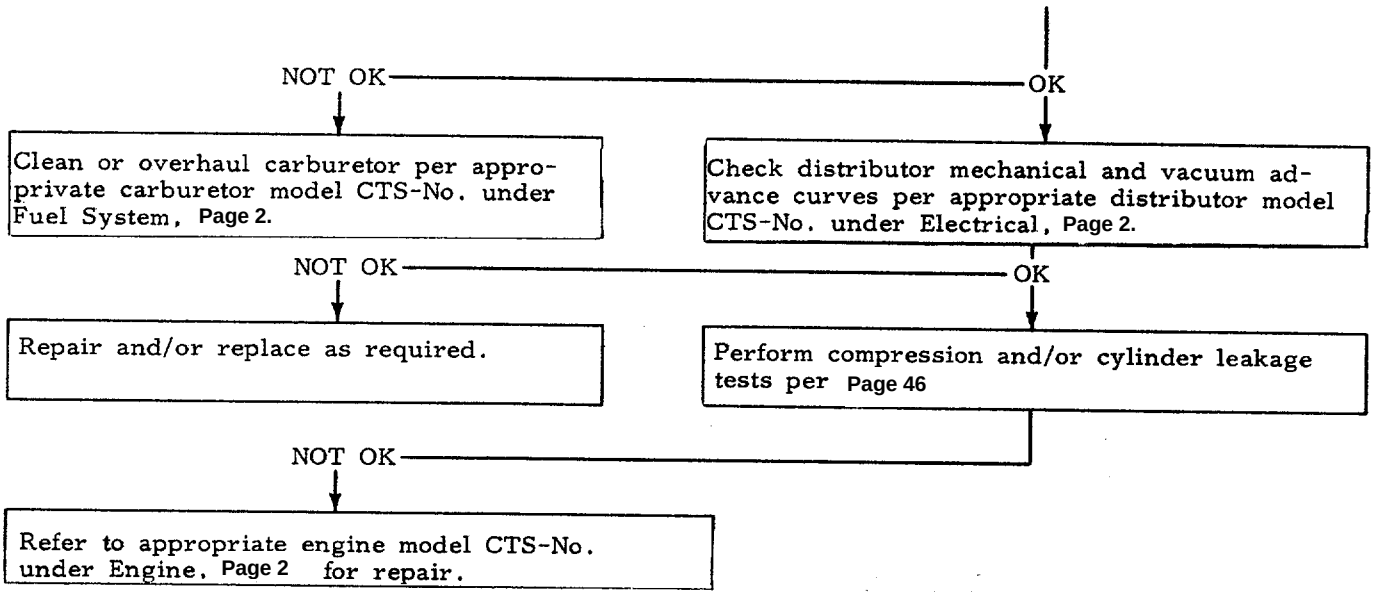
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CHART NO. 12

ENGINE HESITATES - STALLS DURING ACCELERATIONS



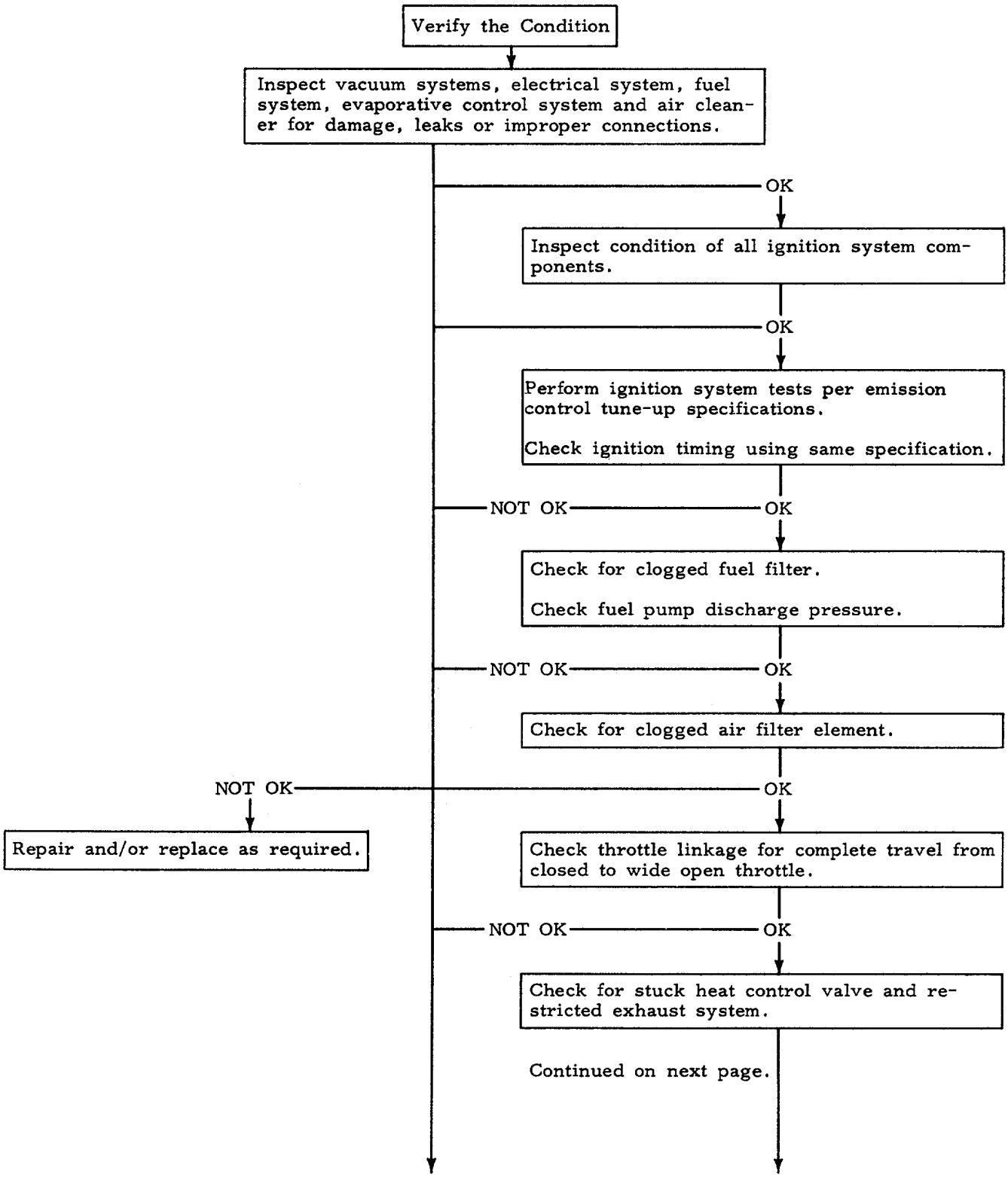
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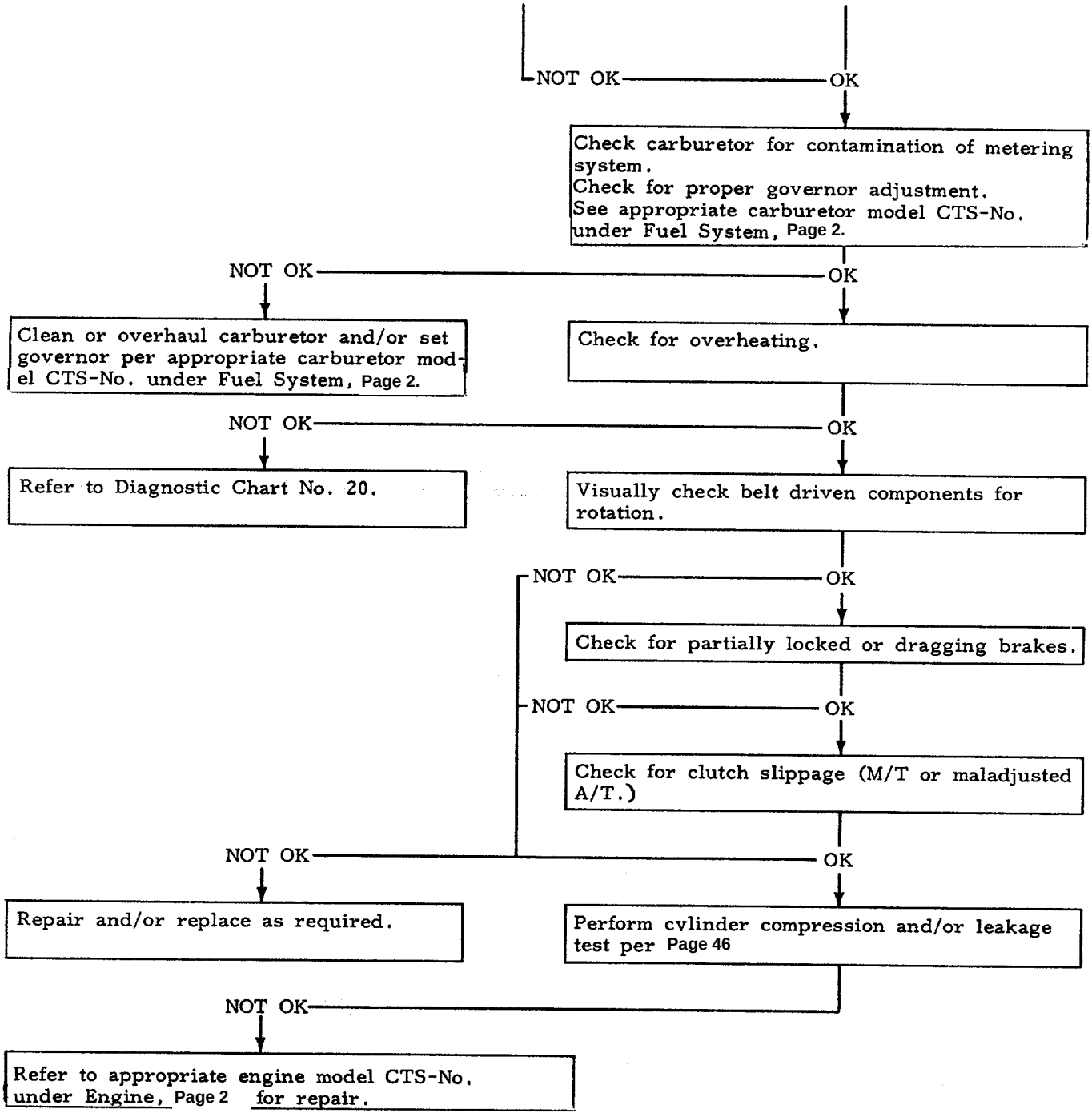
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CHART NO. 13

ENGINE HAS POOR ACCELERATION
(LESS THAN NORMAL POWER)



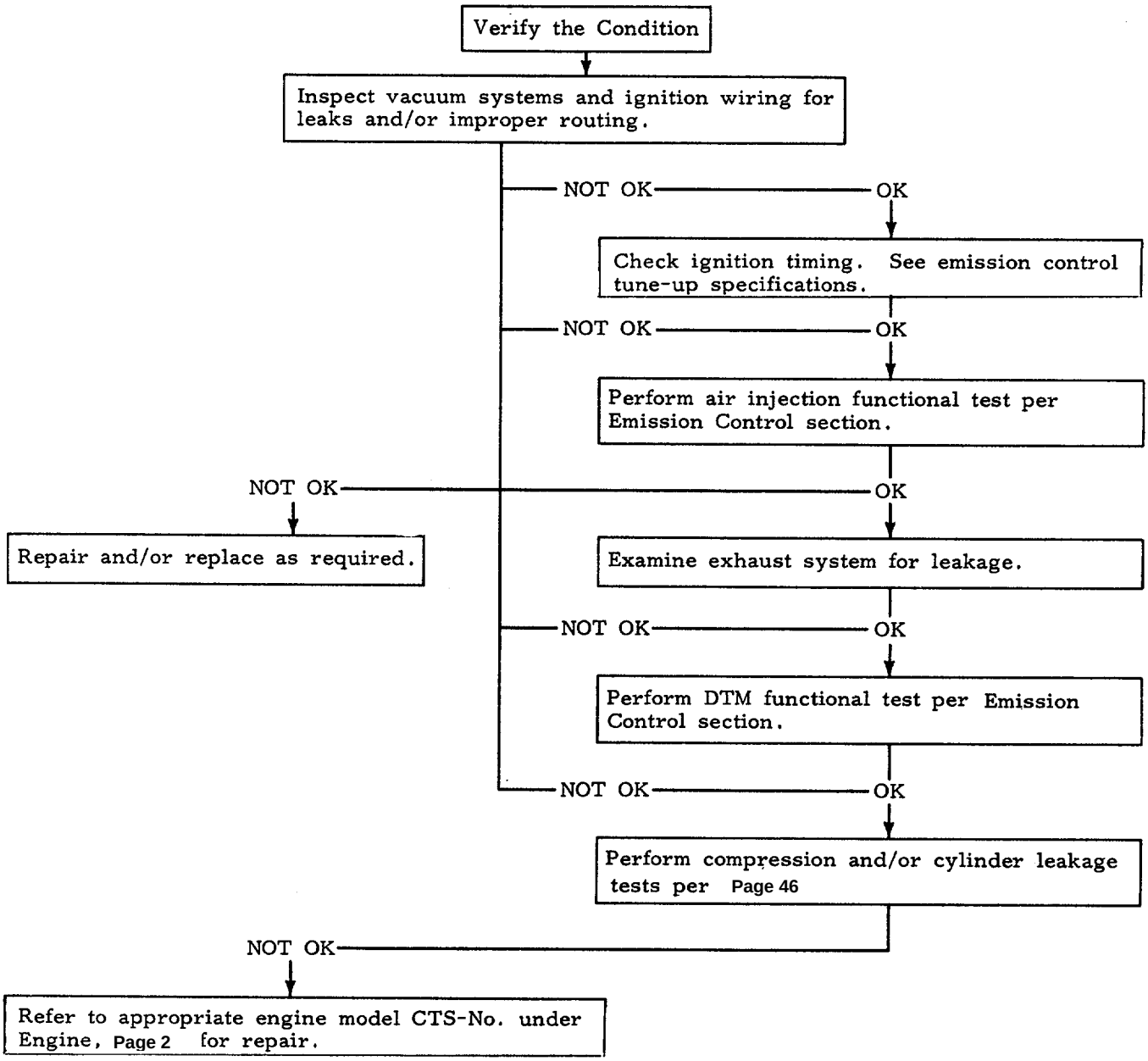
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CHART NO. 14

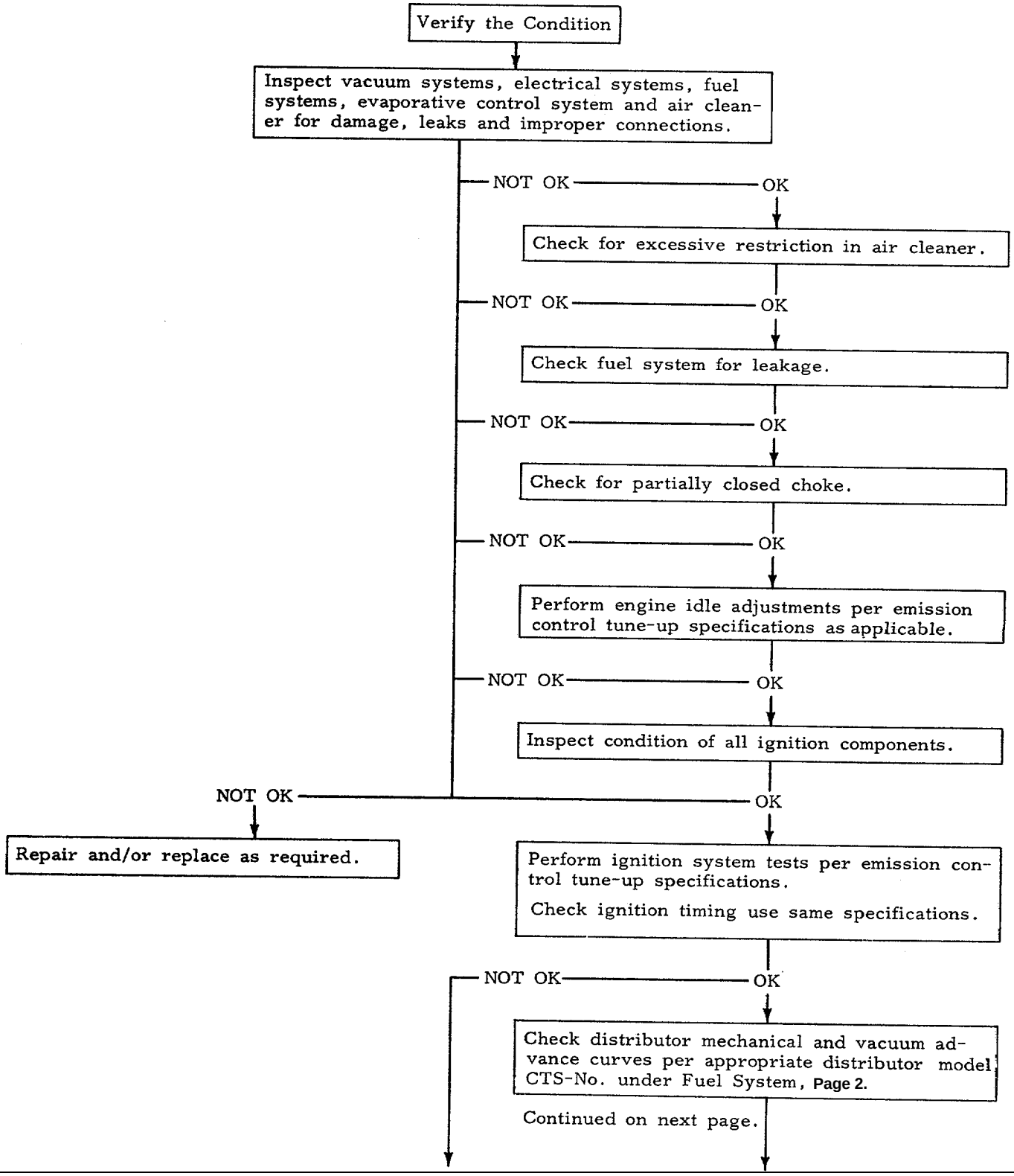
EXHAUST SYSTEM BACKFIRE



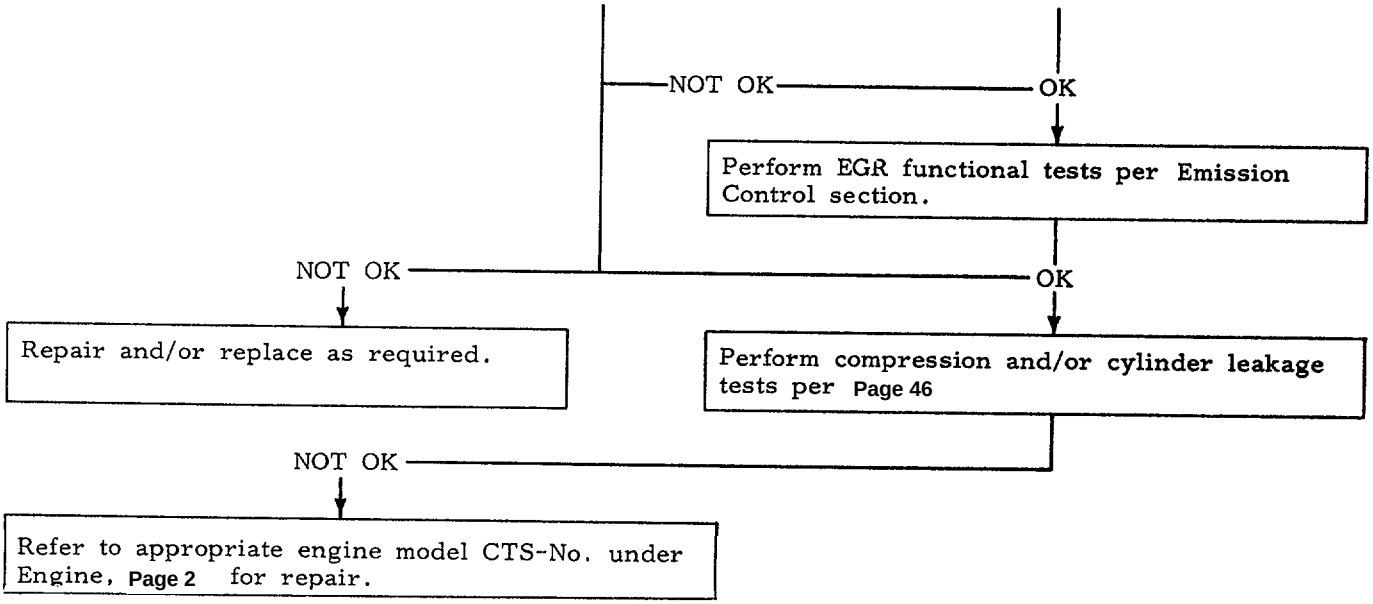
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CHART NO. 15

EXCESSIVE FUEL CONSUMPTION



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CHART NO. 16
EXCESSIVE OIL CONSUMPTION

↓

Verify the Condition

The most common cause of oil loss is leakage. To verify an excessive oil consumption complaint, it is necessary that a thorough inspection be made to insure that leakage does not exist. The following steps should be followed to verify an excessive oil consumption complaint.

A. Steam clean the engine (if necessary) to remove accumulated dirt and/or oil.

B. Drain engine oil and change the oil filter.

C. Fill the crankcase with the specified amount of the recommended grade of oil. (Check to be sure the correct dipstick has been installed.)

D. Check positive crankcase ventilation system for excessive oil pullover into air cleaner.

E. Drive the vehicle under normal conditions until the engine is at normal operating temperature. With the vehicle parked on a level surface, place a clean paper under the engine (to aid in detecting leakage).

F. Shut off engine and check for leakage at:

1. Valve rocker arm cover gaskets.
2. Oil pan gasket.
3. Cylinder block front cover gasket.
4. Cylinder block-to-fuel pump gasket and fuel pump air vent.
5. Intake manifold seals or valley cover gasket.
6. Crankshaft seals.
7. Distributor housing gasket.
8. Oil filter.
9. Oil pressure sending unit.
10. Oil Cooler.

G. When all causes of leakage (if any) have been repaired, check the oil level and adjust oil level to full mark on dipstick.

H. Record the odometer reading. Have the customer operate the engine for the approximate number of miles indicated by the complaint and then return it to you for examination.

I. When customer returns the vehicle, verify the odometer reading. Check the oil level and reinspect the engine for signs of oil leakage.

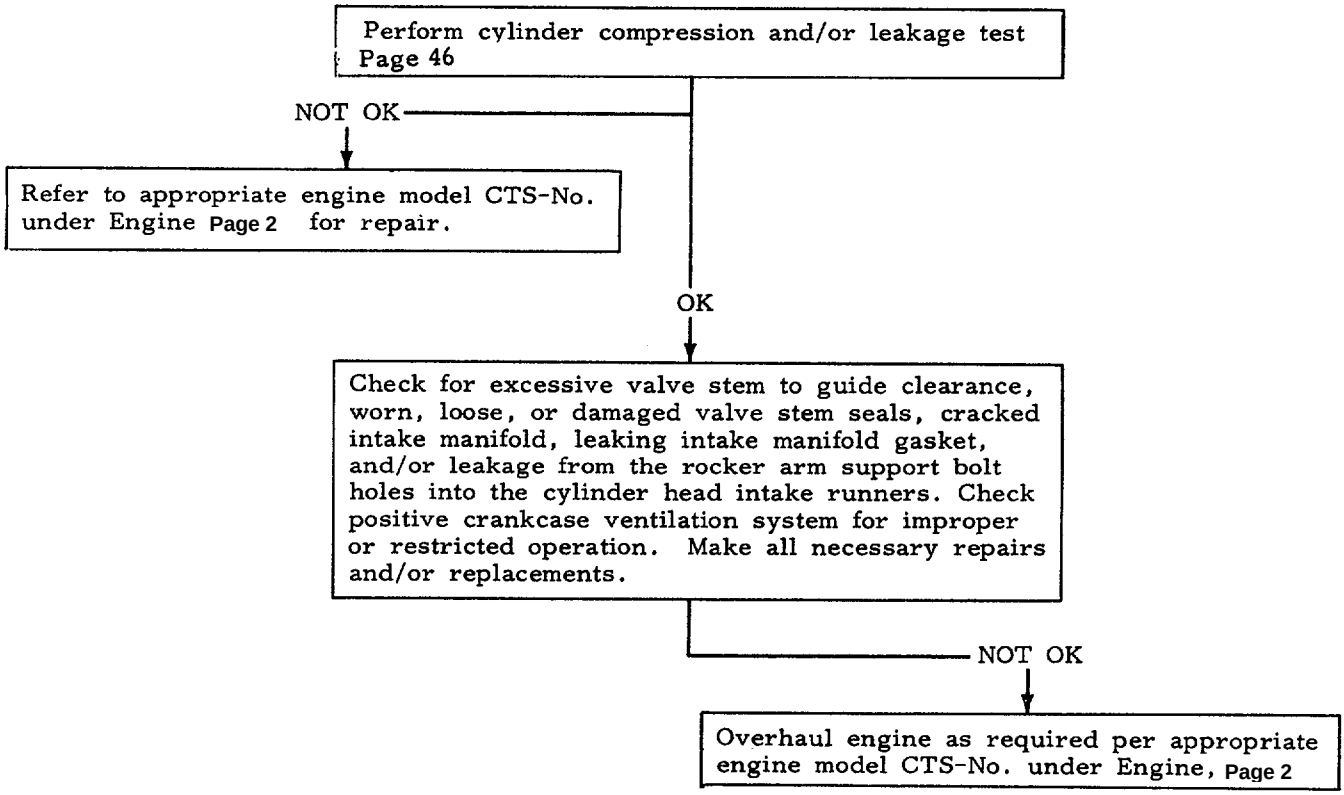
J. Add a measured amount of oil as necessary to bring the oil level to the full mark.

K. If oil consumption is not within specified limits (400-500 miles per quart), proceed with oil consumption diagnosis as outlined below.

NOTE

A new engine may require up to 6000 miles of operation in order to properly seat (break in) the piston rings. For this reason, the engine should not be condemned as long as oil economy is improving with mileage accumulation. If oil economy ceases to improve with mileage accumulation, corrective action should be taken.

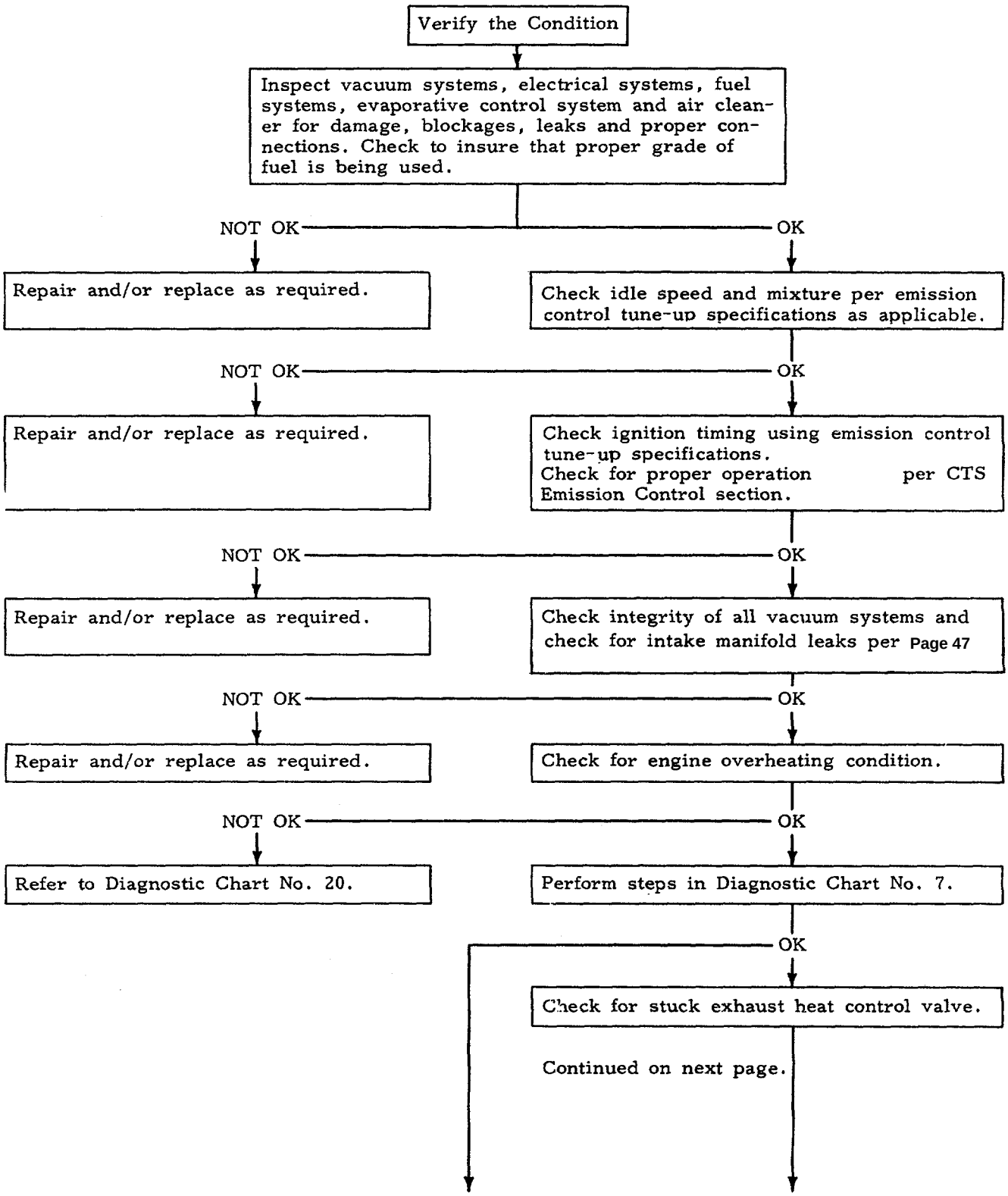
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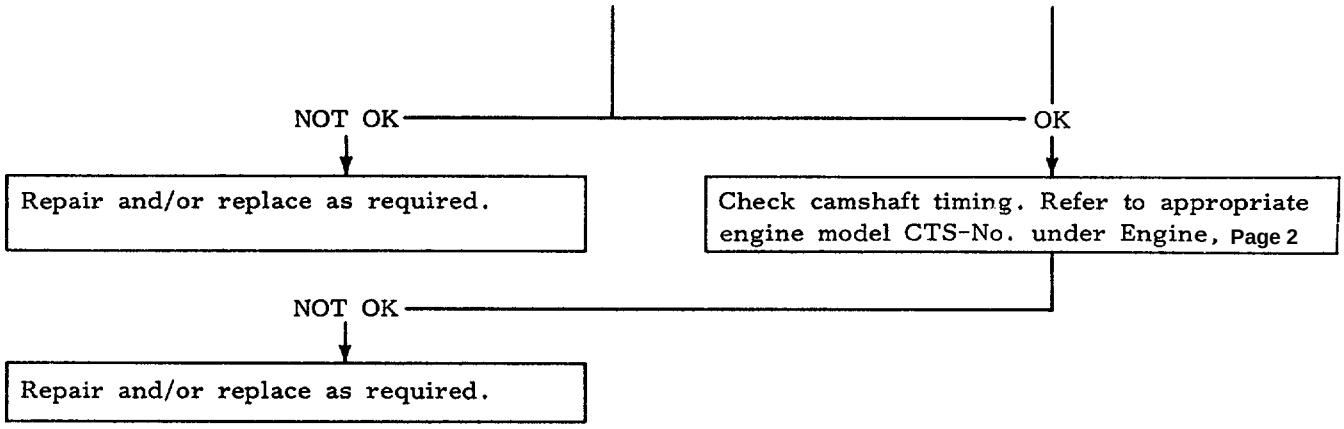
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CHART NO. 17

ENGINE DIESELS - CONTINUES TO RUN AFTER SHUT OFF



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CHART NO. 18

ENGINE NOISE

Noisy engine operation covers a wide range of conditions; therefore, to make the most efficient use of diagnostic aids to correct the condition, an accurate verification of the symptoms must be made. When the symptom is identified as to the type and general location of the noise, proceed to the applicable step outlined below. It can be seen that many of the steps are based on similar symptoms and, indeed, may be a matter of individual interpretation. Therefore, if the most likely step fails to correct the condition, proceed to the next most likely step, and so on until the condition is corrected.

A. Spark Knock or Pinging

This condition is characterized as being increasingly more noticeable as engine load increases. That is, at a given vehicle speed and throttle opening the problem would generally be more noticeable on a steep grade than on a level surface. The condition is due to low octane fuel, excessive spark advance or engine overheating.

If any discrepancies are noted in the following checks, repair and/or replace as required. Advise owner of proper octane fuel and verify correct spark plug heat range. If engine overheating is indicated, perform steps in CHART 20, check ignition timing and check distributor mechanical and vacuum advance curve per CTS ELECTRICAL section.

B. Light Clicking (Varies with Engine Speed)

This condition is usually caused by improperly adjusted, failed or malfunctioning valve train components. Insert feeler gauge between rocker arm and valve stem tip and/or exert pressure on rocker arm. If noise is eliminated, adjust valve clearance to specifications. If condition persists, inspect for worn or malfunctioning valve train components. If no failure is detected, check for excessive valve stem-to-valve guide wear by exerting side pressure on valve stem. If noise is corrected excessive wear is indicated. If valve is eliminated as a possible cause, check for accessory component noise by loosening and/ or removing drive belts, one at a time, until noise stops. Investigate fuel pump and/or pump drive as possible cause.

C. Sharp Rapping (Varies with Engine Speed)

This condition is usually caused by malfunctioning hydraulic lifter and may be located with the aid of a stethoscope. If the problem is not corrected, perform Step B.

D. Hissing

Inspect vacuum systems for leakage due to loose or broken connections and/or failed parts. Inspect manifolds for leaks. Perform cylinder compression and/or leakage tests to identify and isolate cylinder head gasket leaks. Inspect for carburetor gasket leaks.

E. Sharp Snapping Noise During Acceleration

Look for arcing from high tension ignition cables.

F. Squeaks and/or Squeals

Loosen drive belts, one at a time, to determine if accessory component or water pump is at fault.

G. Heavy Squeal During Acceleration

Check for accessory drive belt slippage and adjust tension or replace as required.

H. Ringing, Grinding or Combination of Both

Check for loose, bent or improper pulleys. Check for front end bracket interference between rotating parts and surrounding components caused by misalignment of engine, engine components or surrounding components. Check for worn or damaged water pump or accessory components by loosening drive belts, one at a time, until noise stops.

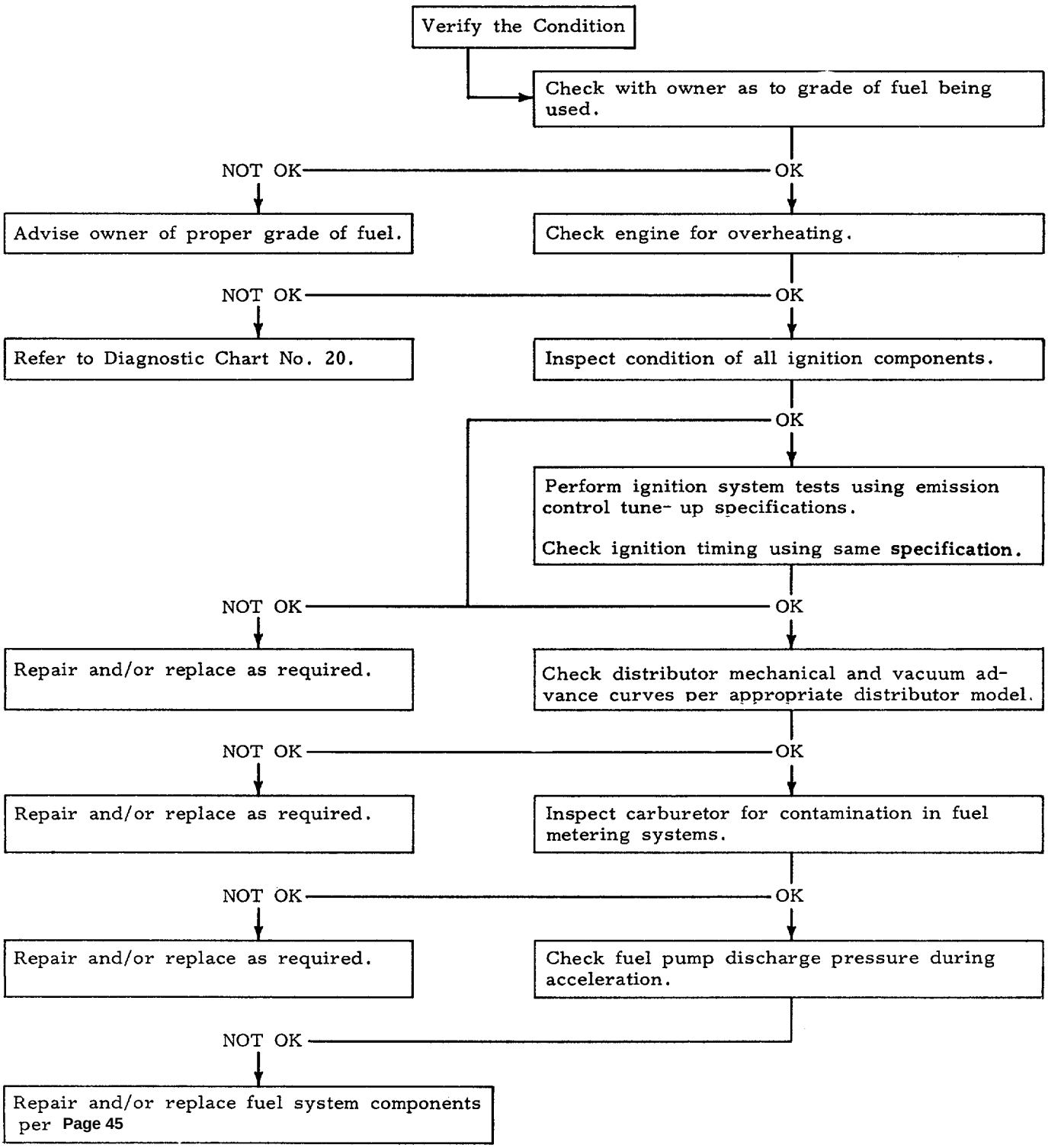
I. Buzzing or Whistling During Engine Operation

Perform radiator cap functional check and verify proper cap sealing. If engine overheating is indicated, perform engine overheating routine. Check for interference with the fan or front end drive components by foreign material, loose or broken surrounding parts. Check for loose carburetor mounting. Check for vacuum leaks. Check power steering.

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CHART NO. 18A

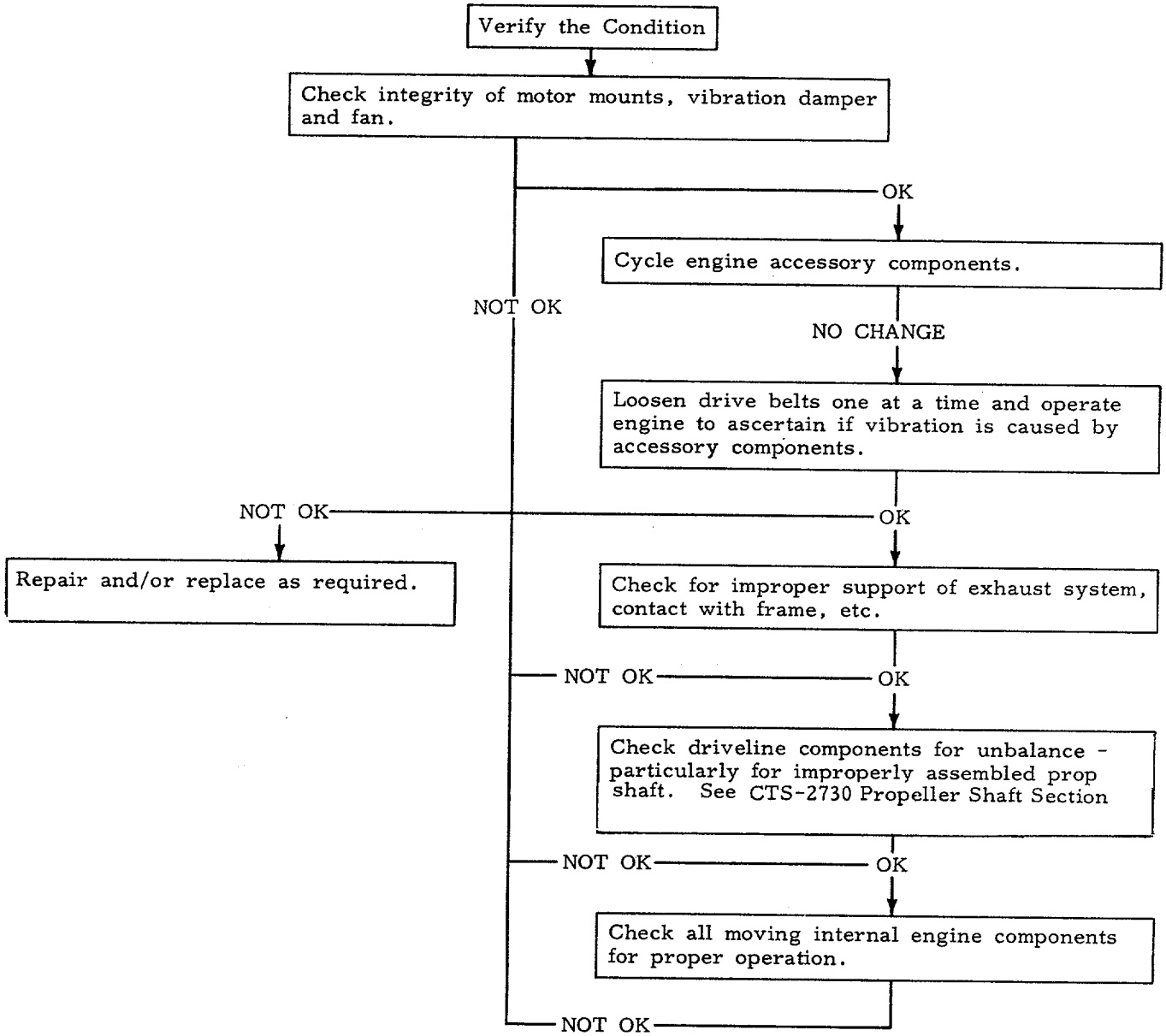
SPARK KNOCK OR PINGING



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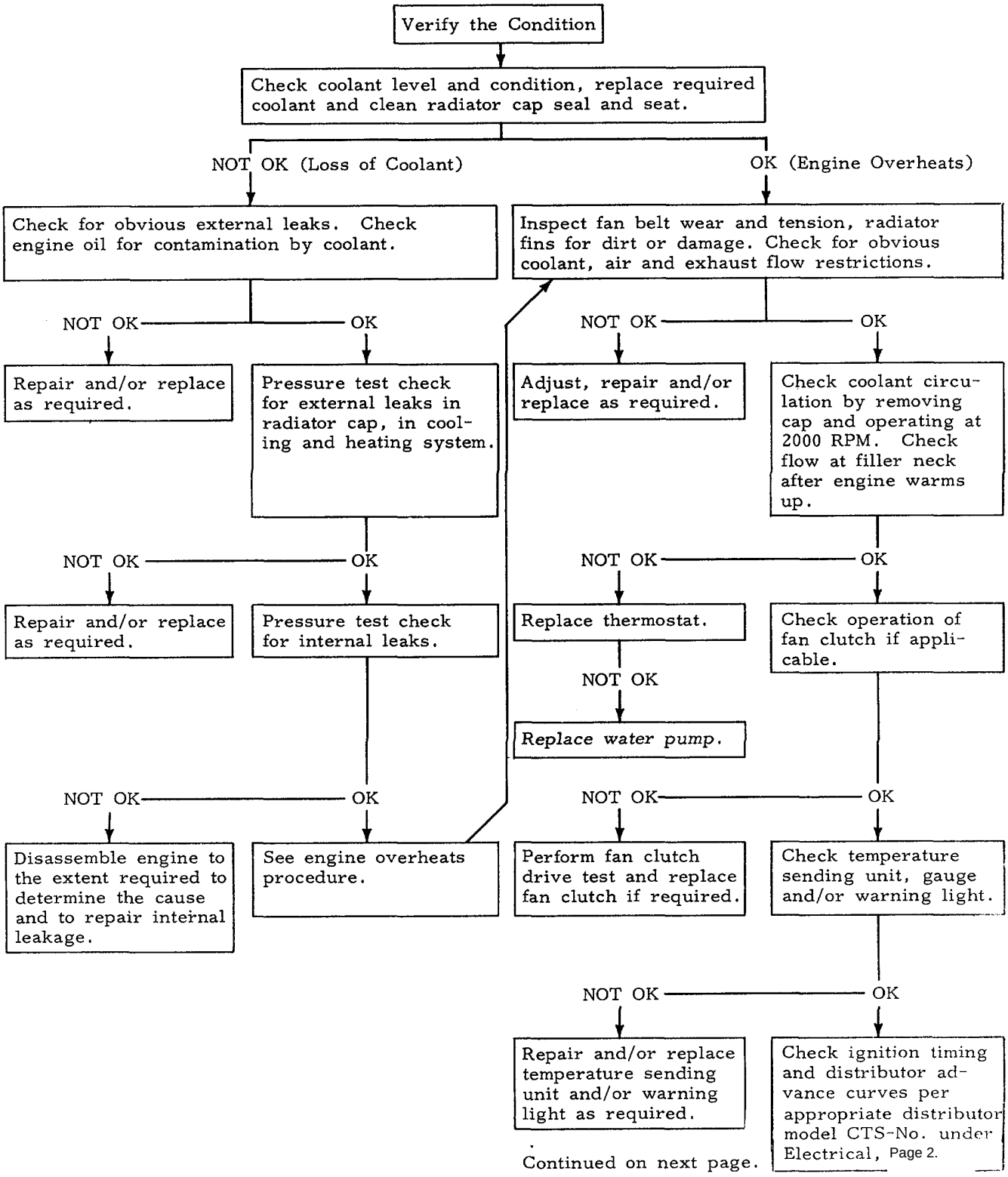
CHART NO. 19

ENGINE VIBRATION



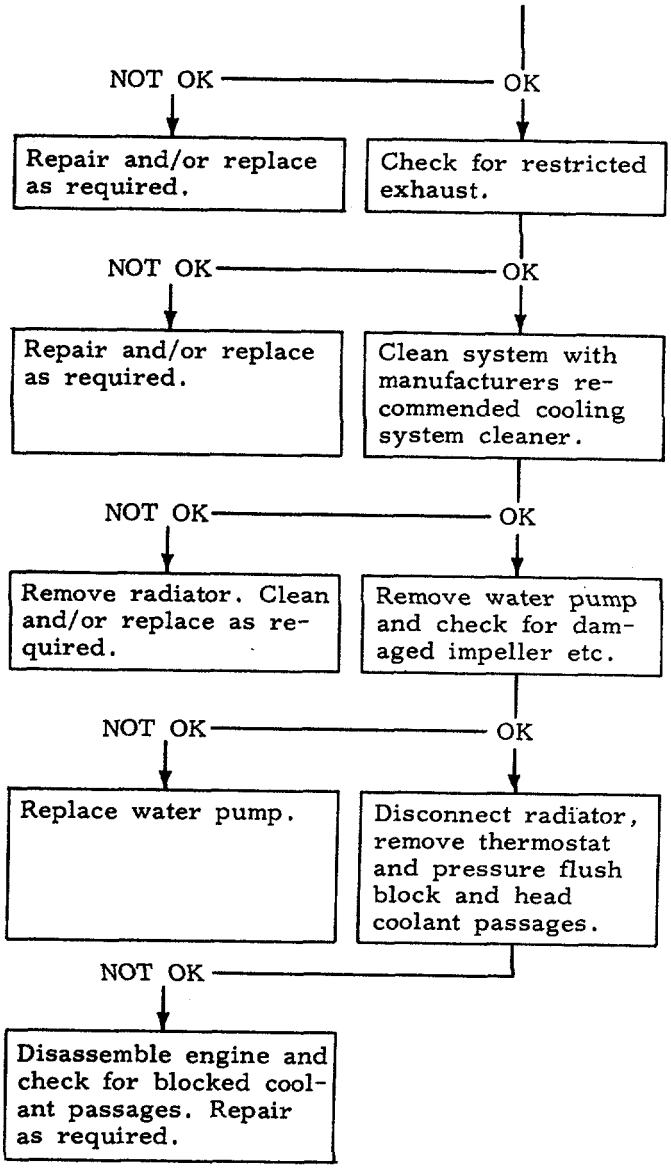
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CHART NO. 20
LOSS OF COOLANT OR ENGINE OVERHEATING



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CHART NO. 21
SMOKE FROM VEHICLE EXHAUST SYSTEM

The color or type of visible smoke from vehicle exhaust can provide clues as to the source of the problem. Three types of "smoke" are generally common to gasoline engines:

White Smoke

Visible white "smoke" in exhaust results from coolant entering the combustion chambers or exhaust system. Check for failed cylinder head gasket or cracked cylinder head casting. If OK, check for cracked crankcase.

Black Smoke

Results from overrich fuel mixture. Check for partially closed choke, or carburetor flooding condition. An overrich mixture usually causes rough engine operation. Perform steps covered in Diagnostic Chart No. 15.

Blue or Bluegray Smoke

Results from oil entering the combustion chambers or exhaust system. Check PCV system per CTS Emission Control section.

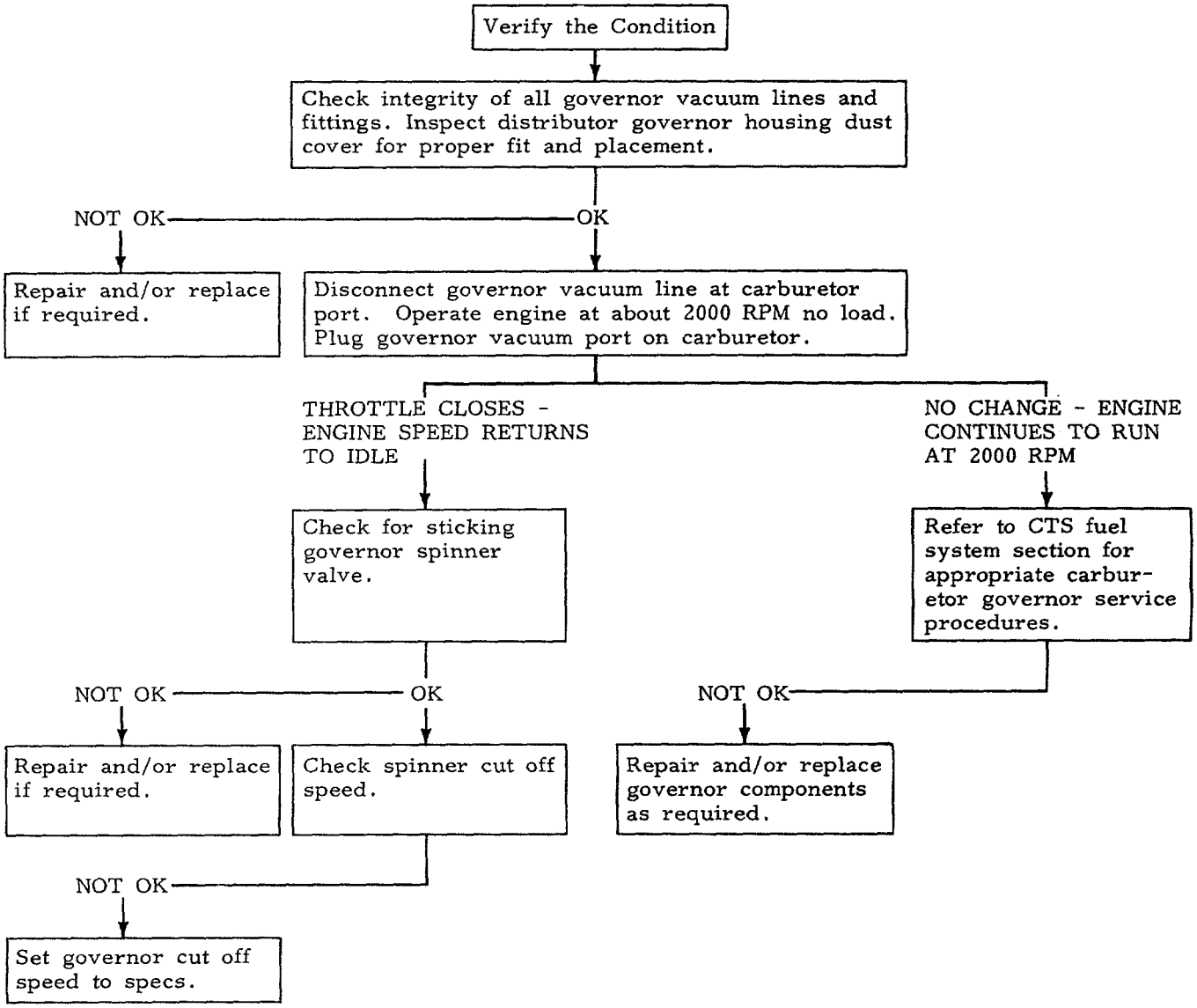
1. Blue smoke noted during wide open throttle operation indicates worn or stuck piston rings.

2. Blue smoke noted during deceleration (high vacuum) indicates failed or worn valve stem seals or worn valve guides.

Refer to appropriate CTS engine section for repair of above difficulties.

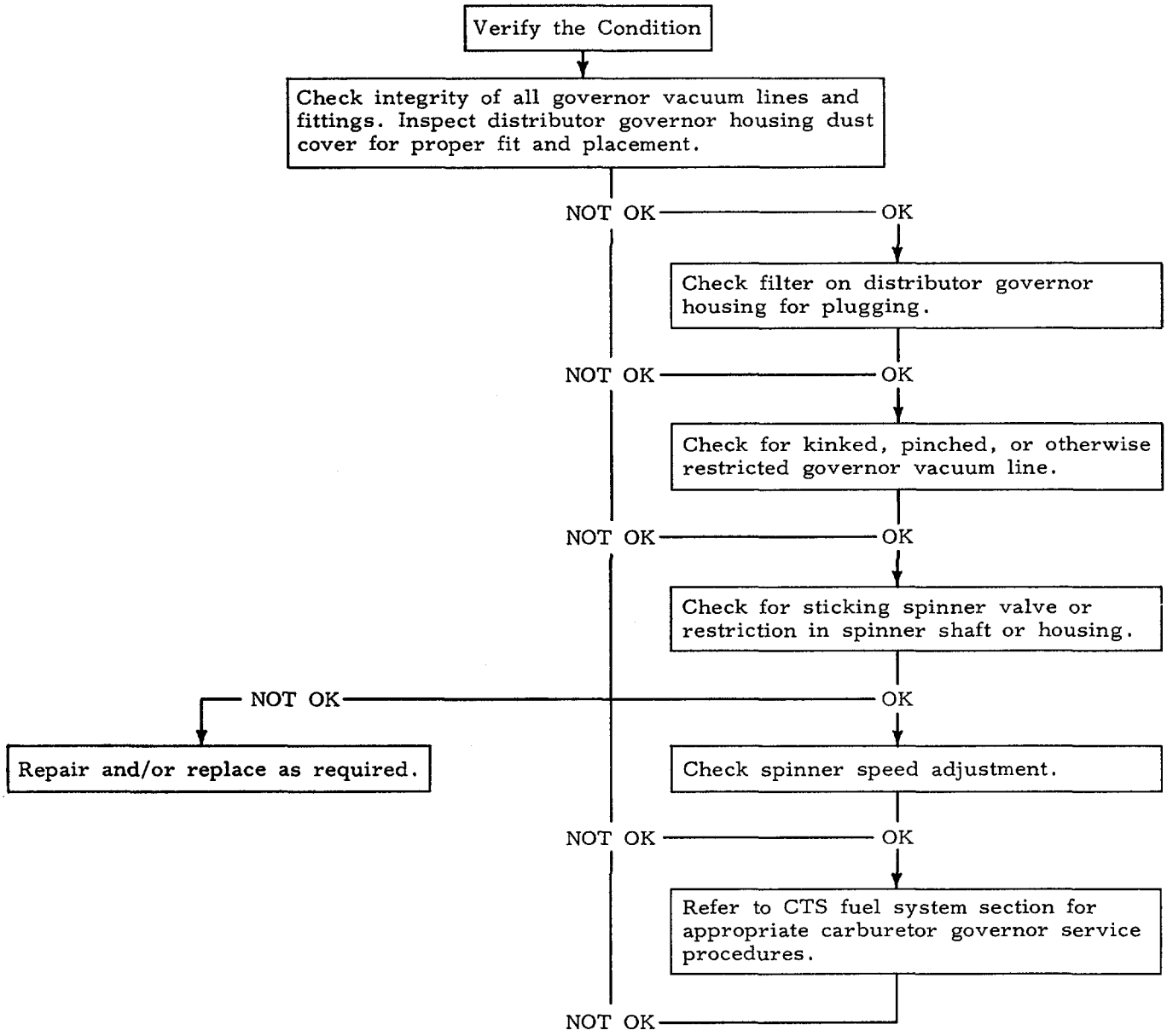
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CHART NO. 22
ENGINE GOVERNOR DOES NOT OPERATE-NO ENGINE SPEED CONTROL



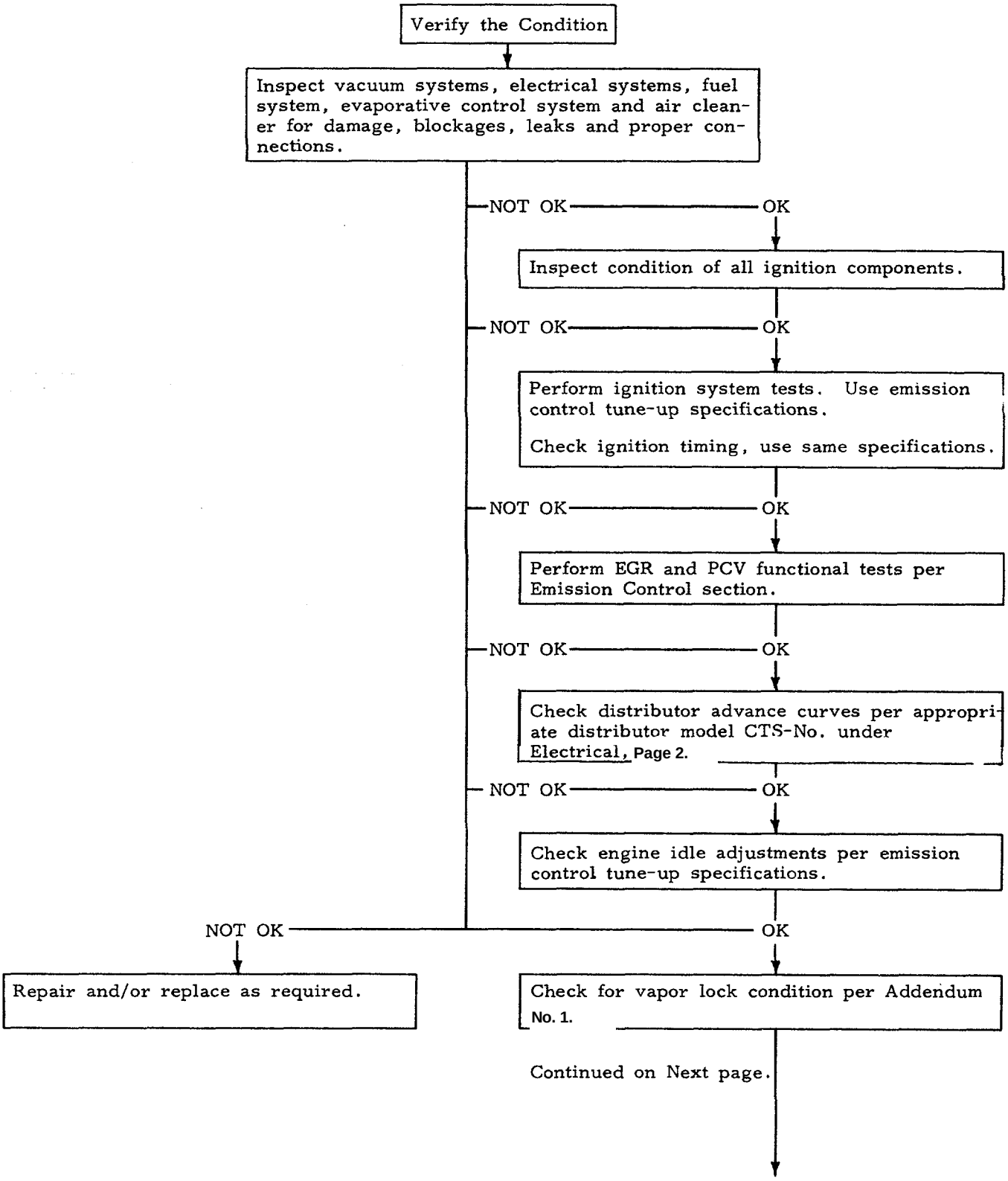
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CHART NO. 23
GOVERNOR CUTS OFF AT LOW SPEED-ERRATIC OPERATION

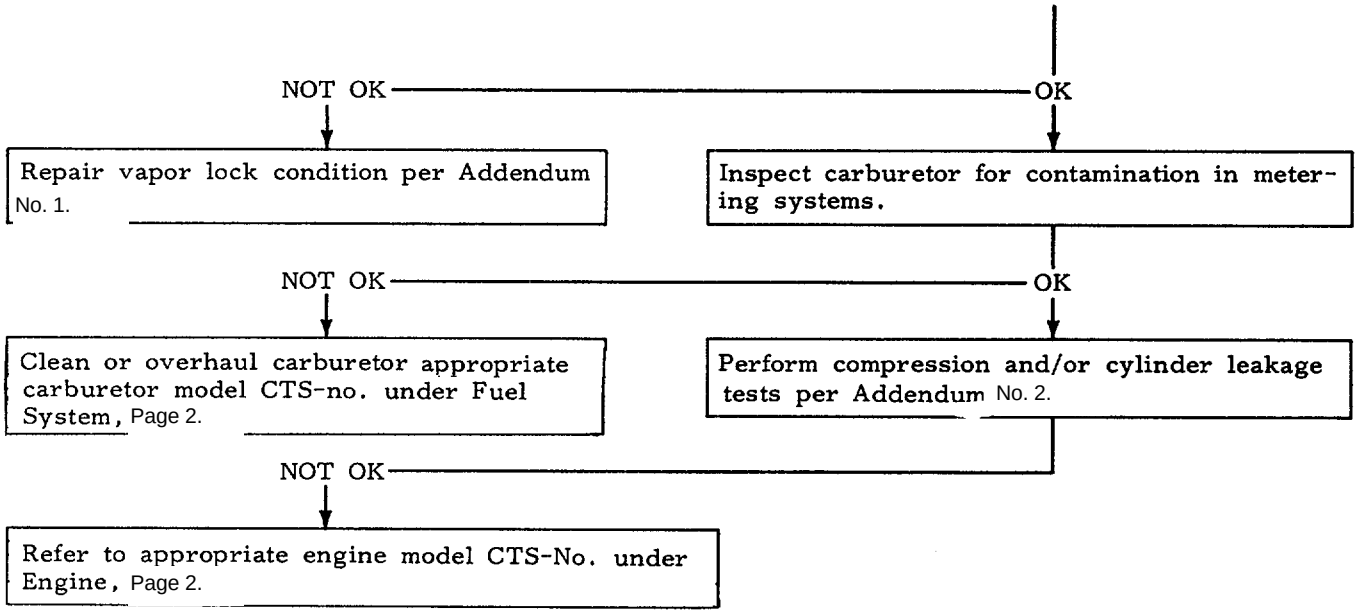


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CHART NO. 24
ENGINE SURGES BELOW GOVERNOR CUT OFF SPEED



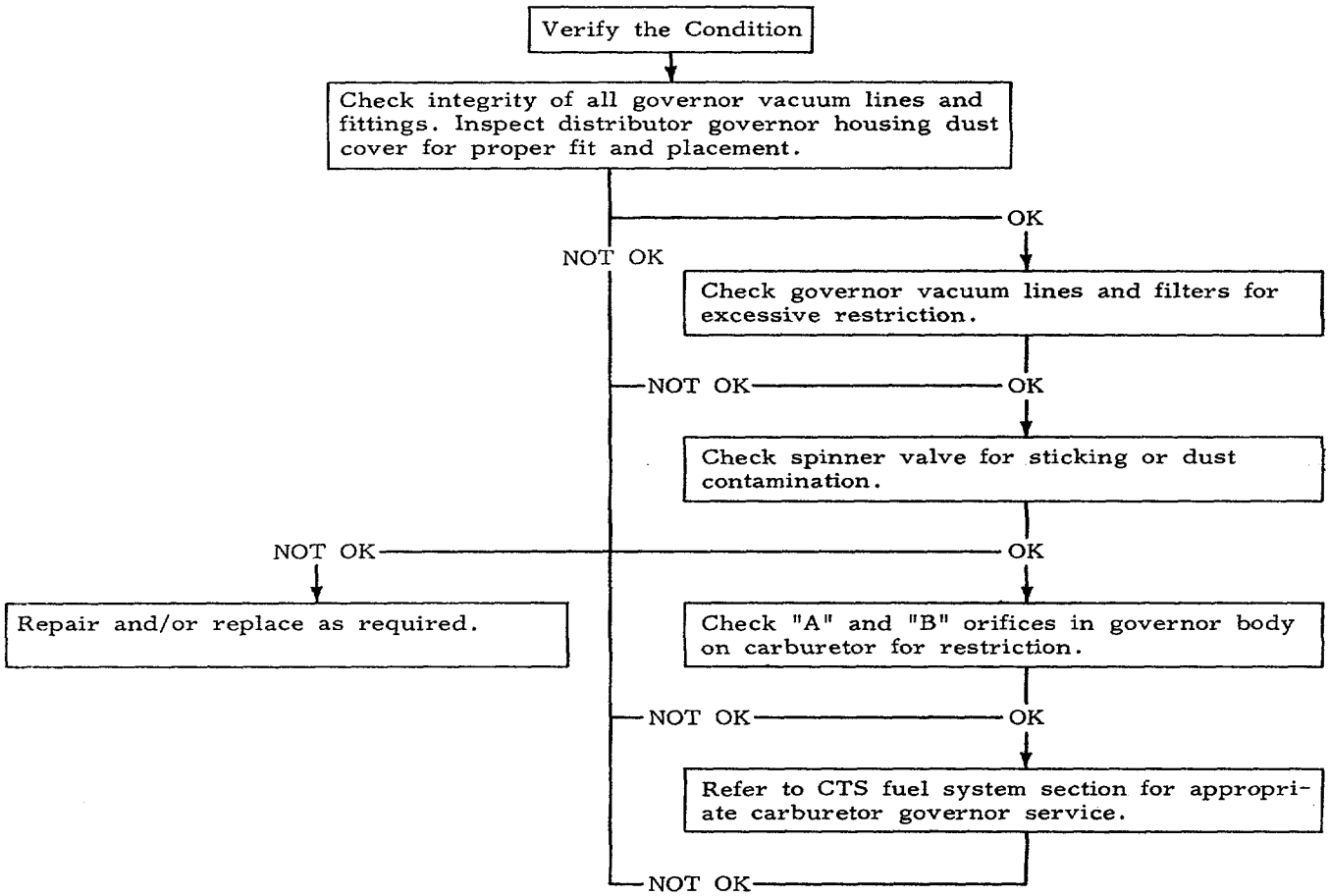
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CHART NO. 25

ENGINE SURGES AT GOVERNED SPEED



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FUEL SYSTEM VAPOR LOCK

Vapor lock occurs when fuel system components become sufficiently heated to cause fuel to vaporize within fuel lines, filter, or fuel pump at a rate which prevents liquid fuel from reaching the carburetor. Vapor lock is generally associated with hot ambient conditions but can still occur in cooler climates when vehicle or engine is operated under heavy load. Vapor lock conditions are aggravated at higher altitudes.

To trouble shoot a suspected vapor lock condition, proceed as follows.

1. Do vapor lock conditions prevail? Look for hot fuel system components. Does engine run OK when cool?

2. Remove carburetor air cleaner and pump throttle by hand. Observe accelerator pump discharge. Absence of pump shot or weak discharge may indicate vapor lock. Check for presence of fuel in tank. Check for fuel system obstructions.

3. Check fuel pump discharge pressure by removing fuel line from carburetor inlet, connect fuel pressure tester to open end of fuel line (*) and crank engine. A vapor locked fuel pump will produce some pressure, although not necessarily specified pressure. Observed pump pressure as low as 1 to 2 psig indicates that the pump is probably OK but should be checked again when engine is running normally.

(*) NOTE: For this test, do not "tee" pressure tester into fuel line between fuel pump and carburetor. No pump discharge pressure would be observed because fuel vapor would be vented to the carburetor bowl through the open needle valve.

If fuel pump has measurable discharge pressure but does not pump liquid fuel when system is very hot, vapor lock is a likely cause.

4. If vapor lock is suspected as the cause for rough engine operation during cruise or acceleration it may be checked as follows.

"Tee" fuel pressure tester fitting into fuel line between fuel pump and carburetor. Place test gauge in vehicle within view of driver or passenger. Connect to fitting with flexible fuel line. Operate vehicle on highway until rough operation occurs.

Note fuel pressure during rough operation. If pressure drops to zero, vapor. lock may be the cause. (Check fuel lines and filter for obstructions.)

Remove fuel pressure tester and fitting from fuel line and allow fuel system components to cool; then check to see that normal engine operation has been restored. If engine does not run, refer to Trouble Shooting Charts 4 or 5.

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COMPRESSION AND CYLINDER LEAKAGE TESTS

Compression Test

The compression test is performed to measure cylinder compression pressure. The absolute value of compression pressure is significant but cylinder to cylinder variation is even more important. Allowable variation from cylinder to cylinder is:

Lowest cylinder pressure must not be less than 75% of the highest cylinder pressure. Greater variation from cylinder to cylinder indicates need for mechanical repair which should be carried out in accordance with the appropriate CTS ENGINE section.

Perform engine compression test as follows:

1. Run engine until normal operating temperature is reached.

2. Remove all spark plugs and install compression gauge in No. 1 cylinder.

3. Remove coil secondary wire from distributor cap and ground it to prevent arcing. Block carburetor throttle open.

4. Connect remote starter switch to starter solenoid or have an assistant available to crank engine.

5. Crank the engine for at least 5 compression strokes or until compression gauge reaches its highest value. Note the number of compression strokes required to reach highest value. Record compression pressure and number of strokes.

6. Repeat the test for each of the other cylinders.

7. If one or more cylinders produce a low reading, squirt about a tablespoon of engine oil into low reading cylinders. Repeat compression test on those cylinders.

a. If compression pressure improves significantly, worn or broken piston rings are at fault.

b. If compression pressure does not improve, valves are at fault or if two adjacent cylinders have low compression, a leaking cylinder head gasket may be the cause.

Cylinder Leakage Test (CLT)

The cylinder leakage test is supplemental to the compression test and can provide diagnostic information as to the cause for loss of compression. The CLT can identify leakage past intake or exhaust valves, leaking cylinder head gasket, worn or broken piston rings, or other cause for loss of compression.

Perform cylinder leakage test as follows.

1. Run engine until normal operating temperature is reached.

2. Remove spark plugs from engine.

3. Remove air cleaner and block carburetor throttle open.

4. Remove oil filler cap.

5. Remove radiator cap. If coolant is low, fill to prescribed level.

6. Turn crankshaft until No. 1 cylinder is at top dead center on compression stroke.

7. Connect and calibrate cylinder leakage tester in accordance with manufacturer's instructions.

8. Record cylinder leakage (usually in percent) and determine source of leakage by listening for air escaping through carburetor, exhaust system, or crankcase (oil filler tube). Look for air bubbles in coolant (radiator top tank).

9. Carefully turn crankshaft in normal direction of rotation until the next cylinder in firing order sequence is at top dead center. Connect CLT to that cylinder and repeat test.

10. Repeat test for each consecutive cylinder in firing order sequence.

When the cause for loss of compression has been identified, repair engine in accordance with the appropriate CTS ENGINE section.

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VACUUM SYSTEM HOSE LEAKAGE TEST

Perform engine vacuum system hose leakage test as follows:

1. Install vacuum gauge and tachometer. Care should be taken to insure that vacuum gauge is connected to manifold vacuum and not to some other vacuum such as ported spark or EGR signal vacuum.

2. Start and run engine until normal operating temperature is reached. Then, with engine running at curb idle speed, record vacuum gauge and tachometer reading (baseline).

3. With engine running at curb idle speed, remove each vacuum hose (one at a time) from vacuum source and plug source. When removing vacuum hose to distributor on engines which have straight manifold vacuum advance, apply at least 15 In. Hg. vacuum to vacuum advance using hand vacuum pump SE-2499 to prevent change in spark timing during test.

4. As each vacuum circuit is checked, record vacuum gauge and tachometer reading. If no change in reading is observed (from baseline), no vacuum leak exists in that particular vacuum hose circuit. If a change in reading is observed, a vacuum leak does exist in that particular vacuum hose circuit and can be located as follows:

a. Remove plug and reinstall vacuum hose.

b. Remove other end of same vacuum hose at next downstream connection and plug.

c. Record vacuum gauge and tachometer readings.

d. Repeat steps 4a through 4c at each hose connection until leak is isolated. Leak is isolated to last component checked when reading returns to baseline value. Replace leaking hose(s) or component(s) identified.

5. Continue procedure until the integrity of all vacuum circuits is verified or restored.

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PART III
IH-DIESEL
EXHAUST EMISSION
EFFECTS AND MAINTENANCE
INTERVAL CHART

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PART III

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REQUIRED MAINTENANCE OPERATIONS

IH-633 DIESEL ENGINE

For effective emission control, it is important that maintenance operations listed on the following pages be performed at the specified periods or mileage intervals indicated.

Service intervals given are based upon average highway operating conditions. Where dusty, off-highway, frequent start and stop or heavily laden operations are encountered, more frequent servicing will be required.

Each numbered maintenance description operations chart is completely explained under the corresponding number in the following text.

		MAINTENANCE INTERVALS (Kilometers, Miles or Months, Which ever Occurs First)		
DESCRIPTION	OPERATION	Kilometers (Every)	Miles (Every)	Months (Every)
1. Engine Oil	Replace: Check: Daily	4000	2500	3
2. Engine Oil Filter	Replace at Initial Replace at: Thereafter:	4000 8000 8000	2500 5000 5000	3 6 6
3. Fuel Filter	Replace at: Initial: Replace at Thereafter: Clean:	4000 24000 24000 4000	2500 15000 15000 2500	3 18 18 3
4. Air Cleaner Filter	Replace:	24000	15000	18
5. Valve Lash	Adjust-	24000	15000	18
6. Fuel Injection Nozzles	Clean and Adjust	24000	15000	18
7. Fuel Injection Pump Timing	Check and Adjust, If Necessary	60000	37500	45
8. High and Low Idle	Check and Adjust, If Necessary	60000	37500	45

Oil type and grades recommended for IH diesel engine used in the Scout Chassis are as follows:

LUBRICATION INSTRUCTIONS
ENGINE LUBRICANT SPECIFICATIONS

DIESEL ENGINE

Temperature	Straight Viscosity Grade	Multi-Viscosity Grade
20 to 120 F (-7 to 49 C)	SAE 30 SAE 20W	SAE-10W-30, 10W-40, 20W-40, 20W-30 SAE-10W-30, 10W-40, 20W-40, 20W-30
0 to 90 F (18 to 32 C)	SAE 10W	SAE-10W-30, 10W-40
-10 to 70 F (-23 to 21 C)	--------	SAE-5W-20, 5W-30

*Below -10 F (32 C)

Use engine oils meeting API service classification "IH No. 1 (CD/CC/SE)", "SE" CC (MIL-L-46152) or "CD (MIL-L-2104C)".

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IH-633 DIESEL ENGINE

The following explanation of the required maintenance operations are numbered to correspond with the operations listed on the maintenance intervals chart:

1. ENGINE LUBRICATING OIL.

Change the lubricating oil ever, -2, 500 miles. More frequent drain intervals should be decided spending on operating conditions and quality of lubricating oil. Inspect lubricating oil connectors and oil lines for wear or leaking.

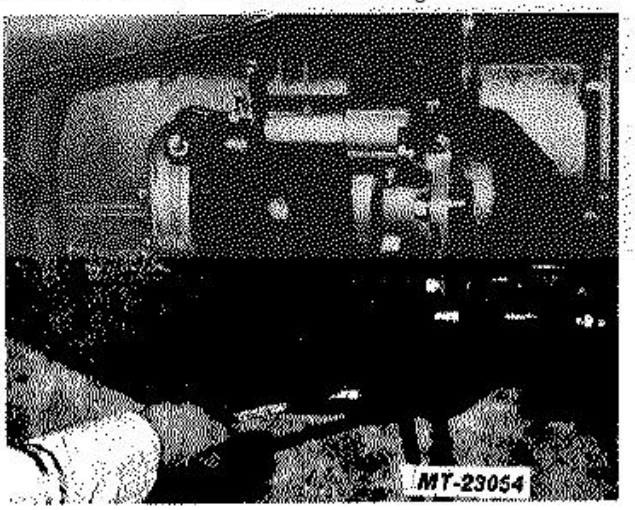


Fig. 1 Engine Oil Draining

Engine oil is drained by removing the drain plug on the bottom of the oil pan. When draining oil, use a container having adequate volume. Drain engine, oil while the engine is hot. Clean drain plug and area before reinstalling plug. Reinstall drain plug. Add sufficient oil to bring the oil level between the H and L marks on the oil level dipstick. See oil type and grades recommended for IH diesel engine.

2. ENGINE LUBRICATING OIL FILTER.

Replace the lubricating oil filters at initial change, 2, 500 miles, at 5, 000 miles and every 5, 000 miles thereafter.

(1) Replacing oil filter element.

a. Place an empty container beneath the oil filter.

b. Loosen the center bolt and separate the oil filter assembly from the adapter.



Fig. 2 Removing Center Bolt

c. Clean the center bolt and filter shell.

d. Replace the element and gasket and fit the oil filter assembly to the adapter. Tighten center bolt .10.3 to 13.0 N·m (14 to 18 lb. ft.). Start engine and run for at least five minutes to warm oil and check for leaks. Recheck and add sufficient oil to bring oil level between H and L marks on oil level dipstick.

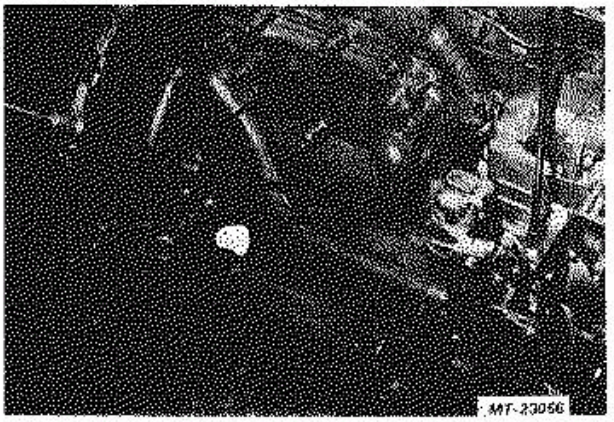


Fig. 3 Checking Engine Oil Level

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3. FUEL FILTER.

Replace, fuel filter element at initial inspection of 2, 500 miles running and clean every 2, 500 miles thereafter, and replace element every 18 months or 15, 000 miles.

IMPORTANT

Fuel filter must be serviced according to above schedule (2500 mile intervals) to prevent damage to fuel injection components. A plugged fuel filter can also result in power loss.

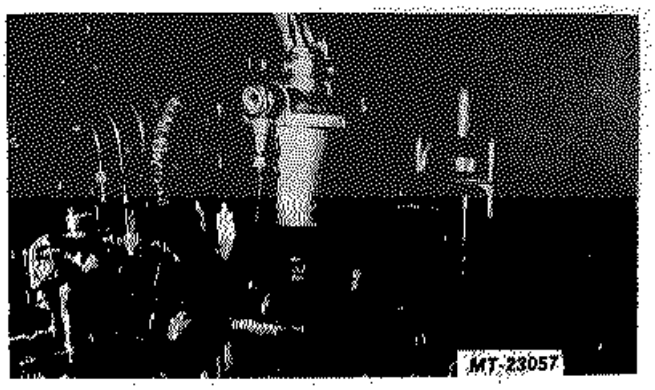


Fig. 4 Fuel Filter

Element Replacement

(1) Separate the case and fuel filter element by removing the center bolt.

(2) After cleaning the filter case and other items, assemble the new fuel filter element. Be sure to use new gaskets.

AIR BLEEDING (FUEL SYSTEM)

Air in the diesel engine fuel system will cause difficult starting. Although the engine starts in some cases, output may be insufficient or the engine may suddenly stop. After cleaning and replacement the fuel filter or disconnecting a fuel line, do not attempt to start the engine until air is bled from the system. After starting the engine, observe the fuel strainer and filter for a short while to verify that no air remains.

1. Air Bleeding of Fuel Filter

Loosen the connector bolt (outlet side) on top of the fuel filter cover. Operate the priming pump of the injection pump by hand until bubbles cease to appear. At this time, retighten the connector bolt.

2. Air Bleeding of Injection Pump

The next step is bleeding of air from the injection pump. There are two bleeder screws. Start with the one nearest the timer. Loosen the bleeder screw and operate the pump until bubbles cease to appear. Retighten the bleeder screw at this time.

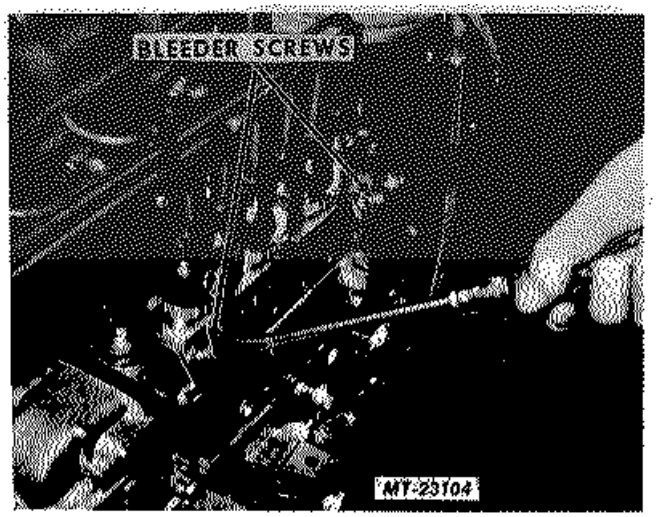


Fig. 5 Air Bleeding of Injection Pump

3. When Bleeding is Ineffective

When bleeding is ineffective, there are surely loose connections in the fuel line between fuel tank and feed pump or the line itself is damaged. Carefully inspect these items.

4. REPLACE AIR CLEANER FILTER.

Remove air cleaner element, clean any accumulation of dirt from air cleaner housing and carburetor air horn. Replace the element at intervals shown on maintenance interval chart.

If element requires cleaning between replacement intervals, tap element lightly on a flat surface or use low air pressure to remove dirt particles. Blow air from inside

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filter to outside. Check element for punctures or splits by looking through filter paper toward light held in center of element. Do Not Wash Element.



Fig. 6 Dry Type Air Cleaner Filter

5. VALVE LASH.

Check valve lash and adjust if necessary, every 15, 000 miles.

Check and Adjusting Valve Clearance

Regardless of whether the engine is cold or hot the clearance should be 0.35 mm (0.0137") for both intake and exhaust valves.

(1) Checking clearance. Set parking brake, place transmission in neutral (manual), and block wheels.

Start the engine and operate it at the slowest idling speed possible. Measure clearance by using a thickness gauge. If the measured value is incorrect, adjust in accordance with the following procedure.



Fig. 7 Checking Valve Clearance

(2) Adjusting clearance

There are two occasions on which the piston is at top dead center; compression stroke and exhaust stroke. If both intake and exhaust valves are closed, top dead center on the compression stroke is indicated. At this time both intake and exhaust valve push rods will have play.

a. Stop the engine. Pull engine stop control "out". By aligning the proper flywheel mark to the pointer of the flywheel housing, bring the No. 1 or No. 6 piston, Figure 7, to Top Dead Center on the compression stroke by using some kind of tool to turn the ring gear attached to the flywheel In case of flywheel mark is not stamped on the flywheel, align the stamped mark on the crankpulley to the pointer.

b. With the No. 1 piston at top dead center on the compression stroke, adjust clearance for valves designated with a zero in the following table. With the No. 6 piston at top dead center on the compression stroke, adjust clearance for valves designated by a triangle. As shown in Figure 8, loosen the lock nut and adjust clearance by using a screwdriver to turn the adjusting screw.

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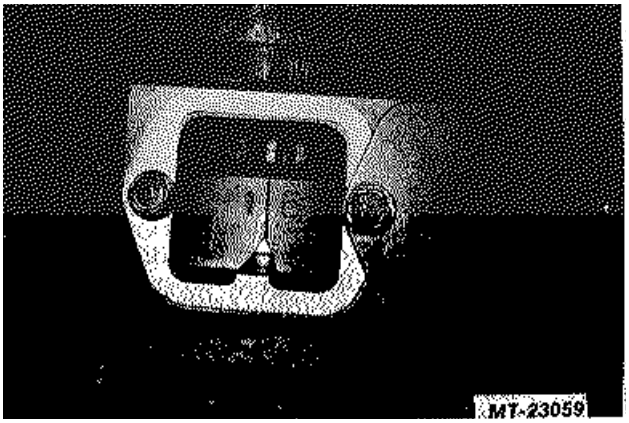


Fig. 8 Aligning Flywheel Mark

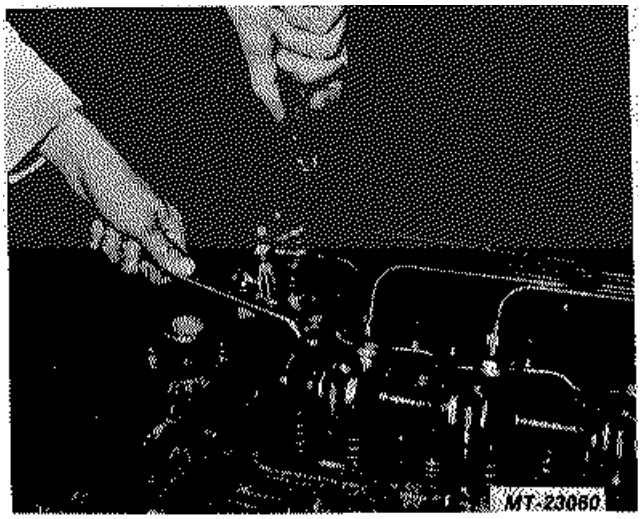


Fig. 9 Adjusting Valve Clearance

6. FUEL INJECTION NOZZLES.

Check opening pressure and atomization of nozzle, clean and adjust if necessary, every 15,000 miles at specified opening pressure according to repair or operation and maintenance manual.

Cylinder No.	1		2		3		4		5		6	
Valve No.	Exhaust No.1	Intake No.2	Intake No.3	Exhaust No.4	Exhaust No.5	Intake No.6	Intake No.7	Exhaust No.8	Exhaust No.9	Intake No.0	Intake No.11	Exhaust No.12
◎	○	○		○		○		○		○		
*			△		△		△		△		△	△

◎ No.1 Piston top dead center
* No.6 Piston top dead center

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See CTS-2716-Fuel System.
Subject: Nozzle Operation Test.

7. FUEL INJECTION PUMP TIMING.
Check fuel injection timing by confirming timing mark coincides with pointer according to repair manual. Fuel injection timing should be checked, and adjusted if necessary, every 37, 500 miles.

See CTS-2716-Fuel System
Subject: Injection Pump-to-Engine Initial Static Timing.

8. FUEL INJECTION PUMP, IDLE SPEED, NO LOAD MAXIMUM SPEED.

Check idle speed and adjust if necessary by turning idling adjusting screw of fuel injection pump and check no load maximum speed to adjust governor if necessary every 37, 500 miles according to repair manual.

FAN BELT TENSION

Standard fan belt tension is that which permits 8 to 12 mm (0.3 to 0.5 in.) deflection (when pushed about 10 kg (22.046 lb.) at a point midway crank and fan pulleys.) Adjust tension if the deflection falls outside this range. Make sure that the belt is free of water or oil, and that it is not frayed. Wipe free of oil or water or make replacement as required. A frayed belt should be replaced. (When two belts are used, replace both at the same time.)



Fig. 10 Checking Fan Belt Tension.

1. Adjustment interval:
Every 2, 500 miles

2. Adjustment dimension:

Fan belt tension should be adjusted periodically. If daily checks reveal a frayed belt or one about to break, make replacement immediately.

3. Adjustment method

a. Loosen the generator mounting bolts.

b. Shift the generator and temporarily tighten the top bolt.

c. Verify that tension is such that pressure applied to the belt by finger at a point midway between the crank and fan pulleys causes a deflection of 8 to 12 mm (0.3 to 0.5 in.)

d. After obtaining correct tension, firmly tighten generator mounting bolts.

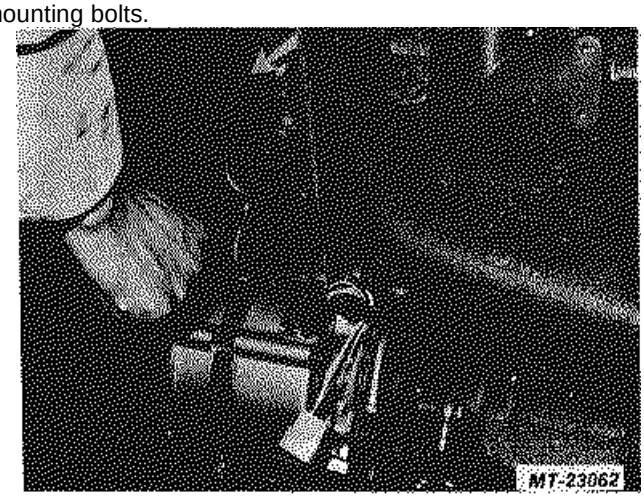


Fig. 11 Fan Belt Adjustment

EXHAUST GAS RECIRCULATION SYSTEM

The exhaust gas recirculation system reduces the amount of oxides of nitrogen (NO_X) in the engine exhaust. Oxides of nitrogen are formed in the engine combustion chambers by a bonding together of oxygen and nitrogen molecules due to extremely high temperatures and pressures during combustion.

The exhaust gas recirculation (EGR) system introduces a controlled amount of exhaust gas into the intake manifold where it mixes with the air entering the combustion chambers. The inert exhaust gas lowers combustion temperature and pressure and thereby reduces formation of oxides of nitrogen.

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The EGR system developed includes a vacuum actuated EGR valve, an air valve, electric push switch, solenoid valve, vacuum pump and thermo-switch. (See Figure 12)

The EGR valve is mounted on the intake manifold with exhaust gas being piped from the exhaust manifold to the EGR valve mounting pad.

The EGR system contains several unique features to compensate for the inherent characteristic of no manifold vacuum with unthrottled engines.

To provide the vacuum to open the EGR valve, a vacuum pump, which is integral with the alternator, is used. The vacuum applied to the EGR valve signal chamber is controlled by the solenoid valve which is in turn controlled by the thermo-switch and the fuel control lever actuated push switch.

To provide a positive flow of exhaust gas through the open EGR valve into the combustion chambers, an air valve is used to create a vacuum in the induction system. This valve, similar to a carburetor throttle body with a throttle plate, is located between the air cleaner and the intake manifold. The position of the butterfly plate in the air valve is controlled by the position of the fuel injection pump control lever by means of a cable. At engine idle, the butterfly is closed causing a relatively high vacuum in the intake manifold. As the fuel control lever is moved to the wide open throttle position, the butterfly opens, thereby reducing the intake manifold vacuum and consequently the amount of exhaust gas flow into the combustion chambers.

As the engine speed is increased toward wide-open throttle operation, the push switch, mounted on the injection pump, opens at a preset fuel control lever position. The switch de-energizes the solenoid valve, shutting off vacuum from the vacuum pump to open the EGR valve.

The electric-thermo-switch is used to prevent exhaust gas recirculation when the engine is cold. The thermo-switch senses engine coolant temperature and is located in the engine thermostat housing. Whenever the coolant temperature is below approximately 500 C, the thermo-switch closes, permitting the push switch to actuate the solenoid valve and establish exhaust gas recirculation in response to fuel control lever position.

DESCRIPTION OF AUXILIARY EMISSION CONTROL DEVICES -EXHAUST EMISSIONS

Devices employed to control the EGR valve operation.

Valve Operation:

(1) Solenoid Valve.

(2) Push Switch Injection Pump's Fuel Control Lever Position Detector.

(3) Bi-Metal Thermo-Switch--Cooling Water Temperature Detector.

Components related to the EGR Gas Flow Quantity.

Air valve with butterfly valve assembly Fuel control lever of injection pump control cable.

1. Devices Related to the EGR Valve Control (Open or Close)

(1) Solenoid Valve. Shown in Figure 12 and 13.

a. The valve is drawn toward the magnetic solenoid when the solenoid is energized by electric current connecting passages (1) and (2). When the electric current is shut off, the valve is forced to return to its original position by spring tension, connecting passages (2) and (3).

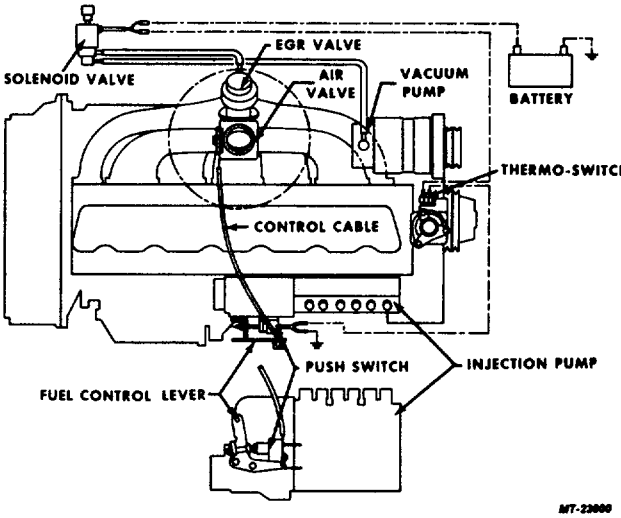


Fig. 12 Emission Control Schematic

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b. The magnetic solenoid is energized by electric current from the cooling water temperature detector (Thermo-Switch) and push switch. The solenoid valve then controls the vacuum. The valve supplies vacuum to the EGR valve to open it when the electric current is supplied to the solenoid.

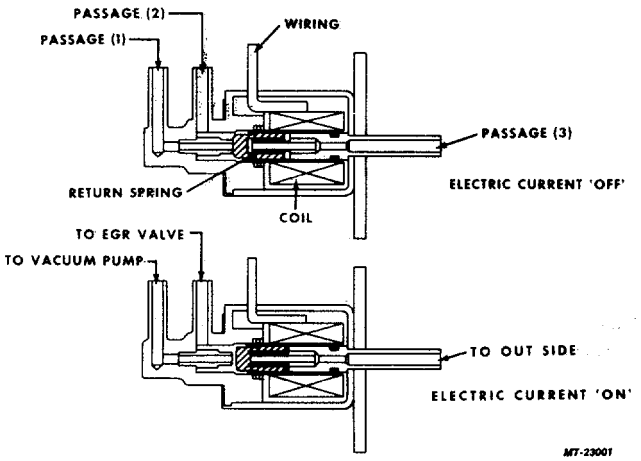


Fig. 13 Solenoid Valve Configuration

(2) Push Switch. Figure 14

a. When the fuel control lever of the injection pump is pulled to the specified position, the push switch adjusting bolt attached to the control lever depresses the push switch which closes the contact point in the switch, and electric current is supplied to the solenoid valve to open the EGR valve by means of vacuum pressure.

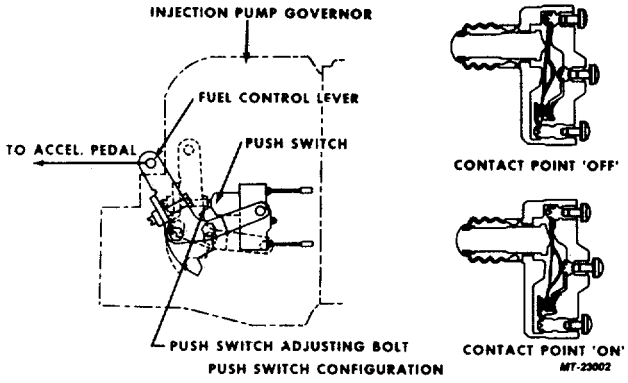


Fig. 14

b. The push switch detects the specified position of the fuel control lever and turns on or off electric current to the solenoid valve controlling (on and off) vacuum pressure for operating the EGR valve.

c. Location of fuel control lever of injection pump (corresponds to 17.3 ± 3st. cyl. # at 800 RPM injection pump speed)

Measured on test stand using the nozzle (DN 12SD12C), the nozzle opening pressure (2300 psi) and the injection tube I.D. 2mm (.079 in.), O.D. 6mm (.236 in.), length 600mm and (23.6 in).

d. Adjustment of push switch adjusting bolt to make the push switch turn off, when the fuel delivery rate reaches the specified, volume at 800 RPM injection pump speed (1600 RPM engine speed).

(3) Bi-Metal Thermo-Switch Figure 15

a. Bi-metal thermo-switch when the cooling water temperature is at the specified temperature or more, contact point in the switch closes to electric current which operates the solenoid.

b. The thermo-switch detects the coolant temperature and turns electric current on or off to the solenoid valve. The EGR valve is opened or closed by means of vacuum supplied, depending on the position of the solenoid valve. During engine warm-up, vacuum supply to the EGR valve is shut off because the thermo-switch has not been activated, with no EGR gas flow to the engine.

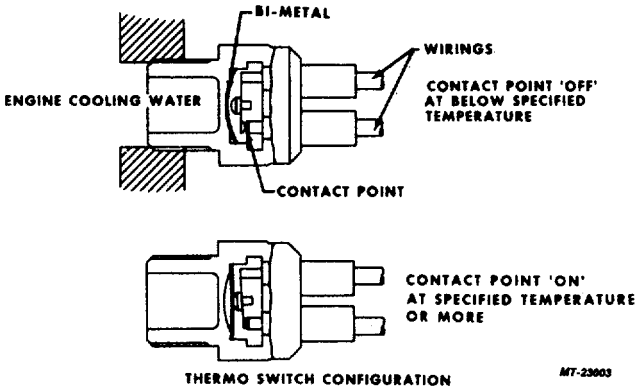


Fig. 15

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(4) Devices Related to EGR Gas Flow Control Air Valve Figure 16

a. The butterfly valve opening angle of the air valve is controlled by movement of a lever attached to the outside of the air valve. This lever varies the manifold vacuum.

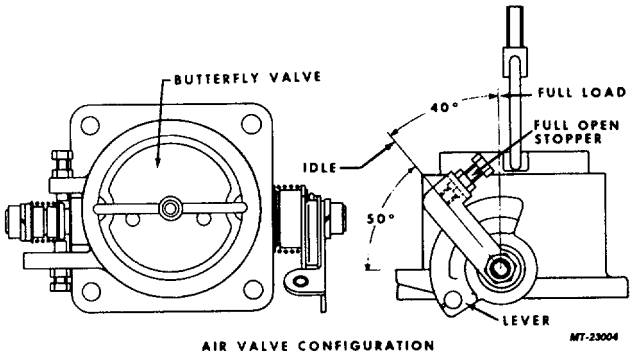


Fig. 16

b. The butterfly valve is connected to the injection pump fuel control level by a control cable, Figure 17. The butterbly valve opening varies simultaneously with the fuel control lever operation. The amount of EGR flow is controlled by varying the intake manifold vacuum.

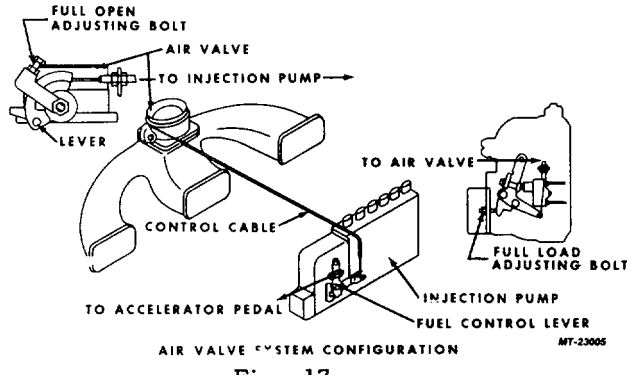


Fig. 17

c. Fuel control lever position (operating angle) of injection pump. Under (WOT) wide open throttle conditions, adjust the air valve lever adjusting bolt so that the injection pump fuel control lever and air valve lever simultaneously contact the full load stop and full open stop, respectively.

EXHAUST GAS RECIRCULATION SYSTEM OPERATION

(Not Back Pressure Type)

The exhaust gas recirculation (EGR) system introduces a metered amount of exhaust gas into the intake manifold where it mixes with the air/fuel mixture entering the combustion chambers. Dilution of the air/fuel mixture with exhaust gas lowers combustion temperature and pressure, thereby reducing formation of oxides of nitrogen.

The EGR valve regulates the amount of exhaust gas entering the intake manifold. The EGR valve is controlled by vacuum, which is determined by position of the fuel control lever and coolant temperature. Operation of the exhaust gas circulation system is illustrated in Figure 18.

While the engine is stopped or operating at full load, the EGR valve is held closed by spring pressure. The exhaust gas recirculation rate is also controlled by intake throttling.

A low temperature vacuum control switch is used in the exhaust gas recirculation system. The purpose of this switch is to prevent exhaust gas recirculation when the engine is cold. The low temperature control senses engine coolant temperature and is located in the coolant passage of the intake manifold. Whenever engine coolant temperature is below 46 deg. C (115 deg. F), the low temperature control valve is open causing solenoid to block vacuum from the EGR valve diaphragm, thus preventing EGR valve operation. When engine warms up and coolant temperature exceeds 46 deg. C (115 deg. F) the low temperature control switch closes permitting vacuum to actuate the EGR valve and establish exhaust gas recirculation in response to throttle plate position.

1. Remove and Check EGR Valve and Clean or Replace, If Necessary

   a. Remove EGR valve from engine.

   b. Apply 10-12" vacuum to EGR valve vacuum port (upper port of dual diaphragm valve). As vacuum is applied, valve pintle should move off seat and retract into valve housing (Figure 19). If valve does not operate when vacuum

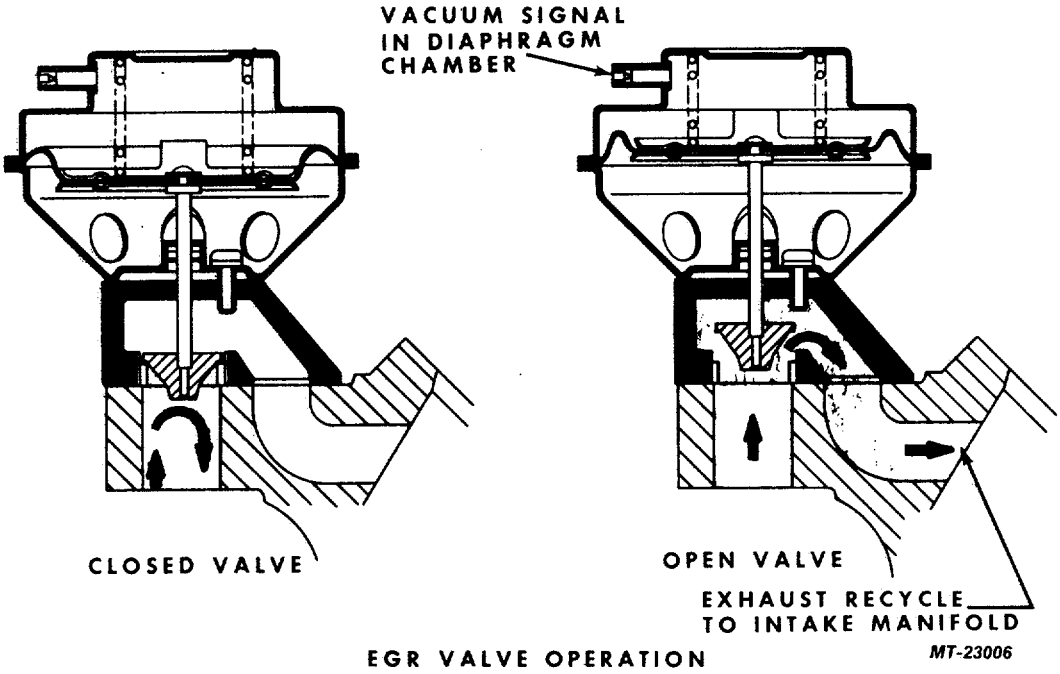


Fig. 18

is applied, valve is faulty and should be replaced.

c. Visually inspect valve for evidence of valve pintle (plunger) not seating or deposit accumulation on pintle or seat. Clean deposits from pintle and seat, if necessary.

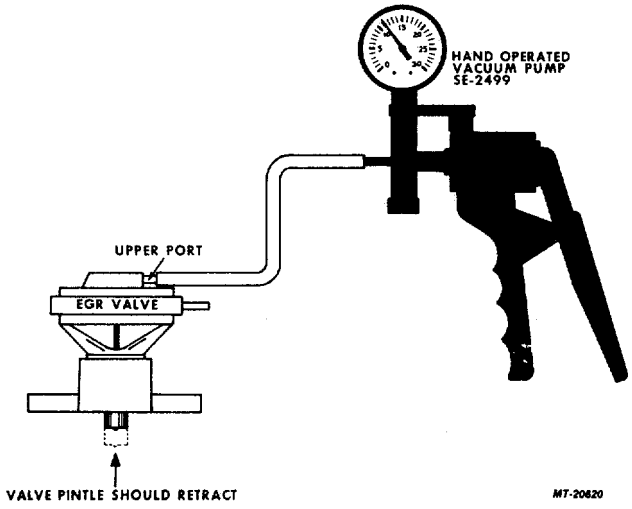


Fig. 19 EGR Valve Test

To clean deposits from pintle and seat of EGR valve, use a sand blast type spark plug cleaner and the following procedure:

(1) Prepare spark plug cleaner by installing rubber adapter with 22 mm (7/8") hole over cleaning (blast) port. Do not install metal adapter clamp (Figure 20).

(2) Insert pintle of EGR valve through hole in rubber plug cleaner adapter.

(3) Holding EGR valve tightly down against adapter, apply sand blast to clean pintle.

CAUTION

Safety goggles should be worn while performing cleaning operation.

(4) After cleaning exposed pintle, hold EGR valve in both hands and press in diaphragm to retract valve pintle into valve housing. Use a 25 mm (1") long bolt (3/4" long bottom dual diaphragm valves) to hold pintle in retracted position. Apply masking tape to cover outlet port of valve.

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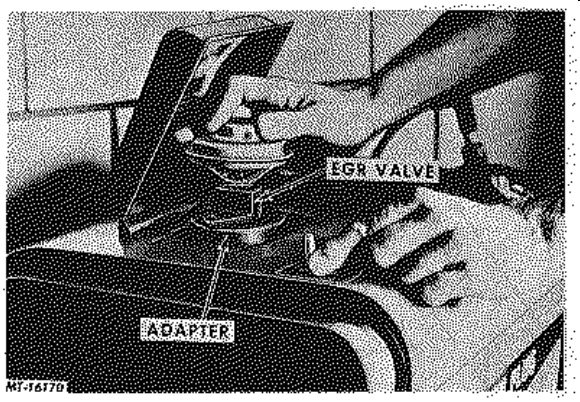


Fig. 20 Cleaning EGR Valve

(5) With pintle opening of valve aligned with hole in cleaning adapter, hold EGR valve down tightly against adapter and apply sand blast to clean interior of valve housing and valve seat.

d. After cleaning, blow all excess sand from interior of valve housing and remove bolt.
e. Recheck valve for proper operation and seating.
f. Replace with new valve, if necessary.

2. Replace EGR Valve

Because EGR valve metering varies between engines, it is important that the correct EGR valve be used in order to obtain optimum engine performance and emission control (see EGR Valve Application Chart).

To assist in identification, EGR valves are coded by a colored disk attached to the center of the vacuum diaphragm housing. The valve may also be identified by the manufacturer's part number stamped on the valve (Figure 21).

See page 30, Part I for Diesel Engine EGR Valve.

IDLE SPEED SETTING PROCEDURE

Injection Pump Low Idle and Buffer Adjustment

Normal curb idle speed (low idle) is adjusted at the low idle adjustment screw at rear of pump (Figure 22 and 23). Buffer adjustment is made at the buffer spring screw also located at rear of pump (Figure 20).

The procedure for checking and adjusting the low idle speed and buffer is as follows:

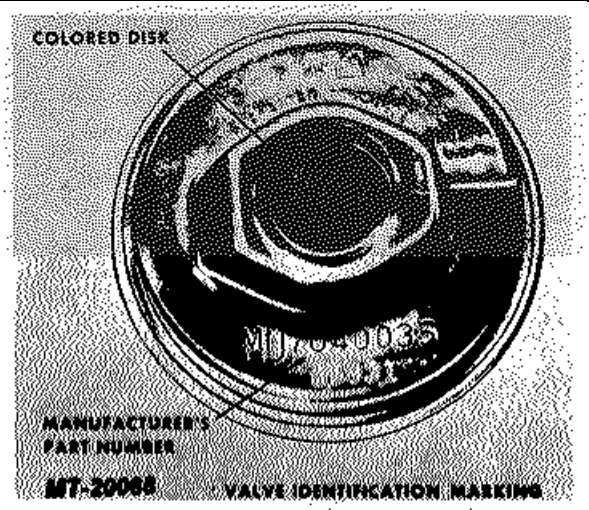


Fig. 21 EGR Valve Identification Marking

(1) Start engine and operate until coolant temperature reaches normal operating temperature.

(2) Allow engine to idle and observe engine speed on tachometer.

(3) If low idle speed is not within specified range (700-750 RPM), adjust as follows:

a. Back our buffer screw adjustment.
b. Loosen locknut on low idle adjustment.
c. Turn low idle adjusting screw to obtain correct idle speed.
d. Tighten locknut on low idle adjustment.
e. Adjust buffer as follows:

1. Run buffer screw in until it touches or takes effect.

2. Increase engine speed to 10-25 RPM above specified speed with buffer screw.

3. Back off buffer adjustment one full turn.

4. Lock the locknut.

IMPORTANT

Accelerate engine two or three times. Allow engine to return to idle speed and observe tachometer reading. If idle speed is not within specified range, check accelerator linkage for binding and repeat idle adjustment per step C.

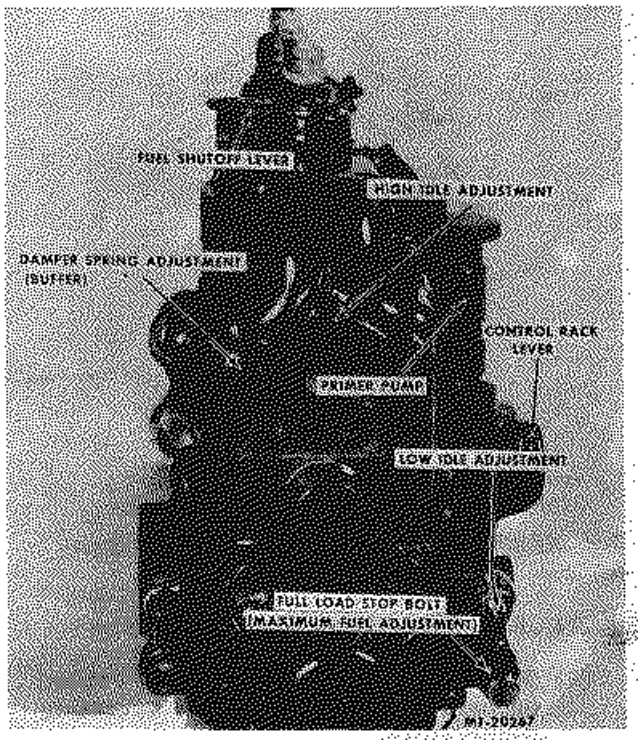


Fig 22 Buffer Adjustment Point

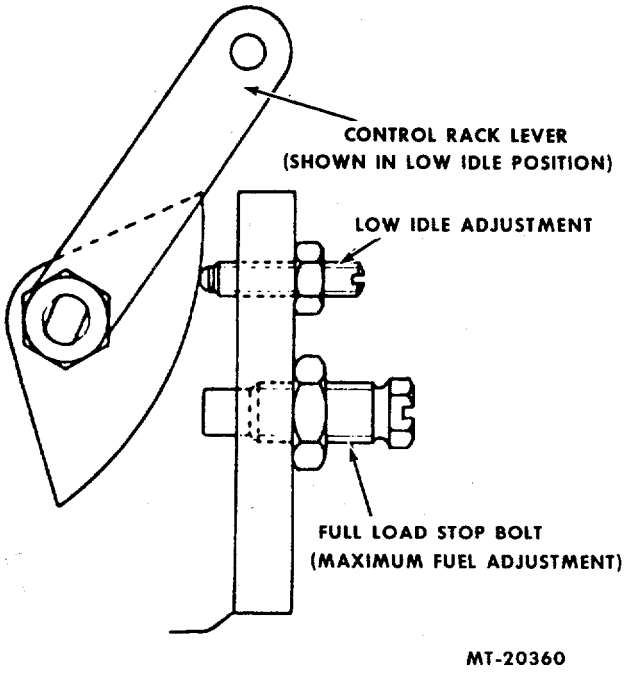


Fig. 23 Low Idle Adjustment Location

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PART IV
TROUBLE SHOOTING

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PART IV

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TROUBLE SHOOTING
PART IV

a. Glow plugs do not heat	Discharged battery Defective wiring Defective starting switch Open glow plugs	
b. Engine does not turn over		
	Defective starting system	Discharged battery
	Seized engine components	Defective starting switch
c. Engine turns over but does not start		
	No exhaust smoke	Defective FUEL SYSTEM
	Some exhaust smoke	Insufficient amount of injected fuel - Air in fuel Defective injection pump
	Normal exhaust smoke	Incorrect injection timing (should be 200 before top dead center) Incorrect nozzle valve opening pressure 100 kg cm2 (1,422 psi) Cylinder compression low
	Low quality fuel	Standard: 30 kg/cm2 (426.7 psi) at 200 rpm Minimum: 19 kg/cm2 (270.3 psi) at 200 rpm
d. Engine starts but does not continue running	Air in fuel Low quality fuel supply	Defective FUEL SYSTEM Defective fuel pump No fuel in tank

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TROUBLE SHOOTING (Cont'd.)

e. Engine is not smooth	Does not reach rated maximum speed	Incorrect governor adjustment Insufficient amount of injection by injection pump Defective nozzle Poor compression Insufficient fuel (air in fuel, feed insufficient) Incorrect fuel control link
	Reaches speed above rated maximum value Has high idling speed	Incorrect governor adjustment or faulty operation Incorrect control rack action Faulty plunger action Faulty internal governor action (when equipped with mechanical all-speed governor)
	Operates unstably	Injection non-uniform Air in fuel Faulty nozzle lines Faulty feed pump Non-uniform injection intervals Non-uniform cylinder compression
	Operates at high speed and does not stop	Faulty fuel control link Faulty governor Stuck plunger
	Stop suddenly during operation	Seized piston Seized camshaft and bushing Stuck injection pump Broken governor No fuel

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TROUBLE SHOOTING (Cont'd.)

f. Engine has low output	Some exhaust smoke	Insufficient amount of injection (FUEL SYSTEM trouble) Moving part near seizure
	Excessive white exhaust smoke	Extreme delay of injection timing Insufficient cylinder compression
	Excessive black exhaust smoke	Delayed injection timing Non-uniform injection Faulty nozzles Incorrect valve timing Clogged air cleaner element
g. Engine overheats	Faulty water pump	Faulty seal packing Incorrect fan belt tension Air entering via water intake side Internal water pump wear
	Clogged muffler Continued overload	
	Dirty radiator	Clogged pipe Clogged core and fin section Pressure device trouble
	FUEL SYSTEM trouble	Faulty nozzles Excessive injection Considerable injection timing delay
	Seized piston (s) Thermostat trouble Low cooling water level High ambient temperature Clogged air cleaner element	

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TROUBLE SHOOTING (Cont'd.)

h. Color of exhaust during operation is not normal	Excessive white exhaust smoke	Excessive injection timing delay (incorrect timing) Incomplete engine warm up Oil entering combustion chambers
	Excessive black exhaust smoke	Excessive injection (incorrect injection pump adjustment) Incorrect nozzle delivery Low cylinder compression Clogged air cleaner element Incorrect valve timing
i. Oil pressure remains low		Low engine oil level Low engine oil viscosity Worn bearing metal Oil pressure switch trouble Faulty oil pump relief valve Oil pump trouble Oil leakage

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EMISSION CONTROL SYSTEMS

FOR

GASOLINE ENGINES

This Service Manual contains Emission Control Systems used on International gasoline engines. Part I includes exhaust emission effects and maintenance interval charts along with complete tune-up specifications. Part II is a troubleshooting guide with reference (IH Engine Division Service Manual and IH Truck Service Manual) CGES numbers and CTS - numbers for individual engine accessory servicing.

The illustrations and specifications in this service manual are based on the latest information available at the time of publication approval.

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PART I

EMISSION CONTROL SYSTEMS

AND

SERVICE OPERATIONS

To function effectively, emission control systems must be properly maintained. Because satisfactory emission limits depend upon proper engine operation, the engine must be kept correctly tuned and adjusted.

It is important that maintenance operations be performed at specified intervals as indicated on the following pages.

Service intervals given are based upon average operating conditions. Where dusty, frequent start and stop or heavily laden operations are encountered, more frequent servicing will be required.

The required maintenance operations should be performed by an International Harvester dealer, or other service outlet equipped and qualified to perform such services. Any replacement parts used for required maintenance services or repairs of emission control systems should be equivalent in quality and performance to genuine IH parts. Use of inferior replacement parts may result in improper operation of emission control systems.

As indicated on the exhaust emission effects chart, engines sold in the U.S.A. are equipped with emission controls that are not used on engines sold in Canada. This is because of more stringent air pollution standards in the USA.

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The following chart show the exhaust emission effects for International Gasoline engines:

EXHAUST EMISSION EFFECTS

Vehicle Model	Engine	Carburetor	Electronic Ignition	Decel Throttle Modulator	Electric Choke	Integral Choke	Remote Choke	Evap. Canister	Air Pump	Exhaust Gas Recirculation	Ported Spark	Modulated Air Cleaner
USA												
	V-345	2300EG	Optional*	Yes	No	No	Manual	Yes	Yes	Yes	No	Modulated or Non-Modulated
	V-345	2210	Optional*	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Modulated or Non-Modulated
	V-392	4150EG	Optional*	Yes	No	No	Manual	Yes	Yes	Yes	**No	Modulated or Non-Modulated
CARGOSTAR	MV-404	2210	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Modulated
	MV-404	2300EG	Yes	Yes	No	No	Manual	Yes	Yes	Yes	Yes	Modulated
	MV-404	4150EG	Yes	Yes	No	No	Manual	Yes	Yes	Yes	Yes	Modulated
	MV-446	4150EG	Yes	Yes	No	No	Manual	Yes	Yes	Yes	No	Modulated
S-SERIES	V-537	2300EG	Yes	Yes	No	No	Manual	Yes	Yes	Yes	No	Modulated Dry
CANADA												
	4-196	1940	Yes	Yes	Yes	Yes	No	No	No	No	Yes	Yes
SCOUT	V-304	2210	Yes	Yes	No	No	Yes	No	No	Yes	Yes	Yes
	V-345	2210	Yes	Yes	No	No	Yes	No	No	Yes	Yes	Yes
	V-345	2300EG	Optional	Yes	No	No	Manual	No	No	Yes	Yes	Modulated or Non-Modulated
	V-345	2210	Optional	Yes	No	No	Yes	No	No	Yes	Yes	Modulated or Non-Modulated
	V-392	4150G	Optional	No	No	No	Manual	No	No	No	Yes	Modulated or Non-Modulated
CARGOSTAR	MV-404	2210	Yes	Yes	No	No	Yes	No	No	No	No	Modulated
	MV-404	2300EG	Yes	Yes	No	No	Manual	No	No	No	No	Modulated
S-SERIES	MV-404	4150G	Yes	Yes	No	No	Manual	No	No	No	No	Modulated
	MV-446	4150G	Yes	Yes	No	No	Manual	No	No	No	No	Modulated
	V-537	2300EG	Yes	Yes	No	No	Manual	No	No	No	No	Modulated Dry
	V-537	4150G	Yes	Yes	No	No	Manual	No	No	No	No	Modulated Dry

*For California Electronic Ignition Only.
**Spark Vacuum Common With EGR Signal Vacuum.

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Each numbered maintenance step under Maintenance Operations on the Chart is completely explained under the corresponding number in the following text.

MAINTENANCE INTERVALS

MAINTENANCE OPERATIONS	(Mileage, Months or Operation Hours, Whichever Occurs First)															
	Km	6400	12800	19200	25600	32000	38400	44800	51200	57600	64000	70400	76800	83200	89600	96000
	Miles	4000	8000	12000	16000	20000	24000	28000	32000	36000	40000	44000	48000	52000	56000	60000
	Mos.	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75
	Hours	125	250	375	500	625	750	875	1000	1125	1250	1375	1500	1625	1750	1875
1. Change Engine Oil and Oil Filter.		R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
2. Check and clean Dist. Cap & Rotor or replace, if necessary. Replace Breaker Points & Condenser, where used.				I			I			I			I			I
3. Check Ignition Cables and Measure Resistance and Replace if necessary.				I			I			I			I			I
4. Replace all Spark Plugs, Check Required Voltage, Replace any Defective Plugs.				R			R			R			R			R
5. Replace Fuel Filter.				R			R			R			R			R
6. Clean or Replace Air Cleaner Filter.				I			I			I			I			I
7. Replace Filter at Bottom of Evaporative Vapor Storage Canister.				R			R			R			R			R
8. Check Engine Bolt Torque and Tighten if necessary.				I			I			I			I			I
9. Check Exhaust Gas Control Valve for Free Operation & Service or Replace if necessary.				I			I			I			I			I
10. Check Coil Output Voltage & Replace Coil if necessary.				I			I			I			I			I
11. Check Initial Advance and Adjust if necessary.				I			I			I			I			I
12. Check Operation of Inlet Air System Valve and Service or Replace if necessary.				I			I			I			I			I
13. Check PCV System Hoses & Replace if necessary; Clean PCV Valve if necessary.				I			I			I			I			I
14. Check Deceleration Throttle Modulator (DTM) Systems & Adjust or Replace if necessary.				I			I			I			I			I
15. Remove and Check EGR Valve and Clean or Replace if necessary.				I			I			I			I			I
16. Check EGR System with Functional Test & Clean or Replace if necessary.				I			I			I			I			I
17. Check Air Injection System and Replace if necessary (USA Engines Only).				I			I			I			I			I
18. Check Curb Idle Speed and Air/Fuel Mixture and Adjust as necessary.				I			I			I			I			I
19. Check Automatic Choke (where used) for Proper Setting and Free Operation.				I			I			I			I			I

R = Replace I = Inspect, Correct, Replace if necessary.

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1. Change Engine Oil and Filter

a. Remove oil drain plug from bottom of oil pan and drain oil.

b. Service oil filter.

Procedure for servicing the spin-on type oil filter is as follows:

(1) Remove oil filter assembly by turning counterclockwise with the hands or a suitable tool. Clean filter mounting pad.

(2) Coat the gasket on the new filter with a film of grease.

(3) Place the new filter in position on the center tube. Hand tighten 1/2 to 3/4 of a turn after gasket first contacts base of mounting pad.

c. Add sufficient oil to bring the oil level between "ADD" and "FULL" marks on oil dipstick (Fig. 2).

d. Start engine and run for at least five minutes to warm oil and check for leaks. Recheck and add sufficient oil to bring oil level between "ADD" and "FULL" marks on the oil dipstick.

Oil types and grades recommended for engines used on IH truck applications are as follows:

GASOLINE ENGINES

Temperature	Straight Viscosity Grade	Multi-Viscosity Grade
20 to 120 F (-7 to 49C)	SAE 30	SAE 10W-30, 10W-40, 20W-40, 20W-30
0 to 90 F (-18 to 32 C)	SAE 20W	SAE 10W-30, 10W-40, 20W-40, 20W-30
-10 to 70 F (-23 to 21C)	SAE 10W	SAE 10W-30, 10W-40
Below -10 F (23 C)	- - - - - - - - - -	SAE 5W-10, 5W-30

Use engine oils meeting service classification "SE" or "CC" (MIL-L-46152).

IMPORTANT

When a universal engine oil (SE-CD) is preferred, the engine oil must have passed the Volvo B-20 cam and tappet test and contain a minimum 0.1% alkyl zinc. IH No. 1 engine oil now meets this requirement.

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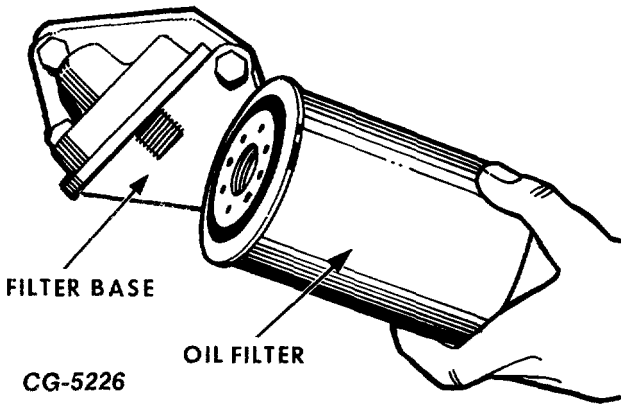


Fig. 1. Typical Spin-on Type Oil Filter

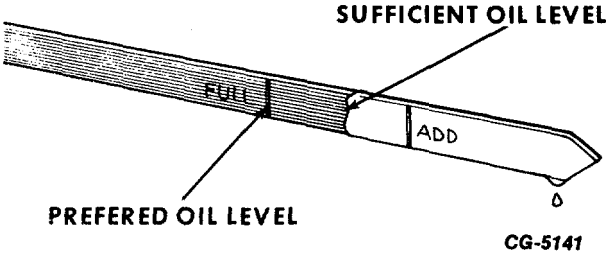


Fig. 2. Proper Oil Level

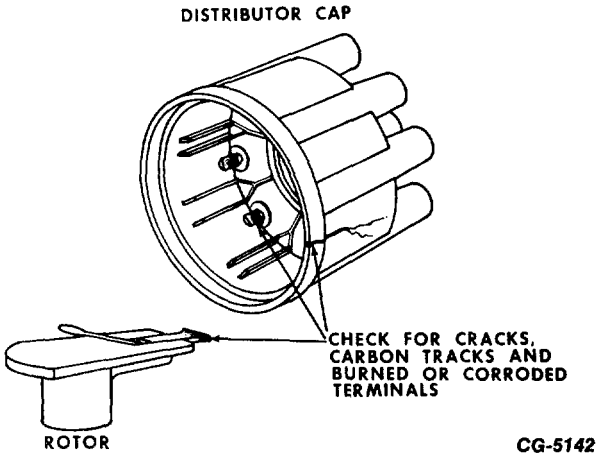


Fig. 3 Inspect Distributor Cap and Rotor

2. Check and Clean Distributor Cap and Rotor or replace, if necessary. Replace Breaker Points and Condenser, where used.

a. Remove distributor cap and rotor.

b. Clean and inspect distributor cap and rotor for cracks, carbon tracks and burned or corroded terminals.

c. Replace breaker points, where used. See Tune-Up Specifications for gap or dwell. Lubricate distributor cam.

d. Replace rotor, if defective, and install in distributor.

e. Replace cap, if defective, and connect high tension cables to cap.

3. Check Ignition Cable and Measure Resistance and Replace, if necessary.

a. Remove high tension cables from spark plugs.

b. Using Engine Performance Tester No. SE-2576 or equivalent, measure resistance of each cable by connecting ohmmeter leads to spark plug end of cable and terminal inside distributor cap.

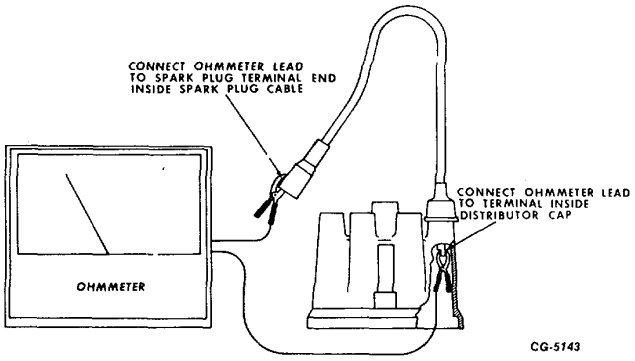


Fig. 4 Checking Ignition Cables with Ohmmeter

c. If resistance exceeds specifications (see Emission Control System Tune-Up Specifications), replace high tension cable(s).

d. Reinstall cap onto distributor.

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e. Inspect high tension ignition cables for cracks or deterioration and replace defective cables.

4. Replace all Spark Plugs, Check Required Voltage and Replace any Defective Plugs.

a. Remove used spark plugs.

b. Check gap of new spark plugs (see Emission Control System Tune-Up Specifications) and adjust gap, if necessary.

Continuous light load operation may produce spark plug fouling, necessitating more frequent spark plug changes than are indicated in the Maintenance Intervals. A change in plug heat range will not correct fouling under these conditions.

To change spark plug gap, bend the outer electrode; never bend the center electrode. Be accurate use a round wire gauge to check the electrode gap. Check the gap of new spark plugs before installation and tighten to specified torque.

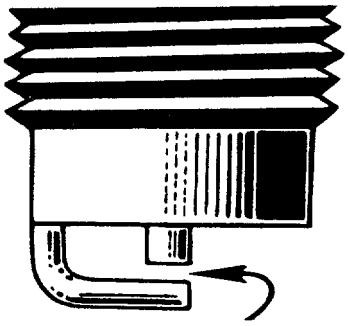


Fig. 5

IH Branches and Dealers are equipped with spark plug cleaning and testing equipment which renders dependable service.

c. Install new spark plugs and torque to specifications (see Emission Control System Tune-Up Specifications.

d. Install high tension spark plug cables onto spark plug terminal.

IMPORTANT

When replacing high tension spark plug cables, be sure cables are routed to proper spark plugs (refer to firing order cast into intake manifold).

e. Connect Tune-Up Scope Tester No. SE-2440, or equivalent.

f. Start and operate engine until normal operating temperatures are reached. Then operate engine at 1000 RPM.

g. Observe required voltage (see Emission Control System Tune-Up Specifications.

h. If required voltage is out of specifications on any cylinder, replace spark plug and repeat Steps a through g.

5. Replace Fuel Filter.

Inline fuel filters are used on most IH engines (Fig. 6). This type of filter is inexpensive and easy to replace when needed.

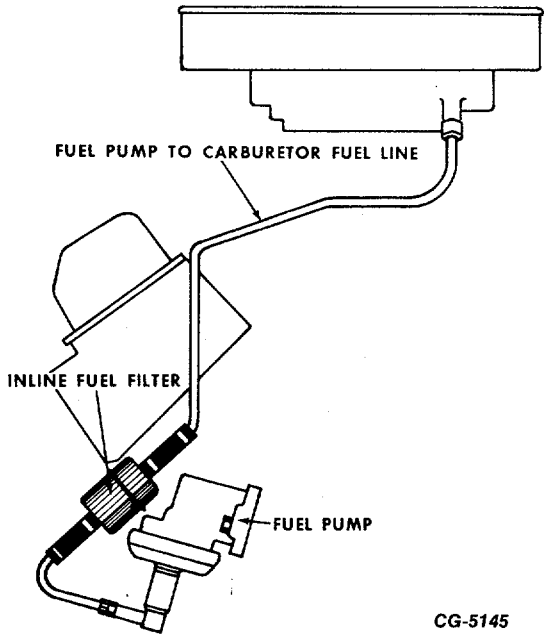


Fig. 6 Inline Fuel Filter Typical on Most Gasoline Engines

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6. Clean or Replace Air Cleaner Filter.

a. Dry Type Remove air cleaner element, clean any accumulation of dirt from air cleaner housing. Tap element lightly on a flat surface or use low air pressure to remove dirt particles. Blow air from inside filter element to outside. Check element for punctures or splits by looking through filter paper toward light held in center of element. Do not wash element. Replace with new element, if necessary.

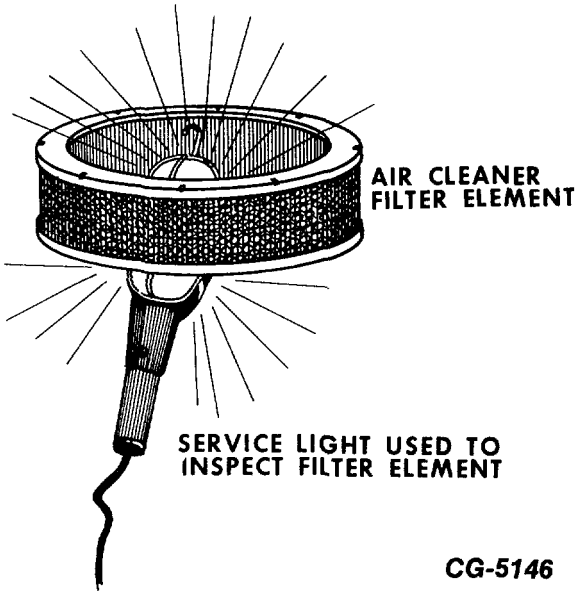


Fig. 7 Dry Type Air Cleaner Filter

b. Oil Bath Type Remove air cleaner from engine. Remove oil sump and drain oil. Wash sump and mesh filter element in solvent and dry with compressed air. Refill sump and oil mesh element with engine oil of same viscosity used in the engine. Allow excess oil to drip from element before reassembly. Reinstall air cleaner.

7. Replace Filter at Bottom of Evaporative Vapor Storage Canister.

The air filter located at the bottom of the vapor storage canister (Fig. 8) should be replaced at the interval shown on the Maintenance Intervals Chart, or more frequently under severe dusty conditions.

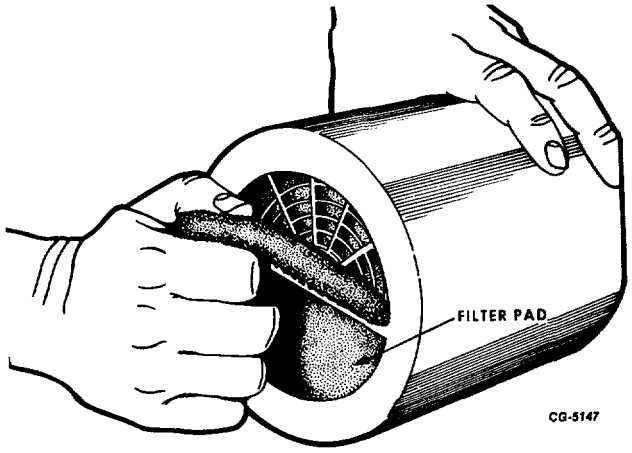


Fig. 8 Vapor Storage Canister Air Filter Location

7A. Gasoline Evaporative Loss Control System (California Only).

In compliance with California air pollution control regulations, all IH gasoline powered vehicles sold in California will utilize gasoline evaporative loss control system which reduces the amount of gasoline vapors entering the atmosphere from the vehicle's fuel system. Below is a schematic view of a typical gasoline evaporative loss control system.

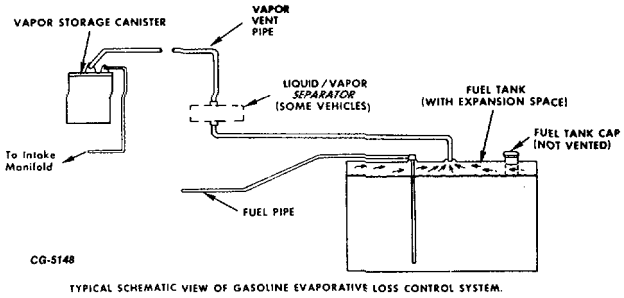


Fig. 9 Typical Schematic View of Fuel Tank Gasoline Evaporative Loss Control System

To accomplish evaporative control the system must perform three basic functions:

1. Provide space for gasoline expansion due to temperature rise.

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2. Limit escape of gasoline vapors to the atmosphere by collecting and storing vapors generated while vehicle is parked with engine shut off.

3. Burn off stored gasoline vapors when engine is operating.

Vapor Storage Canister

When vehicle is parked and engine shut off, gasoline vapors from the carburetor fuel bowl and the fuel tank will be temporarily stored in the charcoal canister until the engine is started. When the engine is started the vapors are drawn from the canister into the engine and burned.

When a vehicle is parked continuously for more than one day, the odor of fuel vapors may be noticed. This is caused by fuel vapors passing out of the canister(s) due to oversaturation of the charcoal. Operating the engine a few minutes will purge the canister(s) of fuel vapors and restore its holding capacity.

Two types of vapor storage canister systems are used in 1979 California vehicles.

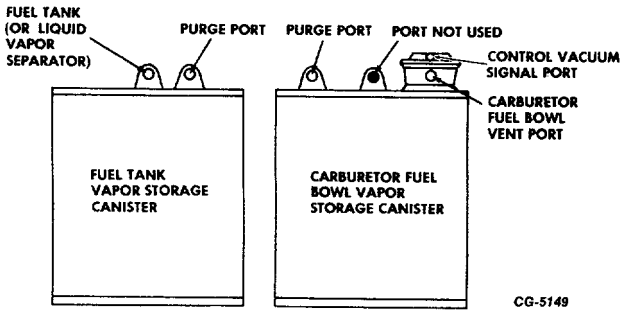


Fig. 10 Vapor Storage Canisters Used on Medium-Heavy Duty Vehicles with Single Tank of 35 Gallon Capacity And Less

1. Two vapor storage canisters are used on medium-heavy duty vehicles with single fuel tanks of 35 gallon capacity or less. One canister is used for storing fuel tank vapors only. This canister has two ports; one port for liquid vapor separator connection and one for canister purge to engine. The other canister is used for carburetor fuel bowl vapors only. This vapor storage canister and its operation is shown in Fig. 12.

2. Three vapor storage canisters are used on medium-heavy duty vehicles with single fuel tank greater than 35 gallon capacity and all multi-tank vehicles. As shown in Figure 10, the fuel tank vapor storage canisters consist of one canister with a vacuum controlled purge valve and one two-port canister which is connected to the bottom of the vacuum controlled purge canister. The two-port canister adds vapor storage capacity for large fuel tank(s) systems.

   The operation of the vacuum controlled purge canister is shown in Figure 13.

   The function of the third vapor storage canister (shown in Fig. 11) is to store carburetor fuel bowl vapors only. The operation of this canister is shown in Fig. 12.

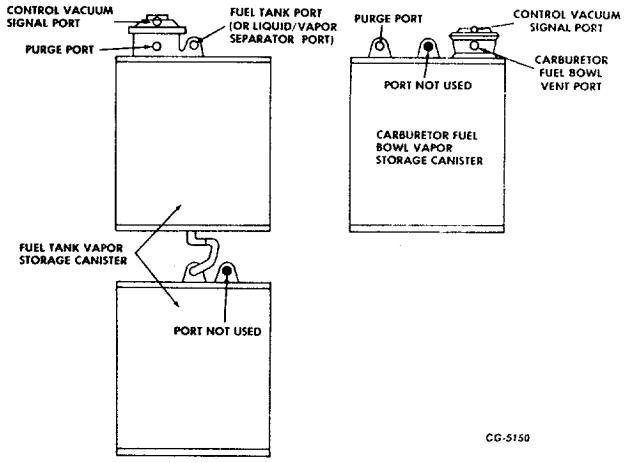
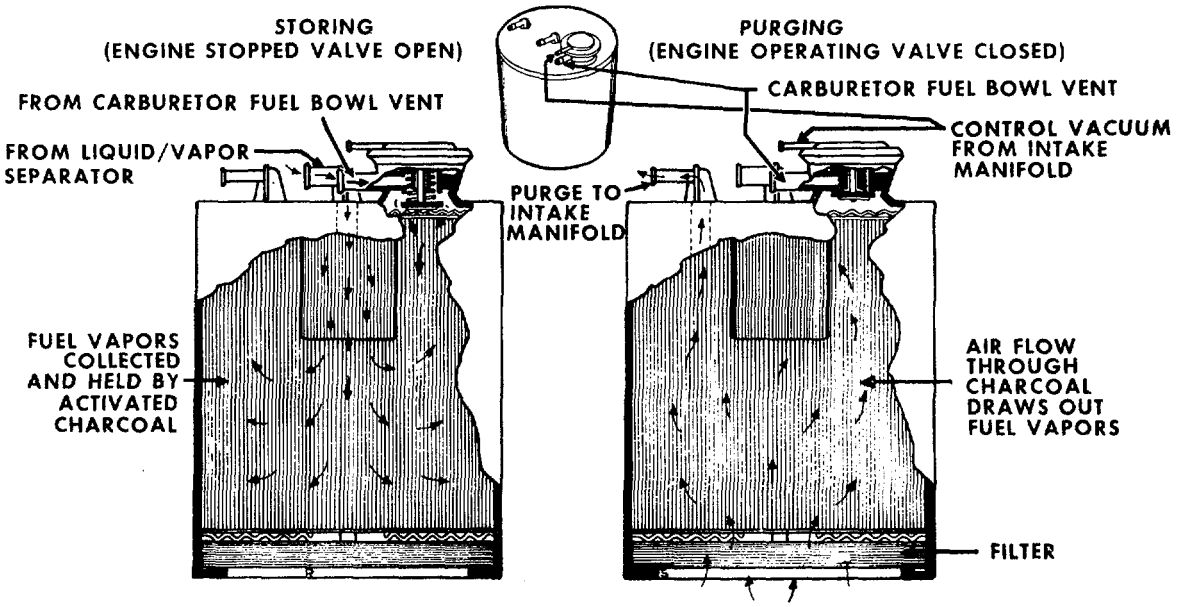


Fig. 11 Vapor Storage Canisters Used on Medium-Heavy Duty Vehicles with Single Fuel Tank Greater Than 35 Gallon Capacity and All Multitank Installations

Canister Operation Test

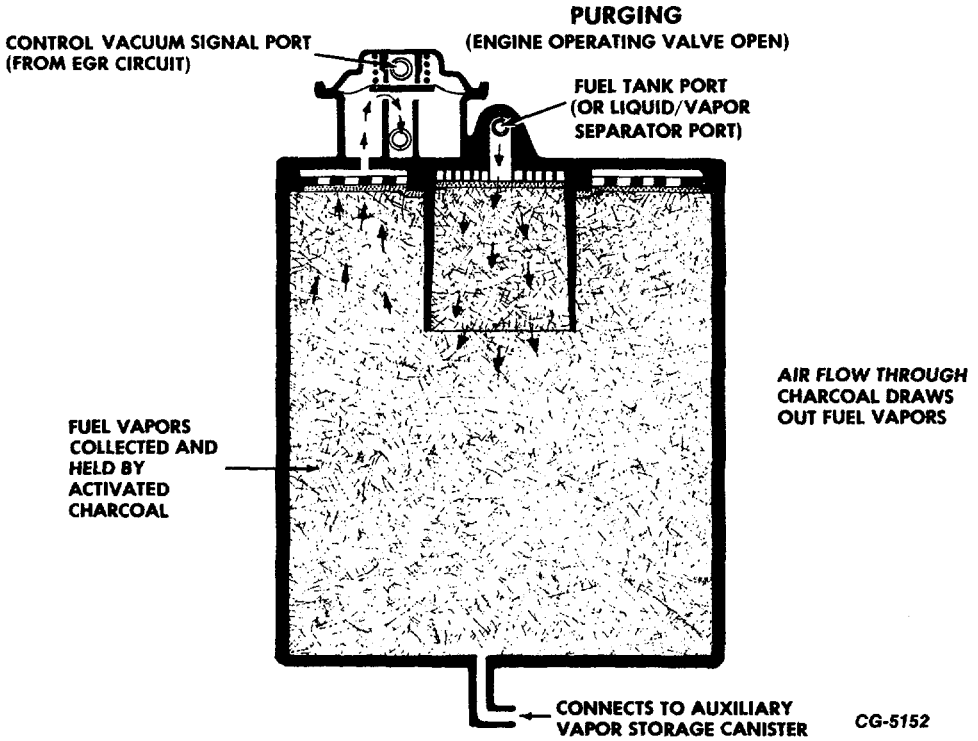
Disconnect control vacuum and purge hoses from canister(s). With engine running at high idle speed and normal operating temperature, a vacuum pull should be felt at each hose end. If no vacuum is felt, reconnect hoses to the proper port on the canister(s) and disconnect at vacuum source on engine. Inspect for obstruction in hoses and hose connecting fittings. Also inspect hoses for cracks, damage or deterioration and replace if necessary.

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VAPOR STORAGE CANISTER OPERATION

Fig. 12 Vapor Storage Canister with Vacuum Controlled Carburetor Fuel Bowl Vent Valve



VAPOR STORAGE CANISTER OPERATION

Fig. 13 Vapor Storage Canister with Vacuum Controlled Purge Valve

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It is important that canister hoses be connected to the proper manifold fitting.

Canister Control Valve Test

Before starting the following test with hand operated vacuum pump (SE-2499), a check pump for leakage (Fig. 14) by placing a finger over the vacuum port and pump until full or near full scale is reached. Watch pump gauge. If vacuum drops rapidly, pump is leaking and should not be used for test. If a very slow leak is indicated, the pump may be used if the degree of pump leakage is kept in mind

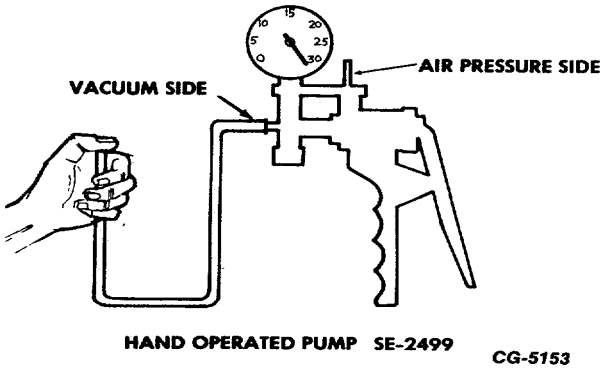


Fig. 14 Check Hand Operated Vacuum Pump SE-2499 for Leakage

1. Test canister fuel bowl vent control valve diaphragm by applying vacuum to the control valve port (smaller top port valve assembly) with hand operated vacuum pump (SE-2499). Observe vacuum pump gauge (Fig. 15). If vacuum drops rapidly the control valve diaphragm is leaking and the canister must be replaced.

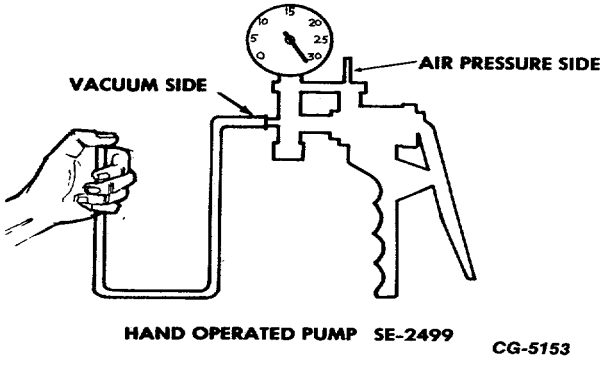


Fig. 15 Canister Fuel Bowl Vent Control Valve Diaphragm Test

2. The valve seat portion of the fuel bowl vent control valve can be tested by applying vacuum to the control valve (same as diaphragm test Fig. 15) and at the same time (with another hand operated pump SE-2499 using air pressure side of pump) apply air pressure to the valve (Fig. 16) until pressure buildup is felt. If pressure buildup is not felt the valve seat is leaking and the canister must be replaced.

3. Test purge control valve diaphragm and valve seat by applying vacuum with hand operated vacuum pump (SE1499) simultaneously to both vacuum signal port and purge port (see Fig. 17). If vacuum of either pump drops rapidly the valve is faulty and the canister must be replaced.

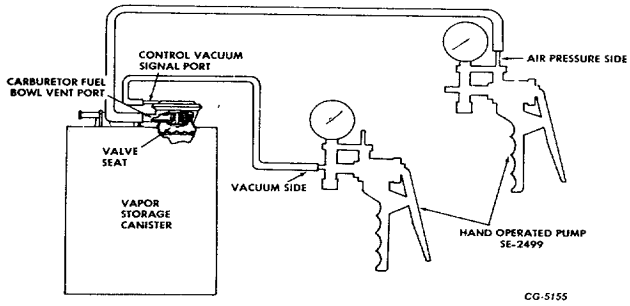


Fig. 16 Canister Fuel Bowl Vent Control Valve Seat Test

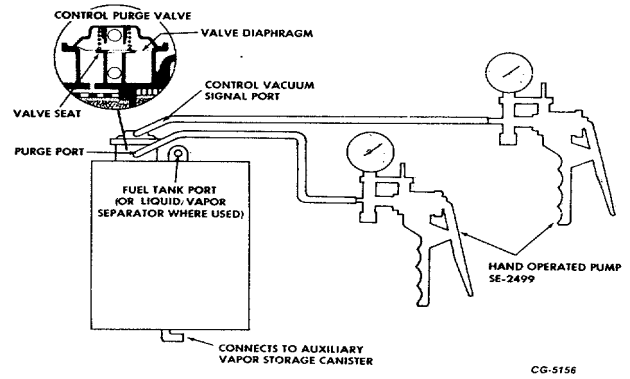


Fig. 17 Canister Purge Control Valve Diaphragm And Valve Seat Test

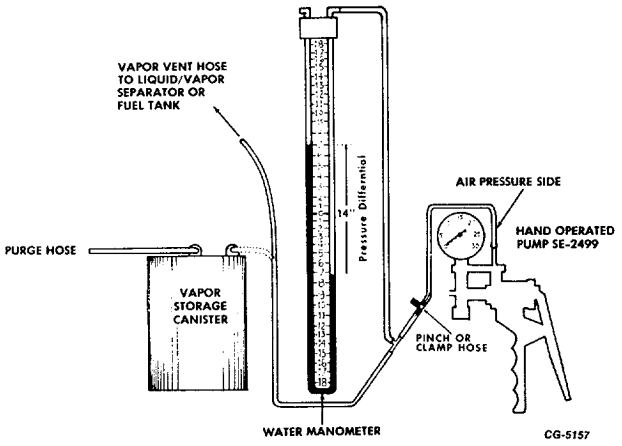


Fig. 18 Method of Pressurizing Vapor Vent System to Check for Leakage

Pressure test fuel tank vapor vent system by disconnecting the hose on canister leading to separator and connect water manometer (SE-2217 or equivalent) and the air pressure side of hand operated vacuum pump (SE-2499) as shown in Figure 18.

Place sufficient water in manometer to allow 356 mm (14") differential in height. Pump the hand operated air pump until a pressure of 356 mm (14") of water is applied to the system (indicated on the manometer). Pinch or clamp hose between tee and air pump to keep system pressurized. Observe manometer. If pressure drops more than 55 mm (2") of water in five (5) minutes, an excessive leak is indicated.

On a warm day it is possible to observe a pressure rise due to evaporation of fuel. This indicates that system is tight. If excessive leakage is indicated, first check fuel tank cap for a loose fit on tank filler neck or a damaged cap gasket. If either of these conditions are found, replace cap. If cap-to-filler neck fit and cap gasket are satisfactory, cover relief valve opening in cap (small hole in portion of cap which enters filler neck) securely with tape. Reinstall cap and again pressurize system and check for leakage.

If excessive leakage persists, check all connections in fuel supply and vapor vent system with soap suds solution to locate leaks. Inspect for cracked or damaged liquid/vapor separator, fuel supply or vapor vent tubes or connecting hoses. If no leaks are found and system holds pressure with valve opening uncovered, it can be assumed that relief valve in cap is faulty. Replace cap.

When pressure testing system following installation of a new fuel tank, it will be necessary to disconnect and plug fuel system line at fuel pump to prevent air leakage through fuel pump and carburetor.

Fuel Tank Cap

Fuel tank caps are nonvented to prevent passing of gasoline vapors directly into the atmosphere.

Some caps incorporate a vacuum relief valve set to open at approximately 178 to 356 mm of water (7" to 14" H20) and a pressure relief valve set to open at approximately 508 to 1524 mm of water (20" to 60" H20).

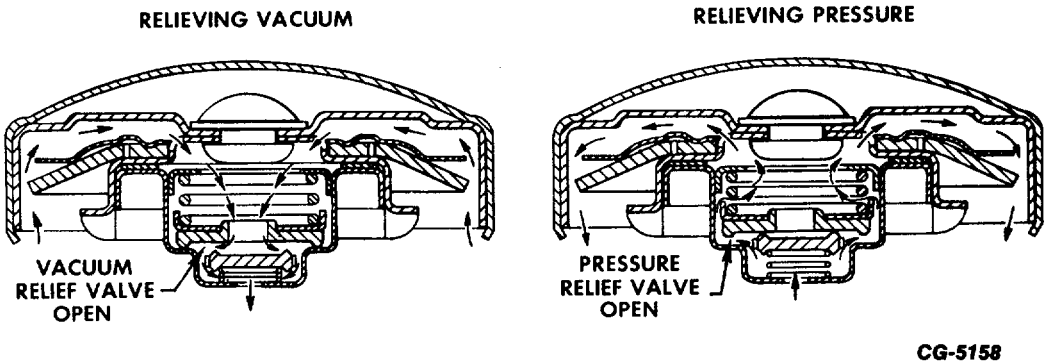


Fig. 19 Fuel Tank Cap Relief Valve Operation

The vacuum valve provides an air intake opening to the fuel tank. As fuel is consumed or contracts due to cooling, causing low pressure (vacuum) in fuel tank, atmospheric pressure opens the vacuum relief valve, permitting air to enter the fuel tank. The pressure relief valve acts as a pressure release in case the vapor vent system becomes plugged. Operation of fuel tank cap vacuum relief valve and pressure relief valves is illustrated in Fig. 19.

Fig. 20 illustrates a typical nonvented fuel tank cap for vehicles with large side mounted fuel tanks.

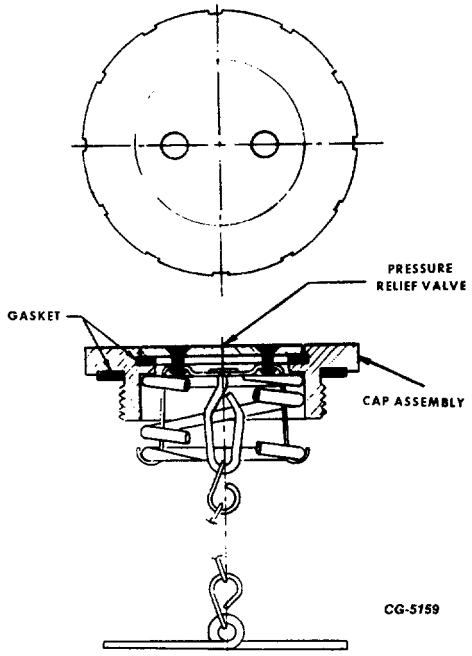


Fig. 20 Fuel Tank Cap (Nonvented Type)

Fuel Tank Cap Relief Valve Test

A quick check of the vacuum and pressure relief valves in the fuel tank cap may be made as follows:

Check vacuum relief valve by applying high suction to hole in relief valve housing (portion of cap which enters filler nect). If vacuum relief valve fails to open (no air flow through valve), cap should be replaced.

To check pressure relief valve, force air lightly into hole in relief valve housing. An immediate leak (air flow) or failure to release (no air flow) indicates that pressure relief valve is faulty and that the cap should be replaced.

Liquid/Vapor Separator

Some vehicles are equipped with a liquid/vapor separator. The purpose of the liquid/vapor separator is to receive any liquid fuel which may enter the fuel tank vapor vent lines due to thermal expansion of fuel or vehicle maneuvering and allow it (liquid fuel) to drain back to the fuel tank permitting only fuel vapors to flow to the vapor storage canister.

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FUEL TANKS

Fuel tanks are designed to provide space to permit expansion of gasoline without overflowing. The tanks incorporate vapor vent outlets which permit passage of gasoline vapors from the tank. Some fuel tanks have multiple vapor vent outlets located such that under any sloping attitude of the vehicle at least one of the vent outlets will be above the level of the gasoline in the tank.

Evaporative loss control systems vary between vehicle models, types of fuel tanks and fuel tank installations. Systems used on various vehicle models are illustrated in Figs. 21 thru 65.

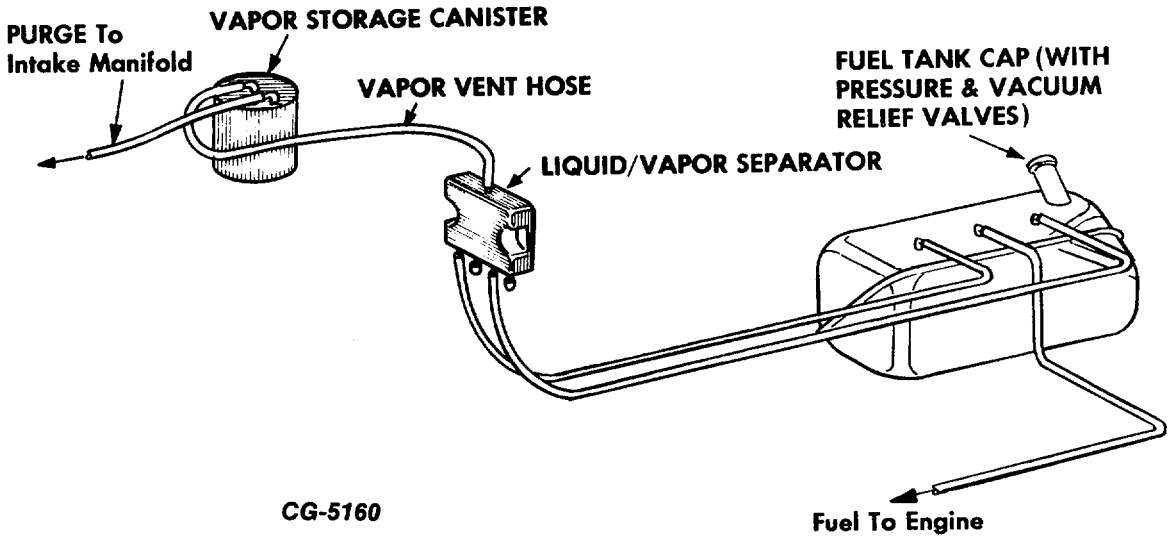


Fig. 21 1600-1800 S-Series Vehicles with 21 Gallon Under Cab Fuel Tank

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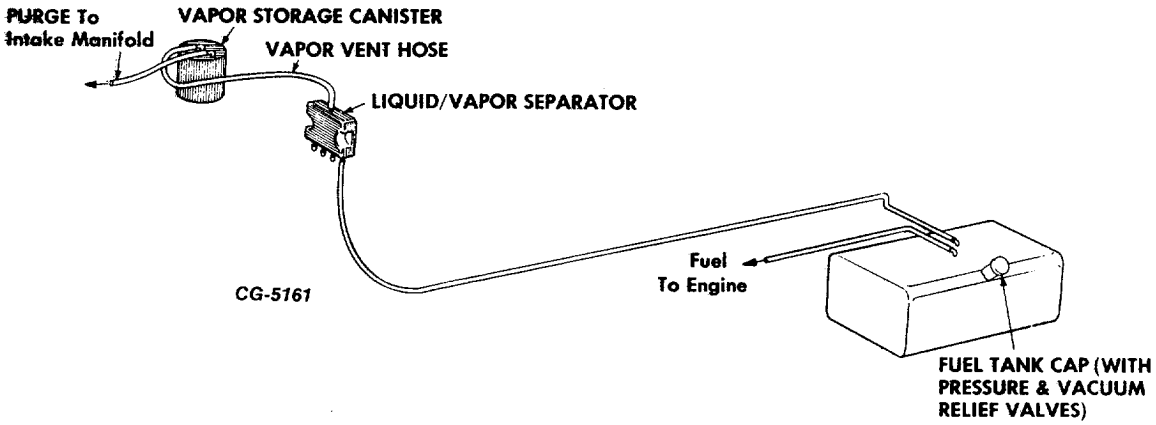


Fig. 22 1600-1800 S-Series Vehicles with 31 Gallon Single Left Fuel Tank

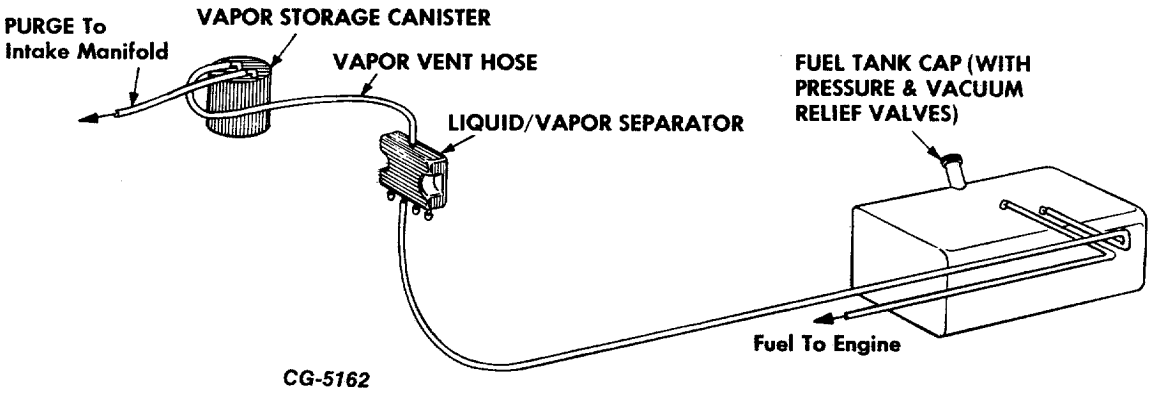


Fig. 23 1600-1800 S-Series Vehicles with 31 Gallon Single Right Fuel Tank

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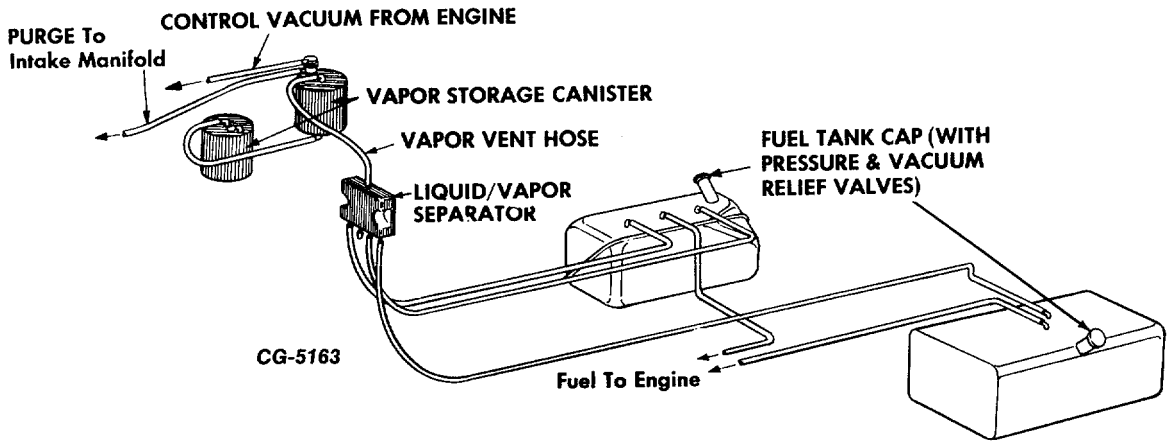


Fig. 24 1600-1800 S-Series Vehicles with 21 Gallon Under Cab Fuel Tank And 31 Gallon Single Left Fuel Tank

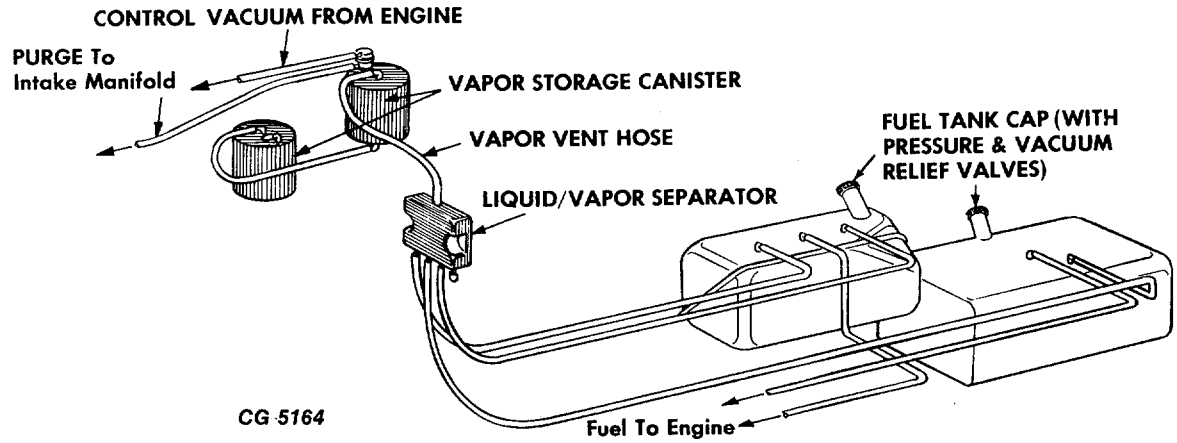


Fig. 25 1600-1800 S-Series Vehicles with 21 Gallon Under Cab Fuel Tank And 31 Gallon Single Right Fuel Tank

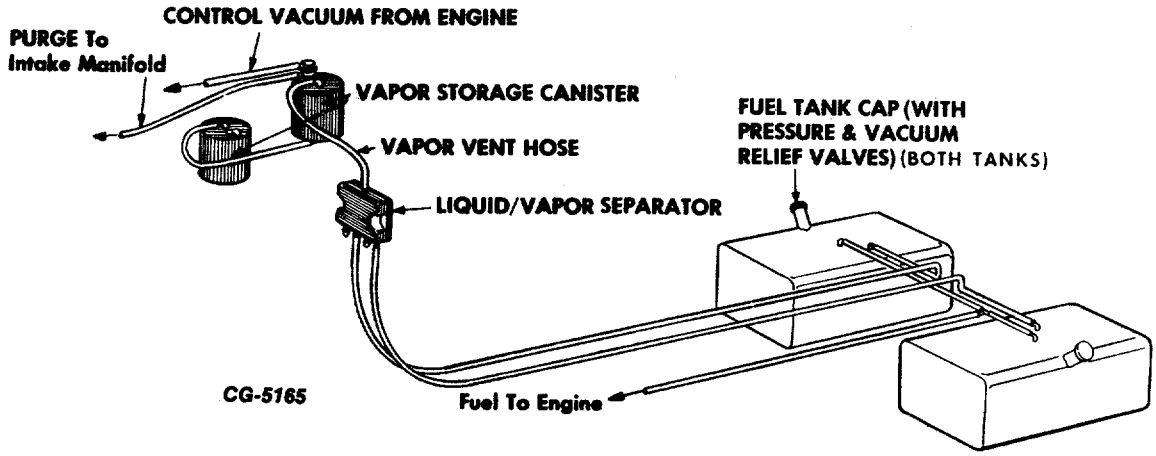


Fig. 26 1600-1800 S-Series Vehicles with 31 Gallon Dual Fuel Tanks

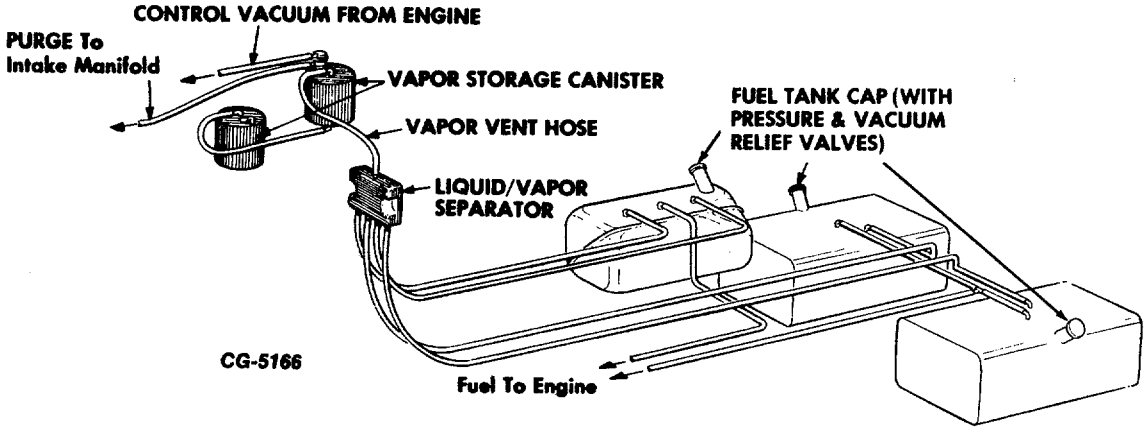


Fig. 27 1600-1800 S-Series Vehicles with 21 Gallon Under Cab Fuel Tank And 31 Gallon Dual Fuel Tanks

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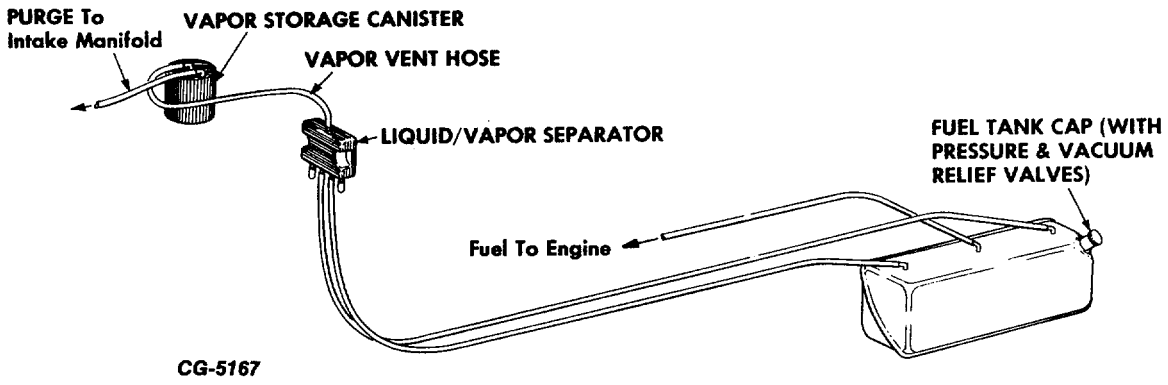


Fig. 28 1600-1800 S-Series Travelcrew Cab Vehicle With 21 Gallon Under Cab Fuel Tank

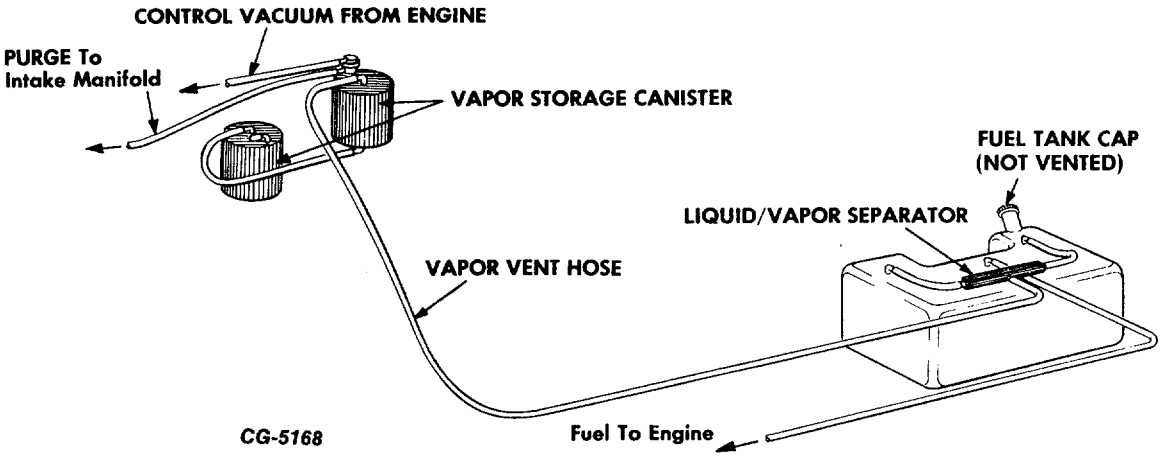


Fig. 29 1600-1800 S-Series Vehicles with 50 Gallon Single Right Fuel Tank

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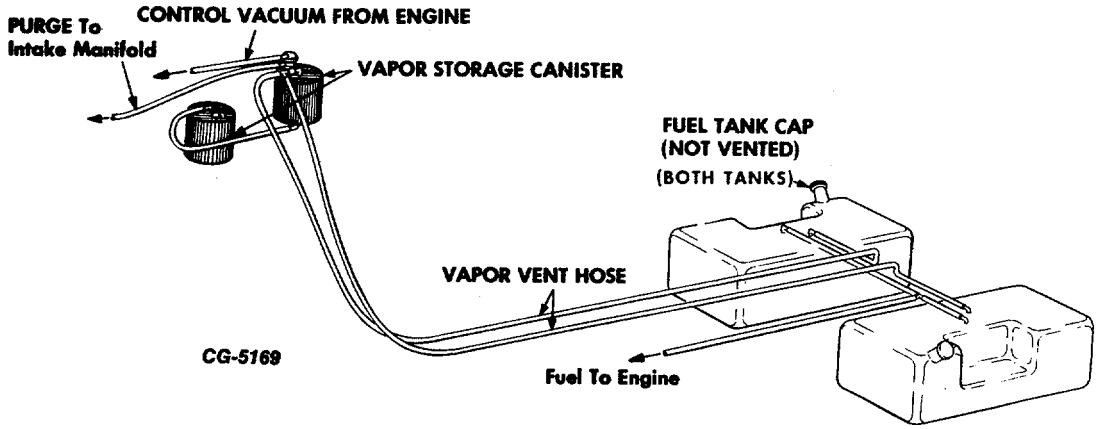


Fig. 30 1600-1800 S-Series Vehicles with 53 Gallon Dual Fuel Tanks

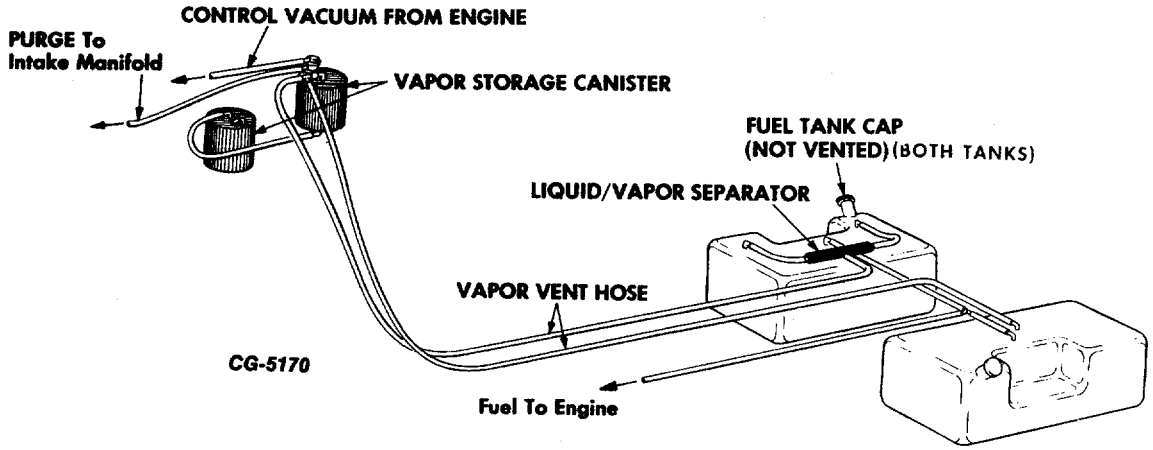


Fig. 31 1600-1800 S-Series Vehicles with 50 Gallon Right Fuel Tank And 53 Gallon Left Fuel Tank

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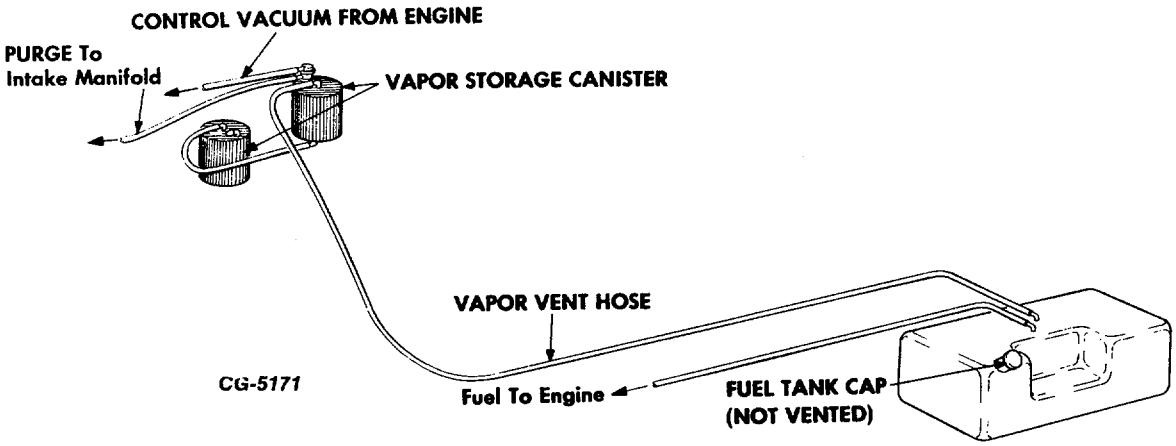


Fig. 32 1600-1800 S-Series Vehicles with 53 Gallon Single Left Fuel Tank

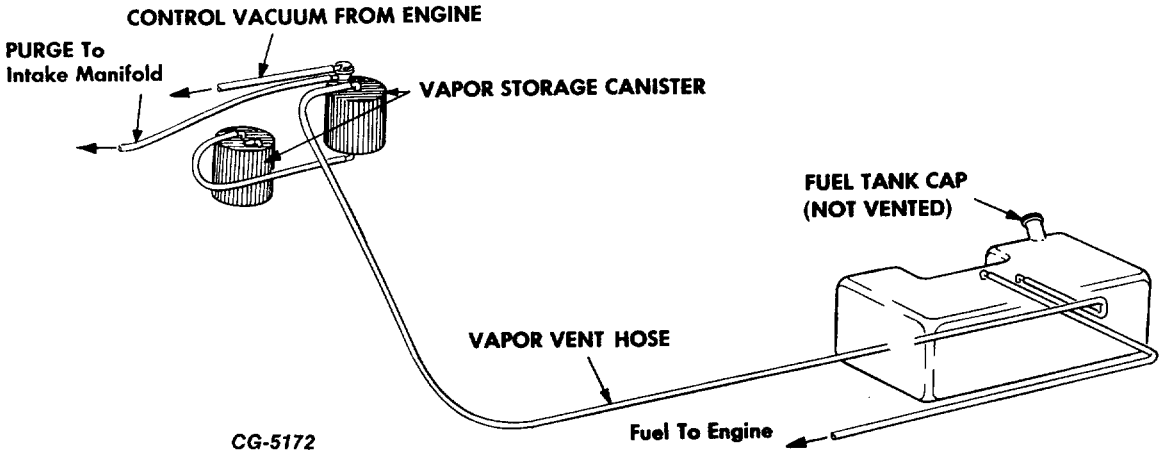


Fig. 33 1600-1800 S-Series Vehicles with 53 Gallon Single Right Fuel Tank

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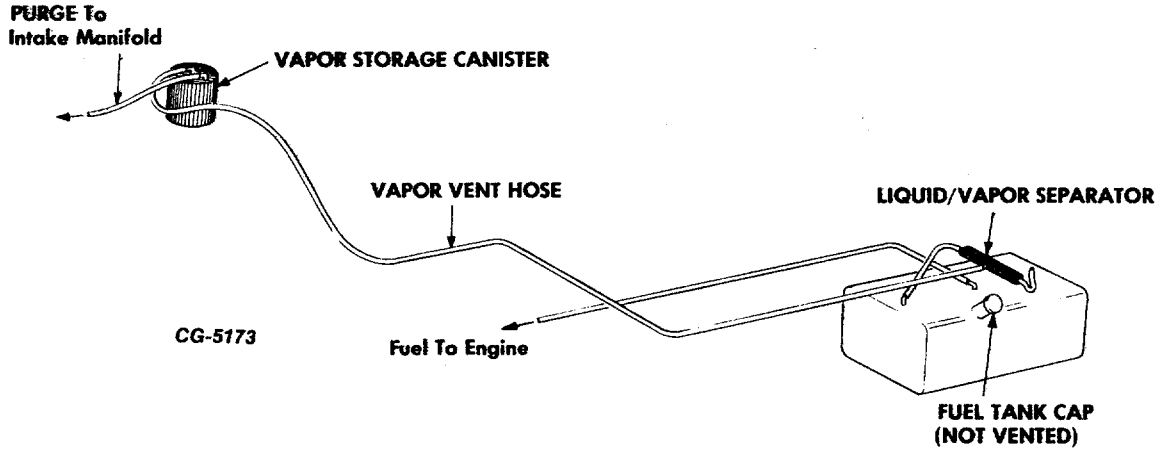


Fig. 34 1603, 1703 and 1803 S-Series Vehicles with 30 Gallon Single Left Fuel Tank

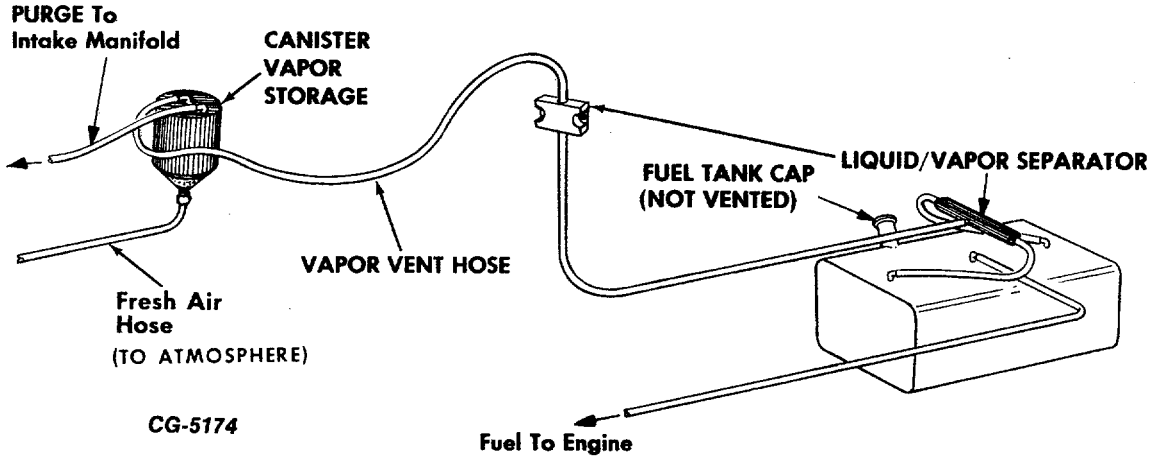


Fig. 35 1603, 1703 and 1803 S-Series Vehicles with 30 Gallon Single Right Fuel Tank

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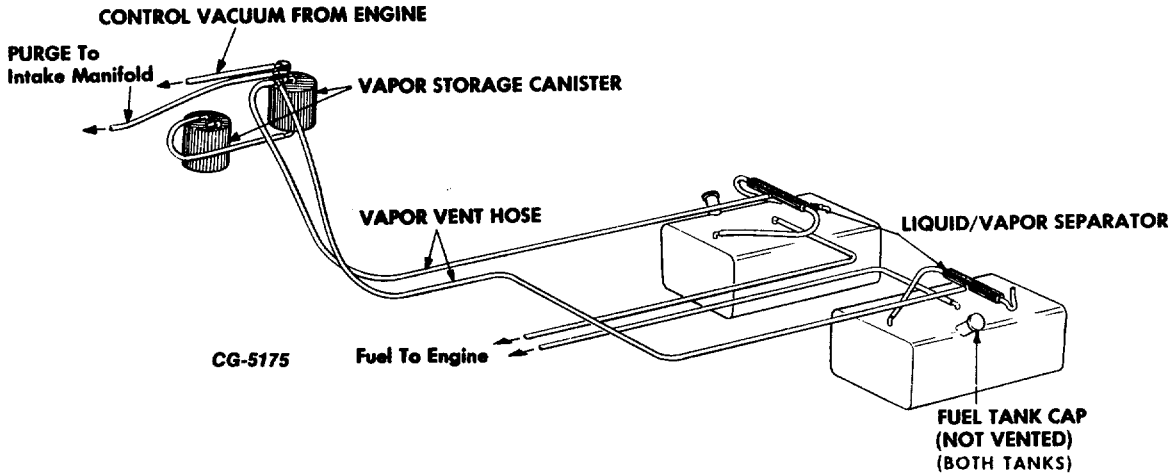


Fig. 36 1603, 1703 and S-Series Vehicles with 30 Gallon Dual Fuel Tanks

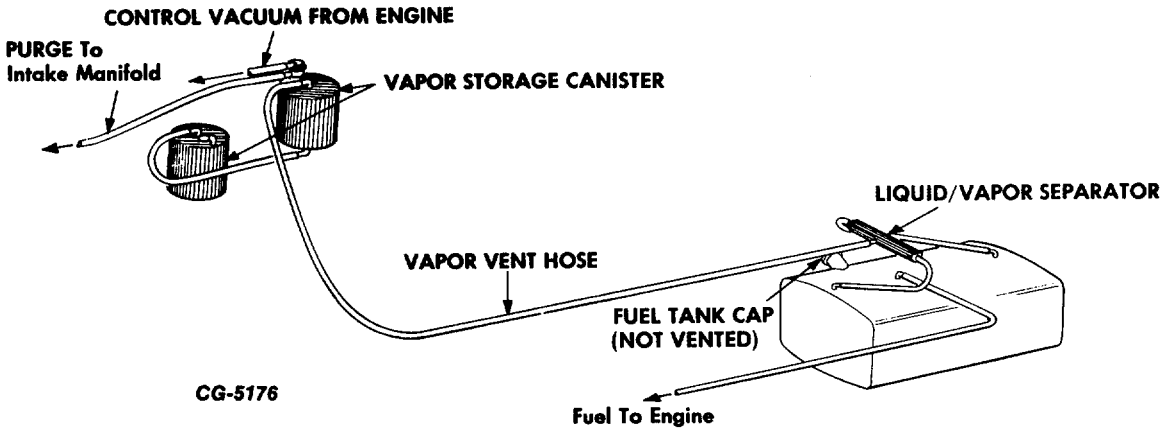


Fig. 37 1603, 1703 and 1803 S-Series Vehicles with 40 Gallon Right Fuel Tank

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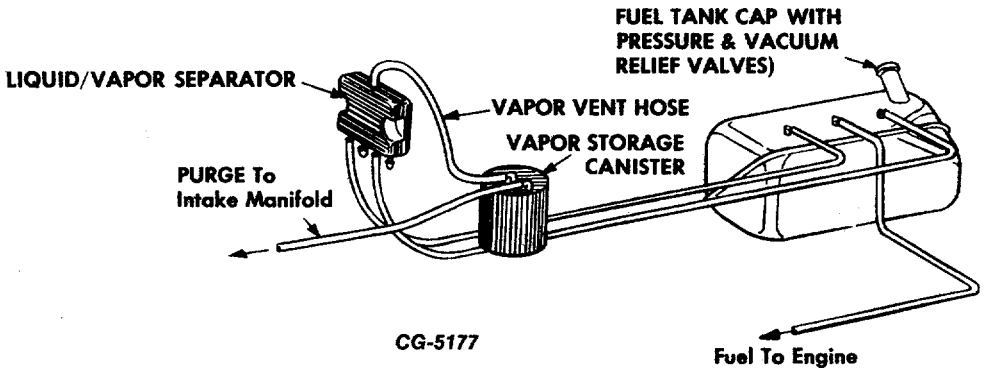


Fig. 38 1600-1800 S-Series Right Hand Drive Vehicles With 21 Gallon Under Cab Fuel Tank

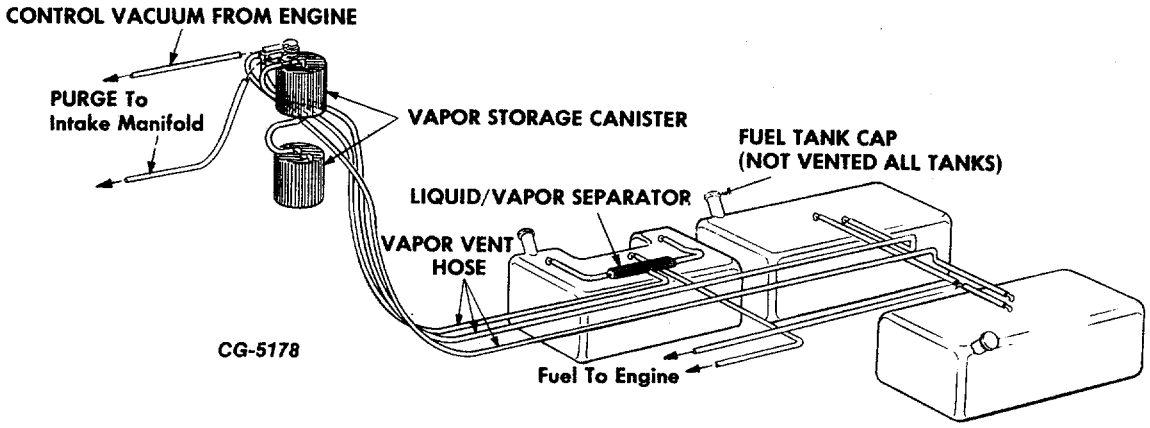


Fig. 39 1600-1800 S-Series Right Hand Drive Vehicles With 50 Gallon Single Left Fuel Tank and 53 Gallon Dual Right Fuel Tanks

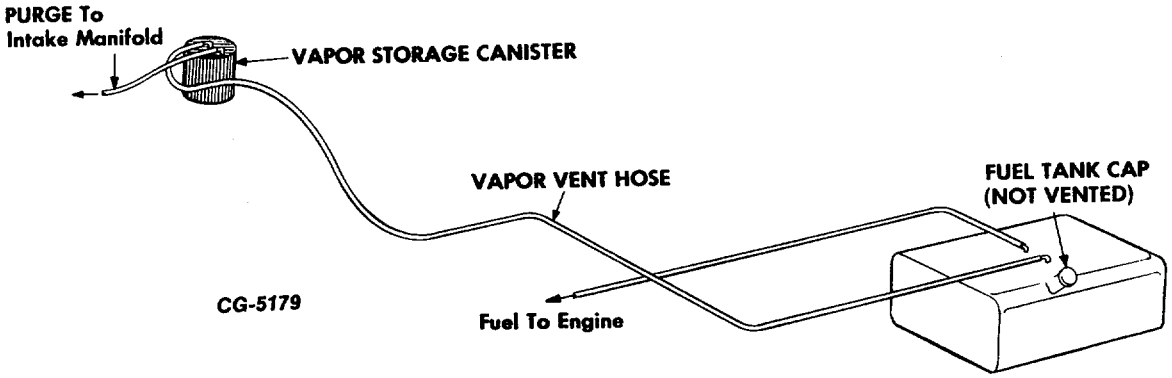


Fig. 40 1703 S-Series Vehicle with 30 Gallon Left Fuel Tank

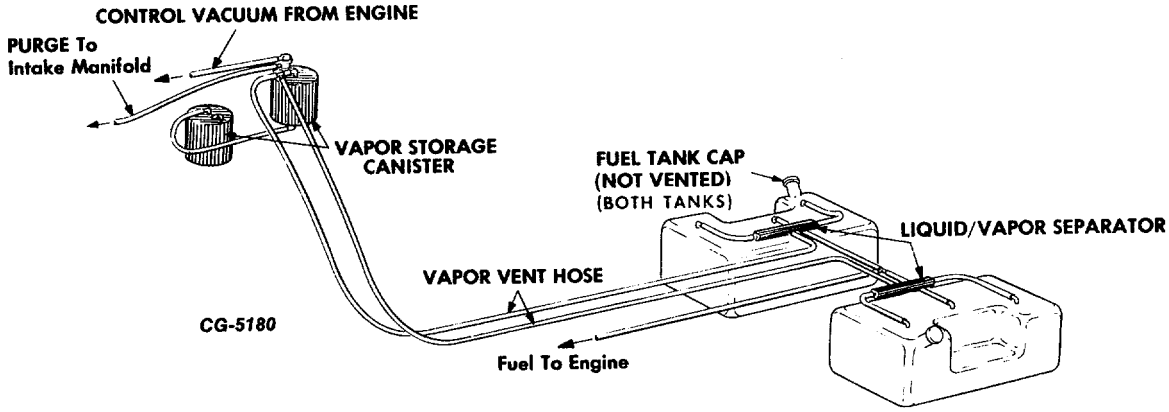


Fig. 41 1703 S-Series Vehicle with 50 Gallon Dual Fuel Tanks

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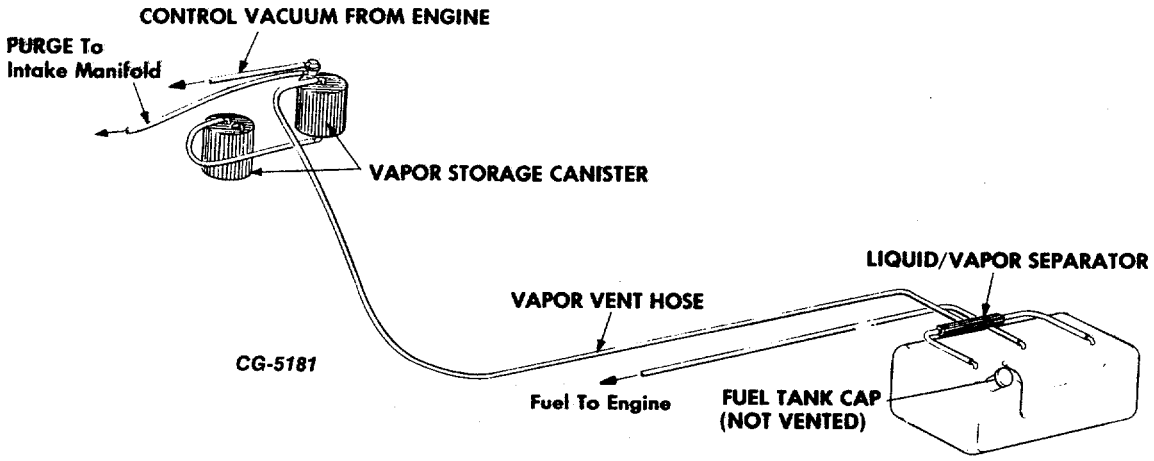


Fig. 42 1703 S-Series Vehicles with 50 Gallon Left Fuel Tank

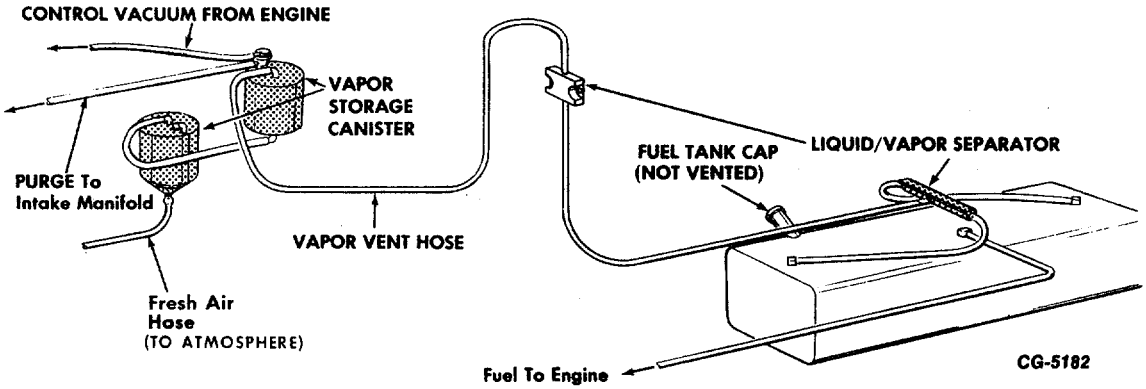


Fig. 43 1603, 1703 and 1803 S-Series Vehicles with Single 60 Gallon Right Fuel Tank

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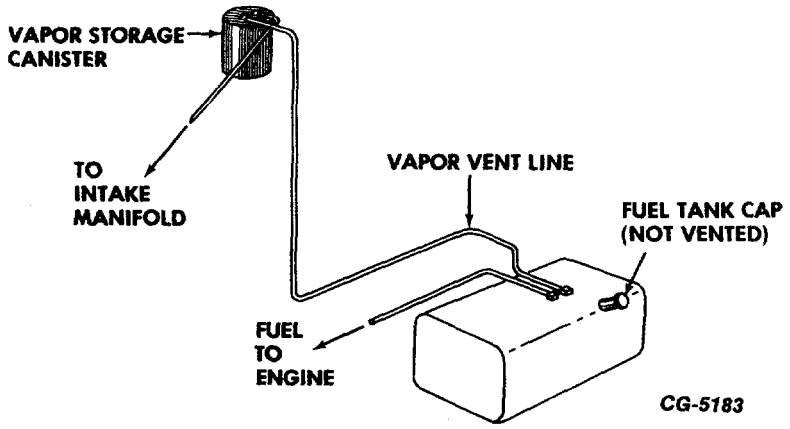


Fig. 44 CO-1610B and COF-1810B Cargostar Vehicles with 30 Gallon Left Fuel Tank

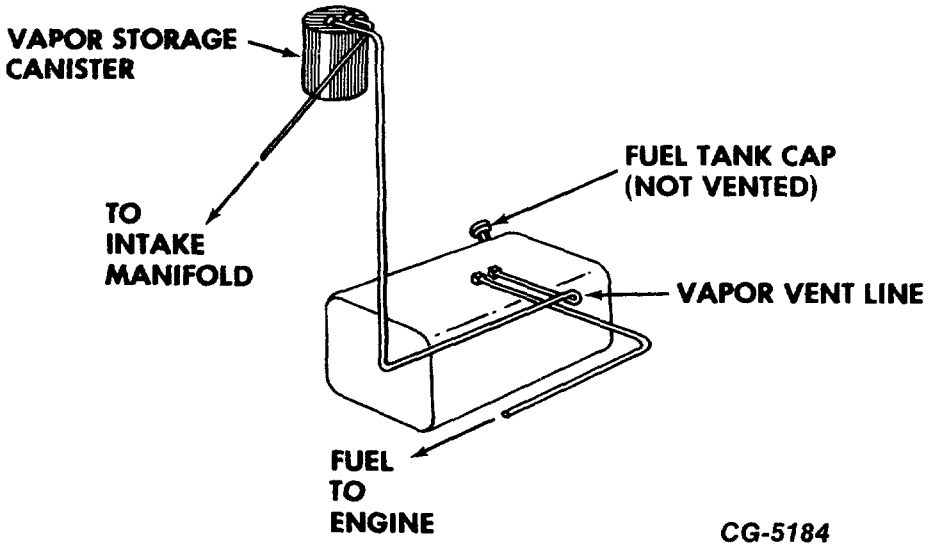


Fig. 45 CO-1610B and COF-1810B Cargostar Vehicles with 30 Gallon Right Fuel Tank

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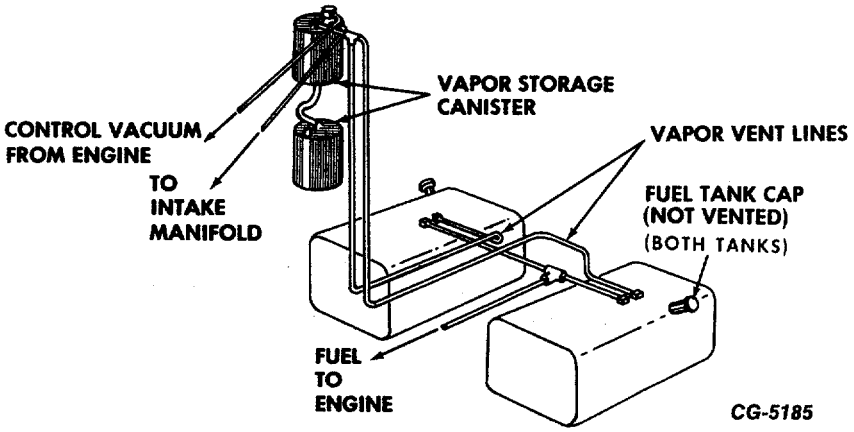


Fig. 46 CO-1610B and COF-1810B Carqostar Vehicles with 30 Gallon Dual Fuel Tanks.

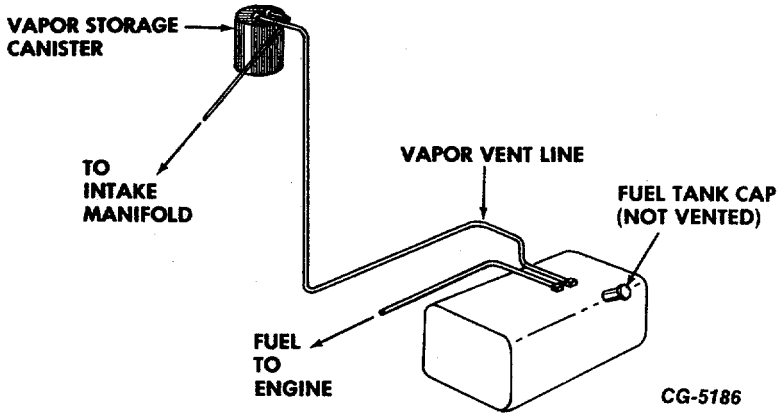


Fig. 47 CO-1610B and COF-1910B Cargostar Vehicles with 33 Gallon Left Fuel Tank

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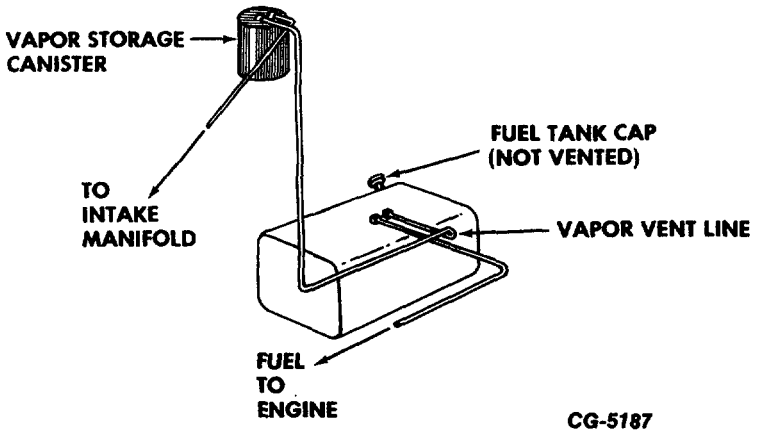


Fig. 48 CO-1610B and COF-1910B Cargostar Vehicles with 33 Gallon Right Fuel Tank

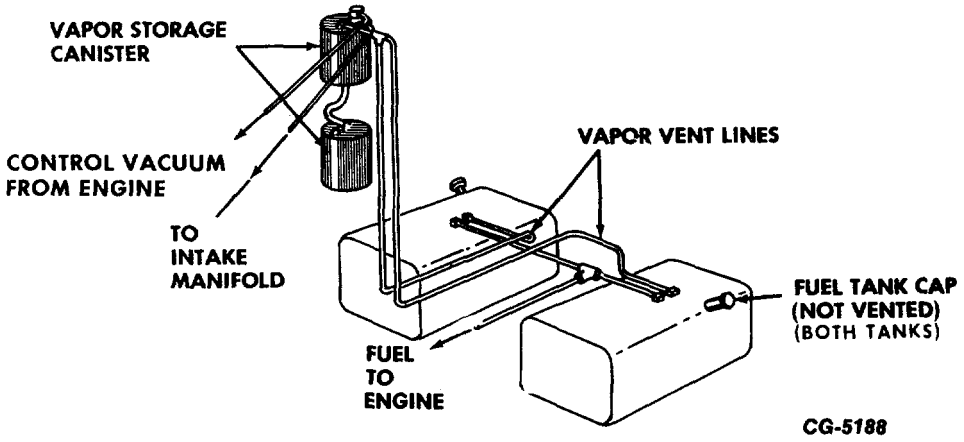


Fig. 49 CO-1610B and COF-1910B Cargostar Vehicles with 33 Gallon Dual Fuel Tanks

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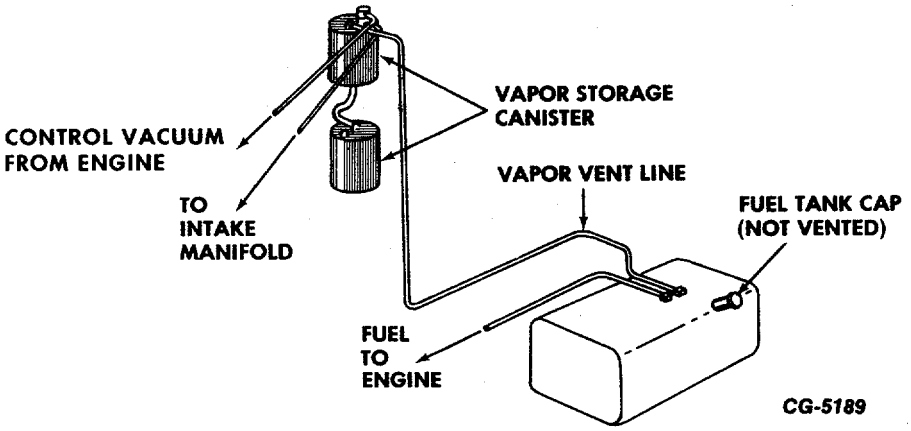


Fig. 50 CO-1610B and COF-1910B Cargostar Vehicles with 50 Gallon Left Fuel Tank

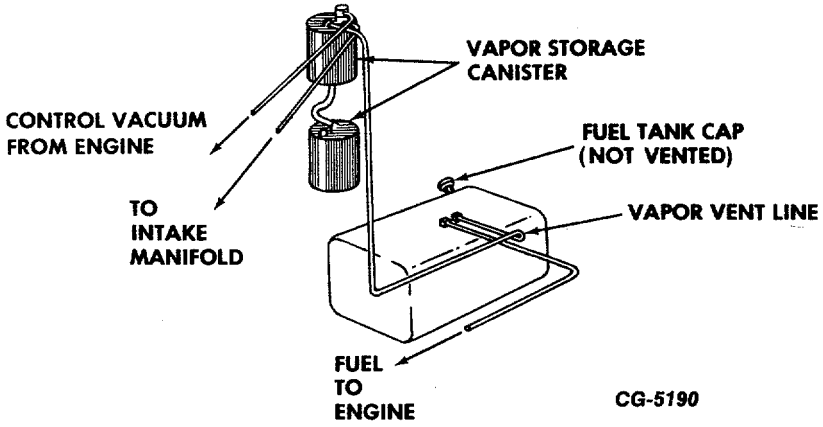
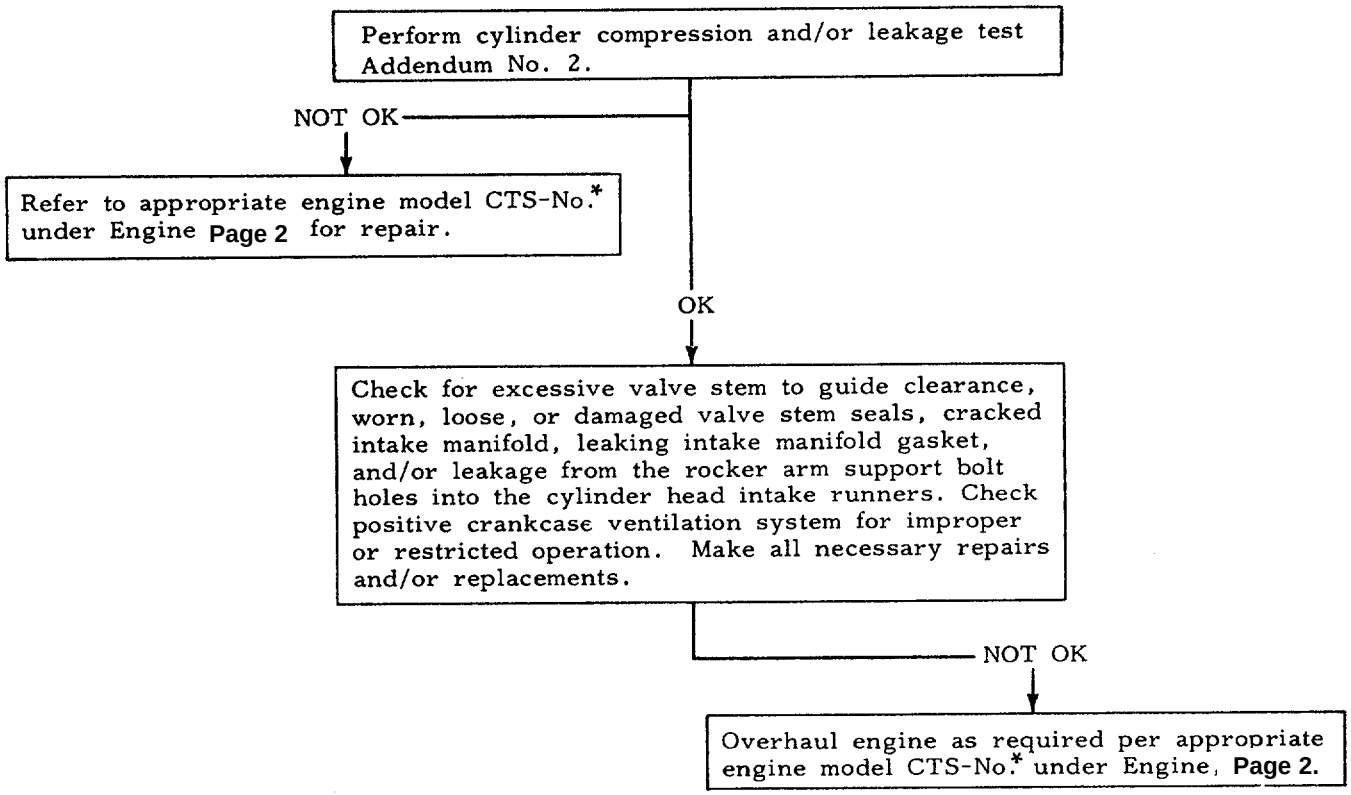


Fig. 51 CO-1610B and COF-1910B Cargostar Vehicles with 50 Gallon Right Fuel Tank

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*See CTS or CGES.

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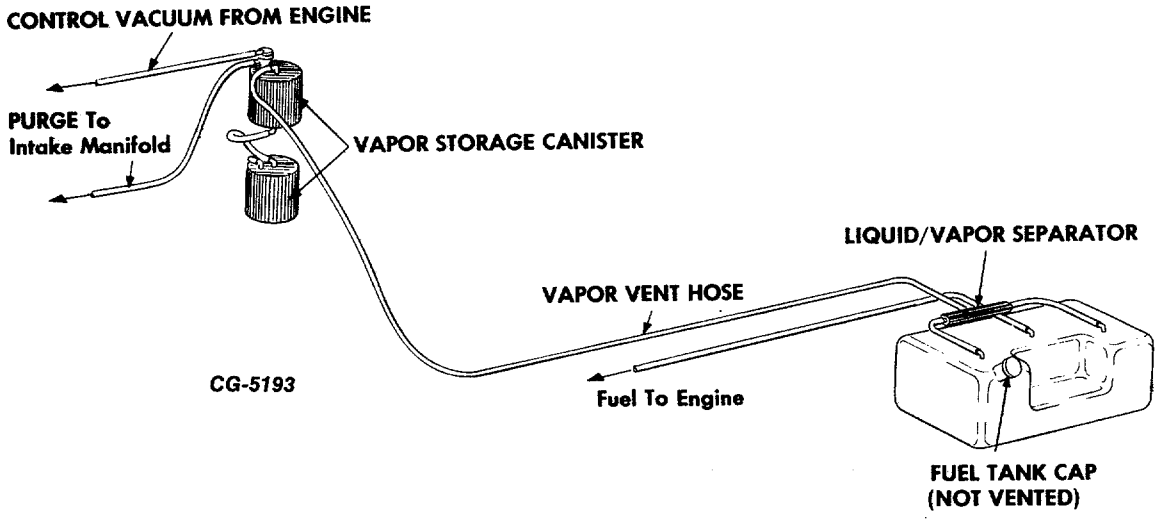


Fig. 54 2010 S-Series Vehicle with 50 Gallon Left Fuel Tank

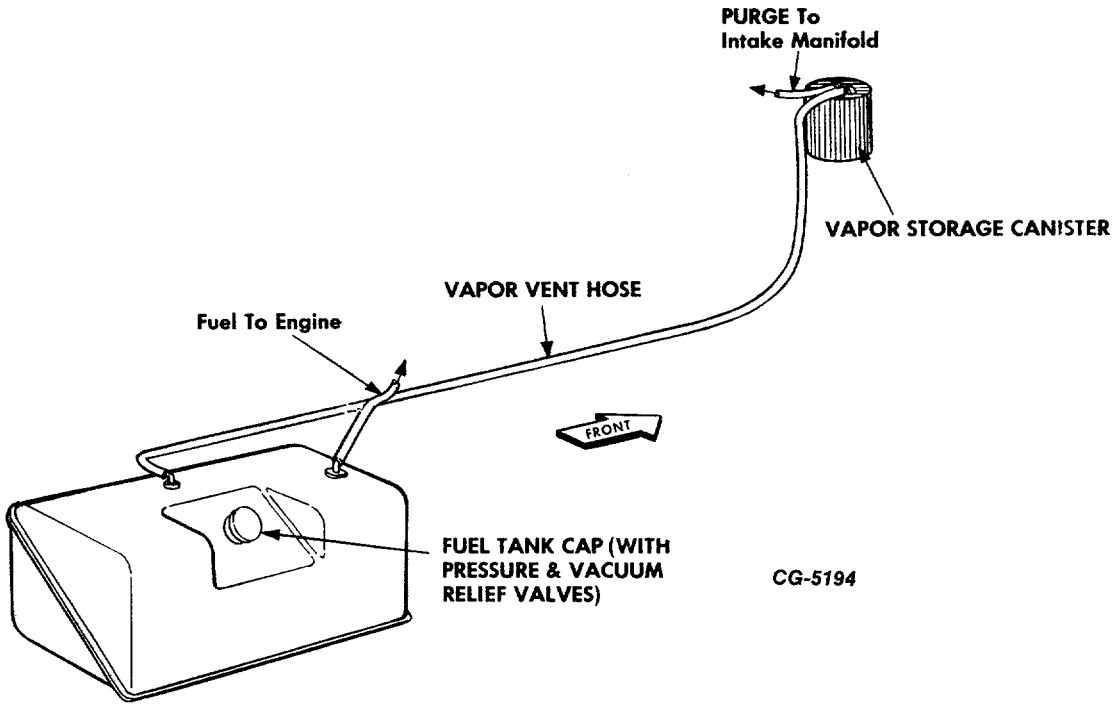


Fig. 55 S-Series 1624, 1724, 1824, 1824 4x4, 1924, 1924 6x6, F1924 And F-1925 Vehicles with 30 Gallon Fuel Tank

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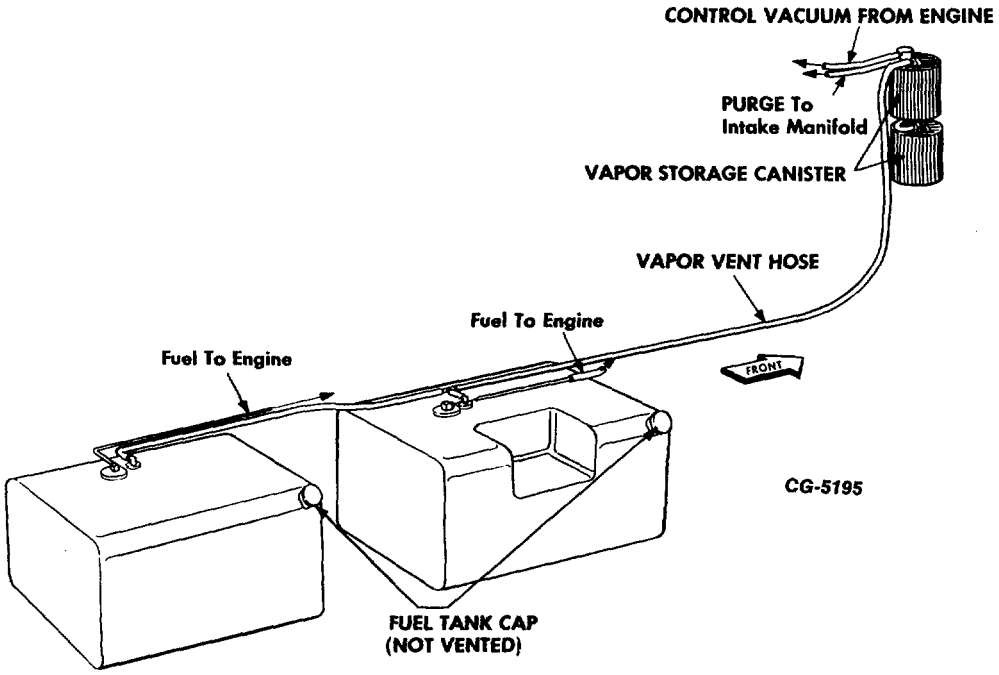


Fig. 56 S-Series 1624, 1724, 1824, 1824 4x4, 1924, 1924 6x6, F-1924 And F-1925 Vehicles with 45 and 48 Gallon Dual Fuel Tanks

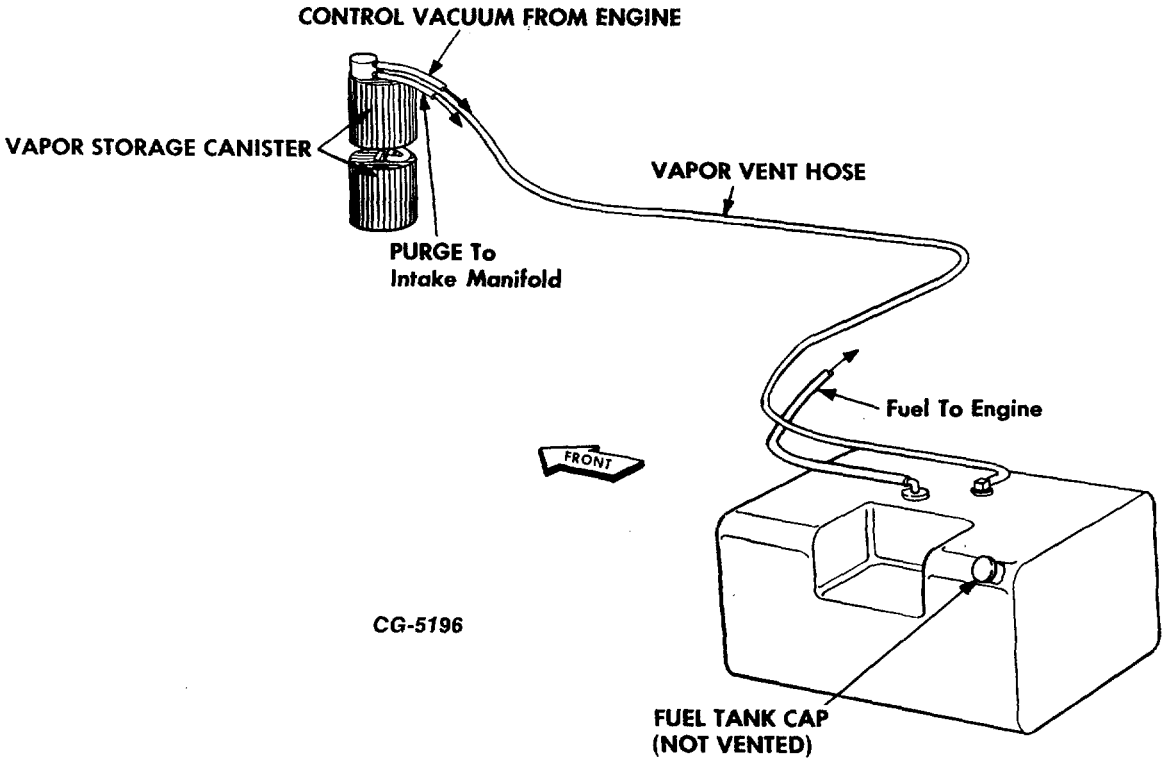


Fig. 57 S-Series 2524 and F2524 Vehicles with 57 Gallon Fuel Tank

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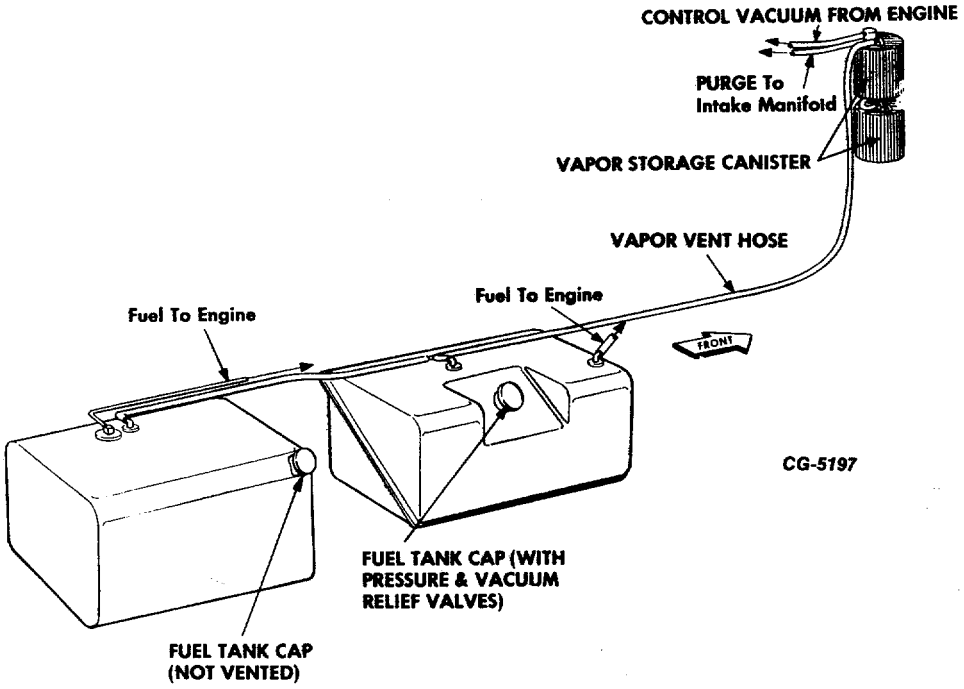


Fig. 58 S-Series 1624, 1724, 1824, 1824 4x4, 1924, 1924 6x6, F1924 And F-1925 Vehicles with 30 and 48 Gallon Fuel Tanks

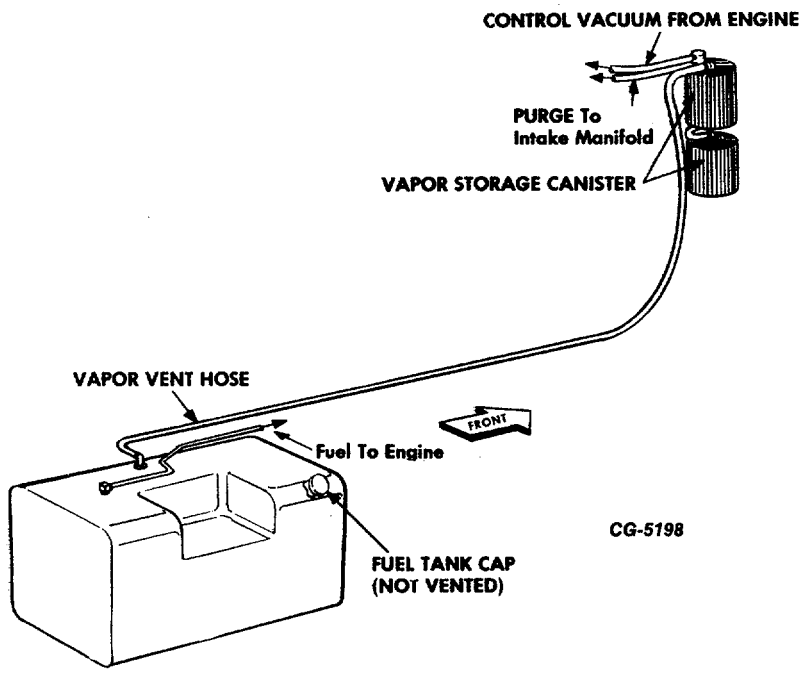


Fig. 59 S-Series 1624, 1724, 1824, 1824 4x4, 1924, 1924 6x6, F1924 And F-1925 Vehicles with 45 Gallon Fuel Tanks

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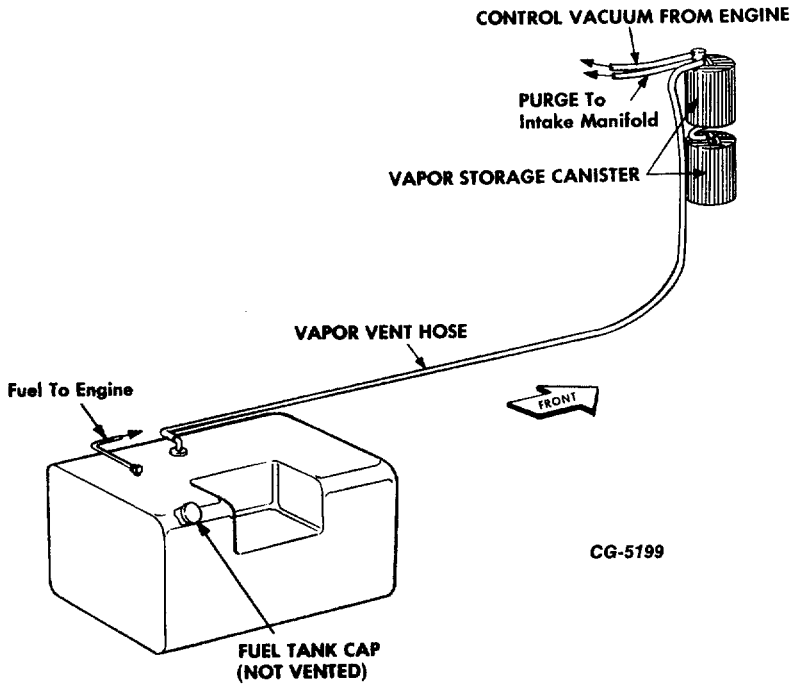


Fig. 60 S-Series 2125 and F2125 Vehicles with 57 Gallon Fuel Tank

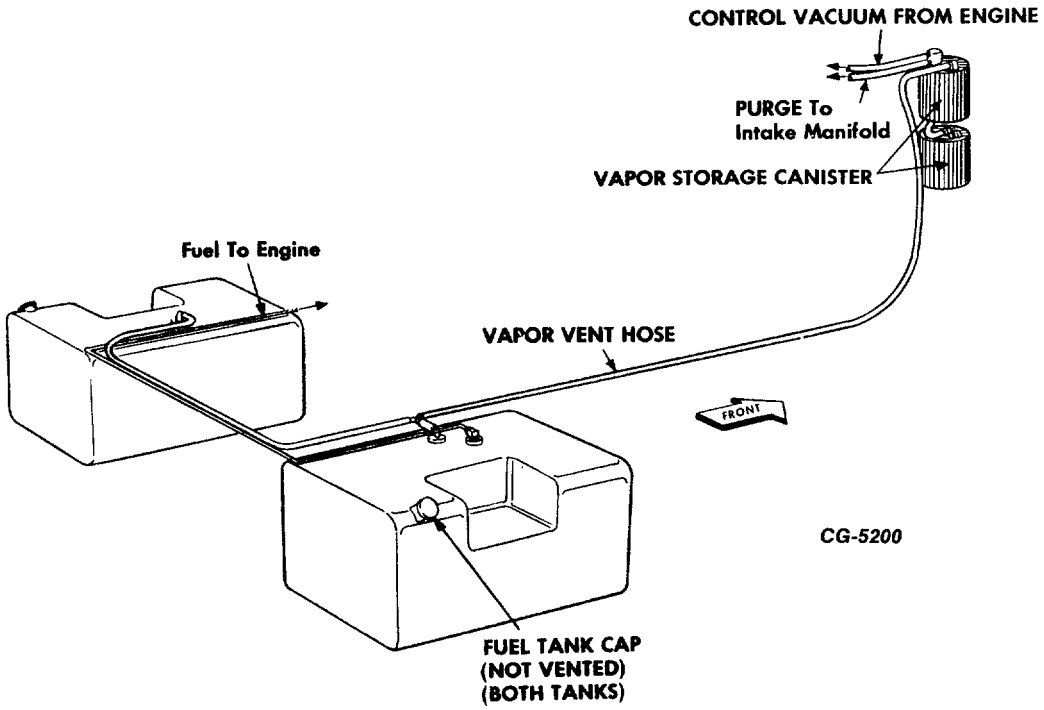


Fig. 61 S-Series 1724, 1824 and 1924 Trailer Toter with 45 Gallon Dual Fuel Tanks
S-Series 2125 and F2125 Vehicles with 57 Gallon Dual Fuel Tanks

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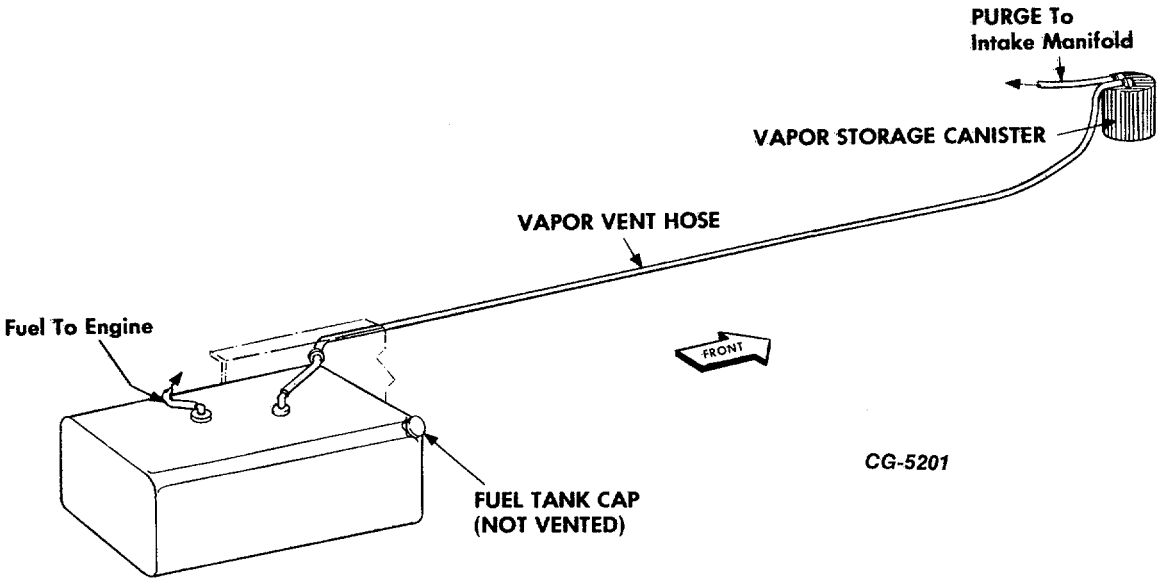


Fig. 62 S-Series 1723 and 1823 Bus with 32 Gallon Fuel Tank

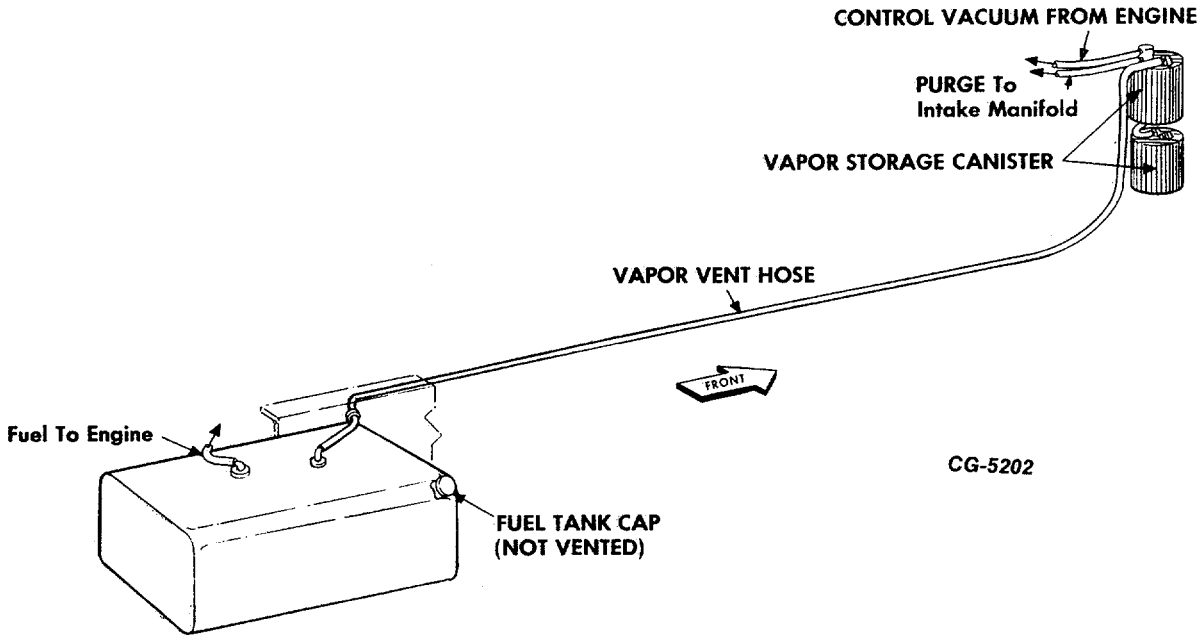


Fig. 63 S-Series 1723 and 1823 Bus with 52 Gallon Fuel Tank

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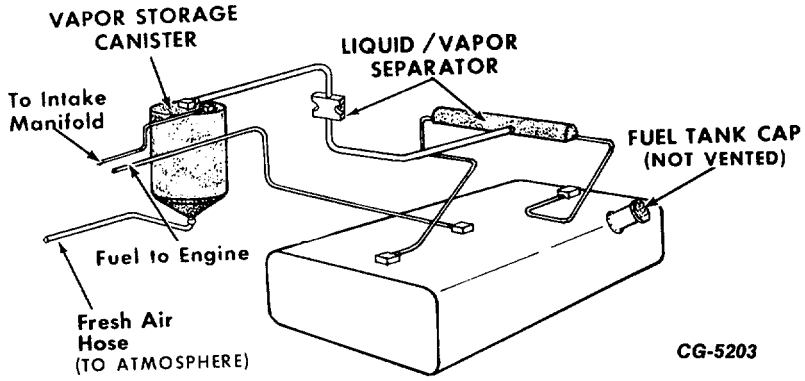


Fig. 64 1610-FC Vehicles with Single 30 Gallon Fuel Tank

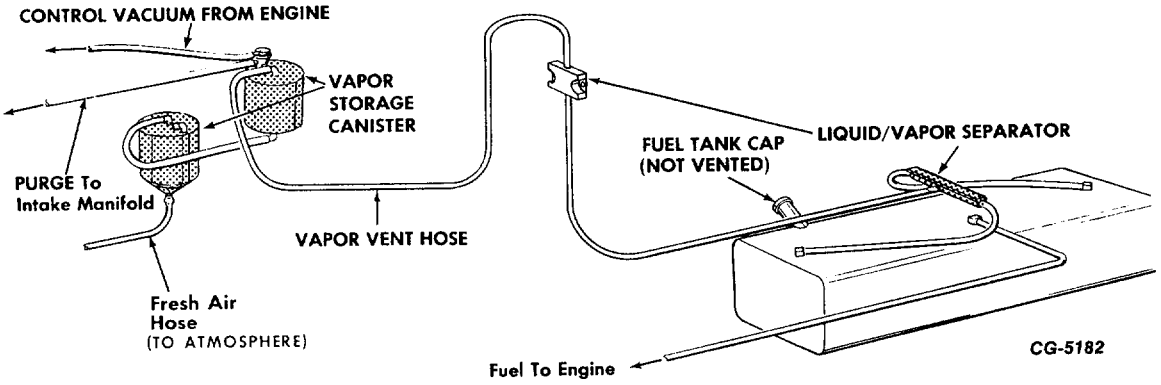


Fig. 65 1610-FC Vehicles with Single 60 Gallon Fuel Tank

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8. Check Engine Bolt Torque and Tighten if necessary.

Torque carburetor, intake manifold and exhaust manifold mounting bolts (see Tune-Up Specifications).

9. Check Exhaust Gas Control Valve for free operation and service or replace, if necessary.

a. Inspect exhaust heat riser valve for free operation (Fig. 66).

b. Free up with solvent, if necessary, while turning valve by hand (valve should turn to closed position when at ambient temperature).

c. If valve cannot be freed with solvent, replace with new valve.

10. Check Coil output Voltage and replace Coil, if necessary.

a. Connect SE-2576, or equivalent, test equipment.

b. Start and operate engine until normal operating temperatures are reached. Then, increase engine speed to 2500 RPM.

c. Record coil output voltage. If coil output voltage is not within specifications (see Tune-Up Specifications), proceed as follows:

d. Measure the D.C. voltage at the positive terminal of the ignition coil with the engine at idle speed and record.

e. Measure battery terminal D.C. voltage with engine at idle speed and record.

f. If coil positive terminal voltage is less than battery terminal voltage by more than .5 volts, replace or repair primary wiring, ignition switch or firewall connector as required. Recheck coil output voltage. If not satisfactory, proceed as follows:

g. Measure ignition coil primary resistance. The resistance from positive terminal to negative terminal with ignition switch off should measure between 1.2 and 1.4 ohms. If resistance is outside these limits, replace coil.

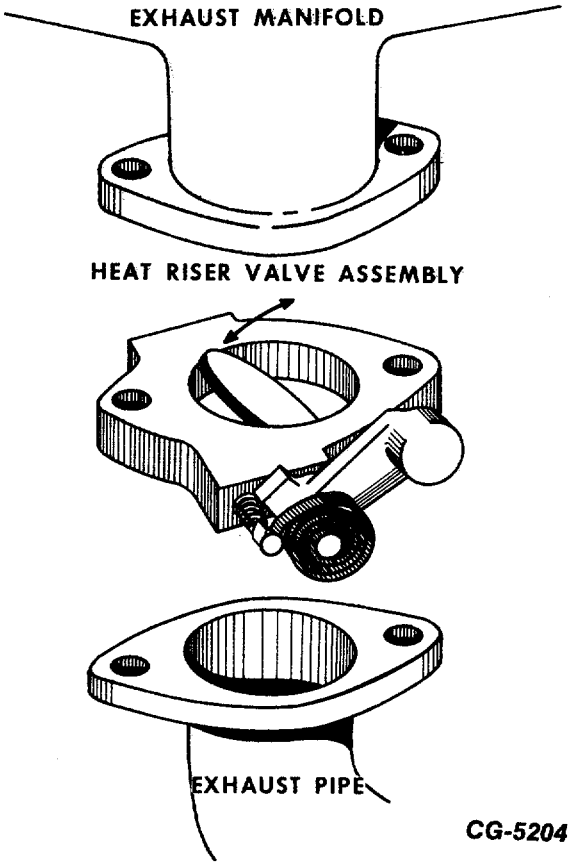


Fig.66 Heat Riser Valve

h. Measure secondary resistance of ignition coil by measuring between the positive terminal and the secondary tower connector. The resistance should measure between 9.4 and 11.1 thousand ohms. If the resistance is outside these limits, replace coil.

i. Off-Engine Coil Check: The ignition coil can be removed from the engine and checked with SE2576 or equivalent test equipment.

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11. Check Initial Advance and Adjust if necessary.

a. Connect timing light.
b. Disconnect and plug vacuum advance hose.
c. Start engine and operate until normal operating temperatures are reached.
d. Observe engine idle speed. Speed must be within specifications (see Tune-Up Specifications); adjust speed to specifications, if necessary.
e. Observe initial advance with timing light.

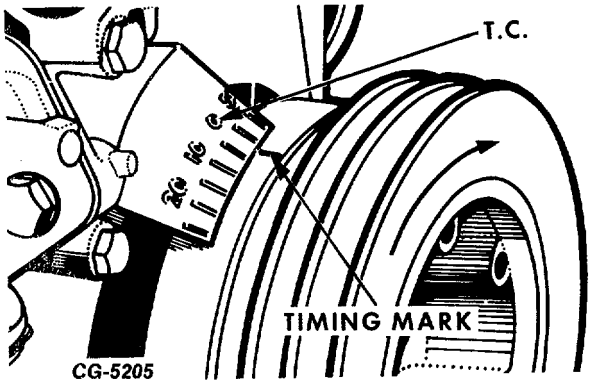


Fig. 67 Typical Location of Timing Marks

f. Loosen distributor clamp and adjust to specifications, if necessary (see Emission Control System Tune-Up Specifications).
Tighten distributor clamp and recheck initial advance.
g. NIV-446 engine, reconnect vacuum advance hose and adjust speed to tune-up specification, if necessary. Other engines, ad just speed to specifications with vacuum advance hose disconnected (Step b).
h. Stop engine. Reconnect vacuum advance hose (if necessary) and remove timing light.

12 . Check Operation of Inlet Air System Valve and Service or Replace, if necessary.

Procedure for servicing the sensor controlled vacuum chamber type air cleaner is as follows: (Canada Scout Vehicles)

a. Test should be conducted when ambient temperature of the vehicle are less than 24 deg. C (75 deg. F) and engine started cold. Air cleaner must have all hoses,

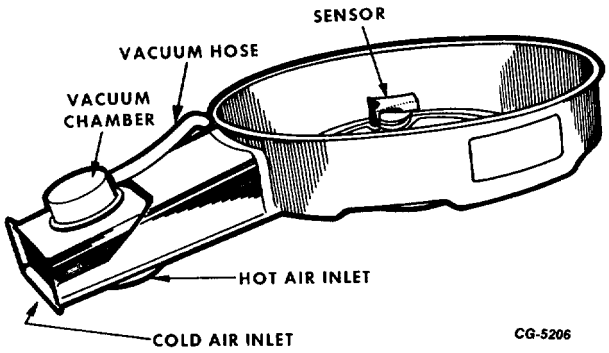


Fig. 68 Sensor Controlled Vacuum Chamber Type Air Cleaner

b. With engine off, inlet tube damper should be in full down position to close heat tube inlet pipe from exhaust manifold stove. Damper position can be determined by looking in end of inlet tube. If damper assembly is not in the correct position, vacuum chamber should be removed and damper movement loosened. Replace vacuum chamber (located on top of inlet tube) and recheck damper position.

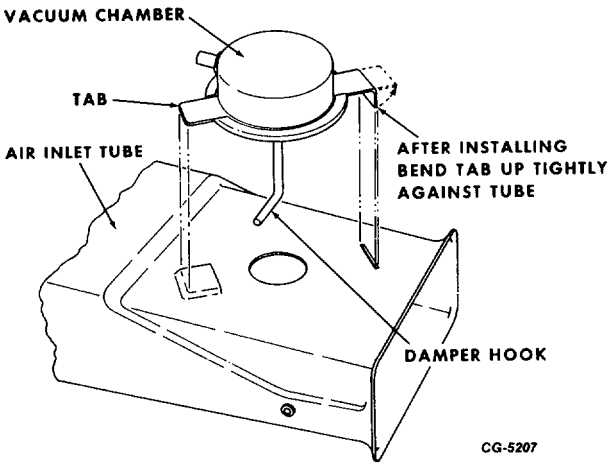


Fig. 69 Vacuum Chamber Details

To replace vacuum chamber (Fig. 69) (cannot be replaced on air cleaners used on 4-196 engines) bend tab nearest inlet tube entrance down from inside tube. Disconnect vacuum hose and lift vacuum chamber, sliding the rear tab out of its slot disengaging

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damper hook from damper. Attach new chamber by engaging hook in damper, sliding rear tab into its slot and fitting front tab into place. A spring preload should be felt when vacuum chamber is pressed firmly against top of inlet tube. If no preload is felt, check the installation or be sure parts are not faulty. Press front vacuum chamber tab firmly against tube inside surface. Connect vacuum hose.

c. Start engine and note that damper has rotated up to close off cold air inlet. Observe damper position by looking in the inlet tube. If damper did not immediately close cold air inlet, proceed as follows:

(1) Shut off engine and disconnect the two hoses from sensor.

(2) Connect the two hose ends together using suitable tubing.

(3) Restart engine and again check damper location. If damper fully closes cold air inlet, temperature sensor is defective and must be replaced (located inside air cleaner body).

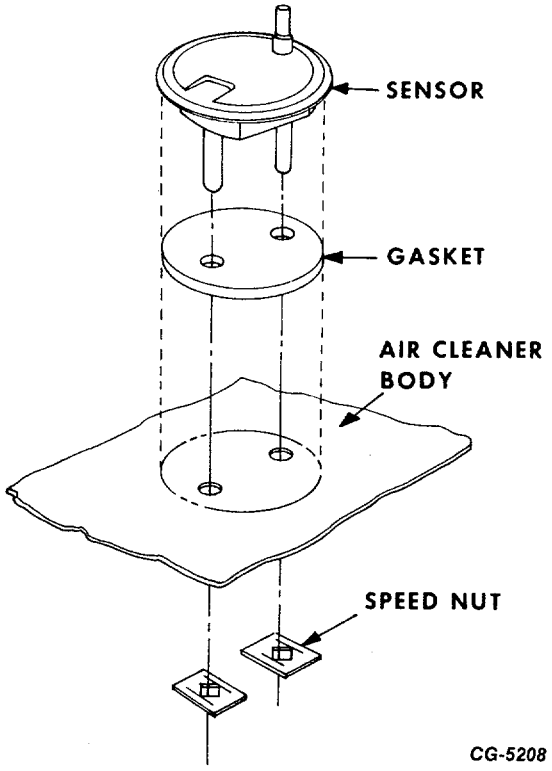


Fig. 70 Sensor Installation

To replace temperature sensor, disconnect two vacuum hoses attached to sensor inlet and outlet tubes on underside of air cleaner body. Remove clamps or speed nuts from tubes and lift sensor from body. Position new sensor and gasket inside air cleaner body. Firmly press two new speed nuts or clamps on tubes to hold sensor in place. Attach vacuum hoses to sensor tubes. If damper does not close cold air inlet, sensor is okay, but damper has bind or vacuum chamber is defective. Remove vacuum chamber and check damper for free movement. If damper moves freely, replace vacuum chamber.

d. After cold start, operate engine for 10 minutes at medium RPM. When engine is at normal operating temperature, slow engine to idle and observe position of inlet tube damper. If damper has not rotated all or part way down to allow some cold air to enter inlet tube, replace temperature sensor.

Procedure for servicing the thermal pellet type air cleaner is as follows: (Cargostar & S-Series Vehicles)

a. With the engine cold and ambient under hood temperature below 32 deg. C (90 deg F), the damper should be closed to the cold air inlet (open to the hot air inlet). This closed to cold air inlet can be checked by looking in the end of the inlet.

b. With the engine at operating temperature and the ambient under hood temperature above 57 deg. C (135 deg. F), the thermal pellet should open the damper allowing cold air to enter the cleaner and at the same time shut off the hot air inlet.

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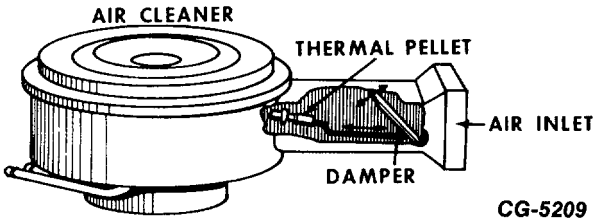


Fig. 71 Pellet Type Controlled Air Cleaner

c. If the damper does not operate as described above, reach in the inlet, move the damper open and check to see if it is sticking. If damper is moving freely and the linkage is connected, then the thermal pellet must be at fault and should be replaced.

When replacing the thermal pellet do not tighten the pellet assembly with a tool. Tighten finger tight only. Use locking compound on the threads to secure in place. If a tool is used, too much pressure may be applied changing the calibration of the thermal pellet and linkage assembly.

13. Check PCV System Hoses and Replace, if necessary, Clean PCV Valve, if necessary.

a. Remove valve from crankcase side, leaving the other end of the valve in hose and connected to intake manifold.

b. With the engine operating, a vacuum should be felt at the end of the valve. If no vacuum is present, the valve, hose and fitting should be removed and cause of restriction determined.

c. Check the inner chamber of the valve to see that it can be moved freely. This may be accomplished by inserting a stiff wire into the valve body and observing whether or not the plunger can be readily moved, or shake the valve and listen for rattle. If the plunger does not move, soak in carburetor cleaner.

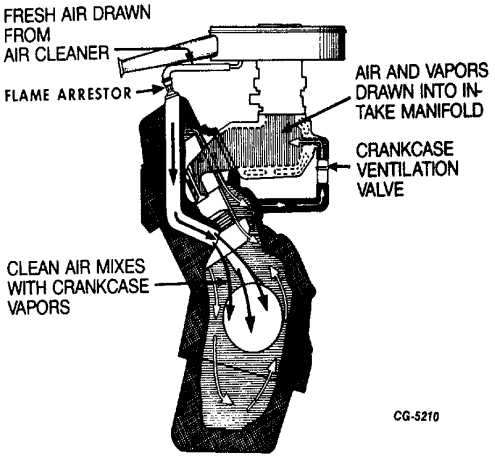


Fig. 72 Typical Air and Vapor Flow Through the System

13A. Positive Crankcase Ventilation Valve (PCV) Operation.

Since the vacuum supply for the PCV system is from the intake manifold, the flow through this system into the manifold must be controlled in such a manner that it varies in proportion to the air-fuel ratio being drawn into the intake manifold.

The PCV valve varies the amount of flow through the system according to the various modes of operation (i.e. idle, cruise, acceleration, etc.). The valve itself consists of a coil spring, valve and a two-piece outer body which is crimped together. The valve dimensions, spring and internal dimensions are such to produce the desired air flow requirements.

During the periods of deceleration and idle, manifold vacuum is high. The high vacuum overcomes the force of the valve spring and the valve bottoms in the manifold end of the valve housing. This does not completely stop the flow but it does restrict (Fig. 73).

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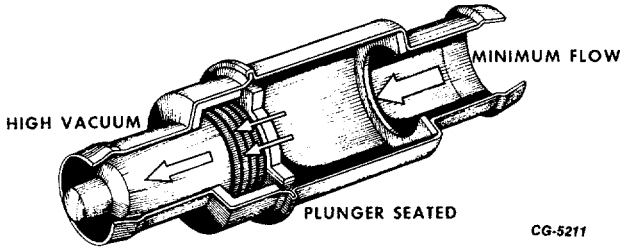


Fig. 73 Plunger Position During Idle or Low Engine Speed

When the engine is accelerated or operated at constant speed, intake manifold vacuum is less than at idle or during deceleration. The spring force is stronger than vacuum pull during this mode so the valve is forced toward the crankcase end of the valve housing. With the valve in this position, more crankcase vapors flow into the intake manifold (Fig. 74).

In the event of a backfire, the valve plunger is forced back and seated against the inlet of the valve body. This prevents the backfire from traveling through the valve and connecting hose into the crankcase (Fig. 75). If the backfire was allowed to enter the crankcase, it could ignite the volatile crankcase blow-by gases.

14. Check Deceleration Throttle Modulator (DTM) System and Adjust or Replace, if necessary.

a. Check modulator for free operation by grasping modulator by large diameter of the plastic housing and pulling (without twisting) toward throttle lever. Plastic housing should move freely against internal spring force for about 6 mm (1/4"). Modulator should be replaced if it does not move freely or does not return rapidly

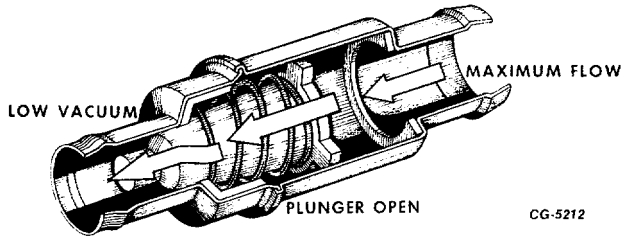


Fig. 74 Plunger Position During High Engine Speed

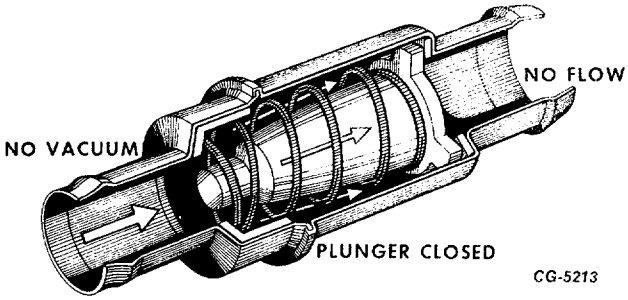


Fig. 75 Plunger Position During Backfire or When Engine is "OFF".

to fully retracted position (Fig. 76).

b. Check throttle modulator speed setting and adjust, if necessary.

(1) Connect tachometer to engine.

(2) Start and operate engine until normal operating temperatures are reached.

(3) Disconnect vacuum hose from modulator and manually apply vacuum to modulator (Fig. 77). If modulator does not extend, unit

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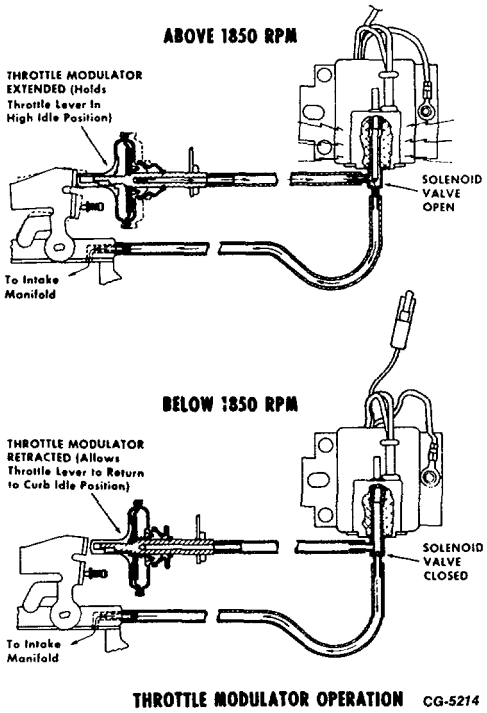


Fig. 76 Throttle Modulator Operation

is faulty and must be replaced. Allow throttle to close against extended modulator.

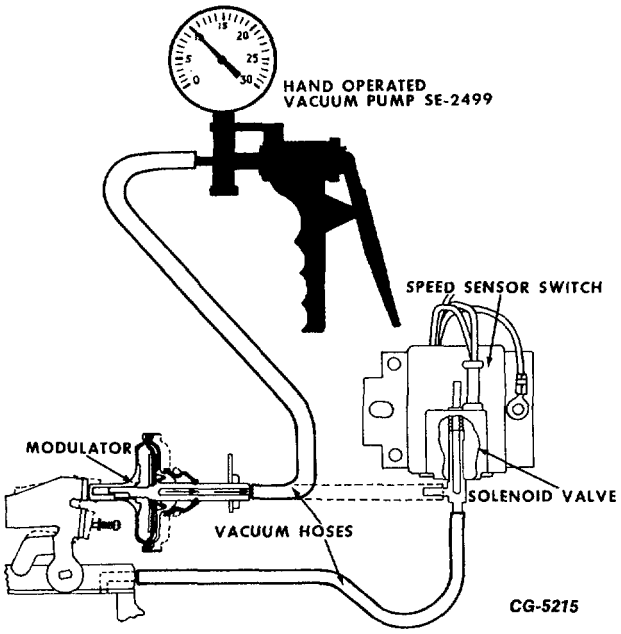


Fig. 77 Modulator Test

(4) Observe engine speed. For proper speed, see Emission Control Tune-Up Specifications.

(5) If modulator is improperly adjusted, loosen lock nut and adjust position of modulator.

(6) Repeat Steps (3) thru (5) until proper speed is achieved; then tighten lock nut.

(7) Reconnect proper vacuum hose to modulator.

c. Perform DTM operational test as follows:

(1) Verify modulator is retracted at idle.

(2) Slowly accelerate the engine and observe the speed at which the modulator extends. Modulator should extend at 1850 ± 50 RPM (Fig. 76).

(3) Slowly decelerate the engine and observe the speed at which the modulator retracts. Modulator should retract at 1850 ± 50 RPM (Fig. 76).

d. Verify solenoid valve functions properly.

(1) Operate engine at any condition.

(2) With wiring harness disconnected from solenois valve, modulator must be in retracted position.

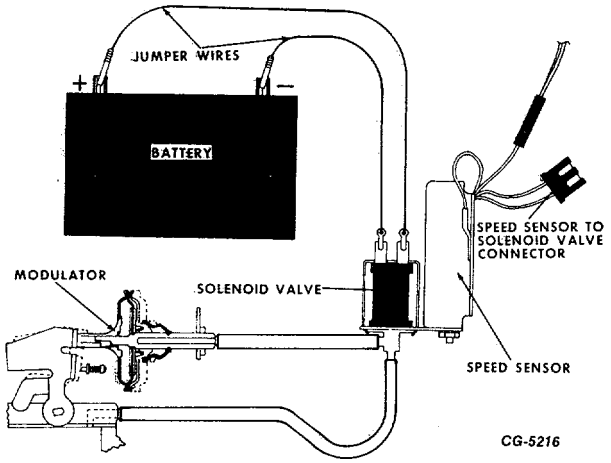


Fig. 78 Jumper Wires From Battery to Solenoid Valve Terminals

(3) With jumper wires from positive terminal of battery and from ground connected to solenoid valve terminals (Fig. 78), modulator must be in extended position.

(4) If modulator does not function properly, solenoid valve is faulty and must be replaced. (The solenoid valve and speed sensor are sold as one assembly.)

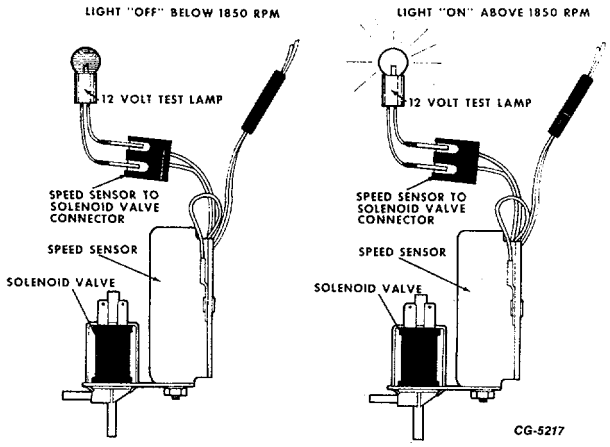


Fig. 79 Speed Sensor Switch Test

e. Verify speed sensor functions properly.

(1) Disconnect wiring harness from solenoid valve and connect a 12-volt test lamp between the two terminals of the harness connector.

(2) Slowly accelerate the engine and observe the speed at which the test lamp lights. Test lamp should light above 1850 ± 50 RPM.

(3) Slowly decelerate the engine and observe speed at which the test lamp goes out. Test lamp should go out below 1850 ± 50 RPM.

(4) If test lamp does not function properly, check speed sensor wiring for proper routing and for clean -and tight connections. If wiring is correct, speed sensor if faulty and must be replaced. (The speed sensor and solenoid valve are sold as one assembly.)

14A. Deceleration Throttle Modulator System (DTM) Operation.

The deceleration throttle modulator system consists basically of a vacuum operated throttle modulator unit on the carburetor, a solenoid vacuum valve and engine speed sensor unit (Fig. 76).

Normally an engine will emit relatively high levels of unburned hydrocarbons during "closed throttle" deceleration. This is because the intake of fuel/air mixture is not sufficient to support complete combustion and the engine "misfires" resulting in fuel being passed through the engine unburned. The deceleration throttle modulator system overcomes this condition by maintaining a slightly greater throttle opening (high idle) during initial deceleration which permits intake of just enough additional fuel/air mixture to promote combustion and eliminate misfire.

The engine speed sensor is calibrated to activate or deactivate (extend or retract) the throttle modulator unit at approximately 1850 RPM engine speed. Operation of the throttle modulator is illustrated in Fig. 76.

Above 1850 RPM engine speed, the solenoid vacuum valve is activated (held open) by electrical current from the engine speed sensor unit. This permits manifold vacuum to act upon the diaphragm of the throttle modulator unit extending the modulator unit to the high idle position. Upon deceleration, the returning carburetor throttle level contacts the extended modulator, thus holding the throttle in high idle position.

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When engine speed drops below 1850 RPM, the speed sensor unit deactivates the solenoid vacuum valve allowing the valve to close and bleed the vacuum from the throttle modulator diaphragm chamber. This permits the diaphragm spring to retract the modulator unit and allow the throttle lever to return to normal curb idle position.

15. Remove and Check EGR Valve and Clean or Replace, if necessary.

For USA Engines Only.

a. Remove EGR valve from engine.

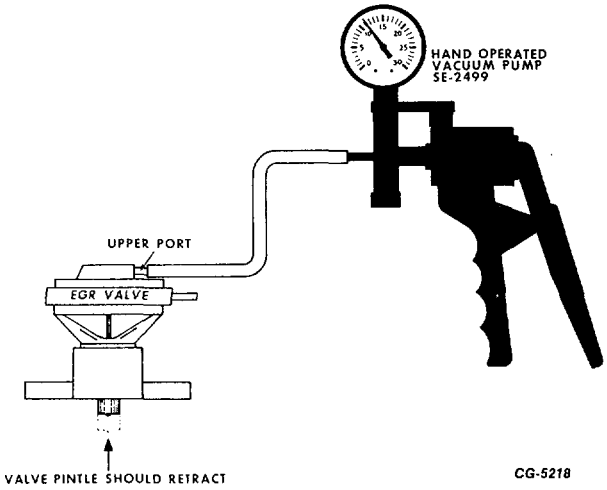


Fig. 80 EGR Valve Test

b. Apply 10-12" vacuum to EGR valve vacuum port (upper port of dual diaphragm valve). As vacuum is applied, valve pintle should move off seat and retract into valve housing (Fig. 80). If valve does not operate when vacuum is applied, valve is faulty and should be replaced.

c. Visually inspect valve for evidence of valve pintle (plunger) not seating or deposit accumulation on pintle or seat. Clean deposits from pintle and seat, if necessary.

To clean deposits from pintle and seat of EGR valve, use a sand blast type spark plug cleaner and the following procedure:

(1) Prepare spark plug cleaner by installing rubber adapter with 22 mm (7/8") hole over cleaning (blast) port. Do not install metal adapter clamp (Fig. 81).

(2) Insert pintle of EGR valve through hole in rubber plug cleaner adapter

(3) Holding EGR valve tightly down adapter, apply sand blast to clean pintle.

CAUTION

Safety goggles should be worn while performing cleaning operation.

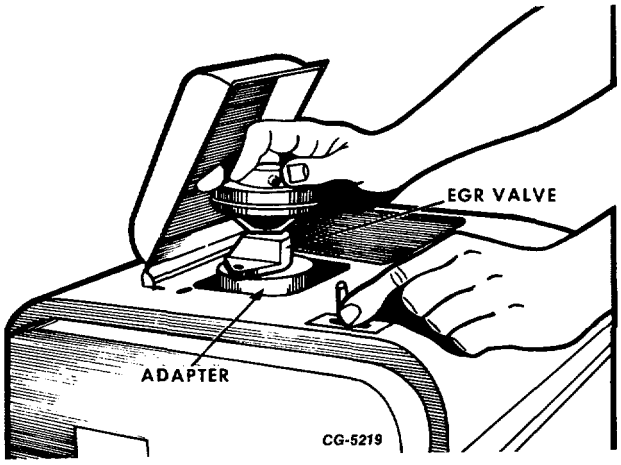


Fig. 81 Cleaning EGR Valve

(4) After cleaning exposed pintle, hold EGR valve in both hands and press in diaphragm to retract valve pintle into valve housing. Use a 25 mm (1") long bolt (3/4" long for dual diaphragm valves) to hold pintle in retracted position. Apply masking tape to cover outlet port of valve.

(5) With pintle opening of valve aligned with hole in cleaning adapter, hold EGR valve down tightly against adapter and apply sand blast to clean interior of valve housing and valve seat.

d. After cleaning, blow all excess sand from interior of valve housing and remove bolt.

e. Recheck valve for proper operation and seating.

f. Replace with new valve, if necessary.

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16. Check EGR System with Functional Test and Clean or Replace, if necessary.

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Perform EGR System Functional Test as follows:

a. Operate engine until it reaches normal operating temperature.

b. Shut off engine Connect tachometer. Connect vacuum pump with vacuum gauge to EGR system vacuum hose at carburetor.

c. Plug fitting at carburetor.

d. With tachometer installed, operate all engines at 2000 RPM.

e. Apply specified vacuum (see Emission Control System Tune-Up Specifications).

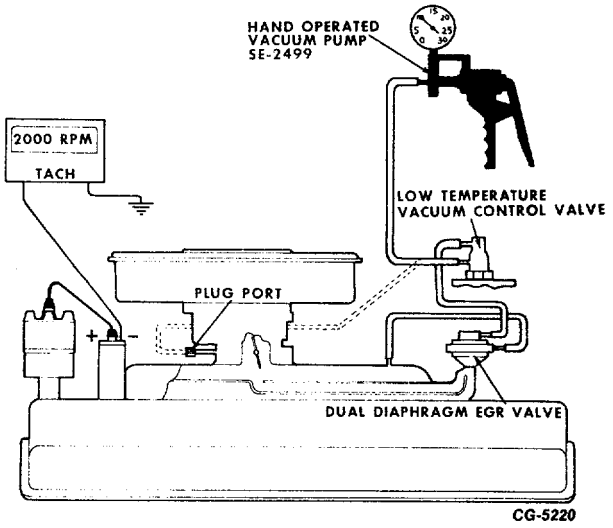


Fig. 82 Complete EGR System Test

f. See Emission Control System Tune-Up Specifications for engine speed drop when vacuum is applied. This procedure checks not only the EGR valve but the intake manifold and related passages as well.

If minimum speed drop specification is not achieved, verify applied vacuum signal acts on valve.

a. Tee vacuum gauge into vacuum hose at EGR valve (upper port on dual diaphragm valves).

b. With engine shut off and normal operating temperature (EGR low temperature vacuum control valve'), any vacuum magnitude applied at carburetor end of vacuum hose should be observed at EGR valve end of hose (Fig. 83).

c. If same vacuum is not observed, inspect vacuum hoses for leaks and replace as necessary.

d. Repeat Step b. If same vacuum is not observed, replace EGR low temperature vacuum control valve.

e. Repeat EGR System Functional Test.

If minimum speed drop specification is still not achieved, check for plugged exhaust gas passages and clean as required.

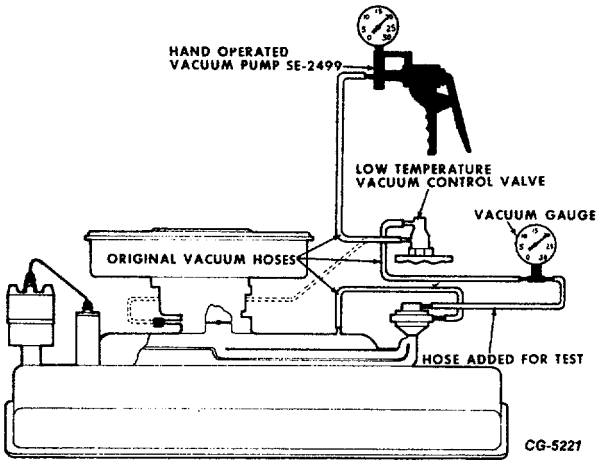


Fig. 83 Low Temperature Vacuum Control Valve and Connecting Hose Test

a. For V-304/345/392 engines, open carburetor throttle plates and examine exhaust gas ports located in floor of intake manifold directly below carburetor. If ports are plugged with deposits, remove carburetor and clean ports as needed.

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For Canada V-304/345 Engines Only.

a. Operate engine until it reaches normal operating temperature.

b. Shut off engine. Connect tachometer and vacuum gauge to engine.

c. Start engine and block throttle open to give 3000 RPM. Observe and record tachometer reading.

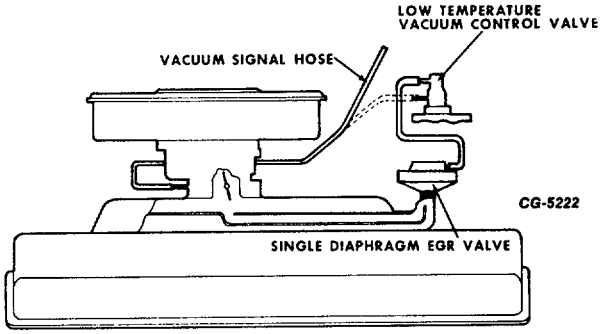


Fig. 84 Single Diaphragm EGR Valve System

d. Disconnect EGR vacuum signal hose (Fig. 84) and again record tachometer reading. If EGR system is functioning properly the minimum speed increase should be 50 rpm for the V-304 and 150 rpm for the V-345. If rpm increase is less than shown above, EGR system is not functioning properly and should be checked per the following steps.

Check low temperature vacuum control valve as follows:

a. With engine operating at fast idle, disconnect vacuum signal hose from low temperature vacuum control valve. A vacuum signal should be felt at the open end of hose. If vacuum is felt, reconnect hose and proceed. If vacuum is not felt, stop engine and check for leaking or restricted vacuum hose or restructed vacuum port in carburetor.

b. With engine operating at fast idle, disconnect vacuum signal hose from EGR valve. A vacuum signal should be felt at the open end of the hose. If vacuum is felt, vacuum supply and low temperature valve are satisfactory (Fig. 84).

If vacuum is not felt:

a. Check for leaking or restricted vacuum hose.

b. Be sure hoses are connected properly to low temperature vacuum control valve.

c. If hoses are satisfactory and vacuum does not pass through low temperature vacuum control valve, valve is faulty and must be replaced.

After correcting any problem and obtaining a vacuum signal at EGR valve, repeat System Operation Test per c and d above.

Check operation of EGR valve as follows:

a. Remove EGR valve from engine.

b. Visually inspect valve for evidence of valve pintle (plunger) not seating. If pintle does not seat due to deposits, clean valve pintle and seat (see EGR Valve Cleaning Procedure). If pintle does not seat properly after cleaning, replace EGR valve.

c. Apply 10-12" Hg vacuum to EGR valve vacuum port (Fig. 82). As vacuum is applied, valve pintle should move off seat and retract into valve housing until end of pintle is approximately flush with surface of valve housing. If valve does not operate when vacuum is applied, valve is faulty and should be replaced.

16A Replace EGR Valve

Because EGR valve metering varies between engines, it is important that the correct EGR valve be used in order to obtain optimum engine performance and emission control (see EGR Valve Application Chart).

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To assist in identification, EGR valves are coded by a colored disk attached to the center of the vacuum diaphragm housing. The valve may also be identified by the manufacturer's part number stamped on the valve (Fig. 85).

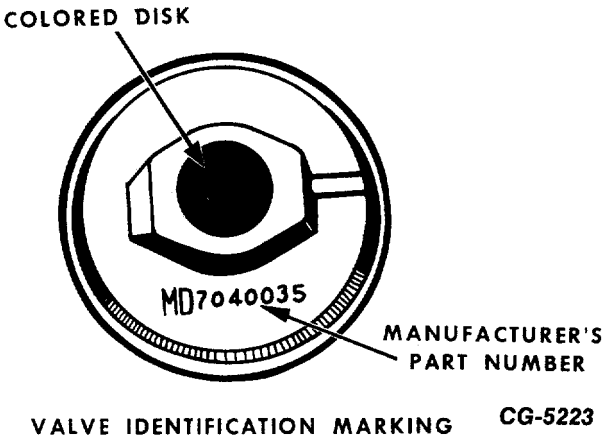


Fig. 85 EGR Valve Identification Marking

16B. Exhaust Gas Recirculation System Operation.

The exhaust gas recirculation (EGR) system introduces a metered amount of exhaust gas into the intake manifold where it mixes with the air/fuel mixture entering the combustion chambers. Dilution of the air/fuel mixture with exhaust gas lowers combustion temperature and pressure, thereby reducing formation of oxides of nitrogen.

The EGR valve regulates the amount of exhaust gas entering the intake manifold. The EGR valve is controlled by ported vacuum, which is determined by position of the carburetor throttle plate(s). Operation of the exhaust gas circulation system is illustrated in Figures 86 and 87.

While the engine is stopped or operating at idle speed (negligible port vacuum), the EGR valve is held closed by spring pressure.

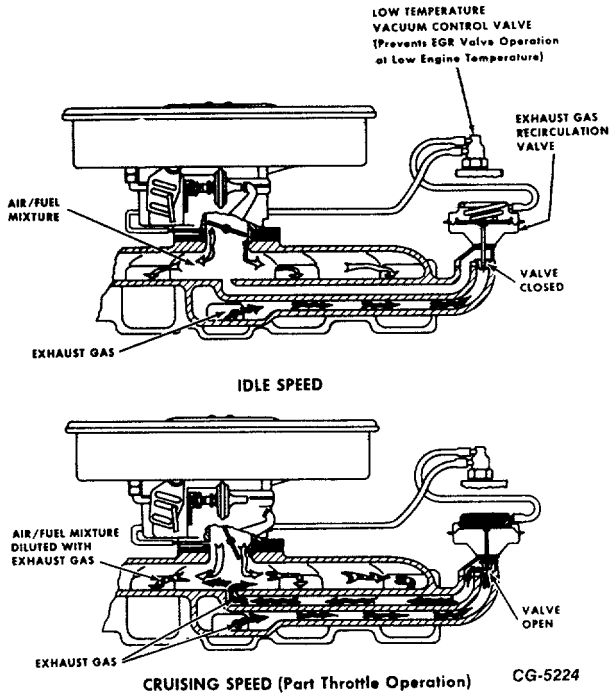


Fig. 86 Exhaust Gas Recirculation System (Single Diaphragm EGR Valve)

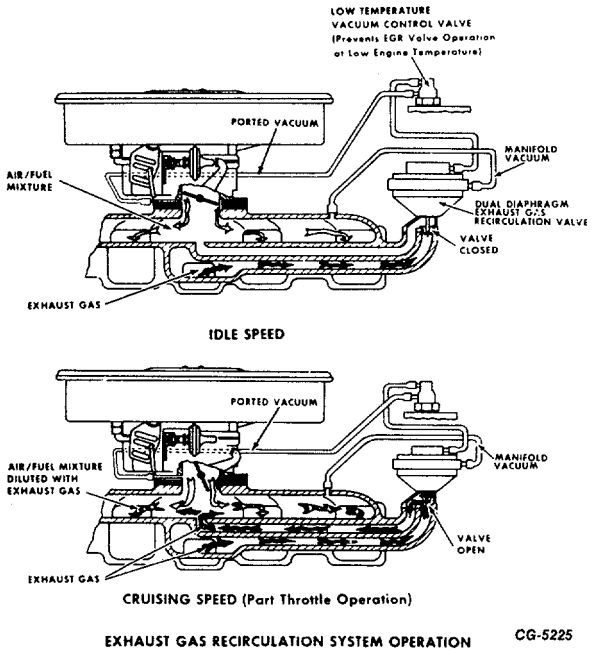


Fig. 87 Exhaust Gas Recirculation System (Dual Diaphragm EGR Valve)

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A low temperature vacuum control valve is used in the exhaust gas recirculation system. The purpose of this valve is to prevent exhaust gas recirculation when the engine is cold. The low temperature control valve senses engine coolant temperature and is located in the coolant passage of the intake manifold. Whenever engine coolant temperature is below 46 deg. C (115 deg. F), the low temperature control valve is closed, blocking vacuum from the EGR valve diaphragm, thus preventing EGR valve operation. When engine warm ups and coolant temperature exceeds 46 deg. C (115 deg. F), the low temperature control valve opens, permitting vacuum to actuate the EGR valve and establish exhaust gas recirculation in response to throttle plate position. The low temperature control valve can be identified by a purple exterior color.

EGR VALVE APPLICATION CHART

(For U.S.A. Model Engines)

50 STATES

Engine	Carburetor	IH No.	Mfr. No.	Color Code
V-345	2210C	480825C1	17057905	Red/White
V-345	2300G	472207C1	17051786	Black/White
V-392	4150G	480824C1	7044409	Green/Black
MV-404	2210C	446981C1	17056690	Green/Yellow
MV-404	2300G	446981C1	17056690	Green/Yellow
MV-404	4150G	440312C1	17053177	White
MV-446	4150G	440312C1	17053177	White
V-537	2300G	440310C1	17053031	Blue/White

CANADA

V-304	2210C	440308C1	7040435	None
V-304	2300G	440306C1	7030983	Black
V-345	2210C	440308C1	7040435	None
V-345	2300G	440306C1	7030983	Black

16C EGR Maintenance Indicating System (V-345 and V-392 Engines Only)

This system is used to alert the vehicle operator, after each 19200 Km (12,000 miles), that the EGR system must be serviced to insure that it is operating properly.

The system consists basically of a switch, or revolution counting device, and an indicating light (Fig. 88).

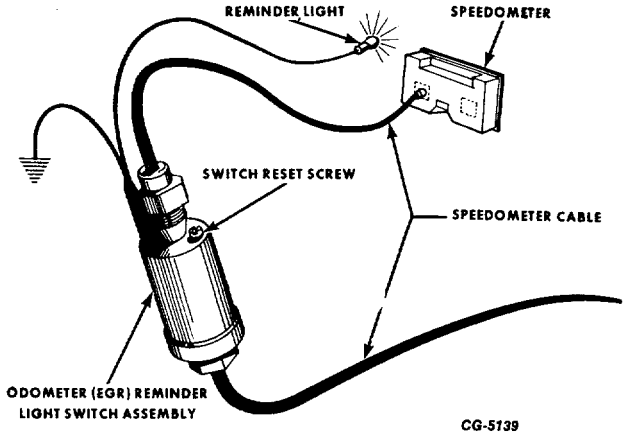


Fig. 88 EGR Maintenance Indicating System

The switch is triggered by a counter mechanism, similar to an odometer, which is connected in series with the speedometer cable. After 19200 Km (12,000 miles), electrical contacts inside the switch snap together and complete the circuit to the indicator light (Fig. 89).

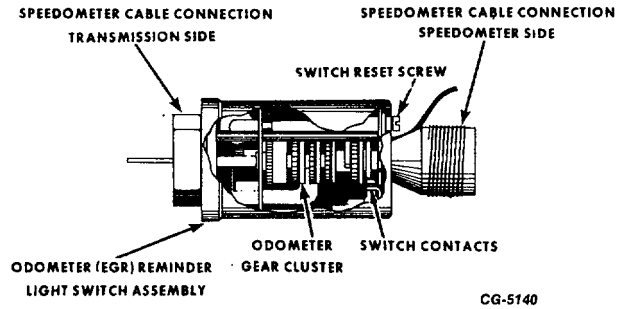


Fig. 89 Reminder Light Switch Assembly

The red indicator light, which has the words "Service EGR" on the face, is mounted on the instrument panel. When lighted, the letters are easily visible even in the daylight.

After the EGR system maintenance is performed, the indicator light can be turned off and the switch reset by turning the reset screw (Fig. 89) about 450 (¼ turn). This zeros the switch's odometer gears and opens the electrical contacts. The switch is then ready to count the next 19200 Km (12,000 mile) interval.

A circuit that tests the indicator light bulb during engine starting is utilized, the same as the brake warning light.

17. Check Air Injection System and Replace, if necessary, (U.S.A. only).

a. Check air injection pump drive belt. Air injection pump drive belt tension can be checked with belt tension gauge SE-2312 (Fig. 90). Check tension at mid-point between the pulleys. Apply gauge to the longest belt span. Instructions for checking are as follows:

(1) Grasp gauge and depress ball handle all the way down. Make certain hook extends beyond legs to pick up the belt.

(2) Apply gauge to belt. Be sure belt is positioned between nose piece and hook and that the nose piece is centered on belt.

(3) Release ball handle quickly. A slow release may present full return of hook, thus giving a false reading.

(4) Observe the area of gauge face indicated at the index mark. If index mark does not indicate a NEW reading on a new belt or a USED reading on a used belt, it will be necessary to increase or decrease belt tension as required.

(5) Before changing belt tension, repeat Step (3) several times to become familiar with gauge operation. Observe gauge reading each . time operation is repeated. Check tension of both belts when so equipped.

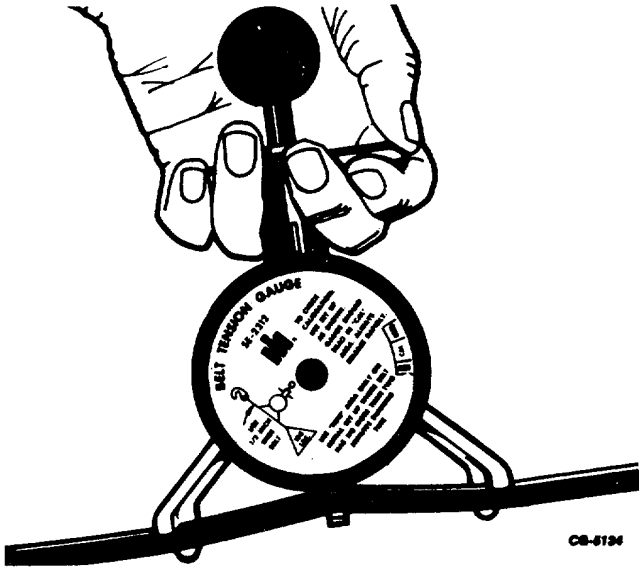


Fig. 90 Checking Belt Tension With SE-2312 Gauge

To establish tension of a loose belt apply SE-2312 gauge to belt and make the adjustment. Tighten belt until proper area for belt is indicated at index mark on gauge. Lock adjustment and recheck belt tension. Readjust as necessary.

When using SE-2312 belt tension gauge, remember to set new belts (belt with less than two minutes running time) to the NEW area on gauge face and used belts (more than two minutes running time) to USED area on gauge.

b. Inspect air pump centrifugal air filter; if clogged or damaged, air pump centrifugal filter can be replaced as follows:

(1) Hold pump pulley from turning and remove pulley mounting bolts.

(2) Insert needle nose pliers and pull filter fan from hub (Fig. 91). Care should be taken to prevent fragments of the fan from entering the air intake hole.

(3) Install new filter fan by drawing it on with the pulley and pulley bolts (Fig. 92). Do not attempt to install the filter by hammering or pressing it on.

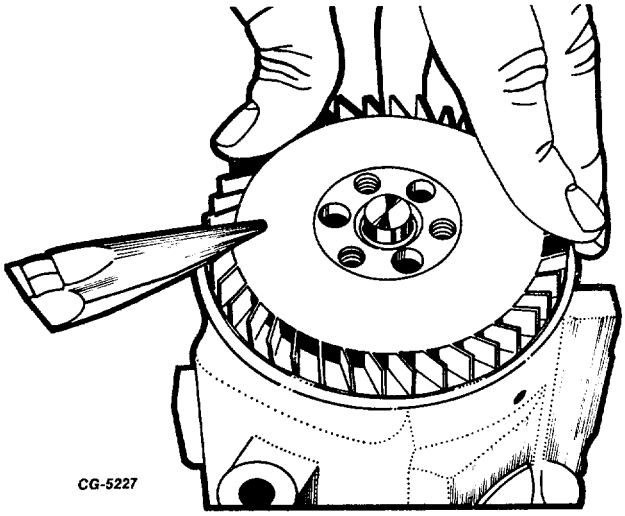


Fig. 91 Removing Centrifugal Air Filter Fan

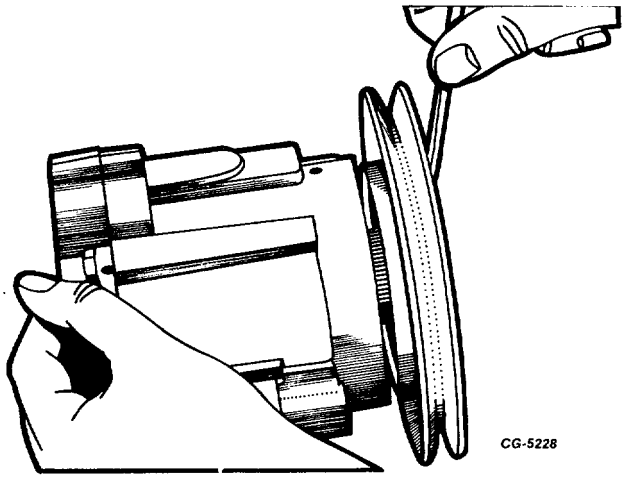


Fig. 92 Installing Centrifugal Air Filter Fan

(4) Draw filter fan down evenly by alternately tightening the pulley mounting bolts. Make certain that the outer edge of the filter slips into the pump housing. A slight amount of interference with housing bore is normal.

(5) Hold pulley from turning and torque pulley bolts to 34 N. m (25 ft. lbs.). The new filter may squeal up on initial operation until its outside diameter sealing lip has worn in.

c. Perform air injection system functional test as follows:

(1) Disconnect one air injection hose from check valve and plug end of hose (V8's only).

(2) Disconnect other air injection hose from check valve and connect air pump tester SE-2498, or equivalent, to end of hose.

(3) Connect tachometer to engine.

(4) Operate engine at speed specified (see Emission Control System Tune-Up Specifications), perform the following.

d. Check air hoses for leaks. If leaks are found, replace hose(s) and repeat Step c.

e. With engine at steady speed specified (see Emission Control System Tune-Up Specifications), check for flow of air through diverter valve external exhaust ports (Fig. 94).

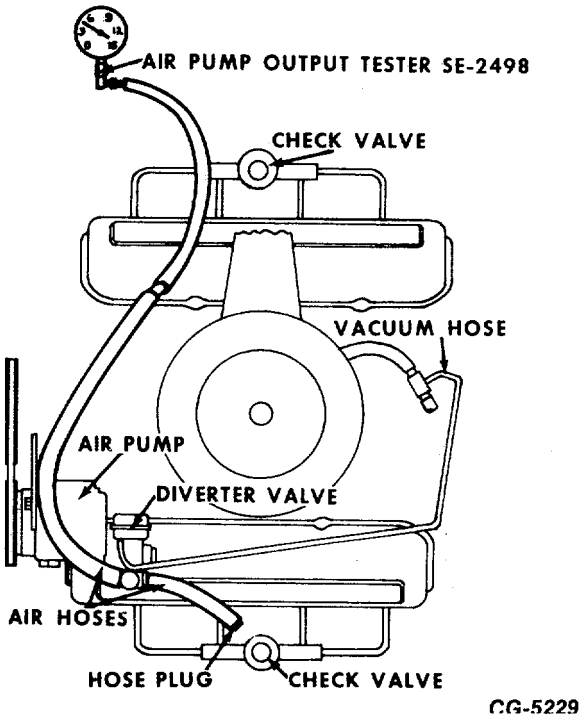


Fig. 93 Checking Air Injection System Output (Small V-8 Engine Shown) Fig. 94 Diverter Valve Operation

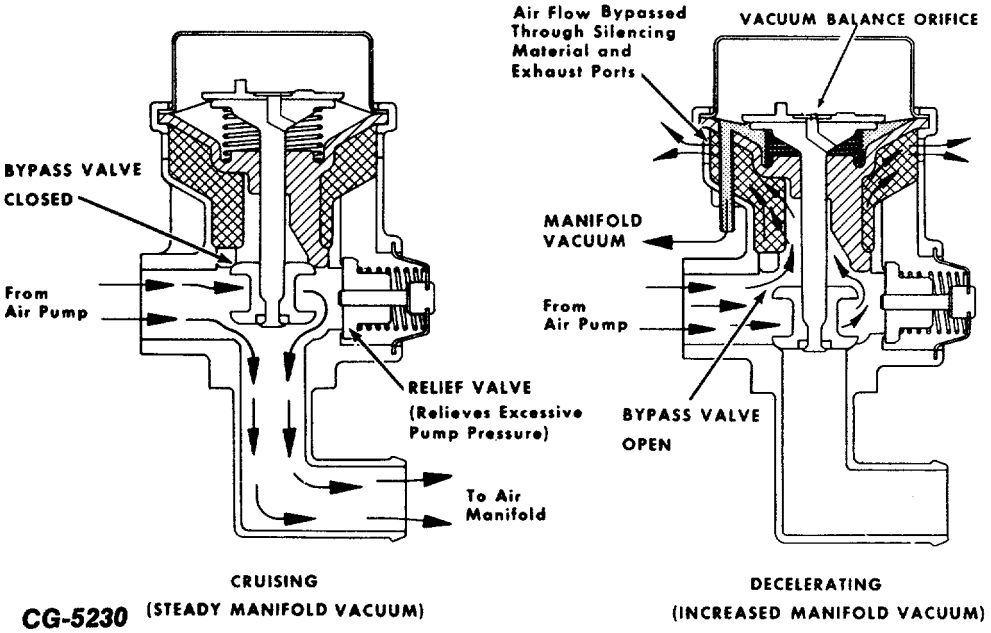


Fig. 94 Diverter Valve Operation

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(1) If air flows through diverter valve external exhaust ports, valve is faulty and must be replaced. After replacing diverter valve, repeat Step c.

(2) If air does not flow through diverter valve external exhaust ports, pump output is low and the pump must be replaced. When installing a new pump or adjusting the air pump belt tension, do not pry on the pump housing.

f. Check diverter valve divert function as follows:

(1) Operate engine at speed specified (see Emission Control System Tune-Up Specifications).

(2) Remove vacuum hose from diverter valve (Fig. 93) and check for a vacuum pull at the end of hose. If no vacuum is felt, replace hose.

(3) Reconnect vacuum hose from diverter valve and check for momentary flow of air through the diverter valve exhaust ports (Fig. 94). After a few seconds, flow of air through the diverter valve exhaust ports should be restored. If divert valve does not function properly, valve is faulty and must be replaced.

17A. Air Injection System Operation.

The air injection system forces air into the cylinder head exhaust ports to promote "after-burning" of any combustibles remaining in the exhaust gases flowing from the combustion chamber. The components of the air injection system are illustrated in Figure 95.

The air pump used in the air injection system is a rotary vane type which is belt driven from the engine. A centrifugal type air filter located behind the pump pulley filters the air entering the pump to prevent entrance of dirt and abrasives (Fig. 91).

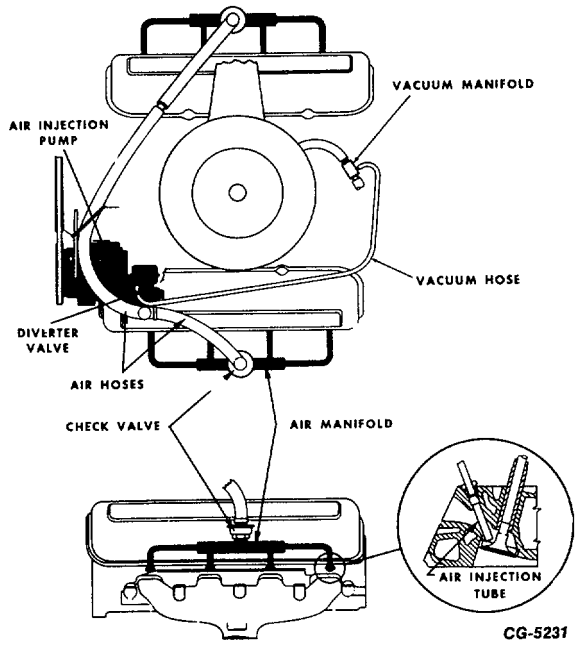


Fig. 95 Air Injection System Used on Small V8 Engine

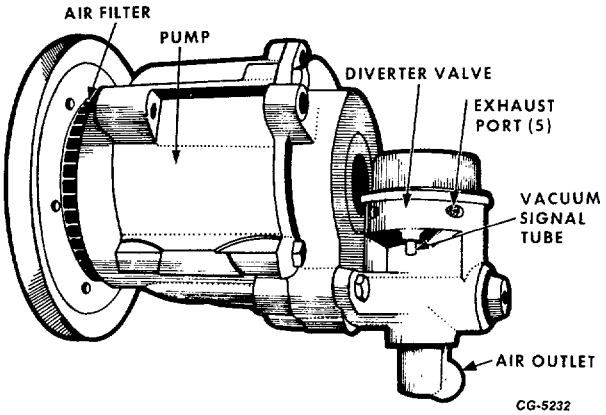


Fig. 96 Air Injection Pump With Diverter Valve

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The air manifold distributes air under pressure from the pump to the individual exhaust ports in the cylinder heads. Figure 95 shows the location of the air manifolds on the small V8 engines. The air manifold is an integral part of the MV and large V8 engine cylinder heads.

A one-way check valve is used on each air manifold to protect the pump from a back flow of high temperature exhaust gas. Stainless steel air injection tubes are used in small V8 cylinder heads to direct the air flow from the air manifold to a point just "downstream" of the exhaust valves. The diverter valve attached to the air pump (Fig. 96) prevents backfire in the exhaust system by shutting off air flow during the first few seconds of deceleration. The diverter valve also incorporates a pressure relief valve which exhausts excessive pump outlet air pressure during high speed operation. Operation of the diverter valve is illustrated in Figure 94.

In normal operation (cruising) the air pump delivers air through the air manifolds into the cylinder head exhaust ports. With the addition of air from the air injection system, an over-rich mixture can cause backfire in the exhaust system. To prevent backfire, the diverter valve momentarily stops the flow of air to the cylinder head exhaust ports during deceleration.

The diverter valve is controlled by intake manifold vacuum. At constant manifold vacuum spring pressure holds the valve in normal delivery position. This permits air to flow from the air pump to the air manifolds. During deceleration high manifold vacuum overcomes spring pressure and moves the valve to bypass position. This closes the outlet port and bypasses the air flow through the internal silencer to the atmosphere. The valve returns to normal delivery position when the vacuum being applied to the diaphragm is balanced through the orifice to the chamber on the other side of the diaphragm. Operating cycle time for the valve is approximately six seconds. In cases of high pump output air pressure (due to high engine speed etc.), the pressure relief valve opens and exhausts excessive air flow through the internal silencer to the atmosphere.

18. Check Curb Idle Speed and Air; Fuel Mixture and Adjust, as necessary.

For U. S. A. (50 States) Engines

Idle speed and fuel mixture adjustments must be made with parking brake applied, air cleaner in place, transmission in neutral and air conditioning "OFF".

When making idle adjustments, disconnect vacuum hose from vapor storage canister and plug end of hose. After idle adjustments have been made, remove plug and reconnect hose to canister.

To compensate for fuel and temperature variations when setting idle mixture, observe these precautions:

a. Do not idle engine continuously for more than three minutes at one time.

b. After each three minutes of idling, increase engine speed to 2000 rpm for one minute.

c. Continue with idle adjustment procedure. Do not idle engine for more than three minutes without repeating Step b.

Winter grade gasolines, being more volatile than summer grade, can yield vapors which result in excessively rich or erratic air/fuel mixtures, particularly at high engine temperatures. Because of this, care must be taken when making carburetor idle mixture adjustments with the exhaust analyzer. Attempts to adjust the idle mixture screw(s) leaner to overcome a rich mixture caused by evaporation of winter grade fuel at high engine temperatures can result in an extremely lean mixture and associated starting and driveability problems when vehicle is cold. Therefore, with winter grade gasolines, observe the following additional precaution:

> Idle mixture adjustments must be made as soon as possible after engine will run without choke (choke plate fully open) before sufficiently high to cause evaporation of winter grade gasolines. Enrichment of the idle mixture by fuel evaporation can be

detected by observing test meter readings. Readings should remain stable. A gradual increase in engine idle speed (RPM) or a tendency for the CO meter to climb toward the rich side without any adjustments being made indicates a richening of the mixture due to fuel evaporation. When this condition occurs, engine should be allowed to cool before making final mixture adjustments.

Setting Procedure:

a. Connect tachometer to engine. (Tachometer should have an expanded scale of 400 to 800 or 0 to 1000 RPM and 1 to 2% accuracy).

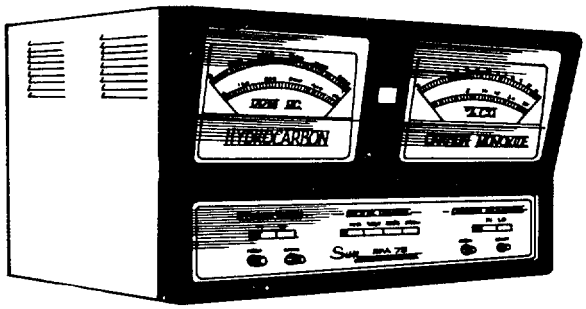


Fig. 97 Exhaust Analyzer-SE-2507

b. Disconnect air injection hose(s) at air manifold check valve(s) and plug air manifold check valve(s).

c. Operate engine until it reaches normal operating temperature (unless winter grade gasoline is used).

d. Adjust curb idle speed to specifications (see Emission Control System Tune-Up Specifications).

e. Prepare Exhaust Analyzer SE-2507, or equivalent, and insert exhaust sample probe into vehicle's tail pipe (refer to test equipment manufacturer's instructions for preparation and hook-up procedures.

f. Observe percent of carbon monoxide (%CO) indicated on analyzer dial and adjust idle mixture screw(s) to obtain specified CO setting (see Emission Control System Tune-Up Specifications), if necessary.

g. Readjust idle speed, if necessary, and readjust mixture screw(s) to provide the specified CO setting at the specified speed.

h. If specified CO setting cannot be obtained, establish proper mixture screw(s) setting as follows:

(1) Remove limiter cap(s). To prevent damage to screw threads or seat, file or grind away the side of the cap. Do not pry cap off.

(2) Gently seat idle mixture screws.

(3) Adjust idle speed and mixture screw(s) (equal number of turns) to provide the specified CO setting at the specified speed.

(4) Install new plastic (service) limiter cap(s) with tab in the mid position.

i. Disconnect test equipment from engine and reconnect air injection hose(s) to air manifold check valve (s).

For Canada Engines Only.

Idle speed and fuel mixture adjustments must be made with parking brake applied, air cleaner in place, transmission in neutral and air conditioning "OFF".

To compensate for fuel and temperature variations when setting idle mixture, observe these precautions:

a. Do not idle engine continuously for more than three minutes at one time.

b. After each three minutes of idling, increase engine speed to 2000 rpm for one minute.

c. Continue with idle adjustment procedure. Do not idle engine for more than three minutes without repeating Step b.

Adjust Procedure Without Exhaust Analyzer:

a. Connect tachometer to engine. (Tachometer should have an expanded scale of 400 to 800 or 0 to 1000 rpm and 1 to 2% accuracy.

b. Remove limiter cap(s). To prevent damage to screw threads or seat, file or grind away the side of the cap. Do not pry cap off.

c. Operate engine until it reaches normal operating temperature.

d. Gently seat idle mixture screws (not required on 4-196 engine).

e. Carefully, adjust idle mixture screws (equal number of turns) to produce maximum idle speed.

f. Carefully adjust curb idle speed screw to give engine speed higher than mid point of idle speed range per specifications (see Emission Control System Tune-Up Specifications). Then carefully adjust curb idle mixture screw(s) (equal number of turns) in until mid point of idle speed range specification is obtained (see Emission Control System Tune-Up Specifications).

g. Install new plastic (service) limiter cap(s) with tab in mid position.

19. Check Automatic Choke (where used) for proper setting and free operation.

a. See Carburetor Service Manual (FUEL SYSTEMS) for proper choke setting procedure.

b. Check choke valve for free operation by opening and closing choke valve manually.

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VACUUM HOSE ROUTING

Vacuum Hose Identification Legend

Key Letter	Location	Color Code
A	Carburetor Port-to-Solenoid Valve	Yellow Stripe
B	Solenoid Valve-to-Throttle Modulator	Blue Stripe
C	Carburetor Port or Intake Manifold Fitting to Distributor Vacuum Advance Unit	Red Stripe
D	Carburetor Port-to-High Temperature Vacuum Valve	White Stripe
E	High Temperature Vacuum Valve-to-Distributor Vacuum Advance Unit	Red Stripe
F	High Temperature Vacuum Valve-to-Vacuum Manifold	Purple Stripe
G	Carburetor Port-to-Vacuum Manifold	(Plain)
H	Carburetor Port-to-Low Temperature Vacuum Valve (EGR System)	Green Stripe
I	Low Temperature Vacuum Valve (EGR System) to EGR Valve	Green Stripe
J	Canister-to-Tee	(Plain)
K	Air Cleaner Temperature Sensor-to-Vacuum Manifold	(Plain)
L	Intake Manifold Vacuum Port-to-Tee	(Plain)
O	Diverter Valve-to-Tee or Intake Manifold Fitting	Purple Stripe

USA-Except California

For engines sold in USA except California use vacuum hose location charts on Figure 98 through and including Figure 105.

USA-California only.

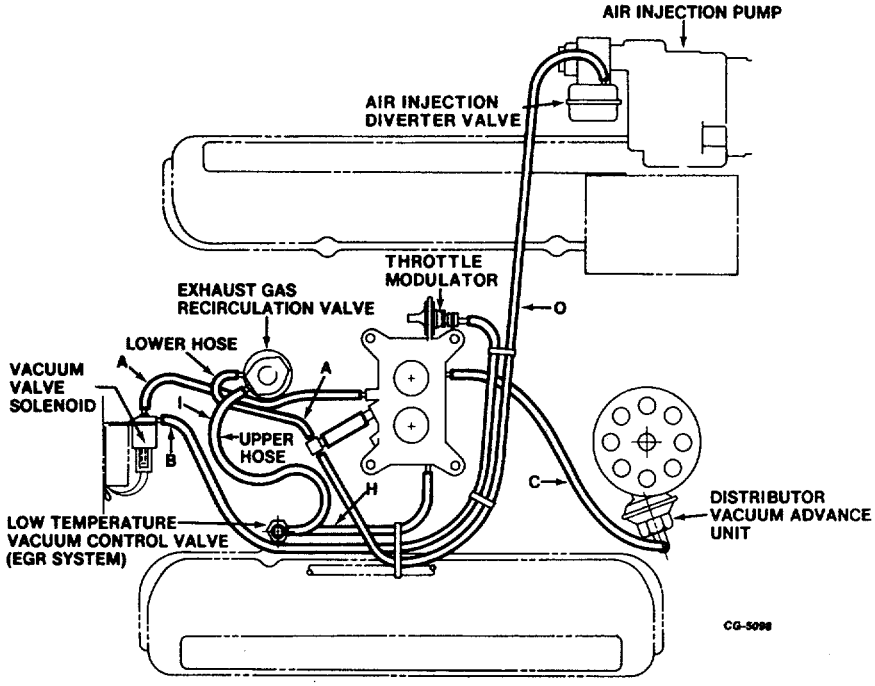
For engines sold in California use vacuum hose location charts on Figure 106 through and including Figure 121.

Canada

For engines sold in Canada use vacuum hose location charts on Figure 122 through and including Figure 129.

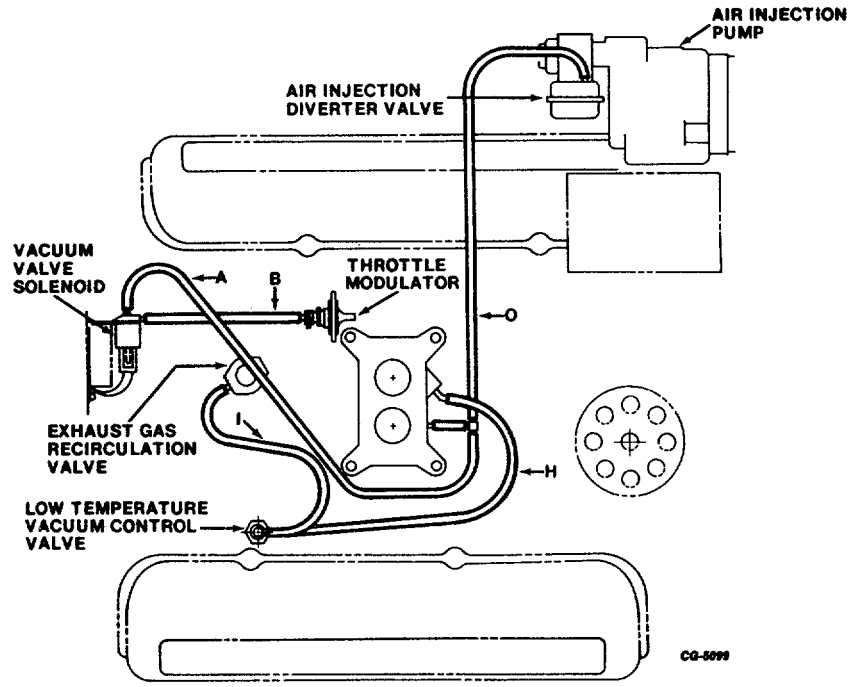
NOTE: The Canada version of the V-392 engine with the 4150G carburetor is not shown because it does not have any external emission controls.

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VACUUM HOSE LOCATIONS ON V-345 ENGINE WITH 2210C CARBURETOR IN CARGOSTAR AND S-SERIES VEHICLES (NOT SOLD IN CALIFORNIA)

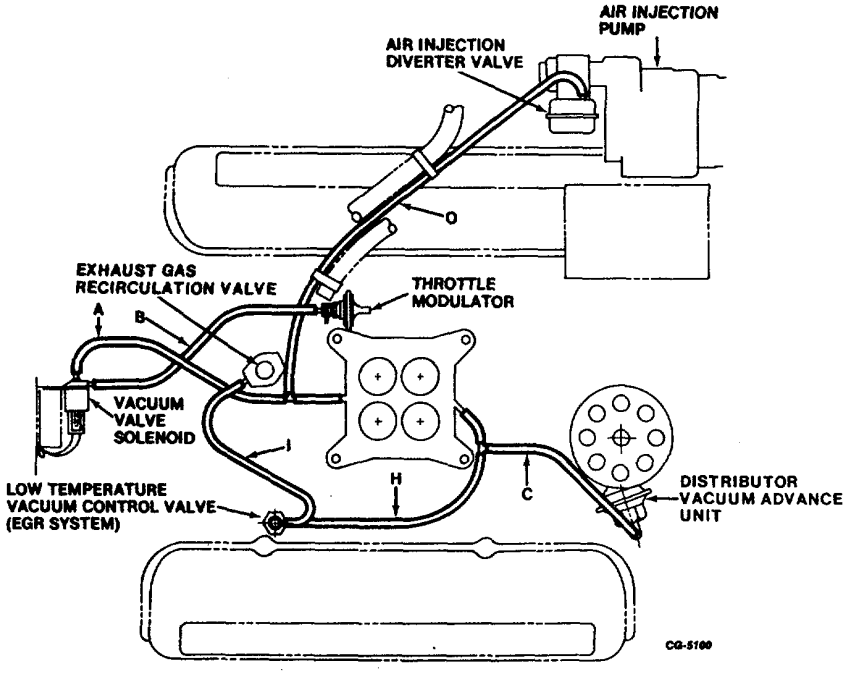
Fig. 98 Vacuum hose locations on V-345 Engine with 2210C Carburetor in Cargostar And S_ Series Vehicles (Sold in USA except California)



VACUUM HOSE LOCATIONS ON V-345 ENGINE WITH 2300EG CARBURETOR IN CARGOSTAR AND S-SERIES VEHICLES (NOT SOLD IN CALIFORNIA)

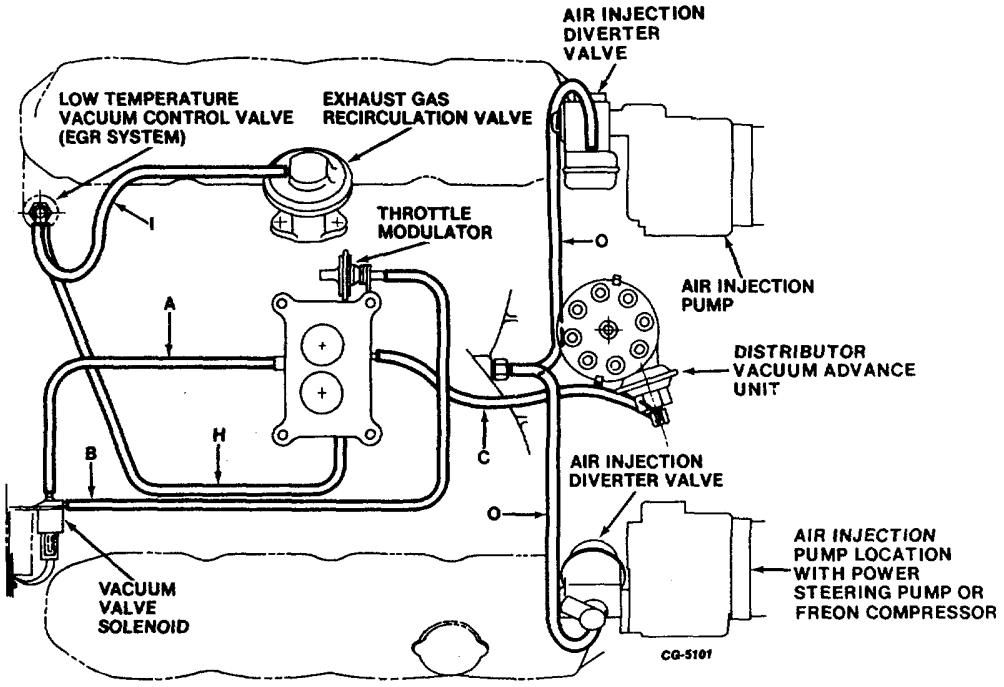
Fig. 99 Vacuum Hose Locations on V-345 Engine with 2300 EG Carburetor in Cargostar and S-Series Vehicles. (Sold in USA Except California)

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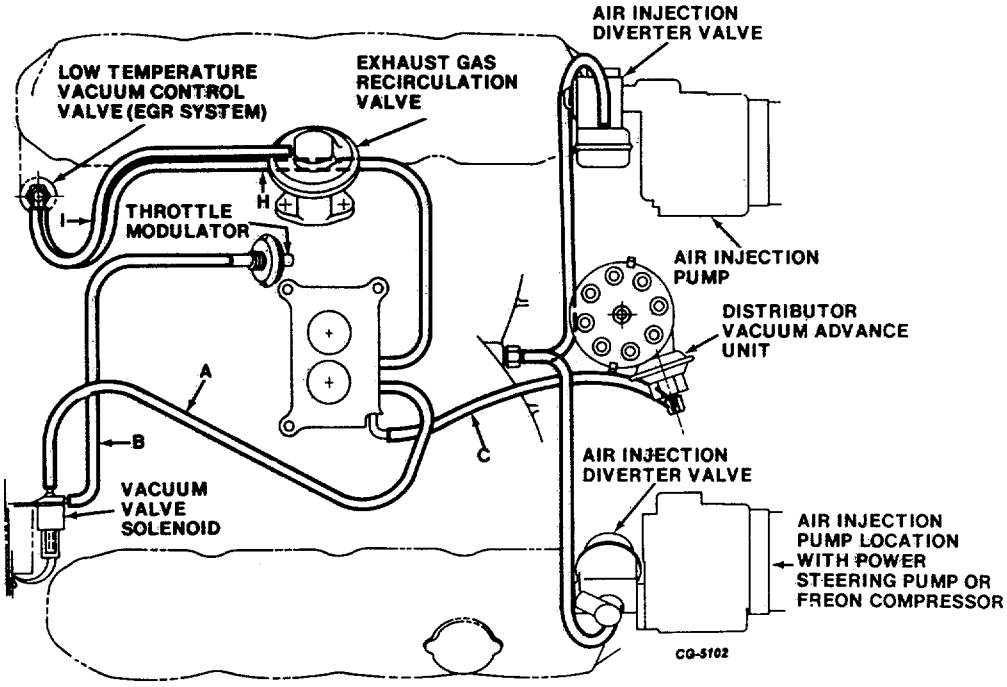
VACUUM HOSE LOCATIONS ON V-392 ENGINE WITH 4150 EG CARBURETOR IN CARGOSTAR AND S-SERIES VEHICLES (NOT SOLD IN CALIFORNIA)

Fig. 100 Vacuum Hose Locations on V-392 Engine with 4150 EG Carburetor in Cargostar and S-Series Vehicles. (Sold in USA Except California)



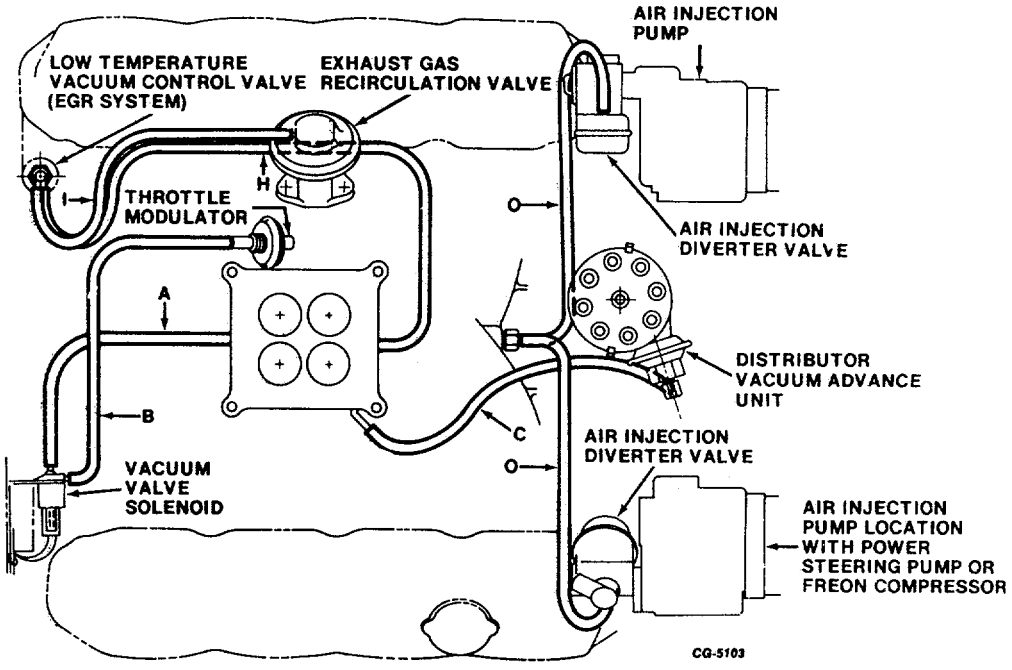
VACUUM HOSE LOCATIONS ON MV-404 ENGINE WITH 2210C CARBURETOR IN CARGOSTAR AND S-SERIES VEHICLES (NOT SOLD IN CALIFORNIA)

Fig. 101 Vacuum Hose Locations on MV-404 Engine with 2210C Carburetor in Cargostar and S-Series Vehicles (Sold in USA Except California)



VACUUM HOSE LOCATIONS ON MV-404 ENGINE WITH 2300EG CARBURETOR IN CARGOSTAR AND S-SERIES VEHICLES (NOT SOLD IN CALIFORNIA)

Fig. 102 Vacuum Hose Locations on MV-404 Engine with 2300 EG Carburetor in Cargostar and S-Series Vehicles. (Sold in USA Except California)



VACUUM HOSE LOCATIONS ON MV-404 ENGINE WITH 4150EG CARBURETOR IN CARGOSTAR AND S-SERIES VEHICLES (NOT SOLD IN CALIFORNIA)

Fig. 103 Vacuum Hose Location on MV-404 Engine with 4150 EG Carburetor in Cargostar and S-Series Vehicles. (Sold in USA Except California)

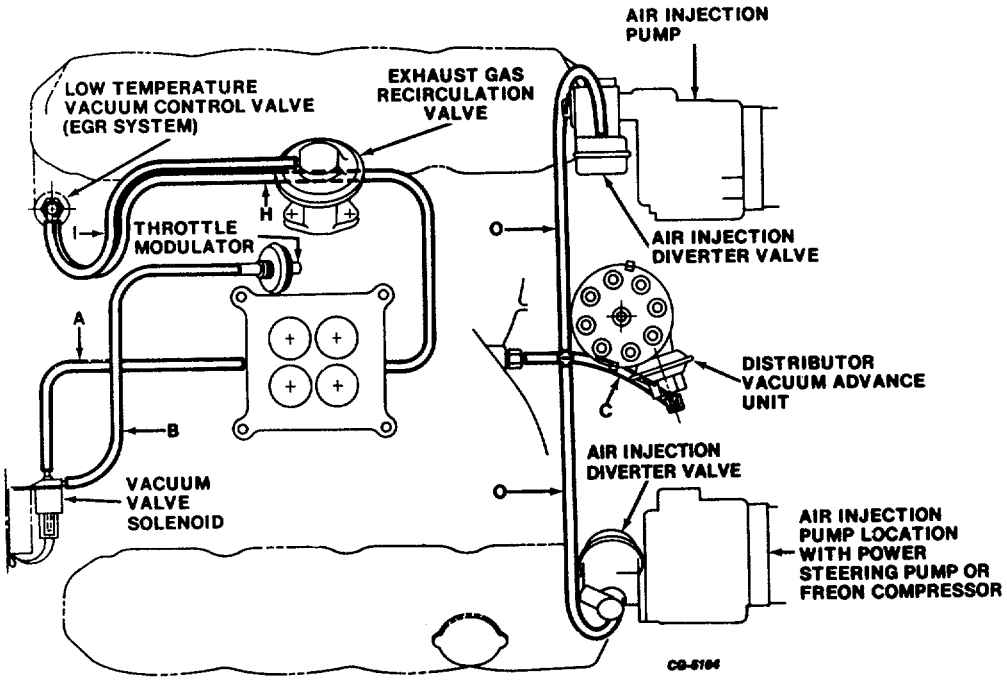


Fig. 104 Vacuum Hose Locations on MV-446 Engine with 4150 EG Carburetor in Cargostar and S-Series Vehicles (Sold in USA Except California)

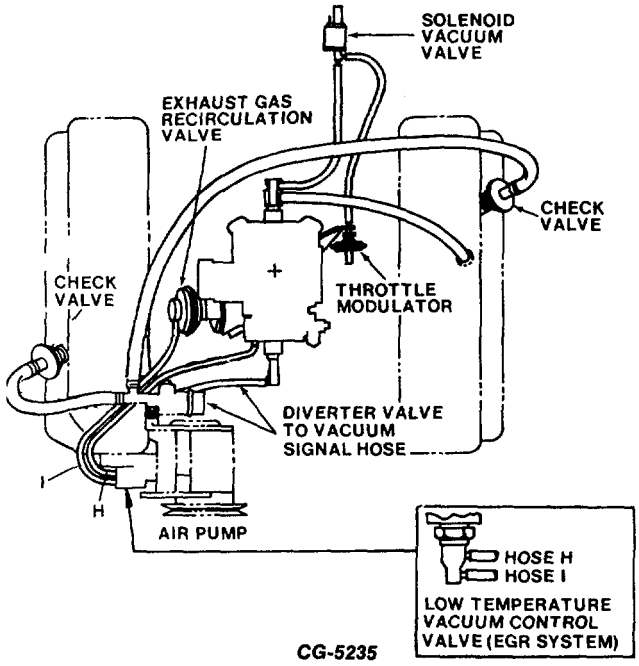


Fig. 105 Vacuum Hose Locations on V-537 Engine with 2300 EG Carburetor in Cargostar and S-Series Vehicles (Sold in USA Except California)

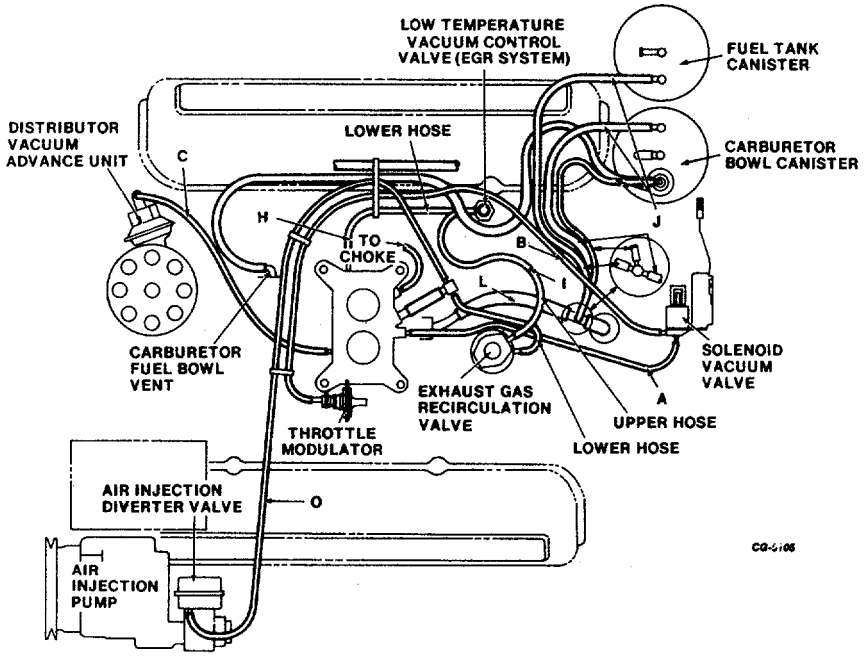


Fig. 106 Vacuum Hose Locations on V-345 Engine with 2210 C Carburetor in Cargostar and S-Series with Two Vapor Storage Canisters (Sold in California)

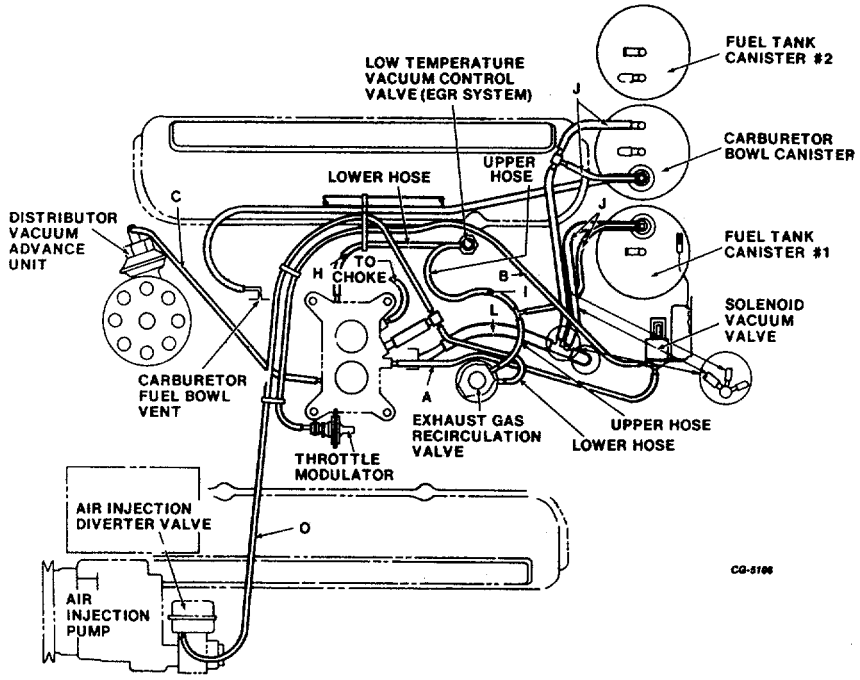


Fig. 107 Vacuum Hose Locations on V-245 Engine with 2210C Carburetor in Cargostar and S-Series Vehicles with Three Vapor Storage Canisters (Sold in California)

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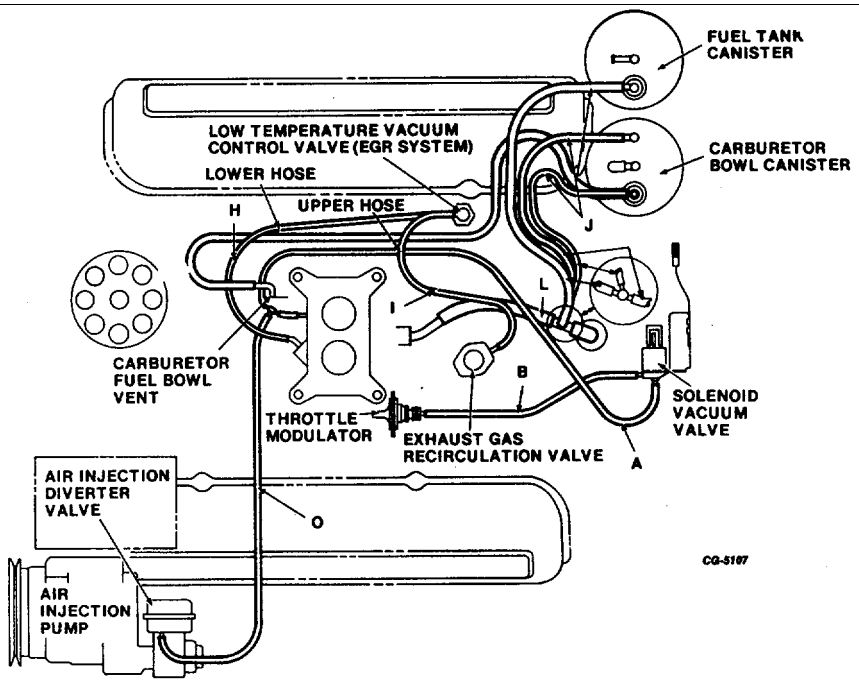


Fig. 108 Vacuum Hose Locations on V-345 Engine with 2300EG Carburetor in Cargostar and S-Series Vehicles with Two Vapor Storage Canisters (Sold in California)

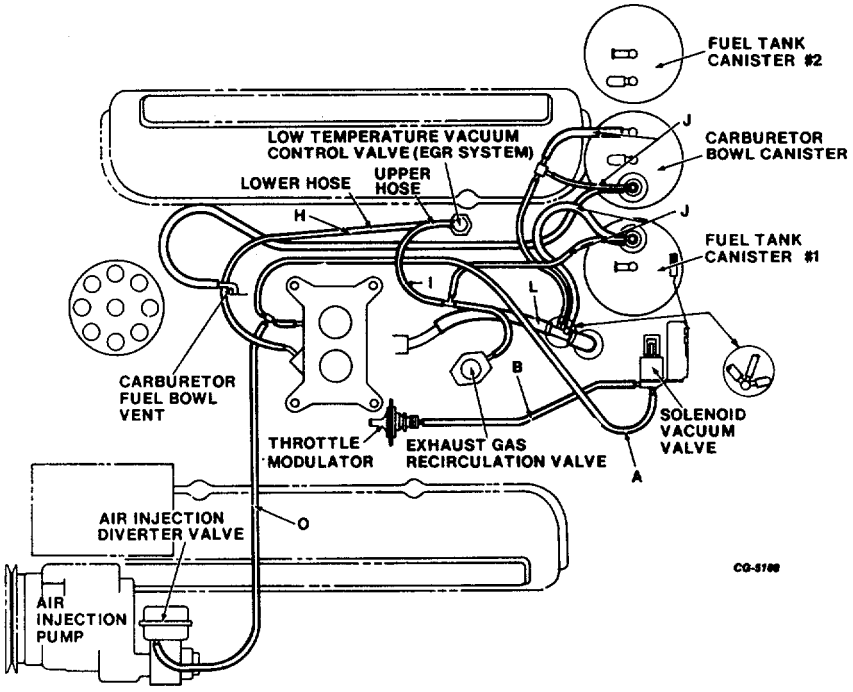


Fig. 109 Vacuum Hose Locations on V-345 Engine with 2300EG Carburetor in Cargostar and S-Series Vehicles with Three Vapor Storage Canisters (Sold in California)

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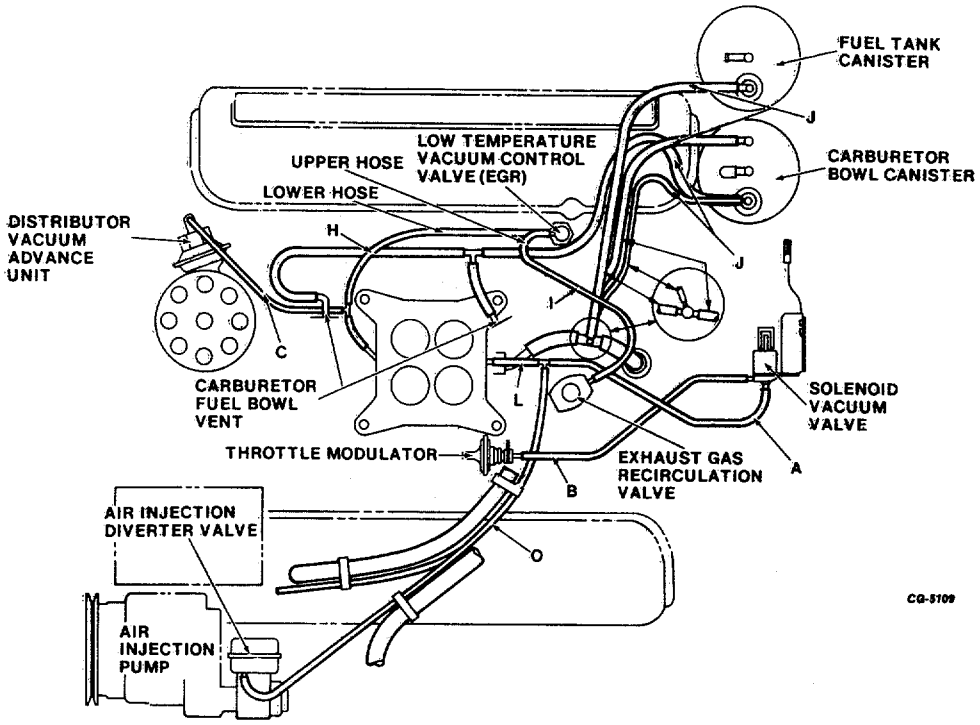


Fig. 110 Vacuum Hose Location on V-392 Engine with 4150EG Carburetor in Cargostar Vehicles with Two Vapor Storage Canisters (Sold in California)

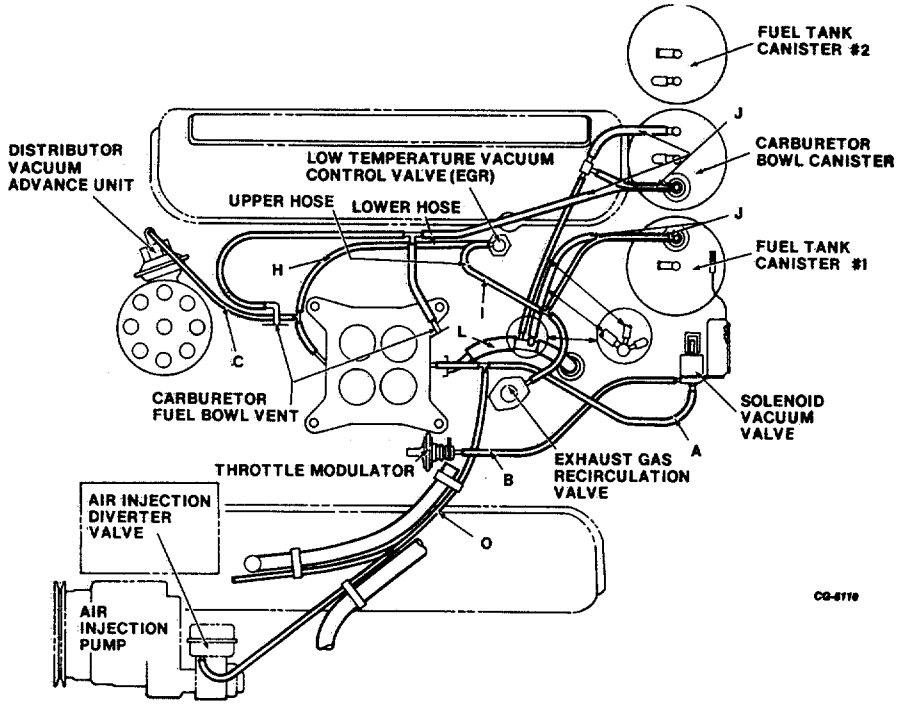


Fig. 111 Vacuum Hose Locations on V-392 Engine with 4150EG Carburetor in Cargostar and S-Series Vehicles with Three Vapor Storage Canisters (Sold in California)

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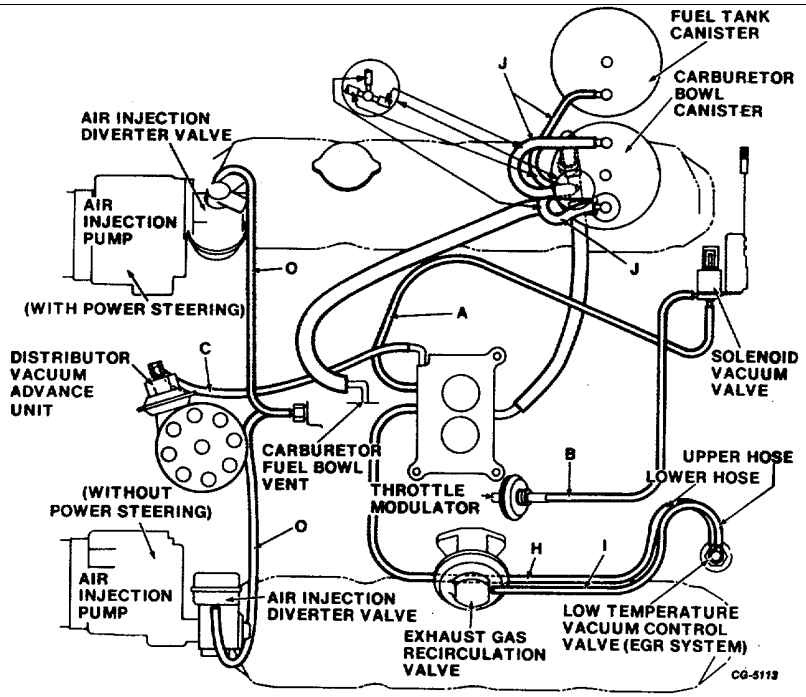


Fig. 112 Vacuum Hose Locations on MV-404 Engine with 2210C Carburetor in Cargostar and S-Series Vehicles with Two Vapor Storage Canisters (Sold in California)

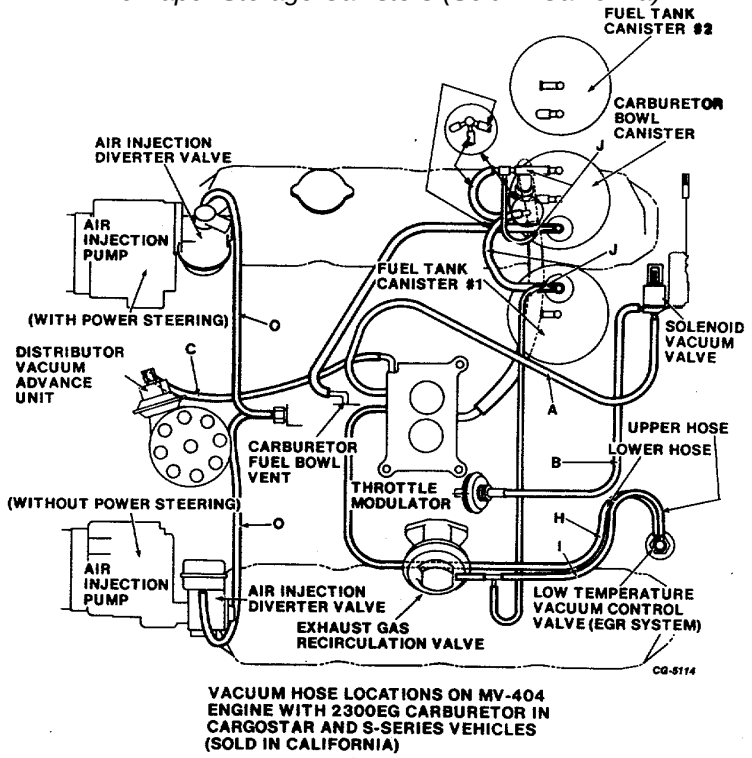
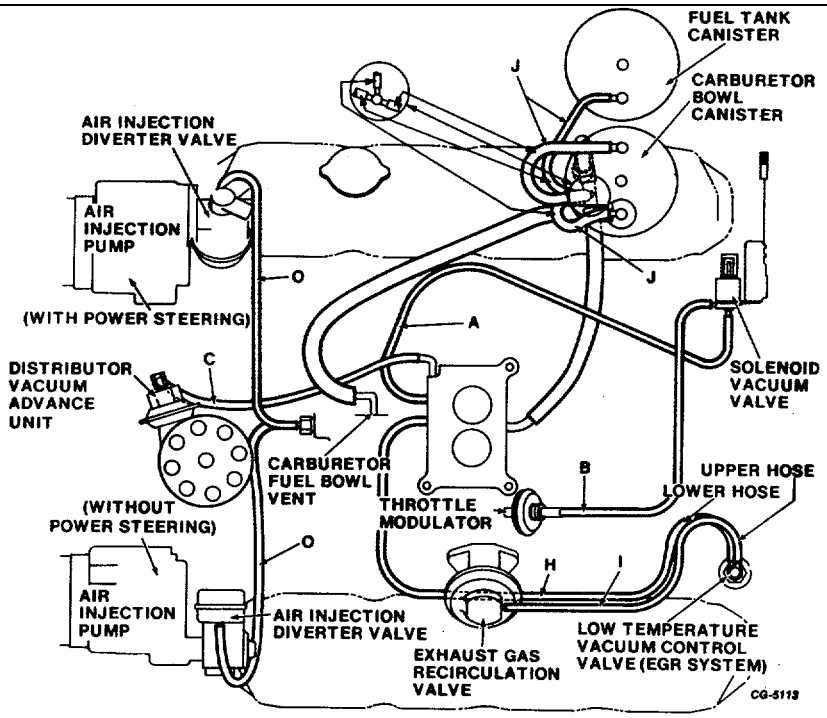
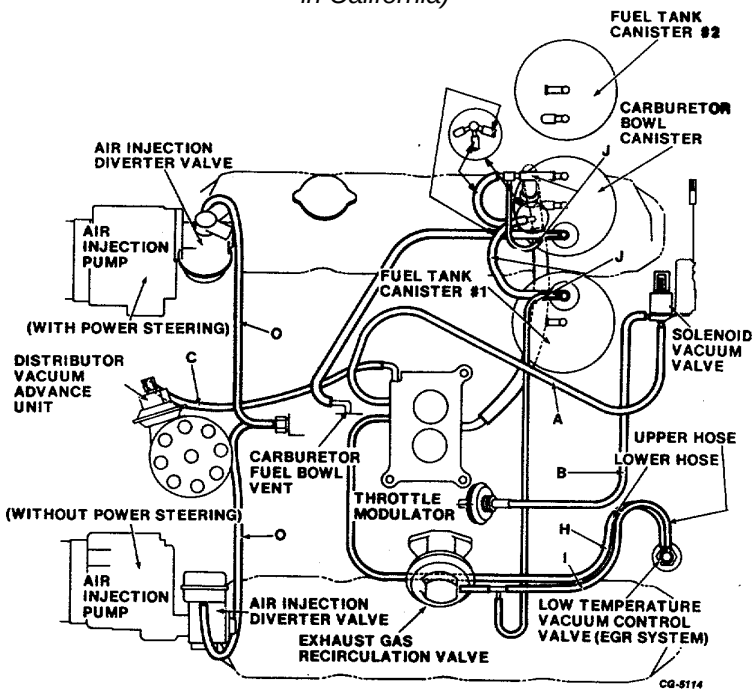


Fig. 113 Vacuum Hose Locations on MV-404 Engine with 2210 C Carburetor in Cargostar and S-Series Vehicles with Three Vapor Storage Canisters (Sold in California)



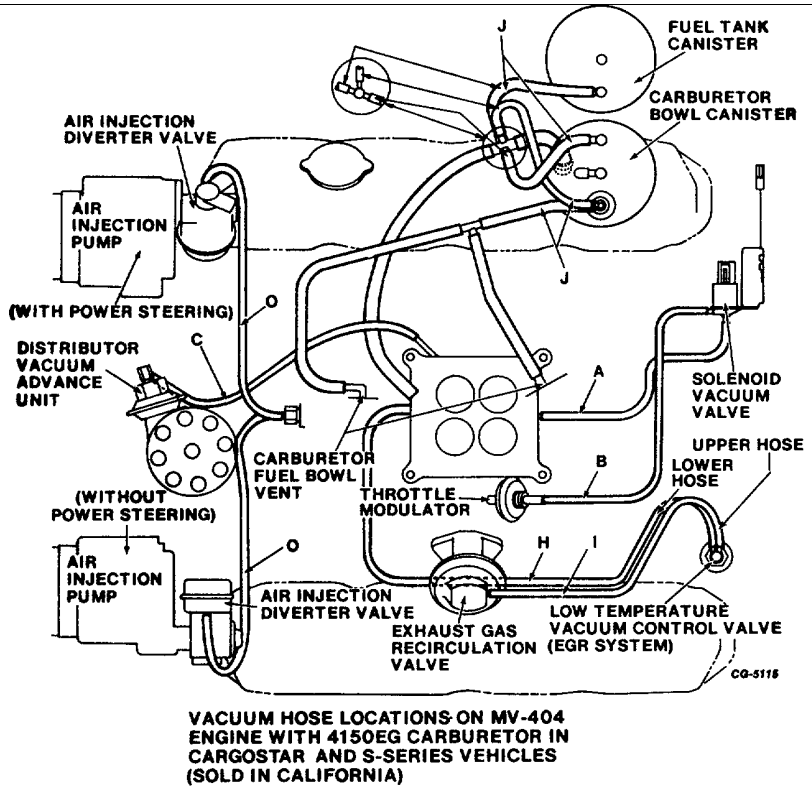
VACUUM HOSE LOCATIONS ON MV-404 ENGINE WITH 2300EG CARBURETOR IN CARGOSTAR AND S-SERIES VEHICLES (SOLD IN CALIFORNIA)

Fig. 114 Vacuum Hose Locations on MV-404 Engine with 2300EG Carburetor in Cargostar and S-Series Vehicles (Sold in California)



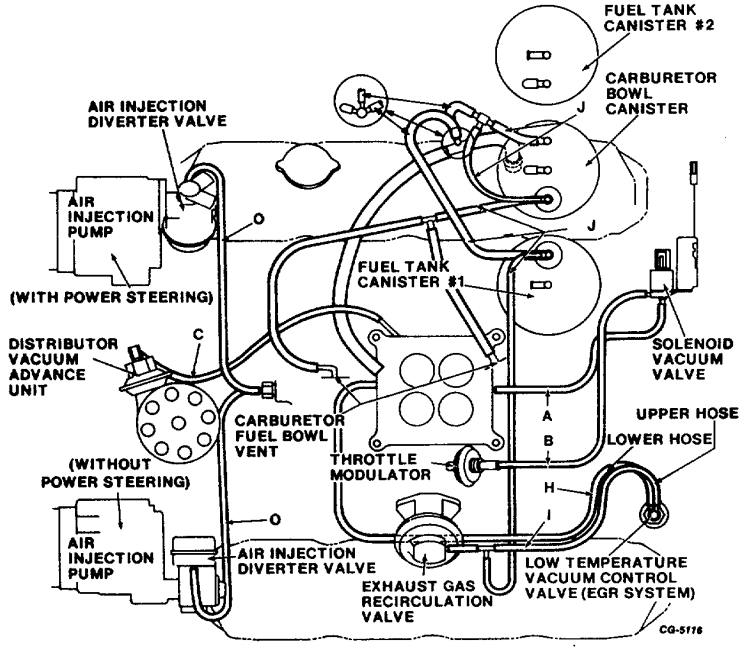
VACUUM HOSE LOCATIONS ON MV-404 ENGINE WITH 2300EG CARBURETOR IN CARGOSTAR AND S-SERIES VEHICLES (SOLD IN CALIFORNIA)

Fig. 115 Vacuum Hose Locations on MV-404 Engine with 2300EG Carburetor in Cargostar and S-Series Vehicles with Three Vapor Storage Canisters (Sold in California)



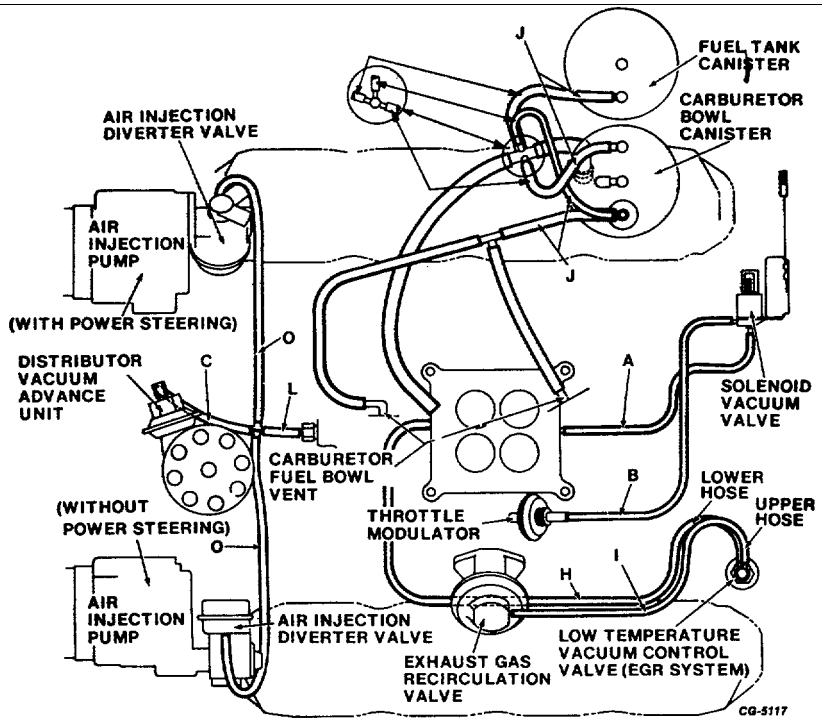
VACUUM HOSE LOCATIONS ON MV-404 ENGINE WITH 4150EG CARBURETOR IN CARGOSTAR AND S-SERIES VEHICLES (SOLD IN CALIFORNIA)

Fig. 116 Vacuum Hose Locations on MV-404 Engine with 4150EG Carburetor in Cargostar and S-Series Vehicles with Two Vapor Storage Canisters ()



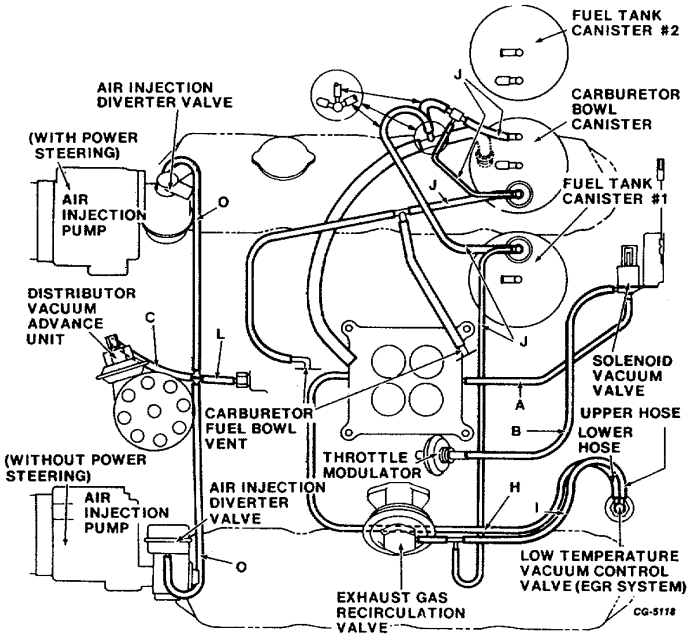
VACUUM HOSE LOCATIONS ON MV-404 ENGINE WITH 4150EG CARBURETOR IN CARGOSTAR AND S-SERIES VEHICLES (SOLD IN CALIFORNIA)

Fig. 117 Vacuum Hose Locations on MV-404 Engine with 4150EG Carburetor in Cargostar and S-Series Vehicles with Three Vapor Storage Canisters (Sold in California)



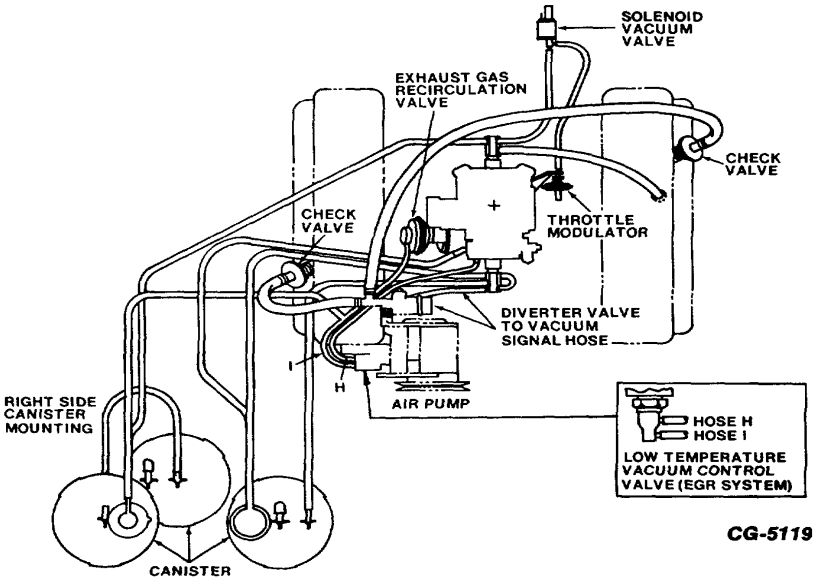
VACUUM HOSE LOCATIONS ON MV-446 ENGINE WITH 4150EG CARBURETOR IN CARGOSTAR AND S-SERIES VEHICLES (SOLD IN CALIFORNIA)

Fig. 118 Vacuum Hose Locations on MV-446 Engine with 4150EG Carburetor in Cargostar and S-Series Vehicles with Two Vapor Storage Canisters (Sold in California)



VACUUM HOSE LOCATIONS ON MV-446 ENGINE WITH 4150EG CARBURETOR IN CARGOSTAR AND S-SERIES VEHICLES (SOLD IN CALIFORNIA)

Fig. 119 Vacuum Hose Locations on MV-446 Engine with 4150EG Carburetor in Cargostar and S-Series Vehicles with Three Vapor Storage Canisters (Sold in California)



VACUUM HOSE LOCATIONS ON V-537 ENGINE WITH 2300EG CARBURETOR IN CARGOSTAR AND S-SERIES VEHICLES (SOLD IN CALIFORNIA)

Fig. 120 Vacuum Hose Locations on V-537 Engine with 2300EG Carburetor in Cargostar and S-Series Vehicles with Three Vapor Storage Canisters Mounted on Right Side (Sold in California)

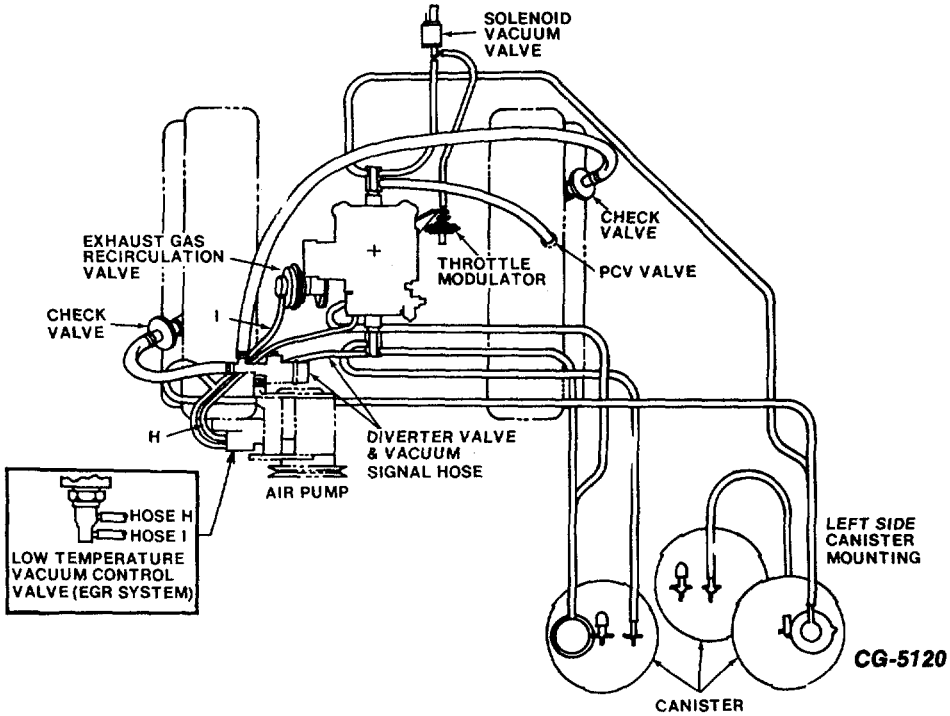


Fig. 121 Vacuum Hose Locations on V-537 Engine with 2300EG Carburetor in Cargostar and S-Series Vehicles with Three Vapor Storage Canisters Mounted on the Left Side (Sold in California)

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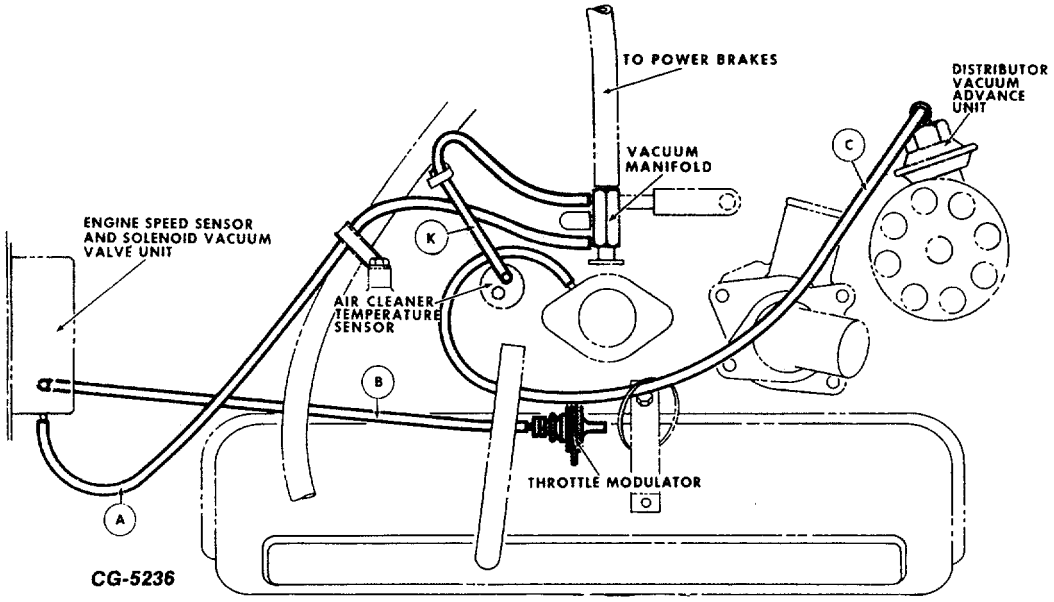


Fig. 122 Vacuum Hose Locations on 4-196 Engine with 194C Carburetor in Scout Vechicles (Sold in Canada)

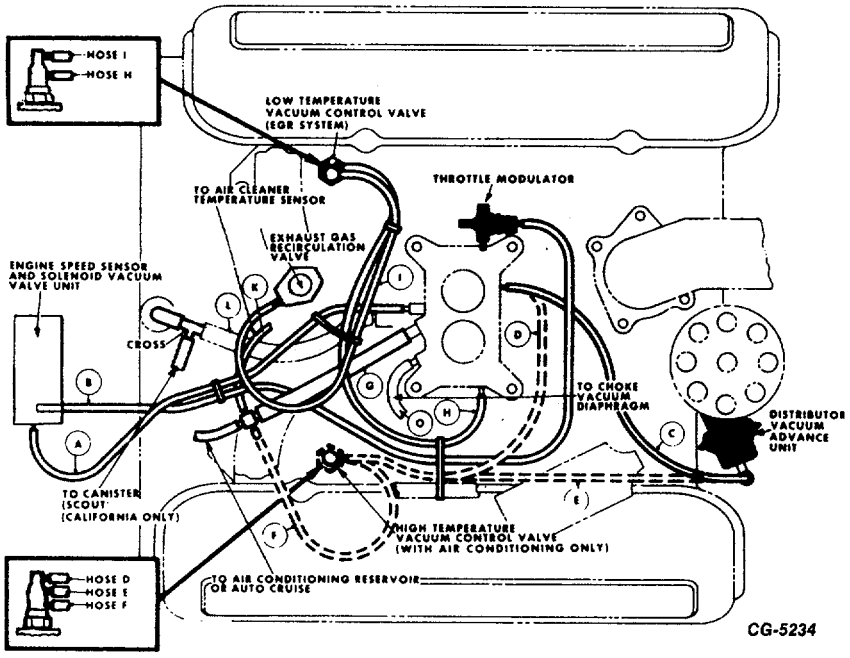


Fig. 123 Vacuum Hose Locations on V-304/345 Engines with 2210C Carburetor in Scout Vechicles (Sold in Canada)

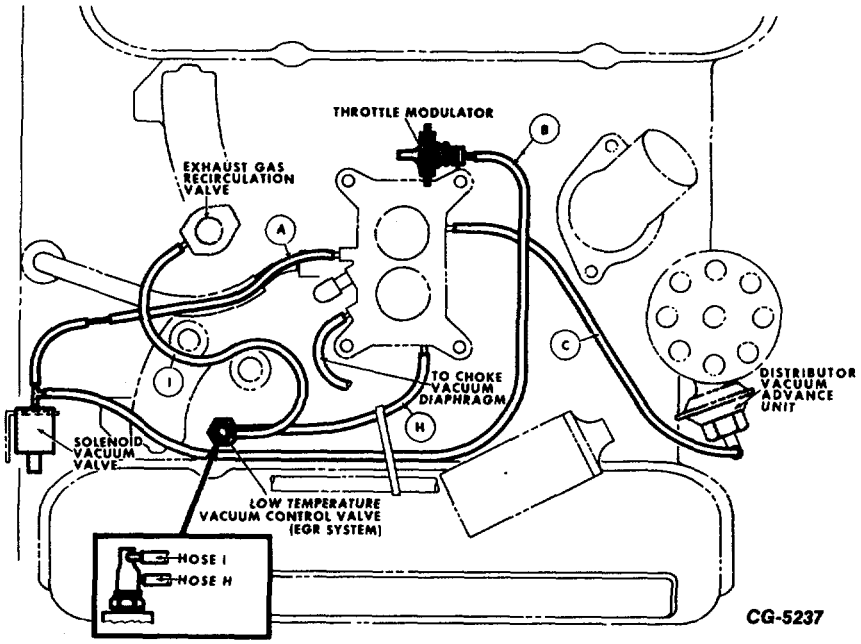


Fig. 124 Vacuum Hose Locations on V-345 Engine with 2210C Carburetor in Cargostar and S-Series Vehicles (Sold in Canada)

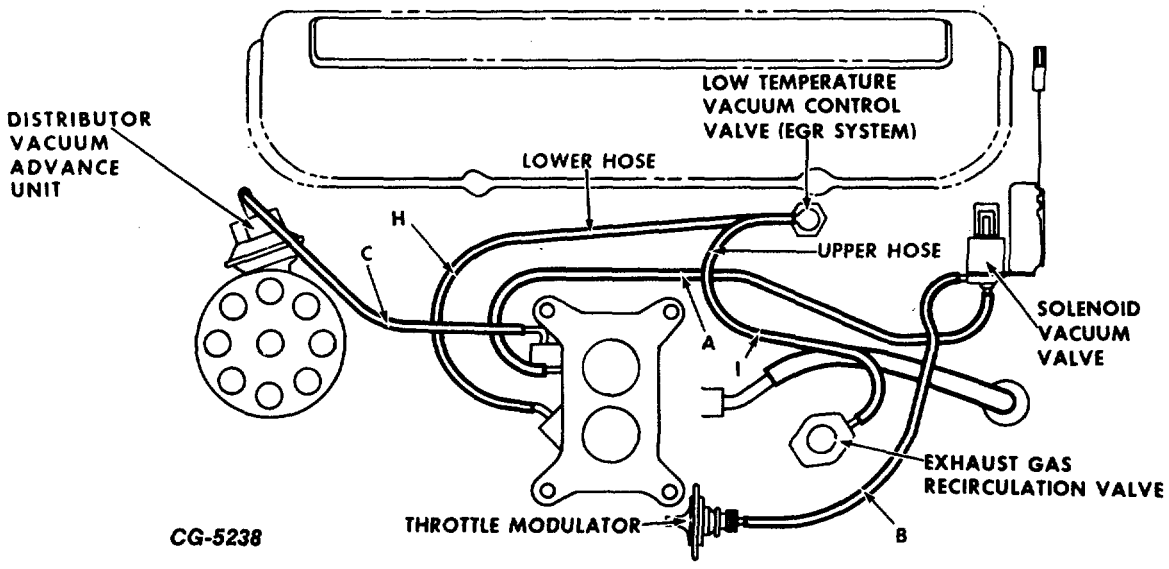


Fig. 125 Vacuum Hose Locations on V-345 Engine with 2300EG Carburetor in Cargostar and S-Series Vehicles (Sold in Canada)

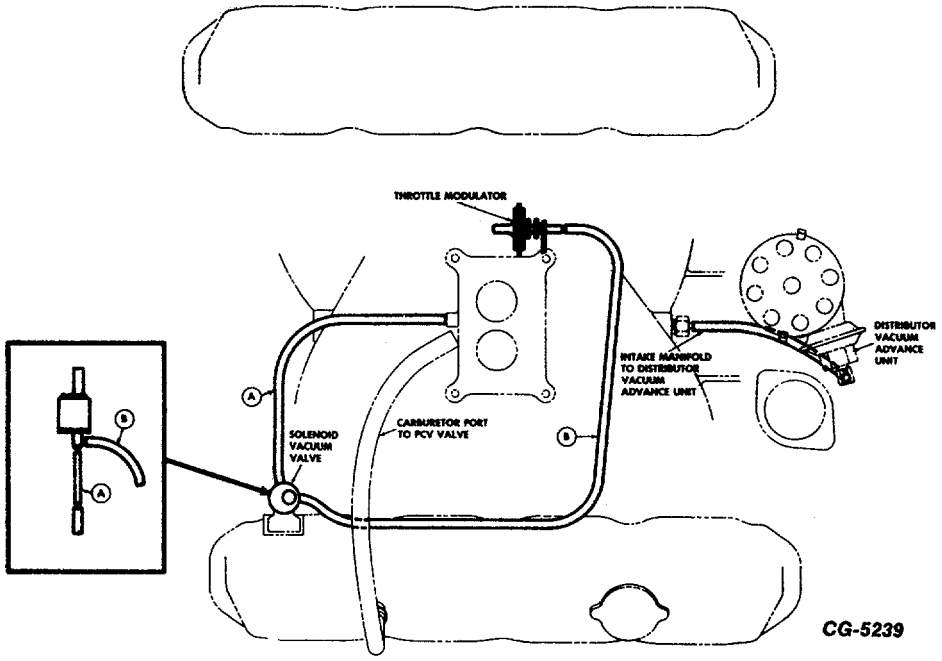


Fig. 126 Vacuum Hose Locations on MV-404 Engine with 2210C Carburetor in Cargostar and S-Series Vehicles (Sold in Canada)

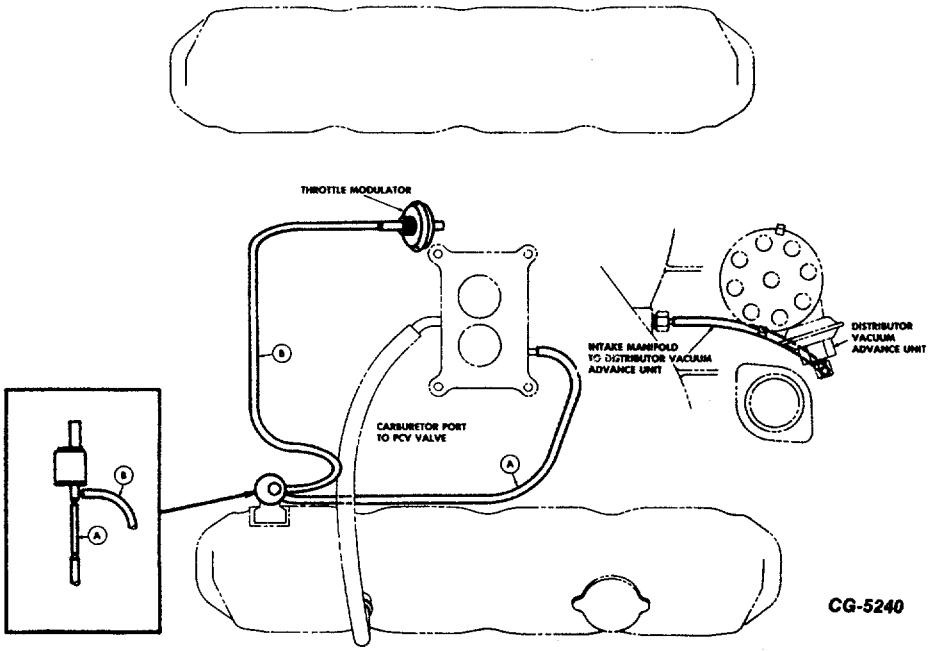


Fig. 127 Vacuum Hose Locations on MV-404 Engine with 2300EG Carburetor in Cargostar and S-Series Vehicles (Sold in Canada)

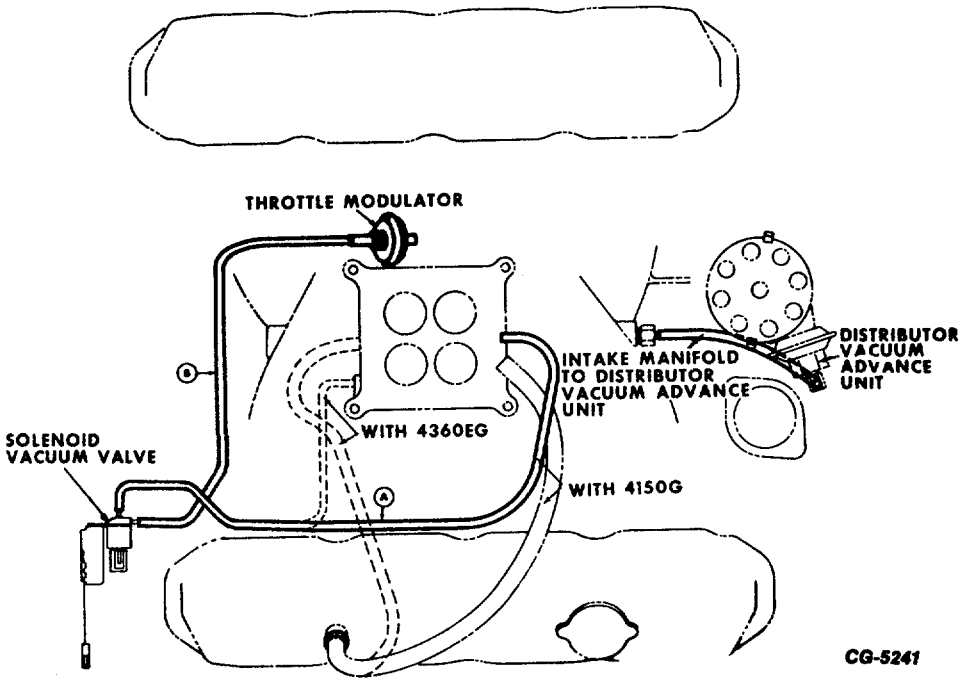


Fig. 128 Vacuum Hose Locations on MV-404/446 Engines with 4150G Carburetor in Cargostar and S-Series Vehicles (Sold in Canada)

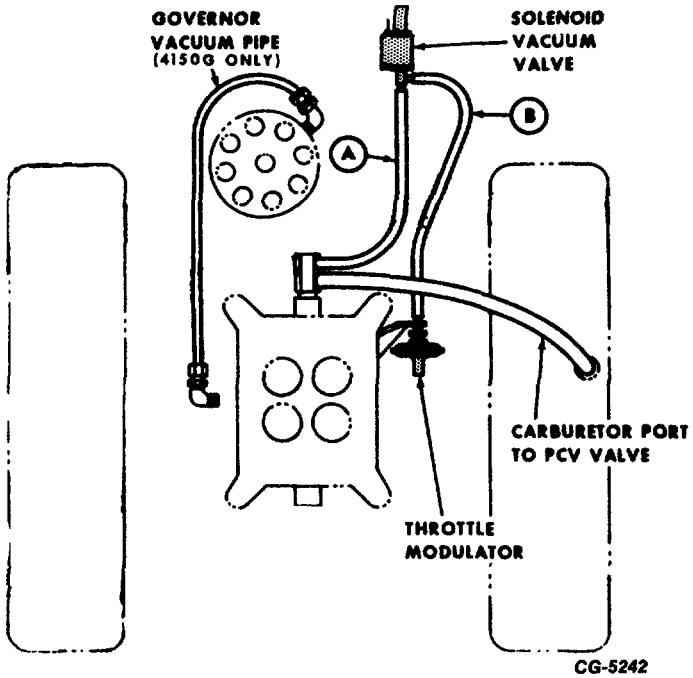


Fig. 129 Vacuum Hose Locations on V-537 Engine with 4150G Carburetor in Cargostar and S-Series Vehicles (Sold in Canada)

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Gasoline for IH Engines

Your engine is designed to operate efficiently in normal operations on "Regular" grade fuels of at least 91 RON (Research Octane Number) or 86.5 anti-knock index designation. (The latter figure is now generally posted on fuel dispensing pumps.) It is recommended that the maximum octane rating used be no more than four octane numbers above the minimum of 91 octane. "Low Lead" fuel containing at least .13 gpl (0.5 gpg) lead, or the equivalent additive, per liter (gallon) may be used.

Continuous use of gasoline which is completely free of lead, or other lubricating additives such as phosphorus, is not recommended. Prolonged use of such fuel can cause excessive exhaust valve seat wear resulting in loss of emission control, poor performance and possible engine failure. Use of a fuel which is too low in anti-knock quality will result in "spark knock." Since anti-knock quality of all "regular" grade gasolines is not the same and factors such as altitude, terrain and air temperature affect operating efficiency, knocking may result even though you are using the grade of fuel recommended for your engine.

Emission Certification Label

The engine exhaust emission control information label attached to the engine valve cover is very valuable to the tune-up technician. It gives him ready information: engine model, cubic inch displacement, timing, idle speeds and idle mixture settings.

Turning IH Engines Equipped with Emission Controls

Tune-up on engines with emission controls is performed in the conventional manner. It is extremely important that the IH tune-up specifications found in this manual be used. It is necessary to become completely familiar with all types of emission controls, how they operate and how they are serviced. Using the recommended specifications and procedures will provide good performance in idling characteristics as well as allow the engine to operate within government regulations.

Owners have the responsibility to see that their engine is properly maintained on a regular schedule, or at any hint of an engine malfunction. The service technician has the responsibility to obtain the knowledge and skills to continuously perform each maintenance job completely and without fault.

Emission Control Tune-Up Specifications

The following tune-up specifications cover Canada and U.S.A. engines. These specifications should be used in conjunction with the scheduled maintenance intervals and the explanation of each maintenance step given on the previous pages.

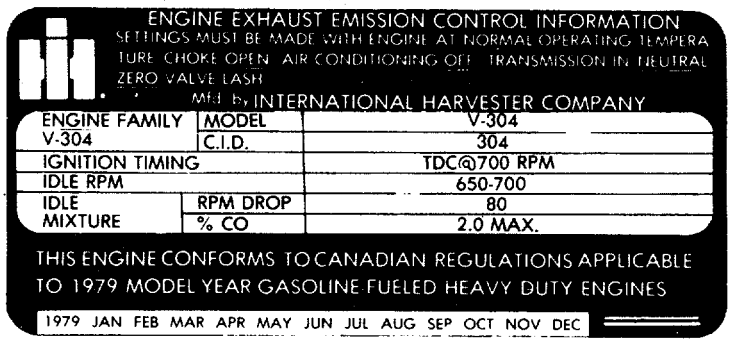


Fig. 130 Typical Engine Exhaust Emission Control Information Label

EMISSION CONTROL SYSTEM TUNE-UP SPECIFICATIONS (U.S.A.)

ENGINE	V-345		V-392	MV-404			MV-446	V-537
CARBURETOR MODEL	2210C	2300EG	4150EG	2210C	2300EG	4150EG	4150EG	2300EG
Ignition System Dwell, Degrees: Breakerless Only	24 - 34							
Air Gap, Trigger Wheel-to-Sensor	.2 mm (.008")							
Coil Output Voltage @2500 RPM	20 KV Min.							
Ignition Timing W/O Vacuum Advance Degrees (Engine at Specified Idle RPM)	5° BTDC	TDC		9° BTDC			5° BTDC	7° BTDC
Ignition Cable Resistance (Maximum) Up to 36" Long	30K Ohms							
Over 36" Long	45K Ohms							
Cold Starting Enrichment System Fast Idle Speed, RPM	2200	2000		1800	2400			2000
Curb Idle Speed & Air/Fuel Mixt. Curb Idle Speed, RPM (In Neutral)	625-675			525-575 *				500-550 *
Mixture, %CO	0.5-1.5	1.0-3.0	0.5-1.5	0.5 - 2.5				1.0-2.0
Spark Plugs Standard:	RJ-6 (CR-43) **			RBN-13Y (R44LTS) **				RN-11Y
Plug Gap	.76 mm (.030")							
Optional for Light Service:	RJ-10Y (CR43S) **			N/A				RN-12Y
Plug Gap	.88 mm (.035")			N/A				.76 mm(.030")
Optional for Severe Service:	N/A			RBN-4 (R44LT) **				
Plug Gap	N/A			.76 mm (.030")				
Torque	38.0 - 40-7 N.m (28-30 ft.lbs.)			16.3-24.4 N.m(12-18 ft.lbs.)				34.0-40.7 N.m (25-30 ft.lbs.)
Required Voltage @ 100 RPM	8 - 15 KV							
Exhaust Gas Recirculation System Functional Test @ 2000 RPM Vacuum to be Applied	33.7 kPa Hg (10.0" Hg) Min.							
Minimum Speed Drop, RPM	400		485	350				375
Air Injection System Engine Speed for Test, RPM	1500	1000						
Minimum Pressure	27.58 kPa (4 psi)							
Decel Throttle Modulator System Speed at which Mod. Funct., RPM	1800 - 1900							
DTM Speed (no load) w/Mod. Extended, RPM	1300-1400	1400-1500	1350-1450	1300 - 1400			1250-1350	1300-1400
Bolt Torque Intake Manifold-to-Cylinder Head	34 - 40 N.m (25-30 ft.lbs.)			36.6 - 50.2 N.m(27-37 ft.lbs.)				40.7-51.5 N.m (30-38 ft.lbs.)
Exhaust Manifold-to-Cylinder Head	34 - 40 N.m (25-30 ft.lbs.)			36.6 - 44.7 N.m(27-33 ft.lbs.)				40.7-51.5 N.m (30-38 ft.lbs.)
Carburetor-to-Intake Manifold	8.1 - 10.8 N.m (6 - 8 ft. lbs.)							

N/A = Not applicable
* = Range 100 rpm higher with Allison Automatic Transmission
** = Approved corresponding spark plug

EMISSION CONTROL SYSTEM TUNE-UP SPECIFICATION (CANADA)

ENGINE	4-196	V-304	V-345		V-392	MV-404			MV-446	V-537	
CARBURETOR MODEL	1940C	2210C	2210C	2300EG	4150G	2210C	2300EG	4150G	4150G	2300EG	4150G
Ignition System Dwell, Degrees: Breaker Point	N/A	28 - 32				N/A					
Breakerless	24 - 34										
Gap, Inches: Points - Reset	N/A	.406 - .508 mm (.016"-.020")				N/A N/A					
Air Gap, Trigger Wheel-to-Sensor	.2 mm (.008")										
Coil Output Voltage @ 2500 RPM	20 KV Min.										
Ignition Timing Without Vacuum Advance, Degrees (Engine at Specified Idle RPM)	TDC					9°BTDC			5°BTDC	7°BTDC	
Ignition Cable Resistance (Max.): Up to 36" Long Over 36" Long	30K Ohms 45K Ohms										
Cold Starting Enrichment System Fast Idle Speed, RPM	2000	2200			2000	1800	2400			2000	
Curb Idle Speed & Air/Fuel Mix. Curb Idle Speed, RPM (In Neutral)	525-575	650 - 700				525-575 *				500-550 *	
Mixture, % CO	0.5-2.0	2.0max.	1.5 max.		2.0max.	0.5-2.5		0.5-2.5		1.5-3.0	
Speed Drop RPM	30	80	60	110	40	50				40	
Spark Plugs Standard	RJ-10Y (CR43S)**		RJ-6(CR43)**			RBN-13Y (R446TS)**				RN-11Y	
Plug Gap	.88mm(.035"		.76 mm (.030")								
Optional for Light Service	N/A		RJ-10Y(CR43S)**			N/A				RN-12Y	
Plug Gap	N/A		.88mm(.035")			N/A				.76mm (.030")	
Optional for Severe Service	N/A					RBN-4 (R44LT)**				N/A	
Plug Gap	N/A					.76 mm (.030")				N/A	
Torque	38.0-40.7N.m(28-30ft.lb.)					16.3-24.4 N.m(12-18ft.lbs.)				34.0-40.7N.m(25-30ft.lbs.)	
Required Voltage @ 1000 RPM	8 - 15 KV										
Exhaust Gas Recirculation System Functional Test @300 RPM Minimum Speed Increase by Removing Signal Vacuum	N/A	50 rpm	150 rpm		N/A						
Decel Throttle Modulator System Speed at which Modulator Functions, RPM	1800 - 1900		N/A		N/A	1800 - 1900					
DTM Speed (No Load) W/Mod. Extended, RPM	1300 - 1400		N/A		N/A	1300 - 1400			1250 - 1350	1300 - 1400	
Bolt Torque Intake Manifold-to-Cylinder Head	34.0-40.7N.m(25-30ft.lbs.)					36.6-50.2N.m(27-37ft.lbs.)				40.7-51.5N.m(30-38ft.lbs.)	
Exhaust Manifold-to-Cylinder Head	34.0-40.7N.m(25-30ft.lbs.)					36.6-44.7N.m(27-33ft.lbs.)				40.7-51.5N.m(30-38ft.lbs.)	
Carburetor-to-Intake Manifold	8.1 - 10.8 N.m (6-8 ft. lbs.)										

N/A = Not applicable
* = Range 100 rpm higher with Allison Automatic Transmission
** = Approved corresponding spark plug

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PART II

TROUBLE-SHOOTING

GUIDE

FOR

INTERNATIONAL

GASOLINE ENGINES

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The following trouble shooting guide can be used for all International gasoline engines.

If each step is followed, a particular problem can be found and corrected without any difficulty.

To use the guide first diagnose the problem; engine will not start, engine idle speed varies, spark knock or pinging, etc. Check the engine diagnostic chart page for the chart number showing the problem. The engine diagnostic chart page shows a chart number for each diagram in the guide.

When the problem is isolated to a particular component and more information is needed for repair or replacement, find the appropriate IH Truck Service Manual for the faulty component by referring to the chart below.

IH ENGINE DIVISION SERVICE MANUAL OR
IH TRUCK SERVICE MANUAL CTS NUMBERS AND SUBJECTS
FOR USE WITH ENGINE DIAGNOSTIC CHARTS

CTS No.	Description
COOLING	
2019	General Information
ELECTRICAL	
2024	Battery
2013	Ignition Coils
2016	Spark Plugs
2481	Distributor, Model 1510 Holley (Breaker Point System)
CGES-145	Electronic Ignition System With Integral Module
2258	Starter Motor (Standard)
2259	Starter Motor (Heavy Duty)
ENGINE	
2145	Failure Analysis-All Engines
2523	Diagnosing Excessive Oil Consumption
CGES-160	V-304/345/392 (8-Cylinder)
2682	4-196 (4-Cylinder)
2664	MV-404/446 (8-Cylinder)
2683	V-537
FUEL SYSTEM	
CGES-120	Carburetor, Model 2300G
CGES-125	Carburetor, Model 4150G
CGES-110	Carburetor, Model 1940C
CGES-115	Carburetor, Model 2210C
2050	Fuel Pump
2056	Air Cleaner
PROPELLER SHAFT	
2045	General Information
2046	Universal Joints and Center Bearings
COMPLETE IH TRUCK SERVICE MANUALS (1979)	
2313	Scout
2315	Loadstar, Cargostar (Medium Duty)
2314	Paystar, Co-Transtar (Heavy Duty)
2311	S-Series
2001	Complete Service Manual for all IH Vehicles

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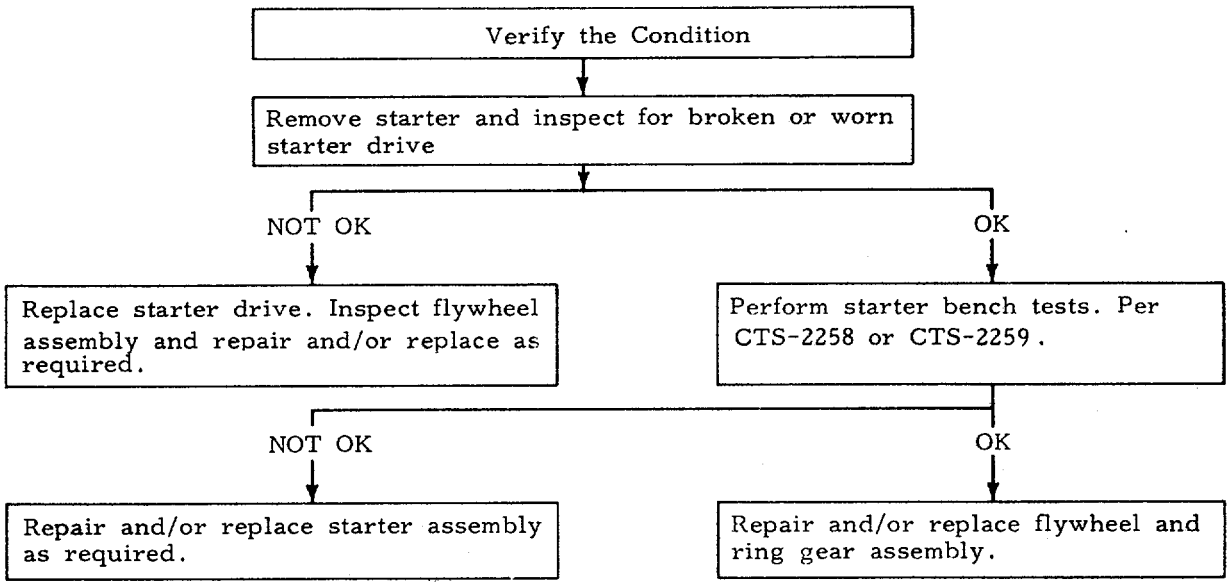
ENGINE DIAGNOSTIC CHARTS

CONDITION	PAGE
CHART	
01-Engine will not crank-starter spins	4
02-Engine Will Not Crank	5
03-Engine Cranks Slowly	7
04-Engine Cranks Normally-Starts Hard When Cold	8
05-Engine Cranks Normally-Starts Hard When Hot	10
06-Engine Idles Rough-Misses	12
07-Engine Idle Speed Varies	14
08-Engine Misses at High Speed	16
09-Engine Misses at Low Speed	18
10-Engine Stalls at Idle-Engine Cold	19
11-Engine Stalls at Idle-Engine Hot	21
12-Engine Hesitates-Stalls During Acceleration	23
13-Engine Has Poor Acceleration	25
14-Exhaust System Backfire	27
15-Excessive Fuel Consumption	28
16-Excessive Oil Consumption	30
17-Engine Diesels-Continues to Run After Shut Off	32
18-Engine Noise	34
18A-Spark Knock or Pinging	35
19-Engine Vibration	36
20-Loss of Coolant or Engine Overheating	37
21-Smoke from Vehicle Exhaust System	39
22-Engine Governor does not Operate-No Engine Speed Control	40
23-Governor Cuts Off at Low Speed-Erratic Operation	41
24-Engine Surges below Governor Cutoff Speed	42
25-Engine Surges at Governed Speed	44
Addendum No. 1-Fuel System Vapor Lock	45
Addendum No. 2-Compression and Cylinder Leakage Tests	46
Addendum No. 3-Vacuum System Hose Leakage Test	47

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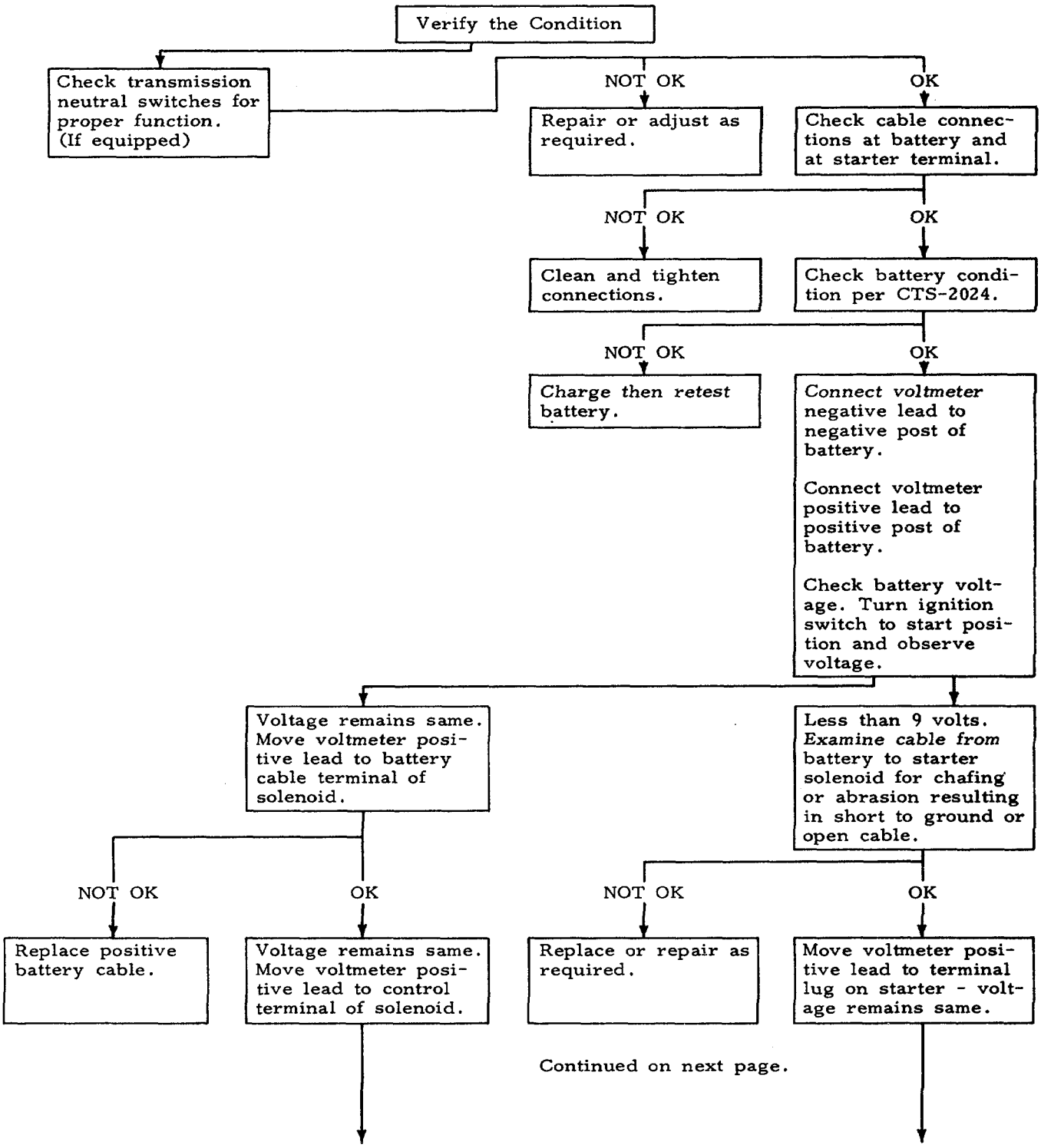
CHART NO. 01

ENGINE WILL NOT CRANK - STARTER SPINS



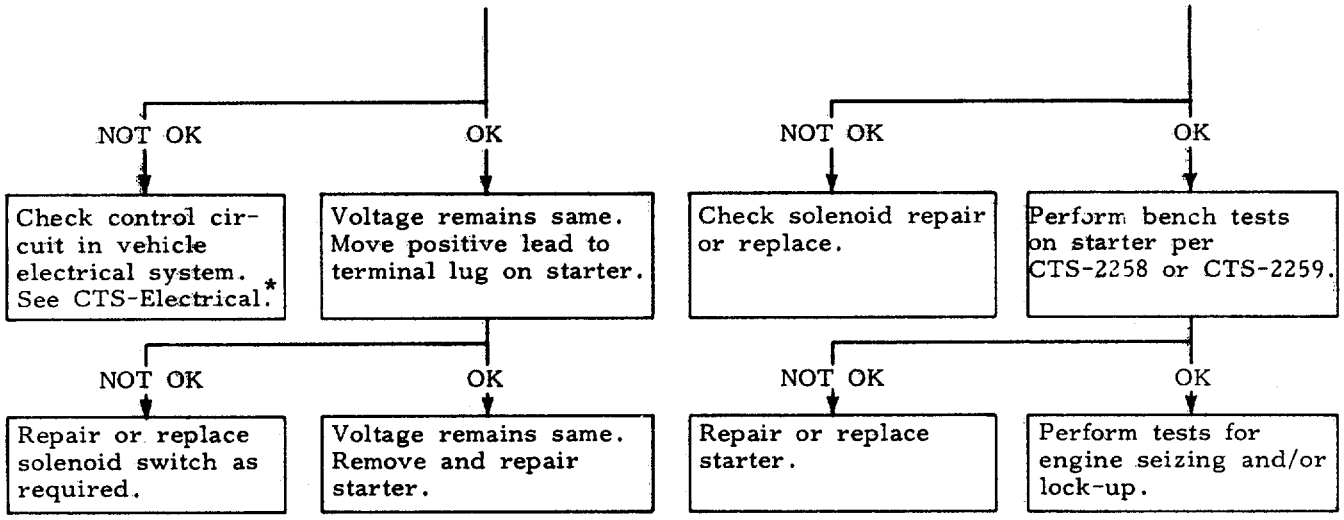
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CHART NO. 02
ENGINE WILL NOT CRANK



Continued on next page.

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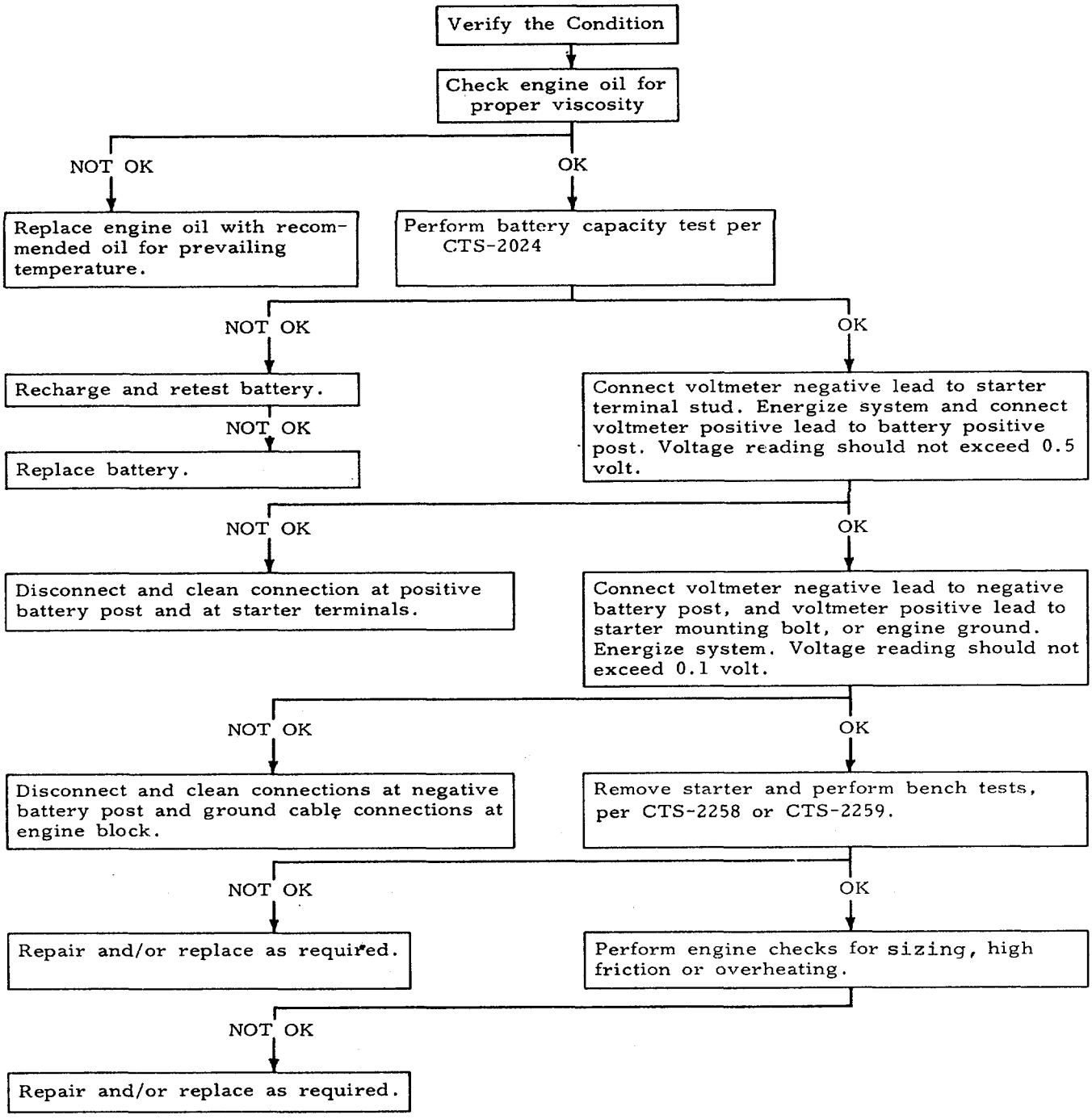


* See CTS or CGES.

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CHART NO. 03

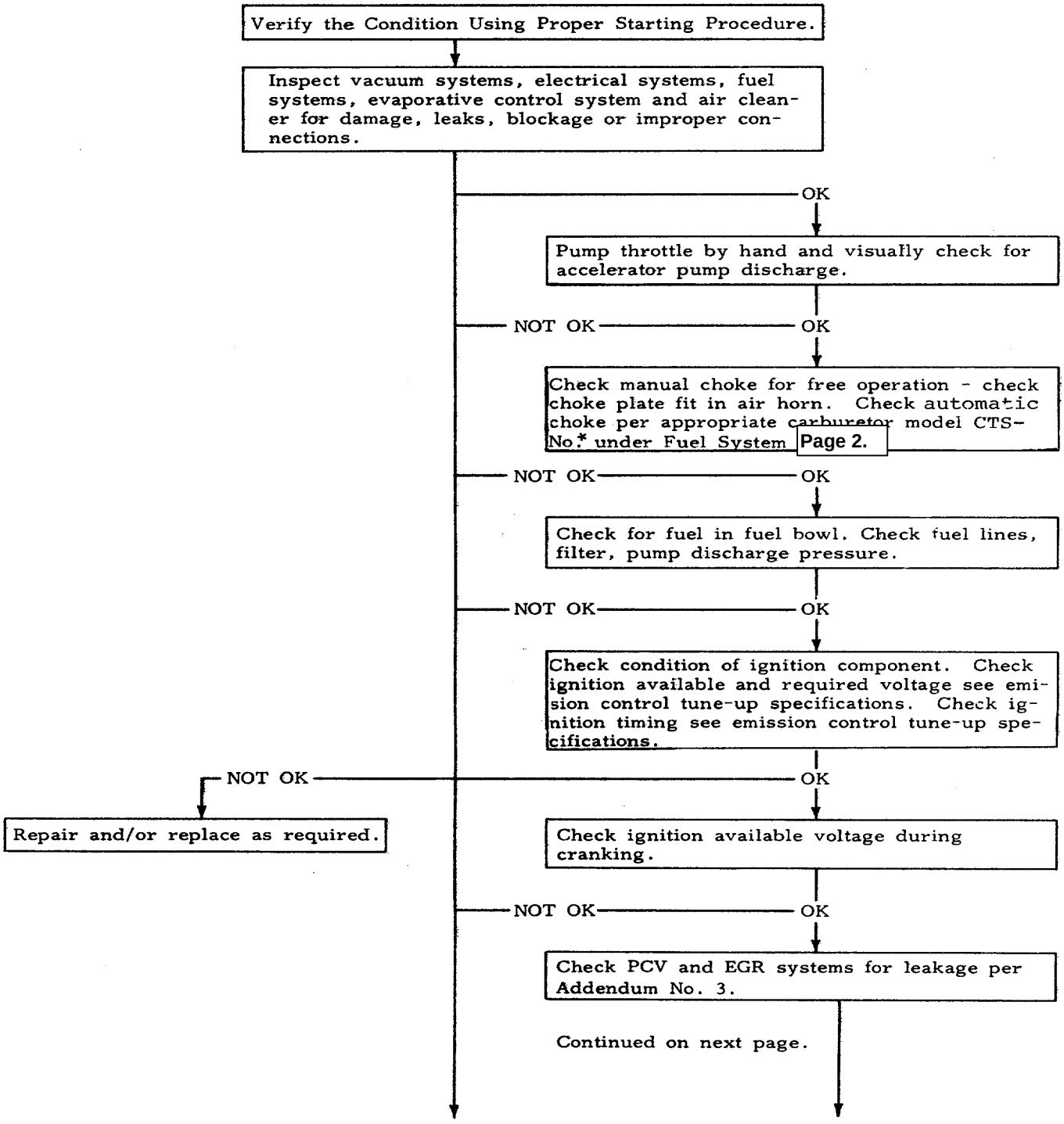
ENGINE CRANKS SLOWLY



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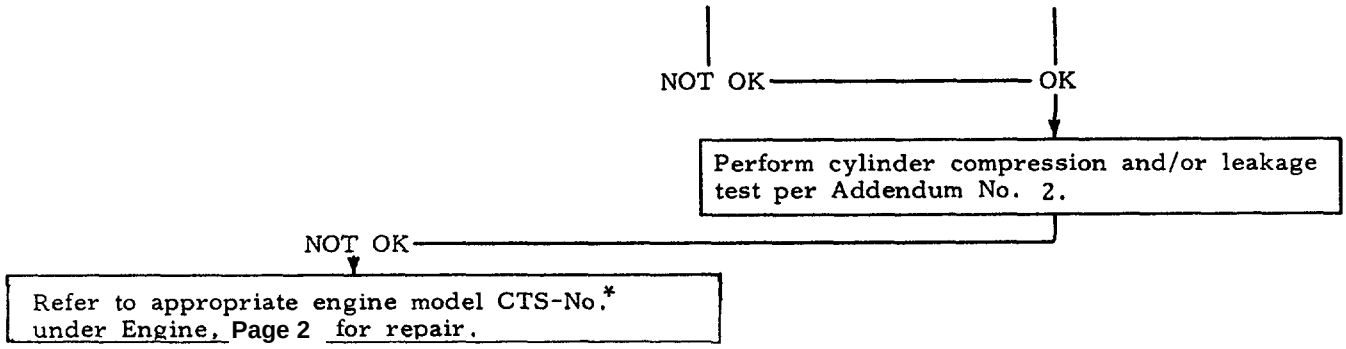
CHART NO. 04

ENGINE CRANKS NORMALLY - STARTS HARD WHEN COLD



* See CTS or CGES.

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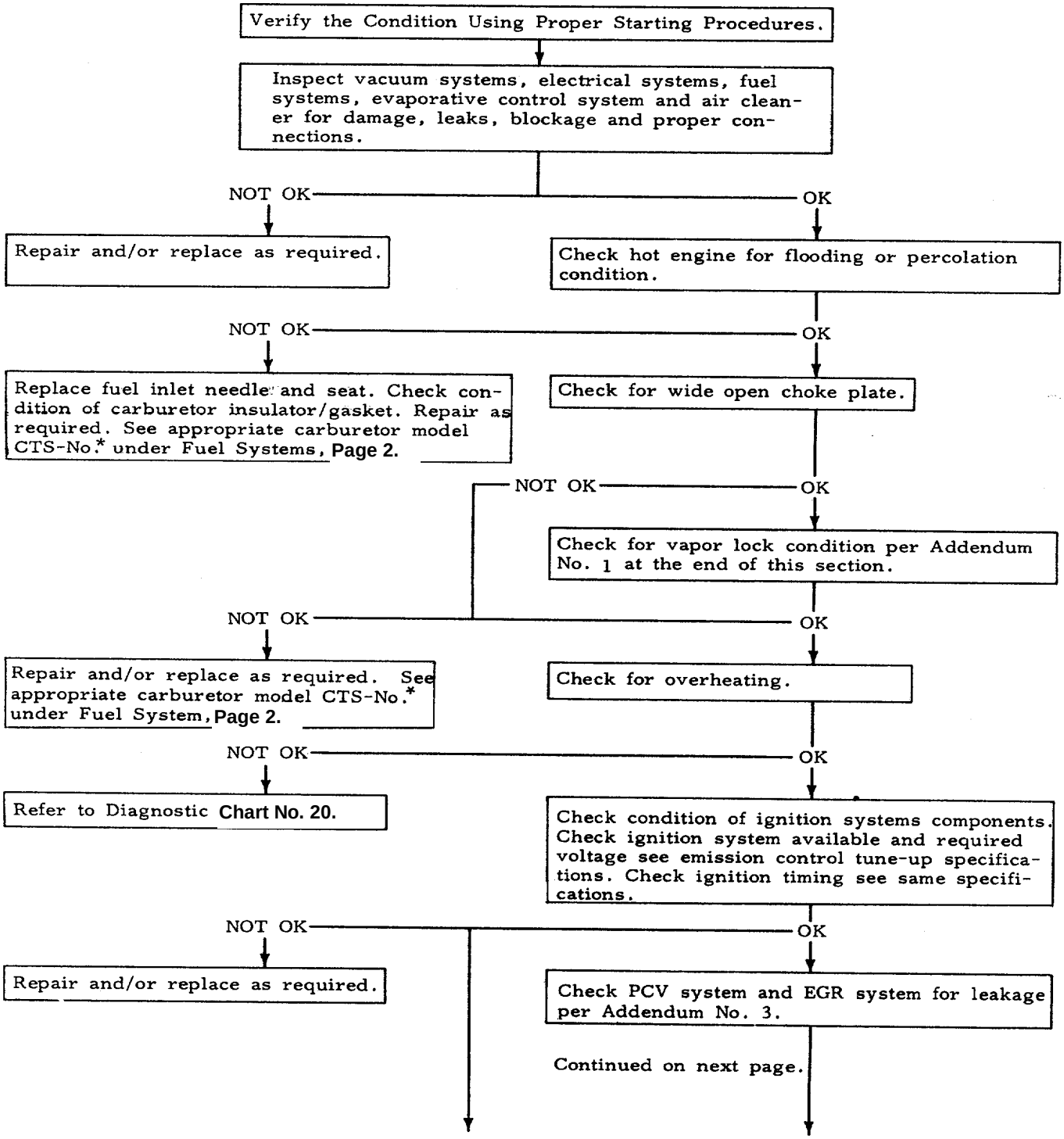


* See CTS or CGES.

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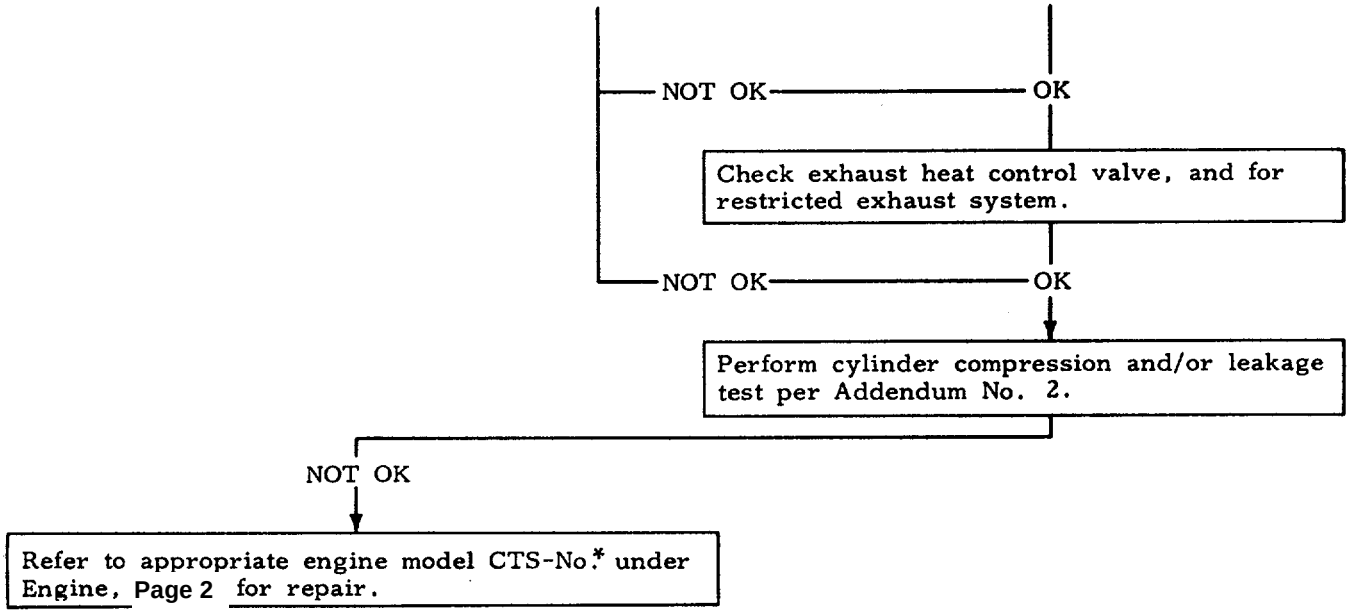
CHART NO. 05

ENGINE CRANKS NORMALLY - STARTS HARD WHEN HOT



* See CTS or CGES.

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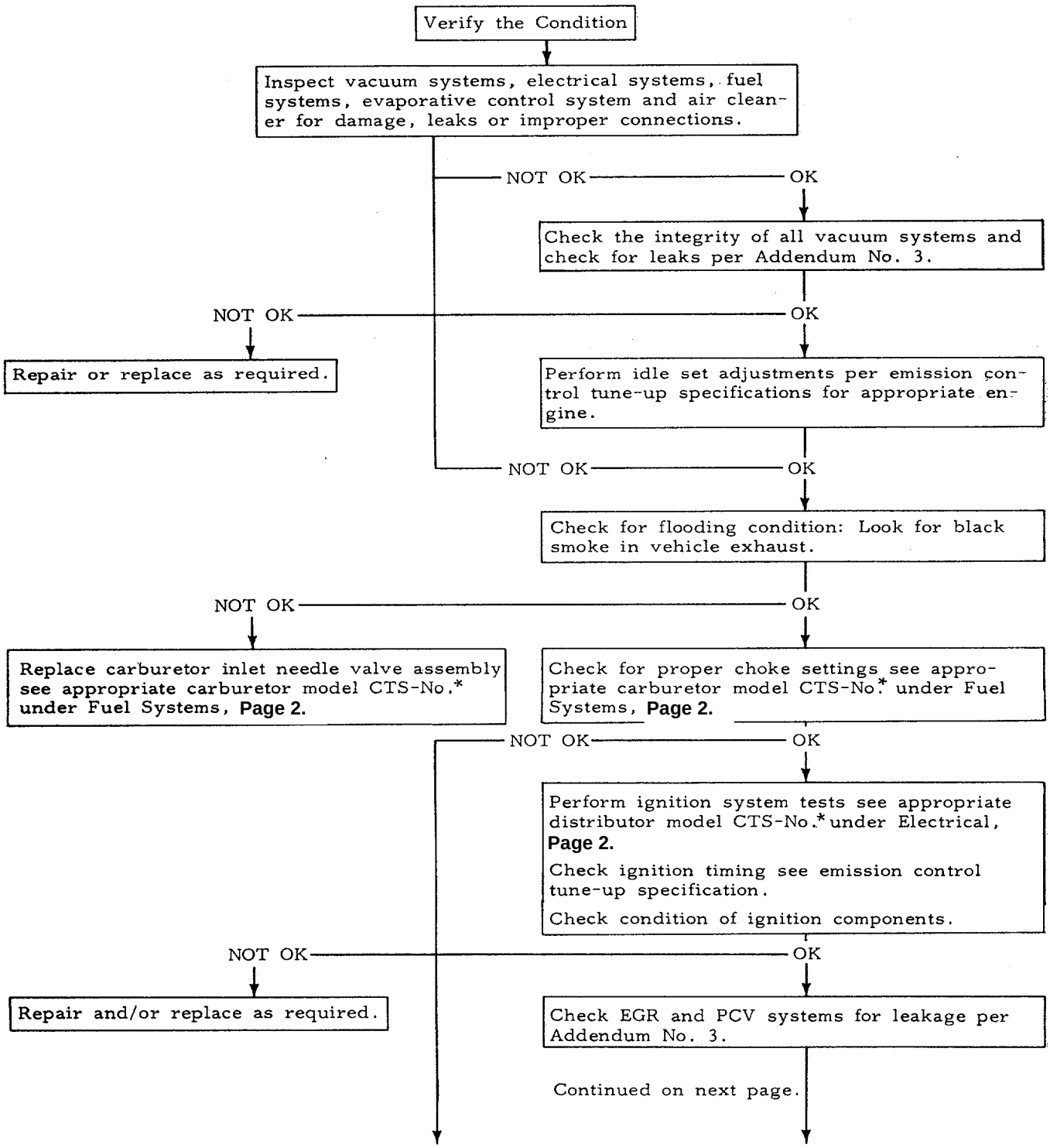


* See CTS or CGES.

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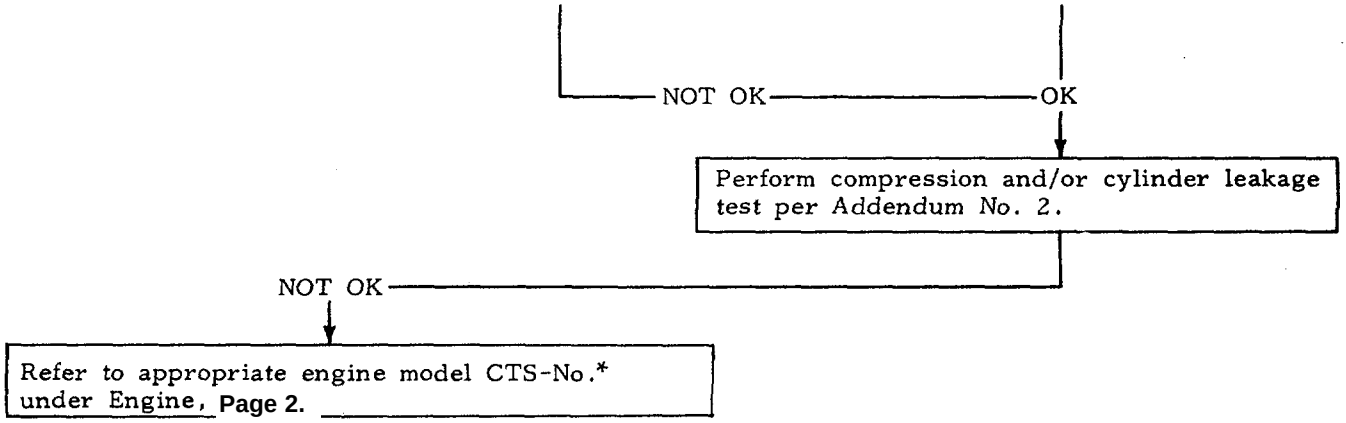
CHART NO. 06

ENGINE IDLES ROUGH - MISSES (WARM OR COLD ENGINE)



* See CTS or CGES.

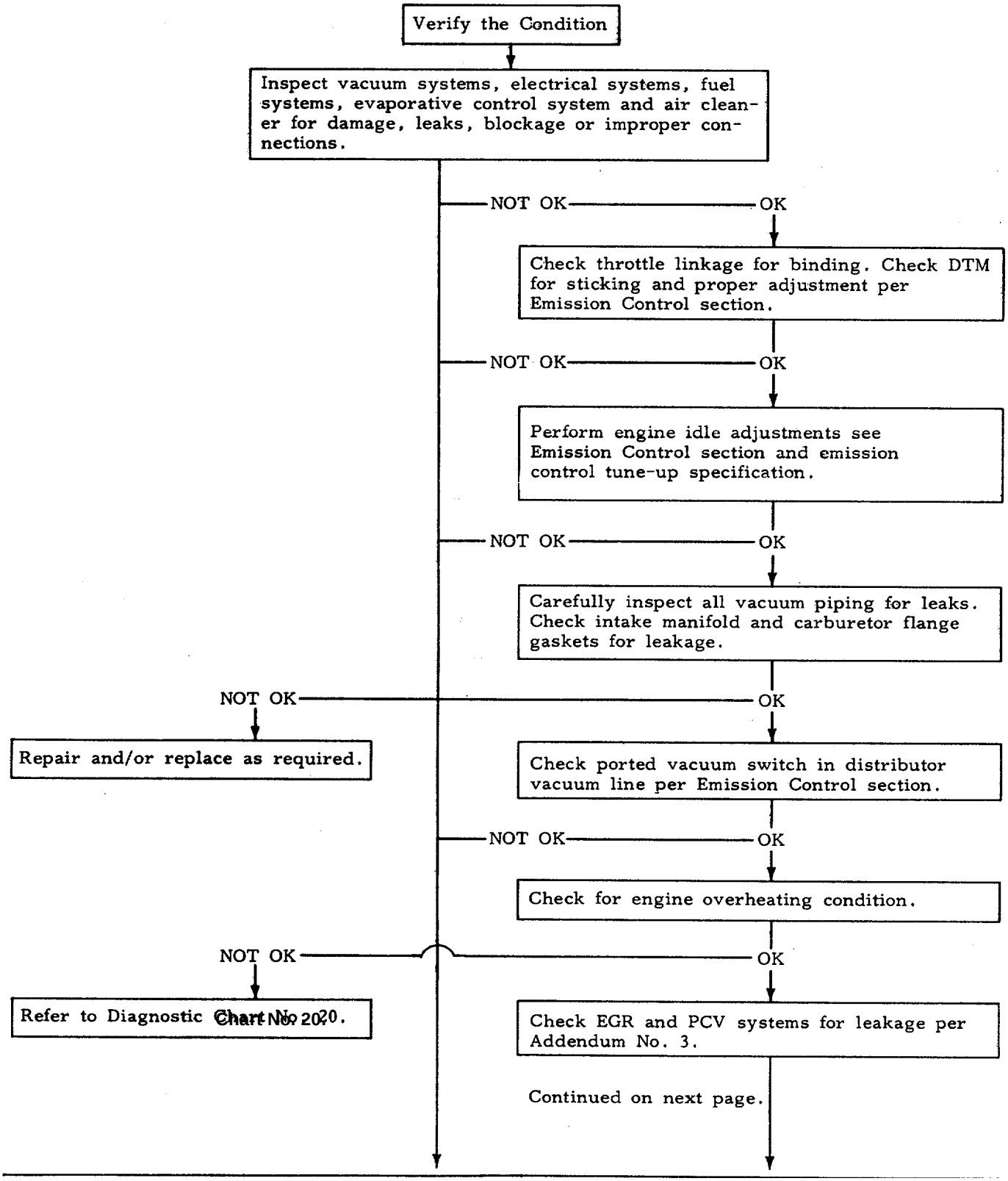
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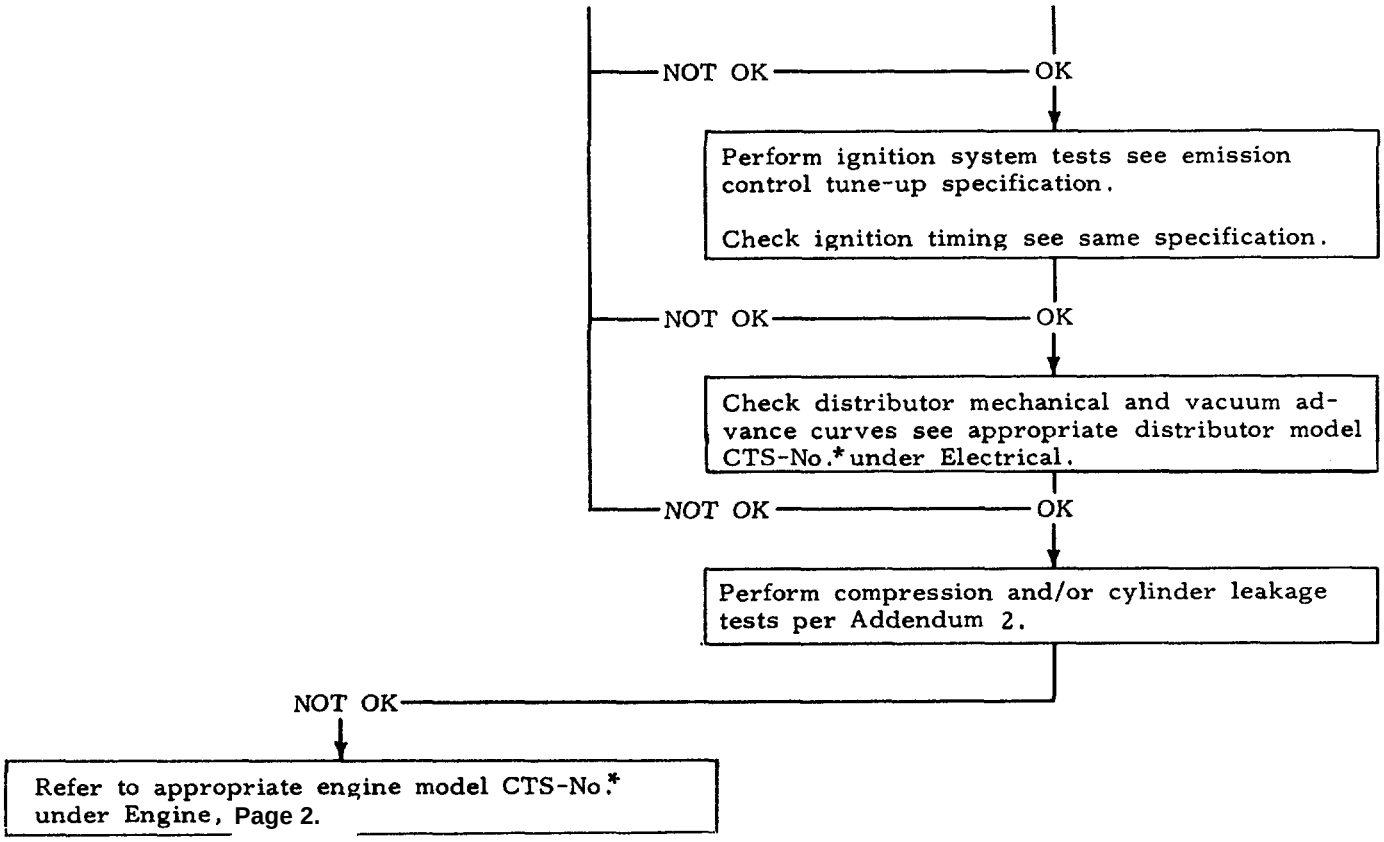


*See CTS or CGES.

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CHART NO. 07
ENGINE IDLE SPEED VARIES

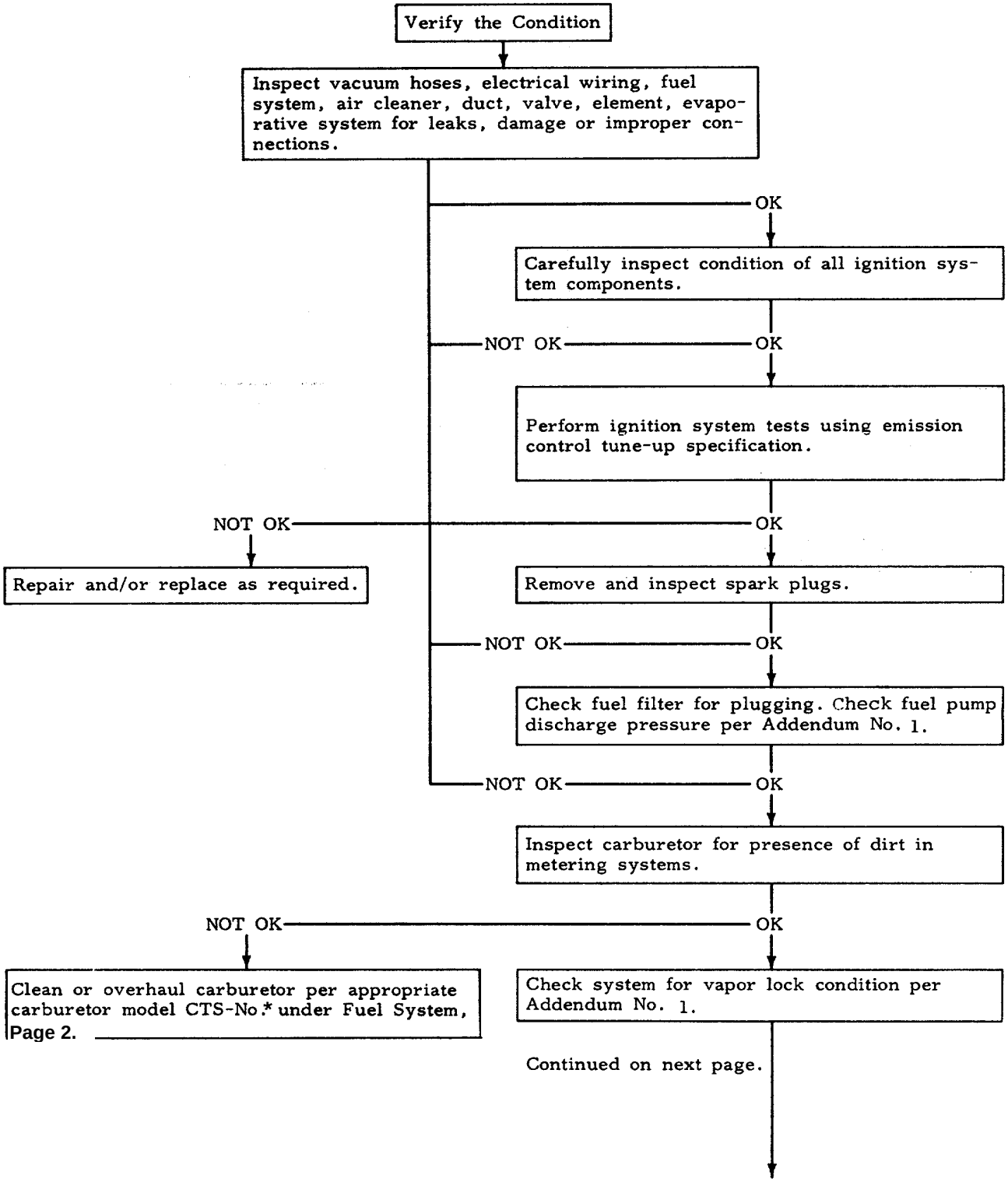




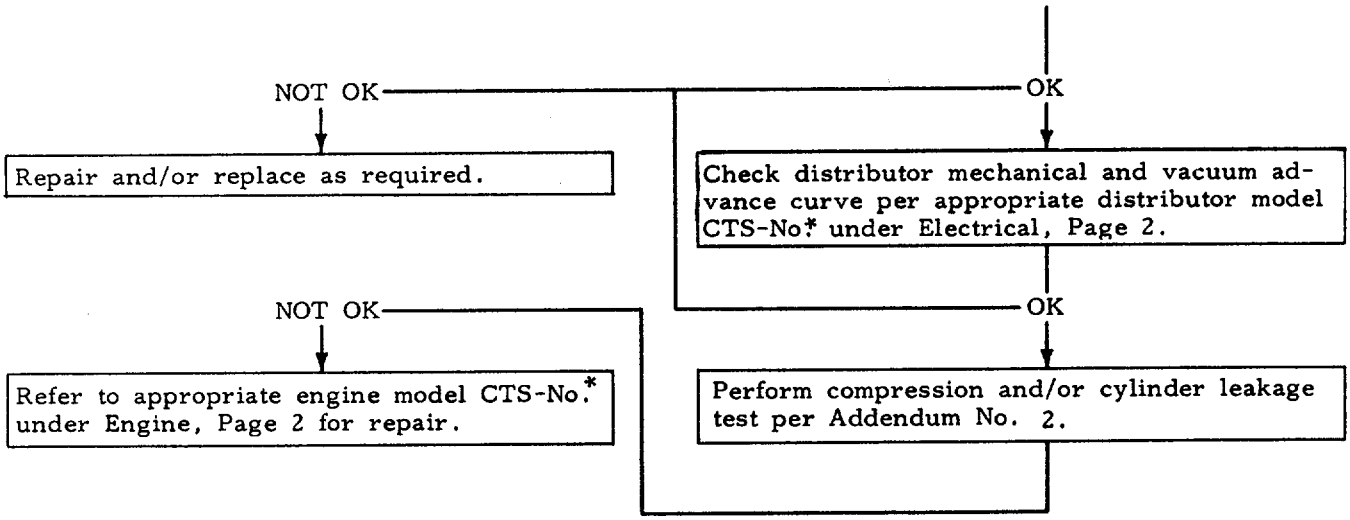
*See CTS or CGES.

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CHART NO. 08
ENGINE MISSES AT HIGH SPEED



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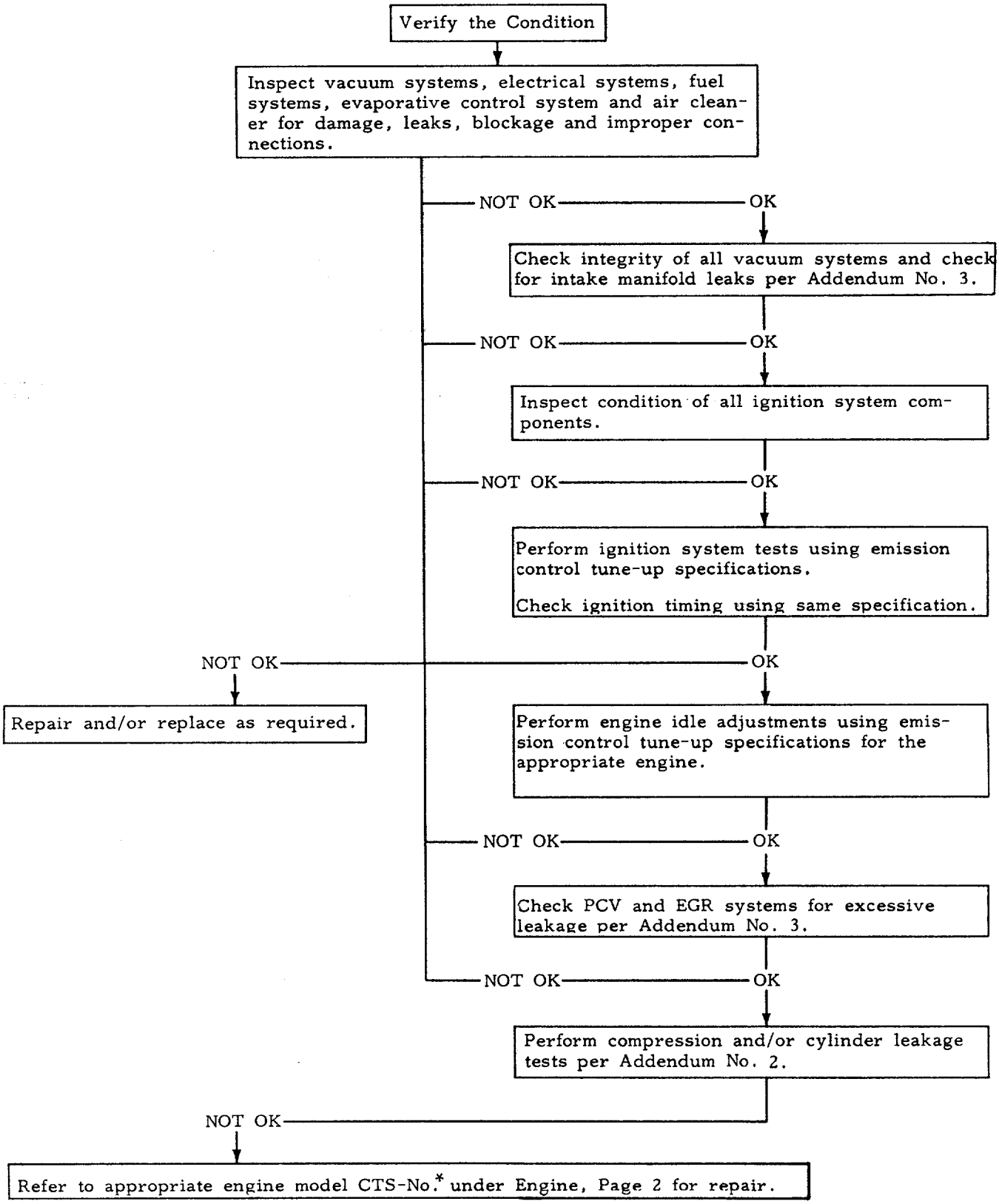


*See CTS or CGES.

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CHART NO. 09

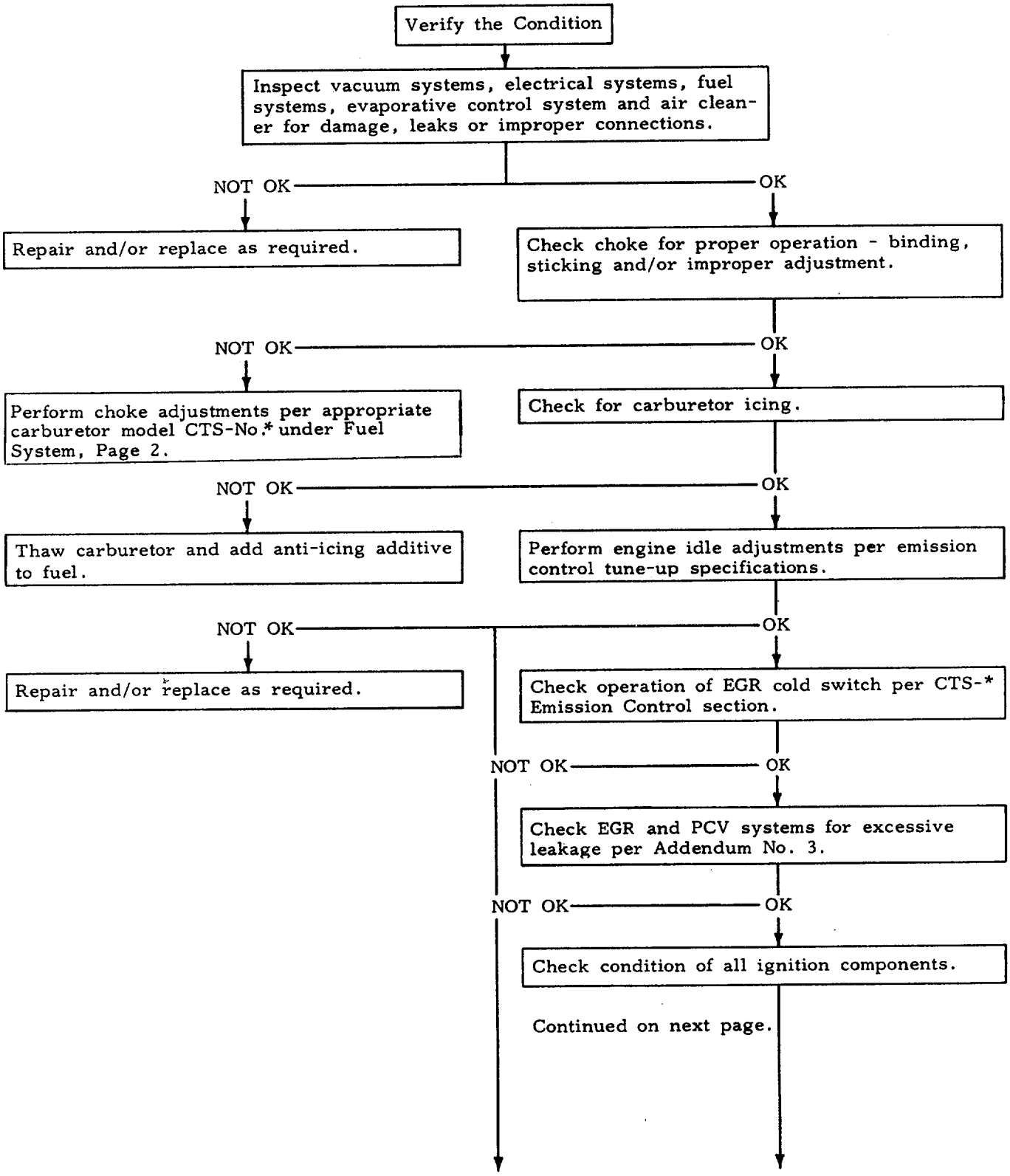
ENGINE MISSES AT LOW SPEED



*See CTS or CGES.

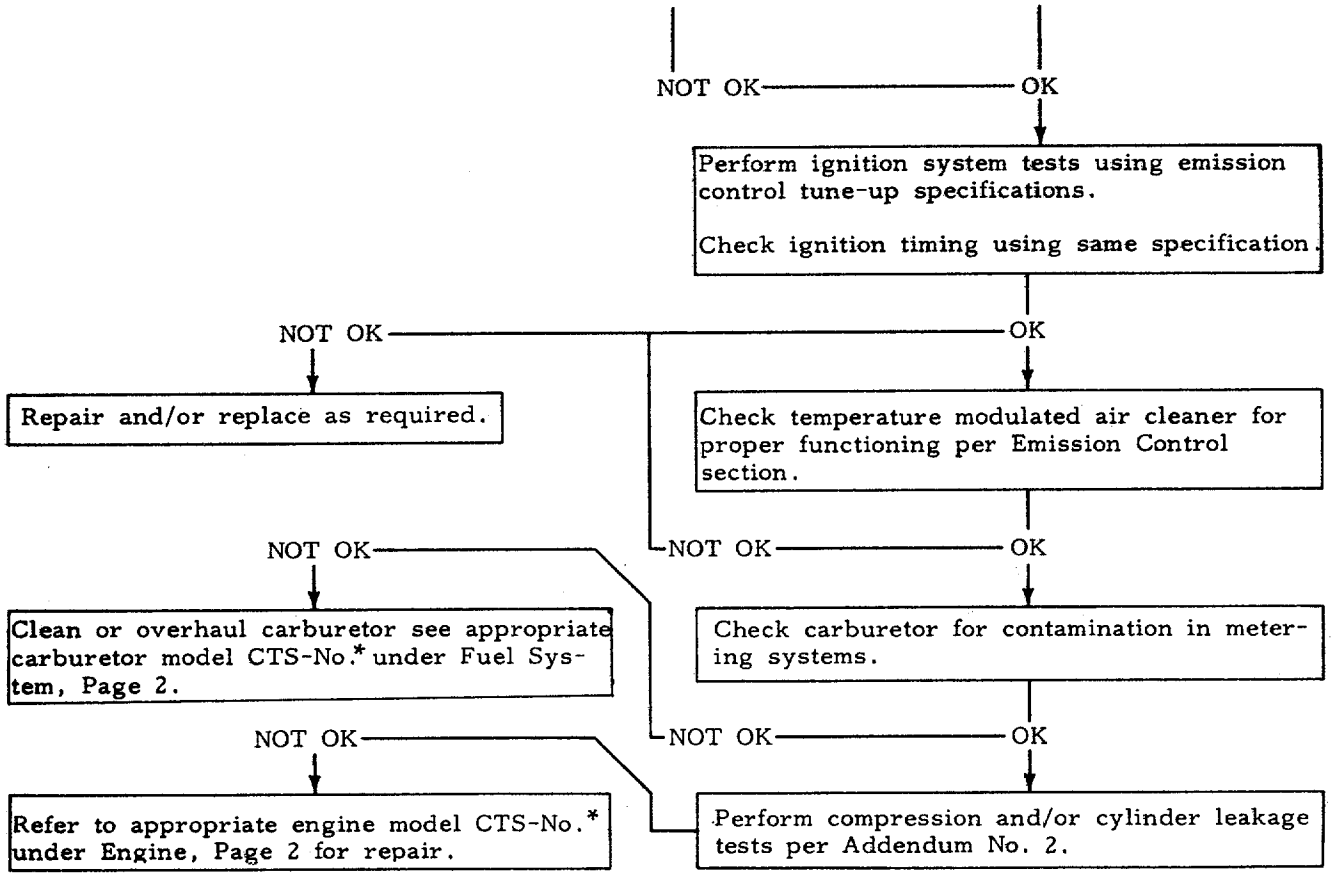
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CHART NO. 10
ENGINE STALLS AT IDLE - ENGINE COLD



*See CTS or CGES.

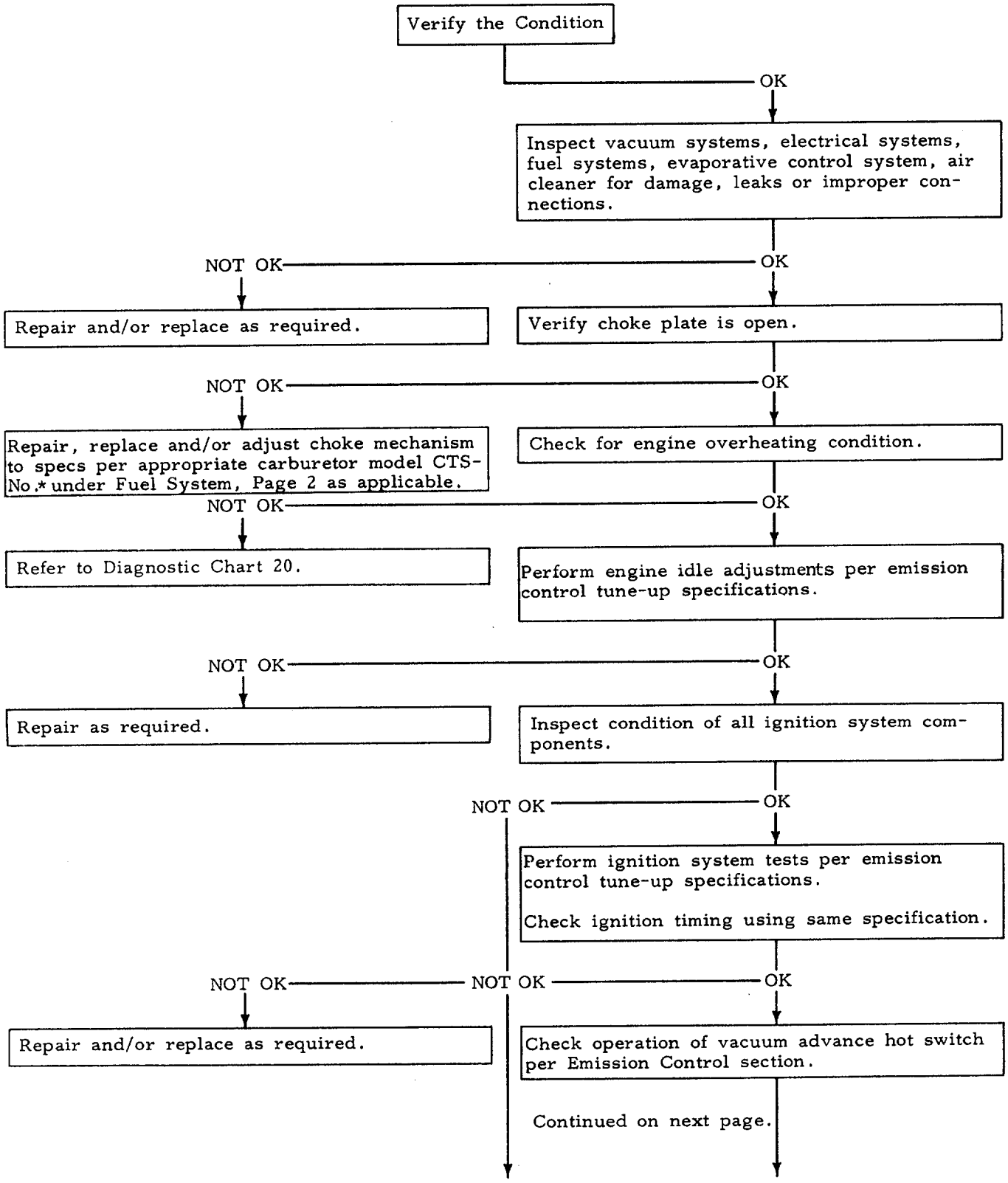
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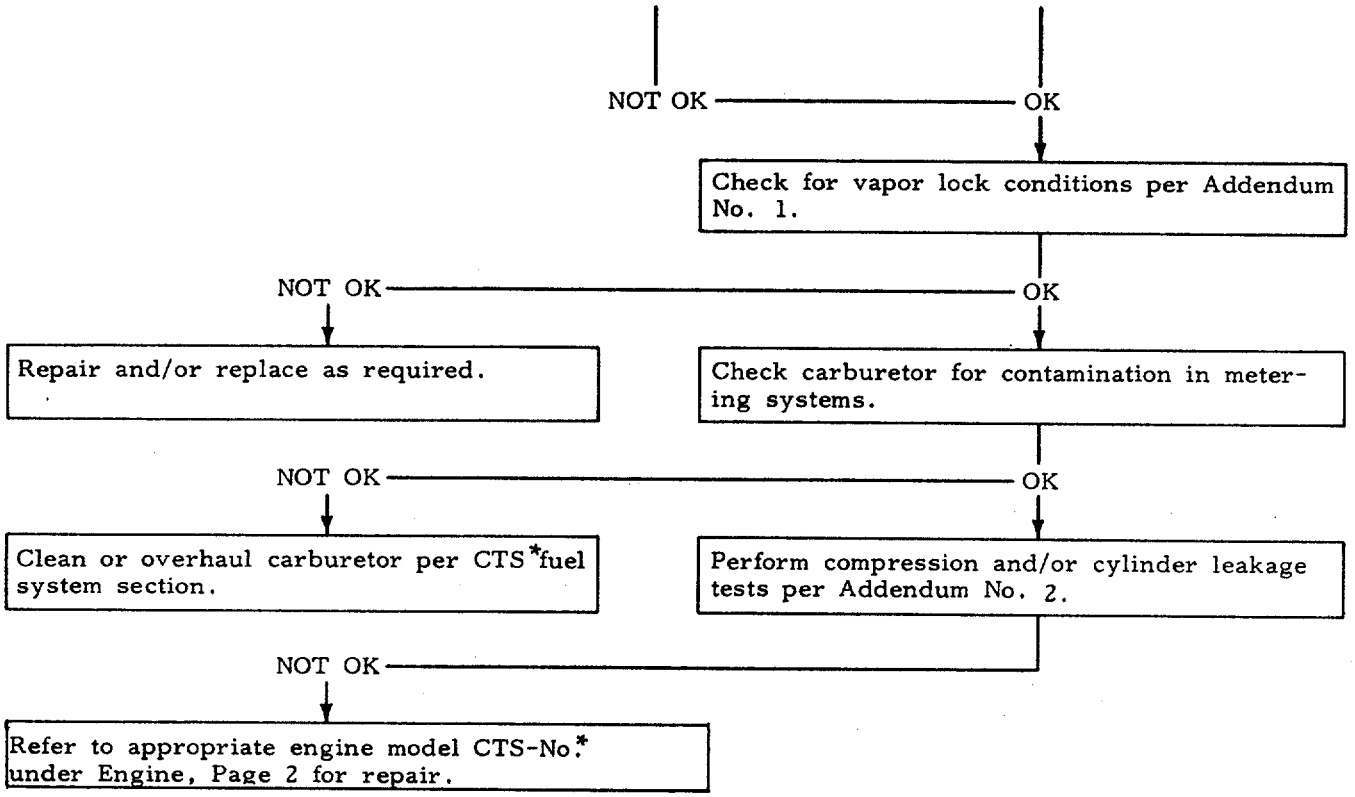
*See CTS or CGES.

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CHART NO. 11
ENGINE STALLS AT IDLE - ENGINE HOT



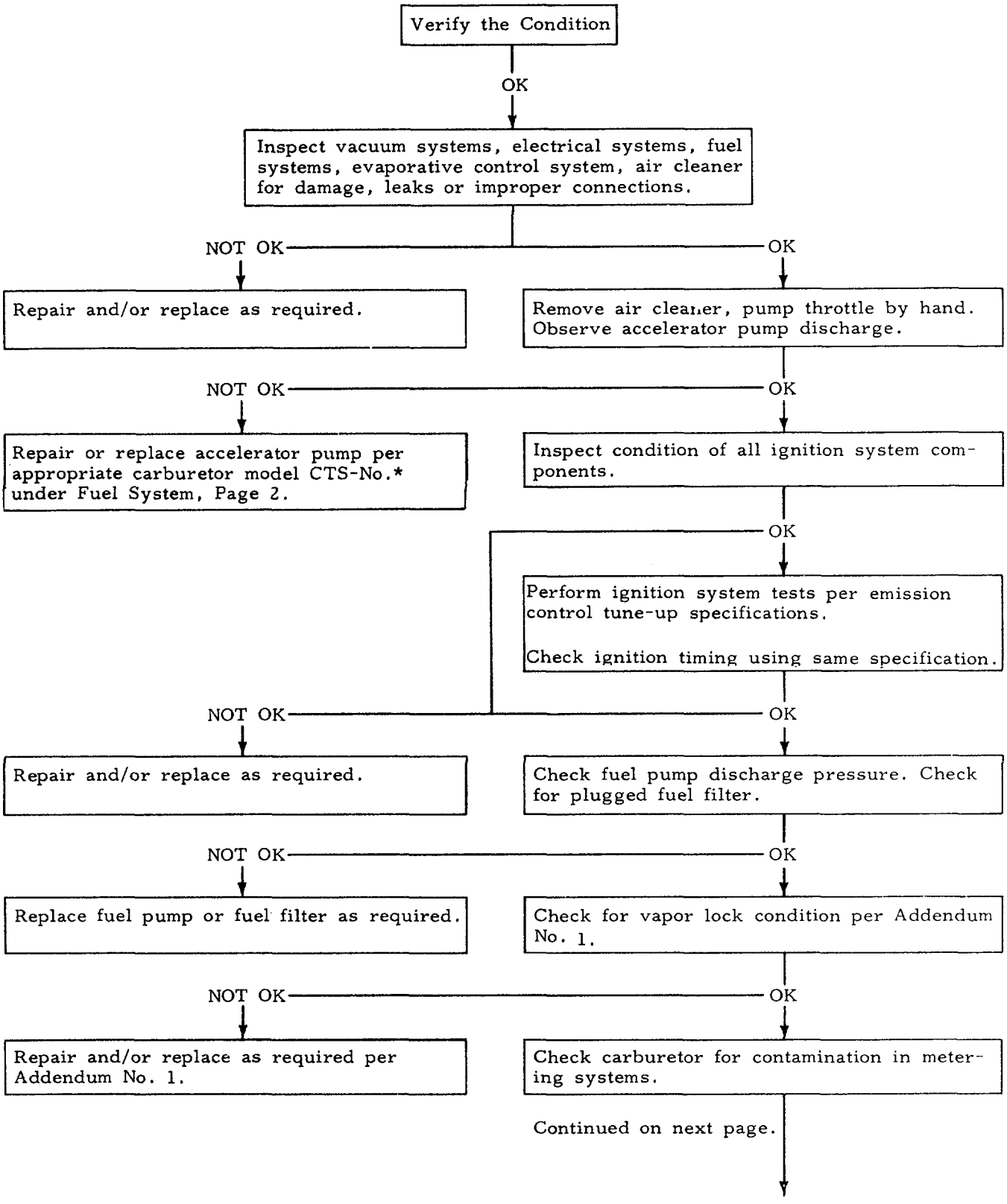
*See CTS or CGES.



*See CTS or CGES.

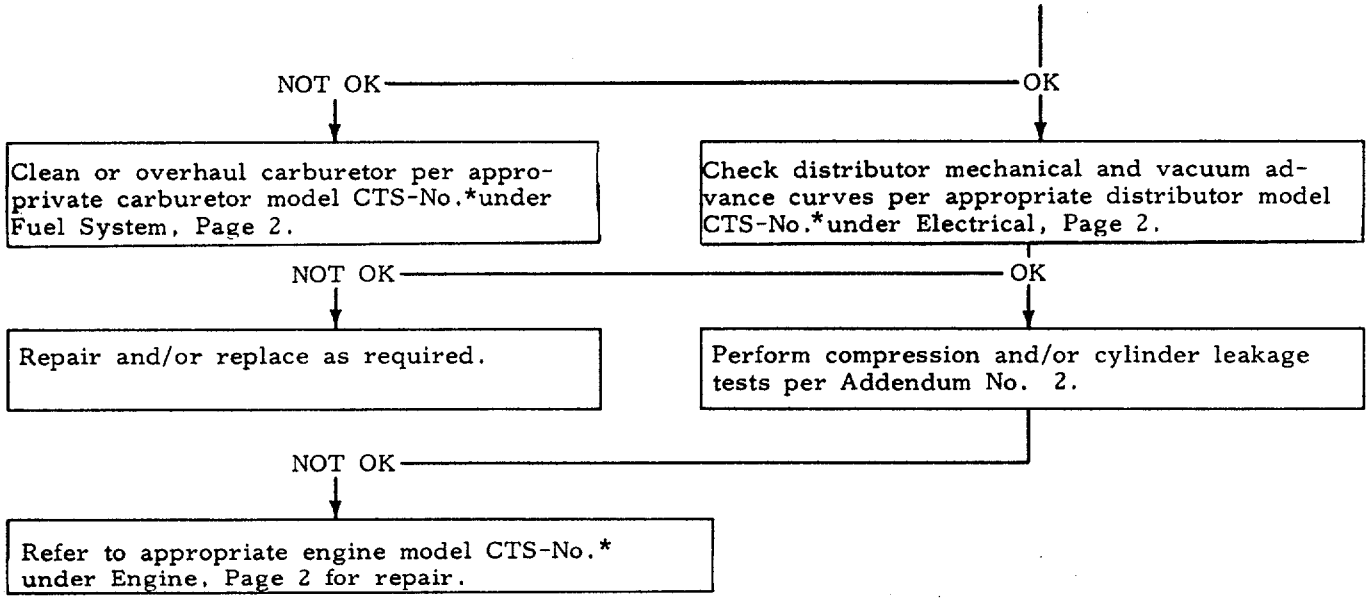
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CHART NO. 12
ENGINE HESITATES - STALLS DURING ACCELERATION



*See CTS or CGES.

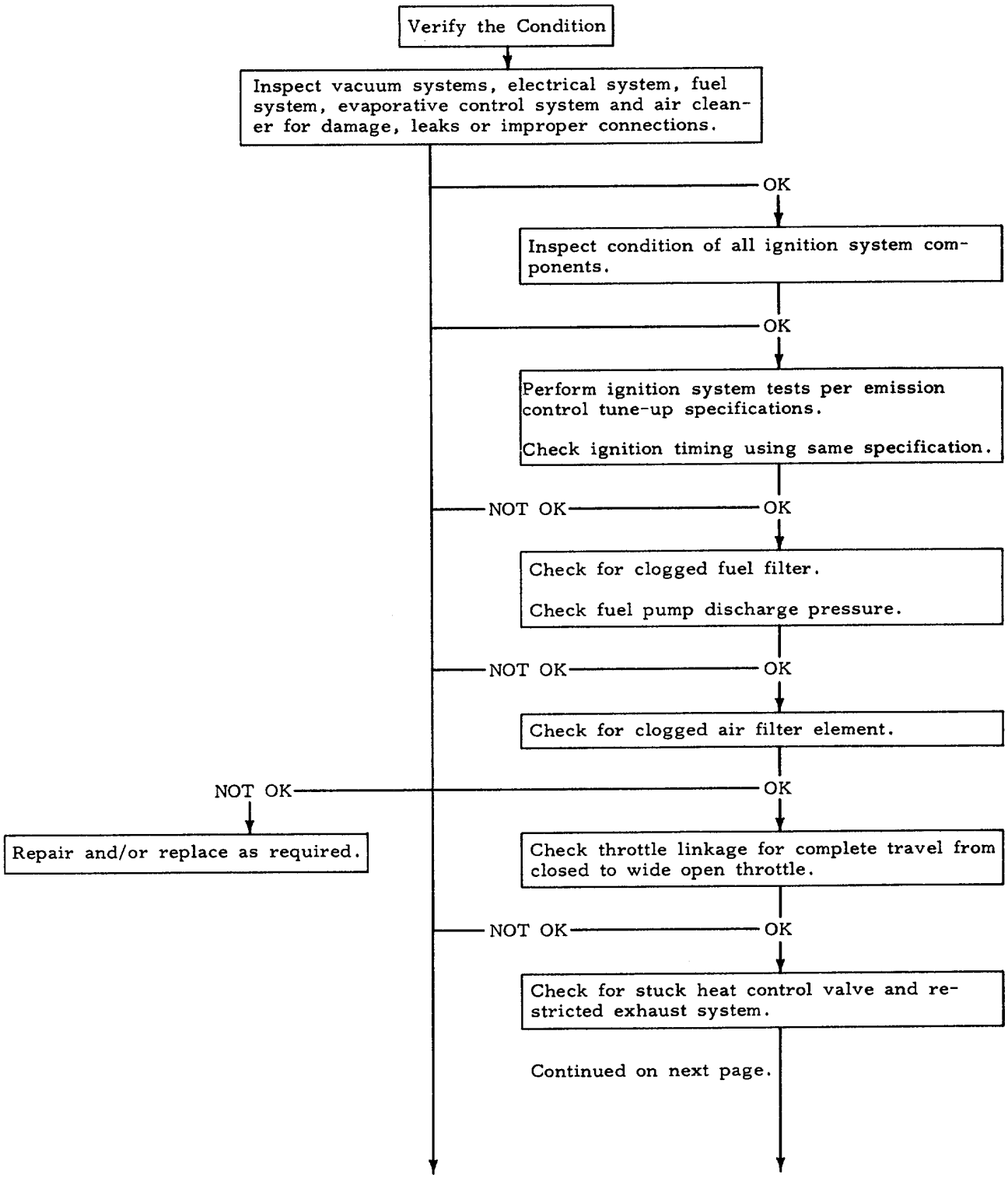
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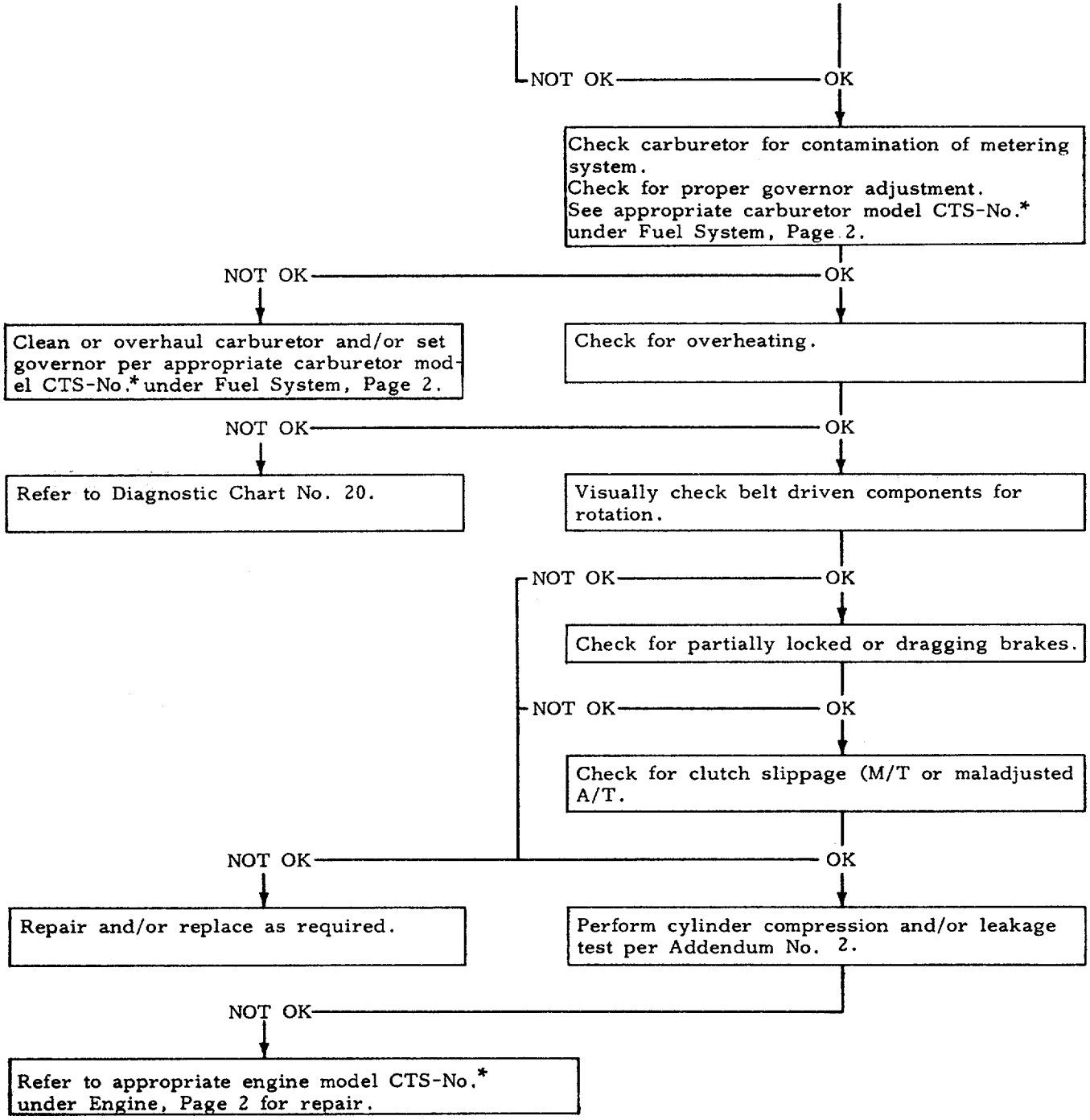
*See CTS or CGES.

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CHART NO. 13
ENGINE HAS POOR ACCELERATION
(LESS THAN NORMAL POWER)



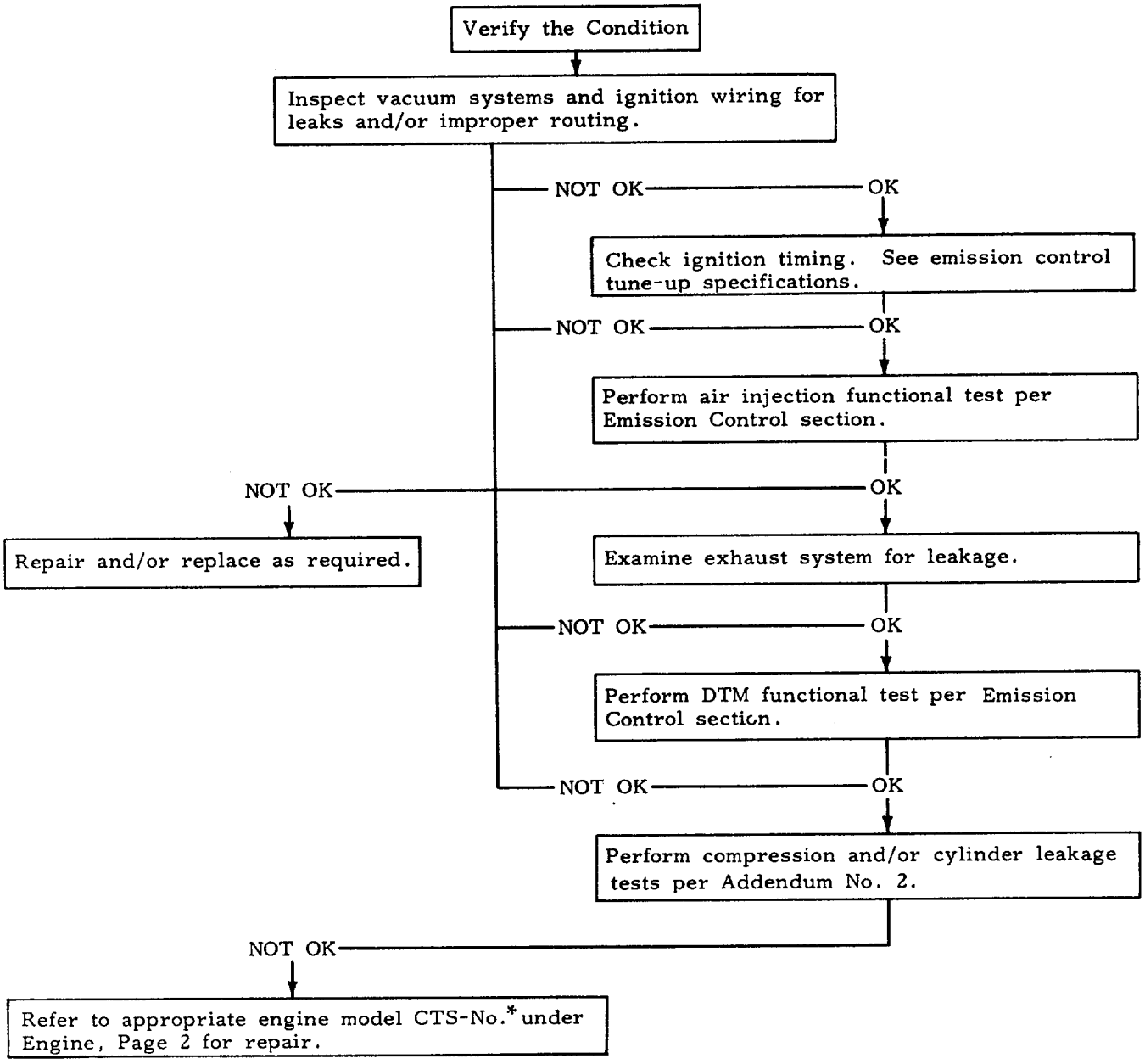
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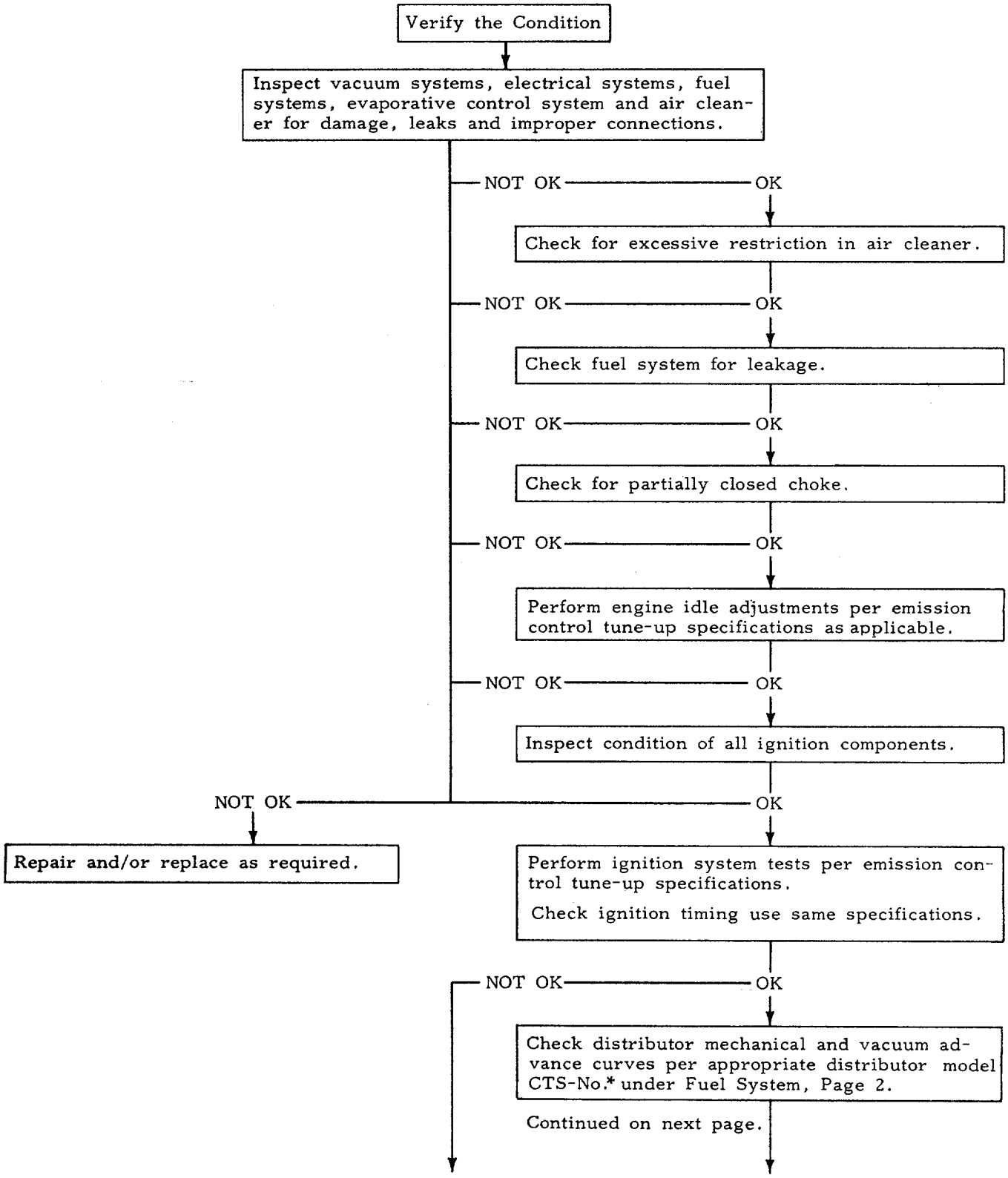
CHART NO. 14
EXHAUST SYSTEM BACKFIRE



*See CTS or CGES.

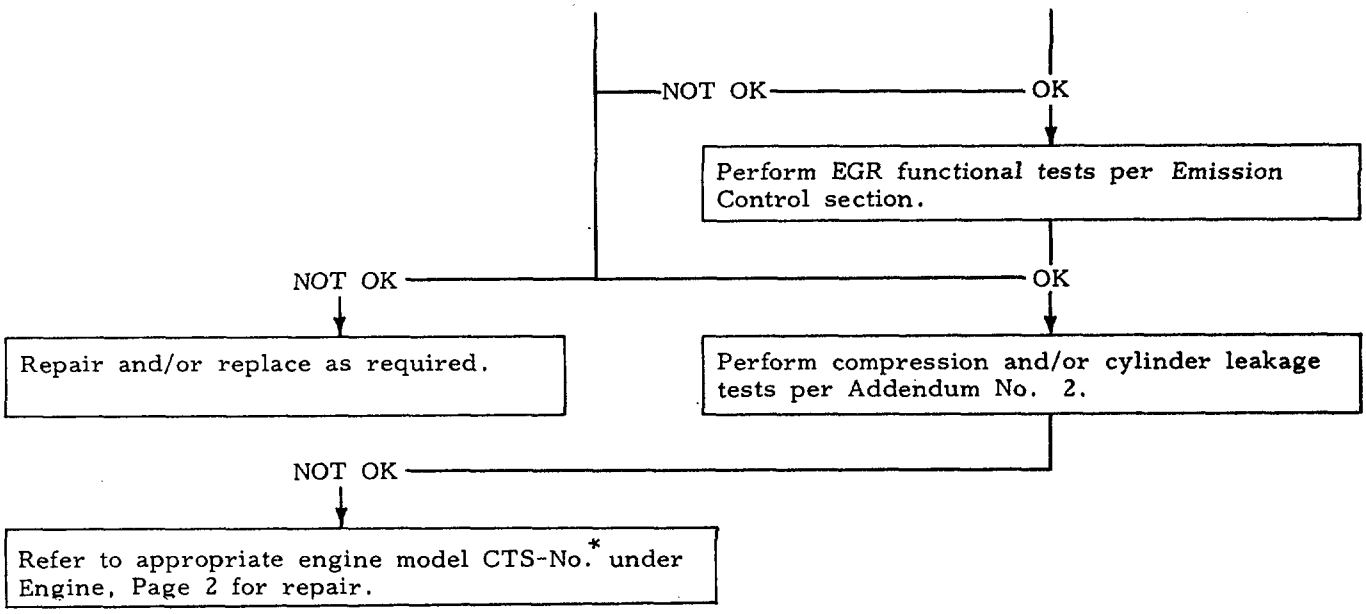
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CHART NO. 15
EXCESSIVE FUEL CONSUMPTION



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CHART NO. 16
EXCESSIVE OIL CONSUMPTION

Verify the Condition

The most common cause of oil loss is leakage. To verify an excessive oil consumption complaint, it is necessary that a thorough inspection be made to insure that leakage does not exist. The following steps should be followed to verify an excessive oil consumption complaint.

A. Steam clean the engine (if necessary) to remove accumulated dirt and/or oil.

B. Drain engine oil and change the oil filter.

C. Fill the crankcase with the specified amount of the recommended grade of oil. (Check to be sure the correct dipstick has been installed.)

D. Check positive crankcase ventilation system for excessive oil pullover into air cleaner.

E. Drive the vehicle under normal conditions until the engine is at normal operating temperature. With the vehicle parked on a level surface, place a clean paper under the engine (to aid in detecting leakage).

F. Shut off engine and check for leakage at:

1. Valve rocker arm cover gaskets.
2. Oil pan gasket.
3. Cylinder block front cover gasket.
4. Cylinder block-to-fuel pump gasket and fuel pump air vent.
5. Intake manifold seals or valley cover gasket. 6. Crankshaft seals.
7. Distributor housing gasket.
8. Oil filter.
9. Oil pressure sending unit.
10. Oil Cooler.

G. When all causes of leakage (if any) have been repaired, check the oil level and adjust oil level to full mark on dipstick.

H. Record the odometer reading. Have the customer operate the engine for the approximate number of miles indicated by the complaint and then return it to you for examination.

I. When customer returns the vehicle, verify the odometer reading. Check the oil level and reinspect the engine for signs of oil leakage.

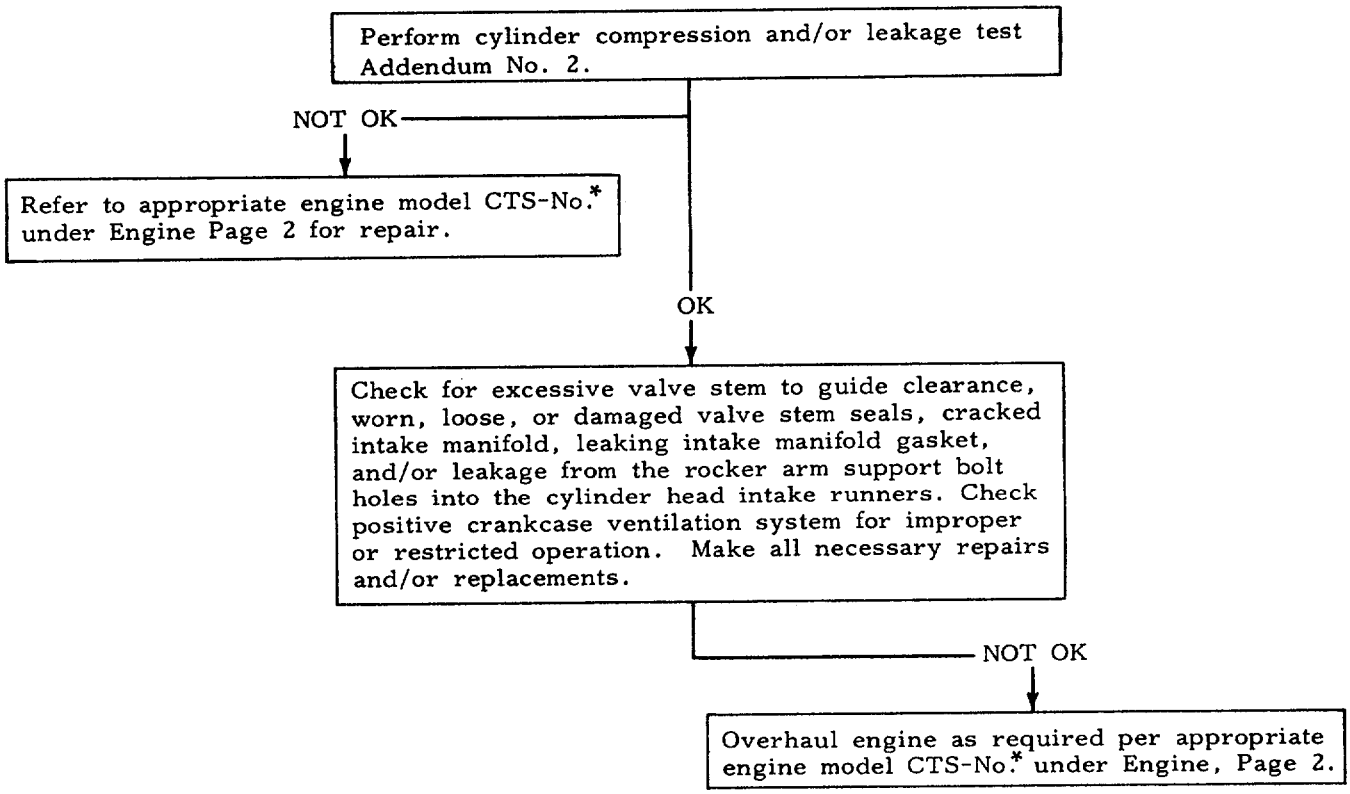
J. Add a measured amount of oil as necessary to bring the oil level to the full mark.

K. If oil consumption is not within specified limits (400-500 miles per quart), proceed with oil consumption diagnosis as outlined below.

NOTE

A new engine may require up to 6000 miles of operation in order to properly seat (break in) the piston rings. For this reason, the engine should not be condemned as long as oil economy is improving with mileage accumulation. If oil economy ceases to improve with mileage accumulation, corrective action should be taken.

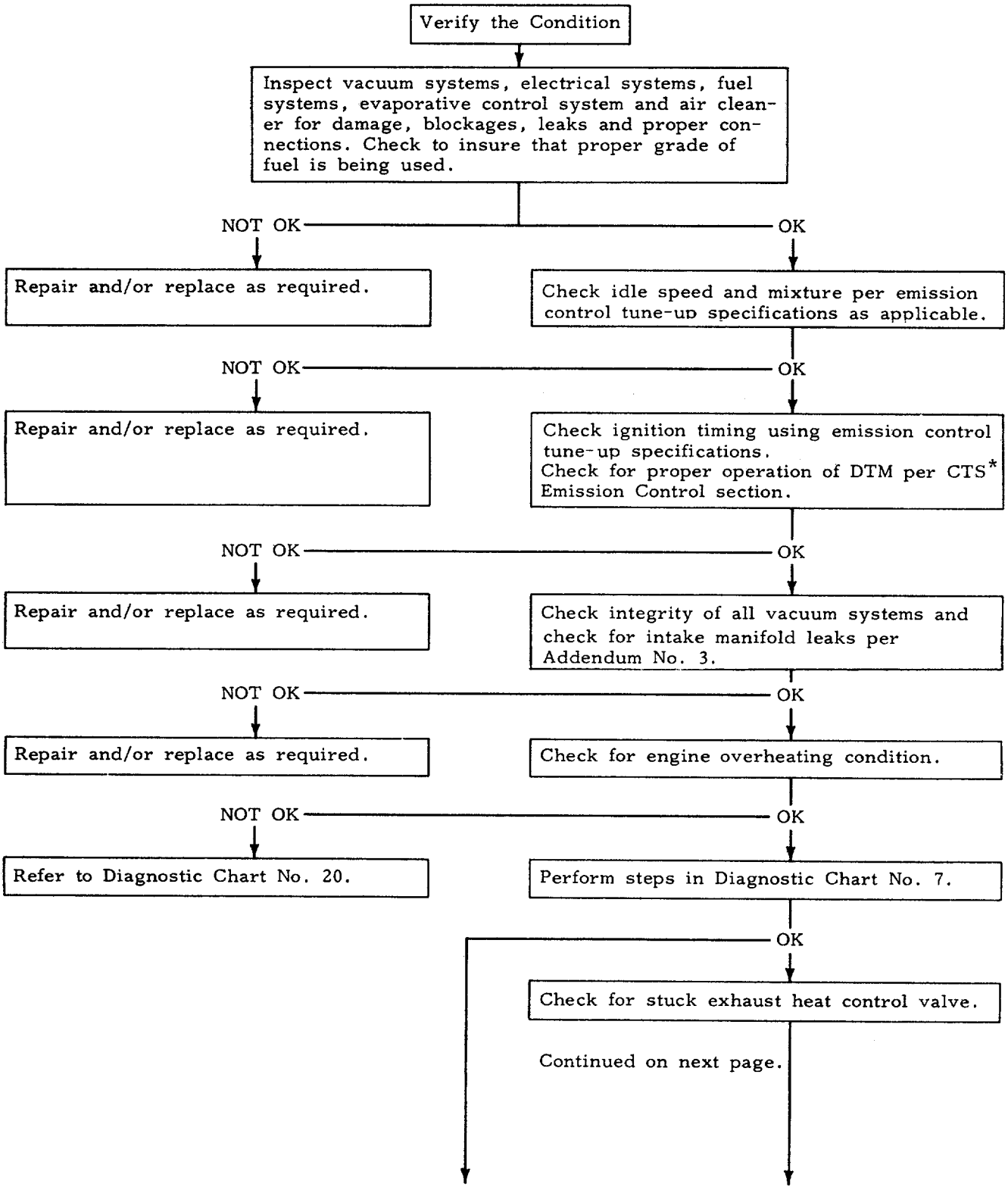
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CHART NO. 17
ENGINE DIESELS - CONTINUES TO RUN AFTER SHUT OFF



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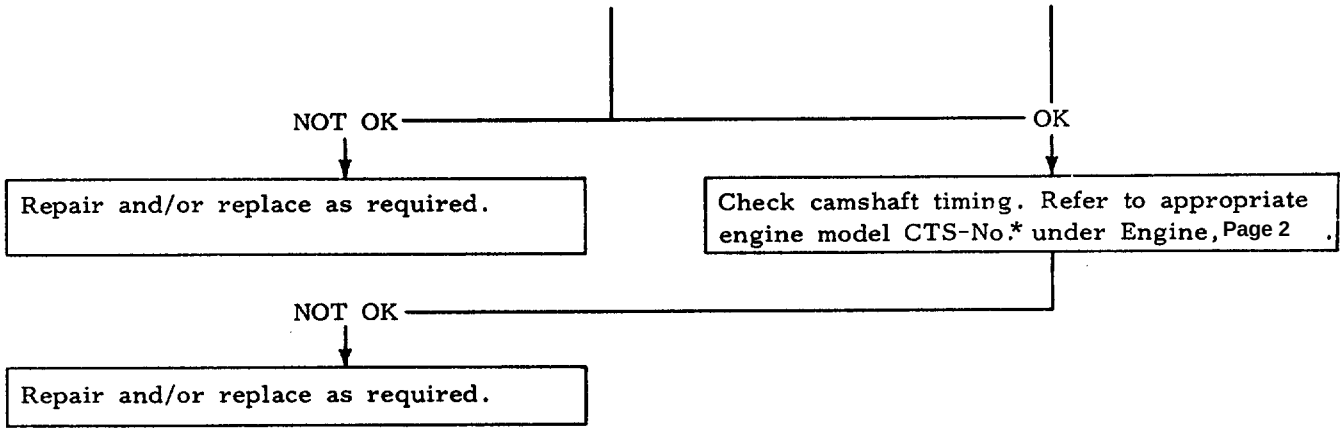

NOT OK
OK
Repair and/or replace as required.
Check camshaft timing. Refer to appropriate engine model CTS-No.* under Engine, Page 2 .
NOT OK
Repair and/or replace as required.

CHART NO. 18

ENGINE NOISE

Noisy engine operation covers a wide range of conditions; therefore, to make the most efficient use of diagnostic aids to correct the condition, an accurate verification of the symptoms must be made. When the symptom is identified as to the type and general location of the noise, proceed to the applicable step outlined below. It can be seen that many of the steps are based on similar symptoms and, indeed, may be a matter of individual interpretation. Therefore, if the most likely step fails to correct the condition, proceed to the next most likely step, and so on until the condition is corrected.

A. Spark Knock or Pinging

This condition is characterized as being increasingly more noticeable as engine load increases. That is, at a given vehicle speed and throttle opening the problem would generally be more noticeable on a steep grade than on a level surface. The condition is due to low octane fuel, excessive spark advance or engine overheating.

If any discrepancies are noted in the following checks, repair and/or replace as required. Advise owner of proper octane fuel and verify correct spark plug heat range. If engine overheating is indicated, perform steps in CHART 20, check ignition timing and check distributor mechanical and vacuum advance curve per CTS * ELECTRICAL section.

B. Light Clicking (Varies with Engine Speed)

This condition is usually caused by improperly adjusted, failed or malfunctioning valve train components. Insert feeler gauge between rocker arm and valve stem tip and/or exert pressure on rocker arm. If noise is eliminated, adjust valve clearance to specifications. If condition persists, inspect for worn or malfunctioning valve train components. If no failure is detected, check for excessive valve stem-to-valve guide wear by exerting side pressure on valve stem. If noise is corrected excessive wear is indicated. If valve is eliminated as a possible cause, check for accessory component noise by loosening and/ or removing drive belts, one at a time, until noise stops. Investigate fuel pump and/or pump drive as possible cause.

C. Sharp Rapping (Varies with Engine Speed)

This condition is usually caused by malfunctioning hydraulic lifter and may be located with the aid of a stethoscope. If the problem is not corrected, perform Step B.

D. Hissing

Inspect vacuum systems for leakage due to loose or broken connections and/or failed parts. Inspect manifolds for leaks. Perform cylinder compression and/or leakage tests to identify and isolate cylinder head gasket leaks. Inspect for carburetor gasket leaks.

E. Sharp Snapping Noise During Acceleration

Look for arcing from high tension ignition cables.

F. Squeaks and/or Squeals

Loosen drive belts, one at a time, to determine if accessory component or water pump is at fault.

G. Heavy Squeal During Acceleration

Check for accessory drive belt slippage and adjust tension or replace as required.

H. Ringing, Grinding or Combination of Both

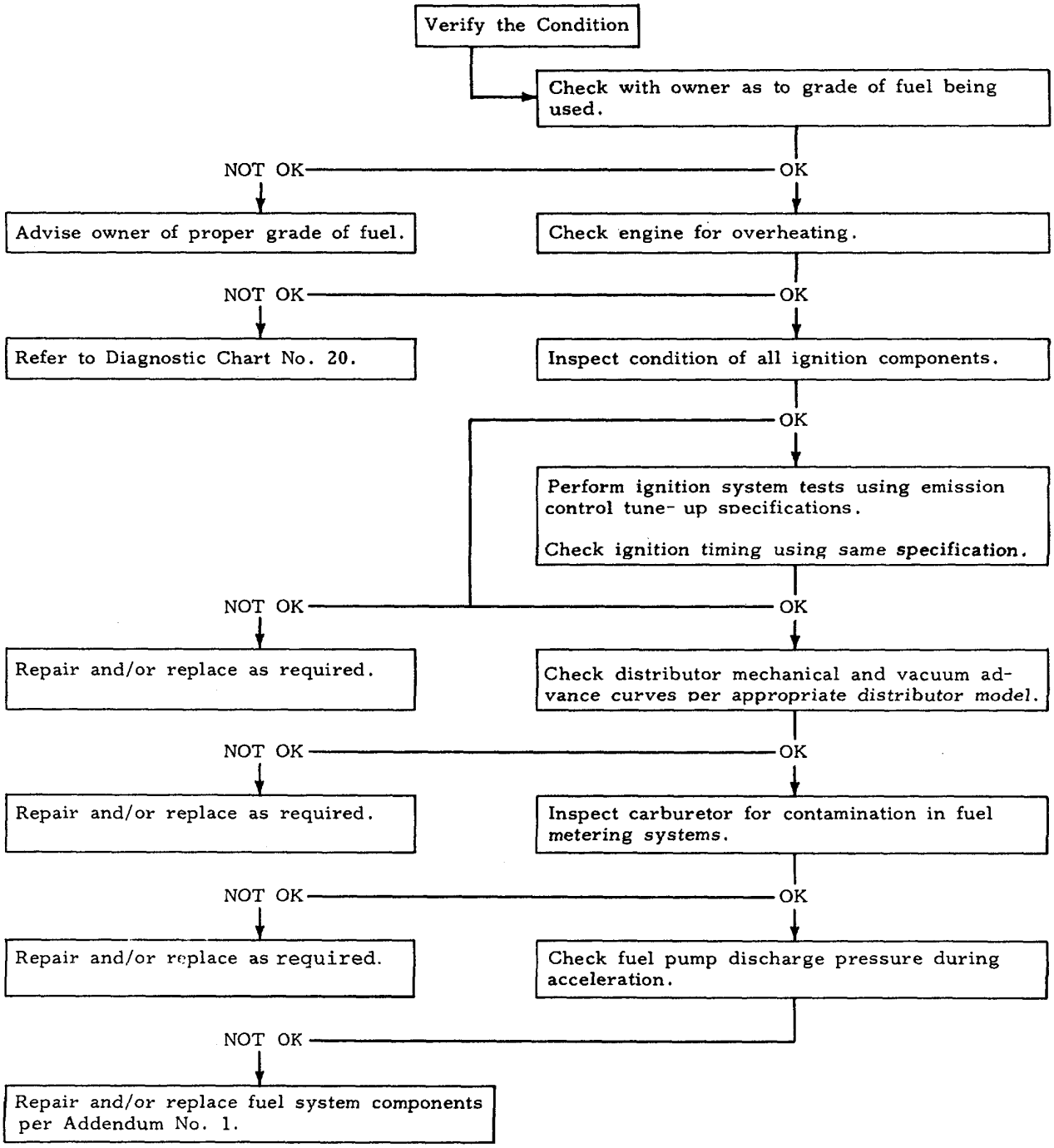
Check for loose, bent or improper pulleys. Check for front end bracket interference between rotating parts and surrounding components caused by misalignment of engine, engine components or surrounding components. Check for worn or damaged water pump or accessory components by loosening drive belts, one at a time, until noise stops.

I. Buzzing or Whistling During Engine Operation

Perform radiator cap functional check and verify proper cap sealing. If engine overheating is indicated, perform engine overheating routine. Check for interference with the fan or front end drive components by foreign material, loose or broken surrounding parts. Check for loose carburetor mounting. Check for vacuum leaks. Check power steering.

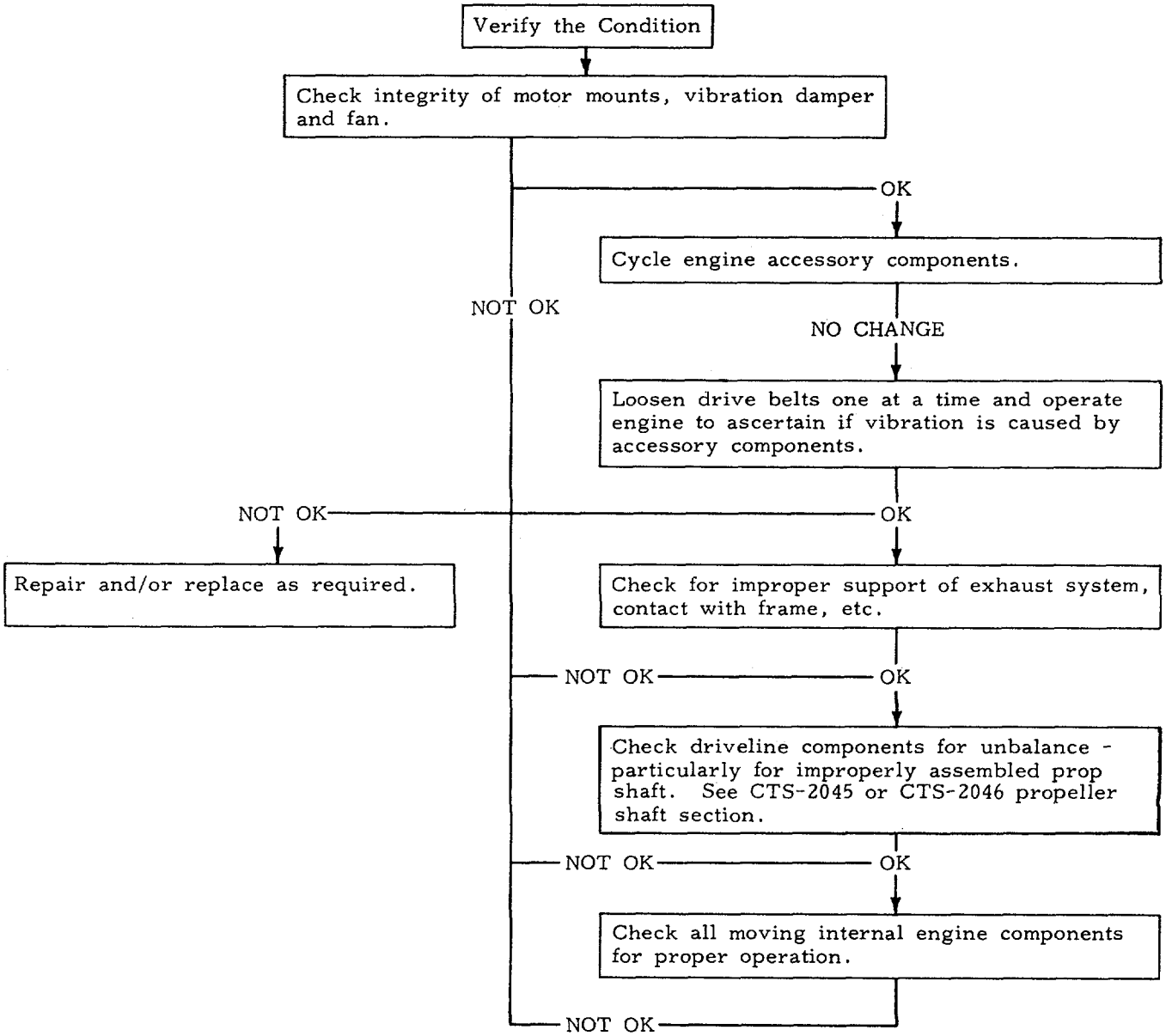
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CHART NO. 18A
SPARK KNOCK OR PINGING



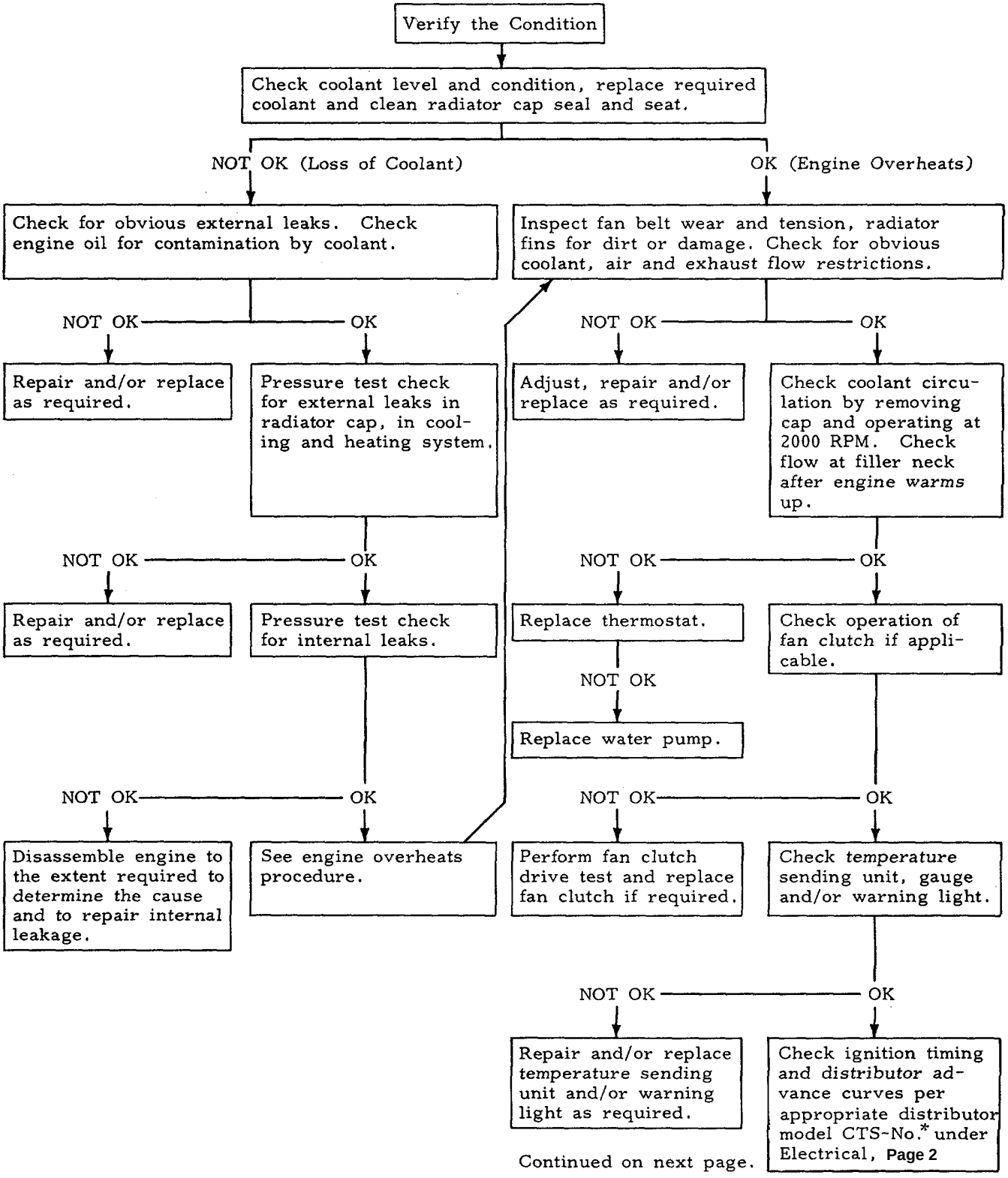
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CHART NO. 19
ENGINE VIBRATION



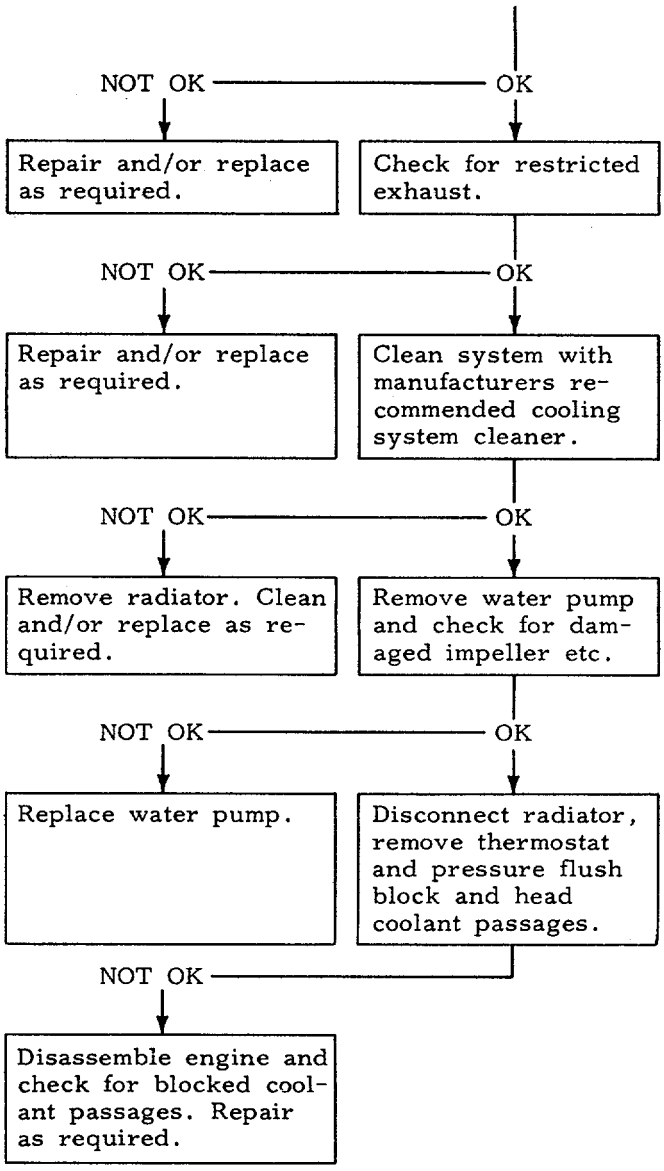
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CHART NO. 20
LOSS OF COOLANT OR ENGINE OVERHEATING



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CHART NO. 21
SMOKE FROM VEHICLE EXHAUST SYSTEM

The color or type of visible smoke from vehicle exhaust can provide clues as to the source of the problem. Three types of "smoke" are generally common to gasoline engines:

White Smoke

Visible white "smoke" in exhaust results from coolant entering the combustion chambers or exhaust system. Check for failed cylinder head gasket or cracked cylinder head casting. If ok, check for cracked crankcase.

Black Smoke

Results from overrich fuel mixture. Check for partially closed choke, or carburetor flooding condition. An overrich mixture usually causes rough engine operation. Perform steps covered in Diagnostic Chart No. 15.

Blue or Bluegray Smoke

Results from oil entering the combustion chambers or exhaust system. Check PCV system per CTS* Emission Control section.

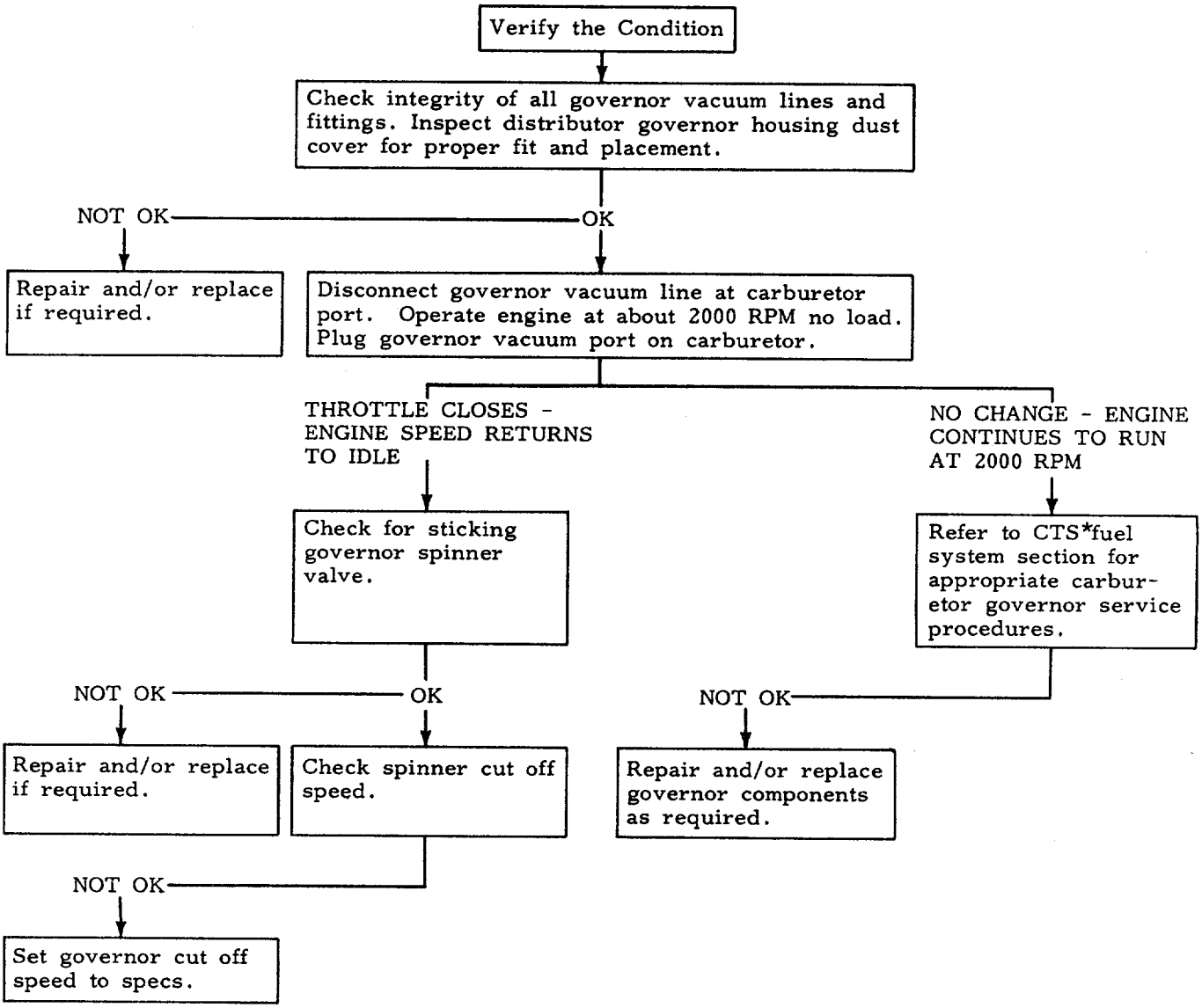
1. Blue smoke noted during wide open throttle operation indicates worn or stuck piston rings.

2. Blue smoke noted during deceleration (high vacuum) indicates failed or worn valve stem seals or worn valve guides.

Refer to appropriate CTS* engine section for repair of above difficulties.

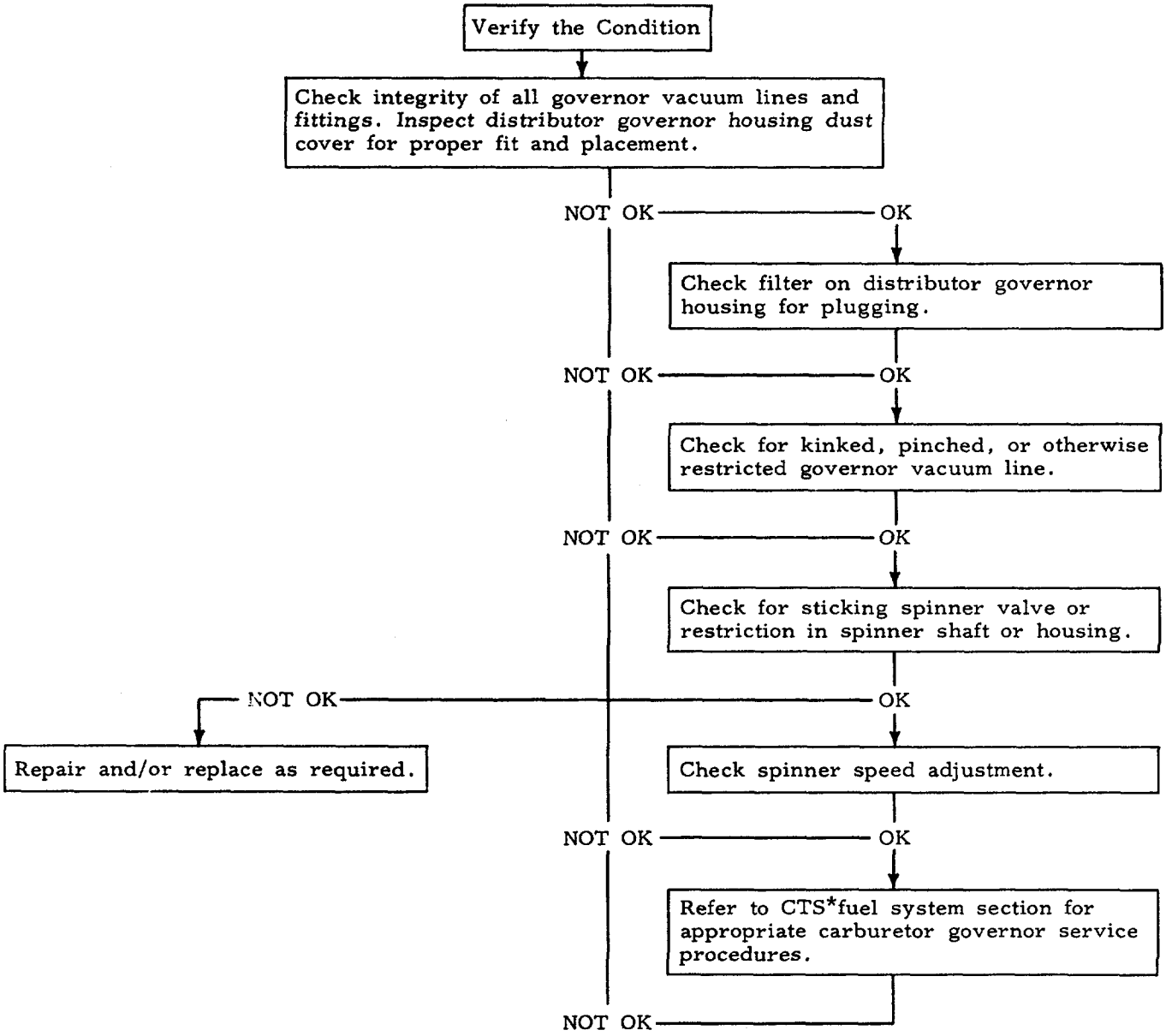
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CHART NO. 22
ENGINE GOVERNOR DOES NOT OPERATE - NO ENGINE SPEED CONTROL



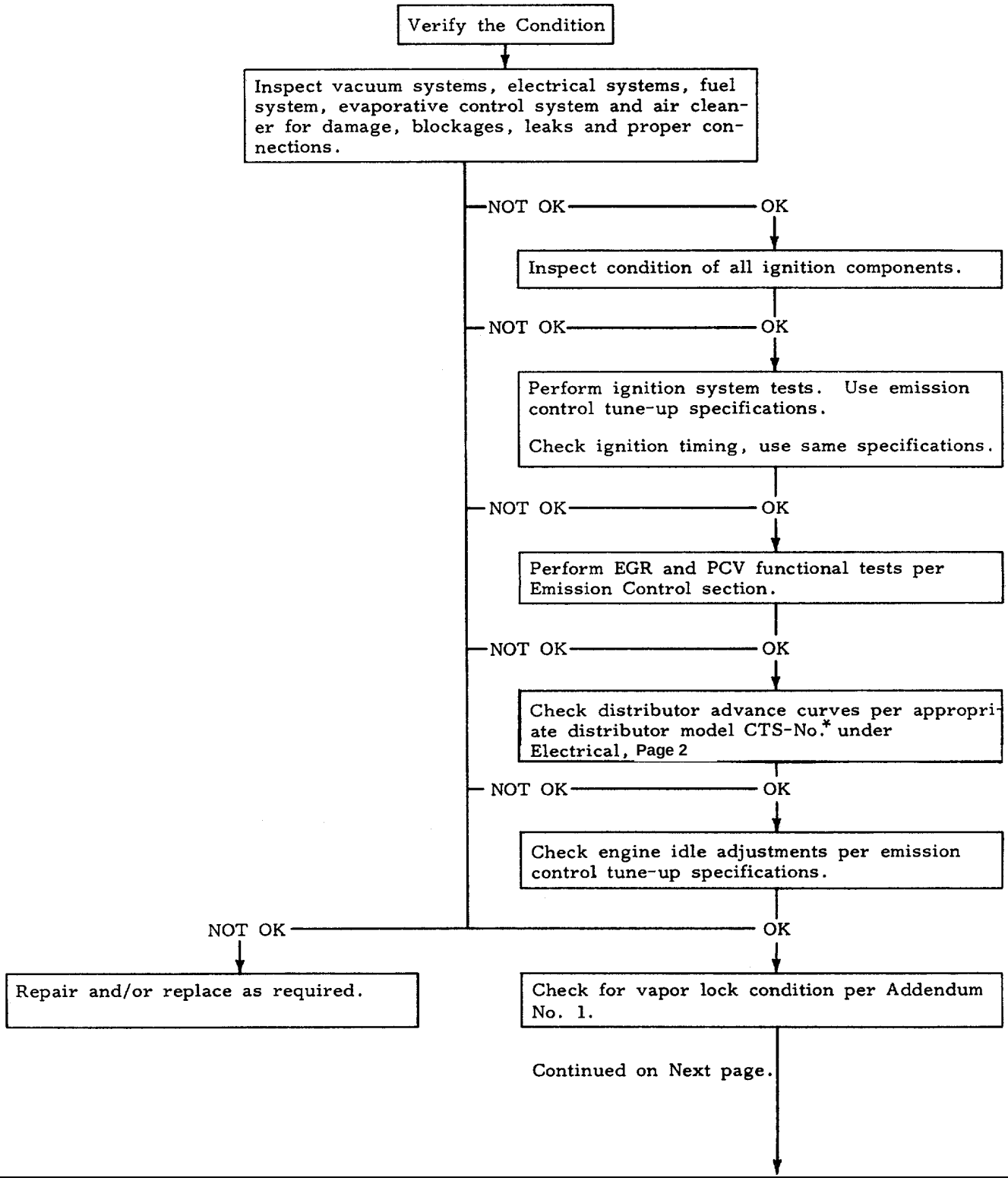
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CHART NO. 23
GOVERNOR CUTS OFF AT LOW SPEED - ERRATIC OPERATION



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CHART NO. 24
ENGINE SURGES BELOW GOVERNOR CUT OFF SPEED



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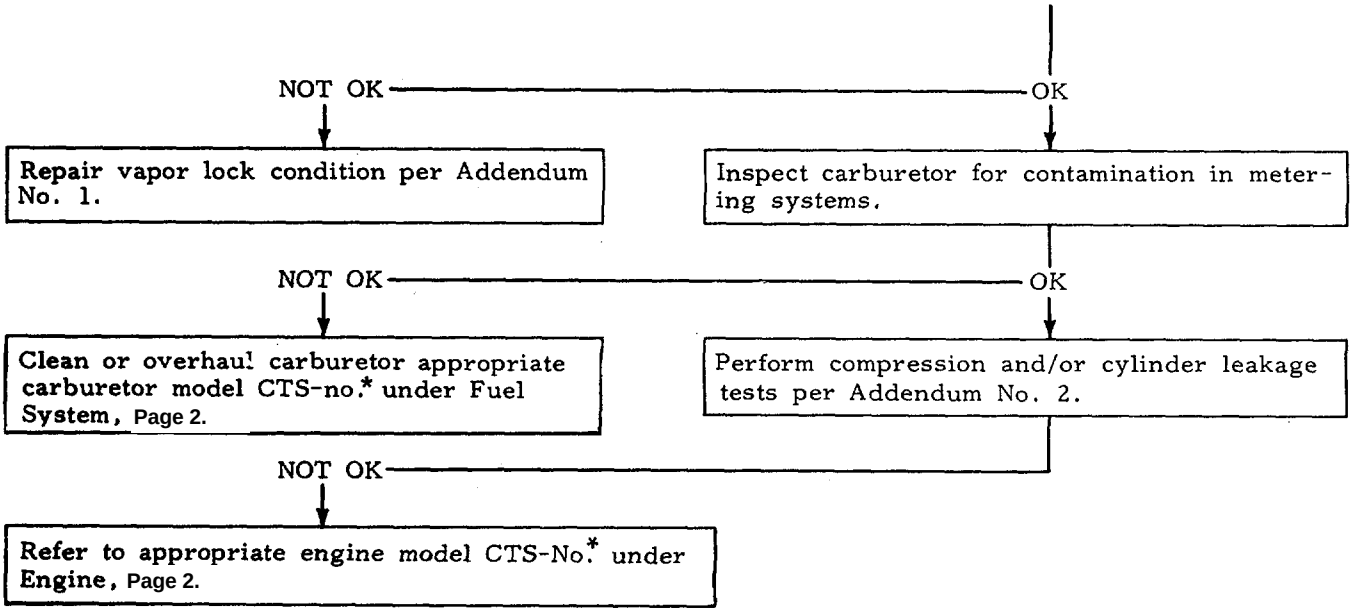
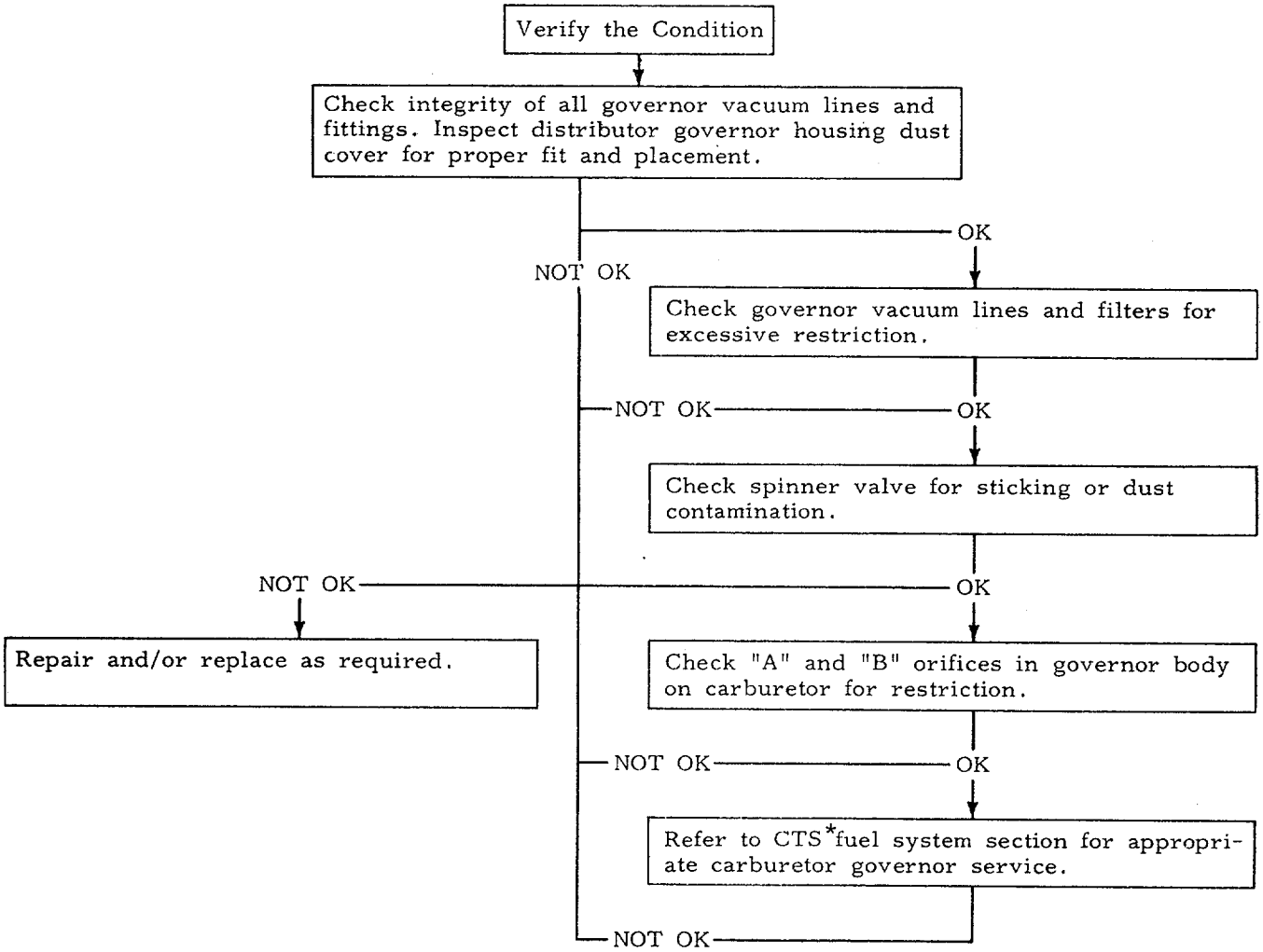

NOT OK
OK
Repair vapor lock condition per Addendum No. 1.
Inspect carburetor for contamination in metering systems.
NOT OK
OK
Clean or overhaul carburetor appropriate carburetor model CTS-no.* under Fuel System, Page 2.
Perform compression and/or cylinder leakage tests per Addendum No. 2.
NOT OK
Refer to appropriate engine model CTS-No.* under Engine, Page 2.

CHART NO. 25
ENGINE SURGES AT GOVERNOR SPEED



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ADDENDUM NO. 1
FUEL SYSTEM VAPOR LOCK

Vapor lock occurs when fuel system components become sufficiently heated to cause fuel to vaporize within fuel lines, filter, or fuel pump at a rate which prevents liquid fuel from reaching the carburetor. Vapor lock is generally associated with hot ambient conditions but can still occur in cooler climates when vehicle or engine is operated under heavy load. Vapor lock conditions are aggravated at higher altitudes.

To trouble shoot a suspected vapor lock condition, proceed as follows.

1. Do vapor lock conditions prevail? Look for hot fuel system components. Does engine run OK when cool?

2. Remove carburetor air cleaner and pump throttle by hand. Observe accelerator pump discharge. Absence of pump shot or weak discharge may indicate vapor lock. Check for presence of fuel in tank. Check for fuel system obstructions.

3. Check fuel pump discharge pressure by removing fuel line from carburetor inlet, connect fuel pressure tester to open end of fuel line (*) and crank engine. A vapor locked fuel pump will produce some pressure, although not necessarily specified pressure. Observed pump pressure as low as 1 to 2 psig indicates that the pump is probably OK but should be checked again when engine is running normally.

(*) NOTE: For this test, do not "tee" pressure tester into fuel line between fuel pump and carburetor. No pump discharge pressure would be observed because fuel vapor would be vented to the carburetor bowl through the open needle valve.

If fuel pump has measurable discharge pressure but does not pump liquid fuel when system is very hot, vapor lock is a likely cause.

4. If vapor lock is suspected as the cause for rough engine operation during cruise or acceleration it may be checked as follows.

"Tee" fuel pressure tester fitting into fuel line between fuel pump and carburetor. Place test gauge in vehicle within view of driver or passenger. Connect to fitting with flexible fuel line. Operate vehicle on highway until rough operation occurs.

Note fuel pressure during rough operation. If pressure drops to zero, vapor lock may be the cause. (Check fuel lines and filter for obstructions.)

Remove fuel pressure tester and fitting from fuel line and allow fuel system components to cool; then check to see that normal engine operation has been restored. If engine does not run, refer to Trouble Shooting Charts 4 or 5.

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ADDENDUM NO. 2
COMPRESSION AND CYLINDER LEAKAGE TESTS

Compression Test

The compression test is performed to measure cylinder compression pressure. The absolute value of compression pressure is significant but cylinder to cylinder variation is even more important. Allowable variation from cylinder to cylinder is:

Lowest cylinder pressure must not be less than 75% of the highest cylinder pressure. Greater variation from cylinder to cylinder indicates-need for mechanical repair which should be carried out in accordance with the appropriate CTS*ENGINE section.

Perform engine compression test as follows:

1. Run engine until normal operating temperature is reached.

2. Remove all spark plugs and install compression gauge in No. 1 cylinder.

3. Remove coil secondary wire from distributor cap and ground it to prevent arcing. Block carburetor throttle open.

4. Connect remote starter switch to starter solenoid or have an assistant available to crank engine.

5. Crank the engine for at least 5 compression strokes or until compression gauge reaches its highest value. Note the number of compression strokes required to reach highest value. Record compression pressure and number of strokes.

6. Repeat the test for each of the other cylinders.

7. If one or more cylinders produce a low reading, squirt about a tablespoon of engine oil into low reading cylinders. Repeat compression test on those cylinders.

a. If compression pressure improves significantly, worn or broken piston rings are at fault.

b. If compression pressure does not improve, valves are at fault or if two adjacent cylinders have low compression, a leaking cylinder head gasket may be the cause.

Cylinder Leakage Test (CLT)

The cylinder leakage test is supplemental to the compression test and can provide diagnostic information as to the cause for loss of compression. The CLT can identify leakage past intake or exhaust valves, leaking cylinder head gasket, worn or broken piston rings, or other cause for loss of compression.

Perform cylinder leakage test as follows.

1. Run engine until normal operating temperature is reached.
2. Remove spark plugs from engine.
3. Remove air cleaner and block carburetor throttle open.
4. Remove oil filler cap.
5. Remove radiator cap. If coolant is low, fill to prescribed level.
6. Turn crankshaft until No. 1 cylinder is at top dead center on compression stroke.
7. Connect and calibrate cylinder leakage tester in accordance with manufacturer's instructions.
8. Record cylinder leakage (usually in percent) and determine source of leakage by listening for air escaping through carburetor, exhaust system, or crankcase (oil filler tube). Look for air bubbles in coolant (radiator top tank),
9. Carefully turn crankshaft in normal direction of rotation until the next cylinder in firing order sequence is at top dead center. Connect CLT to that cylinder and repeat test.
10. Repeat test for each consecutive cylinder in firing order sequence.

When the cause for loss of compression has been identified, repair engine in accordance with the appropriate CTS ENGINE* section.

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ADDENDUM NO. 3
VACUUM SYSTEM HOSE LEAKAGE TEST

Perform engine vacuum system hose leakage test as follows:

1. Install vacuum gauge and tachometer. Care should be taken to insure that vacuum gauge is connected to manifold vacuum and not to some other vacuum such as ported spark or EGR signal vacuum.

2. Start and run engine until normal operating temperature is reached. Then, with engine running at curb idle speed, record vacuum gauge and tachometer reading (baseline).

3. With engine running at curb idle speed, remove each vacuum hose (one at a time) from vacuum source and plug source. When removing vacuum hose to distributor on engines which have straight manifold vacuum advance, apply at least 15 In. Hg. vacuum to vacuum advance using hand vacuum pump SE-2499 to prevent change in spark timing during test.

As each vacuum circuit is checked, record vacuum gauge and tachometer reading. If no change in reading is observed (from baseline), no vacuum leak exists in that particular vacuum hose circuit. If a change in reading is observed, a vacuum leak does exist in that particular vacuum hose circuit and can be located as follows:

a. Remove plug and reinstall vacuum hose.

b. Remove other end of same vacuum hose at next downstream connection and plug.

c. Record vacuum gauge and tachometer readings.

d. Repeat steps 4a through 4c at each hose connection until leak is isolated. Leak is isolated to last component checked when reading returns to baseline value. Replace leaking hose(s) or component(s) identified.

5. Continue procedure until the integrity of all vacuum circuits is verified or restored.

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FUEL PUMPS

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FUEL PUMP SPECIFICATIONS

Engine Model Engine Model	Type \ Drive Type Drive	Fuel Delivery Capacity Fuel Delivery Capacity	Fuel Delivery Pressure Fuel Delivery Pressure	Pump to Engine Speed Ratio Pump to Engine Pressure
4-152, 4-152E	Angular lever and cam	24.3 gal. per hr. up to 4000 rpm	*4 to 5-1/2 psi	1/2
BG-241, 241E BG-265, 265E	Angular lever and cam	20-1/2 gal. per hr. up to 3500 rpm	*3-1/2 to 4-1/2 psi	1/2
BD-282 BD-308	Angular lever and cam	20-1/2 gal. per hr. up to 3500 rpm	*3 to 4-1/2 psi	1/2
RD-372, RD-406 RD-450, RD-501	Angular lever and cam	20 gal. per hr. up to 3500 rpm	*3-1/2 to 5-1/2 psi	1/2
6-232, 6-258	Angular lever and cam	27 gal. per hr. up to 4000 rpm	*4 to 5-1/2 psi	1/2
V-266, 266E V-304, 304E V-345, 345E V-392, 392E	Angular lever and cam	27 gal. per hr. up to 4000 rpm	*4-1/2 to 5-3/4 psi	1/2
V-VS-401 V-VS-478	Angular lever and cam	30 gal. per hr. up to 4000 rpm	*4-1/2 to 5-3/4 psi	1/2
V-VS-549 V-VS-401 V-VS-478 V-VS-549	Electric In-Tank Mounting	NA	3 to 5 psi	Not Applicable
D-354	Angular lever and cam	18 gal. per hr. at 3000 rpm	5 to 8 psi	1/2
DV-462, DV-462B DV-550, DV-550B DVT-573	Electric In-Tank Mounting	NA	3 to 5 psi	Not Applicable

*NOTE: Pressures shown are those obtained on test equipment. Under operating conditions these readings may be lower depending on condition of carburetor, etc. Fuel pressure test must be taken at carburetor inlet height. The lower limit reading is obtained at open throttle and high limit reading at idle.

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DESCRIPTION

The fuel pumps used on most gasoline type engines are of the mechanical type and are mounted on the engine, Fig. 1. The suction side of the pump is connected to the fuel tank and the discharge side is connected to the carburetor by tubing designed to carry the fuel. The purpose of the pump used on gasoline type engines is to suck fuel from the supply tank and push it into the carburetor float bowl as required by the engine.

Electric fuel pumps are also used to supply the fuel from the tank to the engine. In most cases the electric fuel pump is located in the fuel tank, Fig. 2.

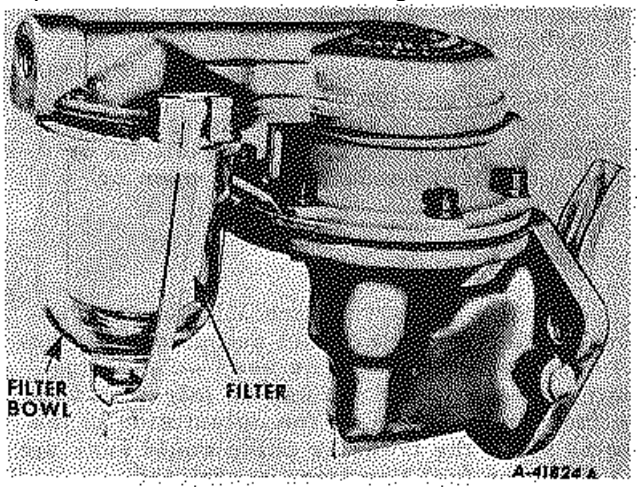


Fig. 1 Mechanical Fuel Pump (Side Mounted Bowl Type)

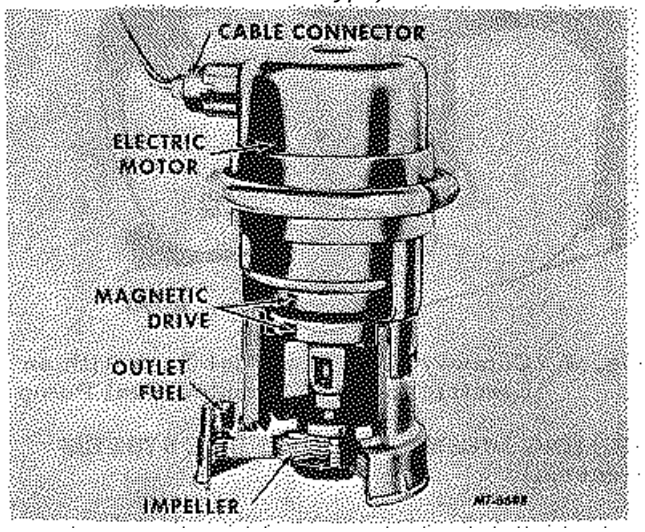


Fig. 2 In-Tank Mounted Electric Fuel Pump

OPERATION

Mechanical Fuel Pump

In general the pumping operation for all mechanical pumps is accomplished through a pump rocker arm which contacts a special cam on the engine camshaft. The rocker arm in turn actuates a diaphragm in the pump, and this action, together with the action of inlet and outlet valves in the pump, causes gasoline to flow through the pump. Pumping action is controlled, however, by fuel pressure in the pump outlet line. When the float needle valve in the carburetor is not seated and the fuel passage into the carburetor float chamber is open, gasoline will flow to the carburetor. When the needle valve is closed and held in place by the pressure of the fuel in the bowl and on the float, the pump will continue to build up pressure until it overcomes the pressure of the pump diaphragm spring. This pressure results in almost complete stoppage of diaphragm movement until further fuel is needed.

Electric Fuel Pump (In-Tank Mounted)

The in-tank mounted electric fuel pump is cushioned in neoprene to dampen vibrations and is supported by an adjustable hanger assembly, which makes it adaptable to all IH fuel tank depths. A spring-loaded latch permits easy motor replacement. Electrical connections are the sealed quick-disconnect type, Fig. 2.

MAINTENANCE

Efficient operation of the fuel pump depends on the proper maintenance of the fuel filter. For this reason the filter should be checked from time to time to note any accumulation of dirt, water, or other foreign objects. The interval for actual cleaning or replacing of the filter element is dependent on engine operating conditions.

Engines which are equipped with in-tank mounted electric fuel pump are either equipped with one or two fuel filters in the system, depending upon the type of engine. Gasoline type engines are equipped with an in-line fuel filter. A primary and secondary fuel filter are both used on diesel engine applications. The primary filter is the first filter in the line from the fuel tank. The secondary fuel filter is usually located on the engine.

To clean the wire screen disc type filter, remove the filter bowl and filter and wash these parts in a commercial carburetor cleaning-

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solvent. Blow dry with compressed air. In some cases where the paper filter is used, it is advisable to simply replace the filter. This is particularly true where fuel additives are used. Such additives can become trapped in filters, and their accumulation may cause a restriction in flow. Restricted filters are usually slippery to the touch.

When reinstalling the fuel filter and bowl always make sure the gasket and spring are in place and that the retainer screw is tight enough to prevent leakage. A leak at the gasket will cause erratic action of the pump and thus retard fuel delivery to the carburetor.

REPAIR OR REPLACEMENT

If it has been determined that fuel system troubles are being caused by a faulty fuel pump, then the pump can either be repaired or replaced. Instructions on the different types of fuel pumps are covered in subsequent paragraphs.

If fuel trouble is encountered on any chassis having an electric fuel pump, Fig. 2, and the pump is suspected, check the pump as follows: Disconnect the fuel line at the carburetor or transfer pump and turn on the ignition switch. If ample fuel flows, you do not have pump trouble. If the pump races but fuel does not flow in sufficient volume, the cause is an air leak in the suction portion of the fuel system (no fuel). If fuel does not flow at all, inspect the fuel lines or filters for restrictions or check the electrical connections for a shorted or open circuit. If all is in order and the pump still does not operate, remove the pump and replace.

INSTALLATION

Mechanical Fuel Pump

Be sure to use a new mounting gasket between the mechanical fuel pump mounting flange and the pad on the crankcase when mounting the pump on the engine. Tighten the capscrews securely.

Connect the fuel lines, first making sure that there is no dirt on the fittings which might be drawn into the system.

If the carburetor has not been removed, there will usually be sufficient fuel in it to run the engine long enough to fill the fuel pump filter bowl. If there is an air leak between the filter bowl and gasket, the pump cannot draw fuel into the bowl. To remedy this, install a new gasket and see that the bowl seats squarely. Tighten the retainer screw securely with the fingers only.

If the fuel pump bowl still does not fill, the trouble may be due to an air-bound condition. In this case, the bowl should be loosened slightly so that the air can escape, and by blowing in the gasoline tank filler neck, fuel will be forced into the pump. Then tighten the bowl securely and start the engine.

Electrical Fuel Pump (In-Tank Mounted)

(Gasoline Engines)

dirt on the fittings which might be drawn into the system.

After the pump is installed and fuel and electrical connections are made, turn on the ignition switch. If ample fuel flows, there is no trouble with the pump. If the pump races but there is no fuel flow, there is an air leak in the suction portion of the fuel system or no fuel in the tank. If no fuel flows at all, inspect the fuel lines or filters for restrictions or check electrical connections for open or shorted circuits.

(Diesel Engines)

For the most part the installation instructions for the electrical fuel pump used on diesel engines is the same as used on gasoline engines, except that air can be introduced to the fuel system even on the output side of the pump, since the transfer pump could suck air if a filter or fuel line were restricted.

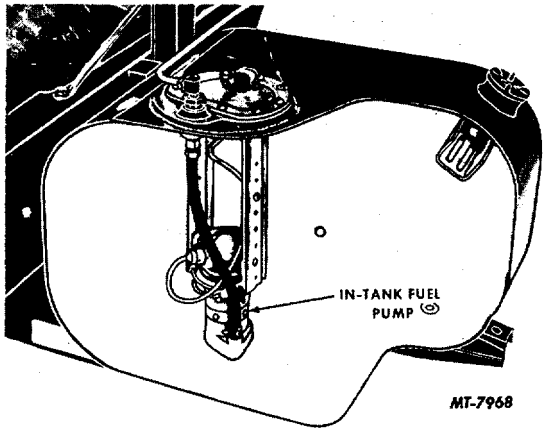


Fig. 3 Cutaway View of a Fuel Tank with an Electric In Tank Mounted Fuel Pump

PRIMING DIESEL ENGINE FUEL SYSTEM (General)
Most vehicles are now equipped with an electric primer switch which is located on the instrument panel and is used to purge air from the fuel system.

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Priming the fuel system will be required whenever a fuel filter is changed, lines are disconnected or when the electric in-tank fuel pump is replaced.

1. Be sure fuel tank has sufficient fuel.
2. Turn switch key to "ON" position. (Do not start engine.)
3. Hold primer switch to "ON" position to energize electric fuel pump.
4. Open vent valve on top of primary filter, close valve when fuel flows out in solid stream.
5. Open vent valve on secondary filter; close valve when fuel flows out in a solid stream.
6. Release primer switch.

PRESSURE CHECKING DIESEL ENGINE FUEL SYSTEM (General)

The locations for making "on-engine" transfer pump pressure checks or lift pump pressure checks are as follows:

1. Transfer Pump Pressure: This check is now made directly on injection pump. Install an adapter fitting to priming inlet at front of injection pump and connect compound test gauge (SE-2004-1) or test kit (SE-2239). Operate engine under load and check transfer pressure (25-40 psi).
2. Lift Pump Pressure (now electric fuel pump): This check is made at primary filter. Install adapter and compound test gauge (SE-2004-1) or test kit (SE2239) to priming vent on primary filter. Operate engine under load and check pressure (3 to 5 psi).

SERVICE FUEL PUMP

Screen Filter Type

Disassembly

The disassembly of mechanical pumps having the screen filter, Fig. 4, can be accomplished in the following manner:

1. Remove the cover bolt, cover and cover gasket. Also remove the screen disc filter.
2. Match-mark the valve housing and pumpbody to assure correct reassembly of parts.
3. Remove the screws which hold the valve housing on the pump body. Separate the housing from the body.
4. Remove the fuel valve retainer screws and retainer and lift the inlet and outlet valves and gaskets out of the valve housing.
5. Unhook the diaphragm from the diaphragm lever and pull the diaphragm and pull rod assembly straight out to prevent damage to the oil seal. Remove the diaphragm spring.
6. Remove the oil seal retainer and oil seal from the pump.
7. If necessary to replace the cam lever, remove the pin retainers from the end of the rocker arm pin. Drive out the pin and withdraw the cam lever spring and diaphragm lever from the pump body.

Inspection

If a fuel pump is overhauled, the diaphragm gaskets, valves, cam lever, spring and diaphragm lever should always be replaced whether these old parts appear serviceable or not. Fuel pump repair kits containing these parts are available. All other parts should be inspected as follows:

1. Inspect the pump body and valve housing for cracks and breakage.
2. Check the pump body, valve housing and cover against a flat surface for warpage.
3. Examine the pump body and valve housing for stripped or crossed threads.
4. Replace screen.
5. Check the cam lever for wear at the camshaft pad and also for wear at the point contacted by the diaphragm lever.
6. Check the springs for corrosion, fracture or weakness.

Assembly

All fuel pumps having the screen filter will have an assembly procedure similar to the following. Refer to Fig. 4 for numbers in parentheses.

1. If the cam lever (21) was removed, place seal (16), seal retainer (15) and spring (14) in pump body (17) and install pull rod of diaphragm assembly (13) through spring, retainer and seal. Assemble diaphragm lever (22) with cam lever (24) and insert hooked end of lever through opening in pump body (17) and engage with diaphragm pull rod. Make sure lever spring (19) is also in place. Obtain a piece of welding rod or

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stock having a diameter slightly less than the cam lever pin (24), and using this rod as an aligning tool, temporarily hold the rocker arm and lever assembly in place.

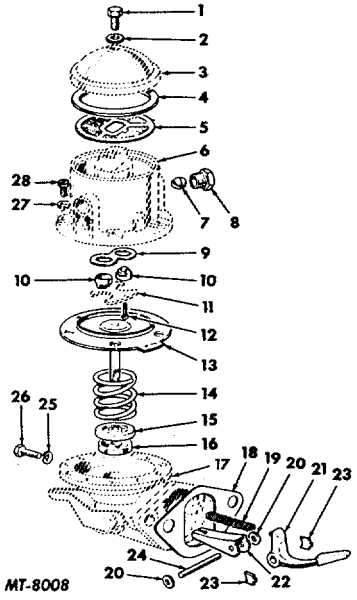


Fig. 4 Exploded View Screen Filter Type Fuel Pump

Legend for Fig. 4

Key	Description
1	BOLT, Cover
2	WASHER, Cover Bolt
3	COVER
4	GASKET, Cover
5	SCREEN, Filter
6	HOUSING, Valve
7	SLEEVE, Compression Tube
8	NUT, Compression Tube
9	GASKET, Inlet and Outlet Valve
10	VALVE, Inlet and Outlet
11	RETAINER, Valve
12	SCREW, Valve Retainer
13	DIAPHRAGM, Pump
14	SPRING, Diaphragm
15	RETAINER, Oil Seal
16	SEA L, Oil
17	BODY, Pump
18	GASKET, Mounting
19	SPRING, Lever
20	WASHER, Rocker Arm
21	LEVER, Cam
22	LEVER, Diaphragm
23	RETAINER, Pin
24	PIN, Cam Lever
25	WASHER, Lock, 5/16 Medium
26	BOLT, Hex Head, 5/16 NF x 7/8
27	WASHER Housing Screw
28	SCREW, Housing

2. Push new pin (24) through the body and cam lever assembly as the aligning rod is drawn out. Install new washer (20) on the end of the pin and install new pin retainers in pump body.

3. Place gasket (9) and valves (10) in valve housing (6) and hold the valves in place with valve retainer (11) and screws (12). To make sure the valves are installed correctly, note that the flat side of the outlet valve must face toward the diaphragm and that the inlet valve is just opposite.

4. Depress the rocker arm enough to bring the diaphragm level with the pump body and hold the rocker arm in this position by means of a wedge or tool. Place pump valve housing (6) over the diaphragm, matching up the alignment marks of the valve housing with the pump body.

5. Install cover screws (28) and lockwashers (27) and partially tighten the screws but do not compress the lockwashers. Remove the wedge or tool from the rocker arm and operate the rocker arm a few times before tightening the valve housing down securely.

6. Place screen assembly (5) and gasket on the valve housing. Then position the cover (3) on pump assembly and install the cover bolt (1) and washer (2).

Suspended or Side-Mounted Bowl Type

The suspended bowl type fuel pump, Fig. 5, and the side-mounted bowl type fuel pump, Fig. 6, are disassembled in the following manner:

1. Loosen the fuel bowl retainer and remove the retainer, fuel bowl gasket and paper or ceramic element.

2. Use pliers and remove the cam lever return spring.

3. Pry out the cam lever shaft seal plug and also remove the shaft retaining spring pin to permit removal of the cam lever pin. Take out the cam lever.

4. Match-mark the edges of the valve housing assembly and pump body assembly with a file to assure correct alignment at reassembly.

5. Remove the valve housing-to-pump body mounting screws and separate the valve Lousing assembly from the pump body.

6. Pull the diaphragm and spring assembly from the pump body.

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7. Take out the two valve housing-to-air dome and filter cover mounting screws and separate the valve housing from the air dome and filter cover. Remove the air dome diaphragm.

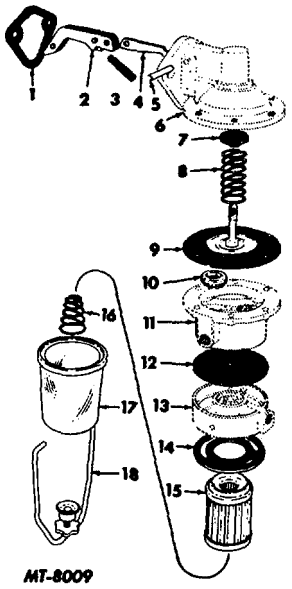


Fig. 5 Exploded View of Suspended Bowl Type Fuel Pump

Legend for Fig. 5.

Key	Description
1	GASKET, Mounting
2	LEVER, Cam
3	SPRING, Cam Lever
4	LEVER, Diaphragm
5	PIN, Cam Lever
6	BODY, Pump
7	SEAL, Oil Assembly
8	SPRING, Diaphragm
9	DIAPHRAGM, Pump
10	VALVE, Inlet and Outlet
11	HOUSING, Valve
12	DIAPHRAGM, Air Dome
13	COVER
14	GASKET, Element Bowl
15	ELEMENT, Paper or Ceramic
16	SPRING, Element (If Used)
17	BOWL, Fuel
18	RETAINER, with SCREW

Inspection

Whenever the fuel pump is serviced there are some parts which should always be replaced whether the old parts appear serviceable or not. These parts are the diaphragm assembly, air dome diaphragm, filter bowl gasket, ceramic or paper filters, valve and cage, cam lever shaft seal plug and the pump to-crankcase gasket. Fuel pump repair kits containing all these parts are available. All other parts should be inspected as follows:

1. Inspect the pump body, valve housing, air dome and filter cover for cracks or breakage in castings.

2. Check the mating surfaces of castings for warpage.

3. Inspect the body and cover for stripped screw threads.

4. Check the rocker arm for wear at the cam-shaft contact point and also at the pivot point.

Assembly

All suspended or side-mounted bowl type fuel pumps will have an assembly procedure similar to the following. Refer to Fig. 6.

1. Place new air dome diaphragm (9) on the dome section of air dome and filter cover (10). Position the open half of the diaphragm over the inlet section of the air dome.

2. Install the valve and cage assembly in the valve housing if they were removed.

3. Assemble valve housing assembly (7) to the air dome and filter cover assembly so that the intake side of the housing mates with the intake side of the air dome. Insert two mounting screws (6) with lockwashers and tighten securely.

4. Install new diaphragm assembly (5) to pump body (20).

5. Insert cam lever (1) into the opening in the pump body. Compress the diaphragm spring slightly so that the forked end of the cam lever engages under the retainer on the end of the diaphragm spring.

6. Fasten the cam lever in the pump body with cam lever pin (21) and secure the pin with cam lever shaft retaining spring pin (4). Seal the pin opening in the pump body with cam lever shaft seal plug (3).

7. Check the matchmarks made at the time of disassembly on the pump body and valve housing assembly and install the valve housing assembly to the pump body.

8. Install mounting screws (8) with lockwashers but tighten only enough for the screws to just touch the lockwashers.

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9. Clamp the pump in a vise having soft jaws. Pull the cam lever to the full intake position and hold while tightening the housing to the pump body mounting screws. This will allow the diaphragm to position itself properly.

10. Place filter bowl gasket (11), new filter (12r, filter spring (14) and filter bowl (15) over the cover section of air dome and filter cover (10) and secure in place with retainer (16).

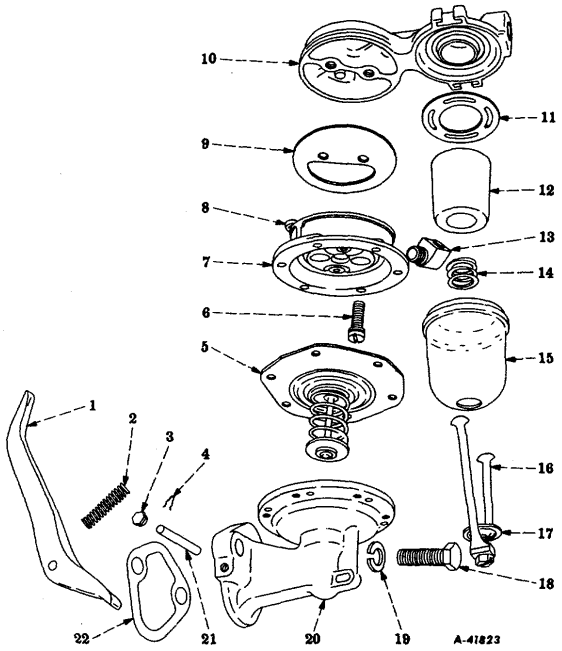


Fig. 6 Exploded View of Side-Mounted Bowl Type Fuel Pump

Legend for Fig. 6

Key	Description	Key	Description
1	LEVER, Cam	12	FILTER, Glazed Ceramic or Paper
2	SPRING, Cam Lever Return	13	ELBOW
3	PLUG, Cam Lever Shaft Seal	14	SPRING, Filter
4	PIN, Spring, Cam Lever Shaft Retaining	15	BOWL, Filter
5	DIAPHRAGM, Assembly	16	RETAINER, with Screw Assembly
6	SCREW, with Lockwasher, Assembly	17	WASHER, Filter Bowl Retaining
7	HOUSING, Valve Assembly	18	BOLT, Hex Head
8	SCREW, with Lockwasher, Assembly	19	LOCKWASHER
9	DIAPHRAGM, Air Dome	20	PUMP BODY
10	AIR DOME and FILTER COVER	21	PIN, Cam Lever
11	GASKET, Filter Bowl	22	GASKET, Pump-to-Crankcase

Electric In-Tank Mounted Type

There is no service on the in-tank mounted electric fuel pump -- only complete replacement of the pump itself.

Do not disassemble the electric fuel pump.

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FUEL INJECTION NOZZLES

FOR IH DIESEL ENGINES
MODELS D-150, D-170, D-190

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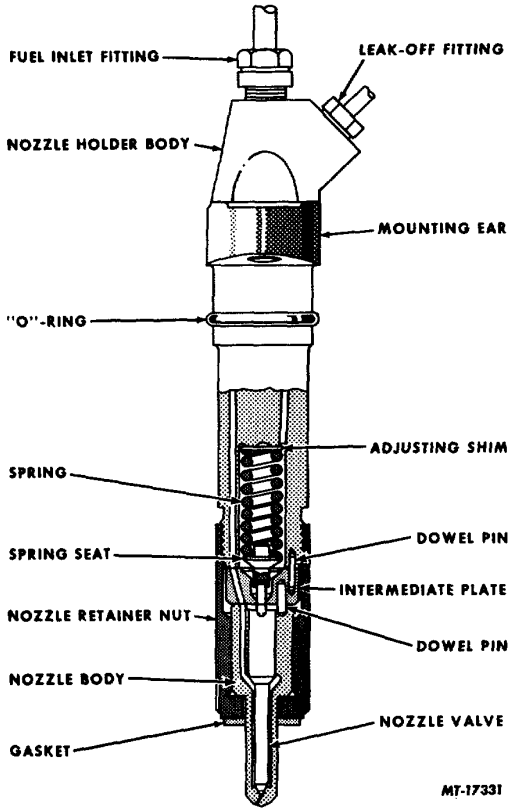


Fig. 1 Sectional View of Injection Nozzle Assembly

DESCRIPTION

The injection nozzles are of the inward opening, differential hydraulically operated, spray hole type. Their function is to direct a metered amount of fuel, under high pressure from the fuel injection pump, into the engine combustion chamber.

The injection nozzle assembly consists of two principal sub-assemblies, the spray nozzle and the nozzle holder. Fig. 1 illustrates a section view of the injection nozzle assembly.

Spray Nozzle

The spray nozzle, Fig. 2, consists of two parts; the nozzle body and the nozzle valve. These parts are lapped to form an extremely close-fitting matched set. (Body and valve cannot be exchanged singly but must be used together and

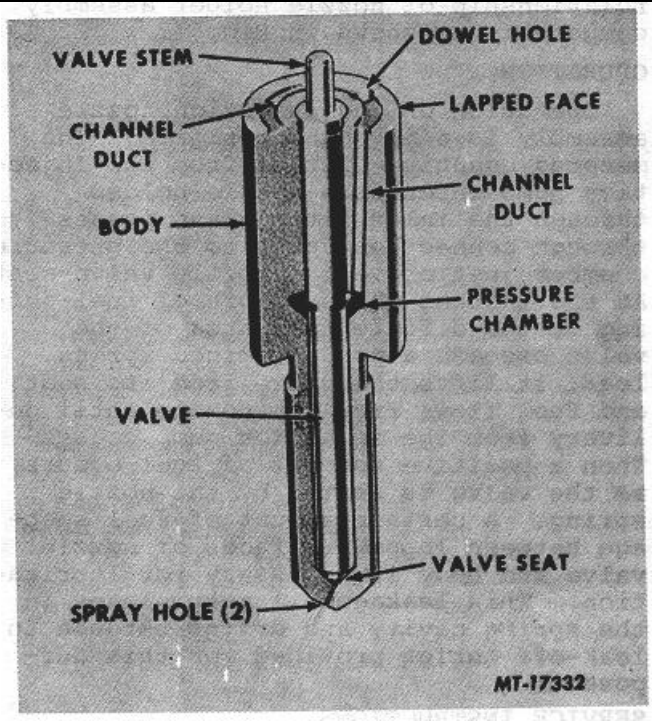


Fig. 2 Cut-Away View of Nozzle Valve And Body

replaced as an assembly.)

The spray nozzle incorporates spray holes (orifices) beneath the valve seat in the tip of the nozzle body. These spray holes are sized and located to provide a spray pattern of finely atomized fuel to produce the most efficient combustion and engine performance.

Nozzle Holder

The nozzle holder is used to hold the nozzle in its correct position in the cylinder head and to provide channels for conducting fuel oil to the nozzle. The holder also contains the spring retainer (intermediate plate), spring and shims for adjusting the opening pressure of the nozzle valve. The lower end of the holder has an accurately ground and lapped surface which makes a leakproof and pressure tight seal with the corresponding lapped surface at the upper end of the spring retainer (intermediate plate). The intermediate plate mates with the lapped surface of the upper end of the nozzle. The nozzle and intermediate plate are held in alignment by dowel pins and are secured to the nozzle

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holder by the nozzle retainer nut. The relationship of nozzle holder assembly components is shown in Fig. 1.

OPERATION

Operation of the injection nozzle assembly is simple and positive. The metered quantity of fuel from the injection pump enters the nozzle holder through the inlet fitting and passes through connection ducts to the pressure chamber just above the nozzle valve seat. At the instant the pressure of fuel acting on the differential area of the valve exceeds a predetermined spring load, it lifts the valve from its seat and fuel flows from the nozzle until delivery from the injection pump ceases. Then a positive cut-off of fuel occurs as the valve is seated by the nozzle spring. A certain amount of fuel seepage between lapped surfaces of nozzle valve and body is necessary for lubrication. This leakage oil accumulates in the spring cavity and drains through to leak-off outlet provided for this purpose.

SERVICE INSTRUCTIONS

Where ideal conditions of good combustion, specified engine temperature control and absolutely clean fuel prevail, nozzles require little attention.

Nozzle trouble is usually indicated by one or more of the following symptoms:

1. Smoky exhaust (black)
2. Loss of power
3. Misfiring
4. Increased fuel consumption
5. Combustion knock
6. Engine overheating

While the above faults may be caused by defective nozzles, they may also be caused by other engine troubles such as wrong fuel, water in fuel, dirty or damaged filters, incorrect maximum fuel setting, faulty injection pump, defective engine lubrication, incorrect pump timing, or faulty engine valves.

Where faulty nozzle operation is suspected on an engine that is misfiring or puffing black smoke, a simple test can be made to determine which cylinder is causing the difficulty.

With the engine running at a speed that makes the defect most pronounced, momentarily loosen the high pressure fuel inlet connection on one nozzle assembly sufficiently to "cut out" the cylinder. Check each cylinder in the same manner. If one is found where loosening makes no difference in the irregular operation or causes puffing of black smoke to cease, the injection nozzle, for that cylinder should be tested.

Nozzle testing, disassembly, cleaning and reconditioning must be done only by an authorized IH Service Station or other diesel service outlet equipped and qualified to perform such services.

When servicing injection nozzle assemblies, the necessity of cleanliness cannot be over-emphasized. A clean workbench, clean washing fluid containers, clean tools and clean hands are all essential to produce satisfactory results.

Removal

1. Before removing nozzle assemblies, clean exterior of each nozzle assembly and the surrounding area with clean fuel oil or solvent to prevent entry of dirt into engine when nozzle assemblies are removed. Also, clean fuel inlet and fuel leak-off piping connections.

2. Disconnect fuel inlet (high pressure) and fuel leak-off pipes from each nozzle assembly. Cover open ends of pipes to prevent entry of dirt.

3. Remove nozzle mounting bolts and pull nozzle assembly with "O" ring and gasket from engine. If assembly seems stuck, rotate it slightly to break it loose from carbon deposits in the cylinder head recess. Be careful not to strike the nozzle tip against any hard surface during removal.

   Cover nozzle assembly fuel inlet and leak-off openings with plastic caps to prevent entry of dirt. Also protect nozzle tip.

4. Place nozzle assemblies in a holding fixture (SE2102) as they are removed from the heads, Fig. 3. The fixture is stamped with numbers corresponding to the cylinder numbering of the engine. Use of this fixture permits replacing nozzles in their respective ports in the cylinder heads.

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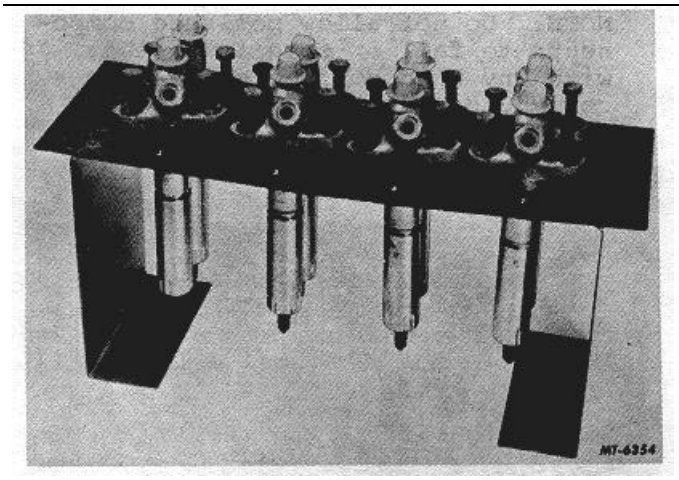


Fig. 3 Nozzle Holding Fixture

Nozzle Operation Test

After removal from the engine, the nozzles should be tested for proper operation on a nozzle test pump. This test will give valuable information about the condition of the nozzles and indicate where service is required. Fig. 4 shows an injection nozzle mounted for testing on the SE2002 Hydraulic Test Pump. The nozzle test procedure is outlined below.

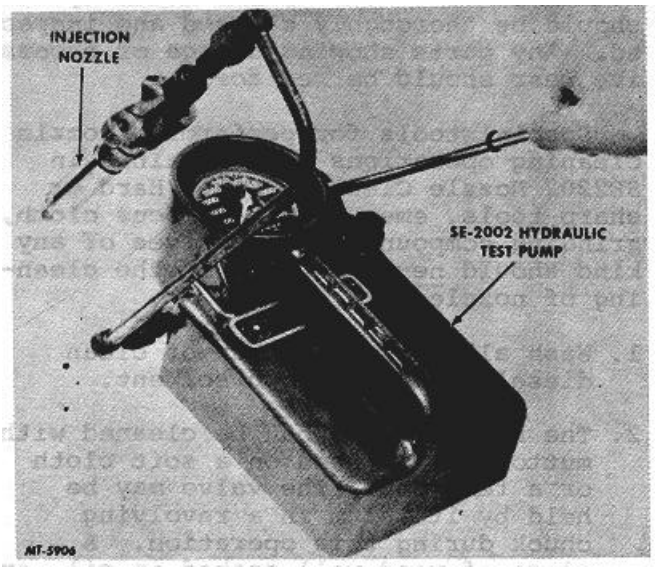


Fig. 4 Nozzle Assembly Mounted in Test Pump

1. Prepare pump for making tests. Fill pump reservoir with clean No. 2 diesel fuel. Open pump valve slightly and operate pump handle to expel air from pump and outlet pipe. Operate pump until solid fuel (without air bubbles) flows from end of outlet pipe. Close pump valve.

2. Connect injection nozzle to test pump. Notice that connector nut has right hand threads for connecting to the injection nozzle and left hand threads for connecting to the pump outlet pipe. Be careful to start connector nut on threads of injection nozzle and outlet pipe at the same time to assure equal tightening. Avoid "cross-threading". Tighten connector nut securely with end wrench.

3. Bleed air from nozzle. Open pump valve and operate pump for several quick strokes to expel (bleed) air from injection nozzle. Fuel should spray from the spray holes in nozzle tip.

   CAUTION: Keep hands away from nozzle spray. Fuel spraying from the nozzle under new high pressure can penetrate the skin and cause infection.

4. Check spray pattern. Operate test pump in smooth, even strokes and observe pattern of fuel spraying from nozzle tip spray holes. The spray should be finely atomized in an even pattern, free from irregular streaks and dribbling. Examples of good and bad spray patterns are shown in Fig. 5.

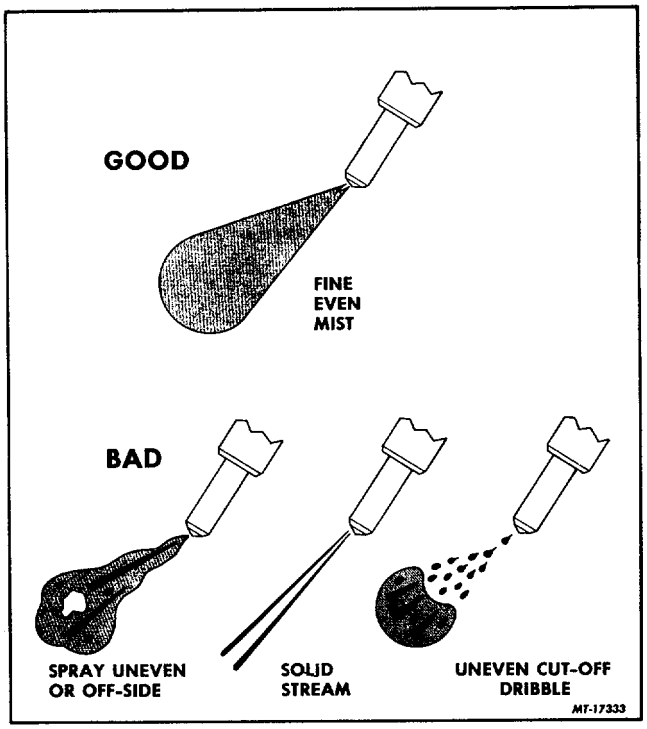


Fig. 5 Nozzle Spray Patterns

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5. Check nozzle opening pressure. Open gage valve, operate test pump in smooth, even strokes and observe pressure gage to determine pressure at which nozzle opens (sprays fuel). Nozzle should operate within specified opening pressure range. See "Specifications".

6. Check for tip leakage. Wipe nozzle tip dry. Operate test pump to maintain pressure at about 500 psi below opening pressure. Nozzle tip should remain dry without an accumulation of fuel drops at spray holes. A slight wetting after about 10 seconds is permissible if no droplets are formed.

7. Check fuel leak-off. Operate test pump in quick strokes and observe for flow of fuel from leak-off part of nozzle. A very slight leak-off is normal. If an excessive amount of fuel is expelled or if fuel surges from leak-off port when test pump is operated, nozzle is faulty.

If nozzle passes above tests, it is suitable for further service in the engine following external cleaning and removal of accumulated carbon. Nozzles showing irregular spray pattern, leakage at nozzle tip spray holes, excessive fuel leak-off or opening pressure below minimum permissible limit should be replaced or serviced (disassembled, cleaned and rebuilt).

Disassembly

Disassembly of the nozzle holder assembly for cleaning, inspection and service can be accomplished as follows:

1. Wipe all dirt and loose carbon from the nozzle assembly with a clean, lint free cloth.

2. Use a holding fixture to clamp nozzle holder assembly in vise. A suitable holding fixture can be made locally from dimensions shown in Fig. 6.

   NOTE: Do not clamp nozzle assembly directly in vise.

3. Use a 12 point deep socket to loosen nozzle retainer nut. (Fig. 6)

4. Remove nozzle retainer nut slowly and remove spray nozzle intermediate plate and other parts.

   NOTE: Do not allow polished components to fall or come in contact with any hard surface since this could cause damage.

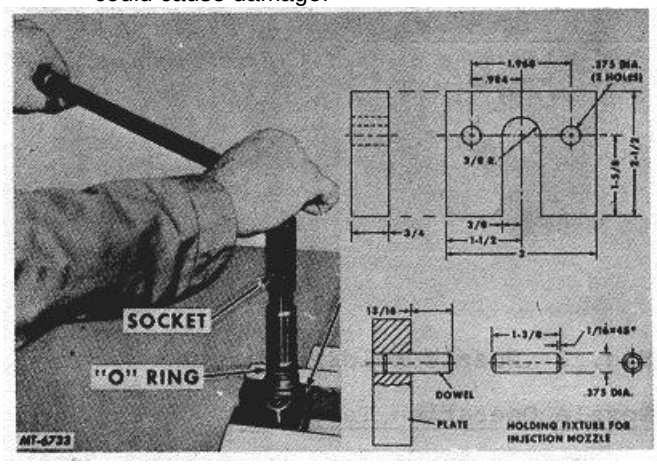


Fig. 6 Loosening Nozzle Retainer Nut

5. Remove nozzle valve from nozzle body. It may be necessary to soak the nozzle in fuel oil or carbon solvent, before removal is possible.

Cleaning and Inspection

All parts of the nozzle assembly should be thoroughly cleaned and inspected. Any parts showing damage or excessive wear should be replaced.

Special tools for performing nozzle cleaning operations are contained in SE2202 Nozzle Cleaning Set. Hard or sharp tools, emery cloth, crocus cloth, grinding compounds or abrasives of any kind should never be used in the cleaning of nozzles.

1. Wash all parts in a pan of clean diesel fuel or carbon solvent.

2. The nozzle valve can be cleaned with mutton tallow used on a soft cloth or a felt pad. The valve may be held by its stem in a revolving chuck during this operation. A piece of wood well soaked in oil, or a brass wire brush will be helpful in removing carbon from the valve. (Fig. 7)

3. Clean outer surface and tip of nozzle body with soft cloth or brass wire brush (Fig. 8). Do not scrape carbon from surface around orifices or damage may result.

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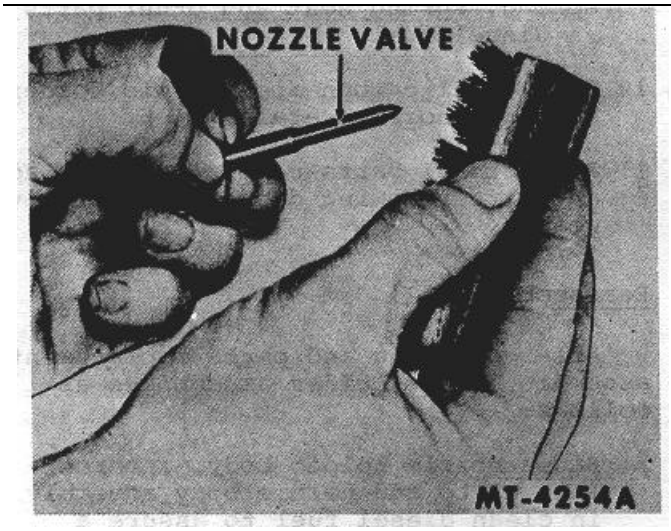


Fig. 7 Cleaning Nozzle Valve

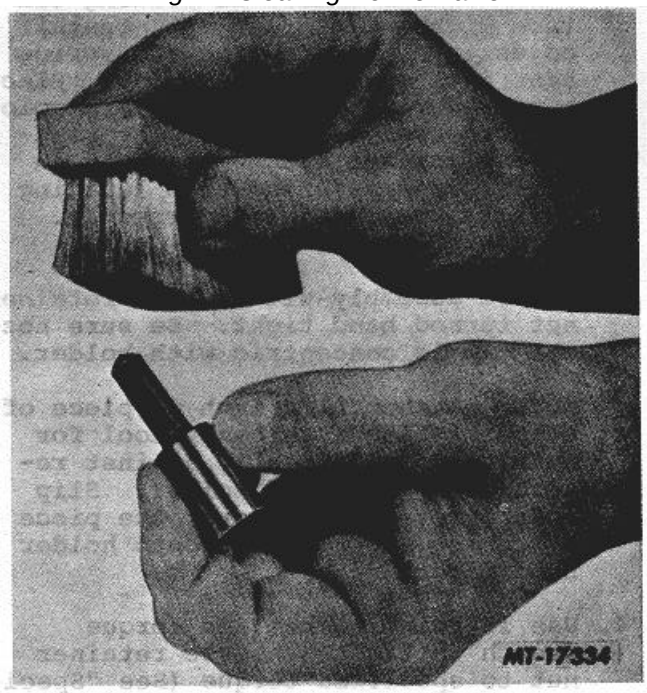


Fig. 8 Cleaning Nozzle Body Tip

4. Use special scraper from nozzle cleaning tool kit to clean pressure chamber area of nozzle body as shown in Fig. 9.

5. Use special valve seat scraper from tool set to nozzle valve seat area of nozzle body as shown in Fig. 10.

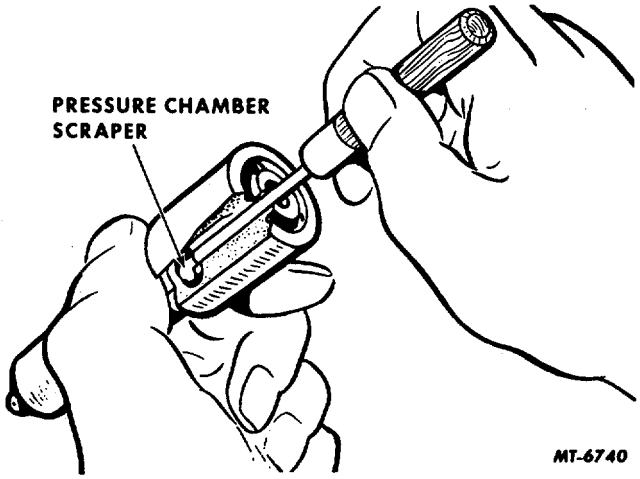


Fig. 9 Cleaning Nozzle Body Pressure Chamber

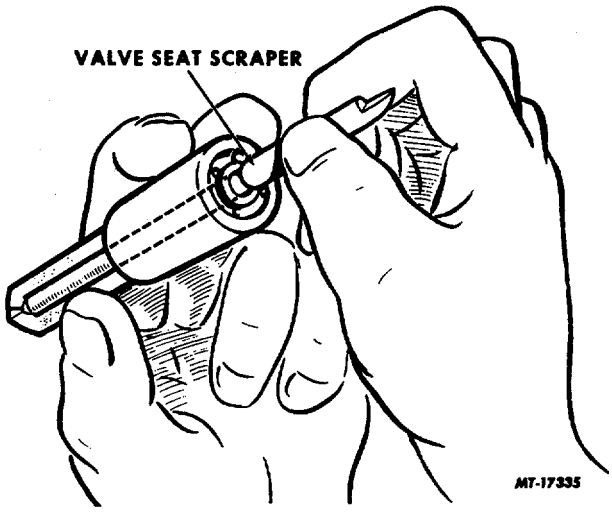


Fig. 10 Cleaning Nozzle Valve Seat

6. Use cleaning needle and pin vise (Fig. 11) from tool set to clean nozzle tip spray holes. Because hole sizes differ it is important to use proper size cleaning needles (see "Specifications"). Spray hole identification is illustrated in Fig. 12.

7. Use tallow or wood polishing stick from nozzle cleaning tool kit to polish nozzle valve seat (Fig. 13).

8. Thoroughly rinse nozzle body and nozzle valve in clean diesel fuel and assemble.

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Fig. 11 Cleaning Spray Holes

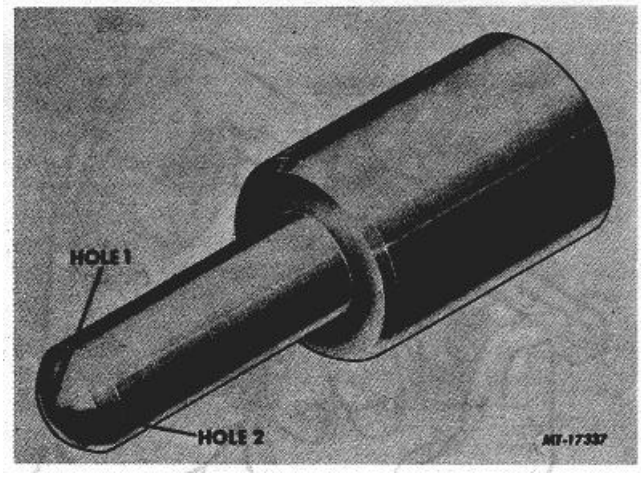


Fig. 12 Spray Hole Identification

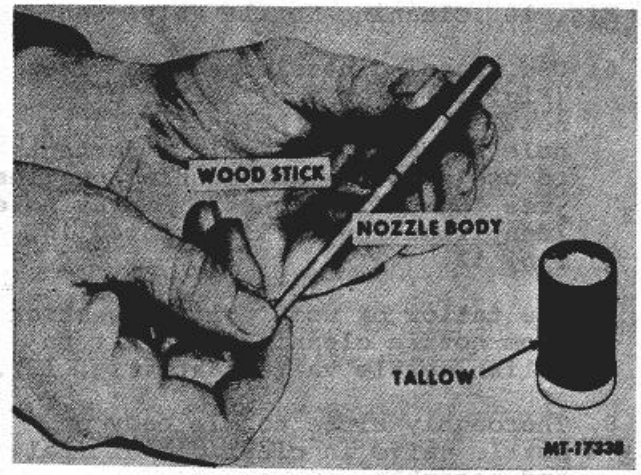


Fig. 13 Polishing Nozzle Valve Seat

9. Wash and rinse intermediate plate, spring, spring seat and other parts in diesel fuel.

10. Remove all carbon from nozzle holder body and nozzle retainer nut.

11. Inspect all parts carefully. Replace any parts showing damage or excessive wear.

Reassembly

After cleaning and parts replacement, assemble nozzle holder assemblies as follows:

1. Rinse nozzle holder body, intermediate plate and nozzle body assembly in clean diesel fuel to assure a clean seat between lapped faces.

2. Place nozzle holder in holding fixture with lapped face up. Install adjusting shims, spring and spring seat into nozzle holder body. Place hardened wear shim (darkest in color) next to spring. Install intermediate plate and nozzle assembly on holder body assuring that locating dowels are positioned correctly. (See Fig. 1)

3. Secure assembly with nozzle retainer nut turned hand tight. Be sure nozzle tip is concentric with holder.

   NOTE: A short 1/4 inch OD piece of copper tubing is a handy tool for holding nozzle tightly against retainer or plate and holder. Slip nozzle retainer nut over the piece of tubing and turn nut onto holder hand tight.

4. Use 12 point socket and torque wrench to tighten nozzle retainer nut to specified torque (See "Specifications").

5. Mount nozzle holder assembly in nozzle test pump and check nozzle operation. (See "Nozzle Operating Test"). If nozzle opening pressure is not within limits specified for new or rebuilt nozzles (See "Specifications") adjust by adding or removing adjusting shims at top end of springs. Be sure hardened wear shim (darkest in color) is placed next to spring.

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Check for leakage between lapped surfaces of nozzle body, intermediate plate and nozzle holder body. Leakage may be either internal or external. External leakage is visible at nozzle retainer nut, and internal leakage is visible at leakoff outlet. Do not attempt to cover leakage by overtightening nozzle retainer nut. Remove nozzle and re-examine pressure faces for dirt or burrs on surface. Clean and retest.

Check spray pattern. Fuel should be finely atomized and free from streaks. If spray pattern is faulty check for dirty or damaged spray holes.

6. Cover fuel inlet and leak-off openings and protect nozzle tip.

Installation

1. Thoroughly clean nozzle bore in cylinder head before reinserting nozzle holder assembly. Pay particular attention to seating surfaces, in order that no small particles or carbon will cause assembly to be cocked or permit blow-by of combustion gases. Don't use hard or sharp tools for cleaning. A round piece of brass properly shaped or a round steel bristle brush is permitted if used with care.

2. Install a new "O" ring and a new gasket on nozzle holder assembly.

   NOTE: Use new "0" ring and gasket each time nozzle is installed.

3. Install nozzle holder assembly into cylinder head nozzle bore. Be careful that nozzle tip does not strike against recess wall.

4. Install capscrews and lockwashers and tighten alternately and evenly to the specified torque. See "Specifications" for torque valve.

5. Remove protective covers from nozzle holder parts and fuel pipes. Connect high pressure fuel inlet and leak-off pipes to nozzle holder.

6. Purge high pressure fuel pipes of air by loosening connector and cranking engine until solid fuel, free from air, flows from connection. Tighten connection.

7. Start engine and check for fuel leakage at high pressure connections.

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INJECTION NOZZLE

TROUBLE SHOOTING GUIDE

FAULT	POSSIBLE CAUSE	REMEDY
Nozzle Blueinq.	1. Faulty installing or tightening.	Replace nozzle.
	2. Insufficient cooling.	Correct cooling system.
Spray pattern distorted.	1. Carbon deposit on tip of nozzle valve.	Clean nozzle
	2. Nozzle hole partially blocked.	Clean nozzle.
	3. Defective nozzle.	Replace nozzle.
Nozzle opening pressure too high.	1. Incorrect shim adjustment	Readjust nozzle.
	2. Nozzle valve dirty or sticky or opening is clogged.	Clean nozzle.
	3. Seized nozzle.	Replace nozzle.
Nozzle opening pressure too low.	1. Incorrect shim adjustment.	Readjust nozzle.
	2. Nozzle valve spring broken.	Replace spring and readjust pressure.
	3. Nozzle seat worn.	Install new or reconditioned nozzle
Nozzle drip.	1. Nozzle leaks because of carbon deposit or sticking nozzle valve.	Clean nozzle.
	2. Defective nozzle.	Replace nozzle.
Excessive leak-off.	1. Dirt between pressure face of nozzle, spring retainer or plate and nozzle holder.	Clean nozzle.
	2. Loose nozzle retainer nut.	Inspect lapped faces and tighten retainer nut.
	3. Defective nozzle.	Replace nozzle.

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SPECIFICATIONS

Nozzle Holder Assembly:	
IH Part Number	465495-C91
Manufacturer's Number	0 432 291 035
Engine Model	D-150, D-170, D-190
Nozzle Valve Seat Angle (Degrees)	60
Nozzle Spray Holes:	
Number of Holes	2
Hole Diameter:	
Hole 1(1)	42 mm (.017")
Hole 2(1)	37 mm (.015")
Nozzle Opening Pressure: (psi.)	
New or Rebuilt	2800 + 50
Minimum Permissible (Used)	2500
Permissible Leakdown	See Text(2)
Nozzle Retainer Nut Torque (lb. ft.)	45-65
Nozzle Holder-to-Engine Mounting Bolt Torque (lb. ft.)	15

(1) See illustration in text for hole locations.

(2) Refer to "Nozzle Operation Test".

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FUEL INJECTION PUMP
(ROBERT BOSCH)

FOR D-150, D-170, D-190
IH DIESEL ENGINES

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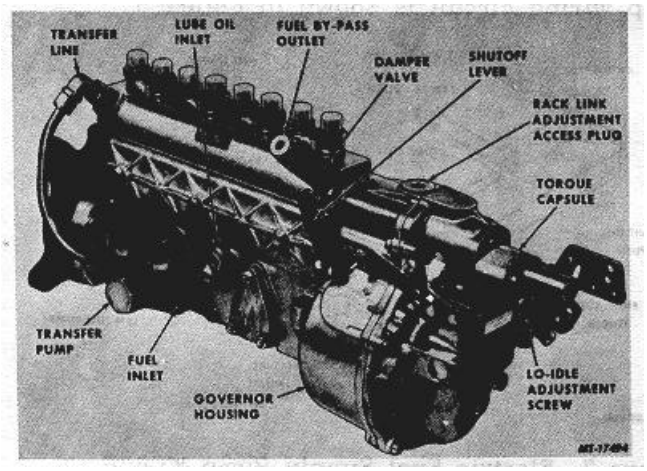


Figure 1 Fuel Injection Pump (Left Side View)

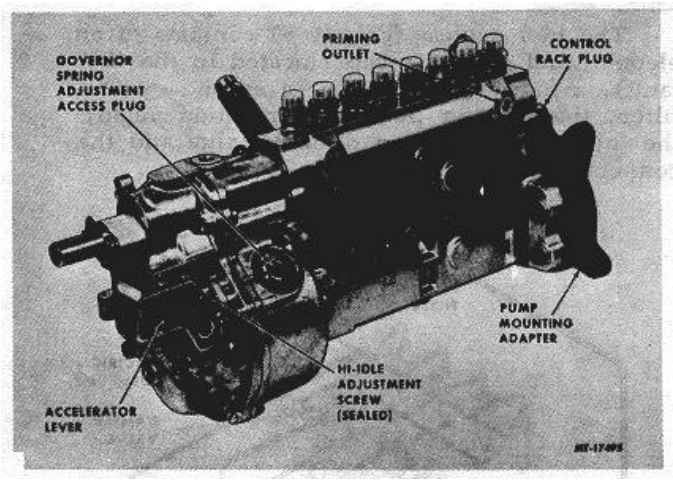


Figure 2 Fuel Injection Pump (Right Side View)

INTRODUCTION

This section covers the Robert Bosch Model PES8A75 Fuel Injection Pump used on model D-150, D-170 and D-190 IH diesel engines.

The injection pump assembly incorporates an integral mechanical flyweight type RQV (all speed) governor.

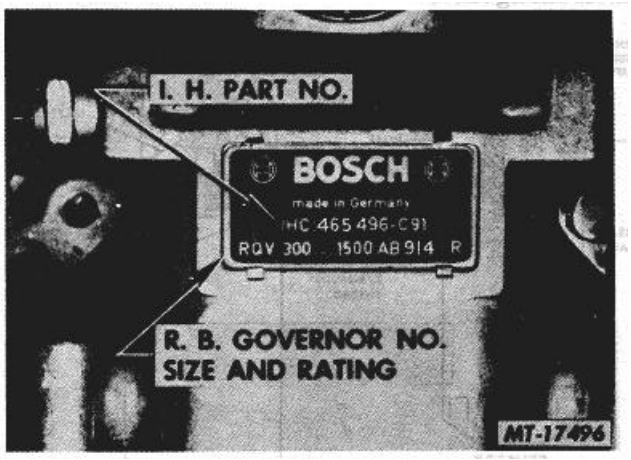


Figure 3 IH Part Number Plate (On Governor Housing)

Identification of injection pump and governor assemblies can be made by referring to name plates found on the injection pump--one on rear of governor housing and one on left side of injection pump housing. The nameplate on rear of governor (Figure 3) gives the IH part number of the complete pump and governor assembly and governor number, size and rating. The nameplate on side of the pump housing (Figure 4) gives the serial number, model code and manufacturer's part number.

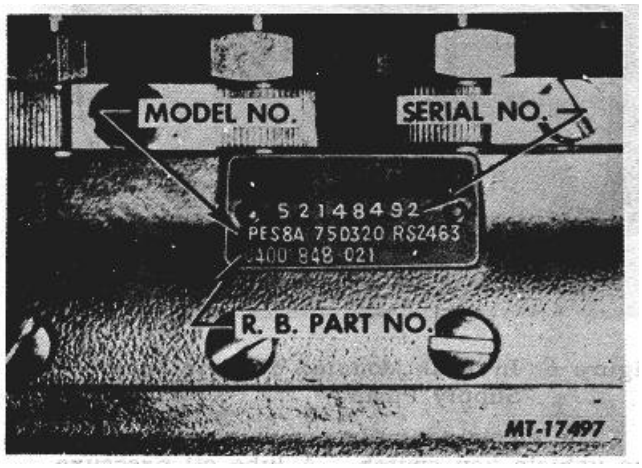


Figure 4 Injection Pump Serial Number Plate (On Pump Housing)

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DESCRIPTION

Fuel System

The fuel system (Figure 5) consists of an electric fuel supply pump (located in the fuel tank), a primary fuel filter, a secondary fuel filter, the transfer pump, an injection pump, the injection nozzles, a damper valve and the connecting pipes and fittings.

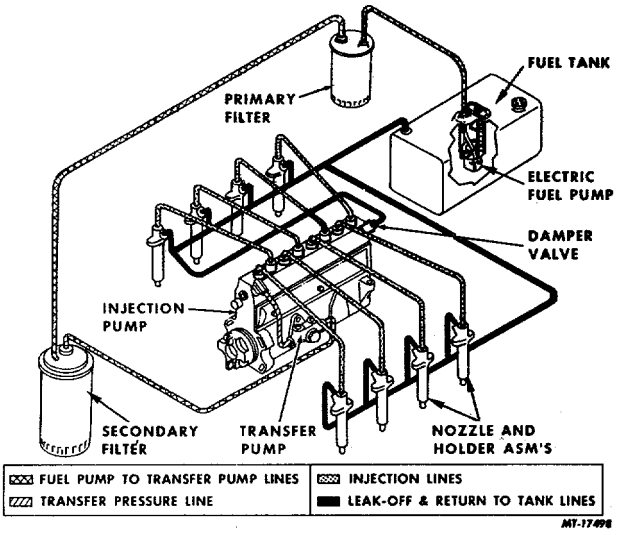


Figure 5 Fuel System

Electric Supply Pump

The in-tank electric fuel supply pump (Figure 6) delivers fuel from the tank, through the fuel filters to the fuel transfer pump.

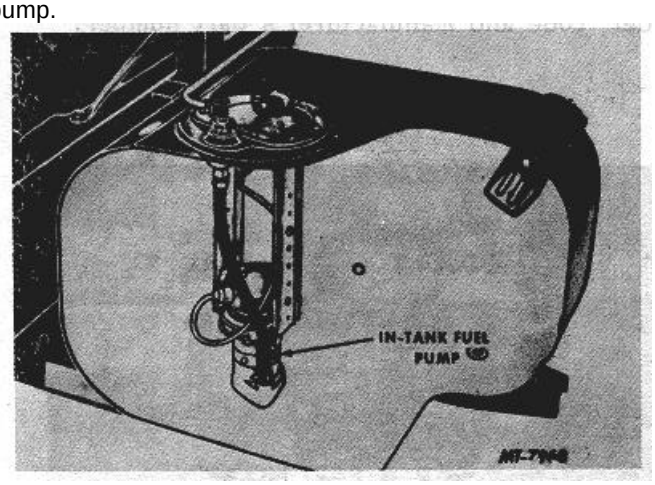


Figure 6 In-Tank Mounted Electric Fuel Supply Pump

The electric supply pump is activated by the vehicle key switch. A lube oil pressure sensitive switch located in the engine oil gallery is used in the supply pump circuit to shut off the supply pump when engine oil pressure drops or if the engine stops. A primer switch on the instrument panel is used to prime the fuel system following fuel filter service or extended vehicle parking. A typical supply pump wiring circuit is shown in Figure 7.

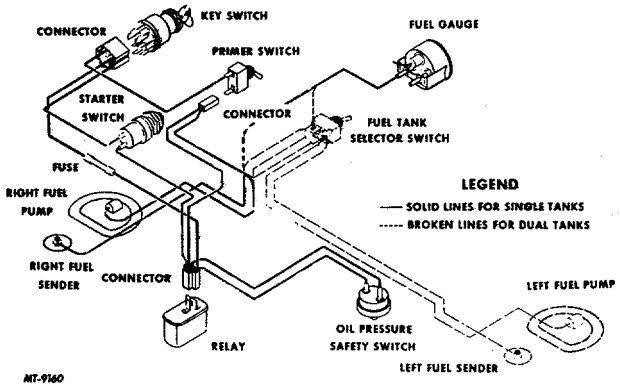


Figure 7 Electric Fuel Supply Pump Wiring Circuit (Typical)

Fuel Filters

The primary fuel filter (Figure 8) serves as a water trap and filters large dirt particles and insoluble gums from the fuel. The filter base has a priming vent for expelling air from the filter when priming the fuel system. This vent can also be used to check supply pump pressure.

The secondary filter (Figure 8) removes any minute particles that may pass through the primary filter. The filter base has a vent for priming the fuel system. This vent can also be used to check for restriction in the primary filter.

Both primary and secondary filters utilize "spin-on" type elements; however, they are not interchangeable.

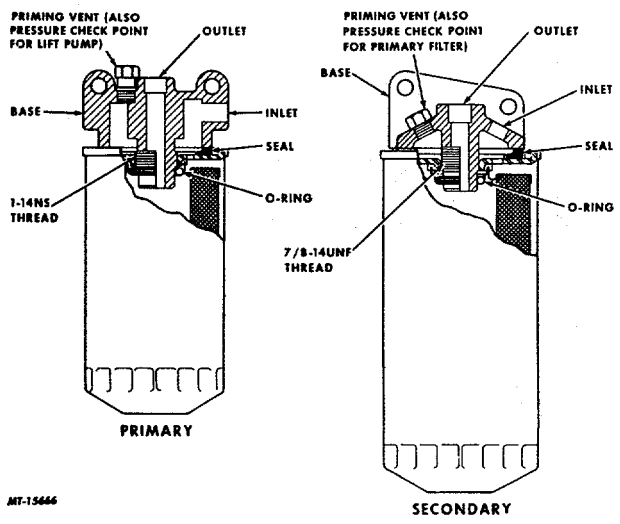


Figure 8 Fuel Filters

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Transfer Pump

The transfer pump is mounted on the side of the injection pump housing (Figure 5) and is driven by the injection pump camshaft. The transfer pump sends fuel from the filters into the fuel gallery of the injection pump housing for charging the injection pump barrels.

The transfer pump can supply more fuel than is required for injection. Excess fuel is routed from the injection pump fuel gallery back to the fuel tank.

Damper Valve

A damper valve, located in the outlet of the injection pump housing fuel gallery (Figure 5) dampens transfer pump pulsations and regulates fuel pressure in the fuel gallery.

Injection Nozzles

The injection nozzles (Figure 9) are the inward opening differential needle type featuring sacless nozzle tips. The injection nozzles are mounted in the engine cylinder head and direct fuel under high pressure from the injection pump into the engine combustion chambers in the form of a fine mist.

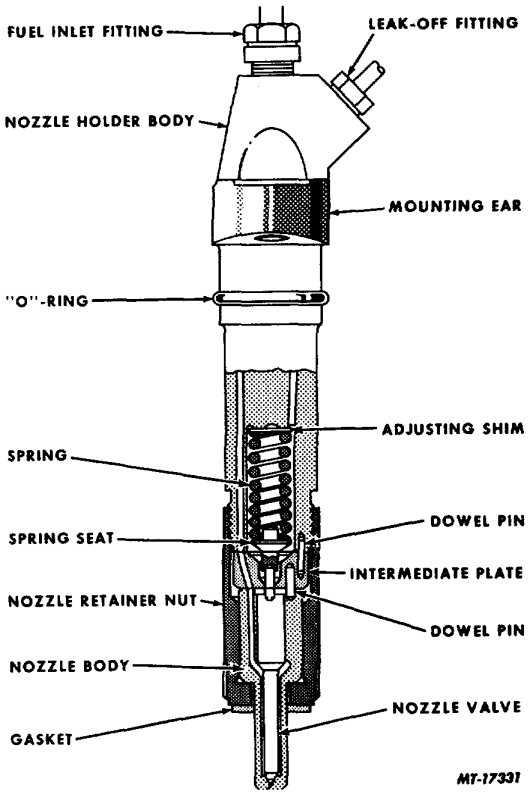


Figure 9. Sectional View of Injection Nozzle Assembly

The injection nozzle valve is held on its seat in the nozzle tip by a strong spring in the nozzle holder. When pressure of the fuel from the injection pump, acting upon the coned surface of the nozzle valve, exceeds spring pressure the valve is lifted off its seat and fuel is forced out the spray holes (orifices) in the nozzle tip. As pressure from the injection pump decreases, spring pressure returns the nozzle valve to its seat ending fuel injection.

Nozzle opening pressure is determined by spring tension which can be adjusted by removing or adding shims between the spring and the nozzle holder body.

Leak-off of fuel past the lapped fit of the valve in the nozzle lip (used for lubrication of the parts) passes through the spring chamber, out the leak-off fitting, and is returned to the fuel tank.

Service instructions for the injection nozzles are covered in a separate section of the service manual. See **FUEL SYSTEM**, Section AE, CTS-2677.

Fuel Lines (Pipes) and Fittings

Low pressure lines used in the fuel system have either conventional or flex-tube type fittings (Figure 10). Flex-tube fittings consist of a fitting body, synthetic rubber sleeve and nut. When installing flex-tube fittings be sure that rubber sleeve is in good condition and line is inserted fully into fitting body. Tighten nut until it bottoms against fitting body.

High pressure lines connecting injection pump and injection nozzles are made from thick wall steel tubing with ball seal type fittings (Figure 10) at both ends. If a line must be removed, disconnect at both ends and remove brackets to prevent bending. If an injection line is damaged, use only genuine IH replacement, since lines are of a specified length and diameter. Always plug or cap ends of lines when disconnected.

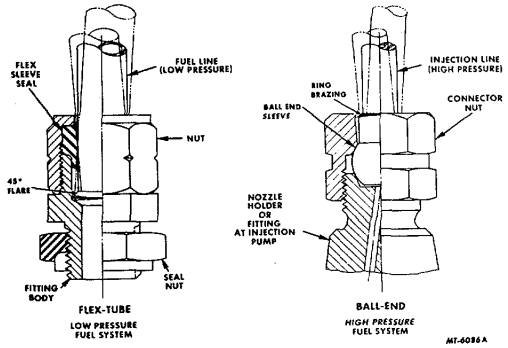


Figure 10 Low and High Pressure Fuel Line Fittings

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INJECTION PUMP

The injection pump (Figures 1 and 2) is the in-line, single action plunger type with individual plunger and barrel pumping elements for each engine cylinder. Pump plunger stroke is constant but effective pumping (metering) stroke is variable and controlled by position of a common plunger control rack operated by the governor and the vehicle accelerator pedal.

The injection pump incorporates a four cylinder start and idle feature whereby fuel is injected into only four of the engines cylinders (nos. 2, 3, 5 and 8) for starting and at idle speed and under light load conditions. As engine load increases, the remaining cylinders (nos. 1, 4, 6 and 7) are also fed fuel and the engine operates on all eight cylinders. The four cylinder start and idle principle reduces the amount of smoke during engine idling particularly when engine is cold.

Pump Operating Principles

The individual plunger and barrel pumping elements (Figure 11) receive fuel under transfer pump pressure from the injection pump housing fuel gallery and force it under very high pressure through the injection nozzles into the engine combustion chambers.

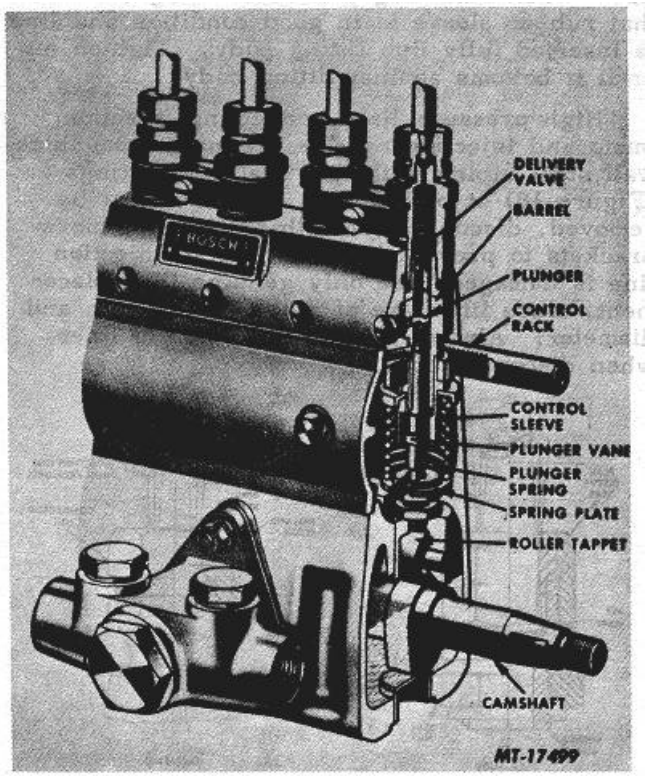


Figure 11 Sectional View of Plunger and Barrel Pumping Element

The injection pump plungers are operated through tappet assemblies driven by the injection pump camshaft. The camshaft is timed to the engine to inject fuel into each cylinder at the proper time.

Each pumping element has a delivery valve above the plunger. The delivery valve which is held on its seat by spring pressure prevents fuel from draining out of the high pressure fuel line between pumping cycles.

The injection cycle can be described by observing the plunger in its four principal positions in the barrel. The four positions (shown in Figure 12) are:

Bottom Dead Center (BDC)

At bottom dead center plunger is held down on lowest point of cam lobe by plunger spring. Top of plunger is below charging port of barrel. Fuel under transfer pump pressure flows through barrel charging port to fill area above plunger and the groove and annulus around the plunger.

Start of Injection (Start Inj.)

Injection begins when the rising plunger covers the charging port and fuel is trapped above the plunger.

Injection (Inj.)

As plunger continues upward with charging port covered, fuel above plunger is forced upward under high pressure, unseats delivery valve, flows to nozzle, opens nozzle valve and is injected into the cylinder.

End of Injection (End Inj.)

When plunger moves up to the point where charging port is again uncovered, fuel pressure above plunger is relieved to the charging gallery. This pressure drop allows delivery valve and injection nozzle valve to seat thus ending injection of fuel into cylinder.

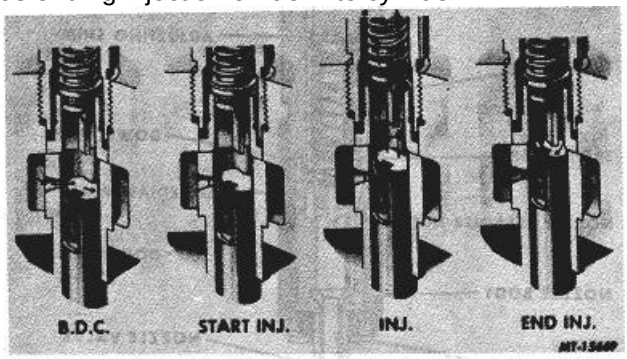


Figure 12 Four Principal Plunger Positions of Injection Cycle (Typical of Cylinders 2, 3, 5 and 8 with Upper Helix)

Metering (providing proper amount of fuel to meet engine requirements at various speeds and loads) is accomplished by rotating plungers in barrels to change the effective pumping stroke. The effective stroke is the distance traveled upward by the plunger from the time the charging port is covered until it is again uncovered. A short effective stroke means a small amount of fuel is injected. As effective stroke increases, amount of fuel injected increases.

Plungers for cylinders 2, 3, 5 and 8 have an upper helix giving a variable beginning of injection and a constant ending of injection. Plungers for cylinders 1, 4, 6 and 7 have a lower helix giving a constant beginning of injection and a variable ending. The two types of plungers are shown in Figure 13.

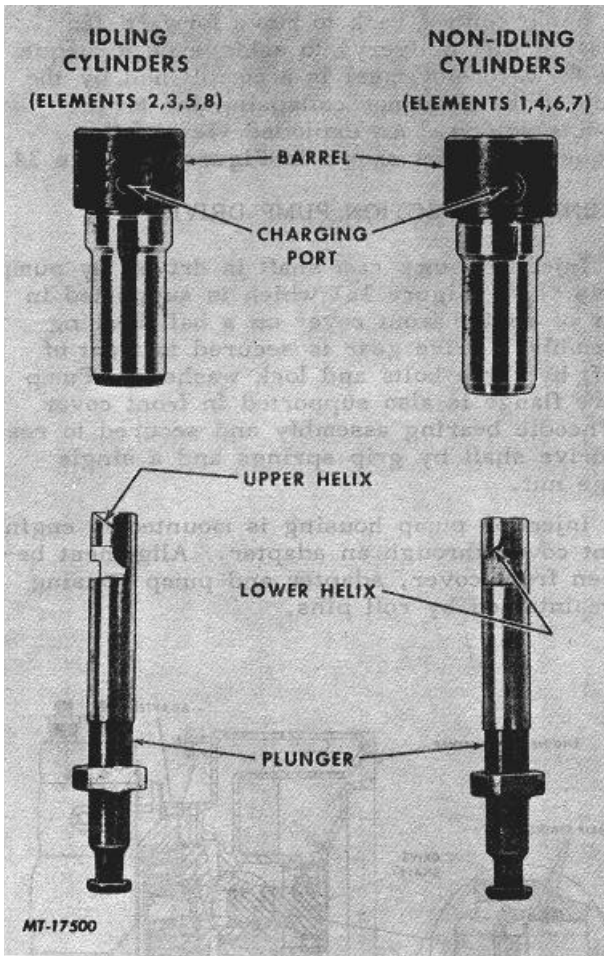


Figure 13 Details of Injection Pump Plungers

The metering function can be described by observing the relationships of plunger helix to barrel charging port under various metering positions as shown in Figure 14.

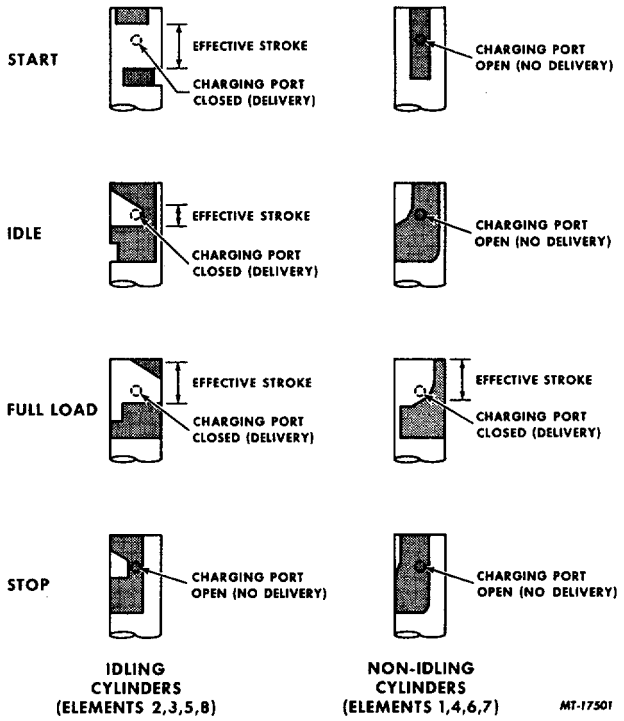


Figure 14 Helix and Charging Port Metering Positions

Starting (Excess Fuel) (Cylinders 2, 3, 5 and 8 only)
For starting, plunger is rotated by control rack (accelerator pedal fully depressed) to a point where a notch on top of plunger lines up with barrel port.

The notch retards timing of injection by causing plunger to cover port later in its upward stroke. Retarding injection during cranking aids in starting.

When engine starts, governor flyweight force increases sufficiently to overcome starting spring, and control rack will rotate plunger to a point where retard notch will no longer line up with its barrel port.

Engine Operating (Metered Delivery)
At engine operating speeds from idle through maximum governed speed, the quantity of fuel delivered is determined by effective stroke (port closing to port opening) as controlled by the accelerator linkage and governor.
At idle speed and under light loads only cylinders 2, 3, 5 and 8 are receiving fuel. Plungers for cylinders 1, 4, 6 and 7 have a shortened helix which does not inject at low engine speeds or light loads.

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Engine Stop (No Delivery)

To stop the engine, plungers are rotated so that vertical slots (stop slots) are in line with barrel ports. As plunger moves up and down fuel is transferred back and forth from top of plunger through vertical slots and into charging gallery. The ports do not close--thus, no delivery.

Plungers are rotated to the various metering positions by the control rack. Rack movement is controlled by the accelerator pedal linkage, governor and engine shut off control.

GOVERNOR

The mechanical flyweight governor, which is integral with the injection pump, is the all speed type, identified by the manufacturer as the RQV 300-1500. The 300-1500 designation refers to the injection pump speed range in which the governor functions. As pump speed is one-half engine speed, this corresponds to engine speeds of 600-3000 rpm. Figure 15 illustrates a cut-away view of the governor assembly.

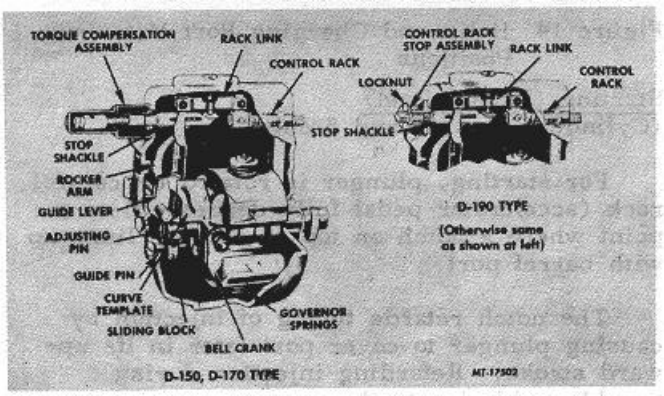


Figure 15 Cut-Away View of Governor Assembly

The functions of the governor are: (1) limit minimum (lo-idle) engine speed, (2) limit maximum engine speed and (3) maintain smooth speed control (without stalling, surging or hunting) within the limits of its regulation throughout the operating speed range of the engine.

The all-speed governor provides speed control at any fixed position of the governor control lever (accelerator). This provides the vehicle operator with the most satisfactory driving characteristics. The governor tends to keep engine speed constant at the level determined by position of the accelerator lever and automatically increases or reduces fuel delivery in response to minute changes in engine loads without a significant change in road speed and without the operator changing position of the accelerator lever.

Another feature of the all speed governor is its capability of providing full range PTO speed control for various applications such as garbage packers, fuel oil pumps and mixer chassis. The operator sets the accelerator lever at power (engine speed) setting required and the governor automatically holds engine speed constant without the operator altering the accelerator lever position.

Torque Compensation (D-150, D-170 Only)

Governors used on D-150 and D-170 engines are equipped with torque compensation.

Torque compensation is an added fuel control adjustment which limits fuel at torque peak while providing advertised performance. The control is necessary to comply with Federal smoke regulations.

The torque compensation assembly (torque capsule), Figure 15, is a device which allows the pump control rack to move forward (increasing fuel delivery) to achieve peak torque. The forward movement is accomplished by the force of the governor collapsing the torque capsule spring. An exploded view of the torque capsule is shown in Figure 84, Page 34.

ENGINE TO INJECTION PUMP DRIVE

Injection pump cam shaft is driven by pump drive shaft (Figure 16) which is supported in rear of engine front cover on a ball bearing assembly. Drive gear is secured to front of shaft by three bolts and lock washers. Pump drive flange is also supported in front cover by needle bearing assembly and secured to rear of drive shaft by grip springs and a single large nut.

Injection pump housing is mounted to engine front cover through an adapter. Alignment between front cover, adapter and pump housing is maintained by roll pins.

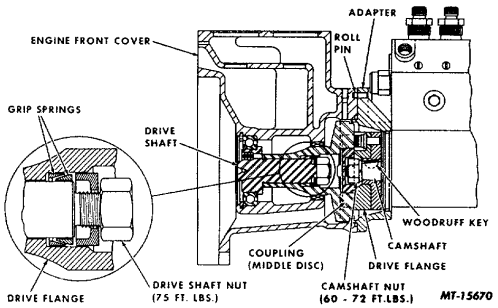


Figure 16 Injection Pump Drive Details

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Camshaft of injection pump has a "keyed-on" drive flange which connects to drive flange of engine through coupling or middle disc. A fine adjustment for pump internal timing is provided in the pump drive flange.

The flange (Figure 17) consists of inner and outer halves held together with four socket head setscrews. The inner half is a taper fit and keys to the pump camshaft. The outer half includes the drive tangs, which mate with middle disc to drive the pump. Punch mark on edge of each flange half is used to index the halves and assure correct reassembly. A slight adjustment to compensate for tolerance stack-up is provided by elongated holes in flange outer half. Adjustment should be made only at time of pump calibration. Setscrews must be kept tight to maintain pump flange at correct position.

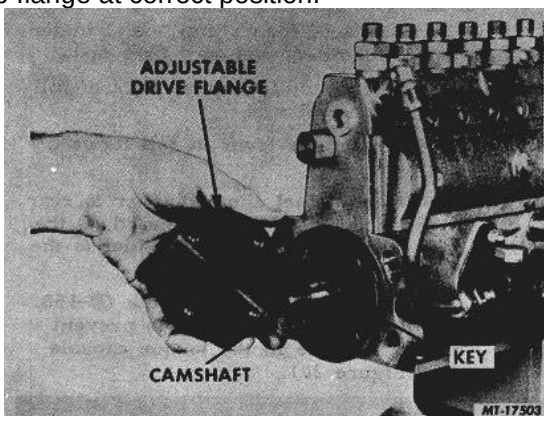


Figure 17 Pump Camshaft Drive Flange

Timing Marks

There are several match marks and other aids on both the pump and the engine to help establish and maintain correct timing. These marks can be used for timing checks and in the event of pump removal and installation, assure that pump will be reinstalled correctly.

For either checking or setting pump to engine timing, the damper pulley and index pointer (Figure 18) on engine front cover is used. When No. 1 piston is on compression stroke and the specified initial setting mark on damper is indexed with pointer, pumping element for No. 1 cylinder is at start of injection. Damper pulley should always be turned to this position whenever a pump replacement is made.

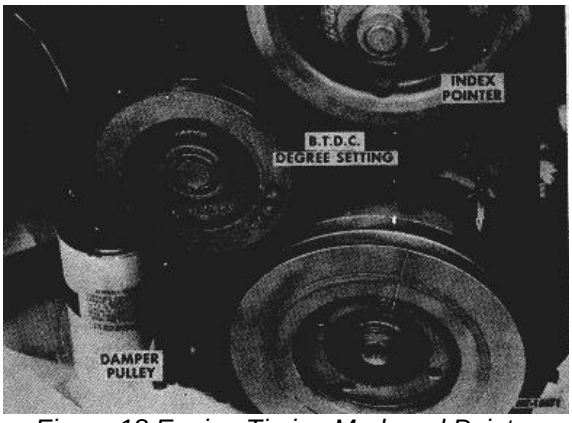


Figure 18 Engine Timing Mark and Pointer

Additional timing marks are visible only when pump is removed from engine. These are located on drive flanges of both engine and pump (Figure 19). Another useful mark is provided in end of pump camshaft. The pump is indexed when this mark (slash) is at 10 o'clock. Features of injection pump to engine timing are shown in Figure 19.

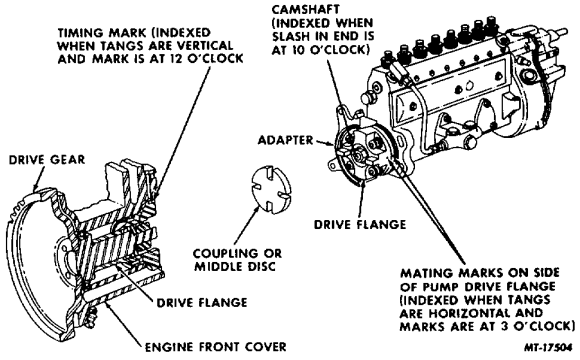


Figure 19 Pump to Engine Timing

MAINTENANCE

Filter Service

Primary and secondary fuel filters should be replaced at specified intervals. The filter elements are the spin-on type. When replacing filters, make sure filter base mounting flange is clean. Apply a thin film of clean engine oil to filter seal (gasket). Screw filter onto filter base until seal contacts base mounting flange, then tighten ¼ to ½ additional turn. Do not overtighten. After new filters have been installed, prime fuel system as outlined under "Priming Fuel System"

Priming Fuel System

The fuel system should be primed following filter replacement, injection pump replacement, disconnecting or reconnecting of fuel lines or before vehicle is started following an extended period of parking or storage.

The procedure for priming the fuel system is as follows:

1. Be sure tank has sufficient fuel.
2. Turn key switch to "ON" position and hold primer switch "ON" to energize electric fuel supply pump.
3. Open priming vent on top of primary filter base. Allow fuel to flow until all air bubbles are expelled and fuel flows in a solid stream. Close vent.
4. Open priming vent on secondary filler base and vent air from fuel per Step 3. Close vent.
5. Open priming vent at upper right front corner of injection pump housing and vent air from fuel per Step 3. Close vent.
6. Release primer switch and return key switch to "OFF" position.

Checking Injection Pump-to-Engine Timing (Drip Spout Method).

The following procedure can be used to check injection pump-to-engine timing.

1. Block shut off control in "SHUT OFF" position. (This will prevent accidental start of engine while positioning No. 1 cylinder on compression stroke per next step.)

2. Rotate engine crankshaft in direction of normal rotation (clockwise as viewed from front) until No. 1 cylinder is on compression stroke. Continue to rotate engine until specified "Start of Injection" timing mark (see SPECIFICATIONS) approaches the index pointer (See Figure 18, Page 9).

NOTE: Engine must be turned manually to establish timing position. Starter may be used to bring timing marks into range but final movement must be performed manually. If engine is inadvertently turned beyond specified timing mark, back up at least ¼ turn from mark and again approach mark in direction of normal engine rotation (clockwise as viewed from front). Do not back engine to align timing marks.

To be sure No. 1 cylinder is on compression stroke, loosen injection nozzle hold down nuts from No. 1 nozzle and while rotating engine watch for nozzle to pop up. This will occur when No. 1 piston starts up on compression. To prevent nozzle from popping completely out, be sure nozzle hold-down bolts are threaded in at least two turns.

Other methods for determining compression stroke on No. 1 cylinder are acceptable; but always be sure to approach timing mark in direction of normal engine rotation.

3. Release shut off control from SHUT OFF position.
4. Remove delivery valve, spring and fill piece from injection pump No. 1 pumping element and install drip spout (see Figure 94, Page 39).

Make drip spout locally from extra injection line and connector nut. Place a receptacle (paper cup, etc.) under drip spout to collect fuel flow, from spout.

5. Position injection pump control rack at full load position as follows:
   a. Hold accelerator lever in full forward position .
   b. Slowly move fuel shut-off lever to rear. A distinct "click" will be heard as the rack moves from the excess fuel to the full load position.

On pumps with torque capsule (D-150, D-170 engines) use a clip to prevent spring collapse in the torque capsule (see Figure 20).

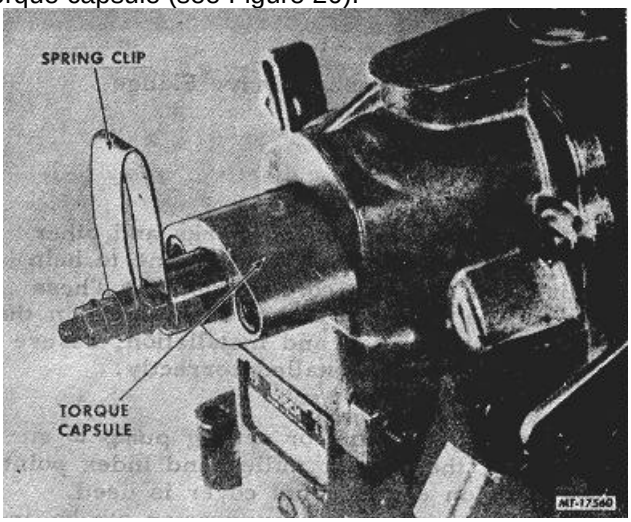


Figure 20 Clip Installed to Prevent Spring Collapse in Torque Capsule (D-150, D-170 Only)

6. Supply fuel to the injection pump fuel gallery using one of the following methods:

   Method A Turn key switch to "ON" position. Have assistant hold primer switch "ON" while timing check is being made to keep fuel gallery filled.

   Method B Fuel gallery can be charged with fuel by suspending a small reservoir of fuel approximately 12 inches above the injection pump to provide a "head" for charging the fuel gallery. The reservoir can be made locally. Use a flexible tube to connect the reservoir to the fuel gallery priming outlet at the right front corner of the pump housing.

7. With engine crankshaft positioned at specified timing mark (per Step 2) and injection pump fuel gallery charged with fuel (per Step 6), fuel should flow from drip spout positioned in No. 1 pumping element. Fuel should drip at the rate of one drop every 3 to 5 seconds. This indicates correct timing (start of injection on No. 1 cylinder).

If fuel flows from drip spout at a rate other than one drop every 3 to 5 seconds, this indicates incorrect pump-to-engine timing. It will be necessary to remove injection pump and reposition the injection pump drive flange on the engine. (See "Preparation of Engine" under INJECTION PUMP INSTALLATION.)

Idle Speed Adjustments: (Lo-Idle)

Normal curb idle speed (lo-idle) is adjusted by turning lo-idle adjustment screw at rear of injection pump (Figure 21]).

Procedure for checking and adjustinglo-idle speed is:

1. Start engine and operate until temperature is up to normal operating range.
2. Allow engine to idle and observe engine speed on tachometer.
3. If lo-idle speed is not within specified range (see SPECIFICATIONS) adjust as follows:

   a. Loosen locknut.
   b. Turn adjusting screw to obtain correct idle speed. To reduce engine rpm, turn adjusting screw "in" (clockwise). To increase engine rpm, turn adjusting screw "out" (counterclockwise).
   c. Tighten locknut.

4. Accelerate engine two or three times. Allow engine to return to idle speed and observe tachometer reading. If idle speed is not within specified range, check accelerator linkage for binding and repeat idle adjustment per Step 3.

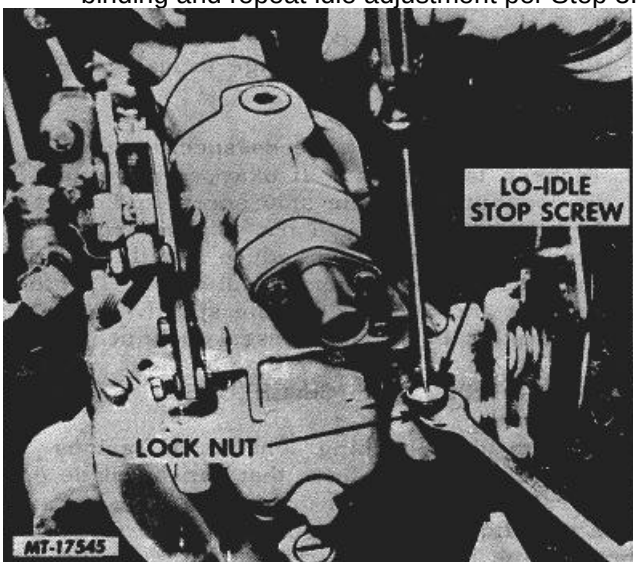


Figure 21 Lo-Idle Adjustment

Maximum No-Load Governed Speed (Hi-Idle)

Maximum no-load governed speed (hi-idle) is the point of engine speed where governor prevents engine rpm from going higher. Hi idle adjustment is located at accelerator lever stop screw (Figure 22) and is initially made on pump calibrating stand. Minor adjustment can be made on engine as follows:

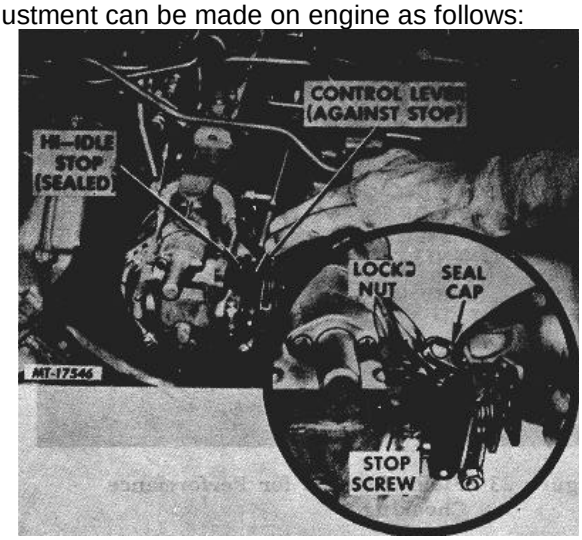


Figure 22. Hi-Idle Adjustment

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1. With engine running and at normal operating temperature, push throttle lever to its full forward position--lever against its stop.

2. Read tachometer and note highest engine rpm. (Make sure tachometer is accurate.)

3. If governed speed does not reach specified limit, check throttle linkage to make sure lever is not restricted.

4. If governed speed exceeds specified limit, recheck tachometer. If okay, remove seal on Locknut of hi-idle -stop screw and reset hi-idle adjustment. Turn stop screw out (counterclockwise) to reduce hi-idle or turn in (clockwise) to increase hi-idle. Tighten locknut and recheck hi-idle speed. When adjustment is correct, reseal locknut.

ON-ENGINE PERFORMANCE CHECKS

Performance checking consists of various pressure and vacuum tests that can be made on an operating engine. In order for these tests to be significant, they should be performed when engine has been normalized and under load. If dynamometer facilities are not available, a field test kit SE-2239 (Figure 23) is available which will enable you to make these tests while operating the engine under load.

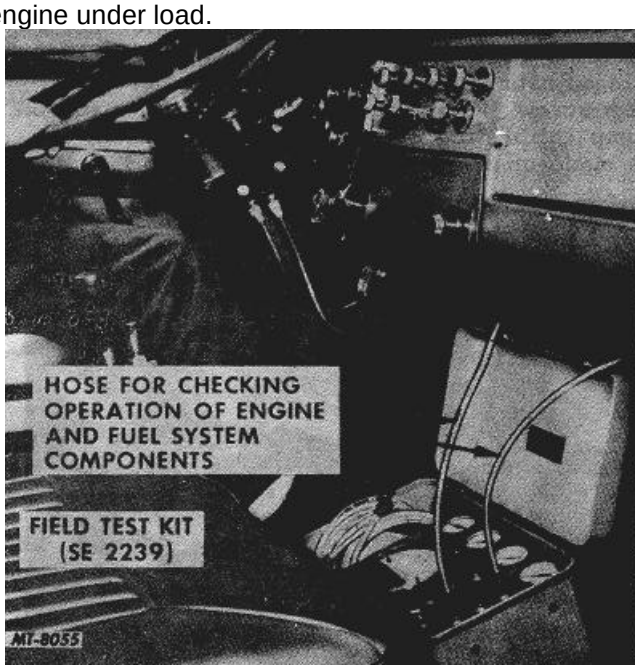


Figure 23. Field Test Kit for Performance Checking

Electric Supply Pump Pressure

Supply pump pressure check connection is made at priming vent on top of primary filter. Install an aclapter at priming vent and connect by hose to SE-2239 field test kit inside cab. Operate engine under load and observe pressure reading. If reading is not within specified range, (see SPECIFICATIONS) supply line may be damaged or plugged, or the electric fuel pump is faulty and must be repaired or replaced.

Transfer Pressure

Transfer pressure check is made directly on injection pump. Install an adapter to priming outlet at right front side of rection pump (Figure 24) and connect by hose to test gauge (SE-2239) in cab. Operate engine under load and observe pressure.

If transfer pressure is lower than specified minimum (see SPECIFICATIONS), replace primary and secondary fuel filter elements and repeat transfer pressure check.

If installation of new filters does not correct transfer pressure, transfer pump repair or replacement may be required. Transfer pump can be removed for repair without removing complete injection pump from engine.

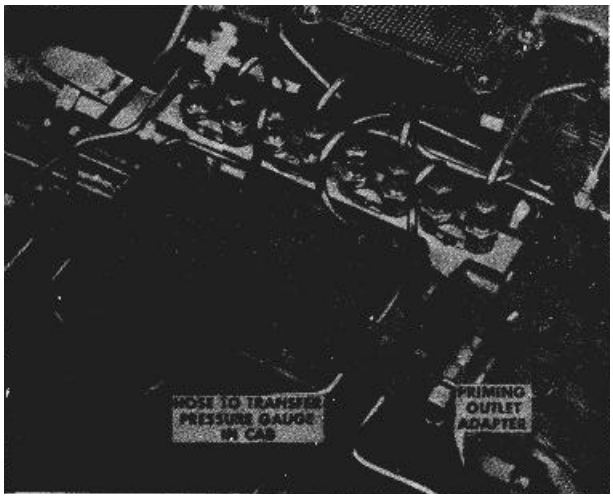


Figure 24. Location for Checking Transfer Pressure

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Manifold Vacuum

The manifold vacuum test is a quick method for checking air cleaner restriction. To check manifold vacuum, obtain a manometer or low range vacuum gauge such as included in SE-2239 test kit. Remove plug from left side of intake manifold and attach hose between manifold and gauge in cab (Figure 25).

To test for restriction, operate engine at either no load or under load. When at normal operating temperature observe vacuum gauge. If vacuum exceeds 20" water or 1.47" mercury, air cleaner or air induction system is restricted and must be corrected.

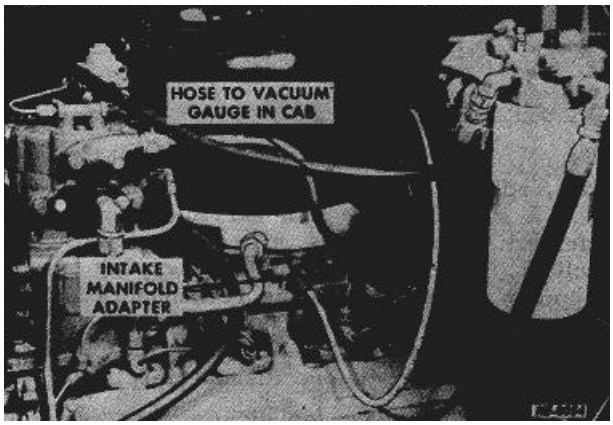


Figure 25. Location for Checking Manifold Vacuum

Exhaust Back Pressure

To check exhaust back pressure, make a tap in the right and left bank exhaust manifolds and install appropriate steel connectors. Location of the taps should be 1 ½ inches above manifold-to-exhaust pipe flange and to outboard side of manifold (one tap per manifold). Connect a short length of steel tubing to fitting so as to insulate gauge hose from exhaust heat. (Tap may be removed and manifold plugged after test or tubing may be plugged and left in place for later testing.) Fasten hose for manometer or low range pressure gauge (SE-2239) to steel tubing and start engine. Check one bank at a time. (It is necessary to check both banks since back pressure will not be exactly the same in both banks.) When engine is at normal operating temperature and while operating under full load observe pressure gauge. If back pressure exceeds 40.8 inches of water or 3 inches of mercury on either bank, exhaust is restricted and cause must be corrected.

INJECTION PUMP REMOVAL

Preparing for Removal

Truck model differences affect pump removal, but the following is always required:

1. Remove air cleaner upper and lower halves. (Manifold crossover adapter if remote mounted type.) Cover manifold openings.
2. Disconnect accelerator rod and shut off control cable from governor.
3. Before disconnecting fuel lines, clean pump and connections with clean diesel fuel.
4. Disconnect injection lines, low pressure lines and lube oil line from pump. Remove fuel line brackets as necessary. Use plastic caps or plugs to protect openings from dirt.

Removal

Removal of pump involves the following:

1. Remove pump stabilizing brackets.
2. Remove four adapter mounting bolts which hold pump adapter and pump housing to rear of engine front cover

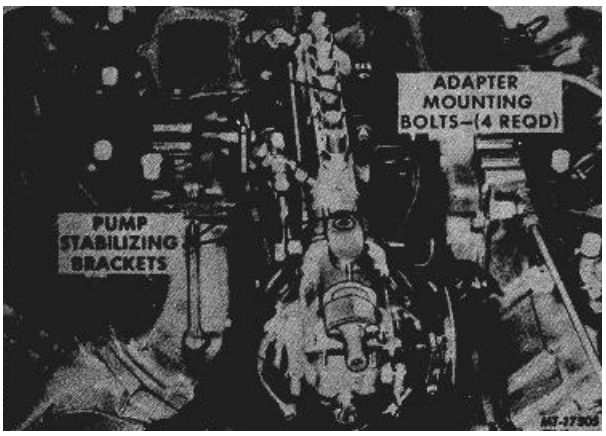


Figure 26. Pump Mounting Details

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3. Pull pump to rear to free drive flange tangs from middle disc. Lift pump from engine (Figure 27).

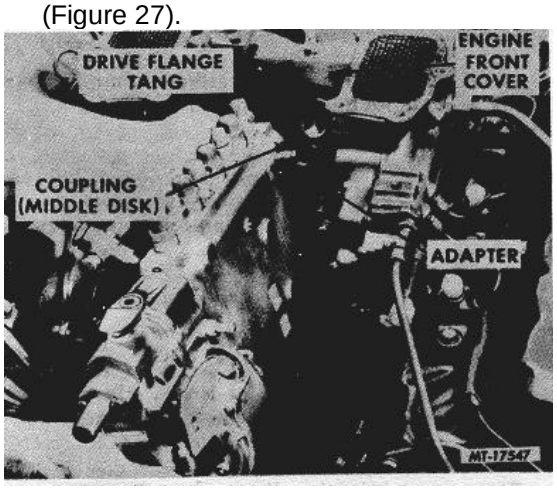


Figure 27 Removing Pump from Engine

NOTE: If injection pump has been operated on an engine in which water or anti-freeze has entered the crankcase, disassemble and clean the pump and governor immediately. Do not store pump before overhaul.

INJECTION PUMP OVERHAUL

Special Tools

To overhaul the pump assembly, metric wrenches and sockets ranging in size from 8 mm through 19 mm will be required. Special rebuild tools (Figure 28) called out through out the text will speed repair work and protect parts from damage.

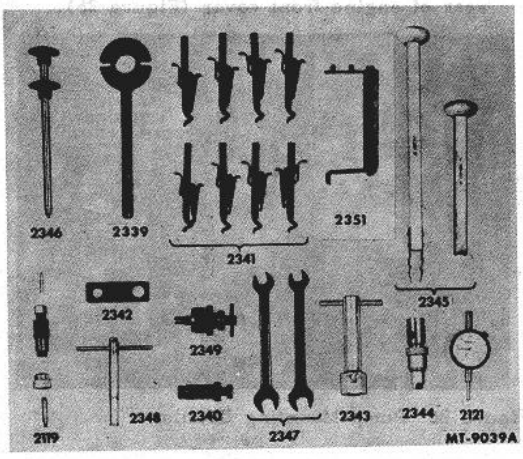


Figure 28 Pump Overhaul Special Tools

Legend for Figure 28

SE-2119	Rack Gauge Holder
SE-2121	Dial Indicator (Inch Reading)
SE-2339	Wrench, Holding, Drive Flange
SE-2340	Remover, Governor Flyweight Damper
SE-2341	Holder, Tappet
SE-2342	Gauge, Camshaft Protrusion
SE-2343	Holder, Dial Indicator
SE-2344	Remover and Installer, Camshaft Cylindrical Nut
SE-2345	Remover and Installer, Tappet
SE-2346	Remover and Installer, Barrel Plunger
SE-2347	Wrench, Tappet Adjusting
SE-2348	Wrench, Governor Spring Adjusting
SE-2349	Remover and Installer, Governor Spring and Adjusting Screw
SE-2351	Fixture, Pump Holding

Preparation for Disassembly

Pump and governor overhaul should be performed in a clean area free from air-borne dirt. A separate injection service room is preferred. Work bench, vise and tools should be clean. The use of trays for keeping injection pump parts in order is recommended.

The pump assembly should be thoroughly cleaned externally before disassembly.

Prepare the pump for disassembly as follows:

1. Drain fuel and lubricating oil from pump and governor housings.
2. Cap or plug fuel and lube oil openings after draining.
3. Use clean diesel fuel or kerosene to clean exterior of pump and governor assembly.
4. Clamp holding fixture SE-2351 (Figure 29) in vise. Secure injection pump assembly to holding fixture with two bolts.

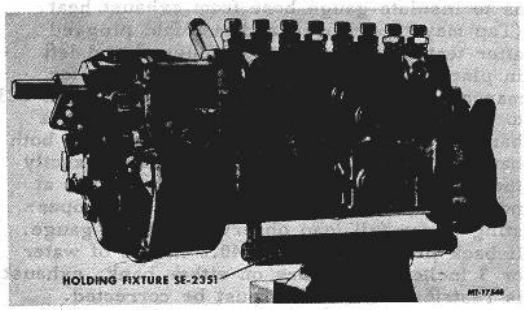


Figure 29 Injection Pump Mounted in Holding Fixture

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Disassembly Procedures:

Governor Disassembly

1. Using 10mm Allen wrench, remove plug from rack link adjustment access hole in top of governor housing.

2. On pumps with control rack stop, remove seal wire and remove rack stop mounting bolts.

   On pumps with torque capsule, remove seal wire, remove torque capsule cover and gasket and remove torque capsule mounting screw bushings.

3. Move accelerator lever fully back against low idle stop screw.

4. Reaching down through rack link adjustment access hole with a small screwdriver (Figure 30), lightly pry stop shackle aside (to right as viewed from rear of pump) to disengage stop shackle from rocker arm pin. (See Figure 15 for relationship of parts.)

   NOTE: To ease this operation interior of governor housing can be lighted by removing seal wire and plug from governor adjustment access hole on side of governor housing and inserting penlight through access hole.

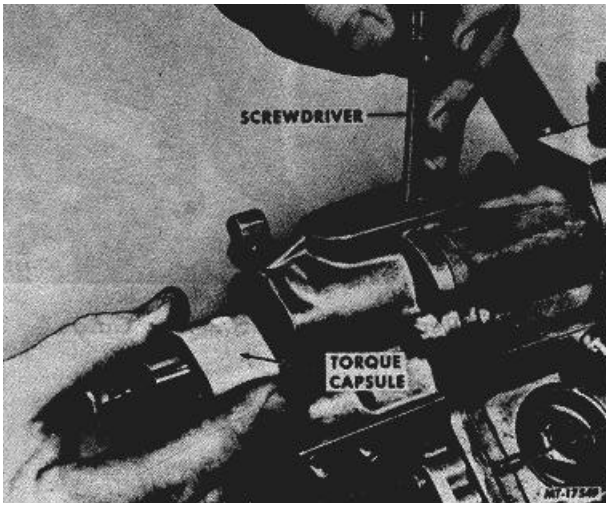


Figure 30 Disengaging Stop Shackle (Governor Housing Cut Away for Illustration)

5. Pull control rack stop assembly of torque capsule assembly to rear to clear mounting studs, then rotate approximately 45 degrees counterclockwise to permit stop shackle to, pass governor levers and slide assembly from governor housing (see Figure 31).

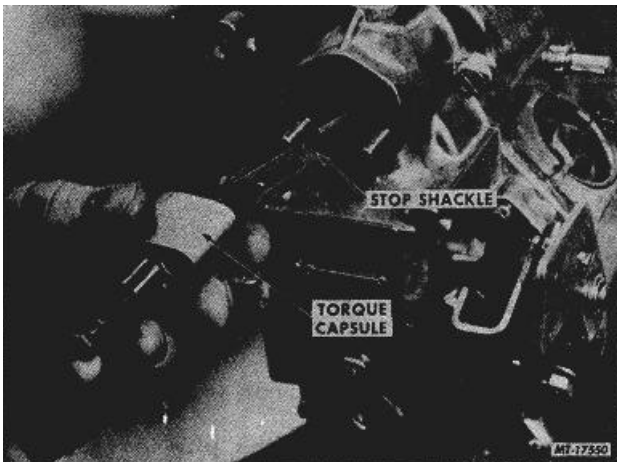


Figure 31 Removing Torque Capsule

6. Remove slotted screw guide pin (Figure 32) from governor cover. Use large screwdriver to fit slot of this screw which has been sealed in place with Loc-Tite.

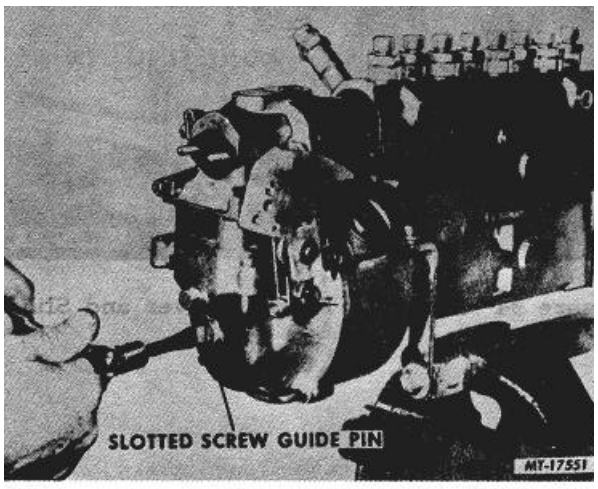


Figure 32 Removing Guide Pin

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7. Remove mounting screws and take off governor cover (Figure 33). Lift cover up and operate accelerator lever to release internal linkage.

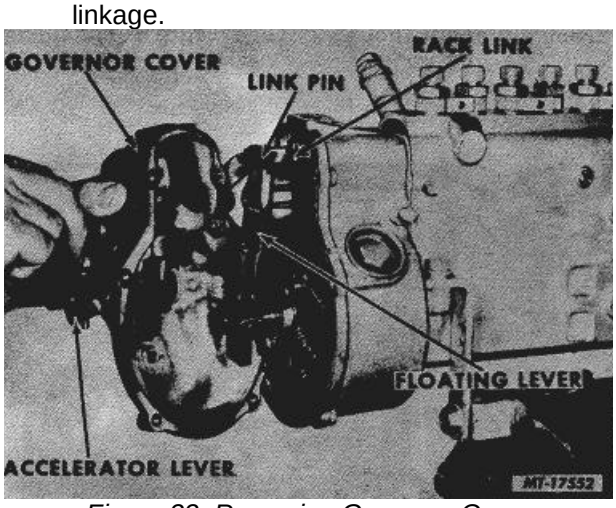


Figure 33 Removing Governor Cover

8. Remove cotter pin and link pin and disconnect floating lever from rack link.

9. Pull top of floating lever back and down to remove floating lever and slider (Figure 34) from adjusting pin.

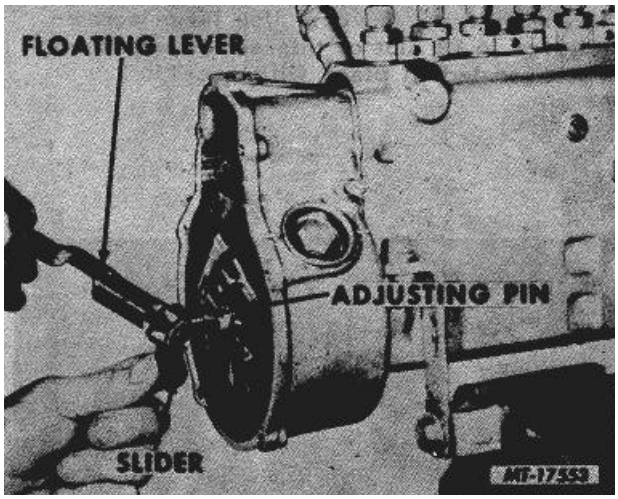


Figure 34 Removing Floating Lever and Slider

10. Raise tabs on lock washer and remove double nutted thru-bolt and adjusting pin from governor flyweight assembly (Figure 35).

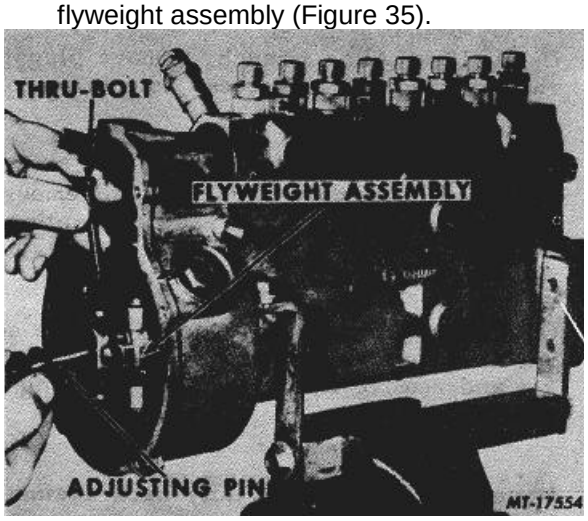


Figure 35. Removing Adjusting Pin from Flyweight Assembly

11. Raise tabs on lock plates, remove two cap screws and take out adjusting pin guide bushing (Figure 36).

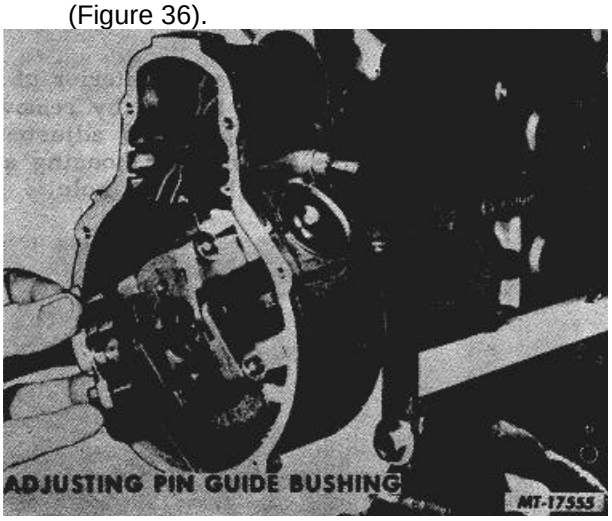


Figure 36 Removing Adjusting Pin Guide Bushing

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12. Using SE-2344 remover tool on slotted cylindrical nut and SE-2339 holding wrench to hold camshaft, remove the cylindrical nut (Figure 37) and spacer shim under nut. It may be necessary to use small quantity of lube on nut to extract spacer shim.

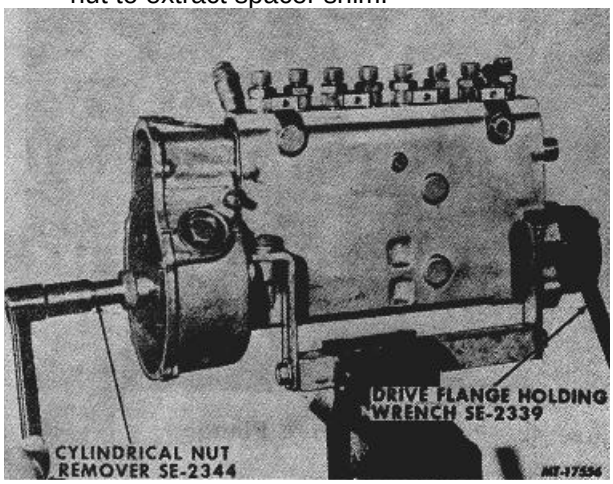


Figure 37. Removing Cylindrical Nut

13. Install SE-2340 governor flyweight remover tool (Figure 38) and remove flyweight assembly. Since governor weight assembly is serviced as a complete unit, no further disassembly is required until rebuild.

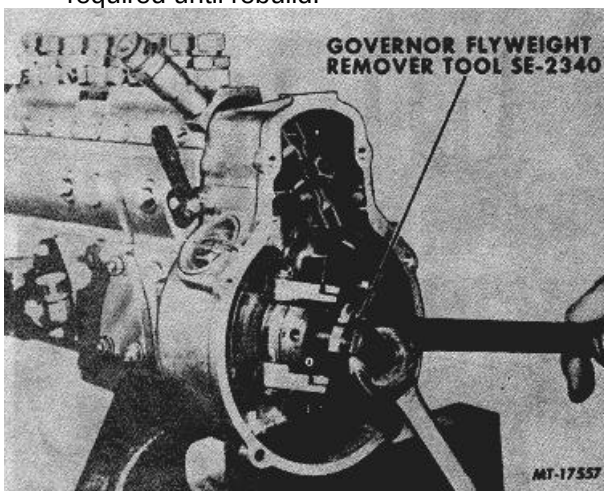


Figure 38. Removing Governor Flyweight Assembly

14. To remove governor housing, remove rack link, link bracket and spring from rear of control rack. Move tab of stop lever return spring aside and unscrew governor housing to pump housing mounting screws. Remove governor housing and bracket.

    NOTE: Governor housing screws are staked. Governor housing will not have to be removed from pump housing unless fuel dilution is suspected, there are other leaks, or further damage is evident.

Pump Disassembly

NOTE: The main body contains several fittings, bushings and plugs on which Loc-Tite has been used. Do not remove these parts unless known to be leaking. Included among these are the inlet fuel adapter fitting, the fuel gallery plug, the lube oil inlet bushing and the bleeder valve bushing.

1. Remove side cover and gasket from pump housing.
2. Remove transfer pump assembly and gasket. Transfer pump is serviced as a complete assembly.
3. Install eight SE-2341 tappet holder tools (Figures 39 and 40) in side of pump to hold all tappets up from camshaft. To prevent tool breakage, lift each tappet by rotating camshaft before installing holder tool.

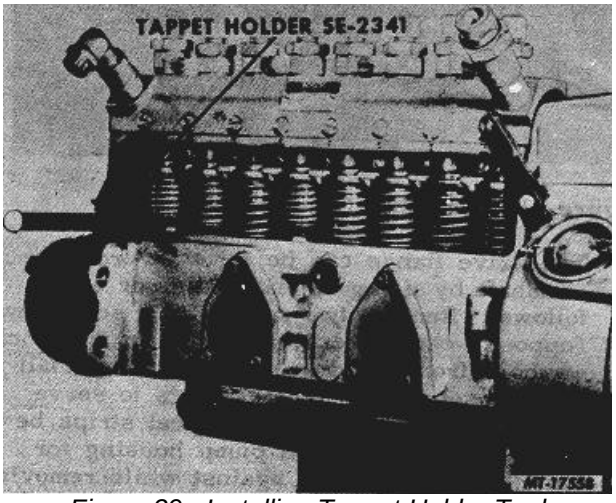


Figure 39. Installing Tappet Holder Tool

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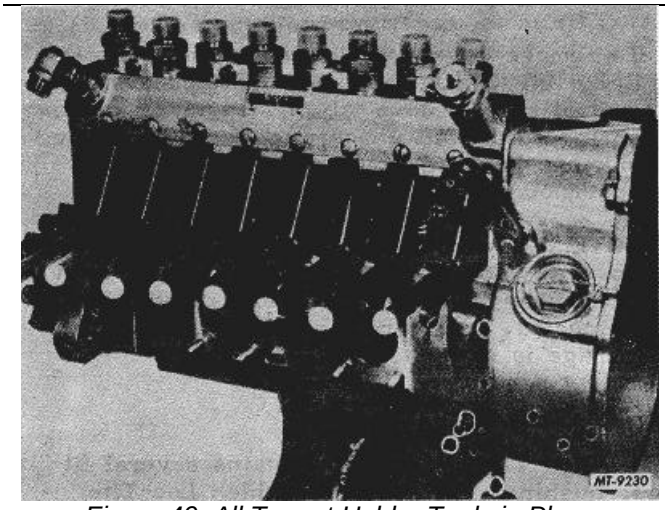


Figure 40 All Tappet Holder Tools in Place

4. Using SE-2339 holding wrench to hold drive flange, remove camshaft nut and washer (Figure 41).

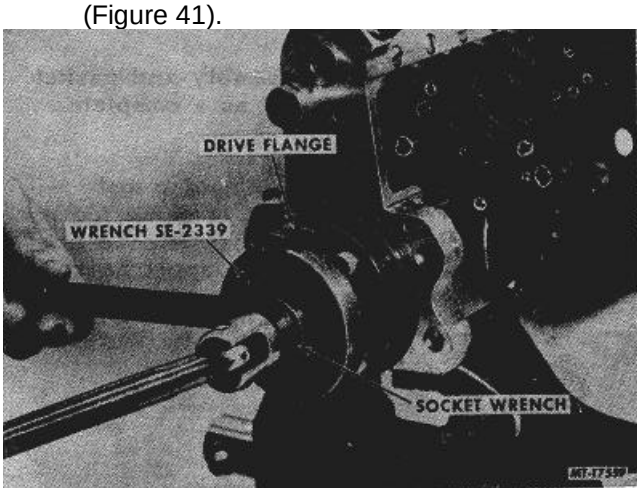


Figure 41 Removing Camshaft Nut

5. The drive flange can be removed from the camshaft by using a gear puller or as follows: Remove two socket head set screws (opposite each other), flat washers and lock washers from the drive flanges. Reinstall the two set screws less washers to serve as puller screws. Use two steel strips between drive flange and pump housing for puller screws to bear against while removing. Turn down set screws until drive flange is removed (Figure 42). Set drive flange and Woodruff key aside.

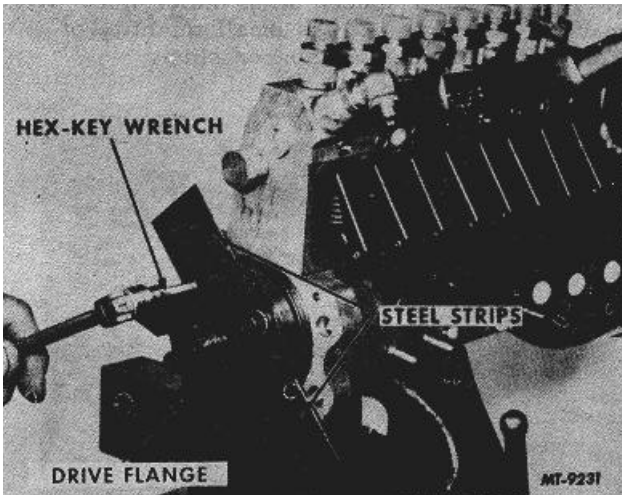


Figure 42 Removing Drive Flange

6. Loosen holding fixture clamp bolts, reposition pump assembly on side (tappet holder tools pointing upward) and retighten fixture clamp bolts.
7. Remove the two camshaft center bearing screws from bottom of pump (Figure 43). Figure 43 Removing Camshaft Center Bearing Screws

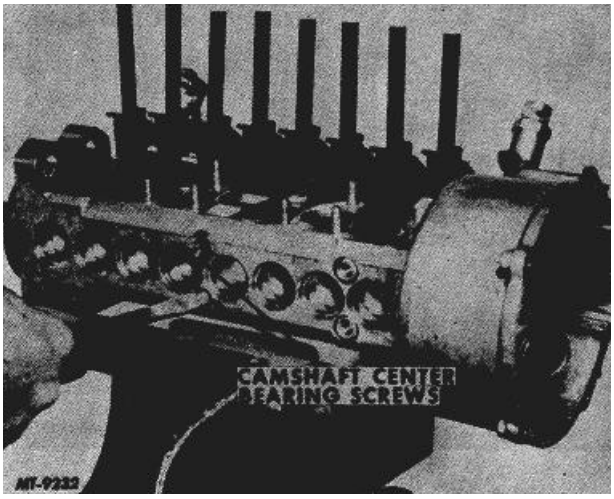


Figure 43. Removing Camshaft Center Bearing Screws

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8. Using large screwdriver remove the four flat head screws from camshaft front bearing retainer and remove retainer (Figure 44).

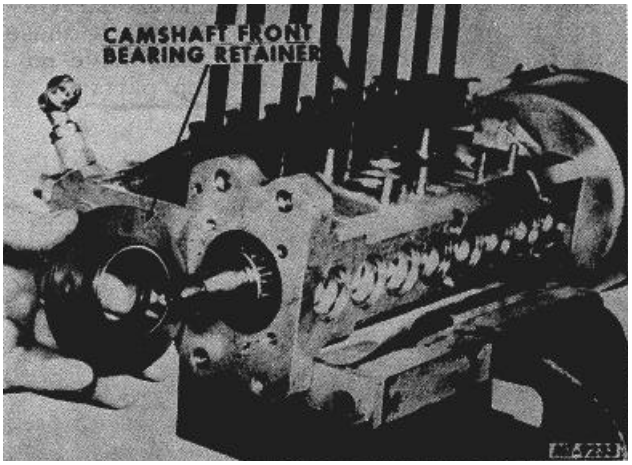


Figure 44 Removing Front Bearing Retainer

9. Remove camshaft (Figure 45) with center bearing and both end bearings out front of pump. A slight tapping on rear of shaft with soft hammer is permitted.

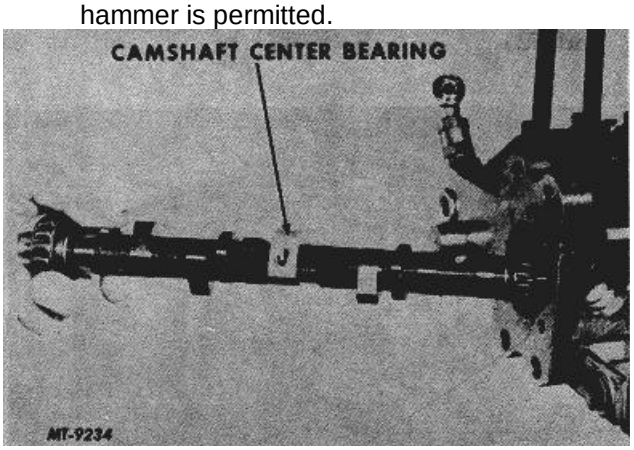


Figure 45 Removing Camshaft

10. Using a 5/8" or 11/16" socket or similar size wooden plug, drive the eight base plugs inside governor housing and remove

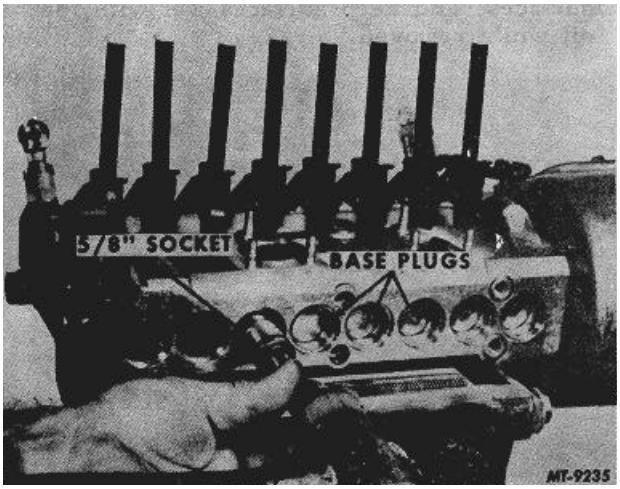


Figure 46 Removing Base Plugs

11. Using SE-2345 tappet remover tool, push roller tappet up so that SE-2341 tappet holder tool can be removed (Figure 47). Clear holder tools from all eight tappets and remove roller tappet assemblies from pump housing. Keep parts in order so that tappets can be returned to their respective bores on reassembly.

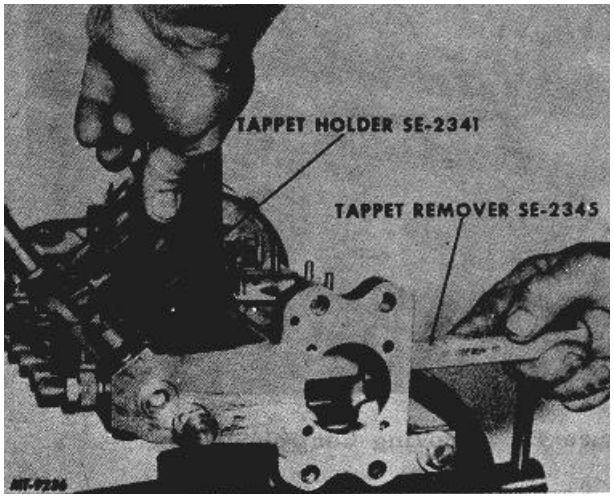


Figure 47 Removing Holder Tool and Tappet

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12. Remove keepers, plunger springs, upper spring seats and plungers (Figure 48). Keep parts in order, don't touch machined surfaces, and keep surfaces wet with fuel oil while removed.

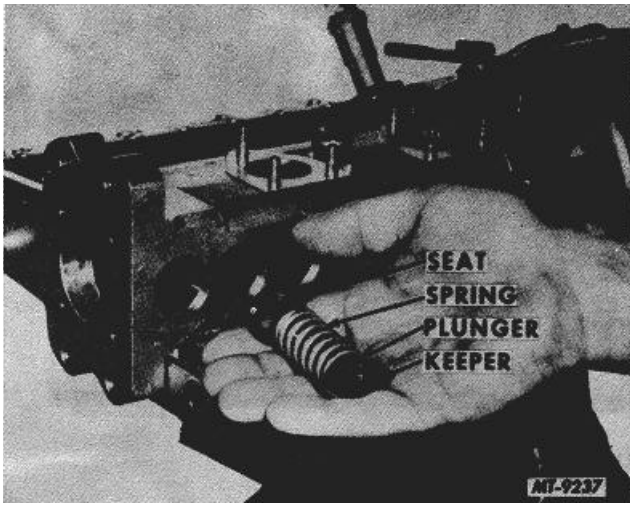


Figure 48. Removing Plungers

13. Remove control sleeves from barrels (Figure 49).

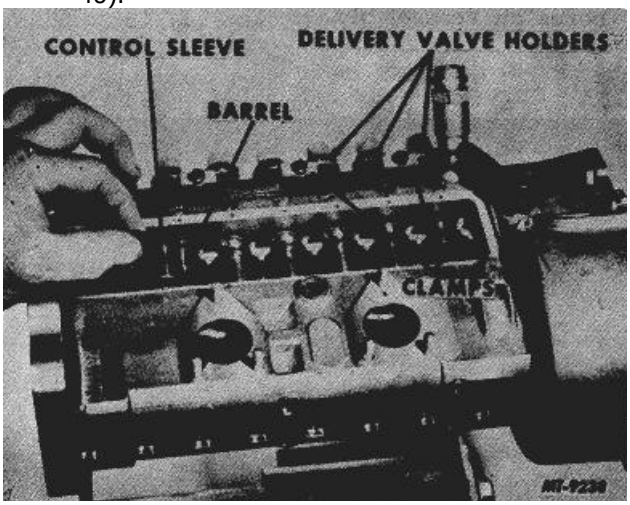


Figure 49. Removing Control Sleeves

14. Remove delivery valve holder clamps and, using a 7/8" socket, remove the holders

15. To remove delivery valves, springs, fillers and gaskets, lift up on barrels from inside pump housing (Figure 50). All these parts can then be lifted out as an assembly. As soon as barrels are removed, keep barrels and plungers together. NOTE: While these parts are mated at assembly, they have no mating marks. Be sure to keep parts in order.

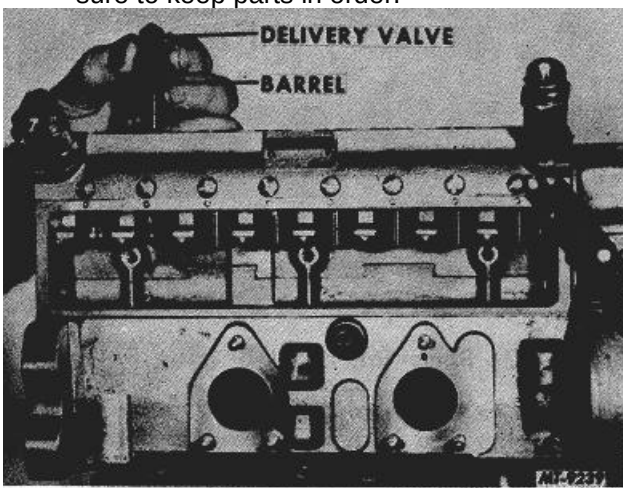


Figure 50. Removing Barrel and Delivery Valve

16. Remove control rack positioning screw and pull control rack from pump housing. Also remove control rack end plug (Figures 51 and 52).

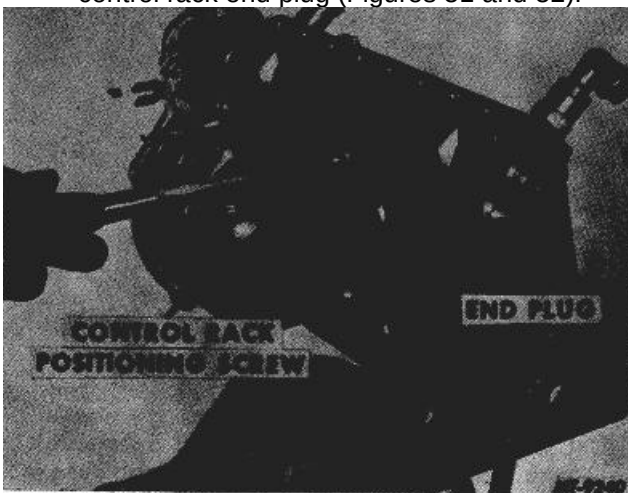


Figure 51. Removing Rack Position Screw

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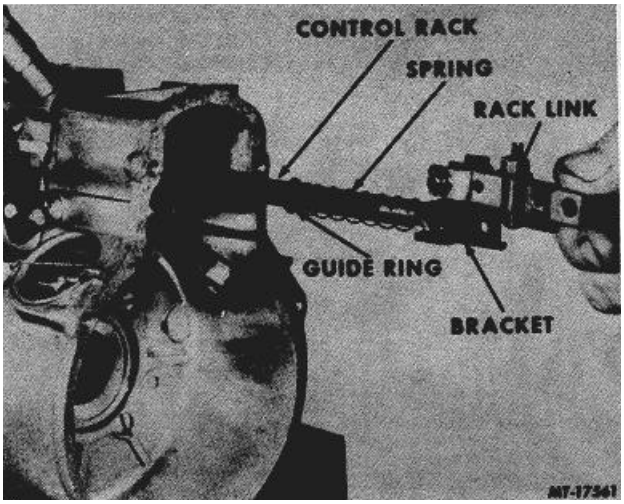


Figure 52 Removing Control Rack

Cleaning and Inspection

All parts must be cleaned and inspected before being reassembled to pump. Use clean fuel oil or calibrating oil to wash parts. When inspecting for damage or wear, it is good practice to replace any part that is questionable. The following list covers some important items to look for:

Governor Housing and Cover: Look for cracks, stripped screw threads, burrs on mating surfaces.

Governor Weight Assembly: While this unit is checked out at time of calibration, look for such visible evidence as worn bell cranks, damaged weights, stripped adjusting nut threads, worn or damaged springs, etc.

Damper Hub Assembly: Check condition of rubber buffers. These are sometimes damaged during reassembly.

Curve Template: Sliding parts should operate free of bind; any grooves or pressure marks on curve should be smoothed with fine emery.

Adjusting Pin: If any parts of the adjusting pin are worn or damaged, replace the complete unit.

Pump Housing: Look for cracks, chips or evidence of over-torquing or stripping of screw threads. Flush housing thoroughly. Leaking or damaged housings cannot be reconditioned.

Barrels and Plungers: Evidence of damage (scratches, scoring, etc.) on lapped surfaces of plunger means both barrel and plunger must be replaced. You can test the set by washing out with test oil and pulling plunger part way out of barrel. It must fall back slowly by its own weight.

Delivery Valve and Seat: If either piece is damaged, both valve and seat must be replaced, since these are lapped parts.

Roller Tappets: Slight pressure marks or grooving can be smoothed out with a polishing cloth, but more serious wear requires that parts be replaced.

Camshaft: Deep wear or grooving on cams or bearing surfaces of camshaft requires that camshaft be replaced.

Roller Bearings: Replace if damaged.

Control Rack: Be sure there are no burrs on gear teeth or scratches along sides. It may be polished with crocus cloth, but replace if any binding with housing exists.

Control Sleeves: If there is only slight damage, control sleeves can be polished and reused. If damage is severe, replace.

Springs: Normally can be reused unless broken or rust coated.

Spring Keepers: Worn or bent keepers should be replaced.

Base Plugs: Can be reused unless they are known to be leaking.

Gaskets, Seals and O-Rings: Should always be replaced whenever the pump is rebuilt.

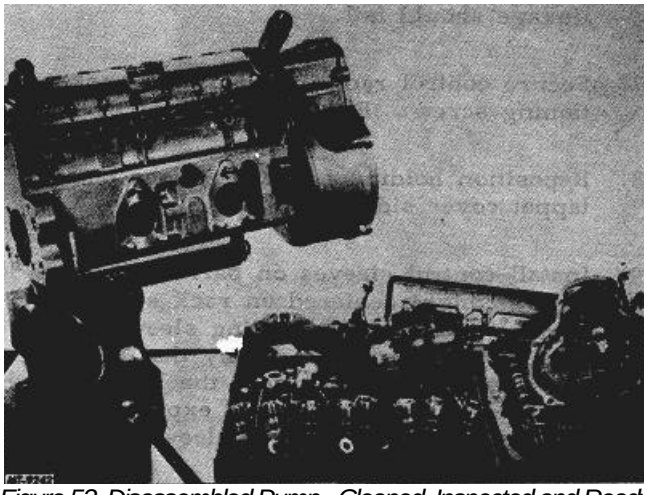


Figure 53 Disassembled Pump - Cleaned, Inspected and Ready for Reassembly

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Reassembly Procedures:

Pump Reassembly

1. Position pump body in SE-2351 holding fixture and clamp upright in vise.
2. If governor housing was removed, obtain new gasket and tap governor housing onto pump housing. Use light lube on gasket. Install mounting screws and restake to secure. Reposition stop lever spring end in hole provided.
3. Noting for correct order, install the barrels, aligning guide slots with pins in pump housing. Pre-lubricate with fuel oil while in- stalling.
4. Install delivery valves and seats, noting that flat is located on valves for the four idling cylinders (cylinder numbers 2, 3, 5 and 8).
5. Install new delivery valve gaskets (1 only), springs fill piece and holders. Use new O-rings and pre-lubricate with fuel oil. In- stall delivery valve holders finger tight. Do not torque until control rack and control sleeves have also been installed.
6. Attach rack link bracket and rack link to rack and with rack spring and washers in place on rack, install control rack through governor and into pump housing. The rack spring is important, since it functions to take up lost motion in the internal pump parts and serves to retract rack if other linkage should fail.
7. Secure control rack in pump with rack positioning screw. Be sure rack is free.
8. Reposition holding fixture to place pump tappet cover side up.
9. Install control sleeves on barrels (Figure 54) with all eight centered on rack segments. Check for bind by operating sleeves with control rack and replace any that do. Sleeves are available in two sizes, the larger of which is standard. When bind is experienced, replace with smaller control sleeve.

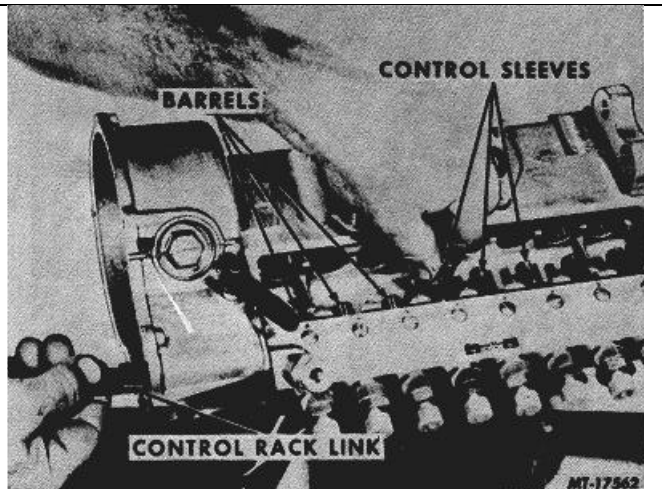


Figure 54 Installing Control Sleeves.

10. Starting at drive end, torque Nos. 1 through 8 delivery valve holders to 22 to 25 ft. lbs. NOTE: Tighten holders to specified torque and relieve twice before final torquing. Operate rack between each sequence to be certain rack has no bind.
11. Install upper spring seats and springs.
12. Using SE-2346 plunger installer tool, grasp plunger in tool and place spring keeper on tool. With marked tang of plunger toward side cover opening and open end of spring keeper away from side cover opening, in- stall plungers and spring keepers in their respective barrels Figure 55. Align plunger tang with control sleeve slot.



Figure 55. Installing Plungers

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13. Using SE-2345 tappet installer and noting guide slot, install tappets in their respective bores. Keep roller pin flush with tap- pet. It will be noted that lube oil supply port passes through number 5 tappet bore. The action of tappet aids oil circulation through pump housing.
14. Compress plunger springs with SE-2345 tappet installer tool and position the eight SE-2341 tappet holder tools on side of pump housing to hold all tappets in their raised position (Figure 56).

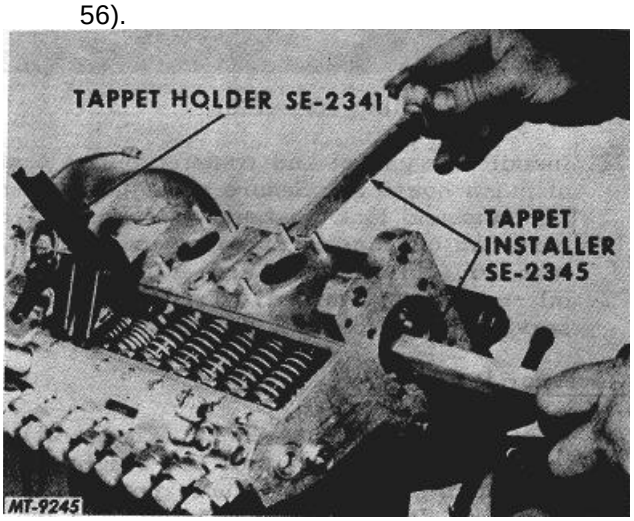


Figure 56 Installing Tappets

15. Place a small dab of lube on center bearing to hold it to camshaft and install camshaft into pump housing. Center bearing is positioned on bottom side of camshaft. Secure center bearing with two screws through bottom of pump housing.
16. Using a thin coat of non-hardening sealing compound (No. 2 Permatex or equivalent) on mating surface, install front bearing retainer. Start all four screws to guide retainer into place, but do not use screws to draw down. Tap retainer into place while turning camshaft to assure alignment (Figure 57). Tighten mounting screws securely.

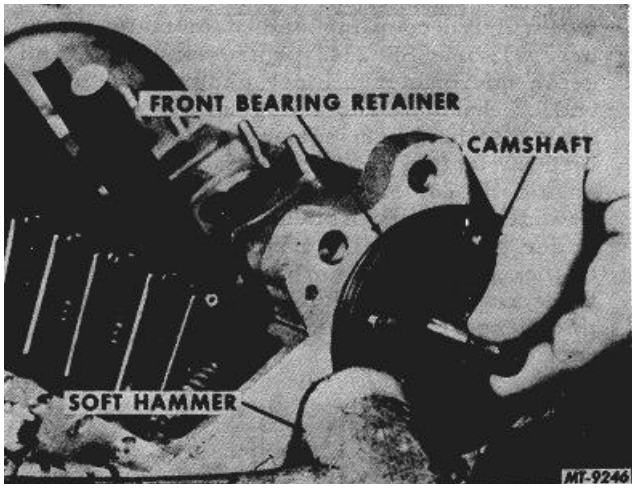


Figure 57 Installing Front Bearing Retainer

17. To check camshaft end play, screw SE-2343 holder tool onto front end of camshaft (Figure 58). Place SE-1848 dial indicator set in holder so indicator will read end play when tool handle is pulled and released. End play is .02-.06mm (.0008"-.0024"). You can change end play by adding or removing shims behind front bearing. NOTE: When installing a new camshaft, use the same number of shims as used on old shaft as a starting point for build-up. Make end play adjustment from there (e.g., zero end play-- use .0016" shim).

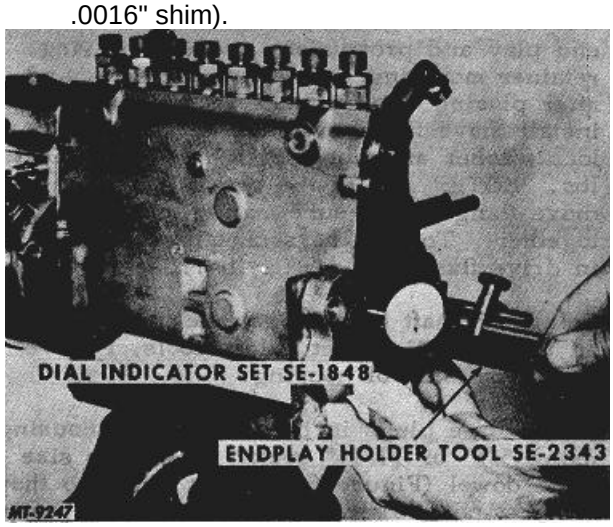


Figure 58 Checking Camshaft End Play

18. To check camshaft protrusion or space between drive coupling and main body (Figure 59), use SE-2342 protrusion gauge and depth micrometer. Place gauge over front end of camshaft and using micrometer, measure distance from surface of tool to machined surface of pump housing. Distance should be 20.7-22.2mm (.817"-.877"). Change camshaft protrusion by adding shims under bearing at governor end of camshaft to increase protrusion or removing shims to decrease protrusion. Maintain same thickness of shims at each end to hold correct end play.

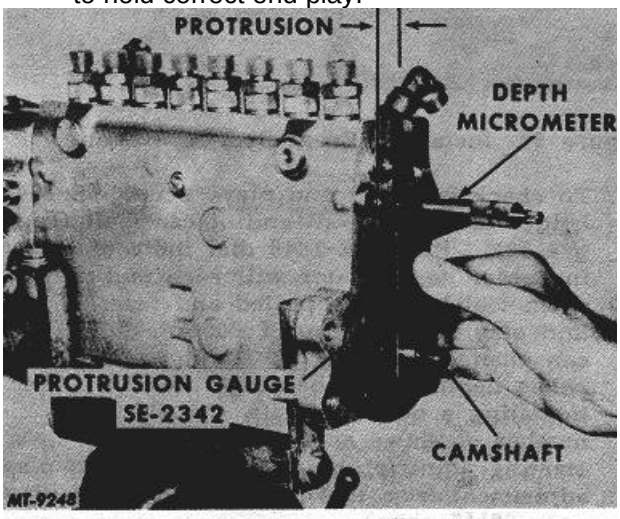


Figure 59 Checking Camshaft Protrusion

19. When satisfied that camshaft has sufficient end play and protrusion, recheck bearing retainer mounting screws for tightness and after placing Woodruff key in camshaft slot, install drive flange on camshaft. Install lock washer and nut and tighten to 60-72 ft. lbs.

NOTE: Check the two halves of the drive flange to be sure mating marks are together. Torque the socket head set screws in drive flange (18-25 ft. lbs.). 20. Using camshaft cams to release pressure on the SE-2341 tappet holder tools, remove tools from side of housing.

21. Install base plugs in bottom of pump housing using 5/8" or 11/16" socket or similar size wood dowel (Figure 60). Seat plugs so they are just past lower edge of chamfer in pump housing. If plugs do not seal, obtain new or apply thin coat of sealant to plug circumference.

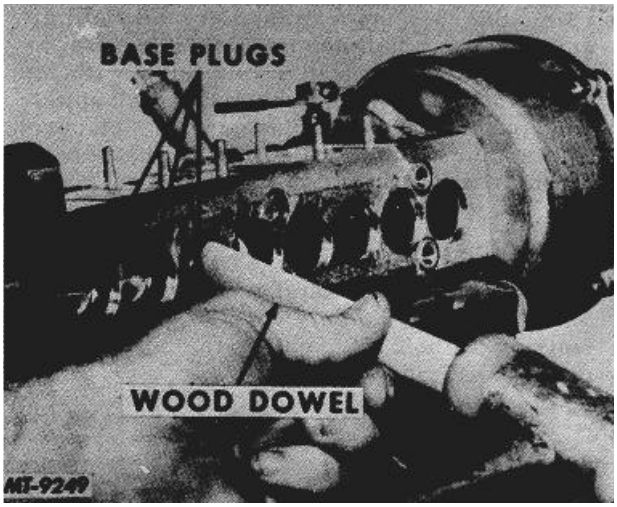


Figure 60 Installing Base Plugs

22. Install new gasket and transfer pump to side of pump housing. Secure with three mounting nuts and lock washers. You can check condition of transfer pump by pressurizing with air (15 to 20 psi) and submerging in oil--no leaks permitted. Transfer pump is serviced as a complete unit only.

Governor Reassembly

Governor flyweight assembly (Figure 61) is serviced as a complete unit but weight springs, spring seats and shims are serviced individually. Instructions for assembling the governor are outlined below.

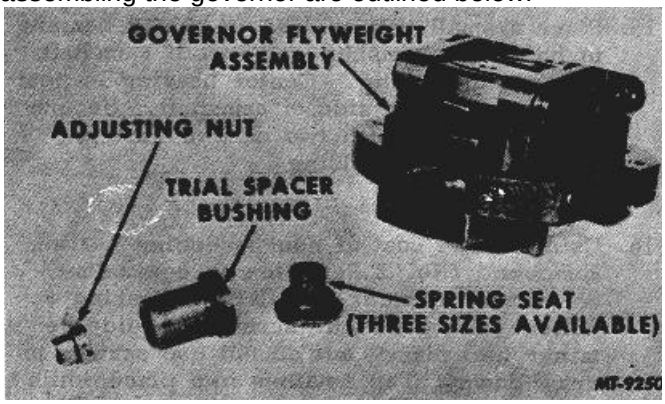


Figure 61. Details of Flyweight Assembly

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1. Perform a static check on balanced movement of governor weights by making a temporary build-up less springs but using spring seats, trial spacer bushings (obtained locally) and adjusting nuts on each weight as follows:

   Install double-nutted thru-bolt in weight assembly. Apply slight pressure to center of bolt and check for excessive rocking movement in one or the other weights (Figure 62). Obtain correct size spring seat so that slight movement in weights can be equalized. When installing the three different size weight springs, remove the trial spacer bushings.

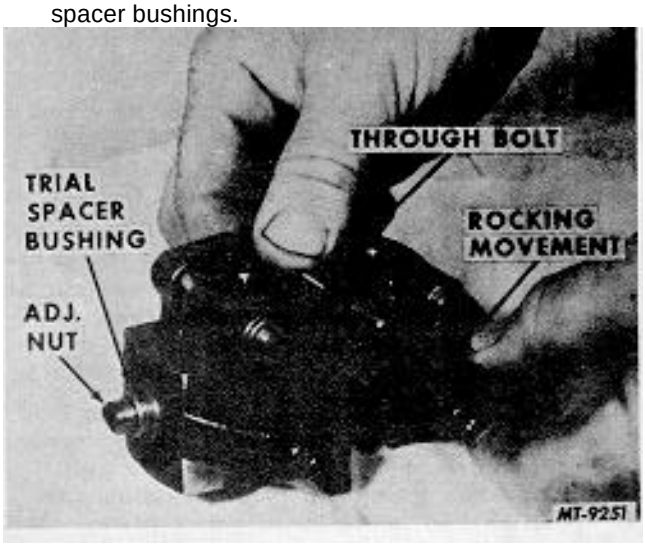


Figure 62 Checking Flyweight Trial Build-Up

2. Reinstall flyweight springs. Always start governor spring reassembly with one shim under lo-idle (large) spring, two shims under intermediate spring and no shims under hi-idle (small) spring. Intermediate spring shims may be changed when pump is calibrated. Always reinstall same color spring as was removed. Install outer spring seat and adjusting nut. When installing adjusting nut, adjustment range is from flush to not more than 2.5mm (.100") protrusion of the threaded bolt (2 to 3 clicks). Post protrusion should be approximately equal on both spring sets.

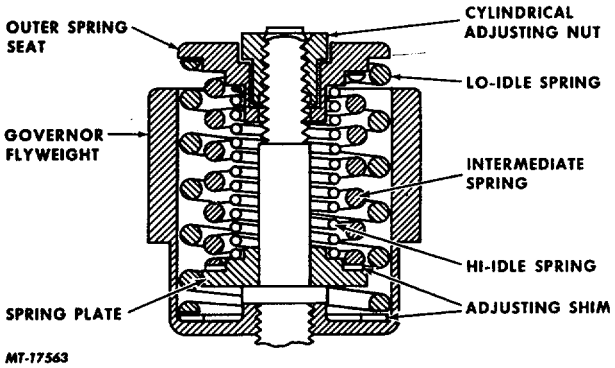


Figure 63 Sectional View of Flyweight Spring Installation

3. Before installing weight assembly on camshaft, inspect damper buffers for damage. Pry up hub to inspect. Replace as a set if needed. (See Figure 64.)

4. Assemble prelubricated buffers in damper retainer and place damper hub on weight assembly (Figure 64).

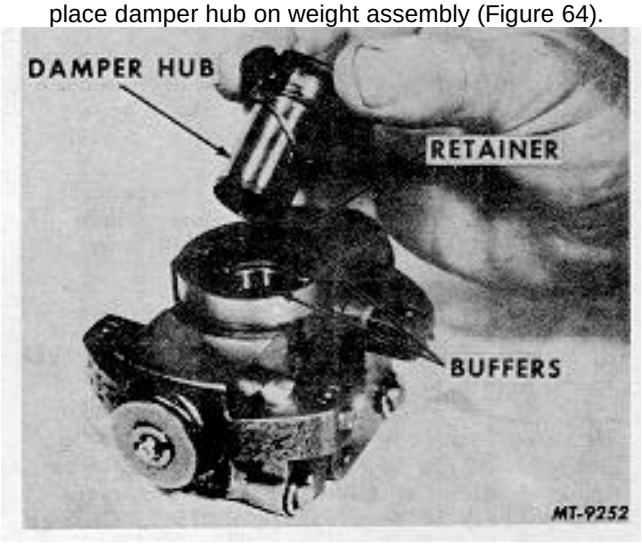


Figure 64 Installing Damper Hub to Flyweight Assembly

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5. Install flyweight assembly to camshaft (Figure 65). Install spacer shim and secure to camshaft with slotted cylindrical nut. Use SE-2344 and SE-2339 rebuild tools. Torque nut to 37-43 ft. lbs.

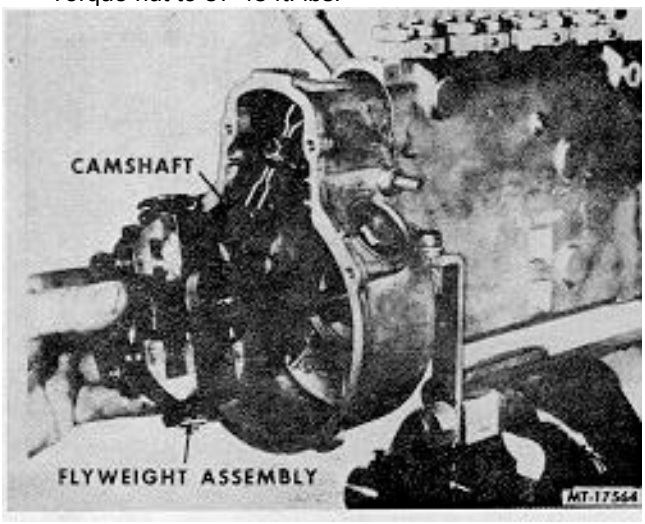


Figure 65 Installing Flyweight Assembly

6. Check action of damper by holding camshaft, grasping weight assembly and twisting to note for slight movement. Use thicker spacer shim to obtain more movement or thinner shim to decrease movement (varying spacer-shim increases or decreases pressure on damper). Purpose of damper is to dampen out injection impulses from governor weights.
7. Install adjusting pin guide bushing; secure bushing with two cap screws--lock screws in place with lock plate tabs.
8. Install adjusting pin assembly; temporarily secure with thru-bolt at this time, since another measurement will be made later in procedure.
9. Install slider and floating lever--open slot of floating lever to right. Pin floating lever to rack link to hold in place.
10. Measure "slider-to-housing" distance (Figure 66). This is made by measuring from back of slider to governor mating surface (no gasket) 38.8mm (1.524"+.015") Change distance by turning screw inside of adjusting pin. One-half turn of adjusting screw moves sliding block approximately . 5mm (.020"). Back screw out to increase distance or turn screw in to decrease distance.

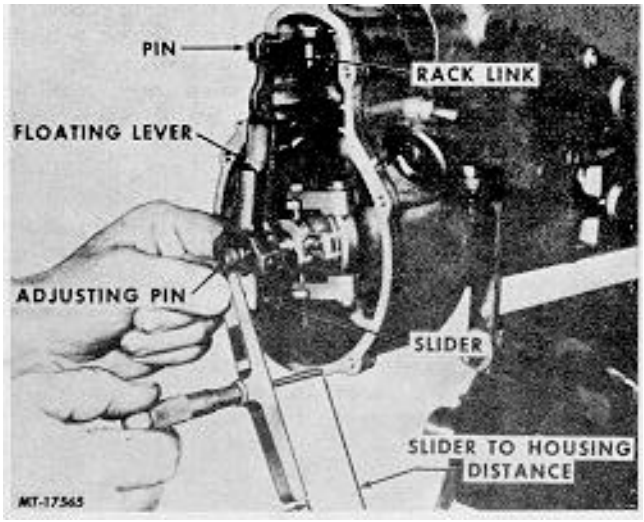


Figure 66 Measuring Slider-to-Housing Distance

11. Secure double-nutted thru-bolt in governor weight assembly by installing lock washer and nut. Bend over tabs of lock washer to secure. Operate rack back and forth to recheck all linkage for free movement.
12. Cut seal cover from hi-idle adjusting screw locknut on governor cover and back out hi-idle adjusting screw. Hi-idle screw is removed so that accelerator lever can be moved full forward for making next check.
13. Measure "basic setting of curve plate (Figure 67). This is measured from governor cover surface (gasket in place) to guide pin shaft when guide pin is in maximum fuel position and bottomed in curve plate. Basic setting is 21.5-21.9mm (.847"-.863").

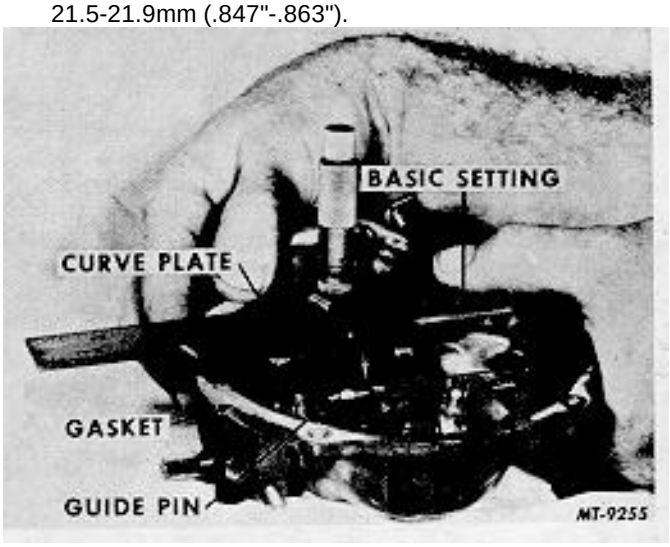


Figure 67 Measuring Curve Plate Basic Setting

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14. Add shims under curve plate mounting to decrease basic setting or remove shims to increase basic setting (Figure 68). Check for free travel of guide pin shaft in curve plate after resetting. Check to be sure cotter pin has been used to secure pin between rack link and floating lever.

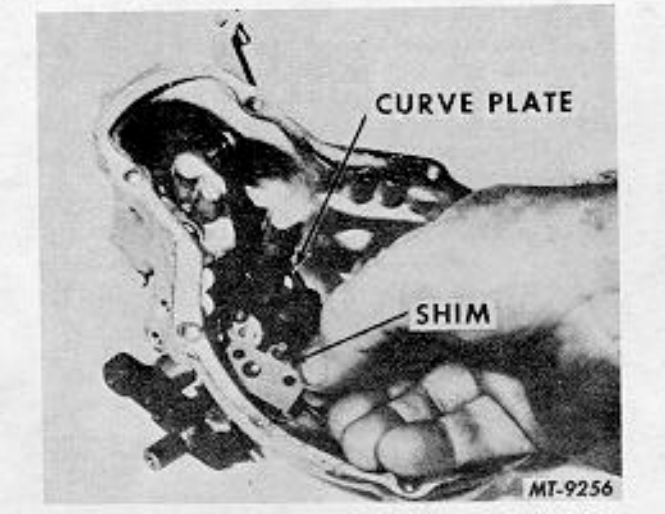


Figure 68 Location for Curve Plate Shim Adjustment

15. Install governor cover to housing. When installing, apply small dab of lube to floating block to hold hollow end up and note that floating block enters floating lever. Operate accelerator lever to facilitate installation. Secure cover with cover screws.

16. Install guide stud screw in rear of governor cover. Apply non-hardening sealing compound to threads before installing. If accelerator lever was removed, reinstall at this time.

17. Position accelerator lever fully back against lo-idle stop screw.

18. Insert torque capsule assembly or control rack stop assembly (with stop shackle) into governor housing. Rotate torque capsule or rack stop assembly approximately 45 degrees in the counterclockwise direction (from installed position). Slide torque capsule or rack stop assembly into governor housing until stop shackle clears governor floating lever, then rotate torque capsule or rack stop assembly 45 degrees clockwise to the horizontal position.

19. Move accelerator lever to the vertical position.

20. Using a hook made from light wire, reach down through adjustment access hole and lift stop shackle up to engage slot in stop shackle with rocker arm pin. (See Figure 69). In some cases, it may be easier to lift stop shackle with hook engaged at rear of mating flange or in slot of stop shackle.

NOTE: To ease this operation, interior of governor housing can be lighted by removing seal wire and plug from governor adjustment access cover on side of governor housing and inserting penlight through access hole.

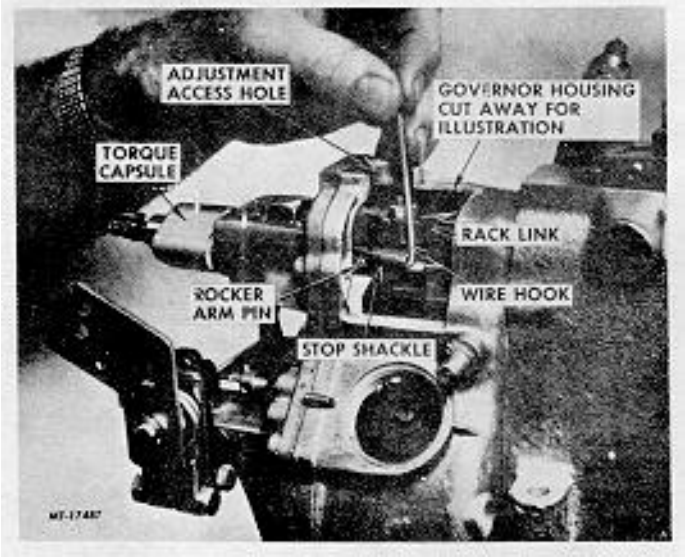


Figure 69 Engaging Stop Shackle to Rocker Arm Pin (Governor Housing Cut Away for Illustration)

21. After stop shackle is engaged with rocker arm pin (Step 20), push torque capsule or rack stop assembly into position against governor housing and secure with mounting screws.

22. Check torque capsule or rack stop assembly as follows:

    a. Hold accelerator lever fully forward. This should place rack in excess fuel (starting) position with adjustment screw on rack link resting on top of mating flange on stop shackle. (See Figure 70)

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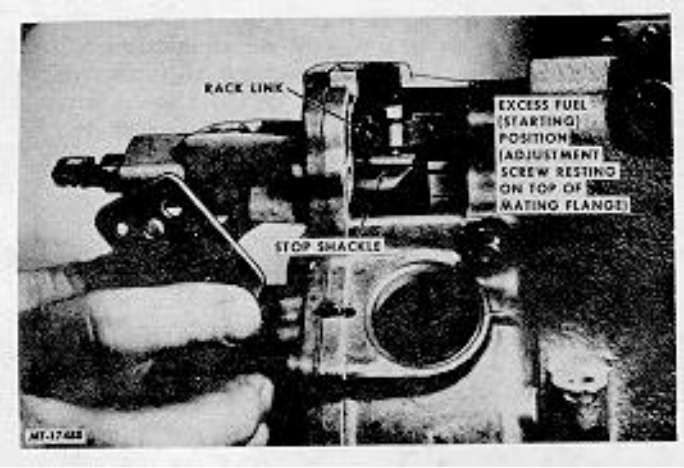


Figure 70 Rack Link and Stop Shackle in Excess Fuel (Starting) Position (Governor Housing Cut Away for Illustration)

b. Slowly move fuel shut-off lever to rear. If installation is correct, a distinct "click" will be heard as rack moves back from excess fuel position and adjustment screw on rack link engages with rear edge of mating flange on stop shackle. (See Figure 71)



Figure 71 Rack Link and Stop Shackle in Full Load Fuel Position (Governor Housing Cut Away for Illustration)

c. If correct positions of parts (steps a and b) cannot be obtained ("click" is not heard), check for proper engagement of slot in stop shackle to rocker arm pin. If necessary, loosen torque capsule mounting screws and connect stop shackle to rocker arm pin per Step 20 above.

NOTE: Confirmation of rack positions can be made by removing plug from front (drive end) of pump housing and observing end of rack. At excess fuel (starting) position, rack should extend approximately 9.525 mm (.375") forward of threaded guide bushing on front of pump housing. At full-load fuel position, end of rack should lie approximately 3.175 mm (.125") inside of threaded guide bushing on pump housing. (See Figure 72)

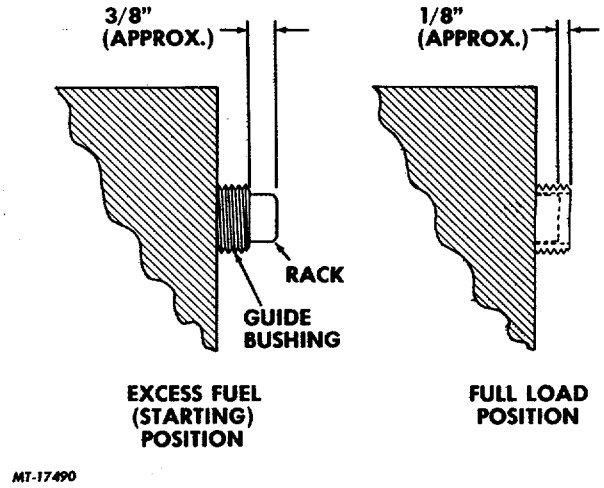


Figure 72 Rack Positions for Confirming Proper Stop Shackle Installation

23. Mount engine adapter to front of pump.

Further reassembly including side cover plate, torque capsule cover, hi-idle adjusting screw and miscellaneous locks, seals, etc. cannot be completed until after pump is calibrated.

Pump is now ready for mounting to calibrating stand.

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INJECTION PUMP CALIBRATION

Following injection pump or governor service and overhaul, the pump must be recalibrated to establish correct internal timing, fuel delivery and governor operation. It is also recommended that pump calibration be checked on a calibrating stand anytime the injection pump is removed to perform engine service operations. Instructions for performing calibration checks and adjustments are outlined below.

Calibrating Stand

Calibrating stands SE-2414 (5.59 kW/7.5 hp), SE-2333 (5.59 kW/7.5 hp) and SE-2192 (3.73 kW/ 5.0 hp) are recommended. Other stands (3.73 kW/5.0 hp minimum) can be used providing they can be adapted accordingly. (Calibrating stand SE-2414 is shown in Figure 73.)

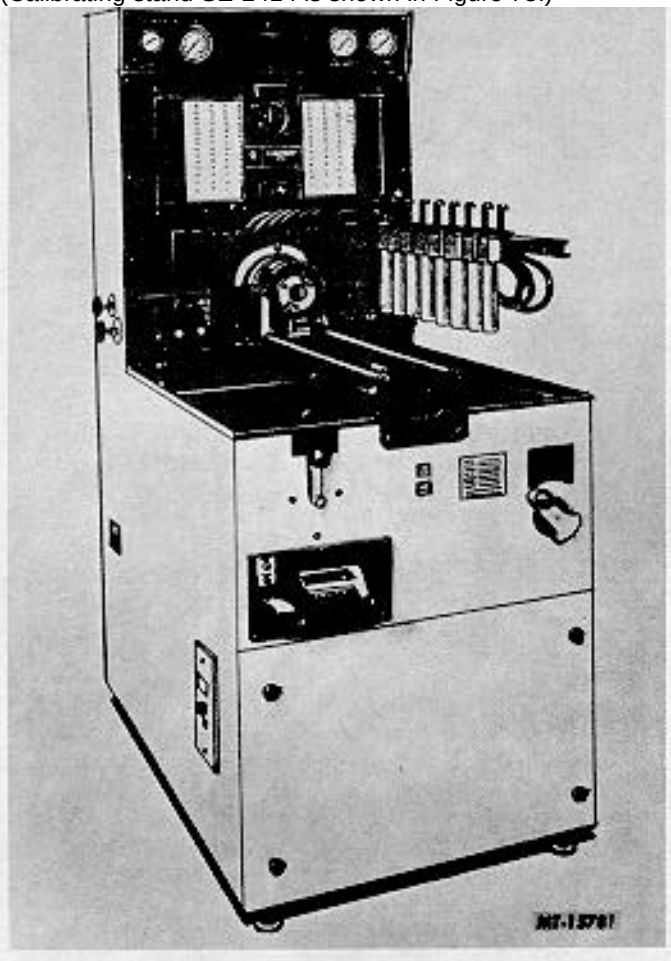


Figure 73 Injection Pump Calibrating Stand (SE-2414)

Master accessory set SE-2415 (Figure 74) is required to adapt calibrating stands SE-2414, SE-2333 or SE-2192 for testing the model PES8A75 injection pump and RQV governor.

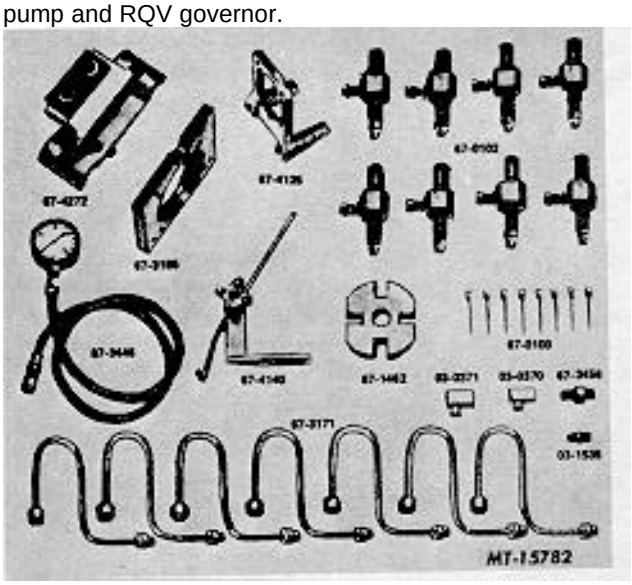


Figure 74 Calibrating Stand Accessory Set (SE-2415)

Legend for Figure 74

Code No.	Quantity	Description
67-4272	1	Bracket, flange mtg.
67-3166	1	Plate, adapter
67-4125	1	Bracket, support
67-0102	1	Test nozzle set
67-3448	1	Gauge (0-100 psi.)
67-4140	1	Throttle positioner
67-1462	1	Disc, drive
67-0100	8	Tubes, bleed off
03-0371	1	Elbow
03-0370	1	Elbow
67-3456	1	Fitting, disconnect
67-3171	8	Fuel lines
03-1535	1	Connector

Additional items required for mounting the injection pump on the calibrating stand are (1) transfer pump-to-injection pump fuel gallery line and fittings (IH part number 393933-C93) and (2) injection pump-to-engine adapter (IH part number 391983-C1). It is suggested that these items be kept at the calibrating stand rather than using the parts from the engine being serviced.

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Calibrating Stand Maintenance

The calibrating stand must be kept in good operating condition. Maintenance checks and lubrication of test stand components must be performed periodically to assure satisfactory results.

Calibrating oil must be of the specified type. Calibrating oil and filters must be changed regularly. Test stand supply pump must maintain specified pressure since injection pump calibration depends upon correct supply pump pressure.

To assure uniform delivery, calibrating stand test nozzles should be tested for balance (equal delivery) every six months or whenever 200 pumps have been tested. The method for balancing the test nozzles is as follows:

1. Adjust all test nozzles to specified test nozzle opening pressure. (See CALIBRATION CHART.)
2. Install an injection pump on calibrating stand.
3. Perform the "Maximum Fuel Delivery Check" and record amount of fuel obtained from No. 1 pumping element.
4. Install each of the remaining test nozzles in the No. 1 nozzle position and note delivery from each nozzle. If necessary, adjust nozzle opening pressure to obtain same flow as recorded for nozzle No. 1 (Step 3). Nozzles must be balanced to within 0.5mm3/stroke.
5. After nozzle balance (uniform delivery) has been obtained, recheck opening pressure of all nozzles. If nozzle opening pressure is not within specified limits, nozzles should be repaired or replaced.

Mounting Pump on Calibrating Stand

NOTE: Before mounting injection pump on calibrating stand, make sure pump can be rotated. This is especially important where pump has been overhauled, tappets replaced, etc. Tappet adjustment could be so high that control tangs on plunger will hit bottom of barrel.

1. Assemble flange mounting bracket and support bracket from accessory set to rails of calibrating stand.
2. Install pump-to-engine adapter on pump housing. Assemble adapter plate from accessory set to adapter on pump housing.
3. Place drive disc from accessory set on tangs of pump drive coupling.
4. Mount injection pump assembly on mounting brackets. Rotate test stand drive to align tangs on drive coupling with slots in drive disc. Slide pump forward to engage drive tangs and bolt adapter flange to flange mounting bracket, see Figure 75. After pump is mounted, rotate test stand and pump two or three revolutions by hand to check for binding.

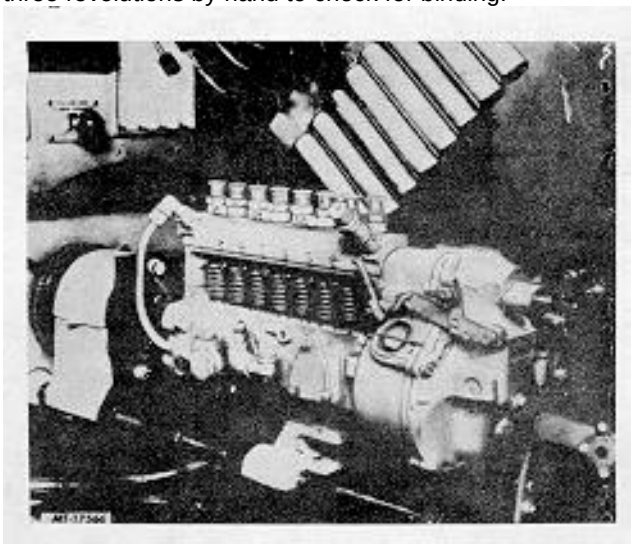


Figure 75 Injection Pump Mounted in Calibrating Stand

5. Remove rack end cap from front of pump and install rack gauge (dial indicator SE-2121) and holder (SE-2119) as shown in Figure 76.

   Zero dial indicator as follows: (See Figure 76)

   a. Loosen mounting bolts of external rack stop bracket and move bracket up out of way.
   b. Use a pull back spring to hold shut off lever to rear holding rack back against internal rack stop.
   c. Zero dial indicator to a slight preload approximately .508 mm (.020").

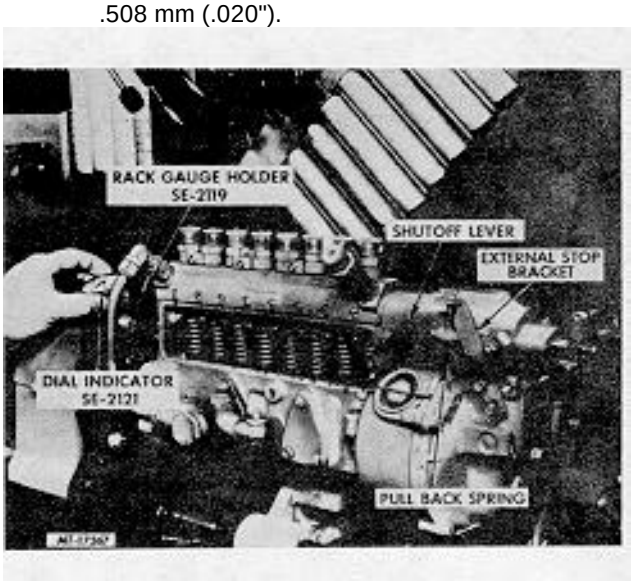


Figure 76 Installing Rack Gauge (Dial Indicator)

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6. Attach supply and return (low pressure) lines between injection pump and calibrating stand (Figure 77). If possible use transparent hoses for both inlet and return lines so that condition of oil can be observed as it flows through pump. This will assure operator that pump is receiving a solid charge of calibrating oil.

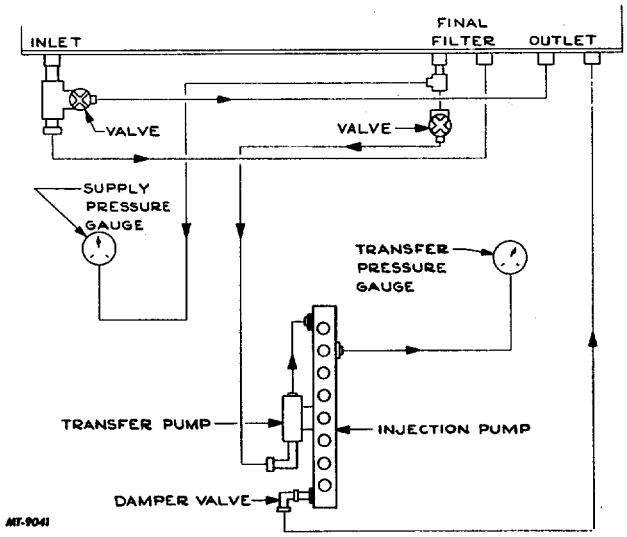


Figure 77 Calibrating Stand Low Pressure Plumbing

7. Prelubricate injection pump assembly by pouring 59.2 cc (2 oz.) of engine oil over tappets and .24 liter (1/2 pt.) into governor housing.

Establishing Initial Plunger Lift (Pre-Stroke)

For No. 1 Pumping Element

1. Remove delivery valve holder, filler, spring, gasket and delivery valve from No. 1 pumping element.
2. Install dial indicator holder and SE-2121 indicator with 4.45 cm (1-3/4") stem extension in No. 1 bore (Figure 78). Extension should bear on top of plunger.

   A satisfactory indicator holder can be made locally from an extra delivery valve holder (IH number 397583-C1), a nut from injection line and an O-ring gasket to fit threaded bore of line nut. Drill a 7.937 mm (5/16") diameter hole in delivery valve holder to receive indicator stem extension. Also drill a 9.525 mm (3/8") diameter hole in line fitting nut to receive indicator shank. To assure tight grip on indicator, use two O-rings or countersink holder 6.35 mm (1/4") with 9.525 mm (3/8") drill. When installing indicator, torque indicator holder into pump 29.8-33.9 N-n (22-25 lb. ft) to prevent barrel from loosening.

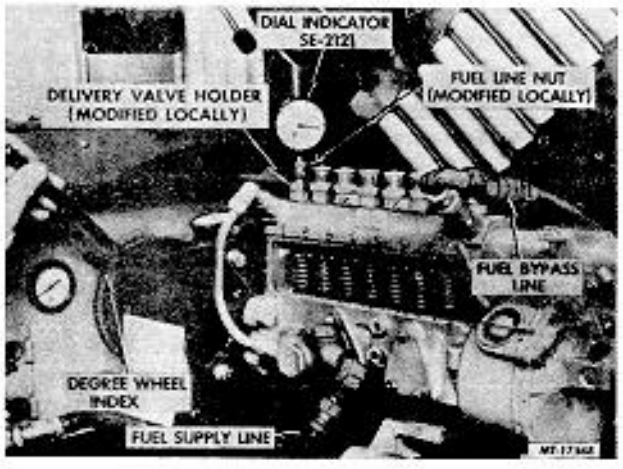


Figure 78 Establishing Initial Plunger Lift (No. 1 Pumping Element)

3. Position control rack in full load position as follows:
   a. Move accelerator lever fully forward.

   b. Pull shut off lever back until a distinct "click" is heard. This indicates that rack link adjustment screw has engaged with stop shackle (full load position).

NOTE: If "click" is not heard, recheck torque capsule or control rack stop installation.

   c. Attach a spring to accelerator lever to hold control rack forward in full load position.

4. Bar calibrating stand over by hand to rotate pump camshaft in normal direction of rotation (counterclockwise as viewed from governor end of pump) until No. 1 plunger is at bottom dead center (base circle of cam). Zero dial indicator.

5. Continue barring calibrating stand in direction of normal pump rotation until dial indicator reads specified plunger lift of 2.0mra (.0787 inch).

6. Set calibrating stand degree wheel at zero.
7. Remove dial indicator and holder and reinstall original delivery valve holder (without delivery valve, spring and fill piece) in No. 1 port.

Phasing the Pump (Low Pressure Method)

This is an actual fuel flow test performed on the injection pump to establish the precise start of injection for each of the eight plungers in firing order.

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Check start of delivery (port closing) on No. 1 element as follows:

1. With rack at full load and with delivery valve, spring and fill piece removed from No. 1 element, install drip spout (made from used injection line) in No. 1 port (Figure 79).

NOTE: Where high pressure delivery equipment is available on calibrating stand, the delivery valves do not have to be removed.

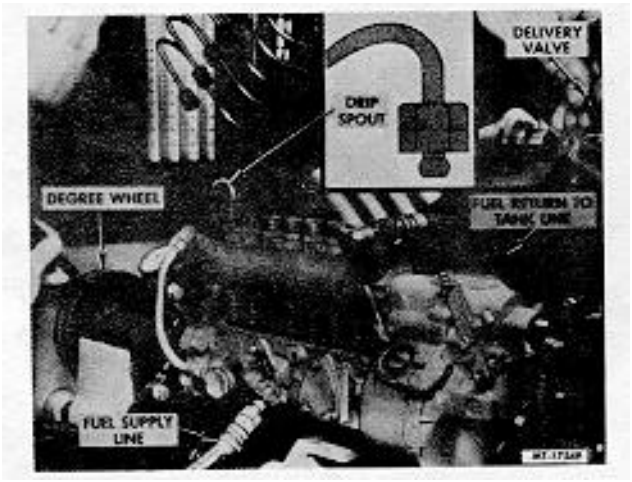


Figure 79 Checking Start of Delivery (No. 1 Pumping Element)

2. Install fuel supply and return lines to pump and turn on test stand fuel flow. Adjust supply pressure to obtain 35 kPa (5 psi) at fuel gallery. Check at priming outlet port on right front corner of pump housing.

3. Turn pump camshaft (clockwise as viewed from drive end) until fuel flows freely from drip spout. Continue to rotate camshaft clockwise slowly until fuel flow from drip spout decreases to one drop every 3 to 5 seconds. (This indicates port closing or start of delivery for No. 1 element.)

4. If this port closing or start of delivery does not occur at the degree wheel zero mark, adjust tappet screw so that port closing of No. 1 and zero mark on degree wheel will coincide.

   Using tappet adjusting wrenches (SE-2347) adjust tappet setting as follows: (Figure 80)

   If port closing occurs before degree wheel zero mark, loosen locknut and turn tappet screw "in". If port closing occurs after zero, turn tappet screw "out". One flat of tappet screw equals approximately 2 degrees travel at degree wheel. Tighten locknut and repeat test after adjustment.

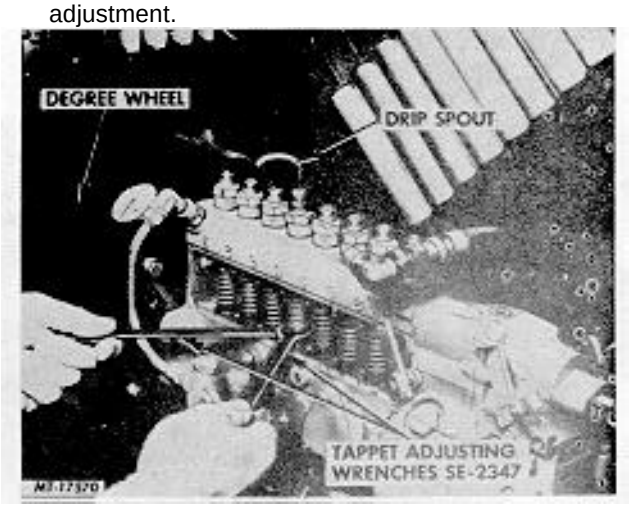


Figure 80 Adjusting Tappet Setting

5. Turn off test stand fuel flow; remove drip spout and reinstall delivery valve, spring and fill piece to No. 1 element.

6. Remove delivery valve, spring and fill piece from No. 8 element and install drip spout.

7. Turn test stand fuel on. Fuel should now flow from drip spout in No. 8 element.

8. Turn pump camshaft clockwise by hand and watch for port closing or start of delivery for No. 8 elements (as indicated at drip spout) when camshaft has been turned to 45 degree mark. If it doesn't, tappet screw must he adjusted.

   If port closing occurs early, turn tappet adjusting screw into roller tappet; if port closing occurs late, turn tappet adjusting screw "out".

9. Continuing in firing order, go on to No. 7 element and remaining elements in 45 degree increments on degree wheel and repeat the steps as covered above for No. 8 element. When all 8 elements have been similarly checked, the pump can be considered in phase.

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Pump-to-Calibrating Stand Installation Check

When all phasing and tappet setting has been completed and delivery valves, springs, fill pieces and retainers have been reinstalled, the pump can now be made ready for the operating tests (Figure 81).

1. When sure test stand nozzles are set for correct opening pressure, install injection lines from accessory kit between injection pump and test nozzles.
2. Check governor assembly for correct installation of torque capsule or rack stop shackle as follows:
   a. Place accelerator lever in full forward position and lock in place.
   b. Pull shutoff lever slowly to rear until click is heard. NOTE: Click indicates that rack link adjustment screw has engaged with stop shackle. If click is not heard, observe rack gauge for visible evidence of rack engagement.
   c. Recheck torque capsule installation or rack stop shackle installation if rack is not engaged.
3. Turn on fuel supply, start drive motor and operate stand at 1500 RPM.
4. Note that fuel is injecting to all eight injection assemblies.
5. Note that transfer pressure gauge shows gallery pressure being maintained to specifications. If not, check; and where required, replace damper valve located in fuel bypass at left rear of pump.
6. Should no adjustment be necessary, proceed to next step.

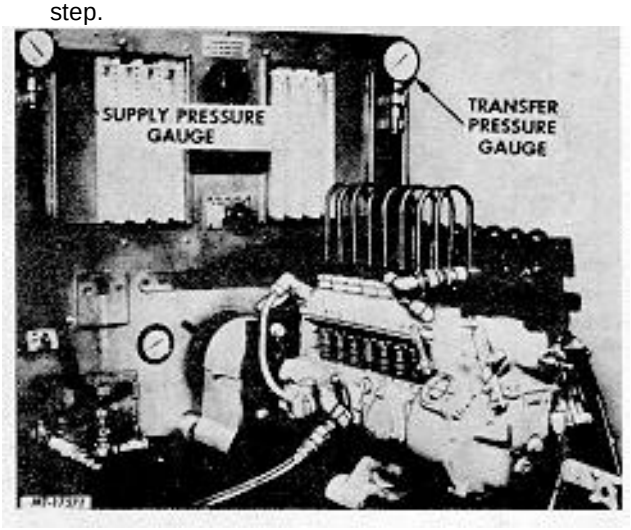


Figure 81 Calibration Stand and Injection Pump Ready for Operation

Check Governor Preliminary Cut-off
(Governor Internal Adjustment)

With accelerator lever in full forward position, hi-idle stop screw removed, operate calibrating stand at 1500 RPM and note control rack maximum fuel reference position (dial indicator reading). Increase test stand speed to 1600 RPM and again note rack position. If rack position at 1600 RPM does not equal rack position at 1500 RPM, this is an indication that governor cutoff is coming into effect too soon and must be adjusted.

Preliminary governor cutoff, which should occur between 1600 and 1800 RPM, is adjusted inside governor housing as follows:

1. Remove seal wire and governor access plug from side of governor housing.

2. Adjust cutoff by increasing or decreasing pre-tension of governor weight spring. Use SE-2348 governor spring adjusting wrench on cylindrical nut to make this adjustment (Figure 82).

To raise governor cutoff, pre-tension is increased; to lower governor cutoff, pretension is decreased. Cam nut is self-locking but must be turned in 1/2 turns to assure its being in locked position.

3. When adjusting pre-tension of governor weight spring, the locking nut must not compress springs so that coils contact one another. To prevent this, the post through the spring set must not protrude more than 2.5mm (0.100") above adjusting nut. Also, adjusting nut must not be backed out past flush with post.

4. Spring set may be one-half turn out of balance with opposite set if necessary to obtain desired governor cutoff.

5. When starting to make governor cutoff adjustment, observe both spring sets to check height of post above adjusting nut. If adjustment of more than one-half turn is needed to increase rack setting, adjust spring set opposite to the one that was adjusted previously.

6. After correct preliminary governor cut-off is obtained, install governor adjustment access plug and seal wire.

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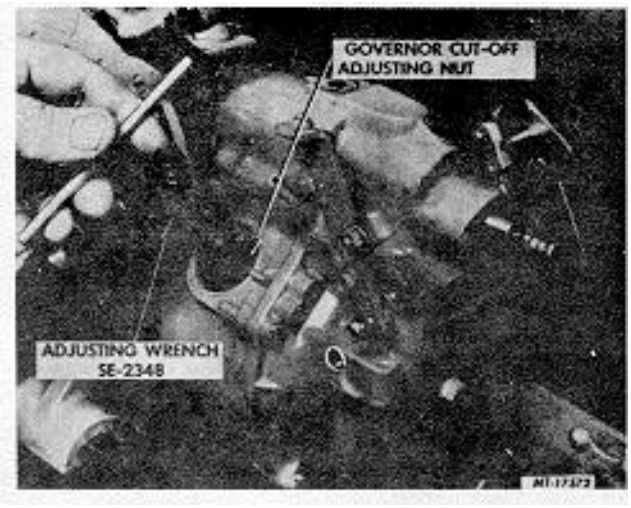


Figure 82 Making Preliminary Governor Cut Off Adjustment

Check Governor Cut-Off
(Governor External Adjustment)

Install hi-idle stop-screw and position accelerator lever in full forward position.

1. Check governor cut-off. Rack position (dial indicator reading) must be the same at 1550 RPM as at 1500 RPM. If it isn't, adjust at hi-idle stop screw.

Check and Set Hi-Idle Rack Position

With the hi-idle stop screw installed and the accelerator lever positioned in the full forward position, operate the stand at 1635 RPM. Check rack setting on dial indicator and compare with specifications given on CALIBRATION CHART. If rack is not positioned within limits given in specifications, make hi-idle adjustment as follows: (Figure 83)

1. Loosen locknut and turn hi-idle stop screw with hex key wrench counterclockwise to decrease rack dimension, or clockwise to increase rack dimension.
2. Tighten locknut and recheck rack dimension.

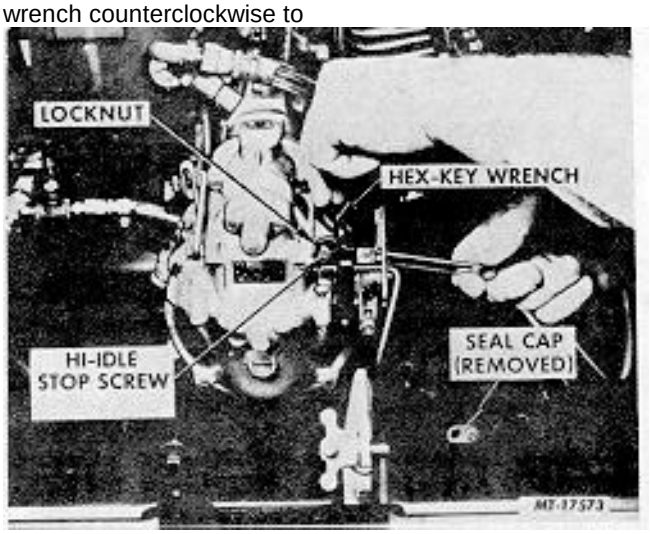


Figure 83 Adjusting Hi-Idle Rack Position

Adjust Maximum (Full Load) Fuel Setting

D-150, D-170 (W/Torque Capsule):

Operate stand at 1500 RPM with accelerator lever at full load position for 1000 strokes. Read and record flow to each of the eight graduates. Compare average flow to specification given on CALIBRATION CHART. If fuel flow is not within specified limits, adjust as follows:

1. Position accelerator lever in full load fuel position.
2. Loosen locknut, remove lock bracket and turn adjusting nut on stop rod as required (Figure 84). Backing adjusting nut "out" increases fuel setting and rack position; turning nut "in" decreases fuel setting and rack position. (See reference maximum fuel rack position.)
   NOTE: When reading dial indicator, make sure torque capsule spring is not collapsed.
3. Tighten locknut and recheck flow to graduates.

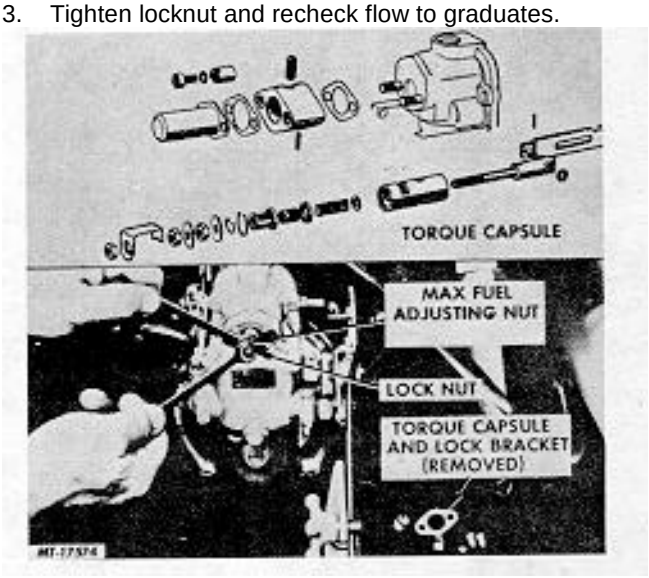


Figure 84 Adjusting Maximum Fuel Setting (D-150,, D-170)

D-190:

Operate stand at 1500 RPM with accelerator lever at full load position for 1000 strokes. Read and record flow to each of the eight graduates. Compare average flow to specifications on CALIBRATION CHART. If adjustment is necessary, adjust as follows:

1. Remove seal wire from maximum fuel adjusting nut.

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2. Loosen locknut.

3. Turn maximum fuel adjusting stud counterclockwise to increase fuel flow or clockwise to decrease fuel flow (Figure 85).

4. Tighten locknut, operate stand and recheck flow to graduates.

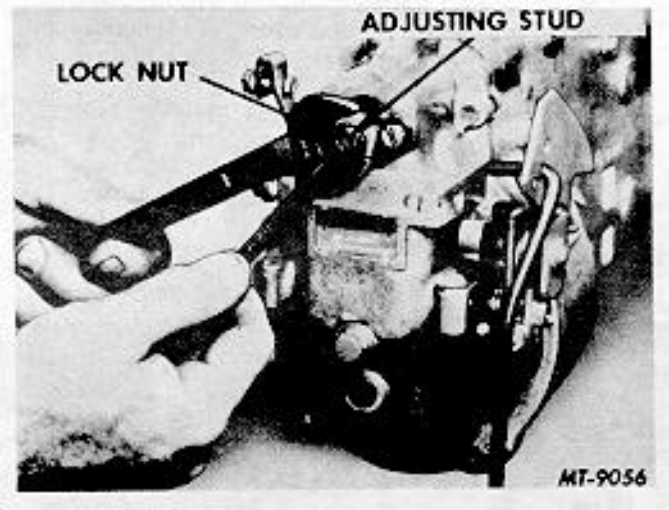


Figure 85 Adjusting Maximum Fuel Setting (D-190)

Check for Balanced Delivery

This test is made to assure equal delivery of fuel from all pumping elements.

Operate stand at 1500 RPM with accelerator lever full forward for 1000 strokes. Check all eight graduates for fuel quantity and record. Repeat test for a second 1000 strokes to verify results.

If fuel flow of one or more pump elements are not within specified balance limits given on CALIBRATION CHART, adjust affected elements as follows: (See Figure 86)

1. Loosen clamping screw of toothed quadrant.
2. Turn control sleeve and plunger with awl or small hex-key wrench.
3. To increase flow from element, turn control sleeve to rear (counterclockwise); to decrease flow from element, turn control sleeve to front (clockwise).
4. After checking balance and setting delivery quantity, the clamping screw of toothed quadrant on each element should be tightened to secure adjustment.

5. The position of the control sleeve relative to the corresponding toothed quadrant should be marked with a scribe. Mark each element once.

   NOTE: Balance should be maintained to as close a tolerance as is reasonably possible to prevent readjustment in later tests.



Figure 86 Adjusting for Balanced Delivery

Check Torque Compensation
(D-150, D-170 Only)

Torque compensation check is made as follows: (See Figure 87)

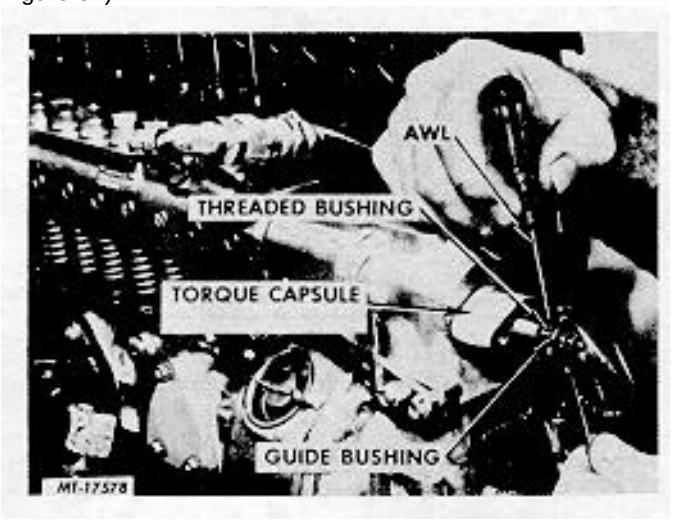


Figure 87 Adjusting Torque Compensation (D-150, D-170)

1. Operate test stand from 1400 to 1550 RPM with accelerator lever in full fuel position. Rack position should be constant.

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2. Check fuel flow by operating test stand at 1000 RPM for 500 strokes. Multiply delivery to each graduate by 2 and record results. Fuel flow should be within limits given on CALIBRATION CHART.

3. Check end rack position by:

   a. Operating stand at RPM specified on chart and recording rack position.

   b. Reducing stand to RPM called for on chart and again noting rack position. Rack position at lower RPM should be same reading at higher RPM.

4. Adjustment for beginning, end and minor flow changes is made on the torque capsule as follows:

   a. Remove lock wire from stop rod.

   b. Hold guide bushing with wrench and turn threaded bushing with awl as required.

   c. Turn threaded bushing "in" to increase spring tension and cause compensating effect to be delayed; turn "out" to decrease spring tension and cause compensating effect to come in sooner.
   d. Reinstall lock wire and recheck.

5. Make a major change by replacing torque capsule guide bushing. Increased thickness decreases torque compensation; decreased thickness increases compensation.

Check Excess Fuel Rack Positions

This is an operating test made to assure that the rack will move out of excess fuel position as specified. Adjustment is made by varying the height of the rack link adjustment screw.

A. Enter Excess Fuel Rack Position:

   1. Operate test stand at 100 RPM with accelerator lever in lo-idle position (fully back).

   2. Move accelerator lever from lo-idle to full load position (fully forward) and observe rack position. Rack position should be 19-21mm (.7480"-.8268") as shown on dial indicator.

B. Exit Excess Fuel Rack Position:
   1. Operate test stand at 250 RPM with accelerator lever in lo-idle position (fully back).

2. Move accelerator lever to full load position (fully forward) and observe position of rack (as shown by dial indicator reading).

   On D-150 and D-170 models, rack position should be the same as recorded for "End of Torque Compensation".

   On D-190 models, rack position should be the same as recorded for "Maximum Fuel Rack Position".

3. If rack position obtained in step 2 is further forward (higher indicator reading) than specified above, this means that the rack is in excess fuel (starting position) and that the rack link adjustment screw must be adjusted as follows: (See Figure 88)

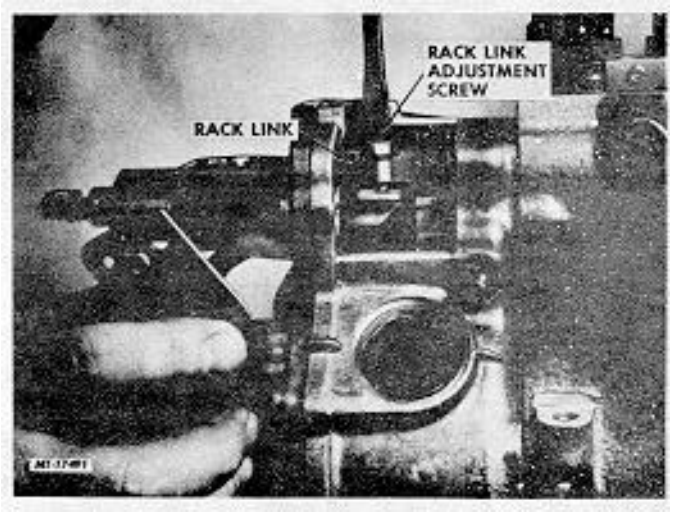


Figure 88 Adjusting Excess Fuel Rack Position (Governor Housing Cut Away for Illustration)

   a. Using 10mm Allen wrench, remove plug from adjustment access hole in top of governor housing.
   b. Loosen adjusting screw locknut (10mm).
   c. Using screwdriver, slowly turn adjustment screw counterclockwise until accelerator lever can be moved from low idle position (fully back) to the fully forward position without lower end of adjustment screw engaging rear edge of stop shackle mating flange. Adjust screw so that it just clears stop shackle mating flange when accelerator lever is moved from fully back to fully forward positions when test stand operating at 250 RPM.

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d. Slowly turn adjustment screw clockwise until lower end of adjustment screw just catches (.79-1.59 mm or 1/32-1/16") rear edge of stop shackle mating flange when accelerator lever is moved from low idle (fully back) to fully forward positions with test stand operating at 250 RPM. When this is obtained, tighten adjustment screw locknut and recheck adjustment by moving accelerator lever from fully back to fully forward positions several times and noting if adjustment screw engages rear edge of stop shackle mating flange each time accelerator lever is moved forward. Readjust screw if necessary.

e. With accelerator lever held fully forward (and adjustment screw engaged with rear edge of stop shackle mating flange), check rack position on dial indicator.

4. Recheck rack positions by repeating "A" (Enter Excess Fuel Position) and steps 1 and 2 above.

5. Reinstall plug in adjustment access hole.

Check Transitions (Four Cylinder Idle)

This is an operating check on the four cylinder idle feature of the injection pump. The object of the test is to check specified flow differential between elements 2, 3, 5, 8 (idling cylinders) and elements 1, 4, 6, 7 (non-idling cylinders).

1. Operate test stand at 300 RPM and locate the transition point by slowly moving the accelerator lever. The transition point is the point at which non-idling elements (1, 4, 6, 7) are delivering only a drop of fuel (Figure 89).
2. Lock accelerator lever in the position which corresponds to the transition point.
3. Operate test stand at 300 RPM for 500 strokes. Check all eight graduates for fuel quantity. (Multiply flow results by 2.)
   a. Record fuel delivery from elements 1, 4, 6 and 7.
   b. Record fuel delivery from elements 2, 3, 5 and 8.
   c. Compare fuel delivery results with specifications given on CALIBRATION CHART.
4. If delivery does not meet specifications:
   a. Replace delivery valve in affected element. (Be sure delivery valve is correct type.)
   b. Adjust fuel delivery at control sleeve.
   c. Recheck transition point.

5. If changes are made (step 4), recheck fuel delivery balance at full load and 1500 RPM.

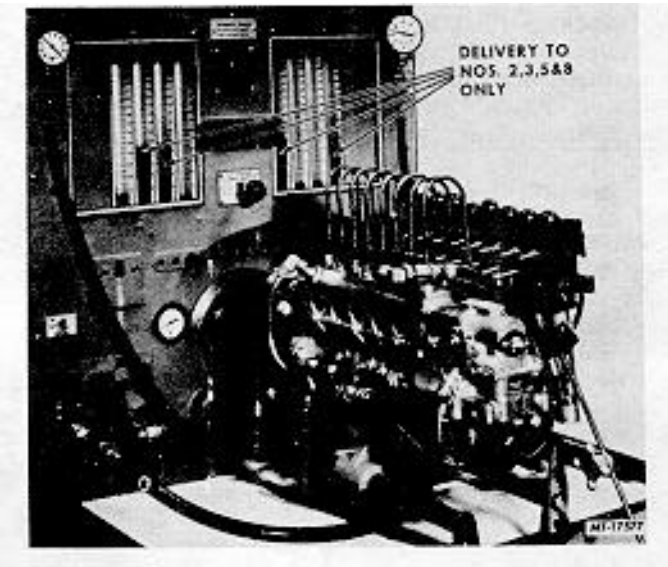


Figure 89 Checking Four Cylinder Idle Transitions

Check and Set Lo-Idle Rack Position

Lo-idle is adjusted on accelerator lever stop screw at right rear side of governor. Check and, if necessary, adjust lo-idle as follows: (See Figure 90)

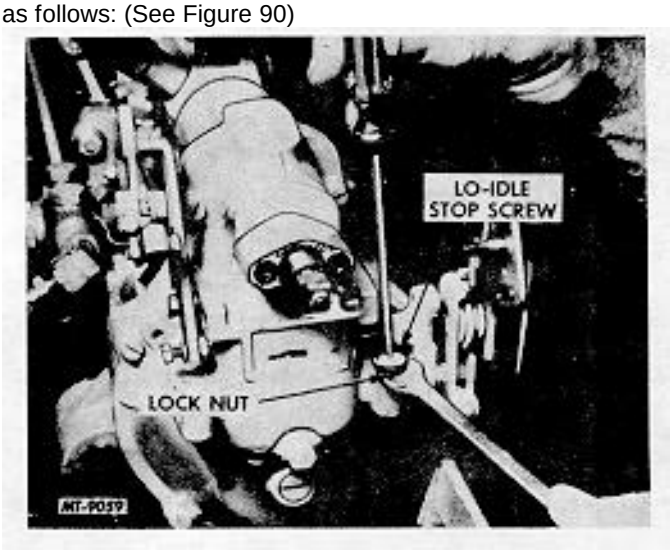


Figure 90 Adjusting Lo-Idle Rack Position

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1. With accelerator lever against lo-idle stop screw, operate stand at 300 RPM.

2. Observe rack position and compare to specifications--6. 0mm (.2362").

3. If not to specifications, turn stop screw "in" to decrease rack dimension or "out" to increase rack dimension.

4. Secure adjustment with locknut.

   NOTE: Final lo-idle adjustment is again checked and, if necessary, reset after pump is installed on engine.

Check Start Fuel Quantity

This is an operating test made to assure that the injection pump provides the proper quantity of fuel to start the engine, see Figure 91.

1. Operate test stand at 100 RPM with accelerator lever in low idle position (fully back).
2. Move accelerator lever from low idle to full load position (fully forward) and lock the lever in the fully forward position. Rack position should be 19-21mm (.7480"-.8268") as shown on dial indicator.
3. Check flow at 100 RPM for 500 strokes. (Multiply results by 2.) Compare flow results to specifications shown on CALIBRATION CHART.

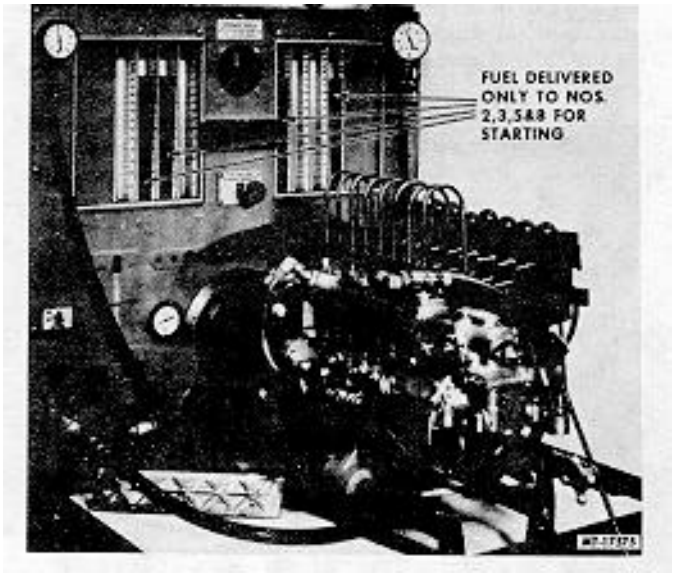


Figure 91 Checking Start Fuel Quantity

Check Fuel Shut-Off

This adjustment is made to protect pump internal stop and rack from damage. Adjustment is made by loosening stop bracket against which shut-off lever will strike (Figure 92). Operate shut-off lever to rear and hold in this position (rack against internal stop). Reposition external stop lever bracket so that shut-off lever will contact bracket stop screw just before rack would be stopped by the internal stop. Rack setting (dial indicator reading) with rack against external stop should never be greater than 1mm (.0394").

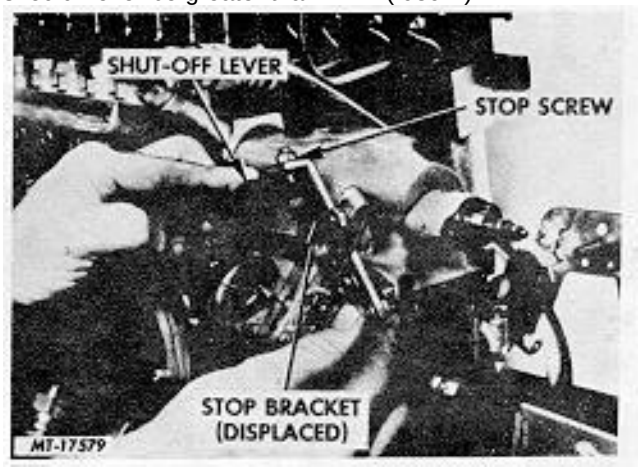


Figure 92 Adjusting External Stop Bracket

Pump Static Timing Check
(Drip Spout Method)

The static timing check is made to assure precise positioning of drive flange tangs. At pump assembly, when drive flange was installed the marked tang of drive flange was located by keyway to its approximate position. Final adjustment is made within the drive flange itself to obtain exact position. This check and adjustment is made at port closing or start of delivery on No. 1 pumping element.

Check and adjust timing as follows:

1. Remove calibrating stand injection lines from pump but leave supply and return lines connected.

2. Remove pump mounting adapter bolts, loosen rail clamp and slide pump back from calibrating stand drive approximately 12.7 cm (5"). Remove middle disc from drive flange.

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3. Remove delivery valve, spring and fill piece from No. 1 injection assembly and install drip spout. Make drip spout locally from extra injection line and connector nut.

4. With dial indicator still installed in front of pump, index camshaft (slash in shaft end at 10 o'clock and drive tangs horizontal). Place drive flange tool (SE-2323) on drive tangs with roll pin of mounting adapter also engaged in tool. (See Figures 93 and 94.)

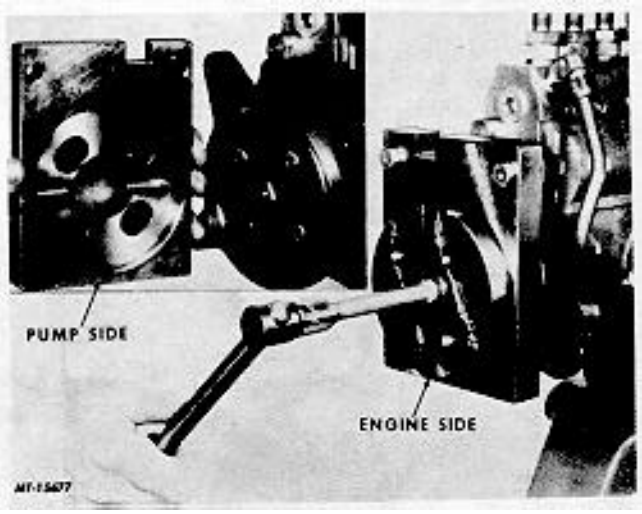


Figure 93 Drive Flange Tool in Pump



Figure 94 Checking Pump Timing

5. Set control rack at maximum fuel position recorded at 1500 RPM. Use clip to prevent spring collapse in torque capsule, where equipped. (See Figure 20, Page 10.)

6. After first noting that four socket head screws in drive flange are loose, turn on fuel supply and look for flow from drip spout. If fuel does not flow, use 7/8" socket on camshaft nut to turn camshaft counterclockwise (viewed from front) until fuel does flow.

7. Rotate camshaft clockwise until flow is reduced to drip (one drop/3-5 seconds). This indicates port closure or start of delivery for No. 1. Turn off fuel supply.

8. With drive flange tangs now indexed, tighten socket head screws in drive flange to specified torque (see TOROUE CHART).

9. Turn on fuel supply and recheck drip spout to be sure camshaft or rack position has not moved while tightening. (No. 1 still at port closure with rack at maximum fuel.) Turn off fuel supply.

10. Remove injection pump from calibrating stand, place in holding fixture and clamp in vise.

11. Remove drive flange tool.

Seal and Protect Pump

When injection pump overhaul and calibration have been completed, always perform the following:

1. Inspect pump for fuel and lube oil leaks and correct as necessary.

2. Be sure access plug in governor housing is tight and all other covers are in place.

3. Install wire seals on governor as required.

4. Install protective closures on both high and low pressure fuel and lube oil openings.

5. Perform final torquing of delivery valve retainers and install delivery valve retainer clamps.

Pump is now ready for installation on engine.

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INJECTION PUMP INSTALLATION

The procedure for reinstalling the injection pump on the engine is outlined below.

Preparation of Engine

1. Inspect pump mounting flange at rear of engine front cover. Also inspect rear stabilizer bracket mounting bosses. Inspect drive flange for damage or wear and note that it is firmly mounted on drive shaft.
2. Rotate engine until specified timing mark on crankshaft damper pulley 'aligns with pointer on engine front cover with No. 1 piston on compression stroke. (See Figure 18, Page 9)

   NOTE: Always rotate engine in direction of normal rotation. Do not "back" engine to align timing marks.
3. Observe to see that pump drive tangs at rear of engine front cover are vertical and that the marked tang is at the 12 o'clock position (Figure 95). If marked tang is down, rotate engine one complete revolution and make sure No. 1 piston is on compression stroke.

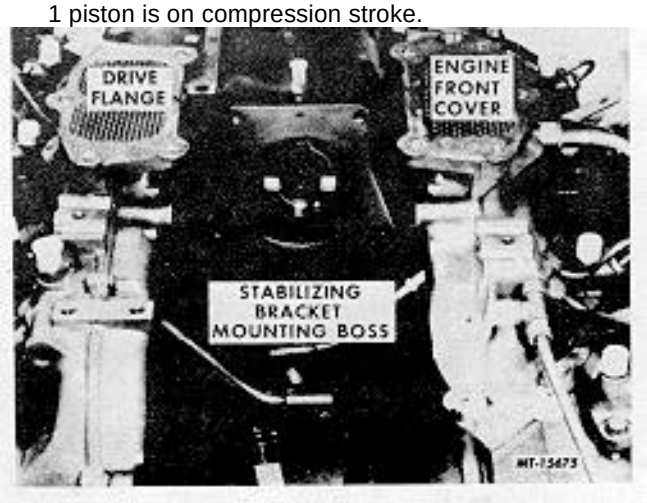


Figure 95 Pump Mounting and Drive Flange

4. To verify correct alignment of drive flange tangs, install drive flange tool SE-2323 on engine (Figure '96).

If drive flange tool cannot be installed, it will be necessary to loosen drive flange mounting nut and realign drive flange.

The procedure for repositioning drive flange or installing a new flange is as follows:

a. Turn crankshaft to specified timing mark with No. 1 piston on compression stroke.

b. Install or loosen and rotate drive flange on shaft so tangs are vertical and marked tang is up.

c. Place drive flange tool over tangs and align tool so as to engage pin in roll pin hole at rear of engine front cover.

d. Install mounting bolts to secure tool.

e. While holding drive flange in this position, tighten drive shaft nut to specified torque (see TORQUE CHART).

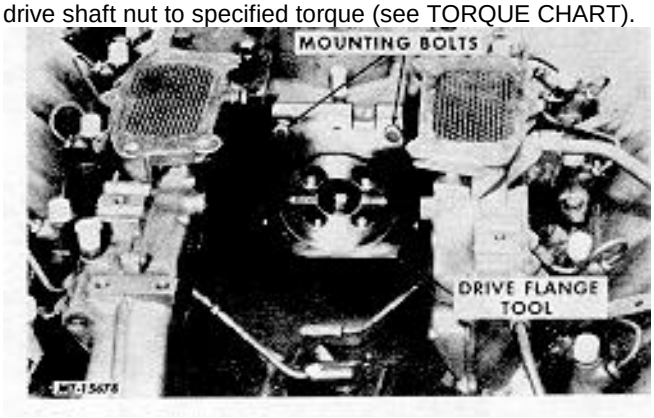


Figure 96 Drive Flange Tool on Engine

5. Remove drive flange tool.

Preparation of Pump

1. Make sure pump static (internal) timing is correct. (See "Pump Static Timing Check" under INJECTION PUMP CALIBRATION.)
2. If pump mounting adapter was removed, reinstall adapter on pump and secure with four mounting bolts.

3. Rotate pump camshaft so that drive flange tangs are horizontal and slash mark on end of camshaft is at 10 o'clock position.

Installation Procedure

With engine and injection pump prepared as outlined above, install pump as follows:

1. Install coupling (middle disc) on tangs of drive flange. Blind hole in center of coupling faces toward pump.

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2. Install injection pump on engine making sure drive flange tangs engage with couplings (Figure 97).



Figure 97 Installing Injection Pump on Engine

3. Secure mounting adapter and injection pump to rear of engine front cover with four mounting bolts.

4. Install stabilizing brackets to side at rear of pump housing.

5. Connect low pressure fuel inlet and return lines and lube oil line to injection pump.

6. Connect high pressure injection lines to injection pump and secure fuel line brackets.

7. Connect accelerator rod and stop control cable to governor levers.

8. Install air cleaner or manifold crossover adapter.

9. Prime fuel system.

10. Operate engine and check for fuel and lube oil leakage at injection pump.

11. With engine at normal operating temperature, adjust lo-idle and hi-idle to specifications.

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TROUBLE SHOOTING GUIDE
INJECTION PUMP AND FUEL SYSTEM

FAULT	POSSIBLE CAUSE	REMEDY
Fuel not reaching injection pump. Engine fails to start.	Tank empty.	Fill tank.
	Primary or secondary filter plugged.	Replace filters.
	Defective in-tank electric fuel pump.	Repair or replace electric fuel pump.
	Fuel lines clogged or damaged.	Clean or replace fuel lines.
	Defective damper valve.	Replace damper valve.
	Defective transfer pump.	Replace transfer pump.
Fuel reaches injection pump but does not inject to nozzle.	One or more injection lines plugged or damaged.	Replace lines.
	Plunger seized or spring broken.	Repair or replace injection pump.
Fuel reaches nozzles but engine fails to start or starts hard.	Cranking speed too slow. (Under 250 RPM)	Recharge battery or correct faulty cranking motor system. Lube oil may be too heavy at low temperature.
	Swirl destroyer struck open. (Where equipped)	Observe operation through opening in air intake manifold.
	Accelerator not in full fuel position.	Correct accelerator linkage.
	Intake air temperature low.	Use starting aids. Check ether device for proper operation. (Check Operator's Manual.)
	Improper fuel or water in fuel.	Drain system and pump housing; use specified fuel and prime system.
	Pump out of time with engine.	Correct timing.
	Poor compression.	Correct engine as required.
	Worn or scored plungers.	Repair or replace injection pump.
Engine starts and stops.	Water or other contaminants in fuel.	Drain system and pump housing; use specified fuel and prime system.
	Air in fuel.	Prime system.
	Fuel filter clogged. Fuel tank vent plugged. Waxed fuel filters. Fuel lines clogged or damaged.	Replace filters. Clean vent. Replace filters; use specified fuel. Clean or replace fuel lines.

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FAULT	POSSIBLE CAUSE	REMEDY
Erratic engine operation (surging or misfiring).	Improper or contaminated fuel.	Drain system and pump housing; use specified fuel and prime system.
	Low transfer pressure.	Change filters, check for fuel line restriction, replace damper valve or transfer pump.
	Injection pipes leaking.	Correct leaks.
	Pump out of time.	Correct timing.
	Nozzles faulty.	Repair or replace nozzles.
	One or more injection lines plugged or damaged.	Replace lines.
	Poor compression.	Correct engine as required.
Engine idles poorly.	Improper lo-idle adjustment.	Make lo-idle adjustment.
	Water in fuel.	Drain system and pump housing; use new fuel and prime.
	Air in fuel.	Bleed system.
	Accelerator linkage incorrect.	Correct linkage as required.
	Incorrect timing.	Check and correct timing.
	Damaged swirl destroyer. (where equipped)	Correct swirl destroyer.
	One or more injection lines damaged.	Replace lines.
	Poor compression.	Correct engine as required.
	Defective lo-speed flyweight spring.	Calibrate injection pump.
	Plungers worn or scored;	Repair or replace injection pump.
Engine has low power but shows no increase in smoke.	Accelerator linkage restricted.	Adjust accelerator linkage.
	Improper hi-idle adjustment.	Make hi-idle adjustment.
	Low transfer pressure.	Change filters, check for fuel line restriction, replace damper valve
	or transfer pump.	
	Low supply pressure.	Repair or replace lift pump.
	Loss of one cylinder.	Injection line plugged.
	Faulty maximum fuel setting.	Calibrate injection pump.
	Plungers worn or scored.	Repair or replace injection pump.
	Exhaust system restricted.	Check pipe diameter or muffler for damage.

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FAULT	POSSIBLE CAUSE	REMEDY
Engine has low power but shows no increase in smoke. (Continued)	Swirl destroyer in "on" position. (where equipped)	Check linkage for bind to prevent jamming.
	Air cleaner restricted.	Check manifold vacuum. Service air cleaner if vacuum exceeds specified limits.
	Nozzles faulty.	Repair or replace nozzles.
	Pump out of time.	Correct timing.
High smoke--with no loss or with increase in power.	Increase in fuel delivery.	Check nozzles.
	Air cleaner restriction.	Service air cleaner.
Overall poor performance.	General mechanical condition of engine poor.	Correct as required before extensive repair to the fuel system.
High smoke at rapid acceleration.	Governor reaching into excess fuel.	Calibrate governor.
Crankcase dilution (fuel in crankcase).	Nozzles faulty.	Check on nozzle tester; repair or replace.
	Transfer pump faulty.	Replace transfer pump.
	Injection pump faulty:	
	a. Incorrect delivery valve holder torque.	Loosen holders and retorque to specifications.
	b. Worn barrel & plunger.	Replace barrel and plunger.
	c. Leakage past rear fuel gallery plug.	Repair or replace pump housing.
	d. Damage to barrel seat.	Repair or replace pump housing.
	e. Cracked housing.	Repair or replace pump housing.
High speed surge.	Injection pump faulty:	
	a. Governor weight imbalance.	Calibrate governor.
	b. Damaged governor damper.	Replace governor buffers.
	c. Too little spring pretension on governor weights or slider.	Calibrate governor.
	d. Sticking control rack.	Loosen delivery valve holders and retorque to specifications.
		Relieve bind in governor internal linkage.
		Correct bind in torque capsule.
		Clean dirt from housing.

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FAULT	POSSIBLE CAUSE	REMEDY
High speed surge. (Continued)	Injection pump faulty: (continued)	
e.	Rack fails to go into excess fuel.	Replace stop shackle. Relieve governor spring pretension. Correct slider dimension.
Engine has low power and increased smoke.	Swirl destroyer in "on" position. (where equipped) Air cleaner restricted. Nozzles faulty. Pump out of time. Loss of one cylinder. Max fuel setting incorrect.	Check for bind in swirl destroyer operation. Service air cleaner. Check on nozzle tester; repair or replace. Correct timing. Check compression. Calibrate injection pump.

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SPECIFICATIONS

Engine Model	D150	D170	D190
Gross Power *, Kilowatts (Brake Horsepower) At RPM	111.9 (150) 3000	126.8 (170) 3000	141.7 (190) 3000
Net Power, Kilowatts (Brake Horsepower) At RPM	102.9 (138) 3000	117.8 (158) 3000	132.7 (178) 3000
Gross Torque *, Newton-meters (Pound-Feet) At RPM	433.9 (320) 2000	461.0 (340) 2000	488.1 (360) 2000
Net Torque, Newton-meters (Pound-Feet) At RPM	414.9 (306) 2000	442.0 (326) 2000	469.1 (346) 2000
Injection Pump Assembly Part Number (Including Governor & Transfer Pump)			
A. IH Part Number	465498-C91	465497-C91	465496-C91
B. Manufacturer's Part Number	0 400 848 022	0 400 848 020	0 400 848 021
Injection Pump Type	In-Line Plunger		
Drive	Timing Gear Train		
Pump Speed	One-Half Engine Speed		
Pump Rotation (Viewed From Drive End)	Clockwise		
Firing Order	1-8-7-3-6-5-4-2		
Initial Timing	32° ±1° BTDC *No. 1 Piston On Compression Stroke - Crankshaft* Damper Timing Mark And Pointer Indexed		
Electric Fuel Pump Pressure	21-35 kPa (3-5 psi) -- At Full Load		
Mechanical Fuel Pump Pressure	110 kPa (16 psi) -- At Full Load		
Transfer Pump Pressure	172 kPa (25 psi) Minimum -- At Full Load		
Engine Compression Pressure	2585-2930 kPa (375-425 psi)		
Governor Type	All Speed		
Minimum Engine Speed (Lo-Idle)	600-650 RPM (No Load)		
Maximum Engine Speed (Hi-Idle)	3200-3350 RPM		
Manifold Vacuum (Air Cleaner Restriction)	50.8 cm (20") Water - 3.73 cm (1.47") Mercury (Maximum Permissible @ Full Load)		
Exhaust Back Pressure (Exhaust Restriction)	103.6 cm (40.8") Water - 7.62 cm (3") Mercury (Maximum Permissible @ Full Load)		

* 73.6 cm (29") Hg. Dry Barometer and 32° C (85°F)

TORQUE CHART

Camshaft Nut (Drive End)	81.3 - 97.6 N-m	(60-72 lb-ft)
Drive Shaft Nut (Engine)	101.7 N-m	(75 lb-ft)
Drive Flange Setscrews	24.4 - 33.9 N-m	(18-25 lb-ft)
Pump-to-Adapter Bolt	33.9 - 47.5 N-m	(25-35 lb-ft)
Pump U-Bracket and Bolt	21.1 - 33.9 N-m	(20-25 lb-ft)
Delivery Valve Holder Nut	29.8 - 33.9 N-m	(22-25 lb-ft) (1)
Governor Flyweight Assembly Nut	50.2 - 58.3 N-m	(37-43 lb-ft)
Damper Valve Fitting	24.4 - 33.9 N-m	(18-25 lb-ft)
Governor Oil Fill Plug	9.5 - 12.2 N-m	(7-9 lb-ft)
Control Rack Cap	9.5 N-m	(7 lb-ft)

(1) Tighten to specified torque and relieve twice before final torquing.

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CALIBRATION CHART

Model PES8A75 Injection Pump With RQV All-Speed Governor For D-150, D-170, D-190 Diesel Engines

Calibrating Stand: SE-2414, SE-2333, SE-2192	Calibration Oil: Viscor Calibration Oil #L-1487C
Accessory Set: SE-2415	Test Nozzle Opening Pressure: 15858 ± 517 kPa (2300 ± 75 psi)
Supply Pressure: 21-35 kPa (3-5 psi)	Transfer Pump Pressure: 193 kPa (28 psi) minimum @ 1500 RPM

Engine Model		D150	D170	D190
Injection Pump Number		465498-C91	465497-C91	465496-C91
Check	RPM	Specifications		
1. Pre-Stroke Setting	0	2.00 mm (.0787") Lift to Port Closure of #1 Plunger @ 10.7 mm (.4212") Rack Position		
2. Pump Camshaft Phasing	-	45° ± .5° Between Cylinders 1-8-7-3-6-5-4-2		
3. Preliminary Governor Cutoff; Rack Position (Accelerator Lever in Full Forward Position with Hi-Idle Stop Screw Removed)				
a)	1500-1600	No change in Rack Position Between 1500 and 1600 RPM (Record)		
b)	1600-1800	Governor Cutoff (Rack Position Change) Should Occur Between 1600 and 1800 RPM (Record)		
4. Governor Cutoff; Rack Position (Accelerator Lever in Full Forward Position with Hi-Idle Stop Screw Installed)	1500-1550	No Change in Rack Position (Record)		
5. Hi-Idle Rack Position	1635	8.5 mm (.3346") Maximum		
6. Maximum Fuel Setting				
a) Rack Position (Ref)	1500	9.3mm (.3661")	9.7mm (.3819")	10.7mm (.4213")
b) Delivery (Avg) (mm3/Stk)	1500	44.0±1.5	53.5±1.5	64.5±1.5
c) Balance (Max. Spread) (mm^3/Stk)	1500	+5 -11 From Avg.	+3 -5 From Avg.	+3 -5 From Avg.
7. Torque Compensation				
a) Average Delivery (mm^3/Stk)	1000	47.5±2	52±2	----
b) Rack Position	1000	9.9mm (.3898") Ref.	10.2mm (.4016") Ref.	----
c) Start of Torque Compensation; Rack Position	1400	Rack Position Must Be Same as 6 a	Rack Position Must Be Same as 6 a	----

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CALIBRATION CHART (Continued)

Engine Model		D150	D170	D190
Injection Pump Number		465498-C91	465497-C91	465496-C91
Check	RPM	Specifications		
7. Torque Compensation (cont'd)				
d) End of Torque Compensation; Rack Position				
1)	950	Record Rack Position	Record Rack Position	----
2)	600	Same as 7d.1	Same as 7d.1	Same as 6a
8. Enter Excess Fuel: Rack Position	100	Rack Position Should be 19-21 mm (.7480"-.8268")		
9. Exit Excess Fuel; Rack Position	250	+0.1 mm (+.0039") -0.0 mm (-.0000") from 7d.2		
10. Transitions; Ave. Delivery (mm^3/Stk)				
a) Cylinders 1-4-6-7	300	1-15		
b) Cylinders 2-3-5-8	300	33-40		
11. Lo-Idle Rack Position	300	6.0 mm (.2362") (Ref.)		
12. Start Fuel Quantity:				
a) Cylinders 1-4-6-7	100	0 mm^3/Stk.		
b) Cylinders 2-3-5-8	100	$120\ ^{+15}_{-8}$ mm^3/Stk.		
13. Fuel Shutoff, Rack Position	0	1.0 mm (.0394") Maximum		
14. Pump Drive Tang Adjustment at Lift-To-Port Closure of #1 Plunger	0	Drive Tangs Must be Horizontal with Punch Marks Facing Transfer Pump		

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Periodic revisions may be made to this publication and mailed automatically to distributors. It is recommended that customers contact their distributors for information on the latest revision.

FUEL INJECTION NOZZLES

FOR INTERNATIONAL
9.0 liter diesel engines

FORM CGES-225
OCTOBER, 1979

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FUEL INJECTION NOZZLES

FOR INTERNATIONAL
9.0 liter diesel engines

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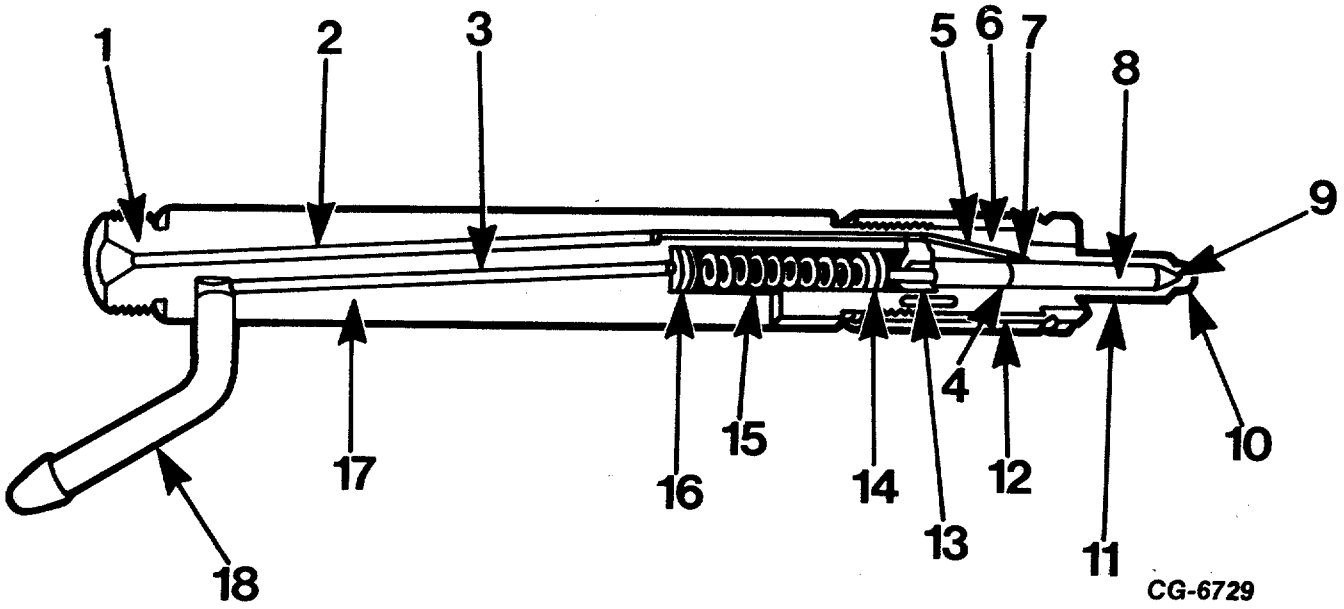


Fig. 1 Sectional View of Injection Nozzle Assembly

1. **High Pressure Tubing Connection**
2. **High Pressure Fuel Duct**
3. **Low Pressure Leak-Off Duct**
4. **Differential Surface**
5. **Nozzle Fuel Duct**
6. **Nozzle Body**
7. **Pressure Chamber**
8. **Nozzle Valve**
9. **Nozzle Sac**
10. **Spray Holes (4)**
11. **Nozzle**
12. **Nozzle Cap Nut**
13. **Nozzle Spacer**
14. **Lower Spring Seat**
15. **Pressure Adjusting Spring**
16. **Pressure Adjusting Spacers**
17. **Nozzle Holder Body**
18. **Leak-Off Connecting**

DESCRIPTION

The injection nozzles are of the inward opening, differential hydraulically operated, spray hole type. Their function is to direct a metered amount of fuel, under high pressure from the fuel injection pump, into the engine combustion chamber.

The injection nozzle assembly consists of two principal sub-assemblies, the nozzle and the nozzle holder. Fig. 1 illustrates a section view of the injection nozzle assembly.

Figure 2 shows an exploded view of the assembly.

Nozzle Holder

The nozzle holder is used to hold the nozzle in its correct position in the cylinder head and to provide channels for conducting fuel oil to the nozzle. The holder also contains the spring retainer (intermediate plate), spring and shims for adjusting the opening pressure of the nozzle valve. The lower end of the holder has an accurately ground and lapped surface which makes a leakproof and pressure tight seal with the corresponding lapped surface at the upper end of the spring retainer (intermediate plate). The intermediate plate mates with the lapped surface of the upper end of the nozzle. The nozzle and intermediate plate are held in alignment by dowel pins and are secured to the nozzle holder by the nozzle retainer nut. The relationship of nozzle holder assembly components is shown in Fig. 1.

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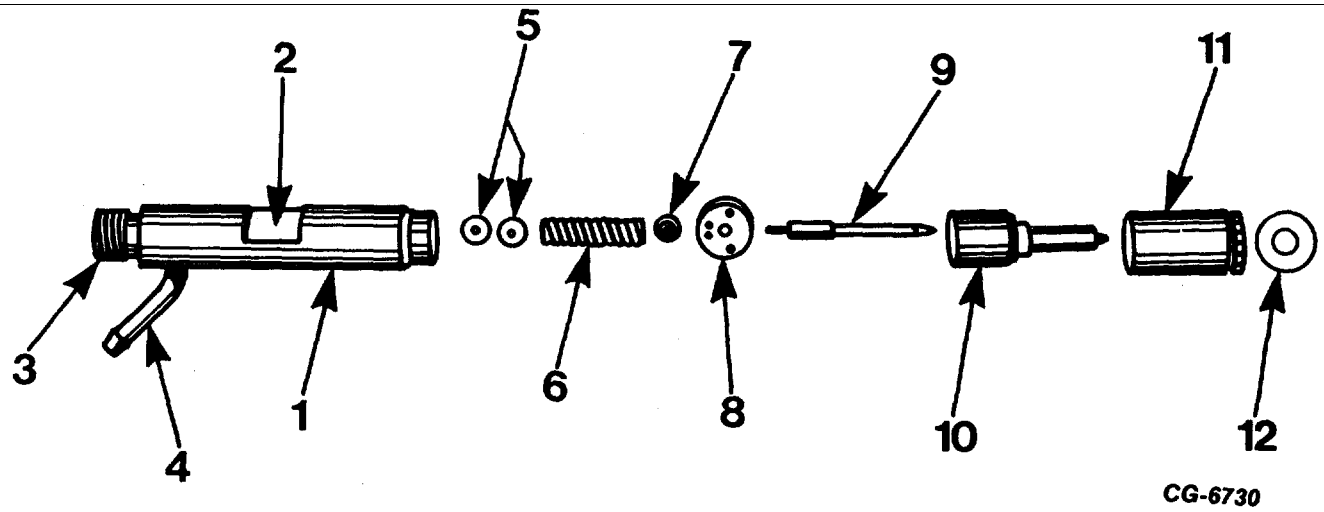


Fig. 2 Injection Nozzle Assembly Exploded View

1. **Nozzle holder body**
2. **Mounting cut-out**
3. **High pressure tubing connection**
4. **Leak-Off connection**
5. **Pressure adjusting spacers**
6. **Pressure adjusting spring**
7. **Lower spring seat**
8. **Nozzle spacer**
9. **Nozzle valve**
10. **Nozzle**
11. **Nozzle cap nut**
12. **Gasket**

OPERATION

Operation of the injection nozzle assembly is simple and positive. The metered quantity of fuel from the injection pump enters the nozzle holder through the inlet fitting and passes through connection ducts to the pressure chamber just above the nozzle valve seat. At the instant the pressure of fuel acting on the differential area of the valve exceeds a predetermined spring load, it lifts the valve from its seat and fuel flows from the nozzle until delivery from the injection pump ceases. Then a positive cut-off of fuel occurs as the valve is seated by the nozzle spring. A certain amount of fuel seepage between lapped surfaces of nozzle valve and body is necessary for lubrication. This leakage oil accumulates in the spring cavity and drains through to the leak-off outlet provided for this purpose.

Nozzle

The nozzle, Fig. 3, consists of two parts; the nozzle body and the nozzle valve. These parts are lapped to form an extremely close-fitting matched set. (Body and valve cannot be exchanged singly but must be used together and replaced as an assembly.)

The nozzle incorporates 4 spray holes (orifices) beneath the valve seat in the tip of the nozzle body. These spray holes are sized and located to provide a spray pattern of finely atomized fuel to produce the most efficient combustion and engine performance.

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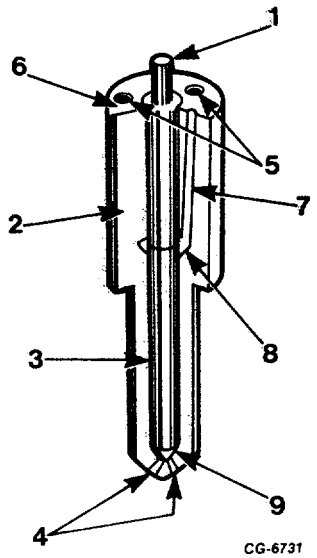


Fig. 3 Cut-Away View of Nozzle Valve And Body

1. **Valve Stem**
2. **Nozzle Body**
3. **Valve**
4. **Spray Holes (4)**
5. **Dowel Holes**
6. **Lapped Face**
7. **Channel Duct**
8. **Pressure Chamber**
9. **Valve Seat**

SERVICE INSTRUCTIONS

Where ideal conditions of good combustion, specified engine temperature control and absolutely clean fuel prevail, nozzles require little attention.

Nozzle trouble is usually indicated by one or more of the following symptoms:

1. Smoky exhaust (black)
2. Loss of power
3. Misfiring
4. Increased fuel consumption
5. Combustion knock
6. Engine overheating

While the above-faults may be caused by defective nozzles, they may also be caused by other engine troubles such as wrong fuel, water in fuel, dirty or damaged filters, incorrect maximum fuel setting, faulty injection pump, defective engine lubrication, incorrect pump timing, or faulty engine valves.

Where faulty nozzle operation is suspected on an engine that is misfiring or puffing black smoke, a simple test can be made to determine which cylinder is causing the difficulty.

With the engine running at a speed that makes the defect most pronounced, momentarily loosen the high pressure fuel inlet connection on one nozzle assembly sufficiently to "cut out" the cylinder. Check each cylinder in the same manner. If one is found where loosening makes no difference in the irregular operation or causes puffing of black smoke to cease, the injection nozzle, for that cylinder should be tested.

Nozzle testing, disassembly, cleaning and reconditioning must be done only by an authorized IH Service Station or other diesel service outlet equipped and qualified to perform such services.

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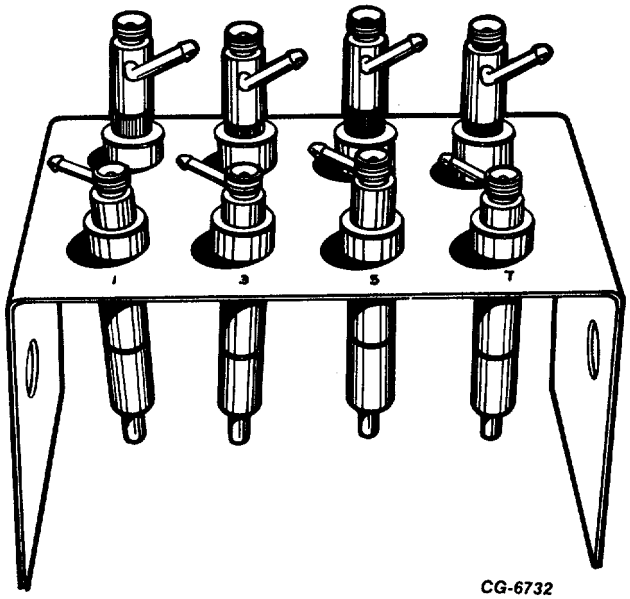


Fig. 4 Nozzle Holding Fixture SE-2102

When servicing injection nozzle assemblies, the necessity of cleanliness cannot be over-emphasized. A clean workbench, clean washing fluid containers, clean tools and clean hands are all essential to produce satisfactory results.

Removal

1. Before removing nozzle assemblies, clean exterior of each nozzle assembly and the surrounding area with clean fuel oil or solvent to prevent entry of dirt into engine when nozzle assemblies are removed. Also, clean fuel inlet and fuel leak-off piping connections.

2. Disconnect fuel inlet (high pressure) and fuel leak-off pipes from each nozzle assembly. Cover open ends of pipes to prevent entry of dirt.

3. Remove nozzle mounting bolt and hold down clamp. Pull nozzle assembly with washer and seal from engine. If assembly seems stuck, rotate it slightly to break it loose from carbon deposits in the cylinder head recess. Be careful not to strike the nozzle tip against any hard surface during removal. Cover nozzle assembly fuel inlet and leak-off openings with plastic caps to prevent entry of dirt. Also protect nozzle tip.

4. Place nozzle assemblies in a holding fixture SE-2102 as they are removed from the heads, Fig. 4. The fixture is stamped with numbers corresponding to the cylinder numbering of the engine. Use of this fixture permits replacing nozzles in their respective ports in the cylinder heads.

Operation Test

After removal from the engine, the nozzles should be tested for proper operation on a nozzle test pump. This test will give valuable information about the condition of the nozzles and indicate where service is required. Fig. 5 shows an injection nozzle mounted for testing on the SE2002 Hydraulic Test Pump. The nozzle test procedure is outlined below.

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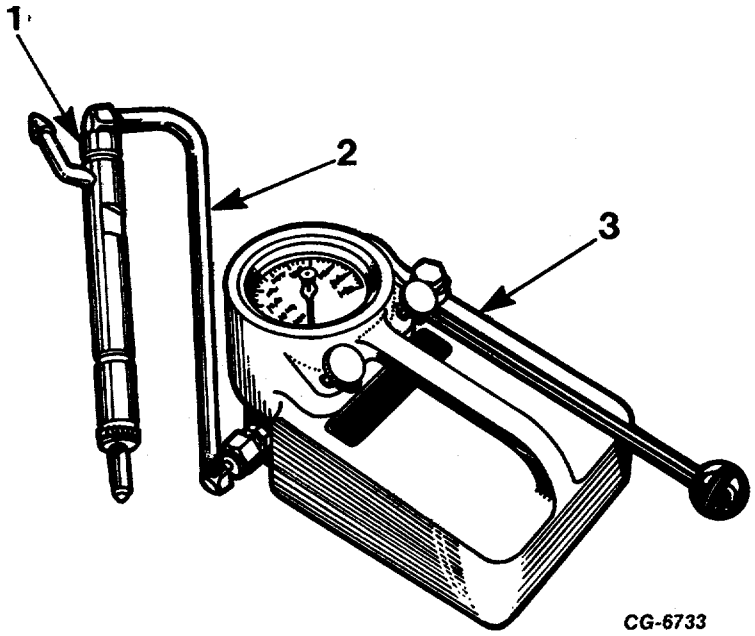


Fig. 5 Nozzle Assembly Mounted in Test Pump

1. Nut SE-2004-3 2. Rigid Connection SE-2004-13 3. Hydraulic Test Pump SE-2002

1. Prepare pump for making tests. Fill pump reservoir with clean No. 2 diesel fuel. Open pump valve slightly and operate pump handle to expel air from pump and outlet pipe. Operate pump until solid fuel (without air bubbles) flows from end of outlet pipe. Close pump valve.

2. Connect injection nozzle to test Pump. Care should be taken to avoid "cross-threading". Tighten connector nut securely with end wrench.

3. Bleed air from nozzle. Open pump valve and operate pump for several quick strokes to expel (bleed) air from injection nozzle. Fuel should spray from the spray holes in nozzle tip.

   CAUTION: Keep hands away from nozzle spray. Fuel spraying from the nozzle under high pressure can penetrate the skin and cause infection.

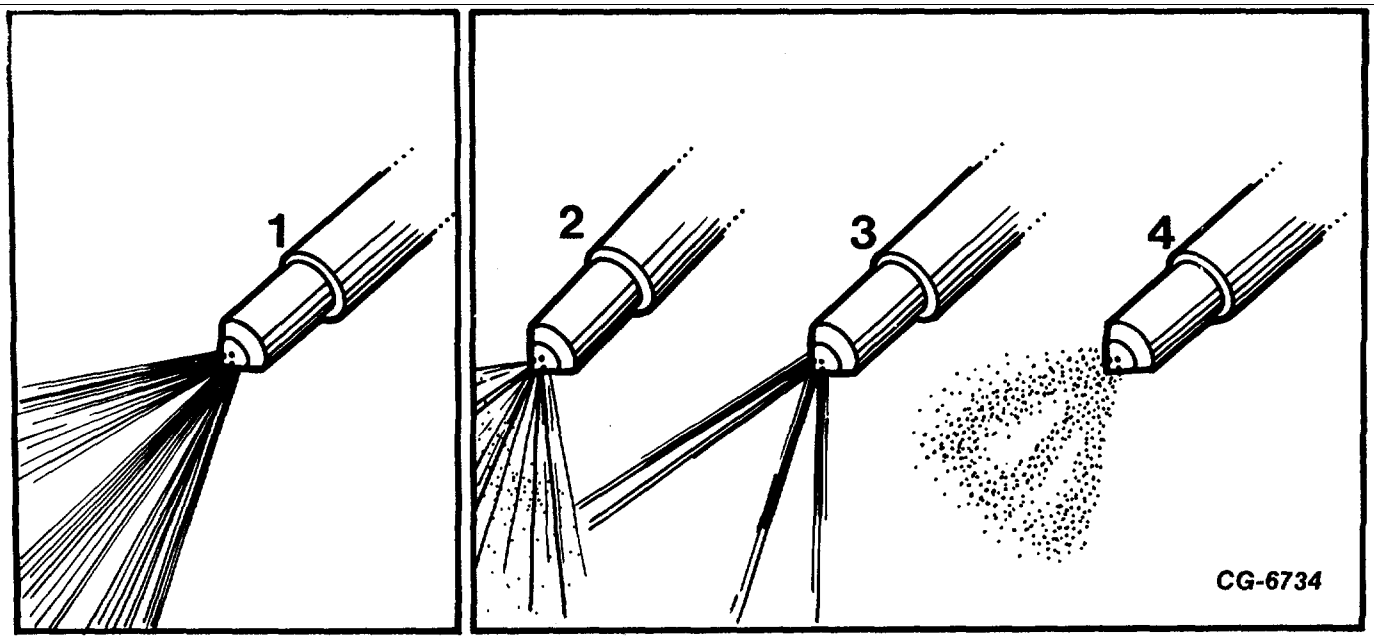
4. Check spray pattern. Operate test pump in smooth, even strokes and observe pattern of fuel spraying from nozzle tip spray holes. The spray should be finely atomized in an even pattern, free from irregular streaks and dribbling. Examples of good and bad spray patterns are shown in Fig. 6.

5. Check nozzle opening pressure. Open gauge valve, build up line pressure by slowly depressing handle until nozzle opens (sprays fuel). Observe gauge to determine pressure at which nozzle opens, then repeat operation until accurate opening pressure is established. (See Specifications).

6. Check for tip leakage. Wipe nozzle tip dry. Operate test pump to maintain pressure at about 100 psi below opening pressure. Nozzle tip should remain dry without an accumulation of fuel drops at spray holes. A slight wetting after about 5 seconds is permissible if no droplets are formed.

7. Check fuel leak-off. Operate test pump in quick strokes and observe for flow of fuel from leak-off part of nozzle. A very slight leak-off is normal. If an excessive amount of fuel is expelled or if fuel surges from leak-off port when test pump is operated, nozzle is faulty.

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Good nozzle spray pattern -- Fig. 6 -- Bad nozzle spray patterns

1. **Fine Even Mist**
2. **Uneven or Off Side**
3. **Solid Stream**
4. **Uneven Cut-Off, Dribble**

If nozzle passes above tests, it is suitable for further service in the engine following external cleaning and removal of accumulated carbon. Nozzles showing irregular spray pattern, leakage at nozzle tip spray holes, excessive fuel leak-off or opening pressure below minimum permissible limit should be replaced or serviced (disassembled, cleaned and rebuilt).

Disassembly

Disassembly of the nozzle holder assembly for cleaning, inspection and service can be accomplished as follows:

1. Wash all external dirt, grease and carbon deposits from holder assembly with a suitable cleaning agent.

2. Remove nozzle gasket from nozzle.

3. A brass wire hand brush should be used to remove hardened deposits of dirt or carbon. DO NOT allow wire brush to come into contact with nozzle spray holes.

IMPORTANT: Soak nozzle holder assembly in a carbon removing cleaning agent ("GUNK", "BENDIX CLEANER", or equivalent) for at least 4 hours before removing nozzle cap nut; otherwise, the nozzle locating pins may be damaged.

4. Special tools SE-2752 and SE-2753 are required when disassembling a nozzle holder assembly. Otherwise, the nozzle locating pins may be damaged (See Figure 7).

5. Injector nozzle holding fixture should be attached to a work bench to prevent fixture from moving.

6. Engage a 9/32" 12 point box wrench to nozzle cap nut.

7. Install nozzle holder assembly with wrench into nozzle holding fixture. With clamping plate in place, tighten clamping bolt until it touches nozzle tip. Then torque clamping bolt to 24-30 Nm (18-22 ft lbs). (Figure 8).

8. Loosen cap nut with box wrench until nut can be turned by hand.

   NOTE: A sharp blow to end of wrench may be required to break carbon bond between nozzle and cap nut.

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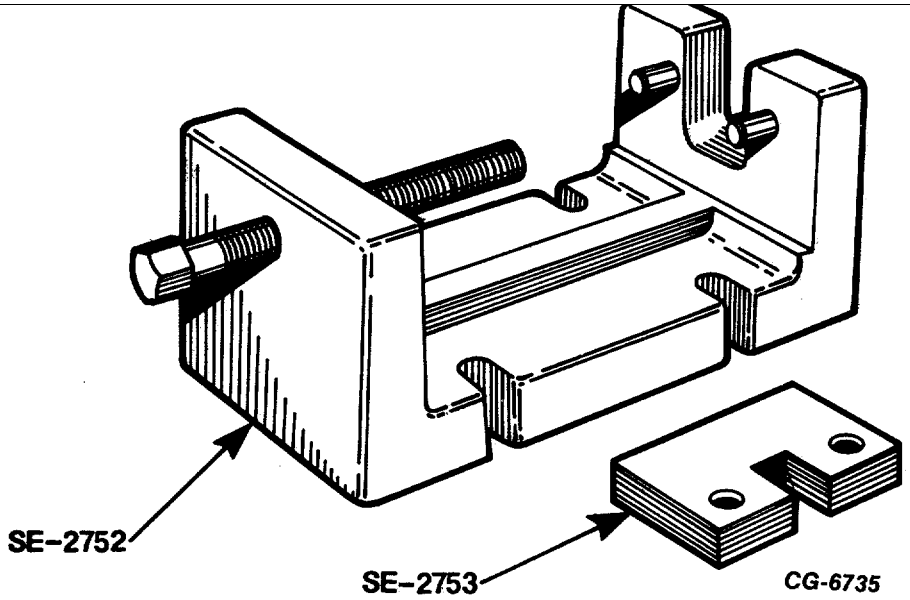


Figure 7. SE-2752 Injector Nozzle Holding Fixture and SE-2753 Injector Nozzle Clamping Plate
1. SE-2752 2. SE-2753

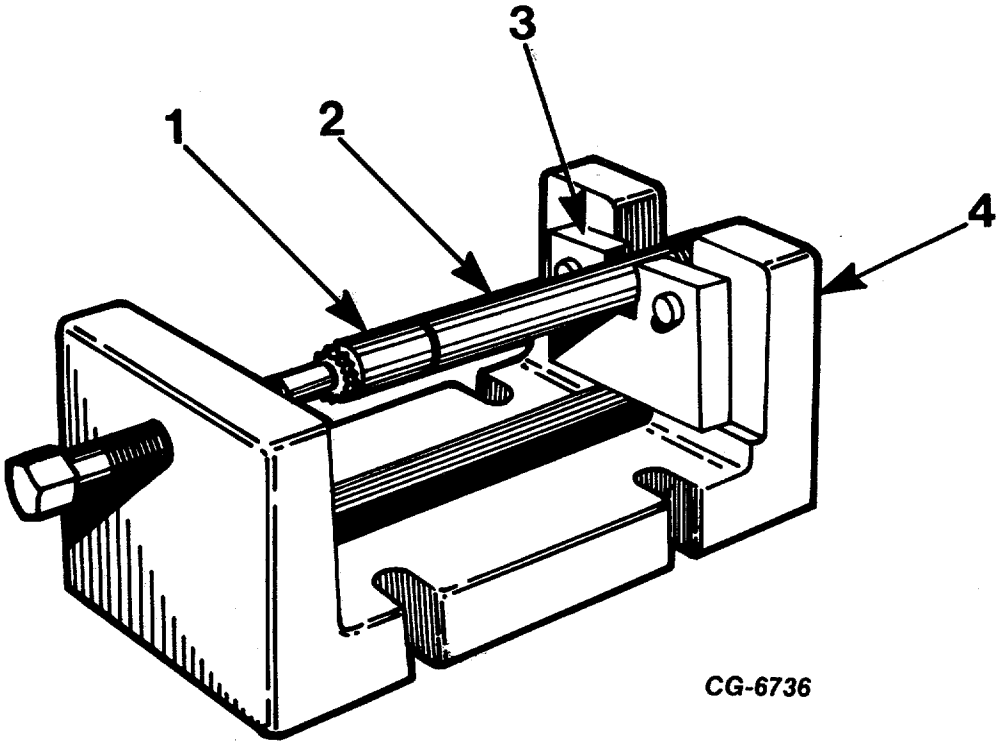


Figure 8. Holding fixture and clamping plate with nozzle installed.
1. Cap 2. Injector Holder 3. SE-2753 4. SE-2752

9. Loosen clamping bolt and remove nozzle holder assembly from holding fixture.
10. Remove cap nut, nozzle spacer and nozzle from holder body.
11. Remove spring seat, spring and spacers from holder body. (See Figure 2

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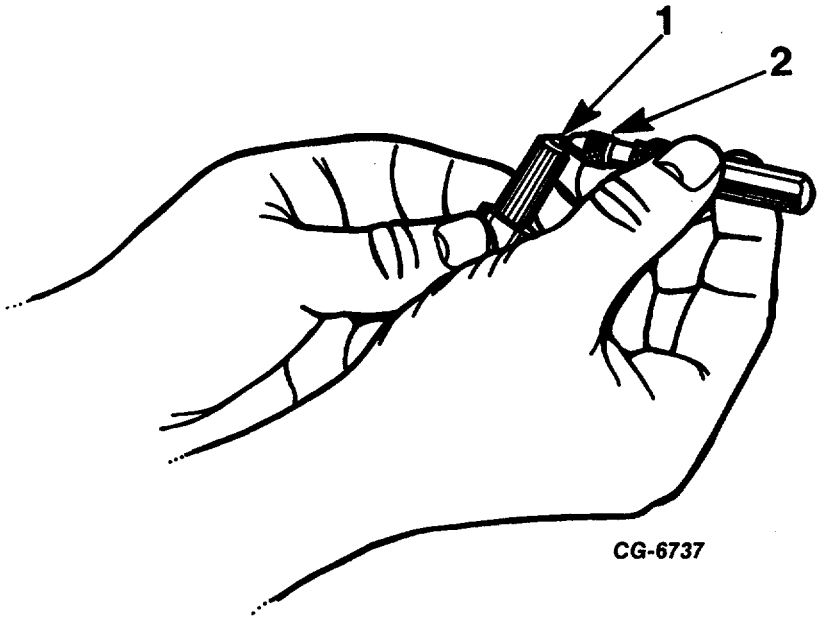


Fig. 9 Cleaning Spray Holes

1. Spray Hole **2. Pin Vise and Cleaning Needle**

Cleaning and Inspection

All parts of the nozzle assembly should be thoroughly cleaned and inspected. Any parts showing damage or excessive wear should be replaced.

Special tools for performing nozzle cleaning operations are contained in SE2202 Nozzle Cleaning Set. Hard or sharp tools, emery cloth, crocus cloth, grinding compounds or abrasives of any kind should never be used in the cleaning of nozzles.

1. Wash all parts in Varsol or an equivalent cleaning agent.

   CAUTION: DO NOT inter-mix nozzle valves. Keep each valve with its original nozzle body.

2. Soak nozzle in a varnish removing cleaning agent.

3. Probe all nozzle spray holes with cleaning needle. .25mm(.011") diameter needle should be used and is part of special tools kit SE-2002.

4. Clean all ducts and nozzle spray holes with compressed air.

5. Thoroughly clean interior of nozzle cap nut. All carbon deposits must be removed (soak to loosen-wire brush to clean).

Reassembly

After cleaning and parts replacement, assemble nozzle holder assemblies as follows:

1. Dip all parts in clean calibrating or lube oil.

2. Insert adjusting spring and spring seat into spring line.

3. Align nozzle spacer locating pins with pin holes in holder body and assemble spacer to body.

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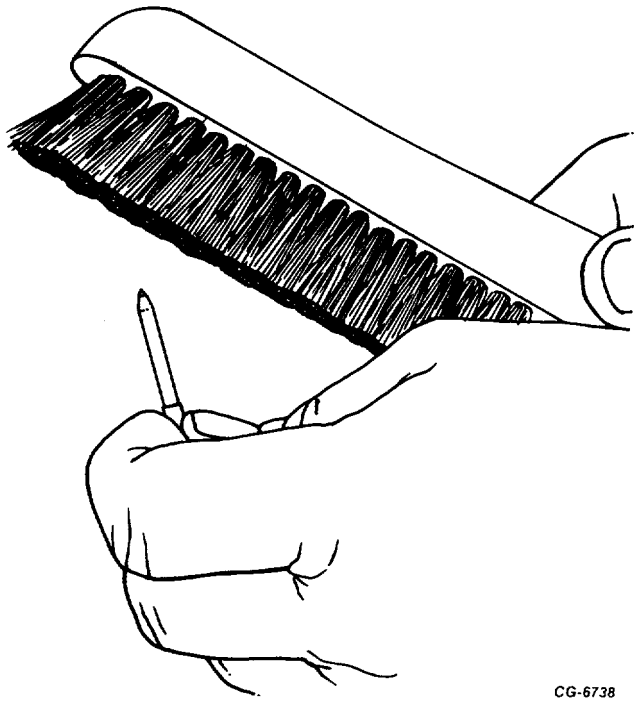


Fig. 10 Cleaning Nozzle Valve

4. Dip nozzle valve in clean calibrating or lube oil. Assemble valve into nozzle body and move valve up and down several times to make certain that valve does not stick.

5. Apply a thin, even coat of "Lubriplate-130 AAA", or equivalent, to the nozzle body seating shoulder, align nozzle body locating pin holes with spacer pins and assemble nozzle to spacer.

6. Assemble cap nut over nozzle and tighten cap nut by hand.

7. Install nozzle holder assembly with box wrench on cap nut into holder fixture. (Figure 8)

8. Tighten cap nut to proper torque (see specifications).

9. Mount nozzle holder assembly in nozzle test pump and check nozzle operation. (See "Nozzle Operating Test").

10. If nozzle opening pressure is not within limits specified for new or rebuilt nozzles (See "Specifications") adjust by adding or removing adjusting shims at top end of springs. Be sure hardened wear shim (darkest in color) is placed next to spring.

    Check for leakage between lapped surfaces of nozzle body, intermediate plate and nozzle holder body. Leakage may be either internal or external. External leakage is visible at nozzle retainer nut, and internal leakage is visible at leak off outlet. Do not attempt to cover leakage by overtightening nozzle retainer nut. Remove nozzle and re-examine pressure faces for dirt or burrs on surface. Clean and retest.

    Check spray pattern (Fig. 6). Fuel should be finely atomized and free from streaks. If spray pattern is faulty check for dirty or damaged spray holes.

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11. Cover fuel inlet and leak-off openings and protect nozzle tip.

Installation

1. Thoroughly clean nozzle bore in cylinder head before reinserting nozzle holder assembly. Pay particular attention to seating surfaces, in order that no small particles or carbon will cause assembly to be cocked or permit blow-by of combustion gases. Don't use hard or sharp tools for cleaning. A round piece of brass properly shaped or a round steel bristle brush is permitted if used with care.

2. Install a new seal and a new gasket on nozzle holder assembly.

   NOTE: Use new seal and gasket each time nozzle is installed.

3. Install nozzle holder assembly into cylinder head nozzle bore. Be careful that nozzle tip does not strike against recess wall.

4. Install clamp, bolt, flat washer, and crab washer. Tighten bolt to specified torque. (See Specifications)

5. Remove protective covers from nozzle holder parts and fuel pipes. Connect high pressure fuel inlet and leak-off pipes to nozzle holder.

6. Purge high pressure fuel pipes of air by loosening connector and cranking engine until solid fuel, free from air, flows from connection. Tighten connection.

7. Start engine and check for fuel leakage at high pressure connections.

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INJECTION NOZZLE
TROUBLE SHOOTING GUIDE

FAULT	POSSIBLE CAUSE	REMEDY
Nozzle Blueing.	1. Faulty installing or tightening.	Replace nozzle.
	2. Insufficient cooling.	Correct cooling system
Spray pattern distorted.	1. Carbon deposit on tip of nozzle valve.	Clean nozzle.
	2. Nozzle holes partially blocked.	Clean nozzle.
	3. Defective nozzle.	Replace nozzle.
Nozzle opening pressure too high.	1. Incorrect shim adjustment	Readjust nozzle.
	2. Nozzle valve dirty or sticky or opening is clogged.	Clean nozzle.
	3. Seized nozzle.	Replace nozzle.
Nozzle opening pressure too low.	1. Incorrect shim adjustment.	Readjust nozzle.
	2. Nozzle valve spring broken.	Replace spring and readjust pressure.
	3. Nozzle seat worn.	Install new or reconditioned nozzle.
Nozzle drip.	1. Nozzle leaks because of carbon deposit or sticking nozzle valve.	Clean nozzle.
	2. Defective nozzle.	Replace nozzle.
Excessive leak-off.	1. Dirt between pressure face of nozzle, spring retainer or plate and nozzle holder.	Clean nozzle.
	2. Loose nozzle retainer nut.	Inspect lapped faces and tighten retainer nut.
	3. Defective nozzle.	Replace nozzle.

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SPECIFICATIONS

Nozzle Holder Assembly: IH Part Number Manufacturer's Number	 489116C92 NHA 7817 1/1
Engine Model	9.0 liter
Nozzle Valve Seat Angle (Degrees)	60
Nozzle Spray Holes: Number of Holes Hole Diameter:	 4 0.29 mm
Nozzle Opening Pressure: (psi.) New or Rebuilt Minimum Permissible (Used)	 3150 ± 75 2750
Permissible Leakdown	See Text (1)
Nozzle Cap Nut Torque (lb. ft.)	40-48 Nm (30-35 Ft. lbs)
Nozzle Holder-to-Engine Mounting Bolt Torque (lb. ft.)	18 - 22 lb. ft

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Periodic revisions may be made to this publication and mailed automatically to distributors. It is recommended that customers contact their distributors for information on the latest revision.

FUEL INJECTION PUMP (ROBERT BOSCH) FOR 9.0 LITER IH DIESEL ENGINE

FORM CGES-220
OCTOBER, 1979

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FUEL INJECTION PUMP (ROBERT BOSCH) FOR 9.0 LITER IH DIESEL ENGINE

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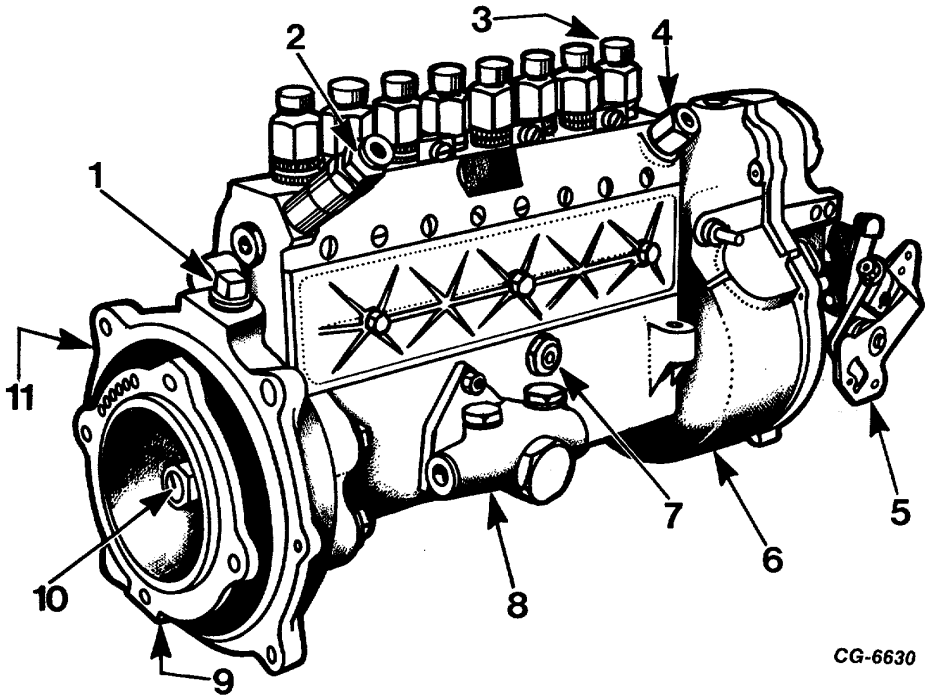


Figure 1. Left Side View of Injection Pump

1. Timing Sight Plug
2. Pressure Regulator Valve
3. Delivery Valve Holder
4. Fuel Inlet
5. Control Lever
6. Governor Housing
7. Lube Oil Inlet
8. Transfer Pump
9. Drive Hub
10. Timing Mark
11. Adapter Housing

DESCRIPTION

The Robert Bosch Model PES 8A95 Fuel Injection Pump is used on the International 9.0 liter diesel engine.

The injection pump is an in-line, single action plunger type, with individual plunger and barrel pumping elements for each engine cylinder. The injection sequence is 1, 8, 7, 3, 6, 5, 4, 2.

A snubber valve is staked in the upper part of each delivery valve holder and maintains residual pressure in the injection lines between pumping cycles.

The injection pump assembly incorporates an integral mechanical flyweight type RQV all speed governor.

The pump control levers, including the Lo-Idle and Hi-Idle adjusting stop screws, are mounted on the left side of the governor assembly. The Fuel Shut-Off lever and stop bracket are located on the right side of the governor.

The injection pump is located between the cylinder heads and intake manifolds at the top of the engine. High pressure lines connect the injection pump to the fuel injection nozzles.

Operating and service instructions for the fuel injection nozzles are given in Section CGES-225 of the service manual. Removal of the injection pump from the engine is detailed in Section CGES-205 of the Service Manual.

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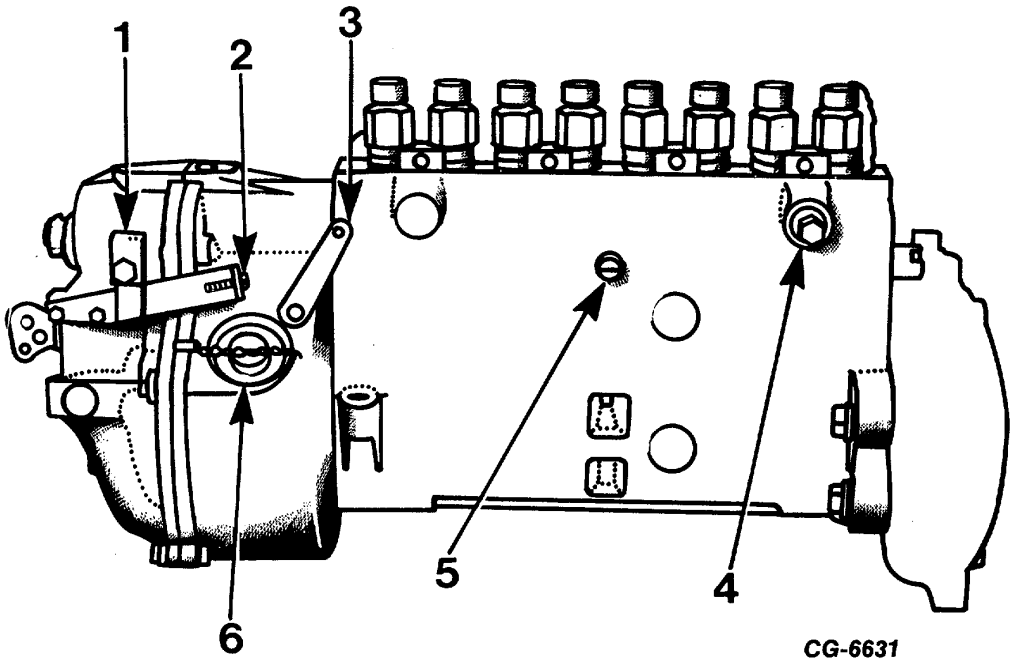


Figure 2. Right Side View of Injection Pump

1. Bracket, Shut-Off Cable
2. Stop, Shut-Off Lever
3. Shut-Off Lever
4. Bleeder Valve
5. Rack Position Screw
6. Governor Adjusting Plug

IDENTIFICATION

Identification of injection pump and governor assemblies can be made by referring to name plates found on the injection pump one on rear of governor housing and one on left side of injection pump housing. The nameplate on rear of governor (Figure 3) gives the IH part number of the complete pump and governor assembly and governor number, size and rating. The nameplate on side of the pump housing (Figure 4) gives the serial number, model code and manufacturer's part number.

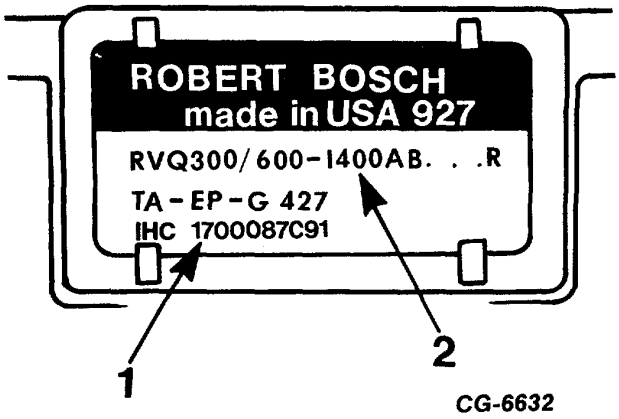


Figure 3. IH Part Number Plate

1. IH Part Number
2. Governor Number Size and Rating

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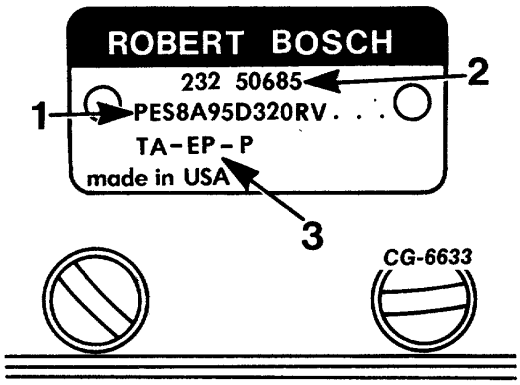


Figure 4. Injection Pump Serial Number Plate

1. Model Number
2. Serial Number
3. Robert Bosch Part Number

OPERATING PRINCIPLES

Injection Pump

The injection pump is the in-line; single action plunger type with individual plunger and barrel pumping elements for each engine cylinder. Pump plunger stroke is constant but effective pumping (metering) stroke is variable and controlled by position of a common plunger control rack operated by the governor and the vehicle accelerator pedal.

The individual plunger and barrel pumping elements (Figure 5) receive fuel under transfer pump pressure from the injection pump housing fuel gallery and force it under very high pressure through the injection nozzles into the engine combustion chambers.

The injection pump plungers are operated through tappet assemblies driven by the injection pump camshaft. The camshaft is timed to the engine to inject fuel into each cylinder at the proper time

Each pumping element has a delivery valve above the plunger. The delivery valve which is held on its seat by spring pressure prevents fuel from draining out of the high pressure fuel line between pumping cycles.

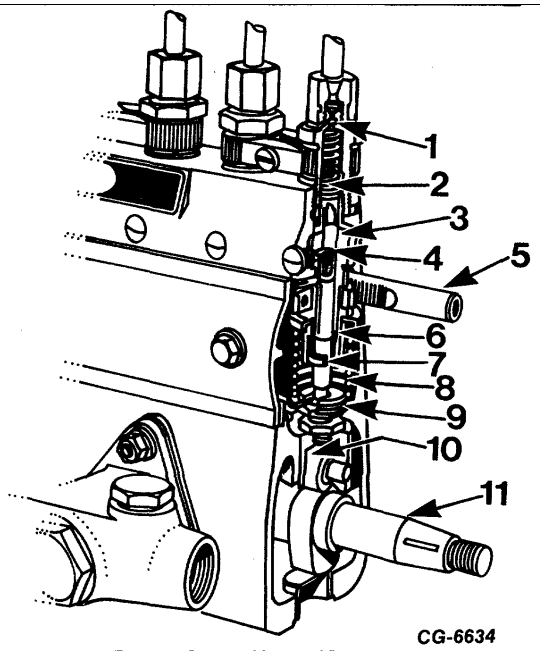


Figure 5. Sectional View of Plunger and Barrel Pumping Element

1. Snubber Valve
2. Delivery Valve
3. Barrel
4. Plunger
5. Control Rack
6. Control Sleeve
7. Plunger Vane
8. Plunger Spring
9. Spring Plate
10. Roller Tappet
11. Camshaft

Each delivery valve holder has a snubber valve assembly staked in the upper part (Figure 6). On the end of the pumping cycle the snubber orifice valve is closed by spring pressure. Fuel drains, through the orifice in the valve, into the cavity above the delivery valve and controls the residual pressure in the high pressure fuel line between pumping cycles.

The injection cycle can be described by observing the plunger in its four principal positions in the barrel. The four positions (shown in Figure 7) are:

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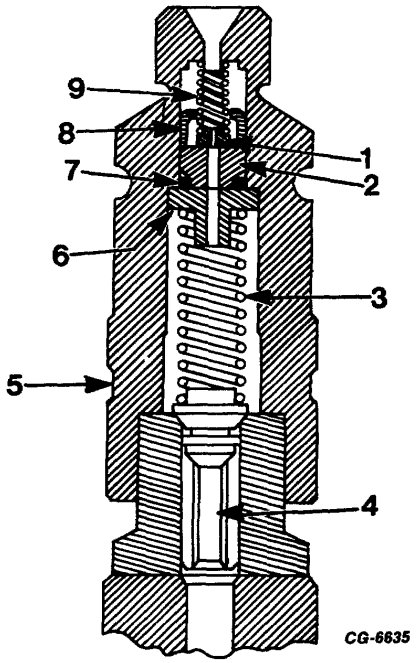


Figure 6. Sectional View of Snubber and Delivery Valve

1. Orifice Valve
2. Orifice Seat
3. Spring
4. Delivery Valve
5. Delivery Valve Holder
6. Spring Seat
7. Fill Washer
8. Spring Cap
9. Spring

Bottom Dead Center (BDC)

At bottom dead center plunger is held down on lowest point of cam lobe by plunger spring. Top of plunger is below charging port of barrel. Fuel at transfer pump pressure flows through charging port to fill area above plunger.

Start of Injection (Start Inj.)

Injection begins when the rising plunger covers the charging port and fuel is trapped above the plunger.

Injection (Inj.)

As plunger continues upward with charging ports covered, fuel above plunger is forced upward under high pressure, unseats delivery valve, unseats snubber valve, flows to nozzle, opens nozzle valve and is injected into the cylinder.

End of Injection (End Inj.)

When plunger moves up to the point where charging port is again uncovered, fuel pressure above plunger is relieved to the charging gallery. This pressure drop allows delivery valve, snubber valve, and injection nozzle valve to seat thus ending injection of fuel into cylinder.

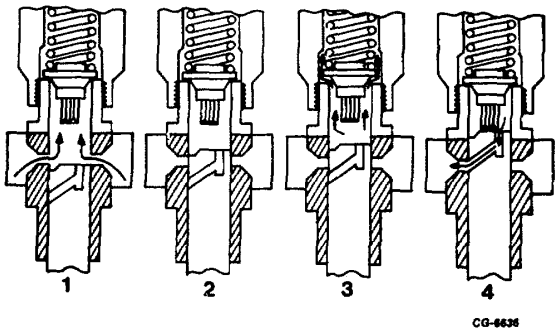


Figure 7. Four Principal Plunger Positions of Injection Cycle

1. Bottom Dead Center
2. Start of Injection
3. Injection
4. End of Injection

Metering (providing proper amount of fuel to meet engine requirements at various speeds and loads) is accomplished by rotating plungers in barrels to change the effective pumping stroke. The effective stroke is the distance traveled upward by the plunger from the time the charging port is covered until it is again uncovered. A short effective stroke means a small amount of fuel is injected. As effective stroke increases, amount of fuel injected increases.

The metering function can be described by observing the relationships of plunger helix to barrel charging port under various metering positions as shown in Figure 9.

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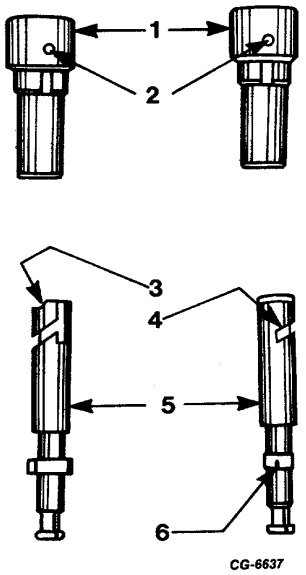


Figure 8. Details of Injection Pump Plunger and Barrel

1. Barrel
2. Charging Port
3. Upper Helix
4. Lower Helix
5. Plunger
6. Installation Mark

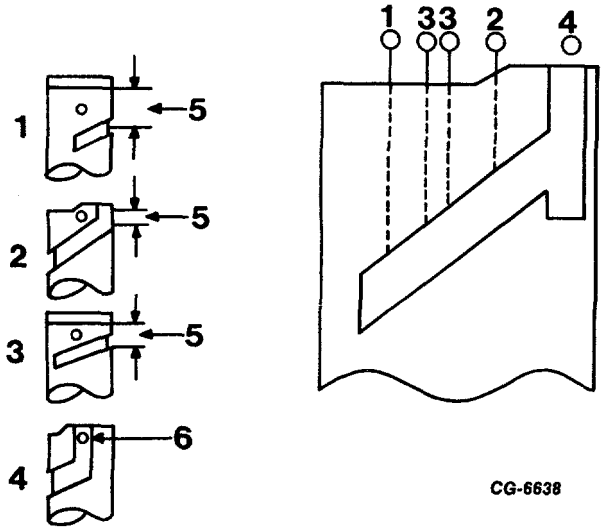


Figure 9. Helix and Charging Port Metering Positions

1. Start Position (Charging Port Closed)
2. Idle Position (Charging Port Closed)
3. Full Load Position (Charging Port Closed)
4. Stop Position (Charging Port Open)
5. Effective Stroke
6. Charging Port Position

Starting (Excess fuel)

For starting, plunger is rotated by control rack (accelerator pedal fully depressed) to a point where the maximum effective stroke (port closing to port opening) is obtained.

When engine starts, release accelerator pedal to rotate plunger out of start fuel position to decrease fuel delivery.

Engine Operating (Metered Delivery)

At engine operating speeds from idle through maximum governed speed, the quantity of fuel delivered is determined by effective stroke (port closing to port opening) as controlled by the accelerator pedal and governor.

Engine Stop (No Delivery)

To stop the engine, plungers are rotated so that vertical slots (stop slots) are in line with barrel ports. As plunger moves up and down fuel is transferred back and forth from top of plunger through vertical slots and into charging gallery. The ports do not close thus, no delivery.

Plungers are rotated to the various metering positions by the control rack. Rack movement is controlled by the accelerator pedal, governor and engine shut off control.

GOVERNOR

The mechanical flyweight governor, which is integral with the injection pump, is the all-speed type, identified by the manufacturer as the RQV 325-1400. The 325-1400 designation refers to the injection pump speed range in which the governor functions. As pump speed is one-half engine speed, this corresponds to engine speeds of 650-2800 rpm. Figure 10 illustrates a cut-away view of the governor assembly.

The functions of the governor are: (1) limit minimum (lo-idle) engine speed, (2) limit maximum engine speed and (3) maintain smooth speed control (without stalling, surging or hunting) within the limits of its regulation throughout the operating speed range of the engine.

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The all-speed governor provides speed control at any fixed position of the control lever (accelerator pedal). This provides the vehicle operator with the most satisfactory driving characteristics. The governor tends to keep engine speed constant at the level determined by position of the accelerator pedal and automatically increases or reduces fuel delivery in response to minute changes in engine speeds without a significant change in road speed and without the operator changing position of the accelerator pedal.

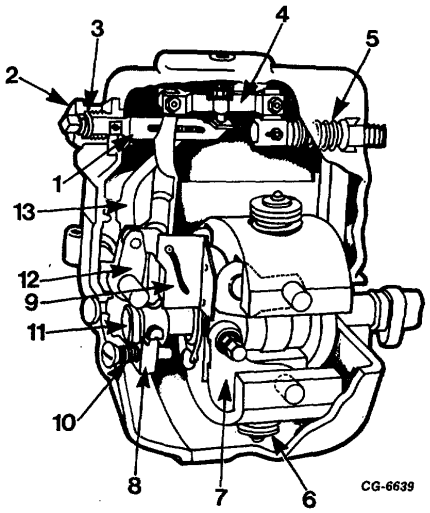


Figure 10. Cut-Away View of Governor Assembly

1. Stop Shackle
2. Lock Nut
3. Control Rack Stop Assembly
4. Rack Link
5. Control Rack
6. Governor Springs
7. Bell Crank
8. Sliding Block
9. S-Plate
10. Guide Pin
11. Adjusting Pin
12. Guide Lever
13. Rocker Arm

Another feature of the all speed governor is its capability of providing PTO speed control for various applications such as garbage packers, fuel oil pumps and mixer chassis. The operator sets the accelerator pedal at power (engine speed) setting required and the governor automatically holds engine speed constant without the operator altering the accelerator pedal position.

The transfer pump, a single action none positive displacement plunger type pump, is driven by the injection pump camshaft.

The transfer pump can supply more fuel than is required for injection. Excess fuel, utilized for cooling injection pump, is routed from the injection pump fuel gallery back to the fuel pump.

PRESSURE REGULATOR VALVE

A pressure regulator valve, located in the left front outlet of the injection pump housing fuel gallery (Figure 1) regulates the fuel pressure in the fuel gallery and dampens transfer pump fuel pulsations.

INJECTION NOZZLES

The engine injection nozzles (Figure 11) are the inward opening differential needle type featuring sactype nozzle tips.

The injection nozzles are mounted in the engine cylinder head and direct fuel under high pressure from the injection pump into the engine combustion chambers in the form of a fine mist.

The injection nozzle valve is held on its seat 'in the nozzle tip by a strong spring in the nozzle holder. When pressure of the fuel from the injection pump, acting upon the coned surface of the nozzle valve, exceeds spring pressure the valve is lifted off its seat and fuel is forced out of the four spray holes (orifices) in the nozzle tip. As pressure from the injection pump decreases, spring pressure returns the nozzle valve to its seat ending fuel injection.

Nozzle opening pressure is determined by spring preload which can be adjusted by removing or adding shims between the spring and the nozzle holder body.

Leak-off of fuel past the lapped fit of the valve in the nozzle tip (used for lubrication of the parts) passes through the spring chamber, out the leak-off line, and is returned to the fuel tank.

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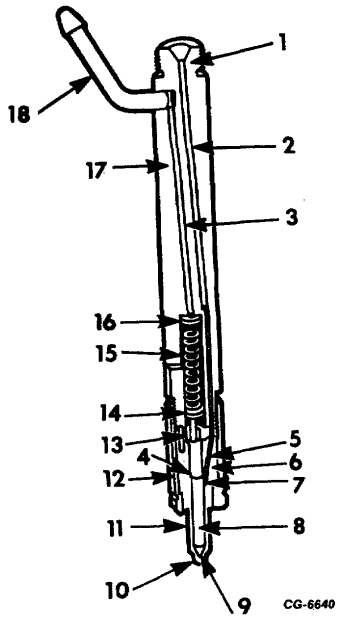


Figure 11. Sectional View of Injection Nozzle Assembly

1. Fuel Inlet Connection
2. High Pressure Fuel Duct
3. Leak-Off Duct
4. Differential Surface
5. Nozzle Fuel Duct
6. Nozzle Body
7. Pressure Chamber
8. Nozzle Valve Connection
9. Nozzle Sac
10. Spray Holes (4)
11. Nozzle
12. Nozzle Cap Nut
13. Nozzle Spacer
14. Spring Seat
15. Adjusting Spring
16. Adjusting Shims
17. Nozzle Holder Body
18. Leak-Off

Service instructions for the injection nozzles are covered in Section CGES-225 of the Service Manual.

FUEL SYSTEM

The fuel system (Figure 12) consists of a primary fuel filter, a transfer pump, a final fuel filter with hand primer pump, an injection pump, injection nozzles, a pressure regulator valve and the connecting lines and fittings.

Fuel is pumped from the fuel tank through the primary filter by the transfer pump, then through the final filter.

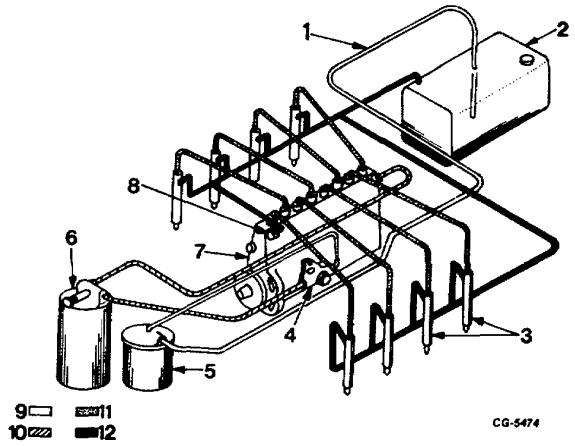


Figure 12. Fuel System

1. Fuel Line
2. Fuel Tank
3. Nozzle Assembly.
4. Transfer Pump
5. Primary Filter
6. Final Filter
7. Injection Pump
8. Pressure Regulator Valve
9. Tank to Transfer Pump Line
10. Transfer Pressure Line
11. Injection Lines
12. Leak-Off and Return ', to Tank Line

Filtered fuel is then directed to the fuel injection pump where it is metered and delivered under high pressure to the injection nozzles located at each combustion chamber in the cylinder heads. Excess fuel from the injection pump and nozzles is directed through the leak-off and return lines to the fuel tank.

FUEL FILTERS

The primary fuel filters (Figure 13) filters large dirt particles and insoluble gums from the fuel.

The final fuel filter removes any minute particles that may pass through the primary filter.

Both primary and final fuel filters utilize "spin-on" type elements; however they are not interchangeable

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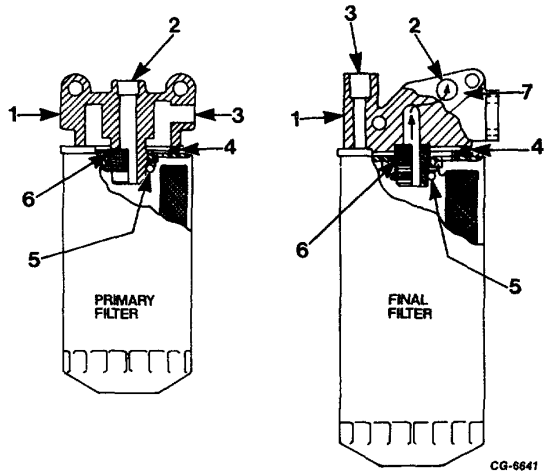


Figure 13. Fuel Filters

1. Filter Base
2. Outlet Port
3. Inlet Port
4. Outer Seal
5. O-Ring
6. Adapter
7. Mounting Pad Primer Pump

FUEL LINES (PIPES) AND FITTINGS

Low pressure lines used in the fuel system have either conventional or flextube type fittings (Figure 14). Flextube fittings consist of a fitting body, synthetic rubber sleeve and nut. When installing flex-tube fittings be sure that rubber sleeve is in good condition and line is inserted fully into fitting body. Tighten nut until it bottoms against fitting body.

High pressure lines connecting injection pump and injection nozzles are made from thick wall steel tubing with swaged ends (Figure 14). If a line must be removed, disconnect at both ends and remove brackets to prevent bending. If an injection line is damaged, use only Genuine IH replacement, since lines are of a specified length and a diameter. Always plug or cap ends of lines when disconnected.

ENGINE TO INJECTION PUMP DRIVE

Camshaft of injection pump has a "keyed on" drive flange to which the drive gear is mounted.

Four slotted mounting holes in the injection pump drive gear provide adjustment for pump timing.

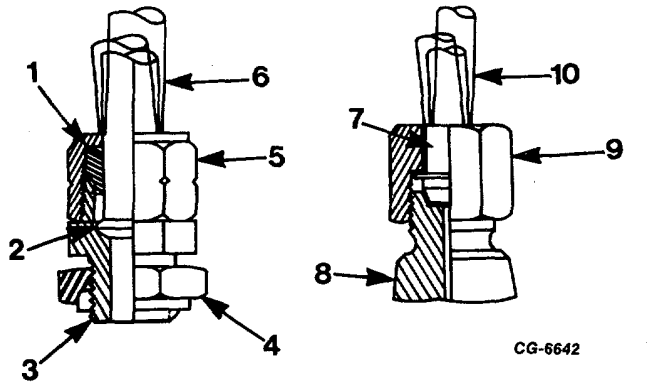


Figure 14. Low and High Pressure Fuel Line Fittings

1. Flex Sleeve Seal
2. 45 Degree Flare
3. Fitting Body
4. Seal Nut
5. Nut
6. Fuel Line (Low Pressure)
7. Sleeve
8. Nozzle Holder or Delivery Valve Holder
9. Connector Nut
10. Injection Line (High Pressure)

TIMING INJECTION PUMP TO ENGINE
Timing Mark Method

There are several match marks and other aids on both the pump and the engine to help establish and maintain correct timing. These marks can be used for timing checks and in the event of pump removal and installation, assure that pump will be reinstalled correctly. Timing procedure is as follows:

1. Block shut off control in "SHUT OFF" position. (This will prevent accidental start of engine while positioning No. 1 cylinder on compression stroke).

2. Rotate engine crankshaft in direction of normal rotation (clockwise as viewed from front) until No. 1 cylinder is on compression stroke. Continue to rotate engine until the 16 degree mark on the crankshaft pulley is aligned with the engine timing pointer. (Figure 15). Pumping element for No. 1 cylinder is at start of injection.

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NOTE: Engine must be turned manually to establish timing position. Starter may be used to bring timing marks into range but final movement must be performed manually. If engine is inadvertently turned beyond specified timing mark, back up at least 1/4 turn from mark and again approach mark in direction of normal engine rotation. DO NOT back engine to align timing marks.

To be sure No. 1 cylinder is on compression stroke, loosen injection nozzle hold down bolt from No. 1 nozzle and while rotating engine watch for nozzle to pop up. This will occur when No. 1 piston starts up on compression. To prevent nozzle from popping completely out, be sure nozzle hold-down bolt is threaded in at least two turns.

Other methods for determining compression stroke on No. 1 cylinder are acceptable; but always be sure to approach timing mark in direction of normal engine rotation.

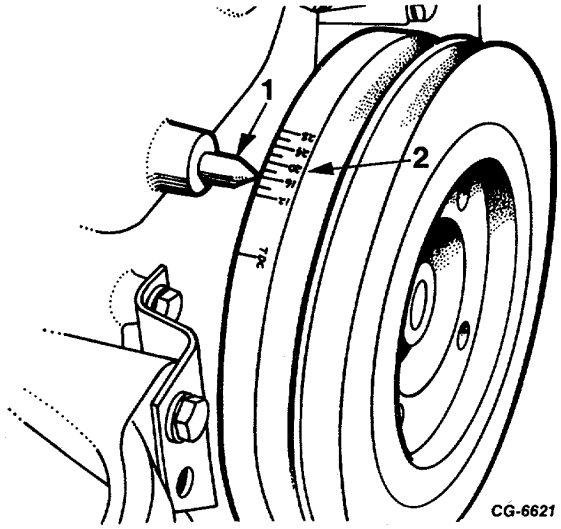


Figure 15. Engine Timing Marks and Pointer Location

1. Index Pointer 2. Timing Marks

3. Remove sight plug on top of injection pump adapter housing. Scribed line on hub must be aligned with pointer pin. (Figure 16)

If injection pump timing marks do not line up, it will be necessary to correct pump to engine timing.

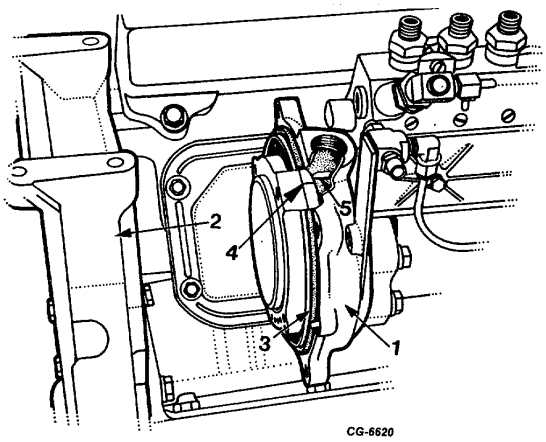


Figure 16. Timing Injection Pump to Engine

1. Injection Pump Adapter
2. Engine Front Cover
3. Gasket
4. Scribed Line On Hub
5. Pointer Pin

4. Before timing adjustment can be made, it will be necessary to drain coolant, remove Fan Drive, Fan, Fan Hub Assembly, water outlet, water return tube and drive gear cover. (For detailed removal procedures, see Section CGES205 of the Service Manual)

5. Loosen drive gear mounting bolts and rotate injection pump hub to align hub scribed line with pointer pin. Using care not to move hub, tighten mounting bolts. (Figure 17) Recheck hub scribed line and pointer pin alignment. (Figure 16)

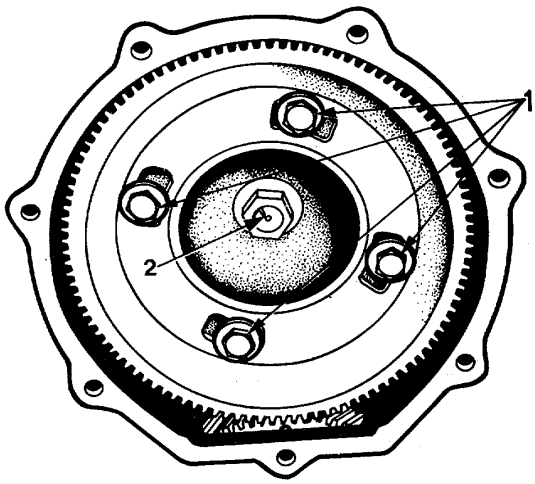


Figure 17. Injection Pump Drive Gear and Mounting Bolts

1. Mounting Bolts 2. Timing Mark on Camshaft at 11 o'clock

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NOTE: To minimize timing inaccuracies during pointer and scribed line alignment viewing, threads must be seen around the circumference of the viewing hole.

6. Install removed parts in reverse order using new gaskets and O-rings as needed and replace coolant.

Drip Spout Method

The drip spout method is an alternate procedure to check injection pump to engine timing. This procedure utilizes the injection pump no. 1 plunger position in relation to the engine timing marks.

7. With engine crankshaft positioned at specified timing mark, (per steps 1 and 2) release shut-off control from SHUT-OFF position.

8. Remove delivery valve, spring and fill piece from injection pump No. 1 pumping element and install drip spout (see Figure 90). Make drip spout locally from extra injection line and connector nut. Place a receptacle (paper cup, etc.) under drip spout to collect fuel flow from spout.

9. Position injection pump control rack at full load position as follows:

Secure control lever in full forward position. Slowly move fuel shut-off lever to rear. A distinct "click" will be heard as the rack moves from the start fuel to the full load position.

10. Supply fuel to the injection pump fuel gallery. Fuel gallery can be charged with fuel by suspending a small reservoir of fuel approximately 12 inches above the injection pump to provide a "head" for charging the fuel gallery. The reservoir can be made locally. Use a flexible tube to connect the reservoir to the fuel gallery bleeder valve at the right front corner of the pump housing.

11. With engine crankshaft positioned at specified timing mark and injection pump fuel gallery charged with fuel, fuel should flow from drip spout at the rate of one drop every 3 to 5 seconds. This indicates correct timing (start of injection on No. 1 cylinder).

12. If fuel flows from drip spout at a rate other than one drop every 3 to 5 seconds, this indicates incorrect pump-to-engine timing. It will be necessary to remove injection pump drive gear cover (per Step 4) for adjusting injection pump timing.

13. Loosen drive gear mounting bolts (Figure 17) and rotate injection pump hub until the specified drop rate is obtained. Tighten mounting bolts, recheck timing and install removed parts.

PRIMING FUEL SYSTEM

The fuel system should be primed following filter replacement, injection pump replacement, disconnecting or reconnecting of fuel lines or before vehicle is started following an extended period of parking or storage. The procedure for priming the fuel system is as follows:

1. Be sure tank has sufficient fuel.

2. Unlock primer pump by turning knob counter clockwise. Primer pump is located on top of final filter base. (Figure 18)

3. Open bleeder valve located on right front of injection pump. Operate priming pump and allow fuel to flow until all air bubbles are expelled and fuel flows in a solid stream.

4. Close vent and lock primer pump. (Push knob forward and turn clockwise)

MAINTENANCE

To obtain satisfactory fuel injection pump performance, the injection pump and fuel system must be properly maintained following the maintenance schedules and instructions outlined in the vehicle operator's manual.

Filter Service

Primary and secondary fuel filters should be replaced at specified intervals. The filter elements are the

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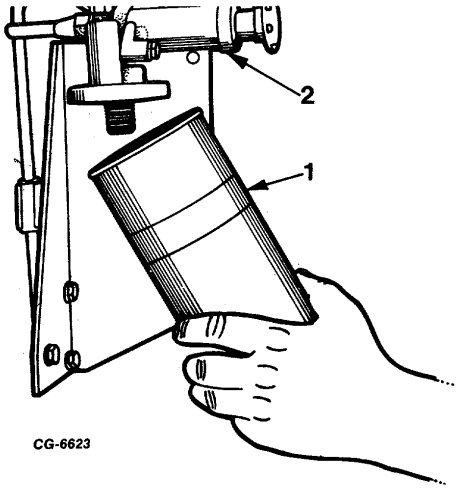


Figure 18. Filter Installation

1. Fuel Filter 2. Primer Pump

spin-on type. (Figure 18)

When replacing filters, make sure filter base mounting flange is clean. Apply a thin film of clean engine oil to filter seal (gasket). Screw filter onto filter base until seal contacts base mounting flange, then tighten ¼ to ½ additional turn. Do not overtighten. After new filters have been installed prime fuel system as outlined under "Priming Fuel System."

Specified Lo-Idle Speed Adjustment

Specified lo-idle speed is adjusted by turning lo-idle adjustment screw at rear of injection pump (Figure 19).

Procedure for checking and adjusting lo-idle speed is:

1. Start engine and operate until temperature is up to normal operating range.
2. Allow engine to idle and observe engine speed on tachometer. (Make sure tachometer is accurate.)
3. If lo-idle speed is not within specified limit, (see SPECIFICATIONS) check accelerator linkage to make sure lever is not restricted and repair if needed.
4. If pump lever is not restricted adjust lo-idle speed as follows:
   a. Loosen locknut.
   b. Turn adjusting screw to obtain correct idle speed. To reduce engine rpm, turn adjusting screw "in" (clockwise). To increase engine rpm, turn adjusting screw "out" (counterclockwise).
   c. Tighten locknut.

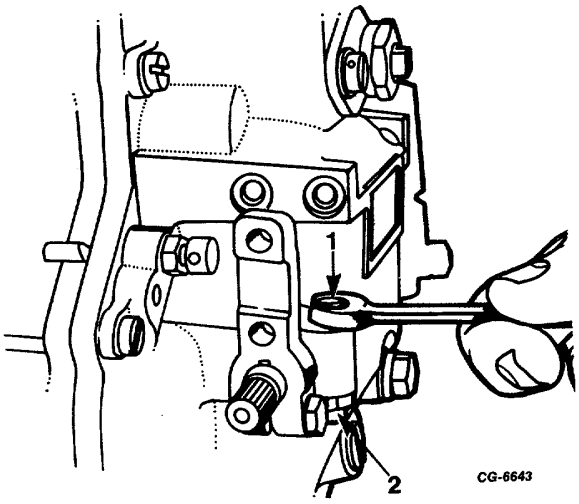


Figure 19. Lo-Idle Adjustment

1. Lo-Idle Stop Screw 2. Lock Nut

Hi-Idle Speed Adjustment

Maximum no-load governed speed (hi-idle) is the point of engine speed where governor prevents engine rpm from going higher. Hi-idle adjustment is located at accelerator lever stop screw (Figure 20) and is initially made on pump calibrating stand. Minor adjustment can be made on engine as follows:

1. With engine running and at normal operating temperature, push control lever to its full forward position lever against hi-idle stop.
2. Read tachometer and note highest engine rpm. (Make sure tachometer is accurate.)
3. If governed speed does not reach specified limit, check throttle linkage to make sure lever is not restricted.

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4. If governed speed is not within specified limits, remove seal on locknut of hi-idle stop screw and reset hi-idle adjustment. Turn stop screw out (counterclockwise) to reduce hi-idle or turn in (clockwise) to increase hi-idle. Tighten locknut and recheck hi-idle speed. When adjustment is correct, reseal locknut.

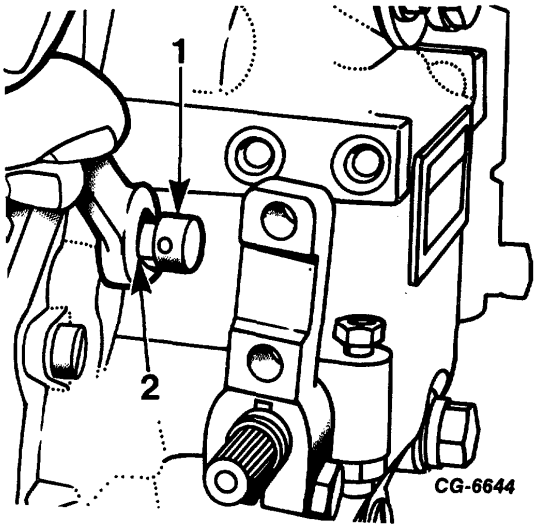


Figure 20. Hi-Idle Adjustment

1. Hi-idle Stop Screw 2. Lock Nut

ON ENGINE PERFORMANCE CHECKS

Performance checking consists of various pressure and vacuum tests that can be made on an operating engine. Some of these tests should be performed when engine has been normalized and under load. If dynamometer facilities are not available, a field test kit SE-2239 (Figure 21) is available which will enable you to make these tests while operating the engine under load.

Transfer Pump Pressure/Vacuum Check

Transfer pump pressure check is made directly on injection pump. Install an adapter at bleeder valve at right front side of injection pump (Figure 2) and connect by hose to test gauge (SE-2239) in cab. Operate engine under full load and at maximum rated engine speed.

If transfer pump fuel pressure is lower than specified minimum (see SPECIFICATIONS), replace primary and secondary fuel filter elements and repeat pressure check.

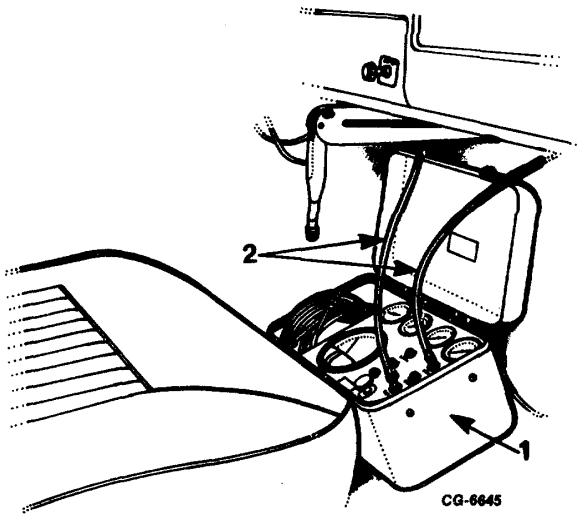


Figure 21. Field Test Kit for Performance Checking

1. Field Test Kit SE-2239
2. Hose for Testing Engine and Fuel System

If installation of new filters does not correct fuel pressure, pressure regulator valve and/or transfer pump replacement may be required.

To verify transfer pump condition, install an adapter in fuel line between primary filter and transfer pump and connect by hose to vacuum test gauge in cab.

If vacuum gauge indicates a higher than specified reading (see SPECIFICATIONS), fuel line(s) from tank to transfer pump could be restricted. Check and repair if needed.

If vacuum test gauge indicates an extreme low reading, transfer pump is faulty and must be replaced. Transfer pump can be removed without removing complete injection pump from engine.

This test is made with engine operated under full load and at maximum rated engine speed.

Manifold Vacuum

The manifold vacuum test is a quick method for checking air cleaner restriction. To check manifold vacuum, obtain a manometer or low range vacuum gauge such as included in SE-2239 test kit. Remove plug from manifold cross-over and attach hose between manifold and gauge in cab.

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To test for restriction, operate engine at either no load or under load. When at normal operating temperature observe vacuum gauge. If vacuum exceeds 20" water or 1.47" mercury, air cleaner or air induction system is restricted and must be corrected.

Exhaust Back Pressure

To check exhaust back pressure, remove pipe plugs (pyrometer thermo switches if equipped) and install a short length of steel tubing with appropriate fittings. Tubing is needed to insulate gauge hose from exhaust heat. Fasten hose for manometer or low range pressure gauge (SE-2239) to steel tubing and start engine check one manifold at a time. It is necessary to check both manifolds since back pressure will differ between left and right exhaust manifolds. When engine is at normal operating temperature and while operating under full load observe pressure gauge. If back pressure is higher than specified (see SPECIFICATIONS), exhaust system is restricted and cause must be corrected.

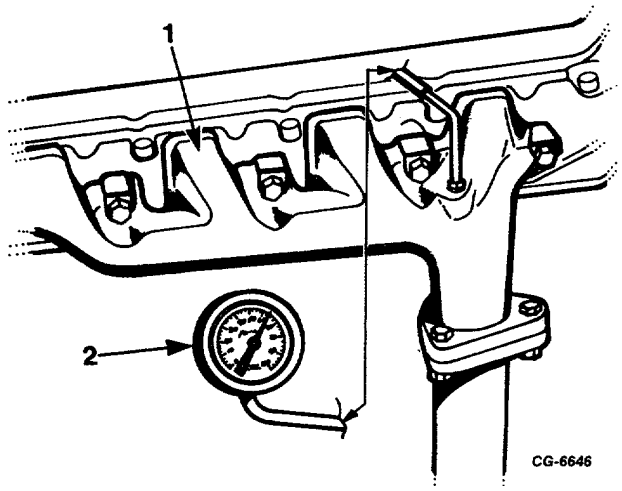


Figure 22. Exhaust Back Pressure Test

1. Manifold 2. Gauge

REMOVAL OF INJECTION PUMP

Preparing for Removal

Truck model differences affect pump removal, but following is always required;

1. Drain engine coolant from radiator and engine block.

2. Disconnect accelerator and shut off control cables from governor.

3. Before disconnecting fuel lines, clean pump and connections with clean diesel fuel.

4. Disconnect injection lines, low pressure lines and lube oil line from pump. Remove fuel line brackets as necessary. Use plastic caps or plugs to protect openings from dirt.

Removal

Remove fan drive, water outlet and return tube, injection pump drive gear cover and drive gear.

(For detailed removal procedure, see Section CGES-205 of the Service Manual.)

NOTE: If injection pump has been operated on an engine in which water or anti-freeze has entered the crankcase, disassemble and clean the pump and governor immediately. Do not store pump before overhaul.

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INJECTION PUMP DISASSEMBLY

Special Tools

To overhaul the pump assembly, metric wrenches and sockets ranging in size from 8mm through 19mm will be required. Special rebuild tools (Figure 23) called out throughout the text will speed repair work and protect parts from damage.

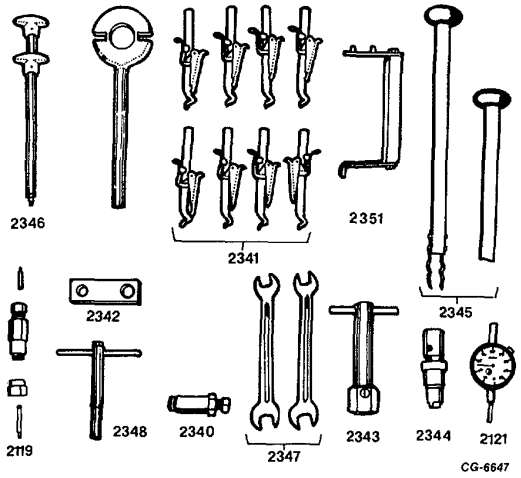


Figure 23. Special Tools for Pump Overhaul

SE-2119	Rack Gauge Holder
SE-2121	Dial Indicator
SE-2340	Remover, Governor Flyweight Damper
SE-2341	Holder, Tappet
SE-2342	Gauge, Camshaft Protrusion
SE-2343	Holder, Dial Indicator
SE-2344	Remover and Installer, Camshaft Cylindrical Nut
SE-2345	Remover and Installer, Tappet
SE-2346	Remover and Installer, Barrel Plunger
SE-2347	Wrench, Tappet Adjusting
SE-2348	Wrench, Governor Spring Adjusting
SE-2351	Fixture, Pump Holding

Preparation for Disassembly

Pump and governor overhaul should be performed in a clean area free from airborne dirt. A separate injection service room is preferred. Work bench, vise and tools should be clean. The use of trays for keeping injection pump parts in order is recommended. The pump assembly should be thoroughly cleaned externally before disassembly. Prepare the pump for disassembly as follows:

1. Drain fuel and lubricating oil from pump and governor housings.

2. Cap or plug fuel and lube oil openings after draining.

3. Use clean diesel fuel or kerosene to clean exterior of pump and governor assembly.

4. Clamp holding fixture SE-2351 (Figure 24) in vise. Remove two pump housing to adapter bolts. Secure injection pump assembly to holding fixture.

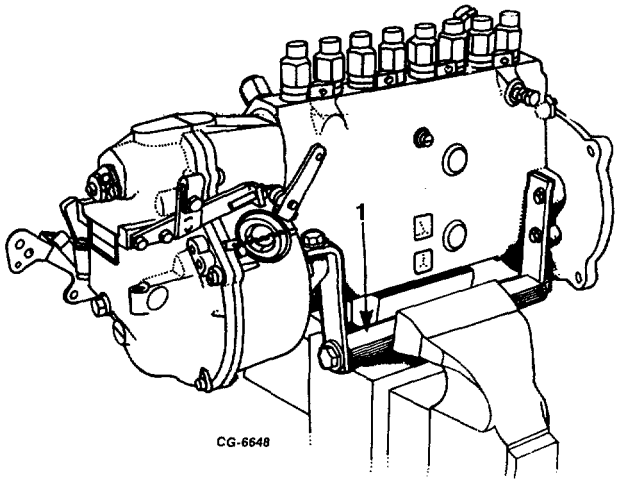


Figure 24. Injection Pump Mounted in Holding Fixture

1. Holding Fixture SE-2351

Governor Disassembly

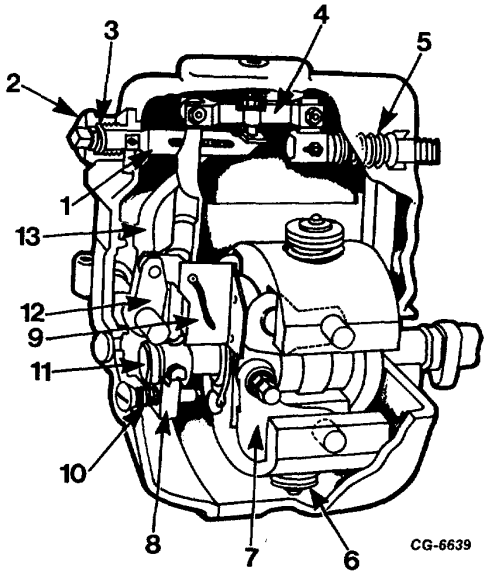


Figure 25. Cut-Away View of Governor Assembly

1. Stop Shackle
2. Lock Nut
3. Control Rack Stop Assembly
4. Rack Link
5. Control Rack
6. Governor Springs
7. Bell Crank
8. Sliding Block
9. S Plate
10. Guide Pin
11. Adjusting Pin
12. Guide Lever
13. Rocker Arms

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1. Using 10mm Allen wrench, remove plug from rack link adjustment access hole in top of governor housing.

2. Remove seal wire and remove two rack stop assembly to governor housing screws.

3. Move control lever fully back against low idle stop screw.

4. Reaching down through rack link adjustment access hole with a small screwdriver (Figure 26), lightly pry stop shackle aside (to right as viewed from rear of pump) to disengage stop shackle from rocker arm pin. (See Figure 25 for relationship of parts.)

   NOTE: To ease this operation, interior of governor housing can be lighted by removing seal wire and plug from governor adjustment access cover on side of governor housing and inserting penlight through access hole.

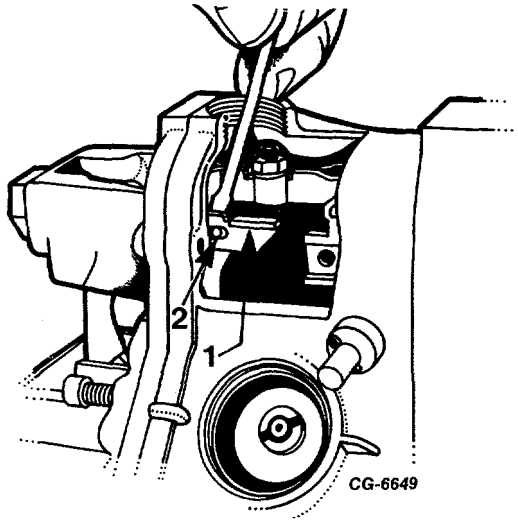


Figure 26. Disengaging Stop Shackle (Cut-Away View for Illustration)

1. Stop Shackle 2. Rocker Arm Pin

5. Pull control rack stop assembly to rear, then rotate approximately 45 degrees counterclockwise to permit stop shackle to pass governor levers and slide assembly from governor housing (see Figure 27).

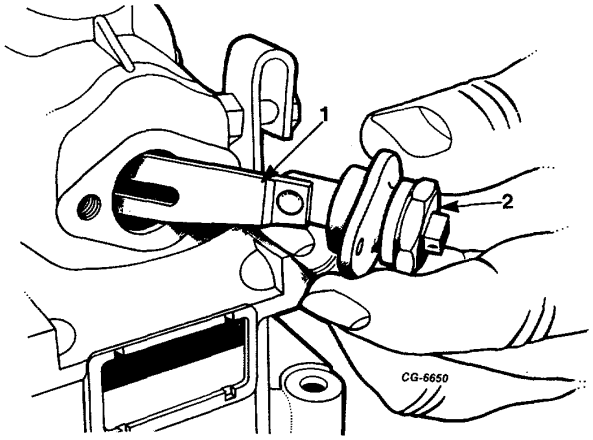


Figure 27. Removing Rack Stop Assembly

1. Stop Shackle 2. Rack Stop Assembly

6. Remove Slotted Screw guide pin (Figure 28) from governor cover. Use large screwdriver to fit slot of this screw which has been sealed in place with Loc-Tite.

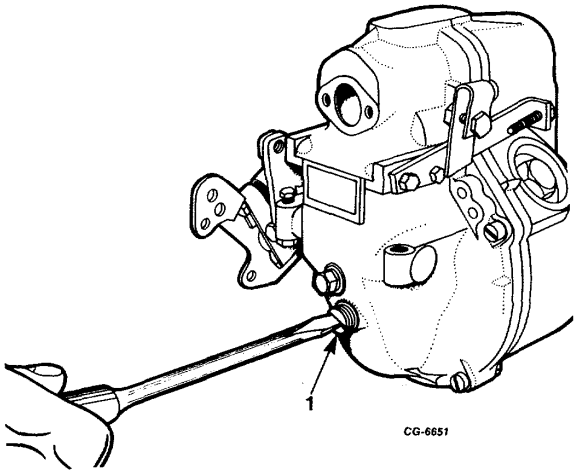


Figure 28. Removing Guide Pin

1. Slotted Screw Guide Pin

7. Remove six governor cover screws and take off governor cover (Figure 29). Lift cover up and operate control lever to release internal linkage.

8. Remove cotter pin and link pin and disconnect floating lever from rack link.

9. Pull top of floating lever back and down to remove floating lever and slider (Figure 30) from guide pin.

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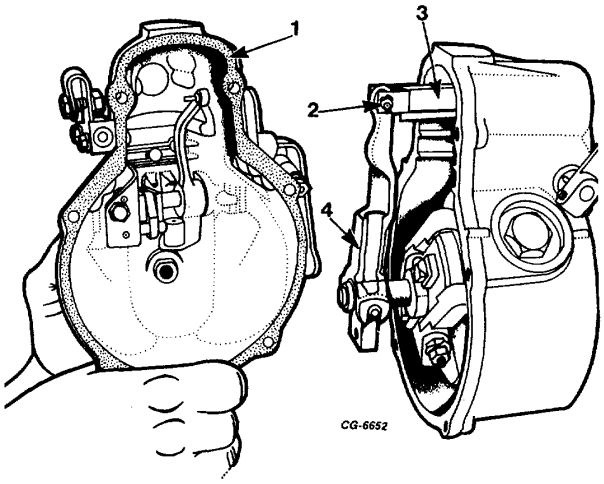


Figure 29. Removing Governor Cover

1. Cover
2. Link Pin
3. Rack Link
4. Floating Lever

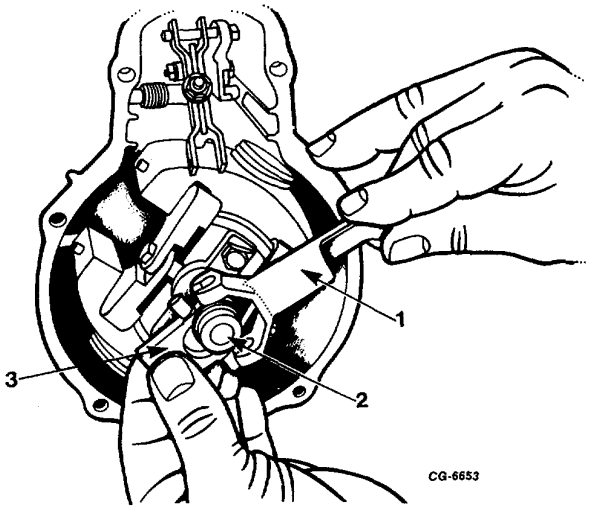


Figure 30. Removing Floating Lever and Slider

1. Floating Lever
2. Adjusting Pin
3. Slider

10. Raise tabs on lock washer and remove double nutted thru-bolt and adjusting pin from governor flyweight assembly (Figure 31).

11. Raise tabs on lock plates, remove two cap screws and take out adjusting pin guide bushing (Figure 32).

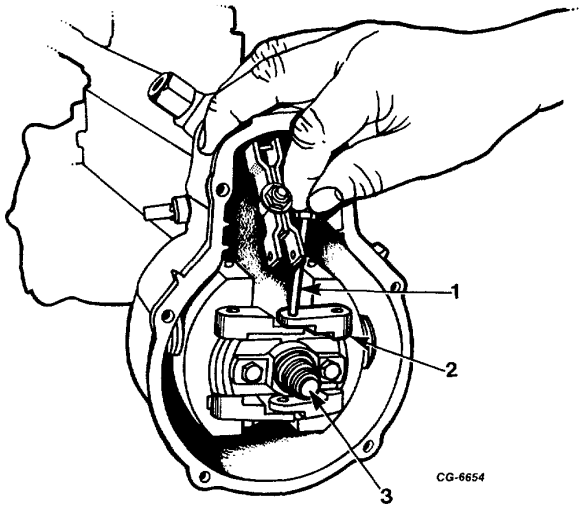


Figure 31. Removing Adjusting Pin from Flyweight Assembly

1. Thru-Bolt
2. Flyweight Assembly
3. Adjusting Pin

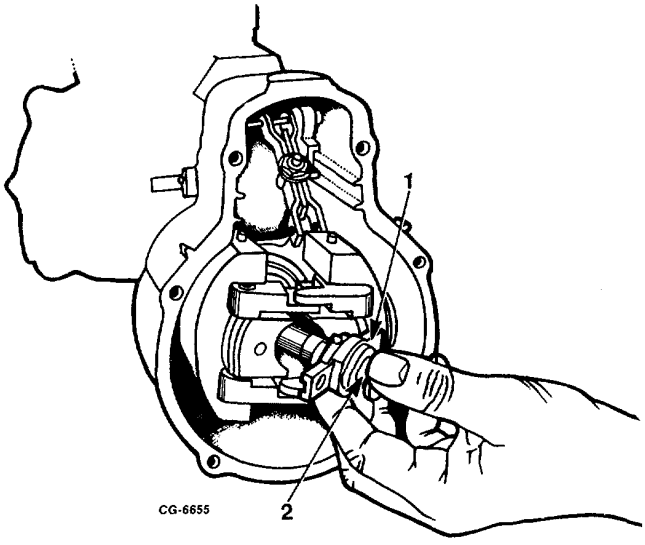


Figure 32. Removing Adjusting Pin Guide Bushing

1. Adjusting Pin Guide Bushing
2. Adjusting Pin

12. Install two 3/8 NC x 3 1/2 bolts in the drive flange. (Figure 37) Using SE-2344 remover tool on slotted cylindrical nut and holding bar between bolts to hold camshaft, remove the cylindrical nut (Figure 33) and spacer shim under the nut. It may be necessary to use small quantity of lube on nut to extract spacer shim.

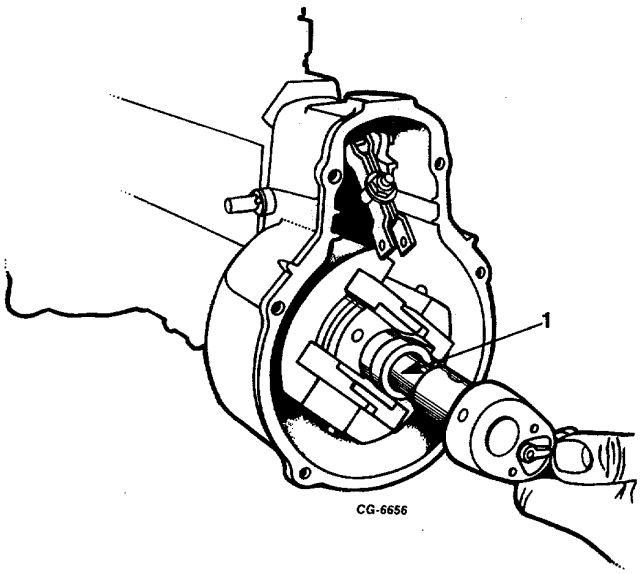


Figure 33. Removing Cylindrical Nut

1. Cylindrical Nut Remover SE-2344

13. Install SE-2340 governor flyweight remover tool (Figure 34) and remove flyweight assembly. Since governor weight assembly is serviced as a complete unit, no further disassembly is required until rebuild.

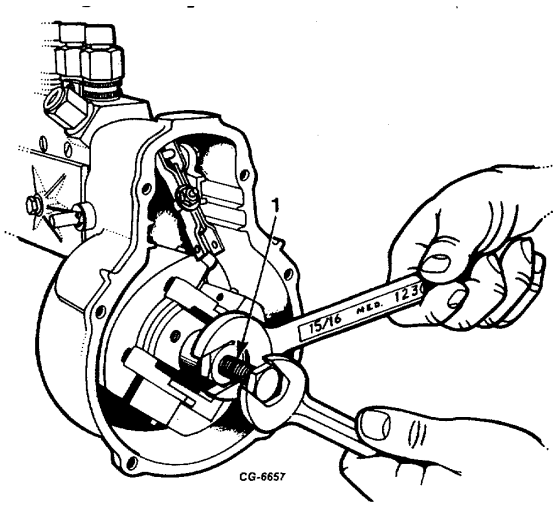


Figure 34. Removing Governor Flyweight Assembly

1. Governor Flyweight Remover Tool SE-2340

14. To remove governor housing, remove rack link, link bracket and spring from rear of control rack. Move tab of stop lever return spring aside and unscrew seven governor housing to pump housing mounting screws. Remove governor housing and bracket.

NOTE: Governor housing screws are staked. Governor housing will not have to be removed from pump housing unless governor housing is damaged or cracked, fuel dilation is suspected, there are other leaks, or camshaft bearing damage is evident.

Pump Disassembly

NOTE: The main body contains several fittings, bushings and plugs on which Loc-Tite has been used. Do not remove these parts unless known to be leaking. Included among these are the inlet fuel adapter fitting, the fuel gallery plug, the lube oil inlet bushing and the bleeder valve bushing.

1. Remove three side cover bolts, remove side cover and gasket from pump housing.

2. Remove three transfer pump nuts and washers. Remove transfer pump and gasket from pump housing.

3. Install eight SE-2341 tappet holder tools (Figures 35 and 36) in side of pump to hold all tappets up from camshaft. To prevent tool breakage, lift each tappet by rotating camshaft before installing holder tool. Figure 35. Installing Tappet Holder Tool

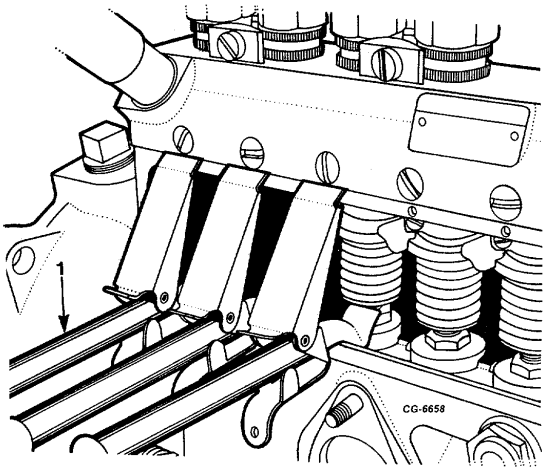


Figure 35. Installing Tappet Holder Tool

1. Tappet Holder SE-2341

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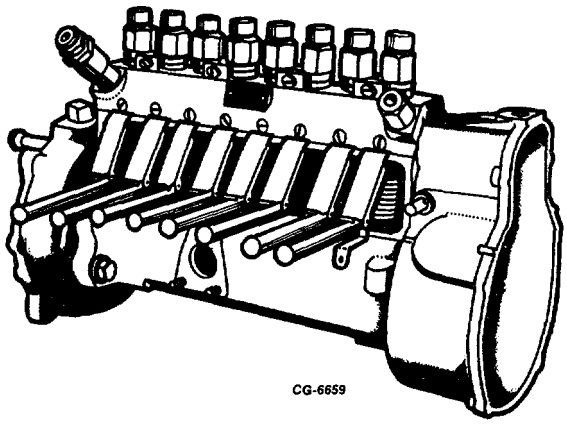


Figure 36. All Tappet Holder Tools in Place

4. Using holding bar to hold drive hub, remove camshaft nut and washer (Figure 37)

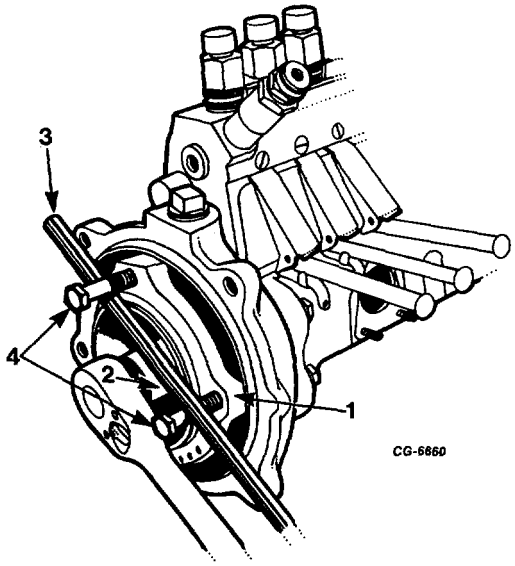


Figure 37. Removing Camshaft Nut
1. Drive Hub 3. Holding Bar
2. Socket Wrench 4. Hub Holder Bolts

5. Remove drive hub from camshaft by using a gear puller. (Figure 38). Remove woodruff key from camshaft.

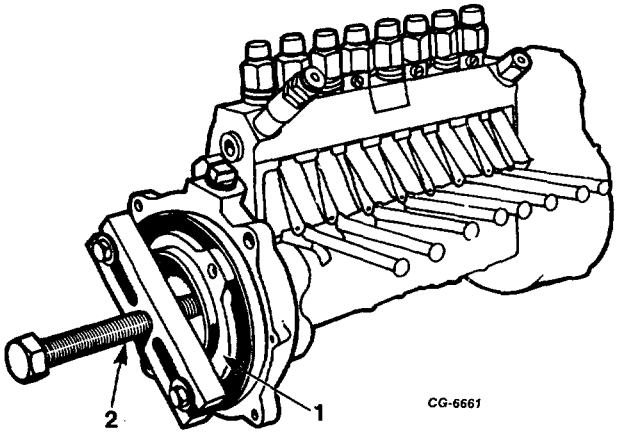


Figure 38. Removing Drive Hub
1. Drive Hub 2. Drive Hub Puller

6. Remove two remaining adapter to pump housing bolts and remove adapter housing (Figure 39).

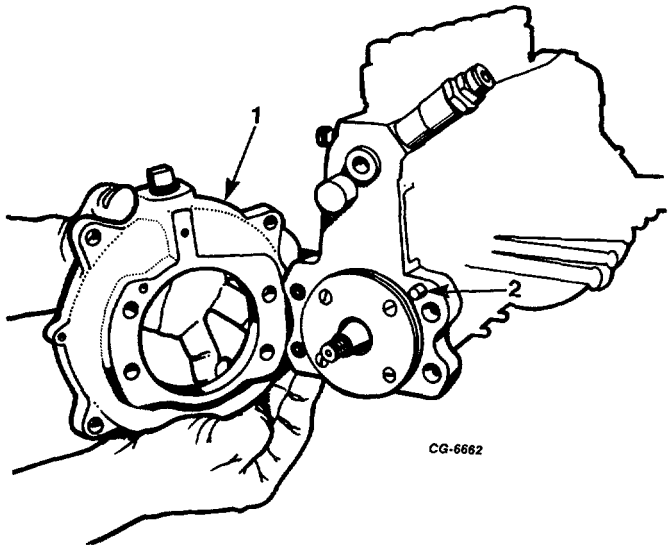


Figure 39. Removing Adapter Housing

1. Adapter Housing 2. Locating Pin

7. Loosen holding fixture clamp bolts, reposition pump assembly on side (tappet holder tools pointing upward) and retighten fixture clamp bolts.

8. Remove the two camshaft center bearing screws from bottom of pump (Figure 40).

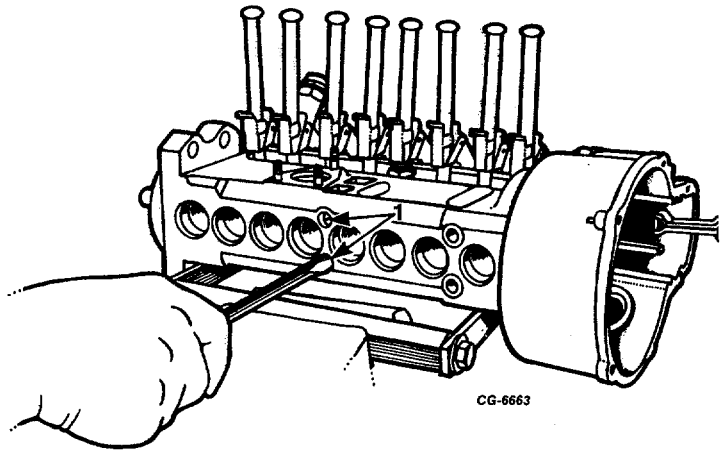


Figure 40. Removing Camshaft Center Bearing Screws
1. Center Bearing Screws

9. Using large screwdriver remove the four flat head screws from camshaft front bearing retainer and remove retainer (Figure 41).

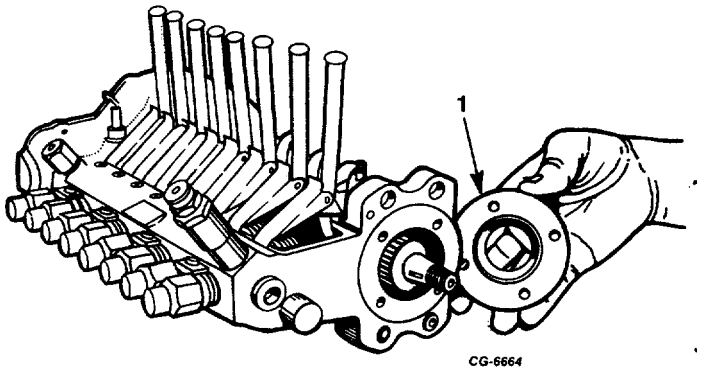


Figure 41. Removing Front Bearing Retainer
1. Front Bearing Retainer

10. Remove camshaft (Figure 42) with center bearing and both end bearings out front of pump. A slight tapping on rear of shaft with soft hammer is permitted.

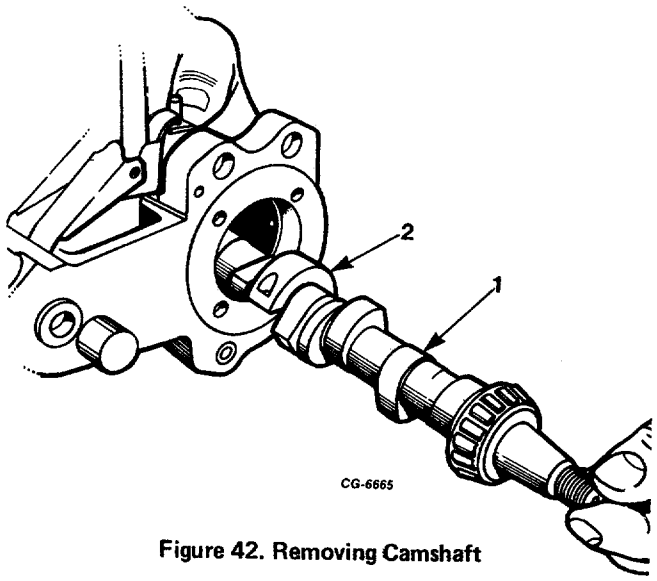


Figure 42. Removing Camshaft

1. Camshaft 2. Center Bearing

11. Using a 5/8" or 11/16" socket or similar size wooden plug, drive the eight base plugs inside pump housing and remove (Figure 43).

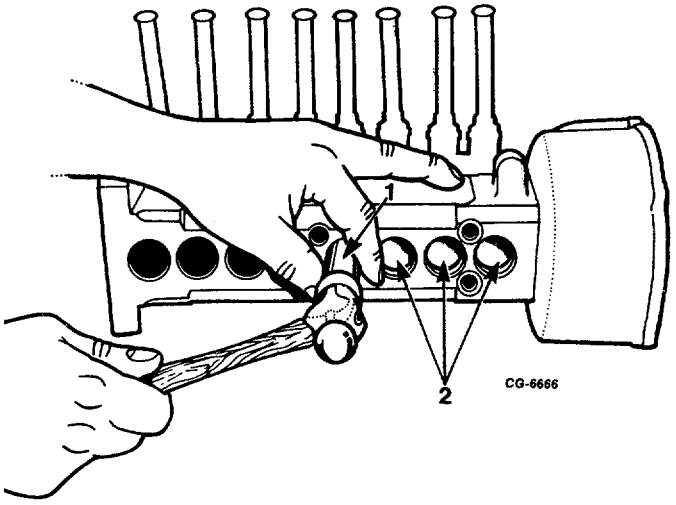


Figure 43. Removing Base Plugs
1. Plug 2. Base Plug

12. Using SE-2345 tappet remover tool, push roller tappet up so that SE-2341 tappet holder tool can be removed (Figure 44). Clear holder tools from all eight tappets and remove roller tappet assemblies from pump housing. Keep parts in order so that tappets can be returned to their respective bores on reassembly.

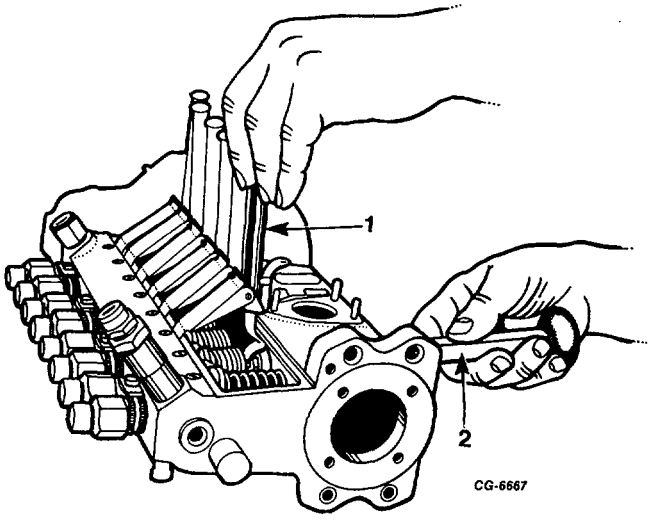


Figure 44. Removing Holder Tool and Tappet
1. Tappet Holder SE-2341
2. Tappet Remover SE-2345

13. Remove keepers, plunger springs, upper spring seats and plungers (Figure 45). Keep parts in order, don't touch machined surfaces, and keep surfaces wet with fuel oil while removed.

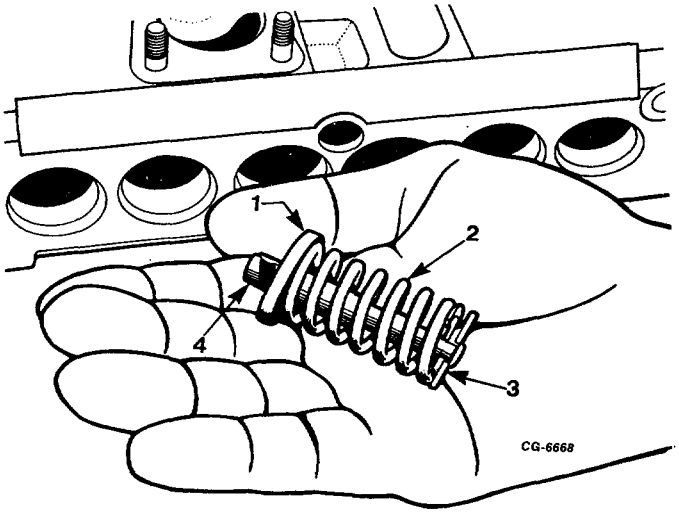


Figure 45. Removing Plungers
1. Seat
2. Spring
3. Keeper
4. Plunger

14. Remove control sleeves from barrels (Figure 46).

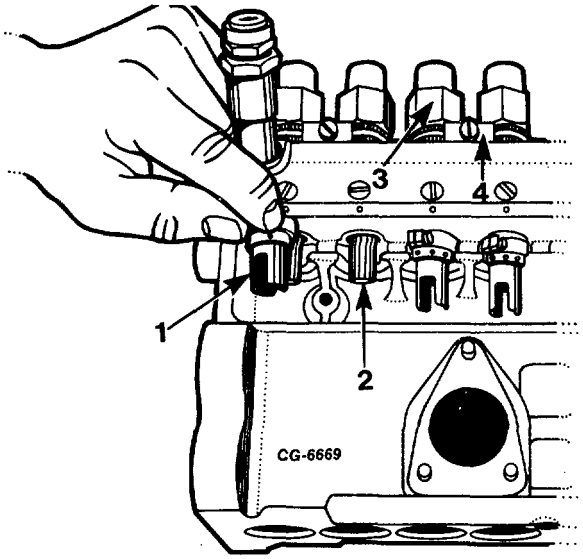


Figure 46. Removing Control Sleeves
1. Control Sleeve
2. Barrel
3. Delivery Valve Holder
4. Clamps

15. Remove delivery valve holder clamps and using a 7/8" socket, remove the holders (Figure 47).

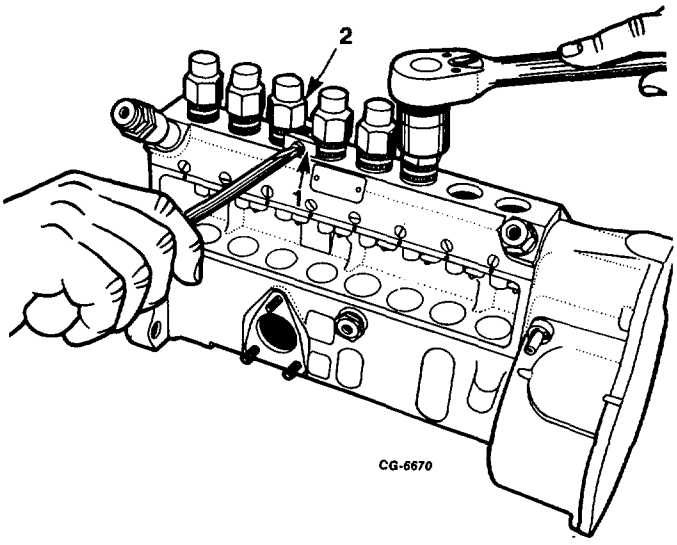


Figure 47. Removing Holder Clamps and Delivery Valve Holders
1. Holder Clamp
2. Delivery Valve Holder

16. Remove fillers, springs, gaskets and delivery valve assemblies by lifting up on barrels from inside of pump housing. As soon as barrels are removed, keep barrels and plungers together. While these parts are mated at assembly, they have no mating marks. Be sure to keep parts in order.

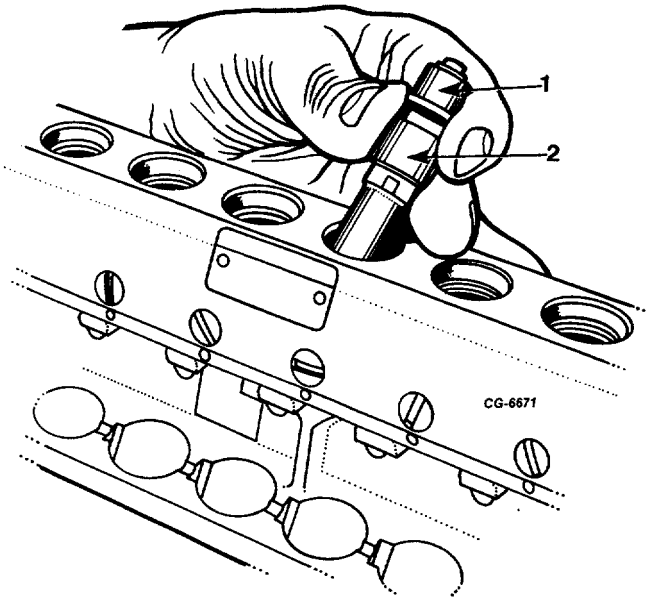


Figure 48. Removing Barrel and Delivery Valve
1. Delivery Valve 2. Barrel

17. Remove control rack positioning screw and control rack end plug (Figure 49)

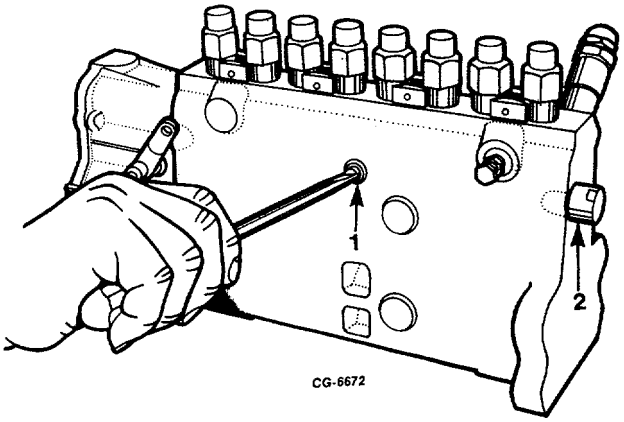


Figure 49. Removing Rack Position Screw
1. Control Rack Positioning Screw
2. End Plug

18. Remove control rack from pump housing (Figure 50).

Figure 50. Removing Control Rack

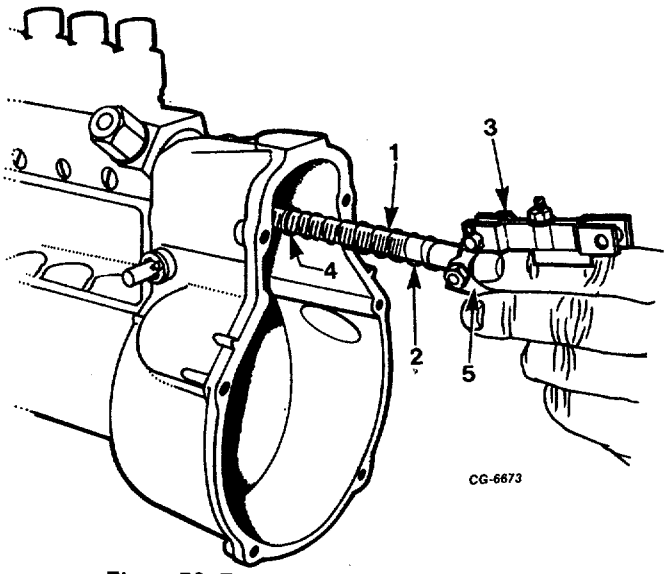


Figure 50. Removing Control Rack
1. Control Rack
2. Spring
3. Rack Link
4. Guide Ring
5. Bracket

A thorough cleaning and inspection of all parts is important to reconditioning the injection pump and governor assembly.

Each machined surface should be cleaned of all old gasket material and wash all parts in clean fuel oil or calibrating oil.

When inspecting for damage or wear, it is a good practice to replace any part that is questionable.

INJECTION PUMP HOUSING

1. Check for cracks, chips or evidence of over-torque or stripping of screw threads and check roller tappet bores for damage. Leaking or damaged housing cannot be reconditioned.

2. Inspect camshaft bearing cups located in governor housing and front bearing retainer, and bearings on camshaft. Replace damaged bearing as follows:

    a. Remove governor housing from pump housing (see Governor Disassembly item 14).

    b. Remove bearing cup and gasket material from governor housing and pump housing. Install new bearing cup.

    c. Obtain new gasket and tap governor housing onto pump housing. Use light lube on gasket. Install mounting screws and restake to secure. Reposition stop lever spring end in hole provided.

    d. Remove and replace bearing cup in front bearing retainer.

    e. Remove and replace bearings on camshaft and use the same number of shims as used under old bearings.

        NOTE: When installing a new camshaft, use the same number of shims as used on old shaft as a starting point for shim build-up to make end play adjustment.

Camshaft: Deep wear or grooving on cams or bearing surfaces of camshaft requires that camshaft be replaced.

Roller Tappets: Slight pressure marks or grooving can be smoothed out with a polishing cloth, but more serious wear requires that parts be replaced.

Spring Keepers: Worn or bent keepers should be replaced.

Springs: Normally can be reused unless broken or rust coated.

Barrels and Plungers: Evidence of damage (scratches, scoring, etc.) on lapped surfaces of plunger means both barrel and plunger must be replaced. You can test the set by washing out with test oil and pulling plunger part way out of barrel. It must fall back slowly by its own weight.

Control Sleeves: If there is only slight damage, control sleeves can be polished and reused. If damage is severe, replace.

Control Rack: Be sure there are no burrs on gear teeth or scratches along sides. It may be polished with crocus cloth, but replace if any binding with housing exists.

Delivery Valve Assembly: If delivery valve seat or needle is damaged, replace both seat and needle with a complete assembly.

Base Plugs: Can be reused unless they are known to be leaking.

Gaskets, Seals and O-Rings: Should always be replaced whenever the pump is rebuilt.

Transfer Pump: Check transfer pump for fuel leakage past the pump drive stem. Plug outlet side of transfer pump and pressurize the inlet side with air to 103-137 kPa (15-20 PSI). When submerged in fuel oil, no air leaks are permitted past the pump drive assembly. Transfer pump is serviced as a complete unit only.

Governor Housing and Cover: Look for cracks, stripped screw threads, burrs on mating surfaces.

Governor Weight Assembly: While this unit is checked out at time of calibration, look for such visible evidence as worn bell cranks, damaged weights, stripped adjusting nut threads, worn or damaged springs.

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Governor flyweight assembly is serviced as a complete unit but weight springs, spring seats and shims are serviced individually. Instructions for reconditioning the governor are outlined below.

1. Perform a static check on balanced movement of governor weights by making a temporary build-up less springs but using spring seats, trial spacer bushings (obtained locally) and adjusting nuts (Figure 51) on each weight as follows:

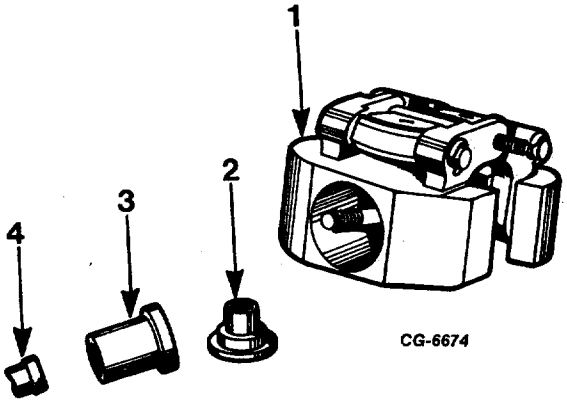


Figure 51. Details of Flyweight Assembly
1. Governor Flyweight Assembly
2. Spring Seat
3. Trial Spacer Bushing
4. Adjusting Nut

Install double-nutted thru-bolt in weight assembly. Apply slight pressure to center of bolt and check for excessive rocking movement in one or the other weights (Figure 52). When installing the three different size weight springs, remove the trial spacer bushings.

2. Reinstall flyweight springs. Always start preliminary shim pack under governor shims as follows:

   Outer spring: 1.0 mm (.040") Intermediate Spring: 1.0 mm (.040") Inner Spring: 1.5 mm (.060") Install outer spring seat and adjusting nut. When installing adjusting nut, preload of governor springs should range from 2 to 3 180 degree clicks from flush nut position with threaded bolt. Preliminary adjustment should be equal on both spring sets.

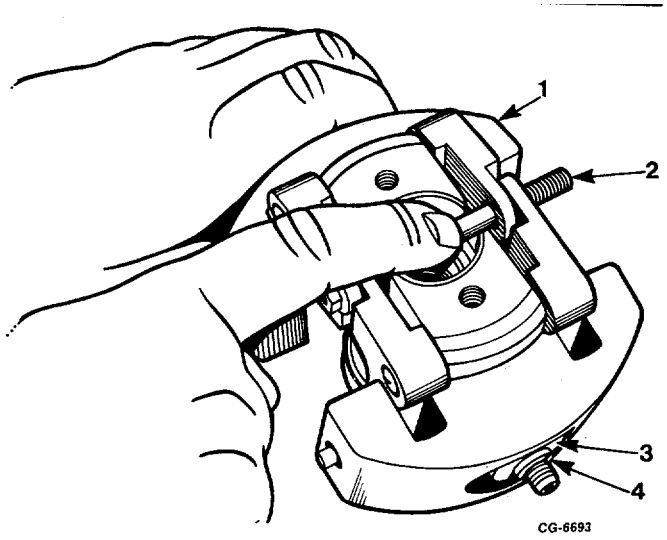


Figure 52. Checking Flyweight Trail Build-Up
1. Rocking Movement
2. Through Bolt
3. Trial Spacer Bushing
4. Adjusting Nut

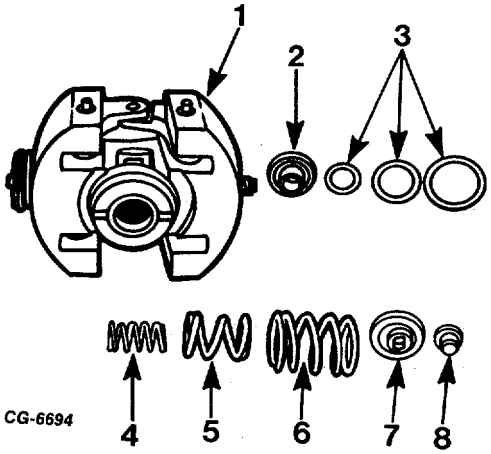


Figure 53. Exploded View of Flyweight Springs
1. Flyweight Assembly
2. Lower Spring Seat
3. Adjusting Shims
4. Inner Spring (Hi-Idle)
5. Intermediate Spring
6. Outer Spring (Lo-Idle)
7. Upper Spring Seat
8. Adjusting Nut

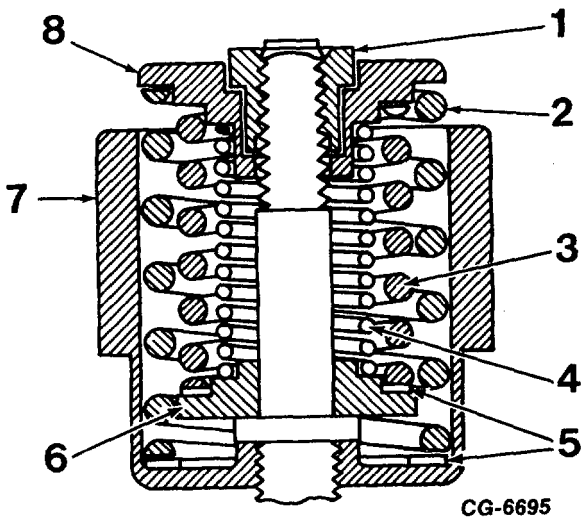


Figure 54. Sectional View of Flyweight Spring Installation

1. Cylindrical Adjusting Nut
2. Lo-Idle Spring
3. Intermediate Spring
4. Hi-Idle Spring
5. Adjusting Shim
6. Lower Spring Seat
7. Flyweight Assembly
8. Upper Spring Seat

3. Inspect damper buffers for damage. Pry up hub to inspect. Replace buffers as a set if needed (Figure 55).

4. Assemble prelubricated buffers in damper retainer and place damper hub on weight assembly.

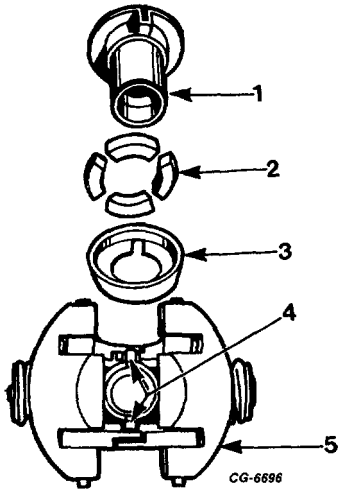


Figure 55. Exploded View of Damper Hub

1. Damper Hub
2. Buffer
3. Retainer
4. Mounting Tang
5. Flyweight Assembly

S-Plate: Sliding parts should operate free of bind; any grooves or pressure marks on curve should be smoothed with fine emery.

Adjusting Pin: If any parts of the adjusting pin are worn or damaged, replace the complete unit.

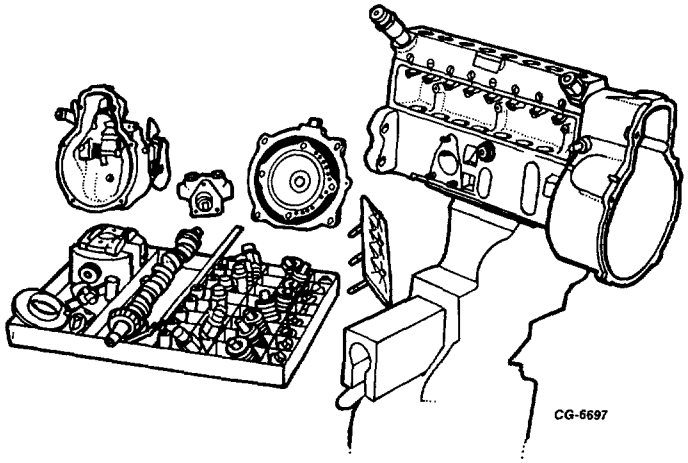


Figure 56. Disassembled Pump - Cleaned, Inspected, Reconditioned and Ready for Reassembly

PUMP REASSEMBLY

1. Position pump body in SE-2351 holding fixture and clamp upright in vise.

2. Noting for correct order, install the barrels, aligning guide slots with pins in pump housing. Prelubricate with fuel oil while installing.

3. Install delivery valves and assemblies.

4. Install new delivery valve gaskets, springs, fillers and delivery valve holders. Use new O-rings and prelubricate with fuel oil. Install delivery valve holders finger tight. Do not torque until control rack and control sleeves have also been installed.

5. Attach rack link bracket and rack link to rack and with rack spring and washers in place on rack, install control rack through governor and into pump housing. The rack spring is important, since it functions to take up lost motion in the internal pump parts and serves to retract rack if other linkage should fail.

6. Secure control rack in pump with rack positioning screw. Be sure rack is free.

7. Reposition holding fixture to place pump tappet cover side up.

8. Install control sleeves on barrels (Figure 57) with all eight centered on rack segments. Check for binding by operating sleeves with control rack and replace any that do.

9. Starting at drive end, torque Nos. 1 through 8 delivery valve holders.

   NOTE: Tighten holders to specified torque and relieve twice before final torquing. Operate rack between each sequence to be certain rack has no binding.

10. Install upper spring seats and springs.

11. Using SE-2346 plunger installer tool, grasp plunger in tool and place spring keeper on tool. With marked tang of plunger toward side cover opening and open end of spring keeper away from side cover opening, install plungers and spring keepers in their respective barrels (Figure 58). Align plunger tang with control sleeve slot.

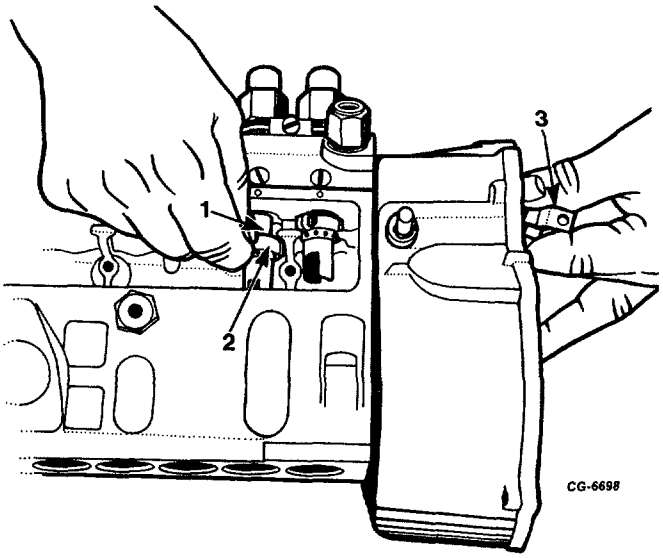


Figure 57. Installing Control Sleeves
1. Barrel
2. Control Sleeves
3. Rack Link

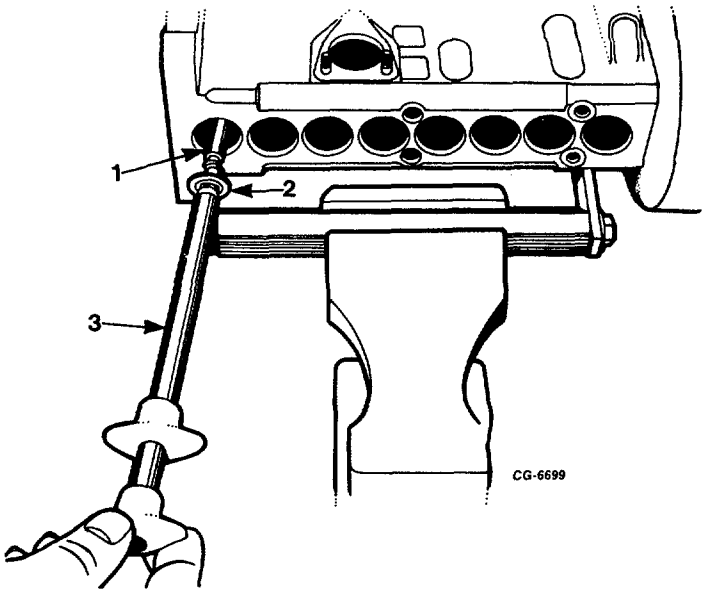


Figure 58. Installing Plungers
1. Plunger
2. Spring Keeper
3. Plunger Installer SE-2346

12. Using SE-2345 tappet installer and noting guide slot, install tappets in their respective bores. Keep roller pin flush with tappet. It will be noted that lube oil supply port passes through number 5 tappet bore. The action of tappet aids oil circulation through pump housing.

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13. Compress plunger springs with SE-2345 tappet installer tool and position the eight SE-2341 tappet holder tools on side of pump housing to hold all tappets in their raised position (Figure 59).

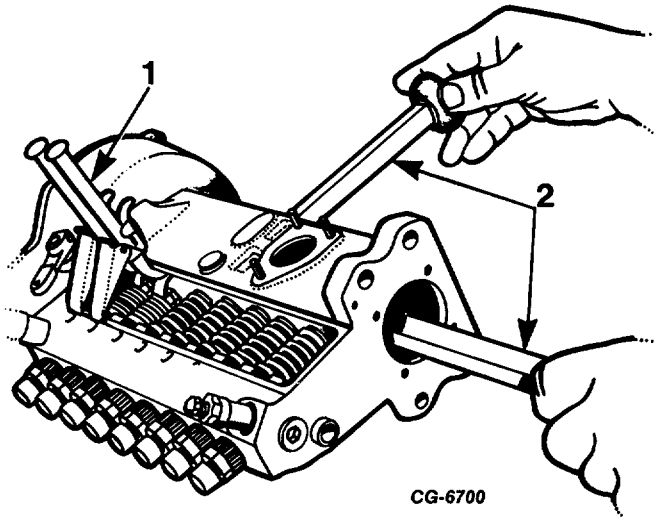


Figure 59. Installing Tappets
1. Tappet Holder SE-2341
2. Tappet Installer SE-2345

14. Place a small dab of lube on center bearing to hold it to camshaft and install camshaft into pump housing. Center bearing is positioned on bottom side of camshaft. Secure center bearing with two screws through bottom of pump housing.

15. Obtain new gasket and install front bearing retainer. Use light lube on gasket. Start all four screws to guide retainer into place, but do not use screws to draw down. Tap retainer into place while turning camshaft to assure alignment (Figure'60). Tighten mounting screws securely.

16. To check camshaft end play, screw SE-2343 holder tool onto front end of camshaft (.Figure 58). Place SE1848 dial indicator set in holder so indicator will read end play when tool handle is pulled and released. End play is .02-.06mm (.0008"-.0024"). Change end play by adding or removing shims behind front bearing.

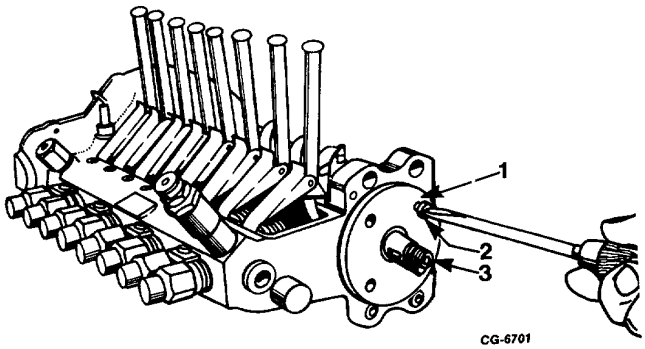


Figure 60. Installing Front Bearing Retainer
1. Front Bearing Retainer
2. Mounting Screw
3. Camshaft

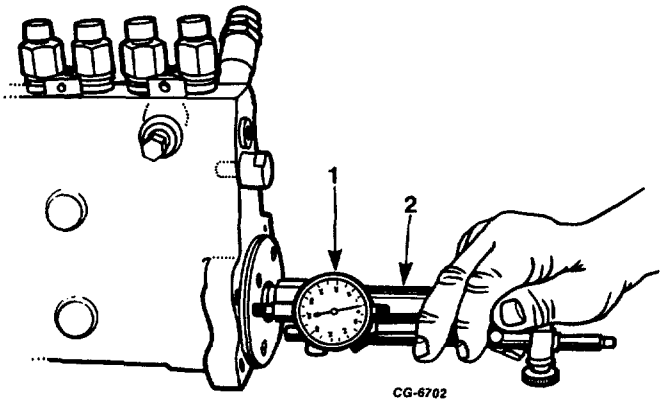


Figure 61. Checking Camshaft End Play
1. Dial Indicator Set SE-1848
2. End Play Holder Tool SE-2343

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17. To check camshaft protrusion or space between drive coupling and main body (Figure 62), use SE-2342 protrusion gauge and depth micrometer. Place gauge over front end of camshaft and using micrometer, measure distance from surface of tool to machined surface of pump housing.-Distance should be 20.7-22.2mm (.817"-.877"). Change camshaft protrusion by adding shims under bearing at governor end of camshaft to increase protrusion or removing shims to decrease protrusion. Maintain same thickness of shims at each end to hold correct end play.

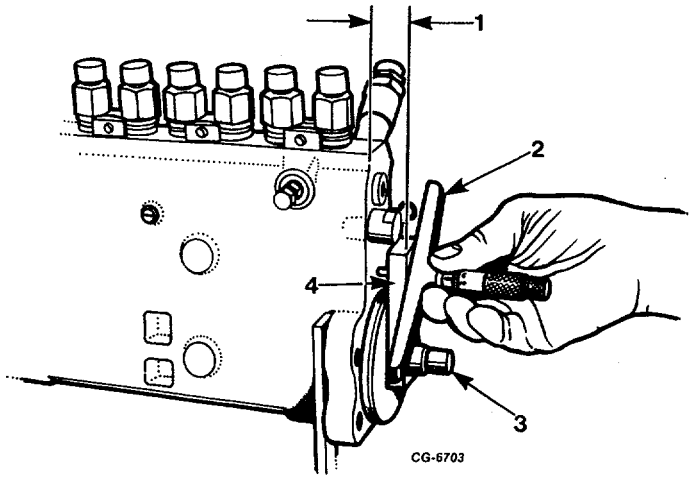


Figure 62. Checking Camshaft Protrusion
1. Protrusion
2. Depth Micrometer
3. Camshaft
4. Protrusion Gauge 2342

18. When satisfied that camshaft has sufficient end play and protrusion, recheck bearing retainer mounting screws for tightness.

19. After placing woodruff key in camshaft slot, temporarily install drive flange assembly, (Figure 63) IH Dart number 406419C91. Install washer and nut, using wrench SE-2339, and tighten to 81.3 97.6 N-m (60-72 lb-ft). Torque the socket head set screws in drive flange to 24.4 - 33.9 N-m (18-25 lb-ft).
NOTE: Temporary drive flange is used as an adapter between pump assembly and calibrating stand and will be replaced after pump has been calibrated.

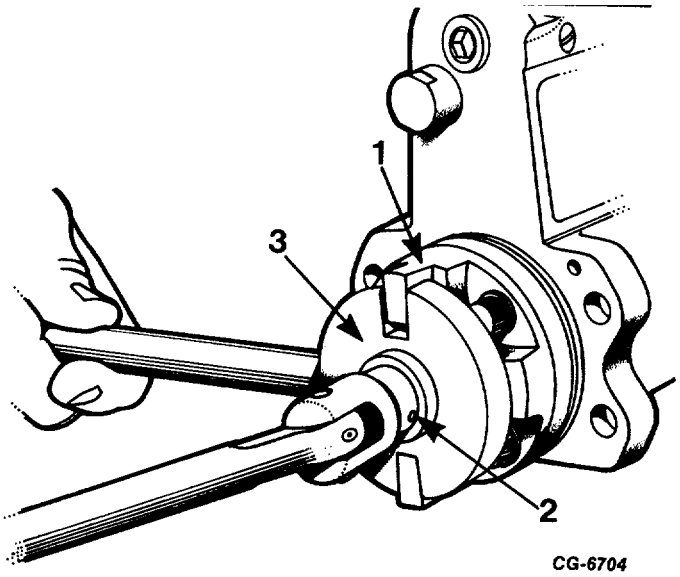


Figure 63. Installing Temporary Camshaft Flange
1. Drive Flange
2. Socket Wrench
3. Wrench SE-2339

20. Using camshaft cams to release pressure on the SE-2341 tappet holder tools, remove tools from side of housing.

21. Install base plugs in bottom of pump housing unit 5/8" or 11/16" socket or similar size wood dowel (Figure 64). Seat plugs so they are just past lower edge of chamfer in pump housing. To prevent leakage, install new plugs and apply thin coat of sealant to plug circumference.

22. Install new gasket and transfer pump to side of pump housing. Secure with three mounting nuts and lock washers.

GOVERNOR REASSEMBLY

1. Install reconditioned flyweight assembly to camshaft (Figure 65). Install spacer shim and secure to camshaft with slotted cylindrical nut. Use SE-2344 and SE-2339 rebuild tools Torque nut to specifications.

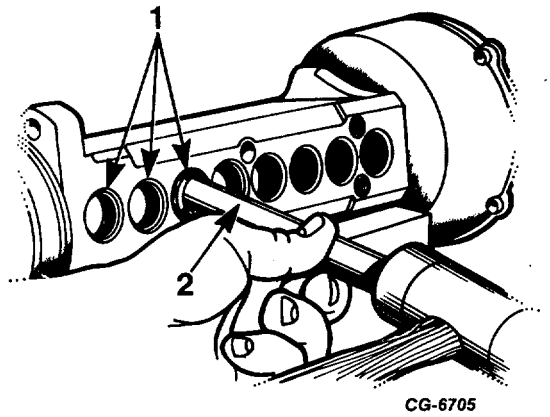


Figure 64. Installing Base Plugs
1. Base Plugs 2. Wood Dowel

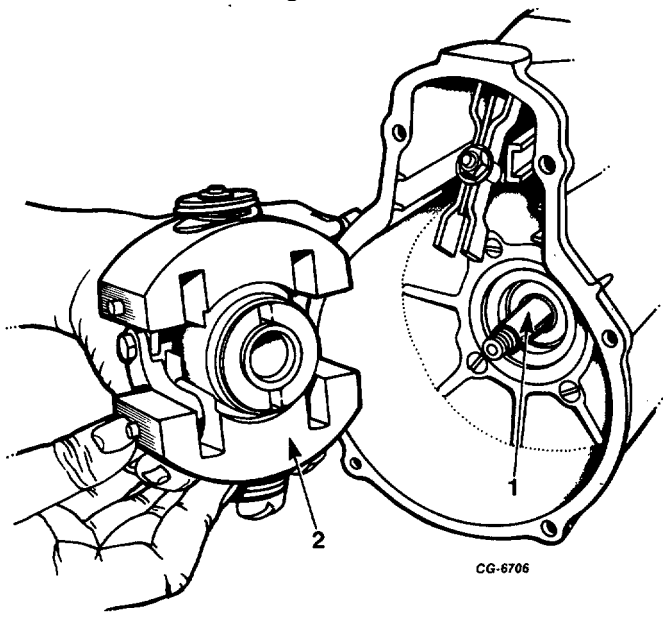


Figure 65. Installing Flyweight Assembly
1. Camshaft 2. Flyweight Assembly

2. Check action of damper by holding camshaft, grasping weight assembly and twisting to note for slight movement. Use thicker spacer shim to obtain more movement or thinner shim to decrease movement. (varying spacer shim increases or decreases pressure on damper). Purpose of damper is to dampen out injection impulses from governor weights.

3. Install adjusting pin guide bushing; secure bushing with two cap screws, lock screws in place with lock plate tabs.

4. Install adjusting pin assembly; temporarily secure with thru-bolt at this time, since another measurement will be made later in procedure.

5. Install slider and floating lever open slot of floating lever to right. Pin floating lever to rack link to hold in place.

6. Measure "slider-to-housing" distance (Figure 66). This is made by measuring from back of slider to governor mating surface (no gasket) 38.8 mm (1.524"+ .015"). Change distance by turning screw inside of adjusting pin. One-half turn of adjusting screw moves sliding block approximately .5mm (.020"). Back screw out to increase distance or turn screw in to decrease distance.

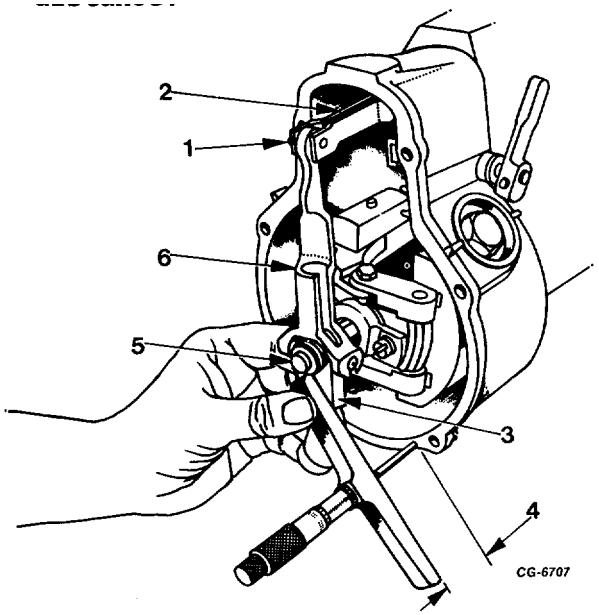


Figure 66. Measuring Slider-to-Housing Distance
1. Pin 4. Slider to Housing Distance
2. Rack Link 5. Adjusting Pin
3. Slider 6. Floating Lever

7. Secure double-nutted thru-bolt in governor weight assembly by installing lock washer and nut. Bend over tabs of lock washer to secure. Operate rack back and forth to recheck all linkage for free movement.

   Remove seal cover from hi-idle adjusting screw locknut on governor cover and back out hi-idle adjusting screw. Hi-idle screw is removed so that control lever can be moved full forward for making next check.

   Measure "basic setting of S-plate (Figure 67). This is measured from governor cover surface (gasket in place) to guide pin shaft when guide pin is in maximum fuel position and bottomed in S-plate. Basic setting is 21.5-21.9mm (.847"-.863").

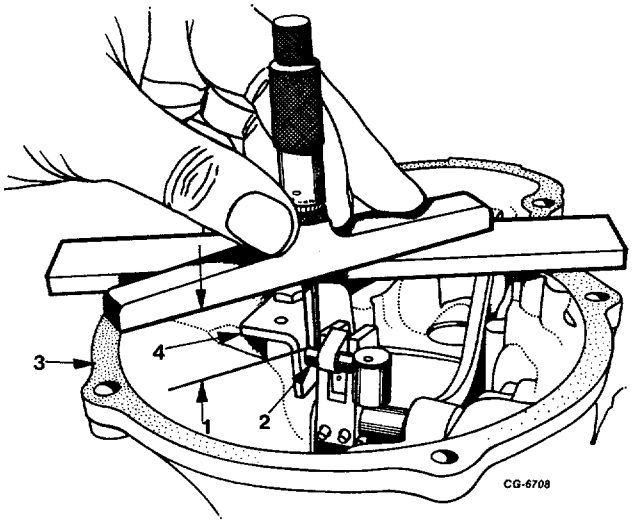


Figure 67. Measuring S-Plate Basic Setting

1. Basic Setting
2. Guide Pin
3. Gasket
4. Curve Plate

8. Add shims under S-plate mounting to decrease basic setting or remove shims to increase basic setting (Figure 68). Check for free travel of guide pin shaft in S-plate after resetting. Check to be sure cotter pin has been used to secure pin between rack link and floating lever.

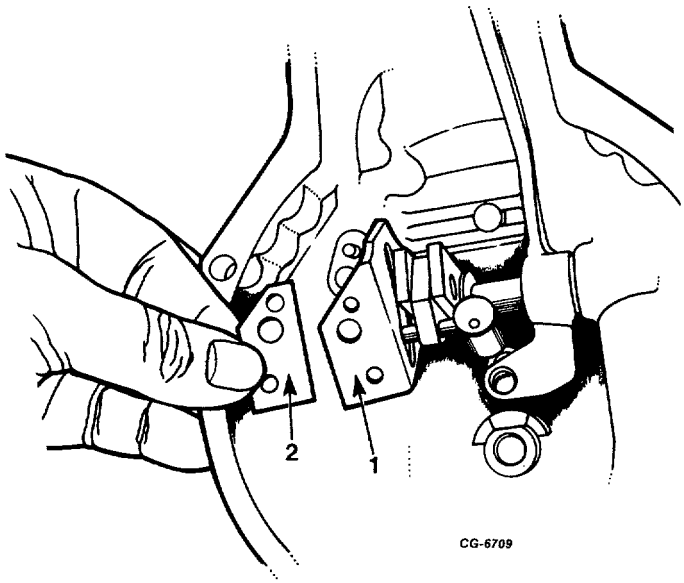


Figure 68. Locating for S-Plate Shim Adjustment
1. S-Plate
2. Shim

9. Install governor cover to housing. When installing, apply small dab of lube to floating block to hold hollow end up and note that floating block enters floating lever. Operate control lever to facilitate installation. Secure cover with six cover screws.

10. Install guide bolt in rear of governor cover. Apply non-hardening sealing compound to threads before installing.

11. If governor control lever and/or accelerator lever assembly were removed, reinstall at this time as follows:

    a. Install woodruff key and governor control lever on shaft and tighten securely.

    b. Install accelerator lever assembly on shaft (Figure 69) and tighten securely.

12. Position control lever fully back against lo-idle stop screw.

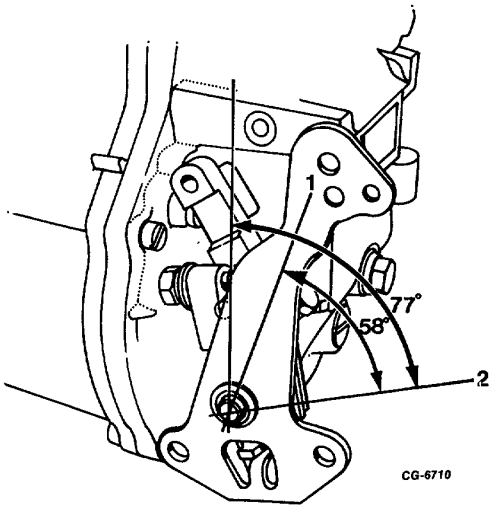


Figure 69. Location for Accelerator Lever Assembly
1. Full Load Position
2. Low Idle Position

13. Insert control rack stop assembly (with stop shackle) into governor housing. Rotate rack stop assembly approximately 45 degrees in the counterclockwise direction (from installed position). Slide rack stop assembly into governor housing until stop shackle clears governor floating lever, then rotate rack stop assembly 45 degrees clockwise to the horizontal position.

14. Move control lever to the vertical position.

15. Using a hook made from light wire, reach down through adjustment access hole and lift stop shackle up to engage slot in stop shackle with rocker arm pin. (See Figure 70). In some cases, it may be easier to lift stop shackle with hook engaged at rear of mating flange or in slot of stop shackle.

    NOTE: To ease this operation, interior of governor housing can be lighted by removing seal wire and plug from governor adjustment access cover on side of governor housing and inserting penlight through access hole.

16. After stop shackle is engaged with rocker arm pin (Step 15), push rack stop assembly into position against governor housing and secure with two mounting screws.

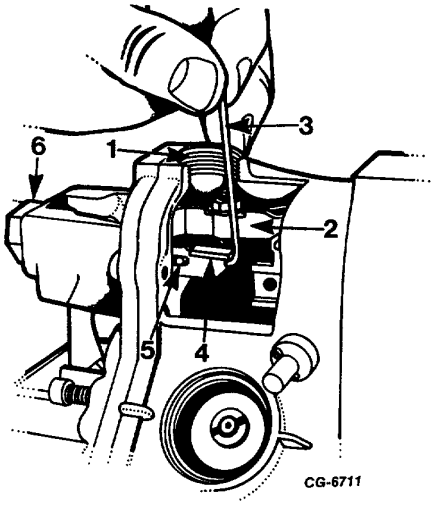


Figure 70. Engaging Stop Shackle to Rocker Arm Pin (Governor Housing Cut Away for Illustration.)
1. Adjustment Access Hole
2. Rack Link
3. Wire Hook
4. Stop Shackle
5. Rocker Arm Pin
6. Rack Stop Assembly

Check rack stop assembly as follows:

a. Hold accelerator lever fully forward. This should place rack in excess fuel (starting) position with adjustment screw of rack link resting on top of mating flange on stop shackle. (See Figure 71).

b. Slowly move fuel shut-off lever to rear. If installation is correct, a distinct "click" will be heard as rack moves back from excess fuel position and adjustment screw on rack link engages with rear edge of mating flange on stop shackle. (See Figure 72)

c. If correct positions of parts (steps a and b) cannot be obtained ("click" is not heard), check for proper engagement of slot in stop shackle to rocker arm pin. If necessary, loosen rack stop assembly mounting screws and connect stop shackle to rocker arm pin per Step 15.

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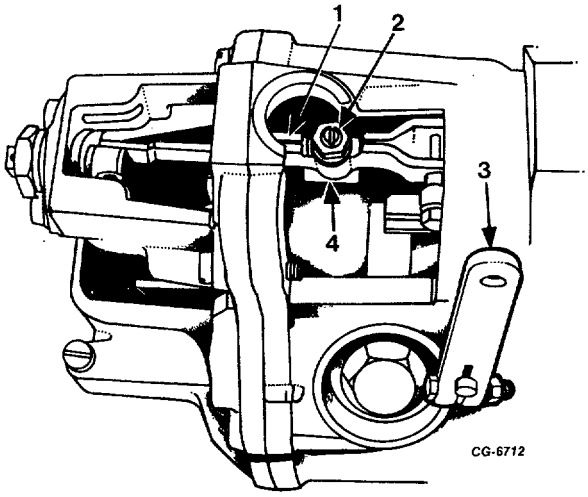


Figure 71. Rack Link and Stop Shackle in Excess Fuel (Starting) Position (Governor Housing Cut Away for Illustration)

1. Rack Link
2. Adjustment Screw Resting on Top of Mating Flange
3. Shut-Off Lever
4. Stop Shackle

NOTE: Confirmation of rack positions can be made by removing plug from front (drive end) of pump housing and observing end of rack. At maximum position, rack should extend approximately 9.5 mm (.375") forward of threaded guide bushing on front of pump housing. At full load fuel position, end of rack should lie approximately 3.2 mm (.125") inside of threaded guide bushing on pump housing. (See Figure 73).

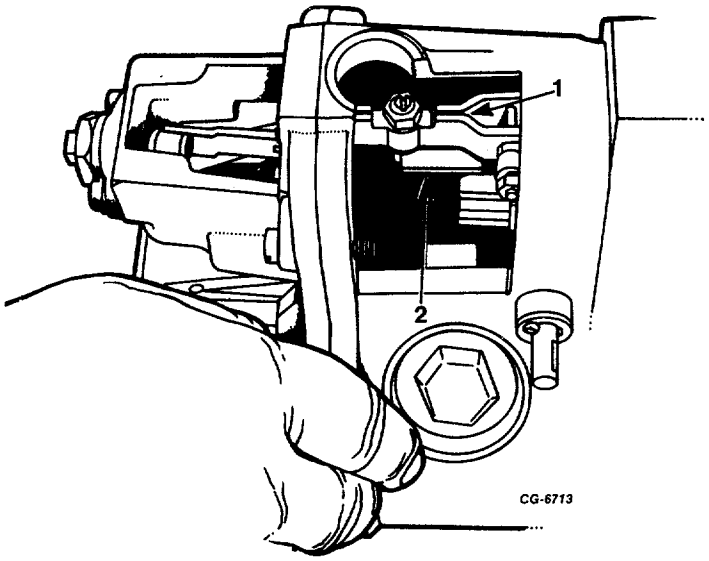


Figure 72. Rack Link and Stop Shackle in Full Load Fuel Position (Governor Housing Cut Away for Illustration)

1. Rack Link
2. Stop Shackle

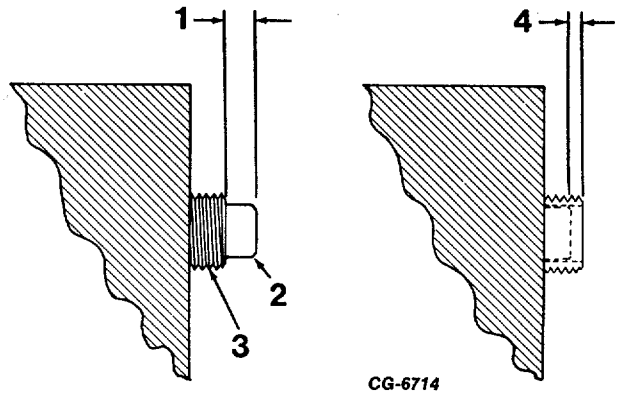


Figure 73. Rack Positions for Confirming Proper Stop Shackle Installation

1. Rack in Maximum Position
2. Rack
3. Guide Bushing
4. Rack Position, Inside of Guide Bushing

Further reassembly including side cover plate, hi-idle adjusting screw and miscellaneous locks, seals, etc. cannot be completed until after pump is calibrated.

Pump is now ready for mounting to calibrating stand.

INJECTION PUMP CALIBRATION

Following injection pump or governor service and overhaul, the pump must be recalibrated to establish correct internal timing, fuel delivery and governor operation. It is also recommended that pump calibration be checked on a calibrating stand anytime the injection pump is removed to perform engine service operations.

IMPORTANT

For proper injection pump operation it is necessary that calibration and adjustment checks are performed in sequence, as outlined in this section.

Calibrating Stand

Calibrating stands SE-2414 (5.59 kW/ 7.5 hp) or SE-2333 (5.59 kW/7.5 hp) are recommended. Other stands can be used providing they can be adapted accordingly. (Calibrating stand SE-2414 is shown in Figure 74)

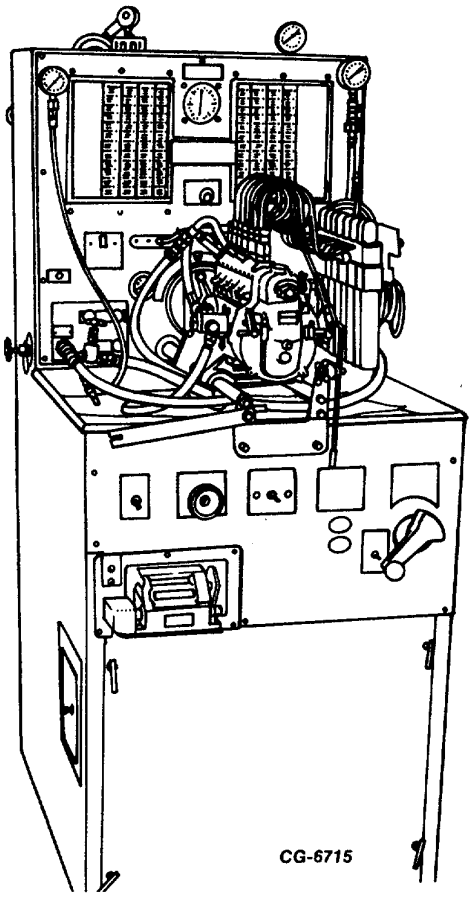


Figure 74. Injection Pump Calibrating Stand (SE-2414)

Accessory set SE-2415 (Figure 75) and SE-2415-4 are required to adapt calibrating stands SE-2414 or SE-2333 for testing the model PES8A95 injection pump and RQV governor

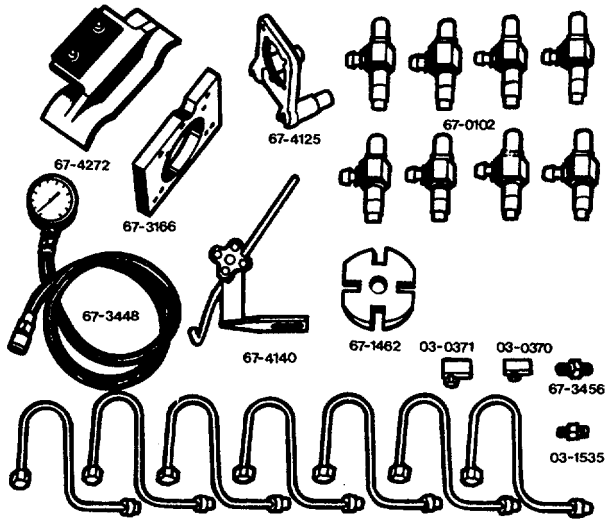


Figure 75. Calibrating Stand Accessory Set (SE-2415)

Legend for Figure 75

Code No.	Quantity	Description
67-4272	1	Bracket, flange mtg.
67-3166	1	Plate, adapter
67-4125	1	Bracket, support
67-0102	1	Test nozzle set
67-3448	1	Gauge (0-100 psi.)
67-4140	1	Throttle positioner
67-1462	1	Disc, drive
67-0100	8	Tubes, bleed off
03-0371	1	Elbow
03-0370	1	Elbow
67-3456	1	Fitting, disconnect
67-5650	8	Fuel lines (SE-2415-4)
03-1535	1	Connector

Additional items required for mounting the injection pump on the calibrating stand are (1) transfer pump-to-injection pump fuel line and fittings made locally and (2) modified injection pump-to-engine adapter (IH part number 391983-C1) and (3) injection pump coupling IH Part number 406419C91.

Calibrating Stand Maintenance

The calibrating stand must be kept in good operating condition. Maintenance checks and lubrication of test stand components must be performed periodically to assure satisfactory results.

Calibrating oil must be of the specified type. Calibrating oil and filters must be changed regularly. Transfer pump must maintain minimum specified pressure since injection pump calibration depends upon correct calibrating oil pressure.

To assure uniform delivery, calibrating stand test nozzles should be tested for balance (equal delivery) every six months or whenever 200 pumps have been tested. The method for balancing the test nozzles is as follows:

a. Adjust all test nozzles to specified test nozzle opening pressure. (See CALIBRATING CHART.)

b. Install an injection pump on calibrating stand.

c. Perform the "Maximum Fuel Delivery Check" and record amount of fuel obtained from No. 1 pumping element.

d. Install each of the remaining test nozzles in the No. 1 nozzle position and note delivery from each nozzle. If necessary, adjust nozzle opening pressure to obtain same flow as recorded for nozzle No. 1 (Step c.). Nozzles must be balanced to within 0.5 cm3 per 1000 strokes.

e. After nozzle balance (uniform delivery) has been obtained, recheck opening pressure of all nozzles. If nozzle opening pressure is not within specified limits, nozzle should be repaired or replaced.

Mounting Pump On Calibrating Stand

Before mounting injection pump on calibrating stand, make sure pump can be rotated. This is especially important where pump has been overhauled, tappets replaced, etc. Tappet adjustment could be so high that control tangs on plunger will hit bottom of barrel.

a. Assemble flange mounting bracket and support bracket from accessory set to rails of calibrating stand.

b. Install pump-to-engine adapter on pump housing. Assemble adapter plate from accessory set to adapter on pump housing.

c. Place drive disc from accessory set on tangs of pump drive coupling.

d. Mount injection pump assembly on mounting brackets. Rotate test stand drive to align tangs on drive coupling with slots in drive disc. Slide pump forward to engage drive tangs. Bolt adapter flange to flange mounting bracket, see Figure 76. After pump is mounted, rotate test stand and pump two or three revolutions by hand to check for binding.

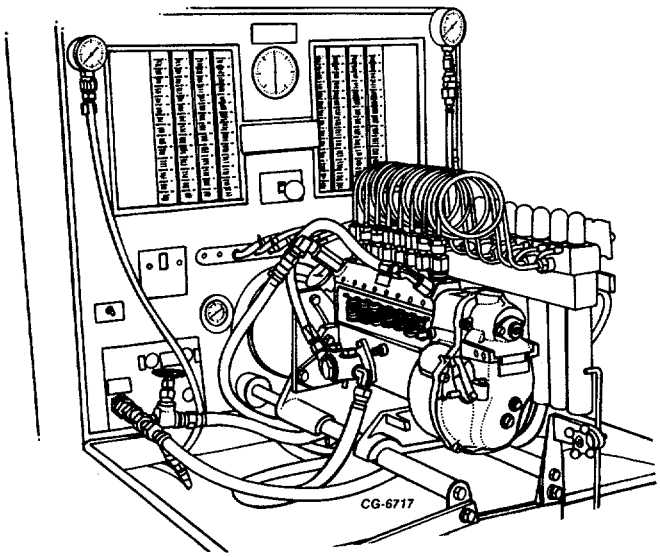


Figure 76. Injection Pump Mounted in Calibrating Stand

e. Attach supply and return (low pressure) lines between injection pump and calibrating stand (Figure 77). If possible use transparent hoses for both inlet and return lines so that condition of oil can be observed as it flows through pump. This will assure operator that pump is receiving a solid charge of calibrating oil.

f. Prelubricate injection pump assembly by pouring 59.2cc (2 oz.) of engine oil over tappets and 240.Occ (8 oz.) into governor housing.

1. Install Dial Indicator

Remove rack end cap from front of pump and install rack gauge (dial indicator SE-2121) as shown in Figure 78. Zero dial indicator as follows:

a. Loosen mounting bolts of external rack stop bracket and remove bracket.

b. Use a pull back spring to hold fuel shut off lever to rear holding rack back against internal rack stop.

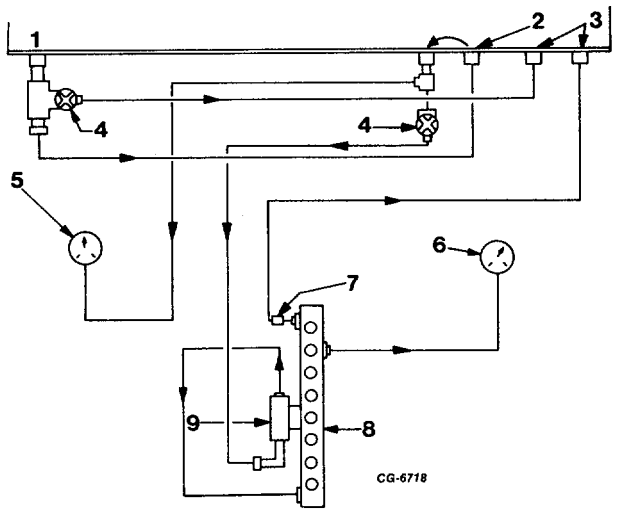


Figure 77. Calibrating Stand Low Pressure Plumbing

1. Inlet
2. Final Filter
3. Outlet
4. Valve
5. Supply Pressure Gauge
6. Transfer Pressure Gauge
7. Pressure Regulator Valve
8. Injection Pump
9. Transfer Pump

c. Zero dial indicator and secure in position.

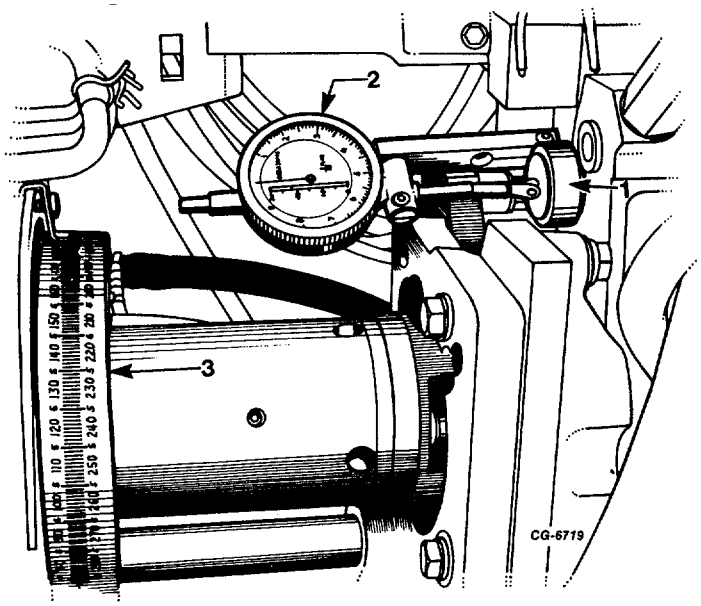


Figure 78. Installing Rack Gauge (Dial Indicator)

1. Rack Gauge Holder SE-2119
2. Dial Indicator SE-2121
3. Degree Wheel Index

Establishing Initial Plunger Lift (Pre-Stroke)
For No. 1 Pumping Element

a. Remove delivery valve holder, filler, spring, gasket and delivery valve assembly from No. 1 pumping element.

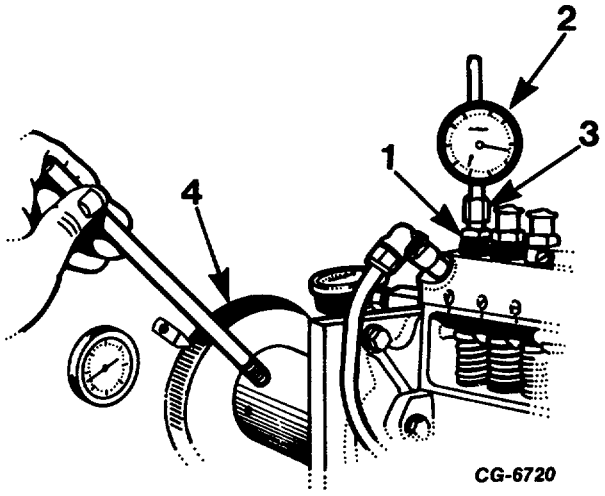


Figure 79. Establishing Initial Plunger Lift (No. 1 Pumping Element)

1. Delivery Valve Holder (Modified Locally)
2. Dial Indicator SE-2121
3. Fuel Line Nut (Modified Locally)
4. Degree Wheel Index

Install dial indicator holder and SE-2121 indicator with 4.45 cm (1-3/4") stem extension in No. 1 bore (Figure 79). Extension should bear on top of plunger.

A satisfactory indicator holder can be made locally from an extra delivery valve holder (IH number 1700575Cl), a nut from injection line and an O-ring gasket to fit threaded bore of line nut. Drill a 8.Omm (5/16") diameter hole in delivery valve holder to receive indicator stem extension. Also drill a 9.5mm (3/8") diameter hole in line fitting nut to receive indicator shank. To assure tight grip on indicator, use two O-rings or countersink holder 6.5mm (1/4") with 9.5fnm (3/8") drill. When installing indicator, torque indicator holder into pump 29.8-33.9 N-m (22-25 lb. ft.) to prevent barrel from loosening.

c. Place control rack in start fuel position as follows:
   1. Move control lever fully forward.

d. Move control lever forward until rack dial indicator reads 17.2-17.5mm (.677" .689") and secure lever. (Start fuel position)

e. Bar calibrating stand over by hand to rotate pump camshaft in normal direction of rotation(clockwise as viewed from drive end of pump) until No. 1 plunger is at bottom dead center (base circle of cam). Zero prestroke dial indicator.

f. Continue barring calibrating stand in direction of normal pump rotation until dial indicator reads specified plunger lift of 2.6mm (.102 inch).

g. Set calibrating stand degree wheel at zero.

h. Remove prestroke dial indicator and holder and reinstall delivery valve seat (without needle), gasket and delivery valve holder (without spring and filler) in No. 1 pumping element.

2. Phasing the Pump (Low Pressure Method)

This is an actual fuel flow test performed on the injection pump to establish the precise start of injection for each of the eight plungers in firing order.

Check start of delivery (port closing) on No. 1 element as follows:

a. With rack at Start Fuel position and with delivery valve needle, spring and filler removed from No. 1 element, install drip spout (made from used injection line) in No. 1 pumping element (Figure 80).

NOTE: Where high pressure delivery equipment available on calibrating stand, the de livery valves do not have to be removed.

b. Install fuel supply and return lines to pump and turn on test stand fuel. supply. Adjust supply pressure to obtain 35 kPa (5 psi) at fuel gallery. Check at Bleeder Valve port on right front corner of pump housing.

c. Turn pump camshaft (clockwise as viewed from drive end) until fuel flows freely from drip spout. Continue to rotate camshaft clockwise

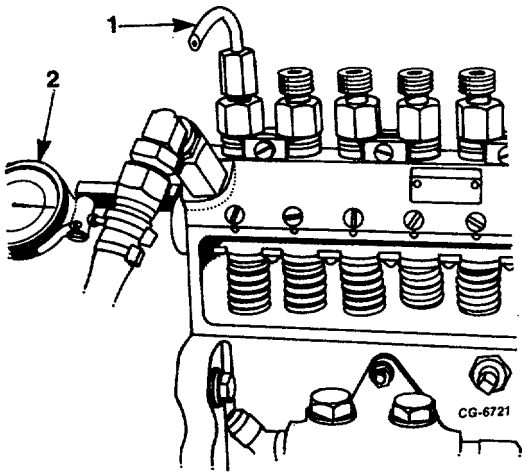


Figure 80. Checking Start of Delivery (No. 1 Pumping Element)

1. Drip Spout 2. Rack Gauge

slowly until fuel flow from drip spout decreases to one drop every 3 to 5 seconds. (This indicates port closing or start of delivery for No. 1 element.)

d. If port closure or start of delivery does not occur at the degree wheel zero mark, adjust tappet screw so that port closing of No. 1 element and zero mark on degree wheel will coincide.

Using tappet adjusting wrenches (SE-2347) adjust tappet setting as follows: (Figure 81)

If port closing occurs before degree wheel zero mark, loosen locknut and turn tappet screw "in". If port closing occurs after zero, turn tappet screw "out". One flat of tappet screw equals approximately 2 degrees travel at degree wheel. Tighten locknut and repeat test after adjustment.

e. Turn off test stand fuel flow; remove drip spout and reinstall delivery valve. needle, spring, filler and delivery valve holder to No. 1 element.

f. Remove delivery valve needle, spring and filler from No. 8 element and install drip spout.

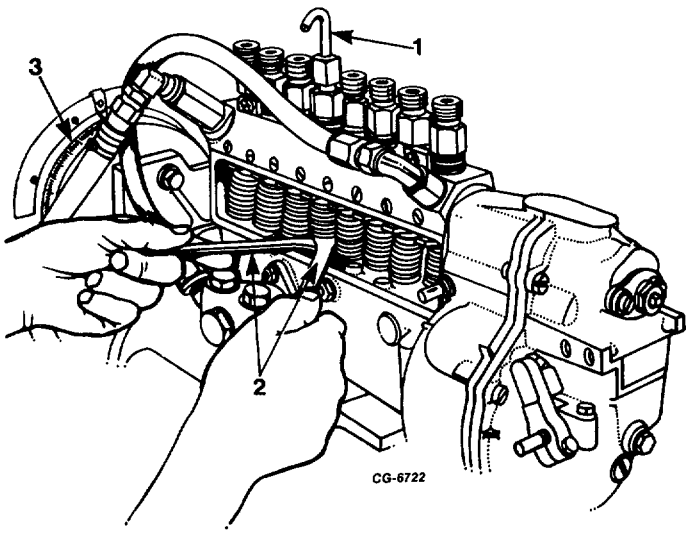


Figure 81. Adjusting Tappet Setting

1. Drip Spout
2. Tappet Adjusting Wrenches (SE-2347)
3. Degree Wheel

g. Turn test stand fuel on. Fuel should now flow from drip spout in No. 8 element.

h. Turn pump camshaft clockwise by hand and watch for port closing or start of delivery for No. 8 element (as indicated at drip spout) when camshaft has been turned to 45 degree mark. If it doesn't, tappet screw must be adjusted per step "d".

If port closing occurs early, turn tappet adjusting screw into roller tappet; if port closing occurs late, turn tappet adjusting screw "out".

i. Continuing in firing order, go on to No. 7 element and remaining elements in 45 degree increments on degree wheel and repeat the steps as covered above for No. 8 element. When all 8 elements have been similarly checked, the pump can be considered in phase.

3. Pump-to-Calibrating Stand Installation Check

When all phasing and tappet setting has been completed and delivery valve assemblies, gaskets, springs, filters and delivery valve holders have been reinstalled and properly torqued, the pump can now be made ready for the operating tests (Figure 82).

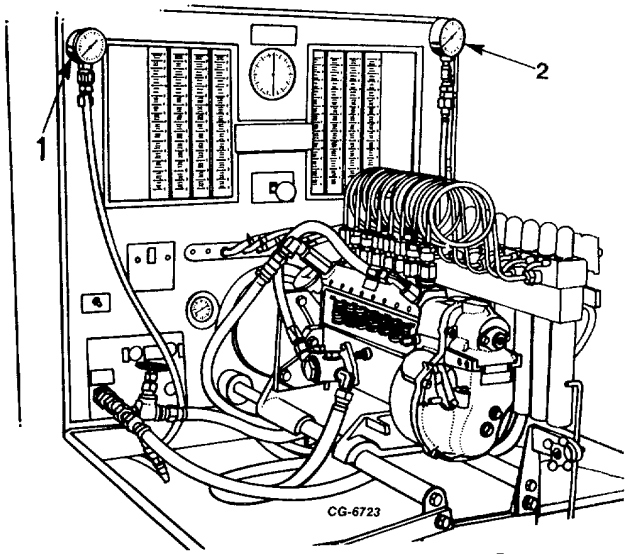


Figure 82. Calibration Stand and Injection Pump Ready for Operation

1. Supply Pressure Gauge
2. Transfer Pressure Gauge

a. When sure test stand nozzles are set for correct opening pressure, install injection lines from accessory kit between injection pump and test nozzles and connect fuel supply lines.

b. Check governor assembly for correct installation of rack stop shackle as follows:

1. Place control lever in full forward position and lock in place.

2. Pull shutoff lever slowly to rear until click is heard. NOTE: Click indicates that rack link adjustment screw has engaged with stop shackle. If click is not heard, observe rack gauge for visible evidence of rack engagement.

3. Recheck rack stop shackle installation if rack is not engaged.

c. Start drive motor and operate stand at 1400 RPM.

d. Note that fuel is injecting to all eight injection assemblies.

e. Note that transfer pressure gauge shows gallery pressure being maintained to specifications. If not, check and correct as needed

f. Should no adjustment be necessary, proceed to next step.

4. Check Governor Preliminary Cut-Off (Governor Internal Adjustment)

With control lever assembly in full forward position and hi-idle stop screw removed, rack position should be 20.021.0mm (.787" .827") as shown on dial indicator prior to start.

Operate calibrating stand at 1420 RPM and observe rack position. Rack position should be 15.2 17.8mm (.599" .700") as shown on dial indicator.

If preliminary governor cut off does not come into effect within specifications, corrective adjustments inside governor housing are made as follows:

a. Remove seal wire and governor access plug from side of governor housing.

b. Check control rack and governor assembly for binding and correct if needed.

c. Adjust cutoff by increasing or decreasing pre-tension of governor weight springs. Use SE-2348 governor spring adjusting wrench on cylindrical nut to make this adjustment (Figure 83).

To raise governor cutoff, pre-tension is increased; to lower governor cutoff, pre-tension is decreased. “Cam" nut is self-locking but must be turned in 1/2 turns to assure its being in locked position. Preload of governor springs should range from 2 to 3 halve (1/2) turns (clicks) from flush on each side. Alter preload range as required.

d. Spring set may be one-half turn out of balance with opposite set if necessary to obtain desired governor cutoff.

e. If specified governor cutoff can not be obtained by adjusting preload, remove adjusting nut, spring seat and intermediate spring. Add or remove intermediate spring shims on both sides to achieve specified control rack position and recheck.

f. If specified governor cutoff cannot be obtained by steps c, d or e, recheck "slider to housing" and "Splate" basic dimensions.

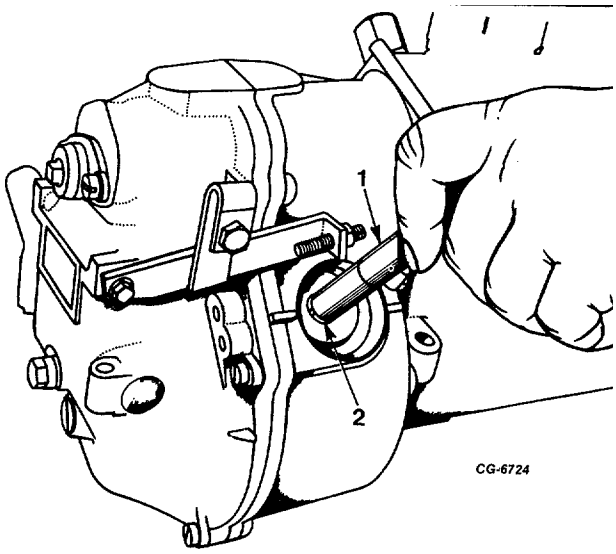


Figure 83. Making Preliminary Governor Cut Off Adjustment

1. Adjusting Wrench SE-2348
2. Governor Cut-Off Adjusting Nut

5. Check Governor Cut-Off (Governor External Adjustment)

Install hi-idle stop screw and operate test stand, with control lever assembly in full load position (fully forward), at 1450-1460 RPM. Check rack setting on dial indicator and compare with specifications given on CALIBRATION CHART.

If rack is not positioned within specified limits, make hi-idle adjustments (Figure 84) as follows:

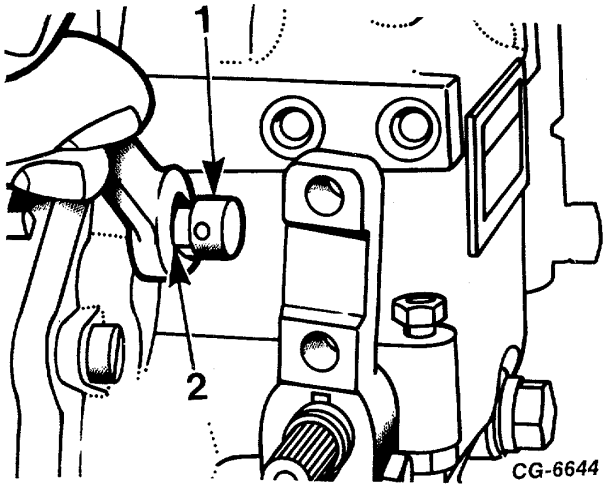


Figure 84. Adjusting Hi-Idle Rack Position
1. Hi-Idle Stop Screw 2. Lock Nut

a. Loosen locknut and turn hi-idle stop screw with wrench counterclockwise to decrease rack dimension, or clockwise to increase rack dimension.

b. Tighten locknut and recheck rack dimension.

6. Governor Performance at No-Load (Hi-Idle) Check

Operate test stand, with control lever assembly in full load position (fully forward), at specified RPM listed on CALIBRATION CHART and observe rack position. Rack position should be 4.0 ñ 0.1mm (.157" ñ .003") as shown on dial indicator.

If specified rack position is unattainable, recheck governor cutoff (internal adjustment)and governor cutoff (external adjustment) calibrations.

7. Governor End Regulation Check

Operate test stand at 1650 RPM with control lever assembly in full load position (fully forward) and observe rack position. Rack position should be 0.1mm (.039") or less.

If specified rack position is unattainable, recheck governor cutoff internal adjustment and governor external adjustment calibrations.

8. Governor Lo-Idle Regulation Check

Operate test stand at 325 RPM with control lever assembly in lo-idle position (fully back). Adjust lo-idle stop screw (Figure 85) to a rack position of 7.0-7.3mm (.275"-.287") as shown on dial indicator.

Increase test stand speed to 820-880 RPM and observe rack position. Rack position should be 2.0 ñ 0.1mm (.078" ñ .004"). If rack is not positioned within limits, make governor adjustments as follows:

a. Remove adjusting nut (count halfturn dicks to flush), spring seat and outer spring. Add or remove outer spring shims to achieve specified control rack position.

b. To increase rack position shims must be added and to decrease rack position shims must be removed. Add or remove same shim pack on both sides.

c. Install outer spring, spring seat, adjusting nut, preload governor springs to initial setting from flush positioh and recheck.

d. If specified rack position cannot be obtained by steps a, b and c, recheck "slider to housing" and "S-plate" basic dimensions.

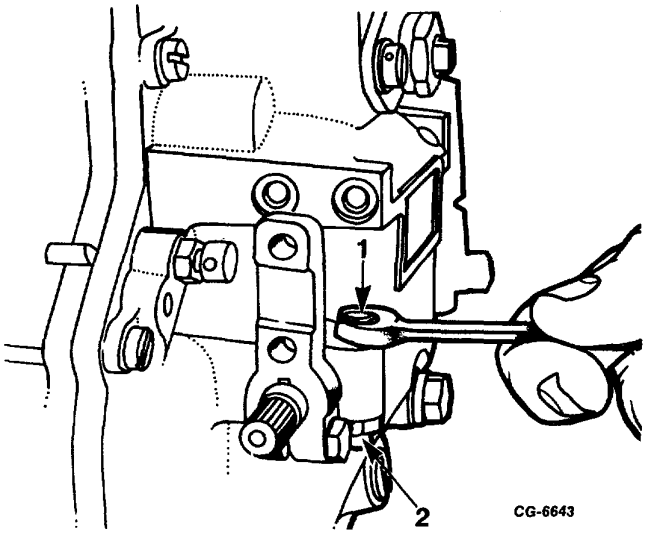


Figure 85. Adjusting Lo-Idle Position

1. Lo-Idle Stop Screw **2. Lock Nut**

9. Lo-Idle Back-Up Check

Operate test stand at 325 RPM with control lever assembly in lo-idle position (fully back). If needed, adjust lo-idle stop screw to a rack position of 7.0-7.3mm (.275"-.287") as shown on dial indicator.

Decrease test stand speed to 100 RPM. Rack position should be 8.9mm (.350") or greater as shown on dial indicator.

If rack is not positioned as specified, repeat governor Lo-Idle Regulation test and recheck Lo-Idle Back-Up.

10. Adjust Full Load Fuel Setting and Balance Delivery

This is an operating test to assure that the injection pump provides the proper quantity of fuel at full load setting and at the same time provides a balanced fuel delivery between pumping elements. Test and adjustment is made as follows:

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a. Operate test stand at 1400 RPM with control lever in full load position (fully forward) and note rack position as shown on dial indicator.

b. Loosen rack stop assembly lock nut (Figure 86) and adjust control rack, with adjusting stud, to specified rack dimension (see CALIBRATION CHART).

c. Operate test stand for fuel delivery at 1400 RPM for 1000 strokes. Read and record flow to each of the eight graduates.

d. If average fuel delivery for all pumping elements and imbalance between individual pumping elements do not meet specifications (see CALIBRATION CHART), adjust affected elements (see Balanced Delivery Adjustment Procedure).

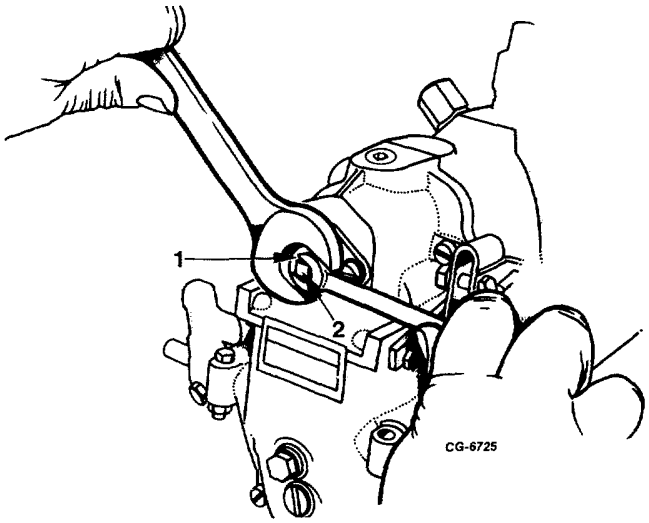


Figure 86. Adjusting Full Load Fuel Setting

1. Lock Nut **2. Adjusting Stud**

Balanced Delivery Adjustment Procedure

If fuel flow of one or more pumping elements are not within specified balance limits given on CALIBRATION CHART, adjust affected elements as follows: (See Figure 87).

a. Loosen clamping screw of toothed quadrant.

b. Turn control sleeve and plunger with awl or small hex-key wrench.

c. To increase flow from element, turn control sleeve to rear (counterclock wise).

d. After checking balance and setting delivery quantity, the clamping screw of toothed quadrant on each element should be marked with a scribe. Mark each element once.

NOTE: Balance should be maintained to as close a tolerance as is reasonably possible to prevent readjustment in later tests.

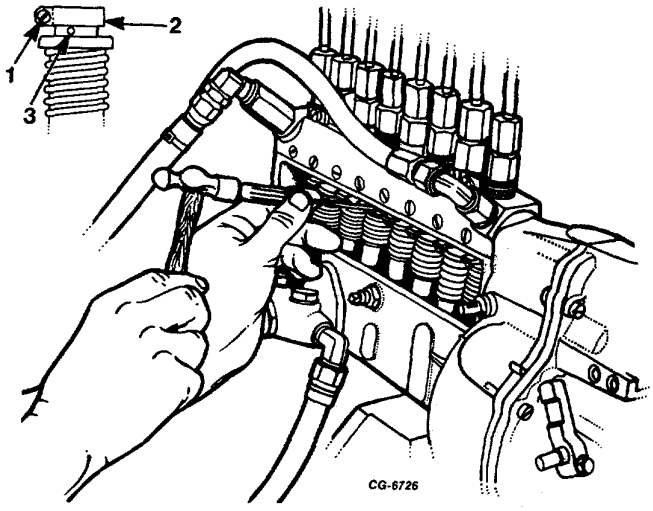


Figure 87. Adjusting for Balanced Delivery

1. Clamping Screw **3. Control Sleeve Indent**
2. Delivery Control Sleeve

11. Fuel Delivery at Lo-Idle Check

This is an operating test to assure that the injection pump provides the proper quantity of fuel at Lo-Idle. Test and adjustment are made as follows:

a. Operate test stand at 325 RPM with control lever in lo-idle position (fully back) for 1000 strokes.

b. Record fuel delivery-from elements and compare results with specifications given on CALIBRATION CHART.

c. Check balanced delivery between pumping elements and compare imbalance with specifications given on CALIBRATION CHART.

d. Adjust fuel delivery and imbalance at control sleeves (see Test 10).

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12. Check Fuel Delivery at 800 RPM

This is an operating test to assure proper pump and governor operation. Perform the test as follows:

a. Operate stand at 800 RPM with control lever locked in full load (fully forward) position for 1000 strokes.

b. Record Fuel delivery from elements and check for balanced delivery between pumping elements and compare with specifications given on CALIBRATION CHART.

c. If fuel delivery exceeds maximum specification, governor and/or injection pump is malfunctioning. Repair as required.

13. Check Fuel Shut-Off

This adjustment is made to protect pump internal stop and rack from damage. Adjustment is made by loosening stop bracket against which shut-off lever will strike (Figure 88). Operate shut-off lever to rear and hold in this position (rack against internal stop). Reposition external stop lever bracket so that shutoff lever will contact bracket stop screw just before rack would be stopped by the internal stop. Rack setting (dial indicator reading) with rack against external stop should be between 0.5 to 1mm (.020"-.040").

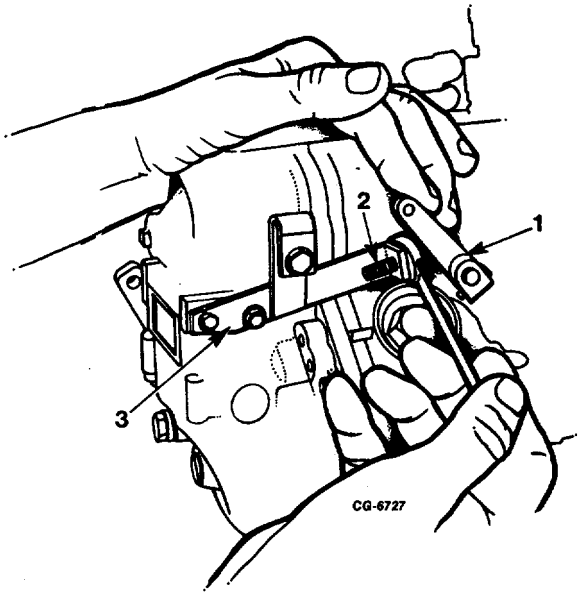


Figure 88. Adjusting External Stop Bracket

1. Shut-Off Lever **3. Stop Bracket**
2. Stop Screw

14. Check Start Fuel Cut-Out

This is an operating test made to assure that control rack will move from start fuel to full load fuel position at specified pump speed. Adjustment is made by varying the height of the rack link adjustment screw.

Increase test stand speed slowly from 50 RPM and simultaneously operate control lever between lo-idle and hi-idle stops until cut-out occurs and observe test stand speed. Test stand speed should be between 205-265 RPM.

If specified test speed is not obtained, reposition rack link adjusting screw height as follows: (See Figure 89)

a. Using 10mm Allen wrench, remove plug from adjustment access hole in top of governor housing.

b. Loosen adjusting screw locknut (10mm).

c. If cut-out occurred below specified speed, turn adjusting screw counterclockwise and if cut-out occurred above specified speed turn adjusting screw clockwise.

d. Tighten adjusting screw locknut and repeat test.

e. Reinstall plug in adjustment access hole.

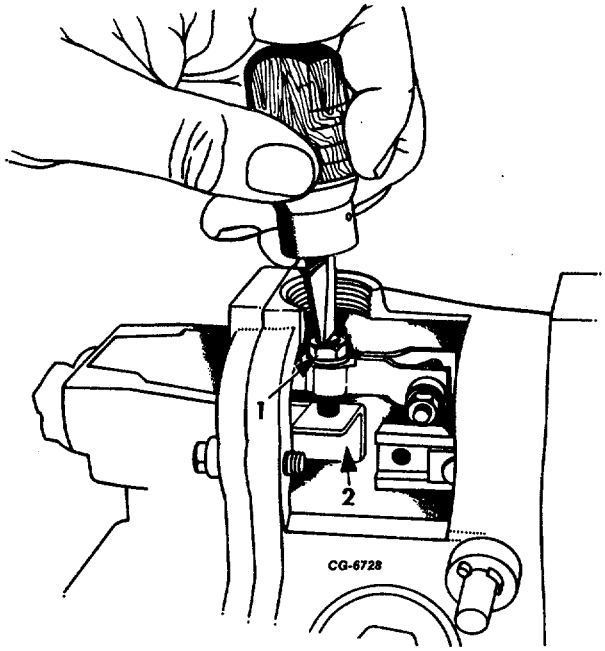


Figure 89. Adjusting Excess Fuel Rack Position (Governor Housing Cut Away for Illustration)

1. Adjustment Screw **2. Stop Shackle**

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15. Check Start Fuel Quantity

This is an operating test made to assure that the injection pump provides the proper quantity of fuel to start the engine. Test is made as follows:

a. Remove dial indicator from injection pump and install rack end cap.

b. Operate test stand at 100 RPM with control lever locked in start position (fully forward) for 1000 strokes.

c. Record fuel delivery from elements and compare with specifications given on CALIBRATION CHART.

d. If fuel delivery does not meet minimum specifications, remove shim(s) from under screw head located at the end of control rack. If fuel delivery exceeds maximum specification, add shim(s) under screw head.

e. Install rack end cap and recheck fuel delivery.

16. Pump Static Timing Check (Drip Spout Method)

The static timing check is made to assure precise positioning of the timing scribed line on the pump drive hub in relation to timing pointer in adapter housing. This check is made at port closing or start of delivery on No. 1 pumping element.

Check timing as follows:

a. Install side cover with new gasket. Remove injection pump from test stand.

b. Remove test stand drive hub from injection pump.

c. Install injection pump adapter housing with 2 bolts on right side of pump, place pump in holding fixture and clamp in vise. Remove adapter housing sight plug.

d. Install woodruff key, drive hub and nut. Torque nut to specification.

e. Remove delivery valve needle, and filler from No. 1 pumping element and install drip spout. Make drip spout locally from extra injection line and connector nut. Place a paper cup under drip spout to collect fuel flow from spout (Figure 90).

f. Install adapter hose with small fuel container to fuel inlet and charge pump fuel gallery. (Figure 90).

g Move control lever to full load (fully forward) position and lock in place. Slowly move shut-off lever to rear. A distinct "Click" will be heard as the rack moves from the start fuel to the full load position.

Lock control lever in full load position.

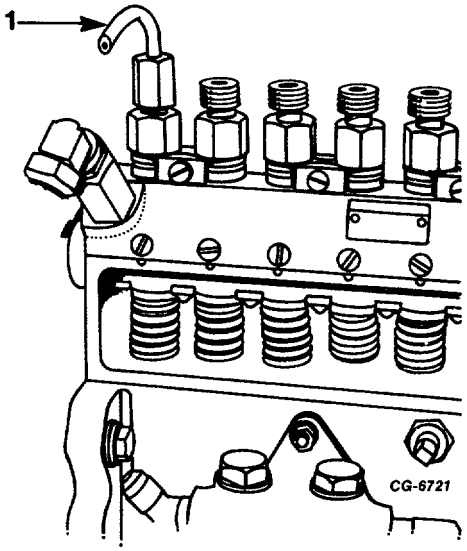


Figure 90. Checking Pump Timing

1. Drip Spout (Made Locally)

h. Rotate drive hub clockwise until fuel flow is reduced to drip at the rate of one drop every 3 to 5 seconds. This indicates port closure or start of delivery for No. 1 pumping element. Check through sight hole and verify that timing pointer lines up with scribed line on hub (Figure 91). If new hub was installed, line should be scribed on hub at this time.

SEAL AND PROTECT PUMP

When injection pump overhaul and calibration have been completed, always perform the following:

1. Inspect pump for fuel and lube oil leaks and correct as necessary.

2. Be sure access plug in governor housing is tight and all other covers are in place.

3. Install anti tamper seals on governor as required.

4. Install protective closures on both high and low pressure fuel and lube oil openings.

5. Install delivery valve retainer clamps.

6. Remove pump from holding fixture and install remaining bolts in adapter housing.

   Pump is now ready for installation on engine.

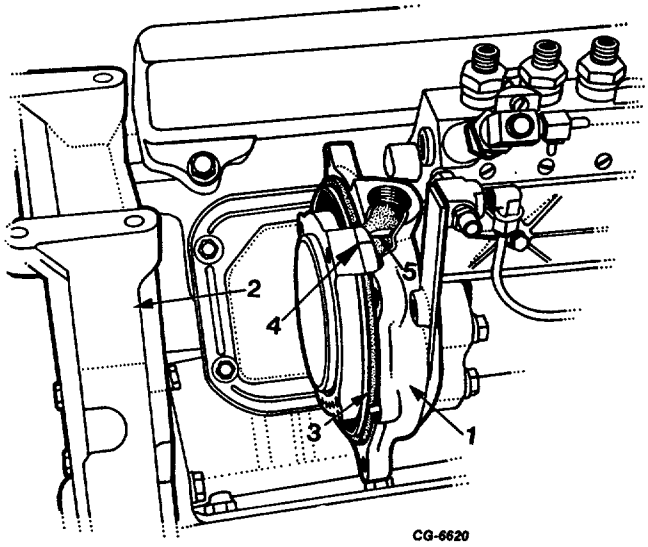
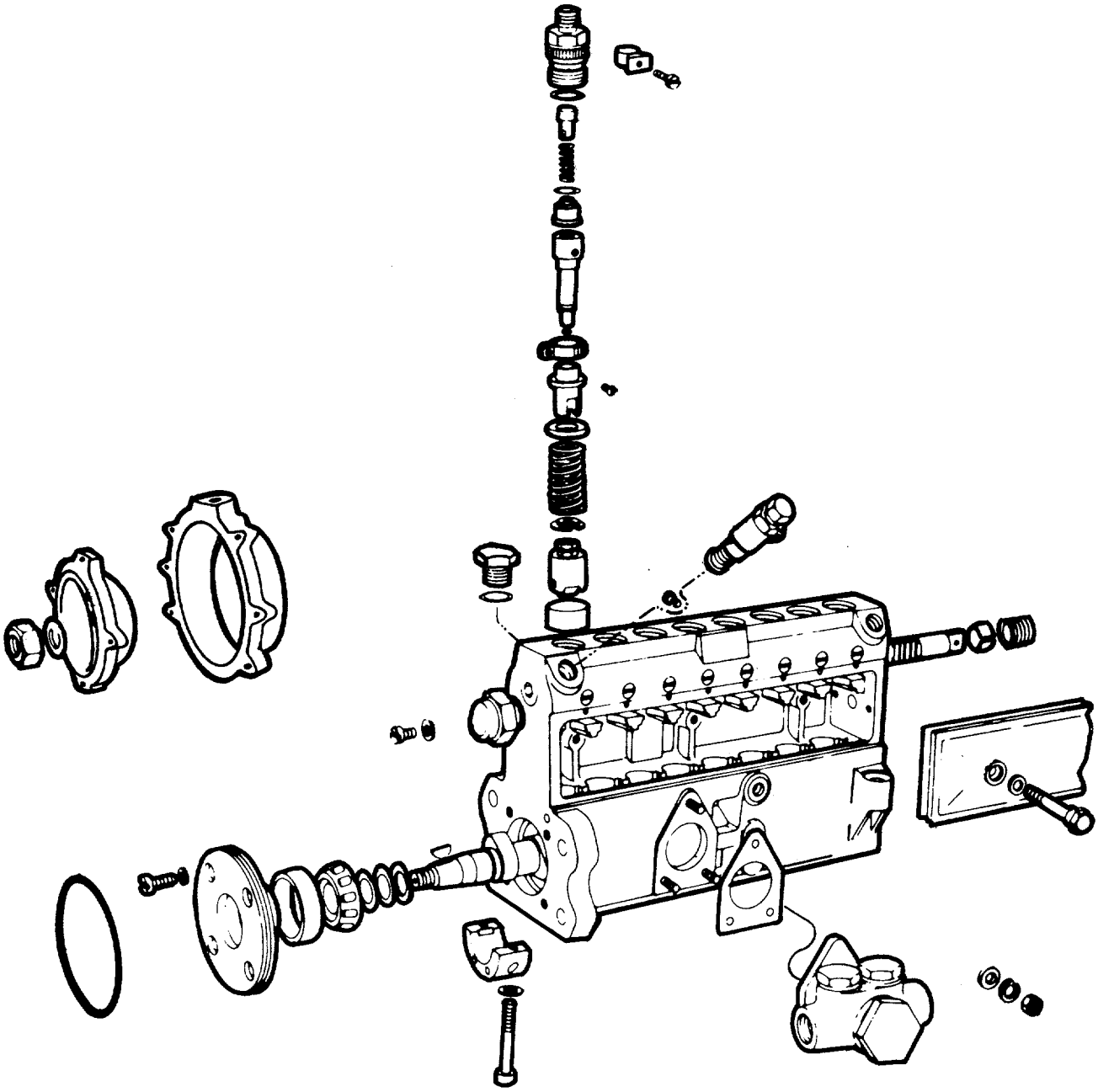


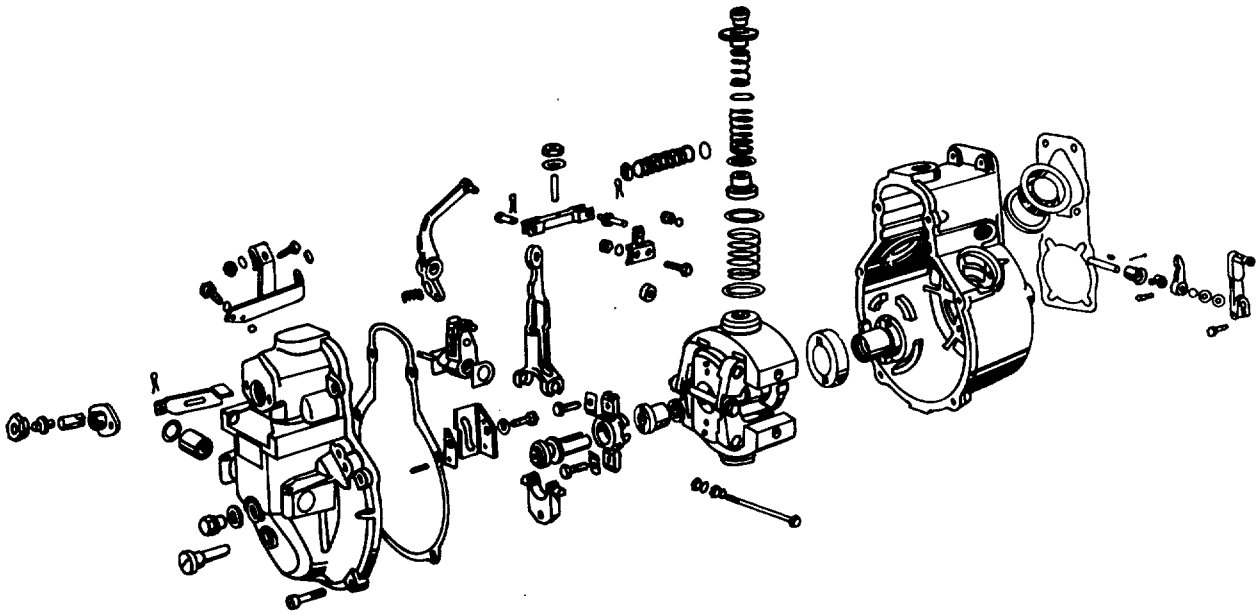
Figure 91. Timing Marks on Pump

1. Injection Pump Adapter
2. Engine Front Cover
3. Gasket
4. Scribed Line On Hub
5. Pointer Pin



EXPLODED VIEW OF PUMP

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EXPLODED VIEW OF GOVERNOR

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INJECTION PUMP INSTALLATION

The procedure for reinstalling the injection pump on the engine is outlined below.

Preparation of Engine

Inspect pump mounting flange at rear of engine front cover. Also inspect injection pump stabilizer brackets and drive gear for damage or wear.

Installation Procedure

Secure mounting adapter and injection pump to rear of engine front cover with four mounting bolts.

Install stabilizing brackets to side at rear of pump housing.

Connect low pressure fuel inlet and return lines and lube oil line to injection pump.

Connect high pressure injection lines to injection pump and secure fuel line brackets.

Connect accelerator rod and stop control cable to governor levers.

Install air cleaner or manifold crossover adapter.

Prime fuel system.

Operate engine and check for fuel and lube oil leakage at injection pump.

Detailed installation instructions are covered in Section CGES-205 of the Service Manual.

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TROUBLE SHOOTING GUIDE

FAULT	POSSIBLE CAUSE	REMEDY
Fuel not reaching injection pump. Engine fails to start	Tank empty.	Fill tank.
	Primary or secondary filter plugged.	Replace filters.
	Fuel lines clogged or damaged.	Clean or replace fuel lines.
	Defective pressure regulator valve.	Replace pressure regulator valve.
	Defective transfer pump	Replace transfer pump.
Fuel reaches injection pump but does not inject to nozzle.	One or more injection lines plugged or damaged.	Replace lines.
	Plunger seized or spring broken.	Repair or replace injection pump.
Fuel reaches nozzles but engine fails to start or starts hard.	Cranking speed too slow.	Recharge battery or correct faulty cranking motor system. Lube oil may be too heavy at low temperature.
	Accelerator not in start fuel position.	Correct accelerator linkage.
	Intake air temperature low.	Use starting aids. Check ether device for proper operation. (Check Operators Manual.)
	Improper fuel or water in fuel.	Drain system and pump housing; use specified fuel and prime system.
	Pump out of time with engine Correct timing.	
	Poor compression.	Correct engine as required.
	Worn or scored plungers.	Repair or replace injection pump.
Engine starts and stops.	Water or other contaminants in fuel.	Drain system and pump housing; use specified fuel and prime system.
	Air in fuel.	Prime system.
	Fuel filters clogged.	Replace filters.
	Fuel tank vent plugged.	Clean vent.
	Waxed fuel filters.	Replace filters; use specified fuel.
	Fuel lines clogged or damaged.	Clean or replace fuel lines.

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TROUBLESHOOTING GUIDE
INJECTION PUMP AND FUEL SYSTEM

FAULT	POSSIBLE CAUSE	REMEDY
Erratic engine operation (surging or misfiring).	Improper or contaminated fuel.	Drain system and pump housing; use specified fuel and prime system.
	Low transfer pressure.	Change filters, check for fuel line restriction, replace pressure regulator valve or transfer pump.
	Injection pipes leaking.	Correct leaks.
	Pump out of time.	Correct timing.
	Nozzles faulty.	Repair or replace nozzles.
	One or more injection lines plugged or damaged.	Replace lines.
	Poor compression.	Correct engine as required.
Engine idles poorly.	Improper lo-idle adjustment	Make lo-idle adjustment.
	Water in fuel.	Drain system and pump housing; use new fuel and prime.
	Air in fuel.	Bleed system.
	Accelerator linkage incorrect.	Correct linkage as required.
	Incorrect timing.	Check and correct timing.
	One or more injection lines damaged.	Replace lines.
	Poor compression.	Correct engine as required.
	Defective lo-speed fly-weight spring.	Calibrate injection pump.
	Plungers worn or scored.	Repair or replace injection pump.
Engine has low power but shows no increase in smoke.	Accelerator linkage restricted.	Adjust accelerator linkage.
	Improper hi-idle adjustment.	Make hi-idle adjustment.
	Low transfer pressure	Change filters, check for fuel line restriction, replace pressure regulator valve or transfer pump.
	Loss of one cylinder.	Injection line plugged.
	Faulty maximum fuel setting.	Calibrate injection pump.
	Plungers worn or scored.	Repair or replace Inj. pump.
	Exhaust system restricted.	Check pipe diameter or muffler for damage.

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FAULT	POSSIBLE CAUSE	REMEDY
Engine has low power but shows no increase in smoke. (Continued)	Air cleaner restricted. Service air cleaner if vacuum exceeds specified	Check manifold vacuum. limits.
	Nozzles faulty.	Repair or replace nozzles.
	Pump out of time.	Correct timing.
High smoke-with no loss or with increase in power.	Increase in fuel delivery.	Check nozzles.
	Air cleaner restriction.	Service air cleaner.
Overall poor performance.	General mechanical condition of engine poor.	Correct as required before extensive repair to the fuel system.
High smoke at rapid acceleration.	Governor reaching into start fuel.	Calibrate governor.
Crankcase dilution (fuel in crankcase).	Nozzles faulty. repair or replace.	Check on nozzle tester;
	Transfer pump faulty.	Replace transfer pump.
	Injection pump faulty:	
	a. Incorrect delivery valve holder torque.	Loosen holders and re-torque to specifications.
	b. Worn barrel & plunger.	Replace barrel and plunger.
	c. Leakage past rear fuel gallery plug.	Repair or replace pump housing.
	d. Damage to barrel seat.	Repair or replace pump housing.
	e. Cracked housing.	Repair or replace pump housing.
High speed surge.	Injection pump faulty:	
	a. Governor weight imbal-ance.	Calibrate governor.
	b. Damaged governor damper	Replace governor buffers.
	c. Too little spring pre-tension on governor weights or slider.	Calibrate governor.
	d. Sticking control rack.	Loosen delivery valve holders and retorque to specifications.
		Relieve bind in governor internal linkage.
		Clean dirt from housing.

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FAULT	POSSIBLE CAUSE	REMEDY
High speed surge. (Continued)	Injection pump faulty: (continued) e. Rack fails to go into start fuel position.	 Replace stop shackle. Relieve governor spring pretension. Correct slider dimension.
Engine has low power and increased smoke.	Air cleaner restricted. Nozzles faulty. Pump out of time. Loss of one cylinder. Max fuel setting incorrect.	Service air cleaner. Check on nozzle tester/ repair or replace. Correct timing. Check compression. Calibrate injection pump.

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SPECIFICATIONS		
Engine: 9.0 Liter	165 HP	180 HP
Gross Power *, Kilowatts (Brake Horsepower) At RPM	123.0 (165) 2800	134.3 (180) 2800
Net Power, Kilowatts (Brake Horsepower) At RPM	114.9 (154) 2800	126.1 (169) 2800
Gross Torque *, Newton-Meters, (Pound-Feet) At RPM	496.3 (366) 1200	543.7 (401) 1200
Net Torque, Newton-Meters (Pound-Feet) At RPM	488.2 (360) 1200	536.9 (396) 1200
Injection Pump Assembly IH Part Number (Including Governor & Transfer Pump)	1700087C91	1700088C91
Injection Pump Type	In-Line Plunger	
Drive	Timing Gear Train	
Pump Speed	One-Half Engine Speed	
Pump Rotation (Viewed From Drive End)	Clockwise	
Firing Order	1-8-7-3-6-5-4-2	
Initial Timing	16° ± 0.5 BTDC No. 1 Piston on Compression Stroke-Crankshaft Damper Timing Mark and Pointer Indexed	
Transfer Pump Vacuum (Maximum) (Between Primary Filter and Transfer Pump)	35.6 cm (14") Mercury @ full load and rated speed	
Transfer Pump Pressure (Minimum) (Between Final Filter and Injection Pump)	172 kPa (28 PSI) @ Full Load and Rated Speed	
Engine Compression Pressure @ 200 RPM	3100-3619 kPa (450-525 PSI)	
Governor Type	All Speed	
Lo-Idle Engine Speed RPM (No Load)	625-675	
Hi-Idle Engine Speed RPM (No Load)	3050-3150	3100-3200
Manifold Vacuum (Air Cleaner Restriction)	50.8 cm (20") Water -3.73 cm (1.47") Mercury (Max. Permissible @ Rated Speed)	
Exhaust Back Pressure (Exhaust Restriction)	155.4 cm (61.2") Water - 11.4 cm (4.5") Mercury (Max. Permissible @ Full Load and Rated Speed)	

*73.6 cm (29") Hg. Dry Barometer and 32° C (85°F) per SAE J-270

Torque Chart

Camshaft Nut (Drive End)	81.3 - 97.6 N-m (60-72 lb-ft)
Pump-to-Adapter Bolt	33.9 - 47.5 N-m (25-35 lb-ft)
Pump Bracket Bolts	21.1 - 33.9 N-m (20 25 lb-ft)
Delivery Valve Holder Nut	29.8 - 33.9 N-m (22-25 lb-ft) (1)
Injection Line Nut	21.7 - 27.1 N-m (16-20 lb-ft)
Governor Flyweight Assembly Nut	50.2 - 58.3 N-m (37-43 lb-ft)
Pressure Regulator Valve Fitting	24.4 - 33.9 N-m (18-25 lb-ft)
Governor Oil Fill Plug	9.5 - 12.2 N-m (7-9 lb-ft)
Control Rack Cap	9.5 - N-m (7 lb-ft)

(1) Tighten to specified torque and relieve twice before final torquing.

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CALIBRATION

Model PES8A95 Injection Pump With RQV All-Speed Governor						
Calibrating Stand: SE214 and 2333				Calibrating Oil: SAE J 967D--ISO-4113		
Accessory Set: SE-2415 SE-2415-4				Test Nozzle Opening Pressure: 17235-17717 kPa (2500-2570 PSI) Balanced Flow		
Engine Model				165	180	
Injection Pump Number (IH Part No.)				1700087C91	1700088C91	
Fuel Pressure In Injection Pump Fuel Gallery				193 kPA (28 PSI) Minimum @ 2800 RPM and Full Load Rack Position		
	TEST SEQUENCE	INJECTION PUMP RPM	CONTROL LEVER ASSY. POSITION	CONTROL RACK POSITION MM (INCH)	FUEL DELIVERY CC/1000 STROKES	REMARKS AND SPECIFICATIONS
1.	Zero control rack position Pre-stroke setting	- - - -	Back Forward	0 17.2 - 17.5 (.677 - .689)	- - - -	 2.6 + 0.05 mm(.102" + .002") Lift to port closure
2.	Pump camshaft phasing	- -	Forward	17.2 - 17.5 (.677 - .689)	- -	45 + 0.5 Degree Firing Order 1-8-7-3-6-5-4-2
3.	Pump-to-stand check	1400	Forward	- -	- -	Check Fuel Flow
4.	Preliminary Governor Cut-Off	1420	Forward (No Hi-Idle Stop)	15.2 - 17.8 (.599 - .700)	- -	Rack position prior to start 20-21 mm (.787 - .827")
5.	Governor cut-off 165 HP 180 HP	1450 - 1460	Forward (Hi-Idle Screw Installed)	9.7 + 0.1 (.381 + .004) 10.6 + 0.1 (.417 + .004)		Rack position is 1mm (.039") Less than full-load rack position.
6.	Governor perform-ance at no load (Hi Idle) 165 HP 180 HP	1530 - 1560 1550 - 1580	Forward	4.0 + 0.1 (.157 + .004)	- -	
7.	Governor end regulation	1650	Forward	1.0 or Less (.004 or Less)	- -	
8.	Lo-Idle regulation	820 - 880	Back	2.0 + 0.1 (.078 + .004)	- -	Prior to test adjust control rack to 7.0-7.3 mm (.275-.287") at 325 RPM
9.	Lo-Idle Back-up check	100	Back	8.9 or more (.350 or more)	- -	Prior to test adjust control rack to 7.0-7.3mm (.275-.287") at 325 RPM
10.	Fuel delivery at full load 165 HP 180 HP	1400	Forward	10.7 + 0.1 (.421 + .004) 11.6 + 0.1 (.456 + .004)	59.5-61.5 72.0-74.0	Maximum imbalance 3.0 cc/1000 strokes between pumping elements
11.	Fuel Delivery at Lo-Idle	325	Back	7.0-7.3 (.275-.287)	9.0-15.0	Maximum imbalance 3.0 cc/1000 strokes between pumping elements.
12.	Fuel delivery at 800 RPM 165 HP 180 HP	800	Forward	10.7 + 0.1 (.421 + .004) 11.6 + 0.1 (.456 + .004)	54.0 Maximum 65.0 Maximum	Maximum imbalance 4.0 cc/1000 strokes between pumping elements
13.	Fuel Shut-Off	- -	- -	.5 - 1.0 (.019 - .039)	- -	Shut-off lever Back against stop.
14.	Start Fuel cut-out	205 - 265	- -	- -	- -	Operate lever from hi-idle to lo-idle
15.	Fuel Delivery at start	100	Forward	- -	75.0 - 95.0	Rack end cap installed

FUEL SYSTEM

LP GAS SYSTEM

CENTURY EQUIPMENT

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INTRODUCTION

LPG is an ideal motor fuel very similar to gasoline. Both are a product of crude-oil. They differ in that LPG is more volatile. That is, it wants to boil or to become a vapor at ordinary atmospheric temperatures. When used in an internal combustion engine LPG is converted from a liquid in the fuel tank to a perfectly dry gas before reaching the combustion chamber. By good carburetion and perfect mixing of the dry gas with air, uniform distribution throughout the manifold is achieved. With gasoline, or wet fuel, this uniform mixing and distribution is not attained.

With complete combustion at a rate slower than gasoline, LPG makes for smoothness of operation because of prolonged power impulses on the power stroke and more uniform bearing pressures.

Being a dry gas, crankcase dilution is minimized and likewise all ill effects such as thinning of the lubricating oil and washing the lubricating oil from the cylinder walls with resultant cylinder wear are eliminated. Lubricating oil can be safely run much longer than on gasoline due to the elimination of carbon deposits, dirt, acid and water content in the lubricating oil.

Harmful carbon within the engine is eliminated. There is no exhaust smoke or obnoxious odors. The time interval between engine shutdowns for overhaul is prolonged. Rings, valves, cylinders and all moving parts lubricated from the crankcase last longer, resulting in a very substantial reduction in the cost of keeping equipment on the road.

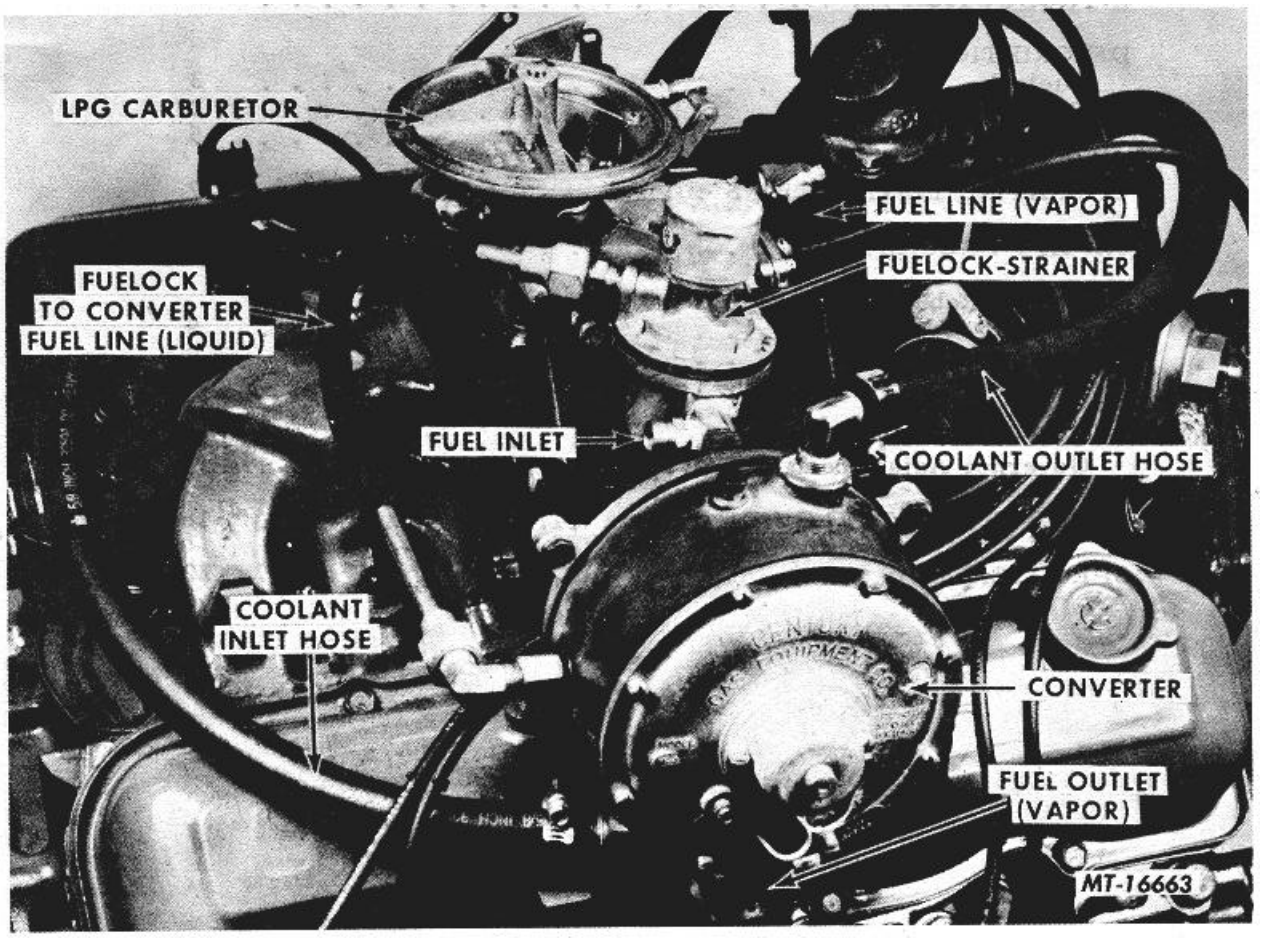


Fig. 1 Typical LPG Installation

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DESCRIPTION

Figure 1 illustrates a typical installation of LPG equipment. An understanding of the complete LPG system and how the various components relate to each other will be made easier by following the fuel flow through the system shown in Figure 1.

LPG flows from the fuel tank through the fuelock-strainer assembly to the converter (regulator). In the converter the liquid fuel becomes a vapor and then proceeds through the fuel line to the carburetor where the gaseous fuel is mixed with air in correct proportions for maximum engine efficiency.

From Figure 1 it can be seen that there are three principle units of the LPG system. These are the fuelock-strainer assembly, converter and carburetor. A description of each operation is discussed in the following paragraphs.

Fuelock Strainer

The fuelock-strainer assembly consists of two separate subassemblies. The fuel strainer (filter) is provided to stop the passage of scale, rust or other foreign matter that may be carried by the liquid fuel as it flows from the fuel tank.

Fuel enters the strainer bowl casting through opening "A" (Figure 2). Large solid particles fall out of the fuel stream and remain in the bowl while the fuel continues to travel upward through the filter pack, where remaining solids are removed, and on into the fuelock. A drain plug is provided for purging the filter bowl.

The fuelock is an electrically actuated solenoid provided to open and close the fuel line as the ignition switch is operated. This will prevent damage to the converter due to any excessive fuel line pressure.

The fuelock plunger (A), (Figure 3) is held against orifice (B) by a combination of weak spring pressure and fuel tank pressure. When battery voltage is applied to coil (C), a strong magnetic field is formed and draws the plunger away from the orifice, thus allowing fuel to flow out opening (D).

Converter

The converter performs the task of transforming liquid fuel to a gaseous fuel in three stages. The function of each stage is discussed separately.

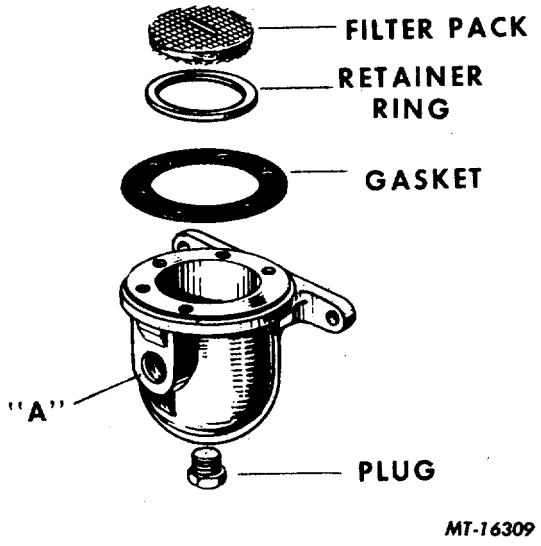


Fig. 2 Fuel Strainer

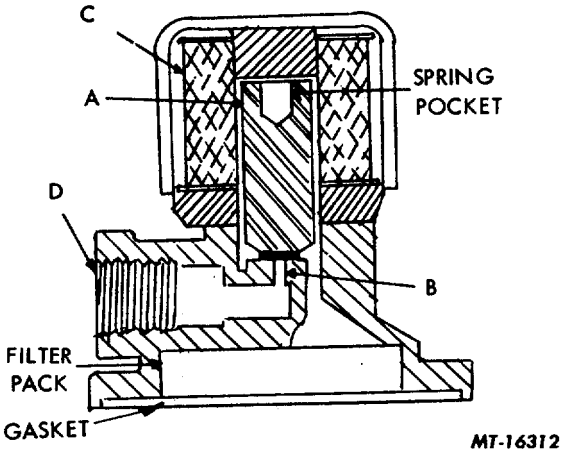


Fig. 3 Fuelock

Primary (High Pressure) Regulator (Figure 4)

A conventional valve, diaphragm and spring regulator controls pressures in the primary and heat exchanging cavities shown in Figure 4. Liquid fuel enters through opening (A) and passage (B) and expands in the primary cavity and heat exchanger (C). Area (C) is a continuous passage through the heat exchanging area and terminates at the secondary valve orifice.

Pressure of expanding fuel forces primary diaphragm (D) upward against the spring which is overpowered and primary valve (E) is closed when the pressure raises to 5-8 pound.

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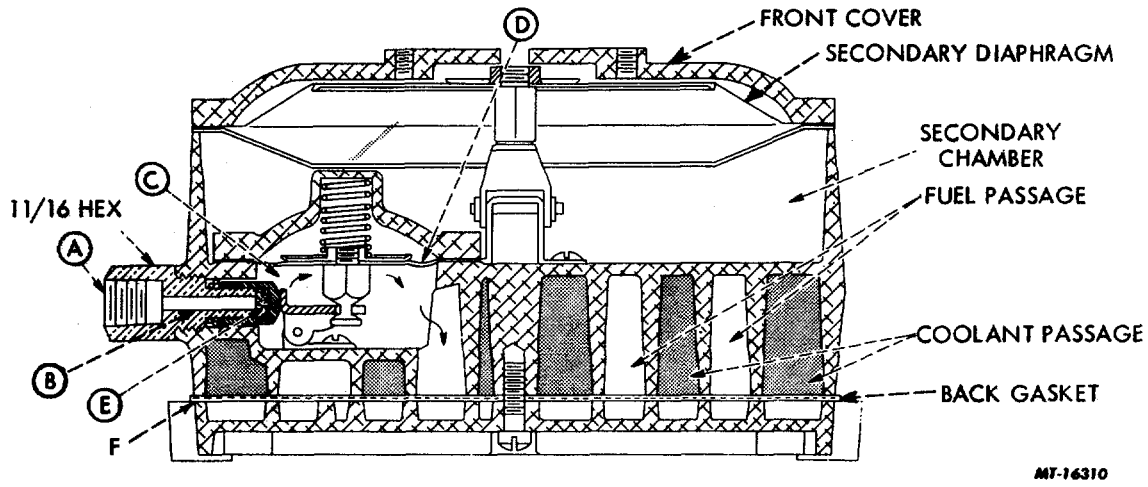


Fig. 4 Primary (High Pressure) Regulator

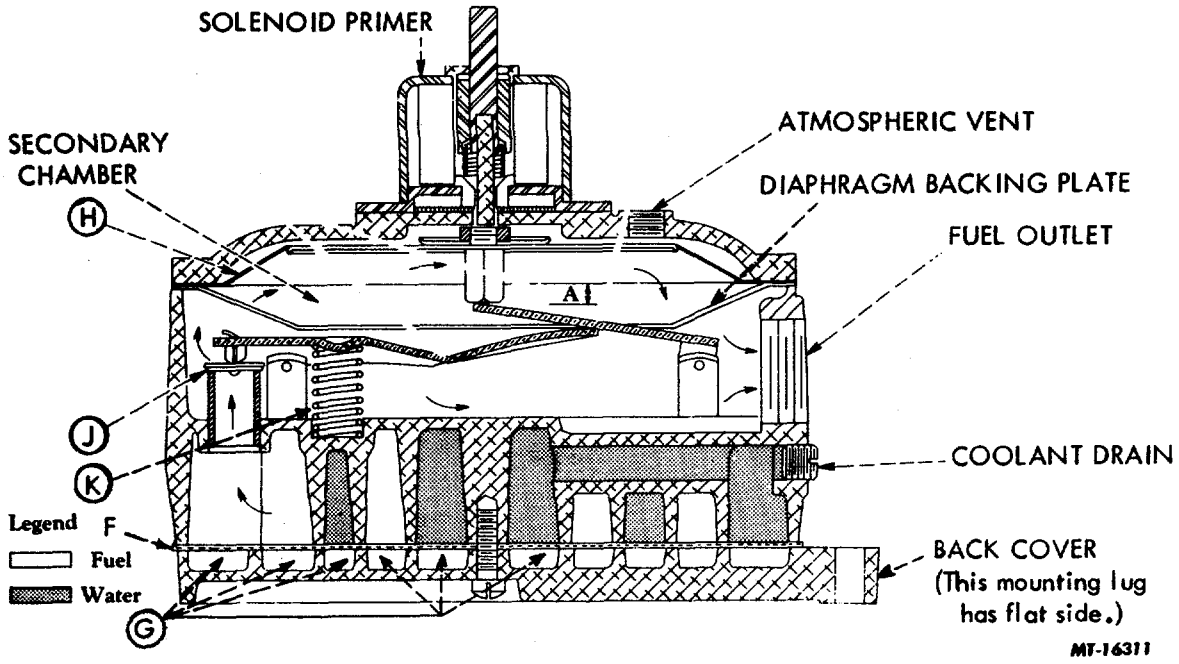


Fig. 5 Secondary Regulator

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Primary valve (E) will remain closed until pressure is reduced by engine demand at which time it opens and the cycle is repeated. During engine operation this regulator functions continuously and maintains consistent pressure in the heat exchanging area.

Heat Exchanger (Figures 4 and 5)

Engine coolant is circulated through continuous passages and heats adjoining casting walls preventing refrigeration due to expansion of regulated fuel.

Back gasket (F) seals coolant passages and expansion areas (G). In case of freezing coolant, this gasket is displaced into the expansion area and absorbs expansion of the foreign coolant. Damage to vital parts is prevented by this built-in safety feature.

Secondary Regulator (Figure 5)

A reduction of pressure (vacuum) occurs in the secondary body upon engine demand. Atmospheric pressure forces diaphragm (H) downward opening secondary-valve (J) through the compound lever system. Vaporized fuel flows through the secondary valve as long as demand persists and in quantities dictated by carburetor adjustment and engine requirement.

Spring (K) closes or regulates the secondary valve as demand varies.

The secondary regulator may be actuated by the solenoid primer to fill vapor hose with fuel prior to starting.

Carburetor

The function of the LPG carburetor (Figures 6 and 7) is to accurately mix the correct proportion of fuel with air to satisfy every speed and load demand of the engine.

The carburetor used with this LPG system is a metering valve type carburetor. By this it is meant that the carburetor mixes the air with the fuel by the exact metering of a special metering valve. Operation of this valve is controlled through a positive linkage connected to the throttle plates such that every movement of the throttle plates also means a corresponding movement of the metering valve. This maintains the correct proportion of the air to fuel ratio.

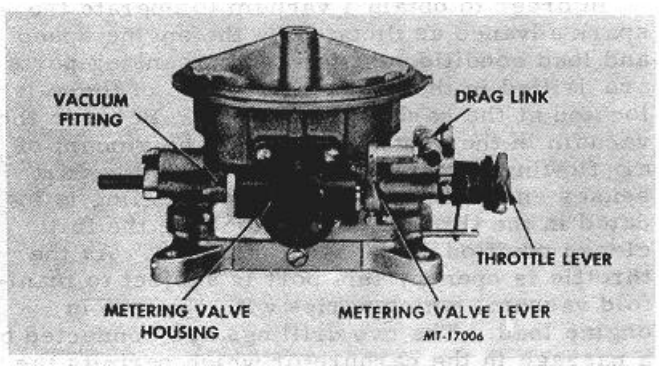


Fig. 6 Nongoverned LPG Carburetor

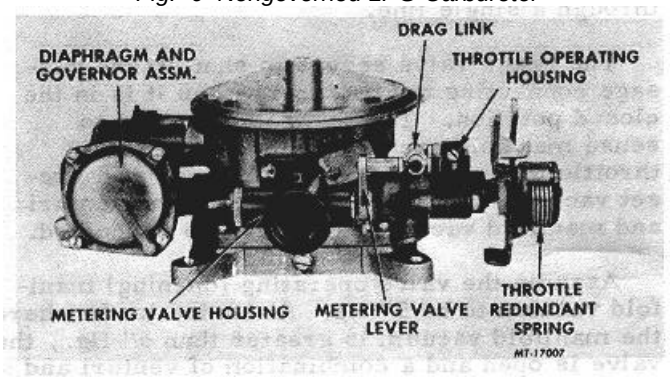


Fig. 7 Governed LPG Carburetor

Fuel enters the carburetor through the metering valve assembly and is distributed through the spray rings located below the throttle plates. Because the fuel does enter below the throttle plates, this type of carburetor is less sensitive to changes in altitude, temperature and barometric pressure.

Fuel for idling enters through a small orifice located above and in front of the main metering valve. This fuel passes through the idle transfer tube and is discharged into the idle discharge port where it is mixed with air before being distributed through the spray rings below the throttle plates. An adjustment is provided in the idle discharge port passage to allow the idle air to fuel ratio to be varied.

A spark control valve is provided on the governed model carburetor to alleviate engine ping.

Generally, engines will detonate (or "ping") if full spark vacuum is delivered to the distributor during heavy engine loads (not W.O.T.) at low or moderate engine speeds. The spark valve reduces the amount of spark vacuum delivered to the distributor, when the engine is operating under heavy load (not W.O.T.), and thus prevents excessive spark advance.

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In order to obtain a vacuum to operate the spark advance as dictated by the engine speed and load conditions, two vacuum sensing ports are drilled in the carburetor. One of these is located at the carburetor venturi. Because the vacuum in the venturi varies as the amount of air flowing through the carburetor, this port senses engine speed. The other drilling is located in the throttle bore just above the full closed position of the throttle plates. As the throttle is opened, this port is subject to manifold vacuum, which varies with changes in engine load. The two drillings are connected by a passage in the carburetor which permits the vacuums from the two ports to be "blended" and transmitted to the distributor diaphragm through a single line.

The spark valve serves to shut off the passage connecting the two ports when it is in the closed position. The valve is arranged to sense manifold vacuum from the port at the throttle plate and is adjusted to open at a preset vacuum. With the valve open, the venturi and manifold vacuum passages are connected.

Assume the valve operating (opening) manifold vacuum to be 5" Hg. At engine loads where the manifold vacuum is greater than 5" Hg., the valve is open and a combination of venturi and manifold vacuums are delivered to the distributor and provide a relatively high spark advance for fuel economy. As the load on the engine increases, the amount of spark vacuum (or advance) decreases toward the W.O.T. requirement. At 5" Hg. (valve operating point) the spark valve closes, shutting off the manifold vacuum connecting passage, thus reducing the amount of spark vacuum that would be attained from the combination of drillings at this engine load.

If the manifold vacuum is not shut-off in this critical range (W.O.T. to 5" Hg.), full vacuum would be delivered and the engine would receive more spark advance than it would tolerate without detonation.

Governor

The governor limits the maximum operating speed of the engine. The governor consists of two units: a throttle-actuating mechanism and a controlling unit. The throttle-actuating unit consists of a diaphragm assembly, governor lever and governor spring. This unit is connected to the primary throttle shaft in such a way that tension of the governor spring tends to open the throttle when the accelerator pedal is depressed. Two calibrated jets in the vacuum passages meter venturi and manifold vacuum to control the governor operating diaphragm. The control unit located in the distributor housing consists of a rotating centrifugally-operated valve which is driven by the distributor shaft at one-half engine speed. The tension of the valve spring holds the valve open. As rotation speed increases, centrifugal force acting on the valve weight overcomes spring tension, closing the valve. Spring tension can be adjusted manually to regulate the speed at which the valve closes. Figure 8 illustrates a typical vacuum type governor.

The carburetor is shown in open throttle position which indicates that the engine is gaining speed but has not reached the point where the governor will begin to control the carburetor and hold the engine at predetermined RPM.

Filtered air enters the governor systems through an opening in the air horn and travels through the tubing and control valve assembly through the "A" and "B" orifices to the carburetor air stream at points (12) and (13). The air is caused to flow by manifold vacuum at point (13) and venturi vacuum at point (12).

With the carburetor and spinner valve in the position shown (Figure 8), the size of the controlling jet keeps the pressure in the governor diaphragm chamber at approximately atmospheric, and no movement of the diaphragm will result.

As soon as the distributor RPM approaches the speed at which the engine is governed, the spinner valve (5) centrifically overcomes spring (7) and begins to restrict or shut off the flow of air. The vacuum present at opening (13) then appears to travel through the orifice, into the diaphragm cover chamber and throughout the entire closed system back to the spinner valve. The amount of pressure drop depends on how far the spinner closes and restricts the supply of air.

The chamber housing the spring and lever opens directly into the area behind the diaphragm and is vented to atmosphere either through the air horn or the carburetor body. This vent allows atmospheric pressure to force the diaphragm to overcome the governor spring and mechanically pull on lever (3) which moves the throttle toward a closed position. As soon as engine RPM starts to drop, the spinner valve (5) starts to open and pressure in the diaphragm chamber becomes more nearly atmospheric allowing the spring (4) to open the throttle to a greater degree. This action is allowed as long as the operating lever (14) is held in the open position, releasing the carburetor to governor control.

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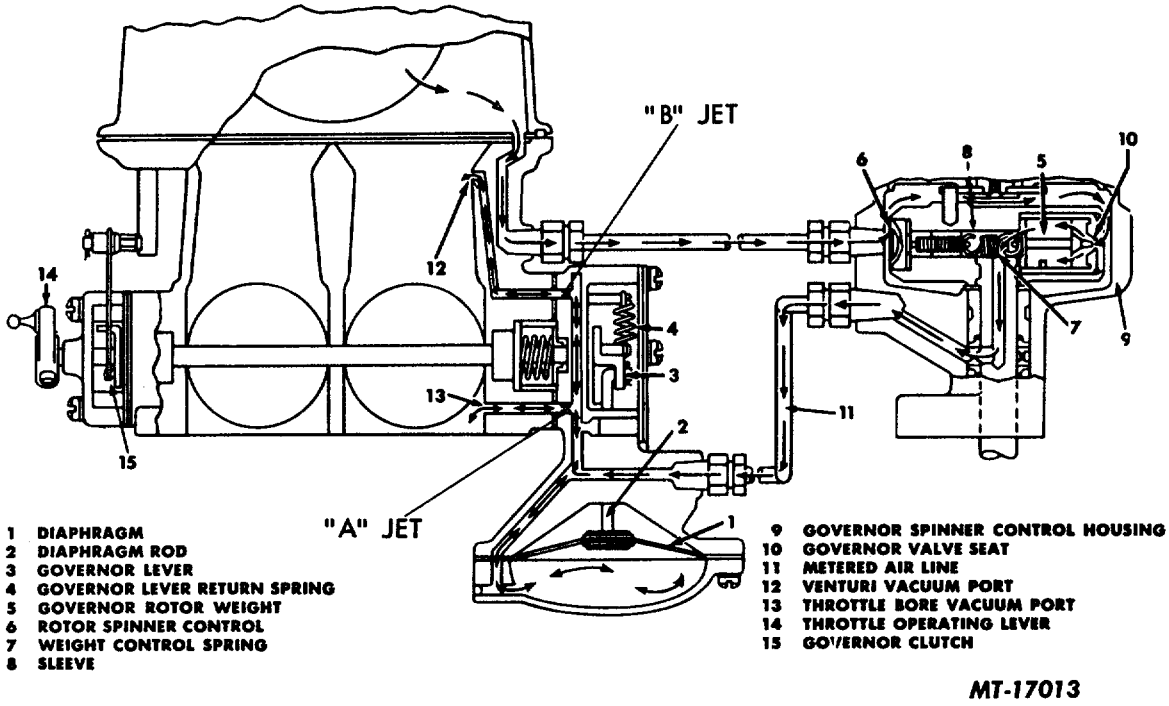


Fig. 8 Typical Vacuum Type Governor

Engine RPM is the result of balancing the two controlling forces, governor spring tension and amount of vacuum in the diaphragm chamber. The vacuum can be introduced at a higher or lower RPM by changing the spinner valve adjusting screw.

OPERATION

Starting Instructions (Engine Cold)

1. Slowly open the vapor valve on fuel tank. It is important that the vapor valve be opened slowly, otherwise, the excess flow valve at the tank or in the line may be "slugged" or automatically closed, requiring up to about 50 seconds for the excess flow valve in the line to relieve itself.

2. Press primer switch 2 or 3 times.

3. Turn the ignition switch to the "ON" position.

4. Push in clutch pedal and hold in until after engine is started.

5. Depress accelerator sufficiently to open the throttle in mid-position.

6. Turn ignition key to start engine and release the instant engine starts. CAUTION: Do not run the starting motor for more than approximately 30 seconds at any time. If the engine fails to start or makes a false start do not turn the key again until the engine has come to a complete stop.

7. After the coolant has warmed up to normal operating temperature, slowly turn the liquid valve on and the vapor valve off.

Starting Instructions (Engine Warm)

1. Slowly open the liquid valve on one tank only.

2. Turn ignition key to start engine in the same manner as described in Item 6 of Cold Start procedure described above.

Shut-Off Instructions

After the vehicle has completed its run and the engine is to be shut off for an indefinite period of time, it will be necessary to close all tank valves and run the engine until fuel is exhausted.

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Operator Maintenance

Most maintenance services which the operator performs on the LPG equipped truck are the same as are called for in the regular operators manual for gasoline trucks. For example, the servicing of the engine air cleaner would be the same. For the crankcase however, a longer interval between oil changes could be expected and this will depend on operating conditions. Operator maintenance on the LPG system itself is chiefly governed by the qualifications of the operator. Unless the operator is well acquainted with all the "Safety Precautions" associated with LPG systems, maintenance operations should be entrusted only to qualified service station personnel.

SAFETY PRECAUTIONS

Safety precautions in the handling of butane propane cannot be overemphasized. There are state, county or city laws, ordinance and fire regulations covering the utilization of liquefied petroleum gas. Such laws, ordinance and fire regulations on this subject must be adhered to in addition to the safety rules given below.

Where local rules are more stringent than those given below, the local rules are to be given priority.

These rules apply to servicing any vehicle or engine using liquefied petroleum gas (butane propane) for engine fuel regardless of the nature of the work to be performed.

1. Select a location for servicing this vehicle where there will be good air circulation. This is to avoid accumulation of gas-air mixtures in and about the vehicle caused by undetected leaks.

2. Such location should be as far as possible from steam cleaners, hot water cleaners, hot dip tanks, etc., and any other device operating with open flame.

3. Shut off the main valves at the fuel tanks and allow the motor to run. This is to exhaust all fuel in the system from the tank to the engine. In the event the truck is disabled and the engine is inoperative, shut the valve at the tank. Bleed the fuel system of propane gas outside of the building before towing the unit into the shop.

4. "DANGER" signs should be placed on either side of the vehicle. There is to be no smoking in the vicinity. No work is to be performed on this vehicle or on others in a nearby zone involving open flames such as cutting or welding, grinding, chiseling or any similar operation which may produce sparks.

5. In order to avoid possible accumulations of explosive gas-air mixtures, these vehicles, whenever possible, should be removed from the shop at the end of the working day.

6. A fire extinguisher (dry powder or carbon dioxide, C02) should be removed from its regular location and placed adjacent to the mechanic's working area-handy for immediate use. When LPG ignites, it should be allowed to burn until, if possible, the source of fuel is shut off. Extinguishing the fire before this is accomplished, can result in dangerous accumulations of gas which might cause a serious flash or explosion.

7. After completing service work and before starting the engine, raise the hood to allow air to circulate around the engine to remove any possible gas accumulation.
8. Never use LPG from the fuel tanks on these vehicles for cleaning parts, blowing of horns, inflating tires, cleaning out the cab or other uses for which it is not intended and by which it is out of control.

   NOTE: This is mentioned because inspections have revealed that operators have used it as a substitute for solvents and compressed air, not realizing the extreme danger of this practice.

9. Whenever the nature of service work requires any operation on the fuel system, the following should be observed.

   a. All threaded connections should be treated with an insoluble lubricant. (Nonhardening sealing compound or aviation gasket maker.) Replace worn or defective fittings.

   b. After connecting up the fuel system, check it for leaks. NO LEAKS ARE PERMISSIBLE. Odorants which are strong smelling compounds (a smell similar to spoiled cabbage) are added to LP-Gas, as warning agents, to indicate leakage of even small quantities of gas.

   c. A lather of soap brushed on with a soft brush will indicate the presence of leaks which are dangerous and wasteful. Never use open flame to check for leakage.

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CAUTION: Pay particular attention to short lengths of rubber hose used anywhere in the piping system to relieve stress and vibration.

10. No work whatever is to be performed on the fuel tanks of liquefied petroleum gas fuel vehicles. Any necessary work should be performed by qualified concerns who normally service such containers and are familiar with local regulations and inspection and test after any repairs are made.

11. Vehicles of this type which have been involved in an accident should not be brought into the shop for repair until the shop foreman has checked the fuel tanks and fuel systems for possible leaks.

12. It is important to remember that all LPG systems are pressurized. Make certain the tank valves are tightly closed and all fuel exhausted from the lines before starting any repair work on the fuel system.

SERVICING

The servicing and rebuilding procedures of the major components of the LPG system are outlined in the following paragraphs. The frequency of such required service is determined largely by operating conditions. Vehicles operating under abnormal conditions will require more frequent servicing. Fuel Strainer (Figure 9)

1. Shut off fuel supply and run engine to empty fuel lines and strainer.

2. Remove fuel inlet line and retaining screws holding strainer bowl to fuelock. Remove strainer bowl.

3. Using a screwdriver as a small prybar, pry out retaining ring and remove filter pack from bottom of fuelock housing. Discard filter pack.

4. Clean all parts in solvent and dry with compressed air. Inspect gasket surfaces for nicks which might cause leaks.

5. Install new filter pack in recess of fuelock base with chamois side of pack upward. Place retaining ring in position and tap into place with a soft-faced hammer. Ring should seat firmly against filter pack.

6. Replace gasket and strainer bowl. Tighten screws securely.

7. Check assembly for leaks by applying air pressure to the fuel inlet and covering all disturbed connections and joints with a soap solution. Replace fuel inlet line.

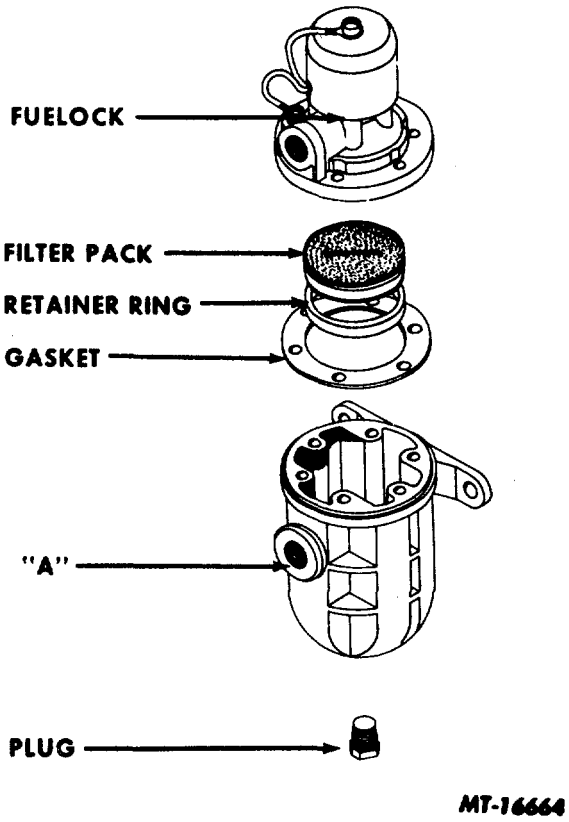


Fig. 9 Replacing Filter Pack

Fuelock (Figure 10)

1. Remove single screw retaining coil case and single screw connecting coil lead to terminal post.

2. Lift coil case and coil off fuelock plunger housing.

3. CAUTION: Be sure there is no fuel pressure in the strainer bowl before completing the next step. Remove flat Phillips head screws holding plunger housing on casting. Lift off plunger housing and remove plunger and spring. Discard “O" ring.

4. Clean housing and spring with solvent. Inspect all parts for damage or any condition that would impair these parts from further service.

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5. Locate new "0" ring on housing. Install spring in plunger and slide upward into housing. Place housing and plunger assembly into position on fuelock casting and insert and tighten retaining screws.

6. Test assembly for leaks by applying air pressure at the strainer bowl inlet and covering all disturbed connections and joints with a soap solution.

7. Replace coil and case.

   NOTE: Coil may have insulated terminal on one lead only. This lead is connected to the terminal post. Be sure the other coil lead is grounded to fuelock assembly with the coil case retaining screw.

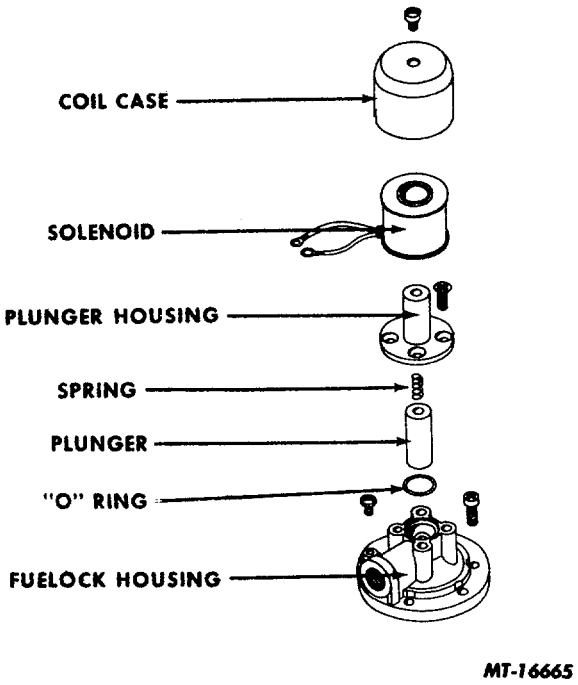


Fig. 10 Fuelock (Exploded View)

Converter

Removal

Disconnect solenoid supply voltage, fuel lines and coolant hoses. Remove mounting bolts and remove the converter from the vehicle.

Disassembly

1. Remove two primer case retaining screws and single screw connecting coil wire to terminal post. Remove primer assembly.

2. Remove front cover retaining screws. Lift off front cover and remove secondary diaphragm assembly and gasket, Figure 11. Discard gasket.

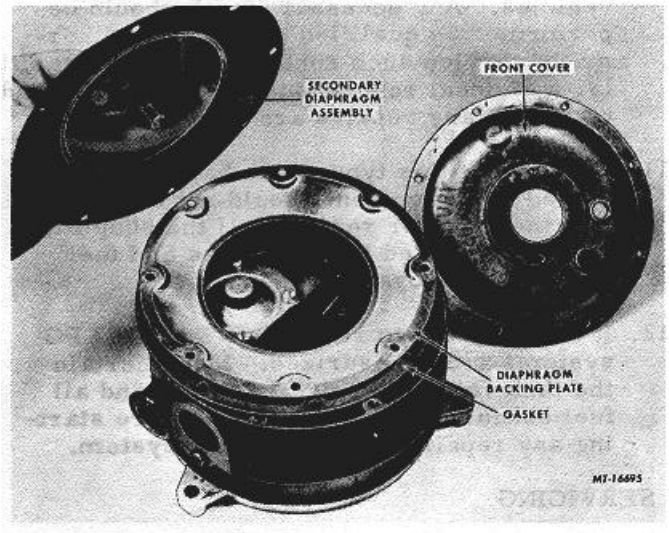


Fig. 11 Secondary Diaphragm Disassembled

3. Remove secondary valve lever assembly. Discard valve seat and valve seat pin, Figure 12.

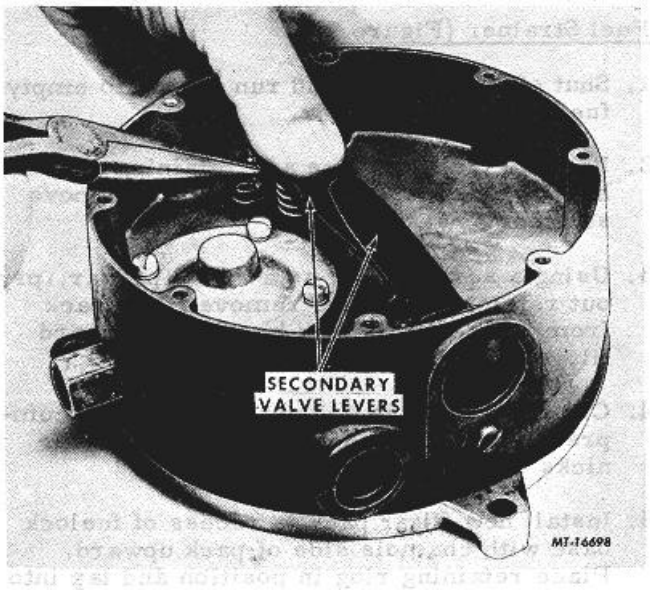


Fig. 12 Removing Secondary Valve Lever

4. Remove primer fuel inlet and valve assembly from side of converter body. Discard inlet gaskets and valve w/seat.

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5. Remove primary diaphragm cover screws and lift off primary cover. Lift primary diaphragm assembly from primary cavity, Figure 13.

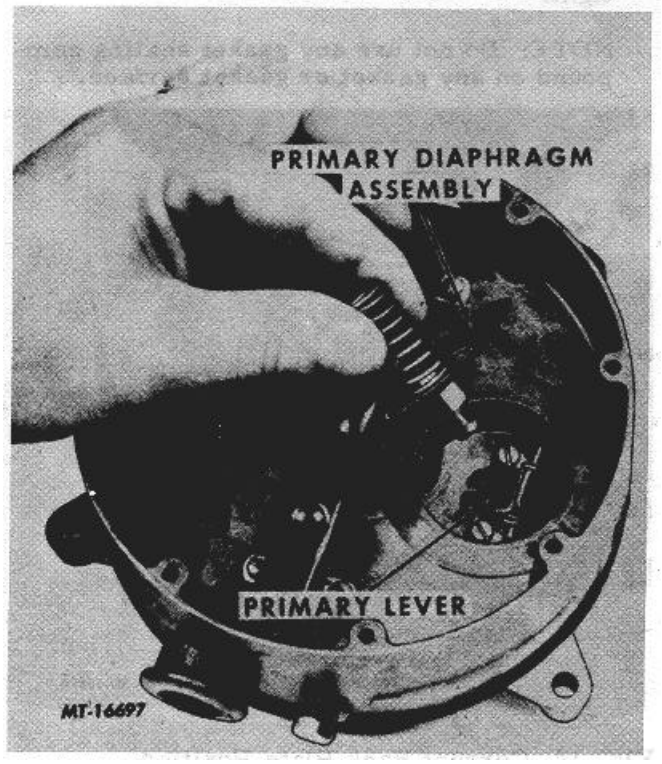


Fig. 13 Removing Primary Diaphragm

6. Remove back plate retaining screws and lift off back plate and gasket. Discard gasket.

Inspection

Clean all parts excluding primer solenoid in solvent and dry with compressed air. Inspect all parts for damage or any condition that would impair these parts from further service.

Special attention should be given to the back cover plate and gasket mating surface of the converter body to determine if these surfaces are perfectly flat. Any variation in these surfaces will cause difficulty in preventing leaks around back cover gasket. Should an uneven or warped condition exist, lap castings on a surface plate until condition is corrected. Do not proceed until this work has been completed. Severely warped parts will require machining or replacement.

Assembly

To insure proper assembly of the converter unit, it is necessary to use aligning pins when replacing diaphragms and gaskets. These aligning pins may be made locally. Obtain four screws, 10-24 x 3 inches and remove the screw heads. File the cut area of the screw stem to remove all burrs and sharp edges.

Failure to use aligning pins may result in wrinkled diaphragms or gaskets which will not function properly.

1. Lay converter face down, place new back gasket in position and insert aligning pins to hold it in place. Locate back cover on pins with mounting ear having flat side directly over vapor outlet, Figure 14. The back cover must be installed in this position. Insert back cover retaining screws in remaining holes, turn down slightly, then replace aligning pins with screws. Start with the center screw and alternate from side to side tightening back cover screws extremely tight.

   NOTE: Do not use any gasket sealing compound on any gasket or gasket surface.

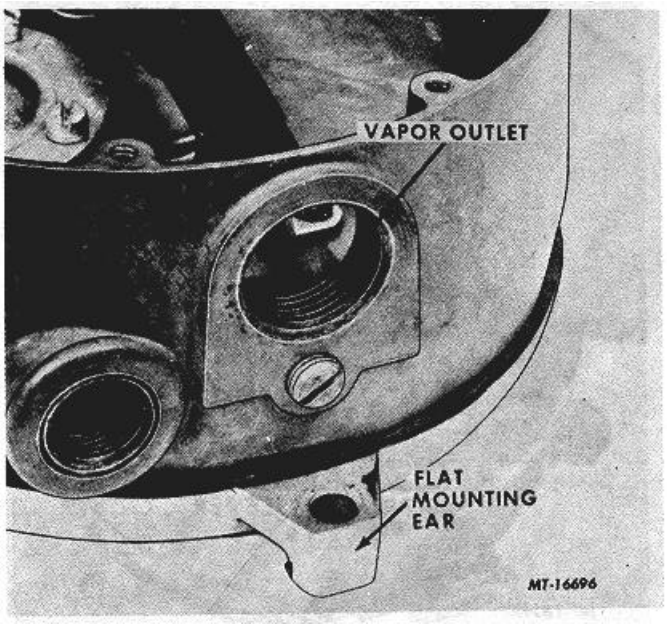


Fig. 14 Correct Back Plate Position

2. Place new primary diaphragm on diaphragm link, Figure 15. Install backing plate with flange away from diaphragm and secure with washer and nut. Tighten nut securely.

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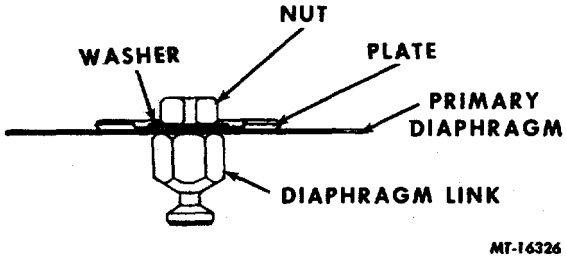


Fig. 15 Primary Diaphragm Assembly

3. Place completed diaphragm assembly in primary cavity and attach primary diaphragm link to primary lever, Figure 16. Hold diaphragm in place with aligning pins. Install spring over nut on primary diaphragm assembly and slide primary cover over aligning pins. Remove any one aligning pin replacing it with a screw turned down lightly against cover. Repeat this procedure with remaining aligning pins. Tighten screws alternately and evenly.

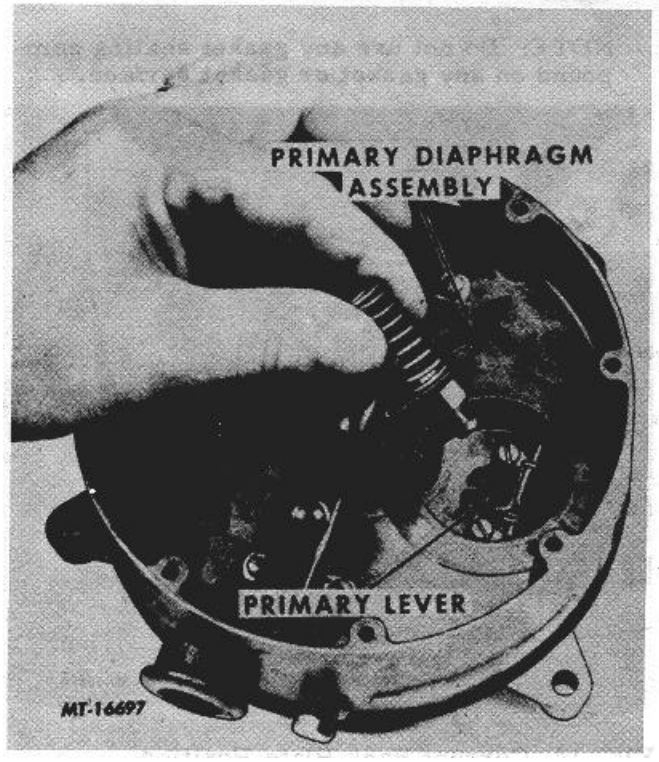


Fig. 16 Installing Primary Diaphragm Assembly

4. Install new primary valve w/seat and three gaskets on primary valve inlet fitting, Figure 17. Insert primary valve assembly in side of converter body and tighten securely.

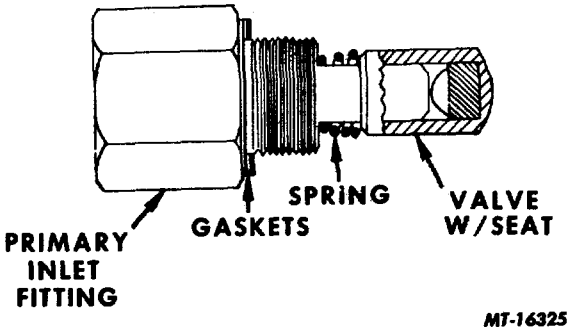


Fig. 17 Primary Inlet and Valve Assembly

The three washers which were installed on the primary inlet valve are provided to make it possible to adjust the pressure which activates the primary valve assembly. The correct pressure may be obtained by the following procedure. Attach a compressed air hose to the primary inlet fitting and an air gauge over the secondary valve orifice. The output should be 5-8 pounds with inlet pressure of 130-180 pounds. If the pressure is high, remove one of the inlet gaskets and recheck. A second gasket may be removed if necessary, but one gasket must remain on the inlet fitting.

If secondary pressure creeps upward, the primary valve is leaking and must be reworked. Inspect valve lever and bracket for any signs of wear or binding. Replace both lever and bracket if problem persists.

5. Assemble new valve seat on valve lever. Insert valve seat pin through valve seat and lever insert. Press valve seat against flat surface and bend pin over sharply, Figure 18. Do not hammer on bent pin. The seat is self-aligning and may not seal properly if held to rigidly against the valve lever.

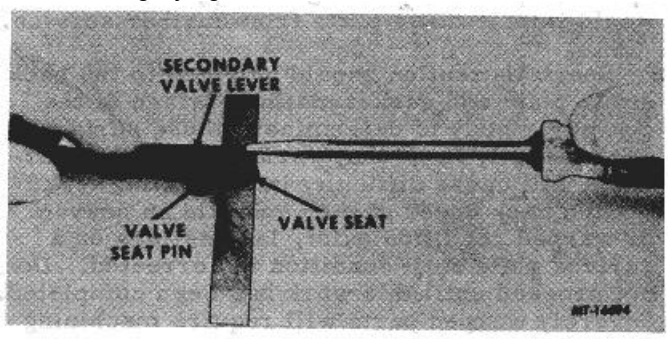


Fig. 18 Assembling Secondary Valve Seat

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6. Place secondary valve lever, compound lever and secondary valve lever spring into position and insert hinge pins. Secure hinge pins with hair pin clips. Be certain that compound lever is on top of valve lever. Refer to Figure 5 for correct positioning.

7. Open secondary valve by hand and allow it to snap closed several times to align seat with orifice. Measure across face of casting to closest point on top of compound lever to obtain correct valve lever setting, Figure 19. Distance should be 1/8" to 5/32". Bend valve lever only to obtain correct setting.

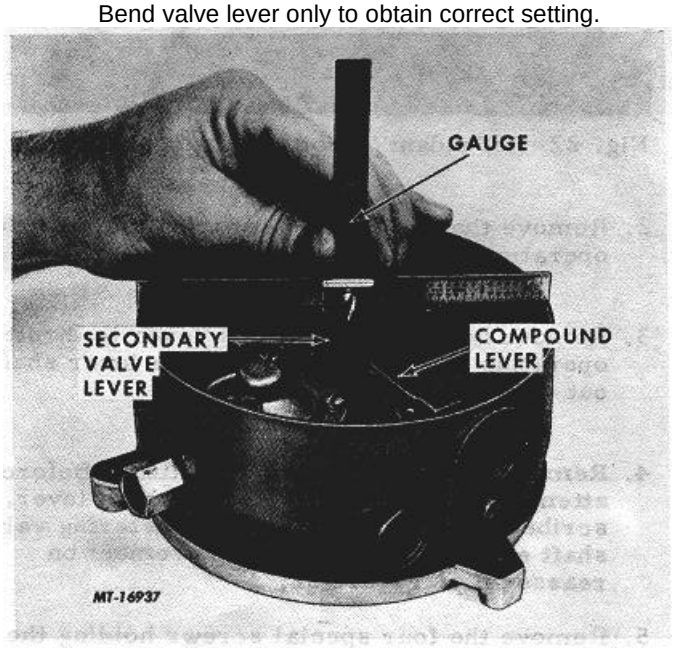


Fig. 19 Secondary Valve Lever Adjustment

8. Test semi-assembled converter by connecting air supply to fuel inlet. Plug one water fitting opening and apply soap bubble to remaining water outlet. Any continuous growth of the soap bubble indicates leakage through the back gasket and will require rework of its installation.

   Test all gasket surfaces, edges, openings, etc., for leaks with soap solution or by immersing the entire unit in water. Any leaks must be corrected before proceeding further. Pay particular attention to secondary seat. If installed correctly, it will not leak.

9. Place large diaphragm plate on diaphragm button with flange of diaphragm plate facing unthreaded end of diaphragm button, Figure 20. Place new diaphragm over threaded end of button with dished side toward large diaphragm plate. Set small diaphragm plate on diaphragm with flange away from diaphragm. Install nut and tighten securely.

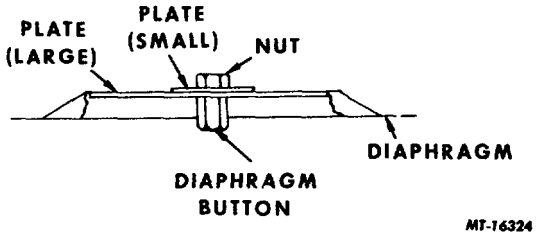


Fig. 20 Secondary Diaphragm Assembly

10. Insert aligning pins in converter body using every other hole. Slide gasket over pins followed by backing plate and secondary diaphragm assembly. Refer to Figure 11 for correct installation.

    NOTE: Backing plate must be installed with lowest surface toward converter body.

11. Locate cover on aligning pins and insert retaining screws removing aligning pins one at a time. Do not tighten screws. Lift secondary diaphragm up against cover by pulling with pliers through center hole in cover. Tighten all screws alternately and evenly while lifting diaphragm. Install primer and check for operation with battery source. Check for clearance between diaphragm assembly and plunger tip. If no clearance exists, recheck valve lever setting.

12. Apply air pressure to inlet fitting and check for secondary valve leakage with soap bubble over vapor outlet. Depress primer manually or electrically to check for air flow. Volume need not be great but should be audible.

13. Mount converter on vehicle and reconnect solenoid supply voltage, fuel lines and coolant hoses.

Carburetor

Removal and Installation

CAUTION: Additional care should be exercised when servicing governed model LPG carburetors equipped with redundant throttle closing linkage. Whenever the throttle return spring is disconnected at either end, the throttle will snap to the closed position under a spring force sufficient to cause personal injury. It is essential, to prevent personal injury, that all instructions be followed in the stated order and hands be kept clear of carburetor throttle linkage when connecting or disconnecting the throttle return spring.

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Removal:

1. Remove the air cleaner.
2. Disconnect the throttle return spring.
3. Remove throttle linkage and carburetor supply lines.
4. Remove carburetor and gasket. Discard gasket.

Installation:

1. Clean gasket surface of intake manifold. Position gasket and carburetor on intake manifold and install lockwashers and nuts. Torque nuts alternately and evenly to 12-15 lbs.
2. Connect accelerator linkage and carburetor supply lines.
3. If so equipped, reload redundant throttle closing linkage. Loading the linkage is accomplished by rotating the throttle lever to wide open throttle (clockwise in Figure 21) by moving accelerator control rod to the right. Do not rotate throttle lever directly since it will snap to the closed position. Then attach the throttle return spring to retainer located at thermostat housing. Slowly return accelerator control lever to the idle position.

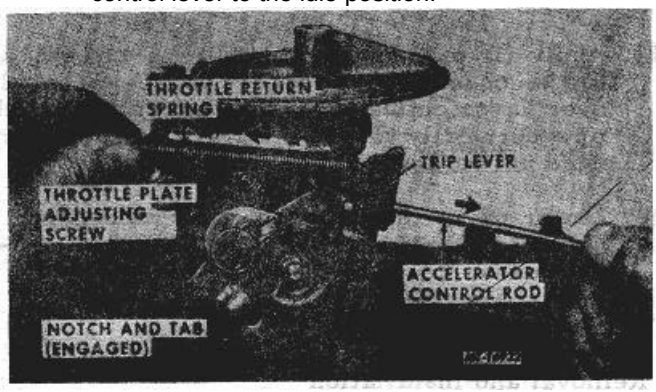


Fig. 21 Reloading Throttle Redundant Closing Linkage

4. Make all required adjustments (See carburetor adjustments, and replace the air cleaner.

Disassembly

1. If carburetor is so equipped, remove the redundant throttle closing linkage safety spring retaining nut, washer, spring drum and spacer washer, Figure 22. Unhook and remove safety spring, trip lever and retaining lever.

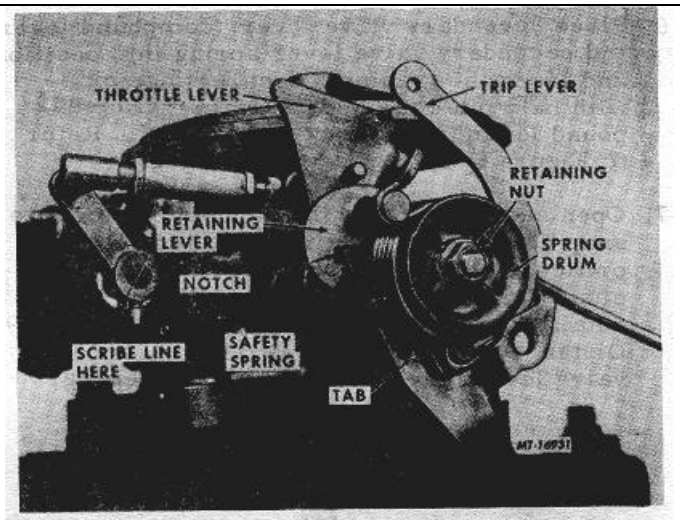


Fig. 22 Redundant Throttle Closing Linkage

2. Remove the two screws securing the throttle operating housing to the carburetor body.
3. Remove bolt retaining clutch lever to throttle operating housing. Slide throttle lever shaft out of housing.
4. Remove air-fuel mixture drag link. Before attempting to remove metering valve lever, scribe a line on the lever and metering valve shaft end to insure correct placement on reassembly, Figure 22.
5. Remove the four special screws holding the metering valve housing to the carburetor body.
6. Remove metering valve housing, metering jet and gasket. Discard gasket. Disassemble metering valve assembly contained in the metering valve housing.
7. Remove idle air-fuel (RPM) mixture adjusting screw located below metering valve housing.
8. Remove and discard governor housing seal. Remove housing plate and discard gasket.
9. Remove diaphragm rod retainer and governor lever, Figure 23. Remove diaphragm cover and diaphragm. Remove governor line fitting s.
10. Remove the three mounting screws holding the governor housing to the carburetor body and remove housing.
11. Remove air horn and gasket. Discard gasket.

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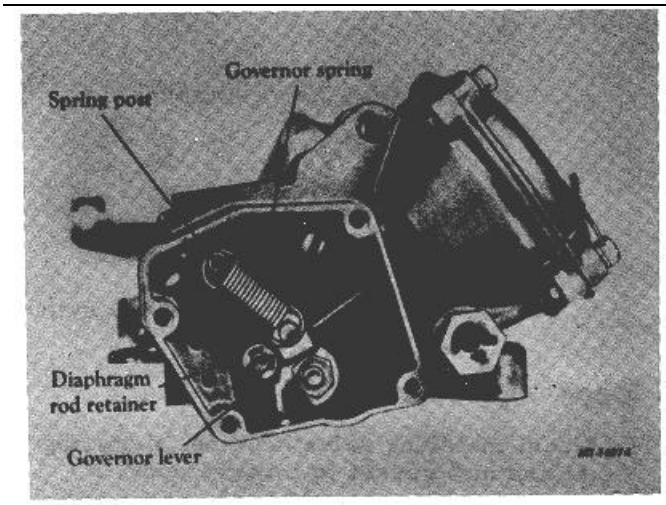


Fig. 23 Interior View of Governor Housing

12. Remove spark valve using socket wrench SE-1969-1, Figure 24. Discard valve and gasket.

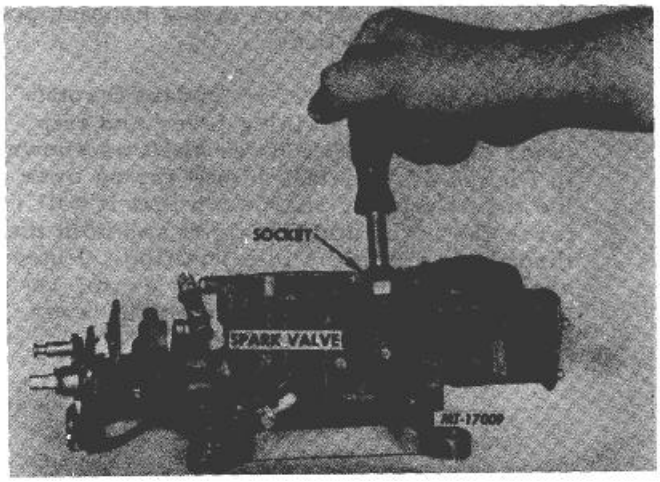


Fig. 24 Removing Spark Valve Using Socket Wrench, SE1969-1

13. Remove governor jet plug and governor jet. Remove idle fuel adjusting needle.

14. Remove five screws holding the carburetor mounting flange to the throttle body. Remove flange and gasket. Discard gasket.

15. If it is necessary to remove the throttle plates, lightly scribe the throttle plates along the throttle shaft and mark both plates and their corresponding bores with a number or letter for proper reassembly, Figure 25.

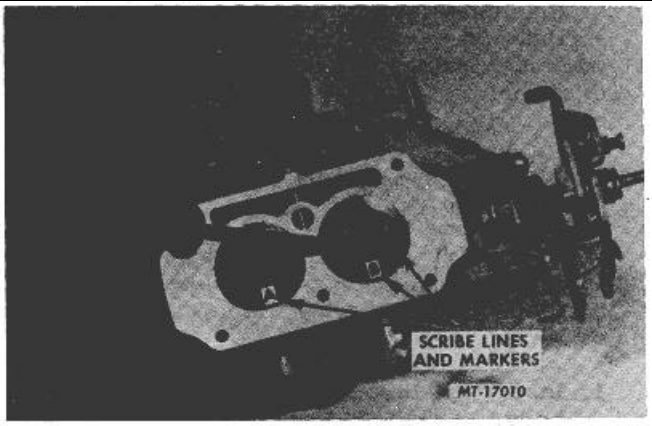


Fig. 25 Scribing Throttle Plates

16. File off staking from ends of throttle plate screws before removal or the threads will be stripped from the throttle shafts. Remove throttle plates. During replacement use new screws.

17. Remove throttle stop and slide throttle shaft out of the throttle body.

Cleaning and Inspection

Soak all parts in a standard carburetor cleaner. If a commercial solvent is not available, lacquer thinner or denatured alcohol may be used. Do not lower parts into sediment which settles to bottom of cleaning tank. Agitate parts while in solution to insure a thorough cleaning. After the parts have been sufficiently soaked, rinse them in hot water to remove all traces of the cleaning solution. Scrub away remaining foreign matter with a stiff brush (not wire) while rinsing parts and castings.

Dry all parts with compressed air. Also direct compressed air through jets, nozzles and passages in castings.

Always discard diaphragms. Reuse of old diaphragms may cause unsatisfactory carburetor performance.

NOTE: Carburetor jets and passages should never be cleaned with a drill, wire or similar object. This method of cleaning will distort jets and passages. A buffing wheel, wire brush, file or other sharp instrument should not be used to remove carbon deposits, since these tools might also remove the protective plating on the carburetor parts. Parts such as "O" rings, gaskets, diaphragms and seals should never be exposed to solvent because of its deteriorating effect on them.

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Inspect major castings for cracks, warpage, stripped screw threads or damaged mating surfaces. Passages in castings must be free of restrictions. If any irregularities are found, replace the casting with a new one.

Assembly

Make sure all holes in the new gaskets have been properly punched and that no foreign matter has adhered to the gaskets. Make sure the governor operating diaphragm is not cut or torn.

1. Insert the throttle shaft into the throttle body.

   Referring to the lines scribed on the throttle plates, install the throttle plates in their proper location with the screws snug but not tight. Close the throttle plates and hold the throttle body up to the light. Little or no light should show between the throttle plates and the throttle bores. If the throttle plates are properly installed and there is no binding when the throttle shafts are rotated, tighten and stake the throttle plate screws.

2. Mount carburetor mounting flange and new gasket to throttle body.

3. Install new spark valve and gasket using socket wrench, SE 1969-1, Figure 24.

4. Install governor jet, governor jet plug and idle fuel adjusting needle.

5. Install air horn and new gasket.

6. Mount governor housing to throttle body. Install governor line fittings.

7. Position the governor diaphragm in the governor housing. Position the diaphragm properly to avoid damage by the screws. Install the cover with the screws finger tight. Pull the diaphragm rod as far as it will go and tighten the cover screws. Install new safety wire and seal.

8. Place governor lever in the housing and insert the diaphragm rod on the smallest stud of the lever, Figure 25. Install retainer.

9. Install governor spring on spring pin and governor lever stud. Install housing cover and new safety wire with seal.

10. Install metering valve assembly in metering valve housing, Figure 26.

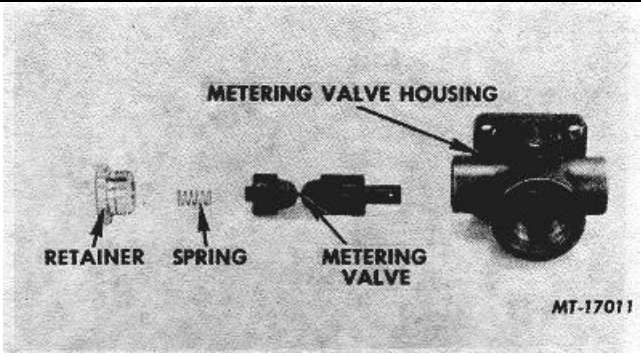


Fig. 26 Metering Valve Assembly

11. Mount metering valve housing, metering jet and new gasket to throttle body.

12. Install idle air-fuel adjusting needle.

13. Referring to the line scribed on the metering valve shaft end and metering valve lever, assemble and install drag link adjusting linkage and metering valve lever, Figure 22.

14. Reassemble throttle operating housing and mount to throttle body.

15. If so equipped, locate redundant throttle closing linkage retaining lever and trip lever on the throttle lever shaft as shown in Figure 27. Install safety spring over the throttle lever shaft such that it will force the notch and tab apart and hold the throttle lever in the idle position. Place spacer washer, safety spring drum, retaining washer and nut on throttle lever shaft. Tighten nut securely.

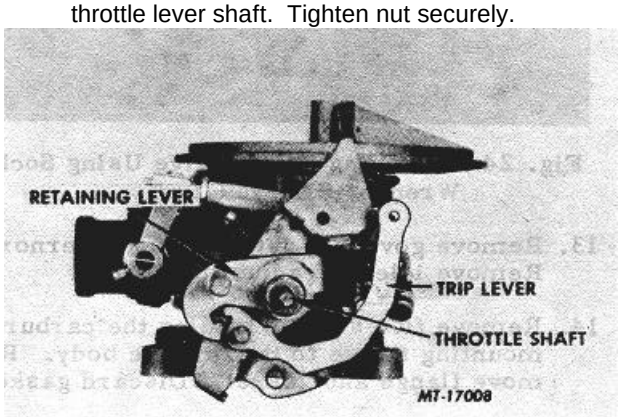


Fig. 27 Installation of Throttle Levers

16. When the proceeding steps have been completed, the carburetor is ready for installation. Refer to the (Removal and Installation) portion of this carburetor section for installation procedures.

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Carburetor Adjustments

All adjustments to LPG carburetors are to be made by certified mechanics with the use of an appropriate CO analyzer. In general, the carburetor will be set to obtain an idle CO in the range of .5 to 1.0% for best emission control with minimum loss in engine performance.

Due to the differences in the molecular structures of gasoline and LPG in their natural state, the same distribution of components will not be present in their exhaust gases. Because of this condition only infrared type CO analyzers can be attested for their reliability and accuracy for LPG measurements. The engine should be at normal operating temperature when making carburetor adjustments. Idle speeds, transmission positions, air conditioner settings, etc., specified when making adjustments to gasoline carburetors should be retained when adjusting LPG carburetors.

1. Connect tachometer to engine (tachometer should have an expanded scale of 400-800 or 0-1000 RPM and 1 to 2% accuracy).

2. Calibrate infrared CO analyzer to the manufacturer's specifications and insert probe as far as possible in the exhaust pipe.

3. With engine running at idle and CO analyzer operating, slowly close idle adjusting needle until seated, Figure 28.

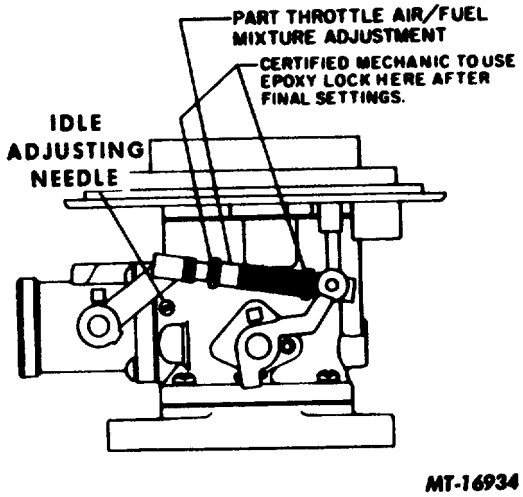


Fig. 28 Carburetor Adjustments

4. Adjust part throttle air fuel mixture drag link to obtain 0.25% CO at 100 RPM below desired RPM, Figure 28.

5. Adjust idle fuel needle to obtain approximately .75% CO.

6. Rotate idle speed (RPM) adjustment screw for desired RPM, Figure 29.

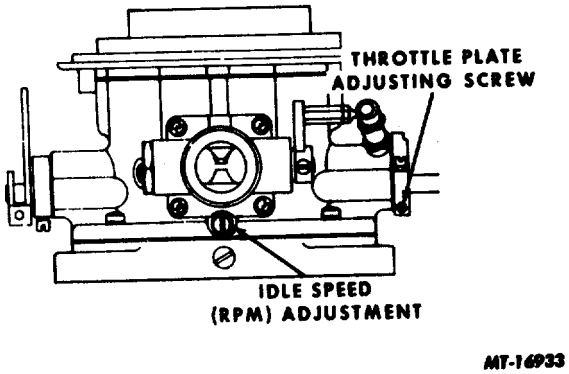


Fig. 29 Carburetor Adjustments

NOTE: The throttle plates position is adjusted at the factory and should only be adjusted in the field, if a sufficient idle speed cannot be obtained by the above procedure. Before making any adjustments to the throttle plates, check for dirt or other foreign matter in the small venturi which could cause a low idle condition.

If the throttle plates must be adjusted on non governed carburetors, it may be necessary to heat the Allen head adjusting screw to 300 to 400 degrees F in order to melt the loctite before adjustments can be made, Figure 29. Apply additional loctite after adjusting.

On governed carburetors, the throttle plate position may be adjusted by rotating the throttle plate adjusting screw shown in Figure 22.

7. Torque lock nuts on air-fuel mixture drag link and recheck CO values.

Governor Adjustment

The procedure outlined below should be followed when making a governor spinner adjustment.

NOTE: It is necessary to use a tachometer to adjust engine RPM.

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Adjust the governor spinner so that engine speed will cut off within the engine no-load cutoff range (see specifications).

1. Turn off ignition. Engine must be completely stopped.

2. Remove governor clamp and gasket assembly.

3. Turn engine over until adjusting screw hole plug appears in the opening.

4. Remove plug with 1/8" allen wrench, Figure 30.

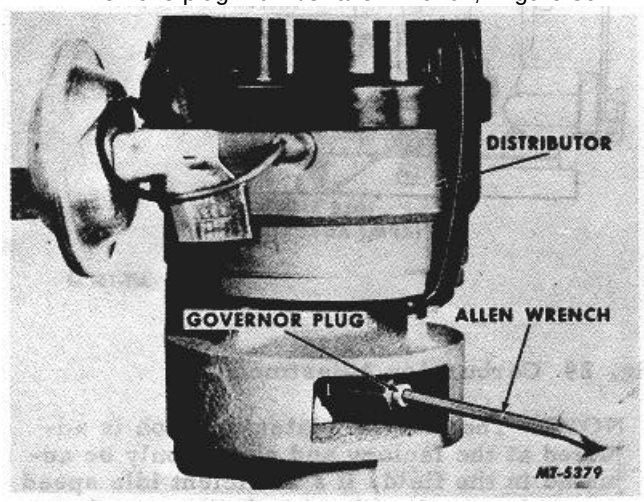


Fig. 30 using Allen Wrench to Remove Governor Plug

5. Insert slotted end of SE-2072-2 governor adjusting tool firmly in hole, engaging adjusting tang, Figure 31. Turn the handle clockwise to decrease speed and counterclockwise to increase speed; 1/4 turn will change the speed approximately 100 RPM.

   NOTE: The adjusting screw is of a special design. The spinner cannot be adjusted with a screwdriver or by any device other than this tool.

6. Reinstall plug with 1/8" allen wrench. Fig. 30 Using Allen Wrench to Remove Governor Plug

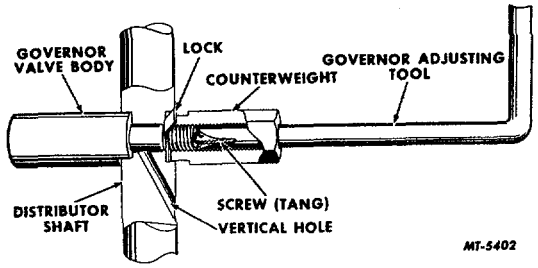


Fig. 31 Adjusting Governor Using Tool, SE2072-2

7. Reinstall governor clamp and gasket assembly.

8. Reinstall governor seal.

LPG SYSTEM
TROUBLE SHOOTING GUIDE

TROUBLE	DIAGNOSIS	CORRECTION
	Fuel Strainer	
Restricted fuel flow.	Filter pack plugged.	Replace filter pack.
	Fuel strainer bowl clogged.	Purge strainer bowl.
	Fuelock	
LP-gas to fuelock. Fuelock does not pass fuel. .	Defective ignition switch.	Repair or replace.
	Blown Fuse.	Replace.
	Fuelock wire incorrectly connected to ignition switch.	Correct to "run" side of switch.
	Poor electrical connection or loose wire. Wire may be broken inside of insulation.	Repair or replace.

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TROUBLE	DIAGNOSIS	CORRECTION
	Fuelock (Continued)	
LP-gas to fuelock, Fuelock does not pass fuel (con't).	Fuelock connected to low voltage side of ignition resistor or connected to ignition lead with built- in resistance.	Reconnect for full voltage.
	Defective coil.	Replace coil.
	Plugged jet.	Clean jet.
	Plunger sticking closed.	Clean or replace plunger and tube.
	Fuelock improperly assembled.	Assemble correctly.
	Battery voltage too low when cranking.	Check electrical system.
Fuelock does not shut off.	Current to fuelock from source other than ignition or safety switch.	Inspect wiring.
	Damaged valve seat or jet.	Replace damaged parts.
	Dirty valve plunger, seat or jet.	Clean all operating parts.
Coil life too short.	Intermittent connection.	Tighten loose connections.
	Plunger does not open fully.	Clean plunger and tube.
Insufficient fuel through fuelock.	Fuel tank valve partially closed.	Open tank valve.
	Tank vapor valve open on liquid withdrawal system.	Open liquid valve and close vapor valve.
	Restricted fuel line or fittings.	Repair or replace.
	Restricted filter.	Clean or replace filter element.
	Fuelock plunger travel limited.	Clean plunger and tube assembly.
	Fuelock plunger return spring incorrectly installed.	Install spring correctly.
	Converter	
No fuel or insufficient fuel to carburetor	Restricted or damaged fuel vapor hose to carburetor.	Clean or replace.
	Pipe dope blocking primary inlet passage.	Clean inlet.
	Primary regulator spring missing.	Replace spring.
	Secondary valve seat stuck.	Repair.
	Secondary levers out of adjustment.	Adjust to specifications.

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TROUBLE	DIAGNOSIS	CORRECTION
	Converter (Continued)	
Primer does not cause fuel to pass.	Incorrect or loose primer wiring.	Repair.
	Defective push button switch.	Replace.
	Defective primer coil.	Replace.
	Primer plunger does not strike diaphragm button.	Adjust secondary lever to specifications.
Fuel leaking through converter (primary pressure high).	Primary valve seat dirty or defective.	Clean or replace.
	Leaking primary diaphragm.	Replace.
	Distorted or worn primary valve lever.	Replace.
	Loose primary lever pivot pin.	Repair.
	Primary spring or washers installed incorrectly.	Repair.
Fuel leaking through converter (primary pressure normal)	Secondary valve seat dirty or damaged.	Clean or replace.
	Secondary spring missing.	Replace.
	Secondary lever incorrectly set.	Adjust secondary lever to specifications.
	Primer actuated.	Trace wiring and correct.
	Primer plunger touching diaphragm button, gasket omitted.	Replace primer gasket.
Freezing or frosting of converter.	Restricted coolant lines.	Repair or replace with larger lines.
	Internal fuel leak.	Replace body casting.
	Low coolant level.	Add coolant.
	Defective water pump.	Replace water pump.
	Air lock in converter.	Remove top water plug in converter and bleed air from system.
	Thermostat missing or defective.	Replace.
	Head gasket leaking.	Replace.

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TROUBLE	DIAGNOSIS	CORRECTION
	Carburetor	
Hard Starting.	Defective Ignition--may include points, plugs, distributor, generator or alternator, voltage regulator, battery and starter.	All components of the electrical and ignition systems should be set to manufacturer's specifications. A low battery defective voltage regulator or starter drag may reduce available ignition voltage below that required for good starting.
	Leaking vapor hose.	Repair or replace.
	Defective converter.	Inspect and test converter for proper operation.
	Defective fuelock.	Repair.
	Plugged filter element.	Replace filter.
	Carburetor improperly adjusted.	Adjust to specifications.
Rough Idle.	Defective Ignition (see hard starting).	Repair Ignition (see hard starting).
	Burned valves.	Check compression to manufacturer's specifications.
	PCV valve stuck.	Clean or replace.
	Intake manifold leak.	Repair.
	Carburetor improperly adjusted.	Adjust idle setting.
Poor acceleration or power loss under load.	See "Hard Starting" and "Rough Idle" causes.	See "Hard Starting" and "Rough Idle" corrections.
	Restricted vapor line.	Use 1-1/2" I.D. vapor hose from converter to carburetor.

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UNIT	ENGINE MODELS			
	RD - 501	V - 304	V - 345	V - 549
CARBURETOR:				
Part Number (IH)	- - -	443129-C91	443130-91	- - -
Part Number (Century)	2192	2527	2251-E	2192
Model	3C-G709	3C-705DT	3C-G705DT	3C-G709
Type	Metering Valve	Metering Valve	Metering Valve	Metering Valve
Spray Ring (Venturi) Size	No. 76	1 3/16 In.	1 1/4 In.	No. 64
Throttle Orifice	No. 19	No. 16	No. 16	No. 19
Metering Valve Size	L-5 1 1/4 In. NPT	R-1 3/4 In. NPT	R-1 3/4 In. NPT	L-5 1 1/4 In. NPT
Idle Speed	See Engine Exhaust Emission Control Information Decal			
CONVERTER:				
Part Number (century)	2504 A	2504 A	2504 A	2540 A
Model	M-6	M-6	M-6	M-6
Type	Two Stage	Two Stage	Two Stage	Two Stage
Capacity (Horsepower)	350 HP	350 HP	350 HP	350 HP
Working Pressure	250 PSI	250 PSI	250 PSI	250 PSI
FUELOCK - STRAINER ASSEMBLY:				
Part Number (I.H.)	160651-R91	243698-R91	243698-R91	160651-R91
Model	STF-020 A	STF-020A3	STF-020A3	STF-020A
Capacity	120 GPH @ 30 PSI	60 GPH @ 100 PSI	60 GPH @ 100 PSI	120 GPH @ 30 PSI
Orifice	.141 In.	.140 In.	.140 In.	.141 In.
Lift On Plunger	.034 In.	.034 In.	.034 In.	.034 In.
Strainer Element	Chamois Skin & Felt	Chamois Skin & Felt	Chamois Skin & Felt	Chamois Skin & Felt
GOVENOR:				
Spring Color	Yellow	- - -	Green	Plain
Spring Anchor Post Fosition	No. 1 Post	- - -	No. 2 Post	No. 1 Post
Hole Below Fly	.040 In.	- - -	.052 In.	.040 In.
Bleed Orifice	None	- - -	.038 In.	None
Governed Speeds	See Engine Exhaust Emission Control Information Decal			
IGNITION SYSTEM:				
Dwell	See Engine Exhaust Emission Control Information Decal			
Point Gap	" " " " " " "			
Spark Plug Type	J-6 or RJ-6	J-6 or RJ-6	J-6 or RJ-6	J-6 or RJ-6
Spark Plug Gap	.015-.020 In.	.015-.020 In.	.015-.020 In.	.015-.020 In.
Ignition Timing	10 Degrees BTC	8 Degrees BTC	10 Degrees BTC	12 Degrees BTC

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UNIT	ENGINE MODELS			
	MV - 404 2 BBL. GOV.	MV - 404 2 BBL NON-GOV	MV - 404 4 BBL GOV	MV - 446 4 BBL GOV.
CARBURETOR:				
Part Number (IH)	- - -	- - -	- - -	- - -
Part Number (Century)	2429	2430	2444	2444
Model	3C-G706	3C-706	3C-G706	3C-G706
Type	Metering Valve	Metering Valve	Metering Valve	Metering Valve
Spray Ring(Venturi) Size	1 5/16 In.	1 5/16 In.	1 5/16 In.	1 5/16 In.
Throttle Orifice	No. 18	No. 18	No. 18	No. 18
Metering Valve Size	P-9 1 In. NPT	P-7 1 In. NPT	P-9 1 In. NPT	P-9 1 In. NPT
Idle Speed	See Engine Exhaust Emission Control Information Decal			
CONVERTER:				
Part Number (Century)	2504 A	2504 A	2504 A	2504 A
Model	M-6	M-6	M-6	M-6
Type	Two Stage	Two Stage	Two Stage	Two Stage
Capacity (Horsepower)	350 HP	350 HP	350 HP	350 HP
Working Pressure	250 PSI	250 PSI	250 PSI	250 PSI
FUELOCK - STRAINER ASSEMBLY:				
Part Number (I.H.)	243698-R91	243698-R91	243698-R91	243698-R91
Model	STF-020A3	STF-020A3	STF-020A3	STF-020A3
Capacity	60 GPH @ 100 PSI	60 GPH @ 100 PSI	60 GPH @ 100 PSI	60 GPH @ 100 PSI
Orifice	.140 In.	.140 In.	.140 In.	.140 In.
Lift On Plunger	.034 In.	.034 In.	.034 In.	.034 In.
Strainer Element	Chamois Skin & Felt	Chamois Skin & Felt	Chamois Skin & Felt	Chamois Skin & Felt
GOVENOR:				
Spring Color	Green	- - -	Green	Green
Spring Acnchor Post Posticn	No. 2	- - -	No. 2	No. 2
Hole Below Fly	.052 In.	- - -	.052 In.	.052 In.
Bleed Orifice	.038 In.	.038 In.	.038 In.	.038 In.
Governed Speeds	See Engine Exhaust Emission Control Information Decal			
IGNITION SYSTEM:				
Dwell	See Engine Exhaust Emission Control Information Decal			
Point Gap	"	"	"	"
Spark Plug Type	RBN-4	RBN-4	RBN-4	RBN-4
Spark Plug Gap	.015-.020 In.	.015-.020 In.	.015-020 In.	.015-.020 In.
Ignition Timing	10 Degrees BTC	10 Degrees BTC	10 Degrees BTC	10 Degrees BTC

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UNIT	ENGINE MODELS		
	V - 537 2 BBL. GOV.	V - 537 4 BBL GOV.	
CARBURETOR:			
Part Number (IH)	- - -	- - -	
Part Number (Century)	2429	2415	
Model	3C-G706	3C-G706	
Type	Metering Valve	Metering Valve	
Spray Ring (Venturi) Size	1 5/16 In.	1 5/16 In.	
Throttle Orifice	No. 18	No. 18	
Metering Valve Size	P-9 1 In. NPT	P-7 1 In. NPT	
Idle Speed	See Engine Exhaust Emission Control Information Decal		
CONVERTER:			
Part Number (Century)	2504 A	2504 A	
Model	M-6	M-6	
Type	Two Stage	Two Stage	
Capacity (Horsepower)	350 HP	350 HP	
Working Pressure	250 PSI	250 PSI	
FUELOCK - STRAINER ASSEMBLY			
Part Nimber (I.H.)	243698-R91	243698-R91	
Model	STF-020A3	STF-020A3	
Capacity	60 GPH @ 100 PSI	60 GPH @ 100 PSI	
Orifice	.140 In.	.140 In.	
Lift On Plunger	.034 In.	.034 In.	
Strainer Element	Chamois Skin & Felt	Chamois Skin & Felt	
GOVENOR:			
Spring Color	Green	Green	
Spring Anchor Post Position	No. 2	No. 2	
Hole Below Fly	.052 In.	.052 In.	
Bleed Orifice	.038 In.	.038 In.	
Governed Speeds	See Engine Exhaust Emission Control Information Decal		
IGNITION SYSTEM:			
Dwell	See Engine Exhaust Emission Control Information Decal		
Point Gap	" " " " " " "		
Spark Plug Type	RN-11Y	RN-11Y	
Spark Plug Gap	.015-020 In.	.015-020 In.	
Ignition Timing	10 Degrees BTC	10 Degrees BTC	

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GENERAL INFORMATION

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1. GENERAL INSTRUCTION

Adequate protection and storage of new vehicles is a strict responsibility of the dealer or branch.

The following procedures are to be used for storing all vehicles. Satisfactory storage arrangements are less costly and troublesome in the long run than haphazard, unplanned methods.

Claims arising from loss and damage that occur while the vehicle is in storage will not be considered for reimbursement by the Warranty Processing Center.

As rapid stock turnover is desirable, sales efforts should be centered on those vehicles that have been on hand and in storage for the longest period of time.

Check your own arrangements against the following suggestions and correct situations which create unnecessary expense and selling problems.

Parking Area

Whenever possible, vehicles should be stored indoors in a dry, well ventilated area and protected from sunlight. When circumstances do not permit, definite precautions must be taken to eliminate conditions which would result in product deterioration, unwarranted expense, and later customer dissatisfaction.

CAUTION:

A. Do not park near transformers or electrical motors, as when the protection wax contained in the tire compound cracks, ozone in the air will attack the exposed area.

B. Do not park near trees, or where high weeds or grass exist. This will prevent damage from birds, tree and weed sap or insects which cause stain.

C. Do not park near railroad tracks, industrial smoke areas, paint shops, or where street and road splash could contact vehicle.

D. When the vehicle cannot be parked on a level surface, block wheels.

Body-Cab

A. If necessary wash vehicle. Washing should be followed by wiping of horizontal surfaces to remove any water. Never wash the vehicle in the direct rays of the hot sun nor when the sheet metal is hot to the touch, as this may cause streaks on the finish. Do not use hot water or strong soaps or detergents or wipe off dirt when the surface is dry as this will scratch the paint.

B. WAXING OR POLISHING NEW VEHICLES

Prior to use of any wax or polish, vehicle must be thoroughly washed.

C. Carefully check the paint and touch up all exposed primed or raw metal surfaces to prevent rust.

D. Clean and wax all chrome and stainless steel metal parts with a thick coat of custom auto wax to prevent discoloration from the elements. NOTE: After each washing be sure that the chrome and bright metal parts are rewaxed as necessary.

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2. FOURTH MONTH STORAGE SERVICE

The operations defined below should be performed on all new vehicles which have been in storage four months.

Operations To Be Performed

A. Start engine and operate at fast idle until normal engine operating temperature is reached.

B. Operate air conditioner (if equipped) for a few moments.

C. Rinse wash vehicle.

D. Touch up any paint damage.

E. Clean and wax bright metal.

F. Check battery water level and specific gravity. NOTE: If gravity is under 1.225, recharge battery.

G. Check radiator coolant level. Also check coolant for adequate freeze protection.

H. Install fuel tank rust inhibitor kit No. 285037-C91 (steel tanks only).

I. Check to assure all tires are inflated (visually).

J. Drive vehicle to parking area. Refer to parking area Cautions outlined under General Instructions.

K. Drain air brake reservoir(s), then close drain cock.

L. Cover end of vertical exhaust stacks.

M. Disconnect battery(s) ground cable. This will prevent accidental starting, or shorting of the electrical system.

N. To prevent fading of the interior trim when the vehicle is exposed to the ultraviolet rays of the sun, spray or apply a coating of Bon-Ami or similar substance on the inside of the windshield and windows.

3. ONCE A MONTH STORAGE SERVICE AFTER FOUR MONTHS

A. Remove vertical exhaust stack covers.

B. Connect battery(s) ground cable.

C. Start engine and operate at fast idle until normal engine operating temperature is reached.

D. Operate air conditioner (if equipped) for a few moments.

E. IMPORTANT: Where vehicles are stored outside, particularly along coastal areas, paint and bright metal deterioration will be more rapid due to prevailing salt water atmosphere and high humidity. For this reason it may be necessary to wash the steel metal parts once a month. This operation must be determined by the brance or dealer.

F. Check tire pressure visually.

G. Engage and disengage clutch and parking brake.

H. Disconnect battery(s) ground cable. This will prevent accidental starting or shorting of the electrical system.

I. Install vertical exhaust stack covers.

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BALL AND ROLLER BEARING MAINTENANCE

Important-In order to assure bearings being free of rust, dirt, or damage, the following procedure relative to handling, and installation is recommended:

1. Cleansing and Lubrication of Bearings

   (a) Use clean kerosene or Stoddard Solvent in a clean container.

   (b) Use clean, lint free rags or towels, and never use waste. Lint from waste may enter bearing.

   (Note: Suitable wheel bearing cleaner equipment is available, which will facilitate bearing cleansing.)

   (c) Dip bearing in kerosene several times, rocking bearing race rings slowly to dislodge grease from ball sockets.

   (d) Spin bearing while repeatedly dipping into kerosene. Continue operation until bearing runs smoothly and quietly or until it is clean and ready for inspection.

   (e) If bearing is found satisfactory, dip in a neutral oil or thin grease and wrap. (Note: Suitable wheel bearing grease packer equipment is available, which will produce excellent results.)

2. Removal and Installation of Bearings

   (a) Shafts or housings must be clean and free from burrs.

   (b) Use properly arranged press plates or arbors for installation or removal of bearings.

   In pressing bearings into place the pressure or load should be so applied that it will not be transferred through the balls.

   For example, if bearing is applied to or removed from shaft, pressure should be applied to inner bearing cone. If bearing is being installed in or removed from a housing or case bore, pressure should be applied to outer bearing cup.

   (c) Do not hammer on bearings. Lead or babbitt hammers may chip off and allow pieces to lodge in bearing. Wooden hammers may leave splinters in bearings. Steel hammers will chip, crack, or Brinell the bearing.

   (d) If necessary to heat bearing for installation or removal, use a light or medium-weight oil heated to 225°F. Allow bearing to stand in this oil until thoroughly heated.

   (e) Upon installation of bearing, lubricate bearing seat with light oil.

   (f) Apply steady pressure. If bearing sticks or binds, ascertain cause. Correct fault and then proceed with operation. A bearing started in a cocked position will bind.

   Burrs in housings or on shafts will cause severe binding and sticking.

   Bearing should rest squarely against shoulder or in recess.

   (g) Bearing should roll freely after installation unless individual specifications call for a preload. Test bearing for bind or drag by holding bearing outer race between thumb and finger, and test for side play. (A radial clearance of .0001" will produce side play of approximately .005" to .006".) Shafts mounted in bearings should rotate freely after installation unless individual specifications call for a preload. Test by revolving shaft assembly.

3. Intermixing of Component Parts-Roller Bearings

Wherever possible, intermixing of roller bearing component parts should be discouraged. Therefore, where possible, IH parts should be used to service IH assemblies.

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STEEL AND ITS HEAT TREATMENT

The heat treatment of steel consists of annealing, hardening and tempering.

Annealing

Annealing consists of heating above the "critical range", then cooling slowly, for the purpose of refining the grain, softening the steel to machinability and relieving the internal strains set up in the steel by forging and hammering, these strains sometimes amounting to several thousand pounds per square inch.

Hardening

Hardening consists of heating above the critical range and cooling quickly, as by quenching in oil or water, the degree of hardness depending upon the carbon content of the steel and the severity of the quench.

Tempering

Water quenching is more severe than oil quenching and is frequently followed by tempering or drawing to reduce the brittleness imparted by the severity of the quench.

Casehardening or Carburizing

Carburizing, carbonizing or casehardening are names applied to the process wherein a piece of low-carbon steel is packed in a carbonaceous material such as bone or leather, or a commercial carburizing material and heated for a number of hours, just above the "critical range" of the steel, or above its point of decalescence, thereby causing the low-carbon steel to absorb carbon on the outer surface for a depth directly dependent upon the number of hours it is heated. Under such conditions, a carbonized case is produced which is capable of responding to ordinary hardening or tempering operations.

Brinell Test

The Brinell test is commonly made with a hydraulic testing machine in which a steel ball of ten millimeter diameter is pressed into the test piece by a load of three thousand kilograms. The diameter of the impression the ball produces in the test piece is then measured and checked against a standard. Thus an impression four millimeters in diameter indicates softer steel than a diameter of three and onehalf millimeters.

The Brinell test is definitely related to the ultimate strength of the material.

Scleroscope Test

The Shore Scleroscope test is made with a small instrument which drops a diamond-tipped hammer approximately ten inches through a small glass tube upon a smooth surface of the steel to be tested, and the height of the rebound of the hammer measured against a scale at the back of the glass tube. Hard steel is taken as being 100 hard on the Scleroscope and soft steel approximately 30 to 35 hard.

Tensile Test

A test bar of the standard S.A.E. form is machined from the material to be tested, and is held in threaded grips in a vertical position in the testing machine. The machine is set in motion and the test bar is slowly stretched until it is broken. The point at which the elongation ceases to be proportional to the load is designated as the elastic limit. This is the highest point at which, if the load were removed, the bar would resume its original length. This is also the point at which, if exceeded, failure of the part commences. The weight of the load at this point is read on the weighing beam of the testing machine and converted into pounds per square inch, to be checked against S.A.E. specifications for that particular steel from which the test bar was made.

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GLOSSARY OF TECHNICAL AND MECHANICAL TERMS

Absorption

The action of a material in extracting substance from the atmosphere (water from air, etc.).

Allowance

Covers variation in dimensions to allow for different qualities of fits.

Alloy Steel

A steel which owes its characteristic properties chiefly to the presence of one or more elements other than carbon; i.e., nickel, chromium, vanadium, molybdenum, etc.

Angle

The difference in direction of two lines which meet or tend to meet. The lines are called sides, and the point of meeting, the vertex of the angle. They are measured by degrees and by radians. One degree is equivalent to the angle at the center of a circle, subtended by an arc whose length equals one three hundred sixtieth (1/360) of the circumference. One radian is equal to the angle at, the center of a circle when subtended by an arc equal in length to the radius of the circle. One radian equals 57.2958 degrees; also 1 radian equals $180/\pi$

The protractor is used for the measurement of angles. A right angle is one which is formed by the radius moving through 1/4 of the circumference. It is a square angle and contains 90°.

An acute angle is one containing less than 90ø. An obtuse angle is one containing more than 90°.

An oblique angle may be any other than a right angle. A reflex angle is one containing more than 180°.

A helical angle is the angle of a thread at the pitch line with the axis of a threaded part; the lead angle of a thread is the total or included angle between the sides or walls of a thread measured on the axial line.

A dihedral angle is one formed by the opening between two intersecting planes.

The vertex of an angle is the point of intersection of the two lines which form the angle.

Brinell Test

A hardness-testing instrument, employing the hardened steel ball indentation method.

B.T.U.

Abbreviation for British Thermal Unit which represents the amount of heat required, to raise the temperature of one pound of water one degree Fahrenheit at or near 32øF. There are 778 foot-pounds of energy in a B.T.U. and 42.4 B.T.U. to one horsepower.

Calibrate

To ascertain the accuracy of and to rectify same, as regards a precision measuring instrument, etc.

Calorie

Any of several thermal units, as: (a) The amount of heat (small calorie) required to raise the temperature of one gram of water one degree Centigrade. (b) The amount of heat (large or great calorie) required to raise a kilogram of water one degree Centigrade. (1 great calorie equals 1000 small calories.)

Cantilever

A projecting beam, bar, or member supported at one end only.

Center of Gravity

That point in a body about which all the parts exactly balance each other.

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Center of Oscillation

If a body oscillates about a horizontal axis which does not pass through its center of gravity, there will be a point on the line drawn from the center of gravity perpendicular to the axis, the motion of which will be the same as if the whole mass were concentrated at that point. This point is called the center of oscillation.

Centrifugal Force

When a body revolves in a curved path, it exerts a force called the centrifugal force upon the arm or cord which restrains it from moving in a straight (tangential) line.

Chamfer

A bevel, or a corner or edge removed, a relief.

Cold Working

Changing the shape of steel parts by compressing, stretching, bending, or twisting, using stresses beyond the yield point and temperatures below the critical range. Cold-drawn steel is finished by being drawn through a die, while cold-rolled steel is finished between rollers.

Contour

Outline or profile of an object.

Cycle

Applied to the internal-combustion, four cycle engine, a cycle comprises four strokes for each piston (1, intake; 2, compression; 3, explosion; 4, exhaust) performed during two revolutions of the crankshaft. An interval or period of time occupied by one round or course of events, recurring in the same order in a series.

Ductility

Ability to withstand stretch without rupture. Ductility is usually measured by the percentage of elongation, after rupture over a gauge length laid off on a specimen before stretching, or by the reduction of area of the original cross section of a specimen when tested in tension.

Dynamic Balance

A crankshaft may be in perfect static balance, but if it is mounted in bearings and revolved at high speed great vibration may develop which would soon cause failure of engine bearings and possibly cause breakage of the shaft itself due to fatigue action.

Dynamic unbalance means that the weight sums of diagonally opposite portions are not equal. Take, for example, a pulley that is in perfect balance. Visualize the pulley mounted on a shaft supported by bearings. Attach a weight to the outer periphery on one edge of the pulley, then attach an exact counterweight to the opposite side of the pulley on the opposite edge. The pulley continues to be in static balance as evidenced by the fact that it turns freely and stops with the counterweights either up, down, or in any other position; but if the pulley is revolved at a high rate of speed its dynamically unbalanced condition will be very much evidenced by the vibration. This dynamic unbalance is eliminated in a crankshaft first by determination of the heavy points and next by drilling into these points until the necessary amount of metal and weight has been removed.

Elastic Limit

The term "elastic limit" is unfortunately used very loosely in general practice. In scientific usage the term is used to denote the highest unit stress at which material will completely recover its form after the stress is removed.

Endurance

In the physical laboratory this term is used to denote the number of cycles of repeated stress withstood by a specimen before failure.

Factor of Safety

Working stresses should never exceed the elastic limit. They are generally based on the ultimate strength of the material. The ratio of the ultimate strength of a given material to the allowable working strength is called the "Factor of Safety".

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Fatigue of Metals

The action which take s place in metals causing failure after a large number of applications o stress. Fatigue failures are characterized by their suddenness and by the absence of genera: deformation in the piece which fails. A wire broken by bending backward and forward is a characteristic fatigue failure.

Cause of Fatigue Failure

The cause of a fatigue failure may be attributed to a repetition of stresses which exceed the elastic limit of the steel. This may be subdivided as follows:

Manufacturer's Responsibility
1. Defective raw material.
2. Defective heat treatment.
3. Defective design.
4. Defective machining.

Truck Operator's Responsibility
1. Overloading.
2. Overspeeding.
3. Rough handling and driving.
4. Road conditions.

Fit

The different classes of fit of shafts in their holes most generally used are as follows:

Shrink Fit-For parts which have to be fitted together by means of an application of heat to expand the hole, at which time the shaft is inserted. On cooling the hole contracts, making a perfect union which requires no keys or other anchors of any kind. The bores are always machined to a smaller diameter than that of the shaft.

Force Fit-For parts which have to be fitted together by means of a press; they must be keyed if they are to be subjected to a twisting force.

Driving Fit-For parts which have to be fitted together with a soft hammer, but which can be afterwards disassembled.

Push Fit-For parts which have to be fitted together by hand without special force, and without having perceptible shake when assembled, they should remain motionless in each other.

Sliding Fit-For all parts which in functioning have to slide constantly on one another, without turning.

Running Fit-For parts which in functioning have to revolve constantly one in the other, at a medium speed and with very little play.

Easy Running Fit-Parts revolving with a relatively large amount of play.

Fillet

A narrow band of material, frequently in shop practice used to designate a radius on a shaft or other part.

Flute

The groove cut in taps and reamers to form the cutting edge and allow room for chips.

Friction

Is the resistance to motion which take s place when one body is moved upon another, and is generally defined as "That force which acts between two bodies at their surface of contact, so as to resist their sliding on each other."

Gauge or Gage

Master, Standard or Reference; terms applying to a nearly perfect gauge used for calibration of working gauges.

Gauge-Limit

A gauge having two sizes, the difference between them representing the tolerance or allowable variation. One size must go into or over the work being checked, and the other size must not go. These gauges are frequently referred to in shop practice as "tolerance gauges" and as "go" and "no go" gauges.

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Gear Tooth Parts

The outside diameter of a gear is the diameter measured over the top of the teeth.

The root diameter of a gear is the diameter measured at the bottom or roots of the teeth.

The center distance is the distance between the centers of two meshing gears, the pitch circles of which are tangent to each other.

The diametral pitch of a gear is the number of teeth for each inch of pitch diameter, and is found by dividing the number of teeth by the pitch diameter.

The circular pitch is the distance from the center of one tooth to the center of the next, measured as an arc along the pitch circle.

The working depth is the depth to which the teeth in a meshing gear enter into the spaces between the teeth of the opposing gear.

The clearance is the amount by which the tooth space is cut deeper than the working depth.

The face of the tooth is that part of the tooth curve that is between the outside circumference and the pitch circle.

The flank of the tooth is that part of the working depth of the tooth which comes inside of the pitch circle.

Gravity

The attraction of bodies toward the center of the earth. Under the influence of gravity alone, all bodies fall to the earth with the same velocity and with the same acceleration. The acceleration increases with the latitude and decreases with the elevation above the level of the sea. Its value at the level of the sea in the latitude of New York is 32.16 feet per second. (In the metric system, Gravity equals 9.81 meters per second at 45 degrees latitude and sea level.)

Hardness

Is that property of a material by virtue of which it resists penetration.

Helix

A spiral. A coiled spring or a screw thread forms a helix. Also, a spiral cut on the side of injection plunger for metering fuel.

Hydraulics

The science dealing with liquids in motion.

Hypoid

Hypoid (contraction of the word hyperboloid) meaning that the pinion is offset with respect to the center line of the ring gear.

Inch-Pounds

A term used to denote work or energy.

Land

One of the sharpened ridges which make up the cutting section of a tap, die, reamer or milling cutter after the flutes or chip clearance spaces have been removed.

Lead

The longitudinal distance which a screw thread advances when turned one complete revolution.

Horsepower

Horsepower (abbreviated H.P.) is the unit of power adopted for engineering work. One horsepower is equal to 33, 000 foot-pounds per minute, or 550 foot-pounds per second. The metric horsepower is equal to 75 kilogram-meters per second, or 542.5 foot-pounds per second, or 32,550 foot-pounds per minute. The kilowatt used in electrical work equals 1.34 horsepower; or one horsepower equals 0.746 kilowatt.

Velocity

Velocity is distance divided by time, and is expressed in feet per minute, miles per hour, etc.

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Inertia

Inertia is that property of a body which causes it to tend to continue in its present state of rest or motion, unless acted upon by some force.

Micrographs

Micrographs are obtained by polishing the surface of a metal, etching the polished surface with a suitable reagent to bring out the metallographic structure, then reproducing, usually by photographic methods, the appearance of the surface as seen through the microscope. Photomicrograph and microphotograph are terms sometimes used for micrographs made by a photographic process.

Momentum

The momentum of a moving body is the intensity of that constant force which, resisting its movement, would bring it to rest in one second.

Momenturn=mass X velocity in feet per second

$$\text{Momentum} = \frac{\text{weight}}{32.16} \times \text{velocity in feet per second}$$

Momentum should not be confused with the moment of a force.

Motion, Newton's Three Laws

1st Law: Every body continues in a state of rest or uniform motion in a straight line, except if it is acted upon by a force to change its state of motion or rest.

2nd Law: If a body is acted upon by several forces, it is acted upon by each of these as if the others did not exist. This is true whether the body is at rest or in motion. In other words, if two or more forces act upon a body at the same time, each produces exactly the same effect as if it acted alone; the total effect or resultant motion of all the forces may be found by a diagram in the same way as the resultant of forces is found.

3rd Law: To every action there is always an equal reaction or, in other words, if a force acts to change the state of motion of a body, the body offers a resistance equal and directly opposite to the force.

Physics

The science of phenomena of inanimate matter involving no chemical changes, comprising mechanics, magnetism, electricity, light, heat and sound.

The 16th letter of the Greek alphabet, corresponding to the English P, is used as a constant to denote the ratio (3.14159+) of the circumference of a circle to its diameter.

Pneumatics

That branch of physics treating of the mechanical properties of air and other gases, as of their weight, pressure, elasticity, etc.

Refrigerant

A substance which produces a refrigeration effect by its absorption of heat while expanding, vaporizing or evaporating. Evaporation is a cooling process.

Static Balance

Balancing of crankshafts is a very important factor in providing long engine life. Crankshafts must be balanced for equalization of weight so that when supported on knife blades the shaft will not revolve. This is the same condition of balance that would obtain with an automobile wheel if a slight counterweight were placed directly opposite the valve stem so that the wheel, if jacked up and given a spin, would stop and remain stationary wherever it was overtaken by inertia after the energy from the force of the spin had spent itself. If not in perfect balance, the wheel would either turn over another revolution or turn back until the heavy point was down.

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Elimination of the heavy place on a crankshaft is termed static balancing. This is accomplished by grinding off portions of the balancing pads forged into both sides of each throw for that purpose.

Stress

An internal force which resists the destructive action of external force. Stresses are always accompanied by strains and deformations. There are tensile stresses, compressive stresses, and shearing stresses. At any point on a stressed member the stress per unit area is called the "unit stress". Stress is the force applied, and:

Strain

Is the resulting deformation.

Specific Gravity

Is a number indicating how many times a certain volume of material is heavier than an equal volume of water at a temperature of 62°F. The weight of one cubic inch of pure water at 62°F. is 0.0361 pound. If the specific gravity of any material is known, the weight of a cubic inch of the material can, therefore, be determined by multiplying its specific gravity by 0.0361.

Tolerance

The range of distance between specified limits, as applied to machine shop practice.

Torsion

That force with which a twisted part tends to return to a state of rest.

Torque

Torque is that which produces or tends to produce rotation or torsion; the product of tangential force multiplied by the radius of the part it rotates. An engine is, therefore, essentially a device for producing torque, and torque is the energy available for producing work.

Toughness

Denotes a combination of strength and ductility, resistance to fatigue, tension and shear.

Vapor

The gaseous form of substances which are normally in the solid or liquid state and which can be changed to these states by increasing pressure or decreasing the temperature.

Volatile

Readily vaporizable (examples: freon, either, gasoline, alcohol, L.P. gases, etc.).

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GLOSSARY OF ELECTRONIC TERMS

Ampere: The practical unit of electrical current; the current produced by one volt acting through a resistance of one ohm.

Amplifier: An electrical device containing transistors, diodes and resistors used for controlling current flow.

Arc-Over: The result of electrical current passage through other than a designated route.

Biasing Resistor: Resistor used to develop a voltage drop and provide transistor operation at other than ground level.

Bypass Resistor: Resistor used to provide fixed current path around some circuit element.

Capacitor or Condenser: Device used to store electrical energy.

Diode: A small wafer like electrical device that allows current to pass through itself in one direction only.

Epoxy: Bonding material used for mounting, joining, reinforcing or insulating electrical components.

Feed-Back Resistor: A resistor through which part of the output current of a device passes back to the input of the device to stabilize current flow.

Heat Sink: Electronic component mounting plate which also serves to dissipate heat from components.

Induced: Made or caused to be as indirect voltage in coil caused by the intermittent current flow through the coil primary windings inducing a voltage in the secondary windings.

Infinite: Greater than an assignable quantity-as applied to the reading of an ohmmeter.

Ohm: Electrical unit of resistance of a circuit in which a potential difference of one volt produces a current of one ampere.

Ohmmeter: Instrument for measuring resistance.

Panelboard: Mounting board for electrical components.

Pole Piece: Stationary and rotating parts of distributor which carry magnetic pulse used to trigger the amplifier.

Printed Circuit: Conductive paths applied to a nonconductive material to eliminate loose wires and condense package size.

Relay: Device to open or close circuits and controlled from a remote point. Resistor: A device used to limit the flow of current to a specified value.

Silicone Grease: A special lubricant having the quality of good heating or cooling conductivity.

Solenoid: A tubular coil for producing magnetic field and changing electrical energy to motion.

Timer Core: Rotating pole piece of magnetic pulse distributor.

Transistor: An electrical device which acts as a switch to control a circuit. It has no moving parts.

Trigger Transistor: Transistor serving as an off or on switch to replace contact points.

Volt: The unit of electromotive force; that electromotive force, which, if steadily) applied to a conductor having a resistance of one ohm, will produce a current of one ampere.

Watt: A unit of electrical power or activity equal to the rate of work represented by a current of one ampere under a pressure of one volt, a volt-ampere. One horsepower is approximately equal to 746 watts.

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WEIGHTS, MEASURES, EQUIVALENTS

STANDARD WEIGHTS AND MEASURES

LONG MEASURE

12 in. . . . . 1 ft.
3 ft. . . . . 1 yd.
16-1/2 ft. . . . . 1 rod
320 rods . . . . . 1 mile
1,760 yds. or 5,280 ft. . . . . 1 mile

SQUARE MEASURE

144 sq. in. . . . . 1 sq. ft.
9 sq. ft. . . . . 1 sq. yd.
4,840 sq. yds., 43,560 sq. ft. . . . . 1 Acre
640 Acres . . . . . 1 sq. mile
An Acre = A square whose side is 208.71 ft. long.

SOLID OR CUBIC MEASURE

1,728 cu. in. . . . . 1 cu. ft.
27 cu. ft. . . . . 1 cu. yd.
1 cord wood = A pile 4 ft. wide x 4 ft. high x 8 ft. long = 128 cu. ft.

LIQUID MEASURE

4 gills . . . . . 1 pt.
2 pts. . . . . 1 qt.
4 qts. . . . . 1 gal.
The U.S. gallon = 231 cu. in. = .13373 cu. ft.
The English gallon = 277.274 cu. in.
The English gallon = 1.20032 U.S. gallons = The volume of 10 lbs. of water at 62°F.

U.S. DRY MEASURE

2 pts. . . . . 1 qt.
8 qts. . . . . 1 pk.
4 pks. . . . . 1 bu.
1 bu. . . . . 2150.42 cu. in. = 1.2445 cu. ft.
A heaped bushel equals 1-1/4 struck bushels as measured above.

COMMERCIAL MEASURE OF WEIGHT

Avoirdupois or Commercial Weight
437.5 grains . . . . . 1 oz.
16 oz. or 7,000 grains . . . . . 1 lb.
2,000 lbs. . . . . 1 net or short ton (commonly used)
2,240 lbs. . . . . 1 gross or long ton

BOARD MEASURE

The unit of solid measure for boards is the foot board measure (B.M.). This is a volume 1 in. in thickness, 12 in. in width, and 1 ft. in length. To obtain the number of feet B.M. of a board or piece of square timber, multiply the length in feet and the breadth in feet and the thickness in inches.

WEIGHT AND MEASURE EQUIVALENTS

1,728 cu. in. . 1 cu. ft. . 27 cu. ft. . 1 cu. yd.
46,656 cu. in. . 1 cu. yd. . 128 cu. ft. . 1 cord
2,150 cu. in. . 1 bushel . 1.24 cu. ft. . 1 bushel
7,056 cu. in. . 1 barrel . 4.08 cu. ft. . 1 barrel
231 cu. in. . 1 gallon . 20.75 cu. ft. . 1 hay bale
144 cu. in. . 1 bd.-ft. . 10.75 cu. ft. . 1 sm. bale
20-23 cu. ft. . 1 cotton bale

SIZE OF BARRELS AND BASKETS U.S. STANDARD BUSHEL

1 bu. . . 4 pks. . . 2445 cu. ft. . . 2150.42 cu. in.
1 pk. . . 8 qts. . . 3111 cu. ft. . . 537.61 cu. in.
1 qt. . . 2 pts. . . 0389 cu. ft. . . 67.20 cu. in.

U.S. STANDARD BARRELS FOR VEGETABLES, FRUIT AND DRY COMMODITIES, EXCEPT CRANBERRIES

1. Capacity . . . . . 7,056 cu. in.
   105 dry qts.
   3.28 bu.
   Head diam. . . . . 17.125 in.
   Bilge diam. . . . . 20.37 in.
   Stave lgth. . . . . 27.125 in.

2. Capacity . . . . . 5,826 cu. in.
   87 dry qts.
   2.709 bu.
   Head diam. . . . . 16.25 in.
   Bilge diam. . . . . 18.62 in.
   Stave lgth. . . . . 28.5 in.

3. Flour Barrel
   Weight . . . . . 200 to 220 lbs.
   Head diam. . . . . 18 in.
   Bilge diam. . . . . 21 in.
   Stave lgth. . . . . 28.5 in.

4. Sugar Barrel
   Weight . . . . . 300 to 360 lbs.
   Head diam. . . . . 20.5 in.
   Bilge diam. . . . . 25.0 in.
   Stave lgth. . . . . 30.0 in.

5. Syracuse Salt Barrel
   Weight . . . . . 280 lbs.
   Head diam. . . . . 18 in.
   Bilge diam. . . . . 21 in.
   Stave lgth. . . . . 29 in.

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ABBREVIATIONS FOR TERMS OF WEIGHT AND MEASURE

Following the name of each unit in the list below is given the abbreviation which the Bureau has adopted. Attention is particularly called to the following principles:

1. The period is omitted after the abbreviations of the metric units, while it is used after those of the customary system.
2. The exponents "2" and "3" are used to signify area and volume, respectively, in the case of the metric units instead of the longer prefixes "sq." or "cu." In conformity with this principle the abbreviation for cubic centimeter is "cm^3" instead of "c.c." or "c.m." The term "cubic centimeter" as used in chemical work is, in fact, a misnomer, since the unit actually used is the "milliter," which has a slightly larger volume.
3. The use of the same abbreviation for both singular and plural is recommended. This practice is already established in expressing metric units and is in accordance with the spirit and chief purpose of abbreviations.
4. It is also suggested that, unless all the text is printed in capital letters, only small letters be used for abbreviations except in the case of A, for acre, where the use of the capital letter is general.

Unit	Abbreviation
acre	A
area	a
avoirdupois	av.
barrel	bbl.
board foot	bd. ft.
bushel	bu.
carat, metric	c
centare	ca
centigram	cg
centiliter	cl
centimeter	cm
chain	ch.
cubic centimeter	cm^3
cubic decimeter	dm^3
cubic dekameter	dkm^3
cubic foot	cu. ft.
cubic hectometer	hm^3
cubic inch	cu. in.
cubic kilometer	km^3
cubic meter	m^3
cubic mile	cu. mi.
cubic millimeter	mm^3
cubic yard	cu. yd.
decigram	dg.
deciliter	dl
decimeter	dm
decistere	ds
dekagram	dkg
dekaliter	dkl.
dekameter	dkm.
dekastere	dks
dram or drachm, apothecaries'	dr. ap. or Z
dram, avoirdupois	dr. av.
dram, fluid	fl. dr.
fathom	fath.
foot	ft.
firkin	fir.
furlong	fur.
gallon	gal.
grain	gr.
gram	g.
hectare	ha
hectogram	hg
hectoliter	hl
hectometer	hm
hogshead	hhd.
hundredweight	cwt.
inch	in.
kilogram	kg
kiloliter	kl
kilometer	km
link	li.
liquid	liq.
liter	l
meter	m
metric ton	t
micron	u
mile	mi.
milligram	mg.
milliliter	ml
millimeter	mm
millimicron	mu
minim	min. or mu
ounce	oz.
ounce, apothecaries'	oz. ap. or Z
ounce, avoirdupois	oz. av.
ounce, fluid	fl. oz.
ounce, troy	oz. t.
peck	pk.
pennyweight	dwt.
point	pt.
pound	lb.
pound, apothecaries'	lb. ap.
pound, avoirdupois	lb. av.
pound, troy	lb. t.
quart	qt.
rod	rd.
scrupe, apothecaries	s. ap. or Z
square centimeter	cm
square chain	sq. ch.
square decimeter	dm^2
square dekameter	dkm^2
square foot	sq. ft.
square hectometer	hm^2
square inch	sq. in.
square kilometer	km^2
square meter	m^2

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Unit	Abbreviation
square mile	sq. mi.
square millimeter	mm^2
square rod	sq. rd.
square yard	sq. yd.
stere	s.

Unit	Abbreviation
ton	tn.
ton, metric	t
troy	t.
yard	yd.

UNITS OF WEIGHT AND MEASURE

(From Circular No. 47 of Bureau of Standards, Department of Commerce, Washington, D.C.)

THE METRIC SYSTEM: Metric units are naturally related. For example: 1 cubic decimeter equals, for all practical purposes, 1 liter, and 1 liter of water weighs 1 kilogram. The metric terms are formed by combining the words "meter," "gram" and "liter" with the six numerical prefixes, as in the following table:

Prefixes	Meaning		Units
milli-=one-thousandth	$\frac{1}{1000}$	.001	"meter" for length
centi=one-hundredth	$\frac{1}{100}$	.01	
deci-=one-tenth	$\frac{1}{10}$	.1	"gram" for weight or mass
Unit=one	$\frac{10}{1}$	1	
deka-=ten		10	
hecto-=one hundred	$\frac{100}{1}$	100	"liter" for capacity
kilo-=one thousand	$\frac{1000}{1}$	1000	

Definitions of Units

The following lists of units include most of those in general use. Simple conversions may be made from the values here given. For example, if a conversion into nautical miles is wanted, the conversion factor for statute mile given in the conversion tables may be used by multiplying it by the factor 1.151553 here given to show relation of nautical mile to statute mile.

Length

FUNDAMENTAL UNITS

A meter (m) is a unit of length equivalent to the distance between the defining lines on the international prototype meter at the International Bureau of Weights and Measures when this standard is at the temperature of melting ice ($0^oC.$).

1 m. = $\frac{3937}{3600}$ yd.

A yard (yd.) is a unit of length equivalent to $\frac{3600}{3937}$ of a meter.

HIGHER AND LOWER UNITS

1 kilometer (km) = 1000 meters.
1 hectometer (hm) = 100 meters.
1 dekameter (dkm) = 10 meters.
1 decimeter (dm) = 0.1 meter.
1 centimeter (cm) = 0.01 meter.
1 millimeter (mm) = 0.001 meter = 0.1 centimeter.
1 micron (u) = 0.000 001 meter = 0.001 millimeter.
1 millimicron (mu) = 0.000 000 001 meter = 0.001 micron.

1 foot (ft.) = $\frac{1}{3}$ yard = $\frac{1200}{3937}$ meter.

1 inch (in.) = $\frac{1}{36}$ yard = $\frac{1}{12}$ foot = $\frac{100}{3937}$ meter.

1 link (li) = 0.22 yard = 7.92 inches.
1 rod (rd.) = 5-1/2 yards = 16-1/2 feet.
1 chain (ch.) = 22 yds. = 100 links = 66 feet = 4 rods.
1 furlong (fur.) = 220 yards = 40 rods = 10 chains.
1 statute mile (mi.) = 1760 yards = 5280 feet = 320 rods.
1 hand = 4 inches.

1 point = $\frac{1}{72}$ inch.

1 mil = 0.001 inch.
1 fathom = 6 feet.
1 span = 9 inches = 1/8 fathom.
1 nautical mile, 1 seal mile, 1 geographical mile = United States = 6080.20 feet = 1.151 553 statute miles = 1353.249 meters

Area

FUNDAMENTAL UNITS

A square meter (m^2) = 1.195985 sq. yd.
A square yard (sq. yd.) = 0.8361307 m^2.

HIGHER AND LOWER UNITS

1 square kilometer (km^2) = 1 000 000 square meters.
1 hectare (ha) or square hectometer (hm^2) = 10 000 square meters.
1 area (a), or square dekameter (dkm^2) = 100 square meters.
1 centare (ca) = 1 square meter.
1 square decimeter (dm^2) = 0.01 square meter.
1 square centimeter (cm^2) = 0.0001 square meter.
1 square millimeter (mm^2) = 0.000 001 square meter = 0.01 square centimeter.

1 square foot (sq. ft.) = $\frac{1}{9}$ square yard.

1 square inch (sq. in.) = $\frac{1}{1296}$ square yard = $\frac{1}{144}$ square foot.

1 square link (sq. li.) = 0.0484 square yard = 62.7264 square inches.
1 square rod (sq. rd.) = 30.25 square yards = 272.25 square feet = 625 square links.
1 square chain (sq. ch.) = 484 square yards = 16 square rods = 100 000 square links.
1 acre (A) = 4840 square yards = 160 square rods = 10 square chains.
1 square mile (sq. mi.) = 3 097 600 square yards = 640 acres.

Volume

FUNDAMENTAL UNITS

A cubic meter (m^3) = 1.307 9428 cu. yd.
A cubic yard (cu. yd.) = .017645594 m.

HIGHER AND LOWER UNITS

1 cubic kilometer (km^3) = 1 000 000 000 cubic meters.
1 cubic hectometer (hm^3) = 1 000 000 cubic meters.
1 cubic dekameter (dkm^3) = 1000 cubic meters.
1 stere (s) = cubic meter.
1 cubic decimeter (dm^3) = 0.001 cubic meter.
1 cubic centimeter (cm^3) = 0.000 001 cubic meter = 0.001 cubic decimeter.
1 cubic millimeter (mm^3) = 0.000 000 001 cubic meter = 0.001 cubic centimeter.

1 cubic foot (cu. ft.) = $\frac{1}{27}$ cubic yard.

1 cubic inch (cu. in.) = $\frac{1}{46656}$ cubic yard = $\frac{1}{1728}$ cubic foot.

1 board foot = 144 cubic inches = $\frac{1}{12}$ cubic foot.

1 cord (cd.) = 128 cubic feet.

Capacity

FUNDAMENTAL UNITS

A liter (l) is a unit of capacity equivalent to the volume occupied by the mass of 1 kilogram of pure water at its maximum density (at a temperature of 4°C. practically and under the standard atmospheric pressure of 760 mm). It is equivalent in volume to 1.00 027 cubic decimeters. One liter = 0.264168 gal.

A gallon (gal.) is a unit of capacity equivalent to the volume of 231 cubic inches. It is used for the measurement of liquid commodities only. 1 gal. = 3.785 332 liter. A British gallon is approximately 20 percent larger.

A bushel (bu.) is a unit of capacity equivalent to the volume of 2150.42 cubic inches. It is used in the measurement of dry commodities only. The bushel is the so-called stricken or struck bushel. Many dry commodities are sold by heaped bushel, which is generally specified in the State Laws to be the usual stricken bushel measure "duly heaped in the form of a cone as high as the article will admit" or "heaped as high as may be without special effort or design." The heaped bushel was originally intended to be 25 percent greater than the bushel. A British bushel is 3 percent larger.

HIGHER AND LOWER UNITS

1 hectoliter (hl) = 100 liters.
1 dekaliter (dkl) = 10 liters.
1 deciliter (dl) = 0.1 liter.
1 centiliter (cl) = 0.01 liter.
1 milliliter (ml) = 0.001 liter = 1.000 027 cubic centimeters.
1 liquid quart (liq. qt.) = 1/4 gallon = 57.75 cubic inches.
1 liquid pint (liq. pt.) = 1/8 gallon = 1/2 liquid quart = 28.875 cubic inches.
1 gill (gi.) = 1/32 gallon = 1/4 liquid pint = 7.21875 cubic inches.
1 fluid ounce (fl. oz.) = $\frac{1}{128}$ gallon = 1/16 liquid pint.
1 fluid dram (fl. dr.) = 1/8 fluid ounce = $\frac{1}{128}$ liquid pint.
1 minim (min.) = $\frac{1}{60}$ fluid dram = 1/4 80 fluid ounce.
1 firkin (fir.) = 9 gallons.
1 peck (pk.) = 1/4 bushel = 537.605 cubic inches.

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1 dry quart (dry qt.) = 1/32 bushel = 1/8 peck = 67.200 625 cubic inches.
1 dry pint (dry pt.) = 1/64 bushel = 1/2 dry quart = 33.600 312 5 cubic inches.
1 barrel (bbl.) (for fruit, vegetables and other dry commodities) = 7056 cubic inches = 105 dry quarts (By U.S. Statute, March 4, 1915).

Mass or Weight

FUNDAMENTAL UNITS

A kilogram (kg) is a unit of mass equivalent to the mass of the International prototype kilogram at the International Bureau of Weights and Measures. One kg. = 2.204 622 341 lb. av.

An avoirdupois pound (lb. av.) = 0.453 427 7 kilogram. A gram (g) is a unit of mass equivalent to one-thousandth of the mass of the International prototype kilogram at the International Bureau of Weights and Measures.

A troy pound (lb. 61) is a unit of mass equivalent to 5760/7000 of that of the avoirdupois pound.

HIGHER AND LOWER UNITS

1 metric ton (t) = 1000 kilograms.
1 hectogram (hg) = 100 grams = 0.1 kilogram.
1 dekagram (dkg) = 10 grams = 0.01 kilogram.
1 decigram (dg) = 0.1 gram.
1 centigram (cg) = 0.01 gram.
1 milligram (mg) = 0.001 gram.
1 avoirdupois ounce (oz. av.) = $\frac{1}{6}$ avoirdupois pound.
1 avoirdupois dram (dr. av.) = 1/2 56 avoirdupois pound - 1/16 avoirdupois ounce.
1 grain (gr.) = $\frac{1}{7000}$ avoirdupois pound = $\frac{10}{4375}$ avoirdupois ounce = $\frac{1}{5760}$ troy pound.
1 apothecaries' pound (lb. ap.) = 1 troy pound = $\frac{5760}{7000}$ avoirdupois pound.
1 apothecaries' or troy ounce (oz. ap. or Z, or oz. t.) = $\frac{1}{12}$ troy pound = $\frac{480}{7000}$ avoirdupois pound = 480 grains.
1 apothecaries' dram (dr. ap. or Z) = $\frac{1}{96}$ apothecaries' pound = 1/8 apothecaries' ounce = 60 grains.
1 pennyweight (dwt.) = $\frac{1}{20}$ troy ounce = 24 grains.
1 apothecaries' scruple (s. ap. or S) = $\frac{1}{3}$ apothecaries' drum = 20 grains.
1 metric carat (c) = 200 milligrams = 0.2 gram.
The old carat in use in this country previous to July 1, 1913, was of 205.3 milligrams.
1 short hundredweight (sh. cwt.) = 100 avoirdupois pounds.
1 long hundredweight (1 cwt.) = 112 avoirdupois pounds.
1 short ton (sh. tn.) = 2000 avoirdupois pounds.
1 long ton (l. tn.) = 2240 avoirdupois pounds.

METRIC AND U.S. EQUIVALENT MEASUREMENTS

Measures of Length

METRIC			U.S.
1	meter	39.37	inches, or 3.28083 feet
.3048	meter	1	foot
1	centimeter	.3937	inch
2.54	centimeters	1	inch
1	millimeter	.03937	inch, or $\frac{1}{22}$ inch nearly
25.4	millimeters	1	inch
1	kilometer	1093.61	yards, or .62137 mile

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CONVERSION TABLE
INCH FRACTIONS AND DECIMALS TO MILLIMETERS

INCHES		mm	INCHES		mm	INCHES		mm	INCHES		mm
Fract.	Dec.		Fract.	Dec.		Fract.	Dec.		Fract.	Dec.	
—	.0004	.01	—	.3	7.620	—	.7874	20	—	1.969	50
—	.001	.0250	5/16	.3125	7.938	51/64	.7969	20.241	2	2.000	50.8
—	.0039	.10	—	.3150	8	13/16	.8125	20.638	2 1/8	2.125	54
—	.005	.127	21/64	.3281	8.334	—	.8268	21	—	2.165	55
—	.0079	.2	—	.3346	8.5	53/64	.8281	21.034	2 1/4	2.250	57.2
—	.0098	.25	11/32	.3438	8.731	27/32	.8438	21.431	—	2.362	60
—	.01	.254	—	.3543	9	55/64	.8594	21.828	2 3/8	2.375	60.3
—	.0118	.3	23/64	.3594	9.128	—	.8662	22	2 1/2	2.500	63.5
1/64	.0156	.397	—	.3740	9.5	7/8	.8750	22.225	—	2.559	65
—	.0157	.4	3/8	.375	9.525	57/64	.8906	22.622	2 5/8	2.625	66.7
—	.0197	.5	25/64	.3906	9.922	—	.9	22.860	2 3/4	2.750	69.9
—	.0236	.6	—	.3937	10	—	.9055	23	—	2.756	70
—	.025	.635	—	.4	10.160	29/32	.9063	23.019	2 7/8	2.875	73
—	.0276	.7	13/32	.4062	10.319	59/64	.9219	23.416	—	2.953	75
—	.0295	.75	—	.4134	10.5	15/16	.9375	23.813	3	3.000	76.2
1/32	.0313	.794	27/64	.4219	10.716	—	.9449	24	—	3.150	80
—	.0315	.8	—	.4331	11	61/64	.9531	24.209	3 1/4	3.250	82.6
—	.0354	.9	7/16	.4375	11.113	31/32	.9688	24.606	—	3.346	85
—	.0394	1	29/64	.4531	11.509	—	.9843	25	3 1/2	3.500	88.9
3/64	.0469	1.191	15/32	.4688	11.906	1	1.000	25.400	—	3.543	90
—	.0472	1.2	—	.4724	12	—	1.024	26	—	3.740	95
—	.05	1.270	31/64	.4844	12.303	1 1/16	1.062	26.988	3 3/4	3.750	95.3
—	.0551	1.4	—	.4921	12.5	—	1.063	27	—	3.937	100
—	.0591	1.5	1/2	.5	12.700	—	1.102	28	4	4.000	101.6
1/16	.0625	1.588	—	.5118	13	1 1/8	1.125	28.575	—	4.331	110
—	.0669	1.7	33/64	.5156	13.097	—	1.142	29	4 1/2	4.500	114.3
—	.075	1.905	17/32	.5326	13.494	—	1.181	30	—	4.724	120
5/64	.0781	1.984	—	.5315	13.5	1 3/16	1.188	30.16	5	5.000	127
—	.0787	2	35/64	.5469	13.891	—	1.221	31	—	5.118	130
—	.0906	2.3	—	.5512	14	1 1/4	1.250	31.75	5 1/2	5.500	139.7
3/32	.0938	2.381	9/16	.5625	14.288	—	1.260	32	—	5.512	140
—	.0984	2.5	—	.571	14.5	—	1.299	33	—	5.906	150
—	.1	2.540	37/64	.5781	14.684	1 5/16	1.312	33.34	6	6.000	152.4
—	.1024	2.6	—	.5906	15	—	1.339	34	—	6.299	160
7/64	.1093	2.776	19/32	.5938	15.081	1 3/8	1.375	34.93	6 1/2	6.500	165.1
—	.1181	3	—	.6	15.240	—	1.378	35	7	7.000	177.8
1/8	.125	3.175	39/64	.6094	15.478	—	1.417	36	—	7.087	180
—	.1378	3.5	—	.6103	15.5	1 7/16	1.438	36.51	7 1/2	7.500	190.5
9/64	.1406	3.572	5/8	.6250	15.875	—	1.457	37	—	7.874	200
5/32	.1563	3.969	—	.6299	16	—	1.496	38	8	8.000	203.2
—	.1575	4	41/64	.6406	16.272	1 1/2	1.500	38.10	8 1/2	8.500	215.9
11/64	.1719	4.366	—	.6496	16.5	—	1.535	39	—	8.661	220
—	.1772	4.5	21/32	.6563	16.669	1 9/16	1.562	39.69	9	9.000	228.6
3/16	.1875	4.763	—	.6693	17	—	1.575	40	—	9.449	240
—	.1969	5	43/64	.6719	17.066	—	1.614	41	9 1/2	9.500	241.3
—	.2	5.080	11/16	.6875	17.463	1 5/8	1.625	41.28	—	9.843	250
13/64	.2031	5.159	—	.6890	17.5	—	1.654	42.	10	10.000	254
—	.2165	5.5	—	.7	17.780	1 11/16	1.688	42.86	—	10.236	260
7/32	.2188	5.556	45/64	.7031	17.859	—	1.693	43	11	11.000	279.4
15/64	.2344	5.953	—	.7087	18	—	1.732	44	—	11.024	280
—	.2362	6	23/32	.7188	18.256	1 3/4	1.750	44.45	—	11.811	300
1/4	.25	6.350	—	.7283	18.5	—	1.772	45	12	12.000	304.8
—	.2559	6.5	47/64	.7344	18.653	—	1.811	46	13	13.000	330.2
17/64	.2656	6.747	—	.7480	19	1 13/16	1.813	46.04	—	13.780	350
—	.2756	7	3/4	.75	19.050	—	1.850	47	14	14.000	355.6
9/32	.2813	7.144	49/64	.7656	19.447	1 7/8	1.875	47.63	15	15.000	381
—	.2953	7.5	—	.7677	19.5	—	1.890	48	—	15.748	400
19/64	.2969	7.541	25/32	.7813	19.844	—	1.929	49	16	16.000	406.4

MATHEMATICAL FORMULAS USED IN SALES ENGINEERING

ROAD SPEED FORMULAS

$$MPH = \frac{RPM \times r}{R \times 168}$$

$$RPM = \frac{MPH \times R \times 168}{r}$$

$$R = \frac{RPM \times r}{MPH \times 168}$$

$$\text{WHEEL RPM} = \frac{MPH \times 166}{r}$$

TRACTIVE EFFORT FORMULAS

$$TE = \frac{T \times 12 \times R \times E}{r}$$

$$T = \frac{TE \times r}{12 \times R \times E}$$

$$R = \frac{TE \times r}{T \times 12 \times E}$$

TRACTIVE FACTOR FORMULAS

$$TF = \frac{T \times 12 \times R \times E}{GVW \times r}$$

$$T = \frac{TF \times GVW \times r}{12 \times R \times E}$$

$$GVW = \frac{T \times 12 \times R \times E}{TF \times r}$$

$$R = \frac{TF \times GVW \times r}{T \times 12 \times E}$$

GRADE ABILITY FORMULAS

$$GA = TF - RR$$

$$TF = GA + RR$$

$$GA = \frac{T \times 12 \times R \times E}{GVW \times r} - RR$$

$$GVW = \frac{T \times 12 \times R \times E}{TF \times r}$$

$$T = \frac{TF \times GVW \times r}{12 \times R \times E}$$

$$R = \frac{TF \times GVW \times r}{12 \times T \times E}$$

HORSEPOWER FORMULAS

$$IHP = \frac{MEP \times A \times S \times N}{33000 \times C}$$

$$S = \text{Stroke (Ft.)} \times RPM$$

$$IHP = BHP + \text{Friction HP}$$

$$BHP = \frac{BMEP \times A \times S \times N}{33000 \times C}$$

$$BHP = \frac{2 \times RPM \times \pi \times T}{33000}$$

$$BHP = \frac{T \times RPM}{5252}$$

$$BHP = \frac{D \times RPM \times 0.75 \text{ (Approx.)}}{5252}$$

TORQUE FORMULAS

$$T = \frac{D \times BMEP}{150.8}$$

$$T = D \times 0.75 \text{ (Approx.)}$$

$$T = \frac{BHP \times 5252}{RPM}$$

DRAWBAR PULL

$$DBP = TE - RR$$

CLUTCH TORQUE CAPACITY

$$T = \left\{\begin{array}{l}\text{Total Spring Pressure} \times \\ \text{Mean Radius of Lining} \\ \times \text{2 Faces} \times .25 \text{ Coefficient of Friction} \div 12\end{array}\right.$$

GRADE ABILITY— HORSEPOWER FORMULAS

$$GA = \frac{33750 \times BHP}{GVW \times MPH} - RR$$

$$GVW = \frac{33750 \times BHP}{MPH \times TF}$$

$$MPH = \frac{33750 \times BHP}{GVW \times TF}$$

$$HP = \frac{GVW \times MPH \times TF}{33750}$$

KEY TO SYMBOLS USED ABOVE

A = Area of piston head in sq. in.
BHP = Brake horsepower.
BMEP = Brake mean effective pressure.
C = No. cycles (4 for IH).
D = Piston displacement in cu. in.
DBP = Drawbar pull.
E = Mechanical efficiency (.90 direct, .85 in other gears).
GA = Grade ability, factor (G x 100 = % Grade).
GVW = Gross weight, lb.
IHP = Indicated horsepower.
MEP = Mean effective pressure.
MPH = Miles per hour.
N = Number of cylinders.
r = Effective tire radius (loaded) (inches)
R = Total reduction to 1.00.
RPM = Engine speed revolutions per minute (r.p.m.)
RR = Rolling or road resistance (.012 lbs. for good concrete roads.
S = Piston speed in feet per minute.
T = Torque—lb.-ft.
TE = Tractive effort, lb.
TF = Tractive factor, lb. per lb. gross.
π = Pi = 3.1416; ratio of diameter to circumference of circle.

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INSTRUMENTS
S-SERIES

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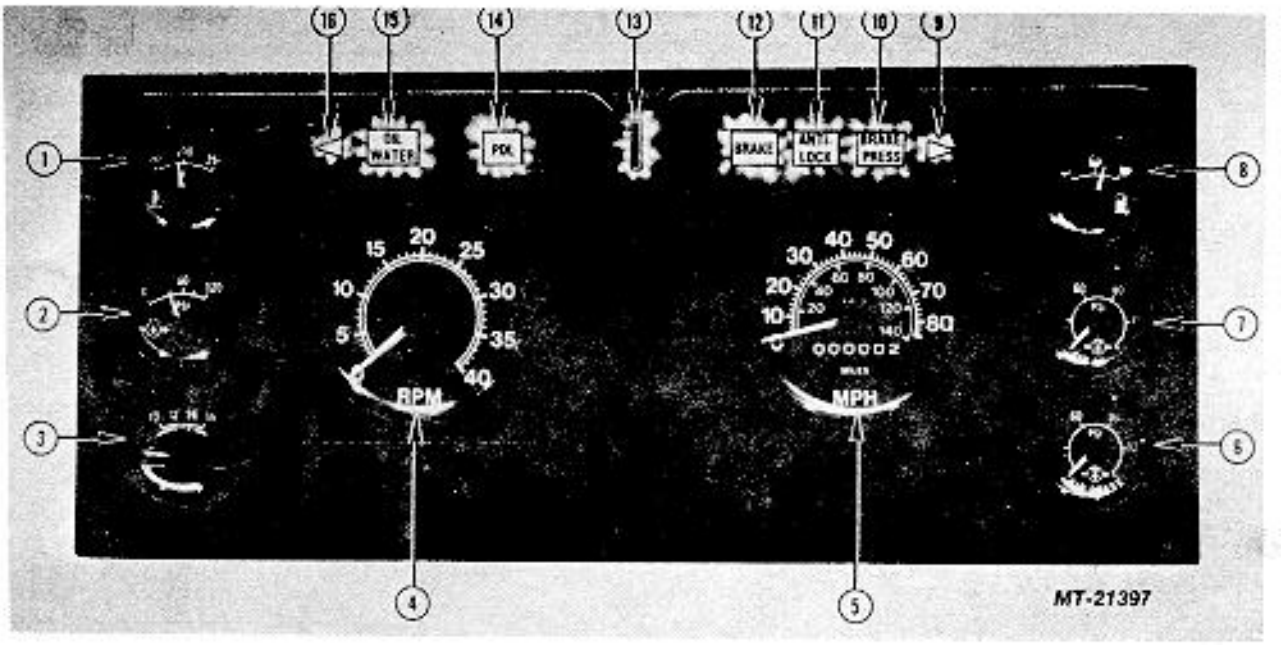


*Fig. 1. S-Series Instruments (Typical *)*

Legend for Fig. 1.

Key	Description	Key	Description
1	GAUGE, Water Temperature	9	INDICATOR, Right Hand Turn Signal
2	GAUGE, Oil Pressure	10	INDICATOR, Brake Air Pressure
3	VOLTMETER	11	INDICATOR, Antilock Mounting
4	TACHOMETER	12	INDICATOR, Parking Brake
5	SPEEDOMETER	13	INDICATOR, High Beam
6	GAUGE, Air Pressure	14	INDICATOR, Power Divider Lock
7	GAUGE, Air Pressure	15	INDICATOR, Oil Pressure/Water Temperature
8	GAUGE, Fuel Level	16	INDICATOR, Left Hand Turn Signal

* Gauges which read totally metric are also available

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DESCRIPTION - SYSTEM

Instruments used on S-Series trucks include voltmeter, fuel gauge, oil pressure gauge, water temperature gauge, speedometer, tachometer and air or vacuum gauges, plus oil, water, brake and power divider lock warning lights.

All of the aforementioned instruments are located on the instrument panel in a demountable instrument cluster (Fig. 1) directly in front of the driver. Gauges and panel lights of the cluster are connected to the vehicle electrical system by a flexible printed circuit. Optional gauges for such other items as engine oil temperature, transmission oil temperature, hour meter, etc. are located to the right of heater controls in a separate panel. Optional gauges are wired independent of the printed circuit.

INSTRUMENT CLUSTER

The instrument cluster is a reliable, quick disconnect package for the most commonly used instruments. Should the need arise, cluster body can be quickly detached from the instrument panel for quick access to any of its components. Either the complete cluster assembly or its components can be replaced.

CAUTION

Always disconnect battery negative (ground) cable before servicing instrument cluster or its components.

Remove Complete Cluster

1. Unscrew the four cluster mounting screws.
2. Tilt or lift out cluster assembly from instrument panel (Fig. 2).
3. Pull wiring harness connector from printed circuit on back of cluster assembly (Fig. 3).

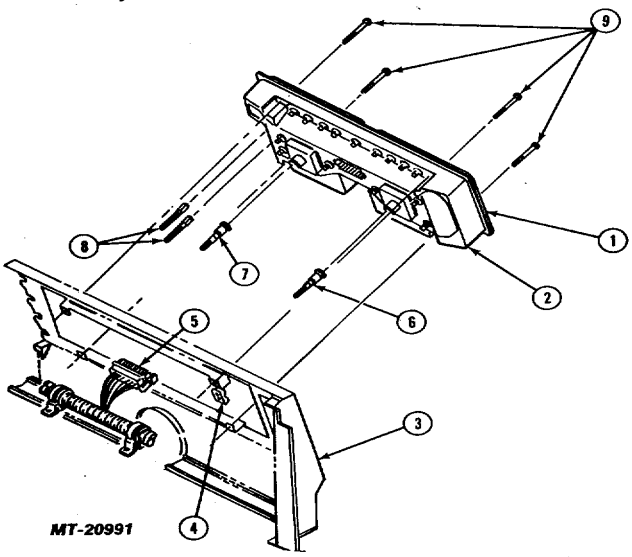


Fig. 2. Removing Instrument Cluster

Legend for Fig. 2.

Key	Description	Key	Description
1	BEZEL, Instrument Cluster	6	CABLE, Tachometer
2	CLUSTER, Assembly	7	CABLE, Speedometer
3	PANEL, Instrument	8	HOSE, Air Pressure
4	NUT, Spring 8-18	9	SCREW, Mounting #8-18 x 2-1/4
5	CONNECTOR, Wiring Harness		

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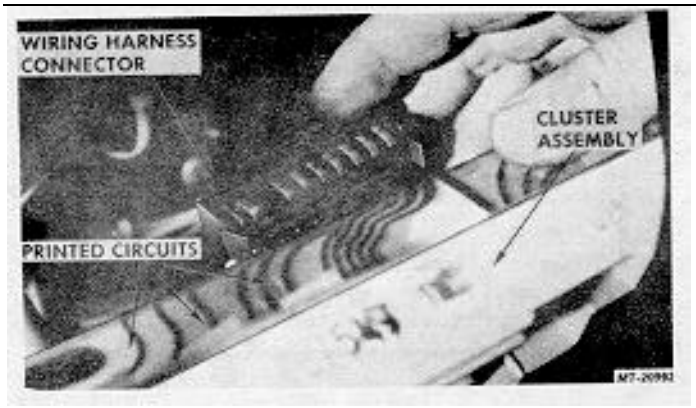


Fig. 3. Removing Wiring Harness Connector

4. Press down on quick-connect spring clasp (Fig. 4) and disconnect flexible cables from back of speedometer and tachometer.

5. Unscrew air or vacuum lines from fittings (Fig. ,5) on back of air or vacuum gauges. Two gauges are used with air braked trucks --one gauge only with vacuum (hydraulic) braked trucks.

6. Instrument cluster assembly is now free to be removed from instrument panel.

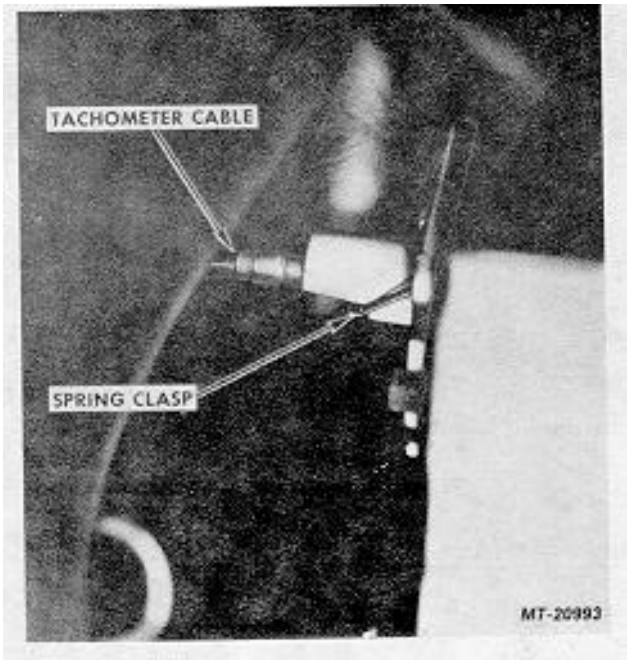


Fig. 4. Releasing Speedometer and Tachometer Cable

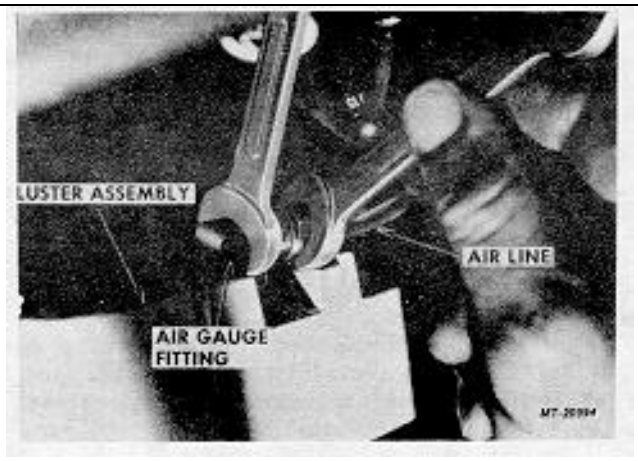


Fig. 5. Removing Air or Vacuum Lines

Remove Instrument Cluster Components

If it is desired that individual components are to be removed, procedure is as follows:

1. With the four cluster mounting screws removed, remove a fifth mounting screw from center of cluster bezel and detach bezel (Fig. 6).

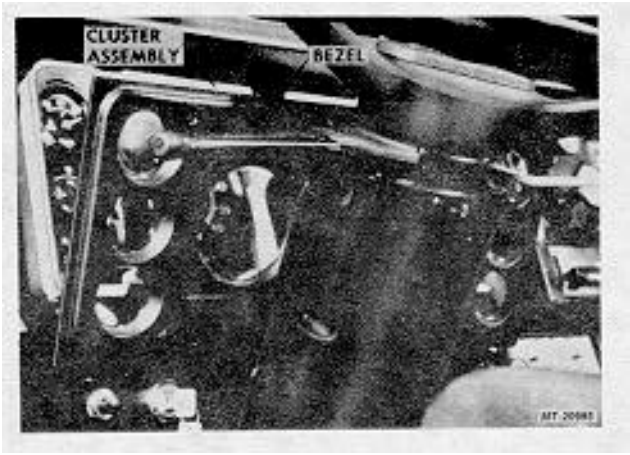


Fig. 6. Removing Instrument Cluster Bezel

2. Individual gauges can now be removed by loosening gauge mounting screws as required. All electrically actuated gauges (Fig. 7) are removed from front and have plug-in spring loaded connections. Speedometer and tachometer (Fig. 8) are also front serviceable and can be removed from cluster without disconnecting cables. (If cables are to be removed, these are quick-disconnect from rear of cluster.)

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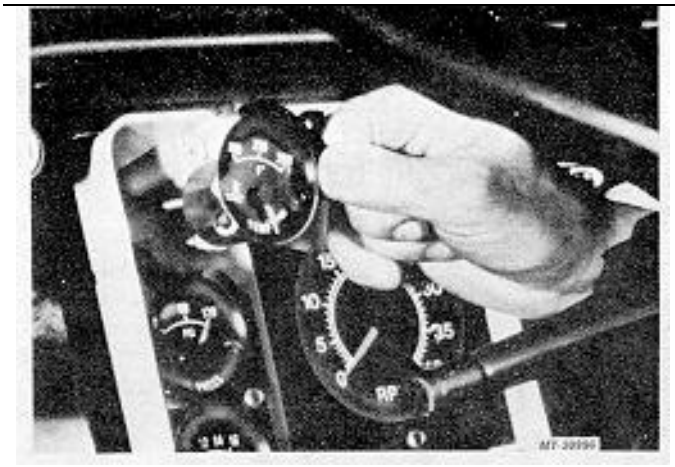


Fig. 7. Removing Electrically Actuated Water Temperature Gauge



Fig. 8. Removing Tachometer

3. Mechanical type air gauges (Fig. 9) are front serviceable after removing air line fittings from rear of cluster (Fig. 5).

IMPORTANT

Air gauges are mounted to a common bracket and are installed or removed as a pair from the cluster body. Also, when reinstalling air lines and fittings, use a non-hardening type sealant on screw threads.

4. Light bulbs are plug-in, spring-loaded type and are serviceable from either front or rear of instrument cluster (Figs. 10 & 11).

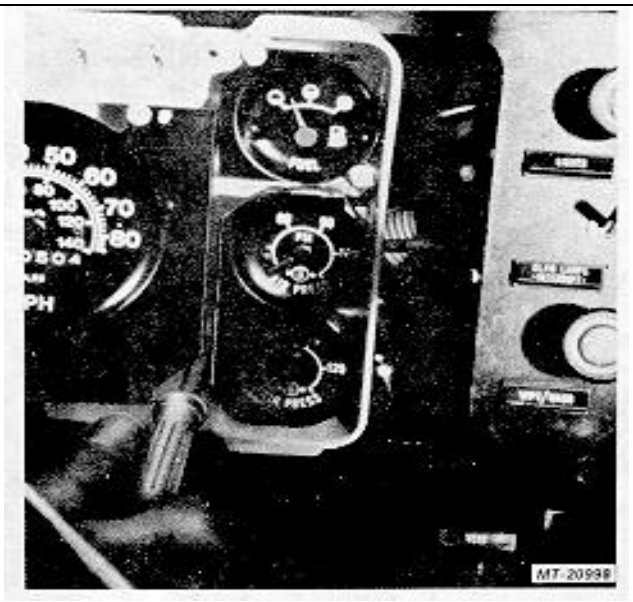


Fig. 9. Removing Air Gauges



Fig. 10. Removing Bulb from Front of Cluster

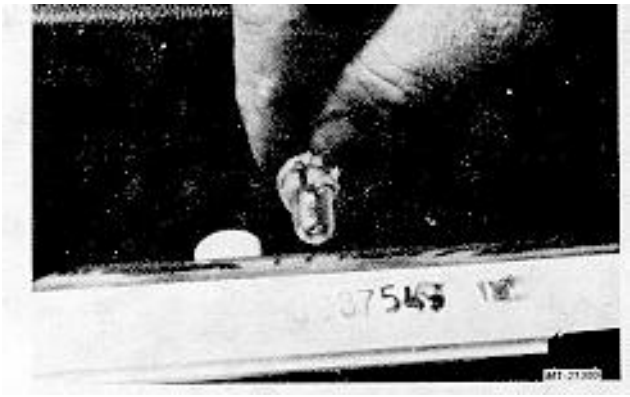


Fig. 11. Removing Bulb and Bulb Socket from Rear of Cluster.

FLEX-PRINTED CIRCUIT

One component of instrument cluster which is integral with cluster body itself is the flexprinted circuit. This tough flexible plastic film is cemented to cluster body to simplify instrument wiring (25 electrical connections are replaced by one). However, if the need should arise for electrical trouble shooting, individual circuits on the printed circuit are easily checked. This is accomplished with cluster removed (Fig. 12).

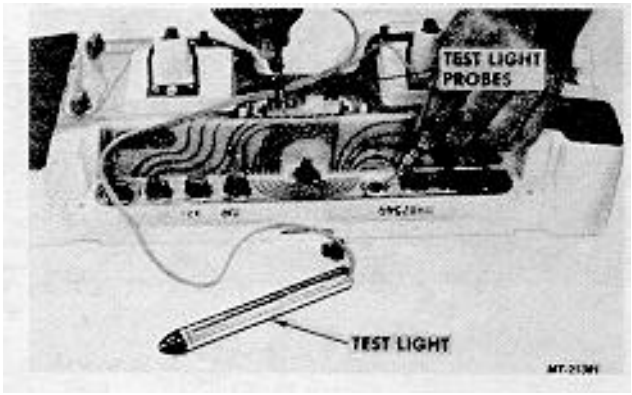


Fig. 12. Checking Printed Circuit Continuity

Testing

Obtain SE-2060-4 Test Light or equivalent tester and position test probes on a selected circuit in a manner similar to that shown in Fig. 12. If test light illuminates, circuit is unbroken, or if test light fails to illuminate circuit is broken. Check each circuit in turn and if a broken circuit is found, instrument cluster body must be replaced.

Replacement

Since printed circuit is cemented to and integral with instrument cluster body, the printed circuit and cluster body are available for replacement as a complete assembly only. Where replacement is required, obtain new instrument cluster body assembly and transfer all gauges and light bulbs from old cluster body to new. Individual parts of the instrument cluster, available for service, are shown in Fig. 13.

SPEEDOMETER

The speedometer used on this vehicle indicates miles and kilometers per hour. Distance traveled is recorded (in miles*) on an odometer. Speedolneteir is driven by a semi-rigid cable connectted to a set of gears in vehicle transmission. Sptcifiedcl gears match the particular truck model and take into consideration such other factors as tire size and rear axle ratio, The semi-rigid cable which connects transmission driven gear to the speedometer head consists of an outer case and an inner core. Odometer records up to 999,999 miles* and returns to zero. School bus models record 99,999.9 miles.* (*Total metric speedometers record kilometers.)

SPEEDOMETER ADAPTER

Should the need arise for changing a truck axle ratio or tire size, a corresponding change must also be made to the speedometer drive. This is accomplished by changing the speedometer adapter and in some instances the driven gear in the truck transmission. Information for finding the correct adapter and driven gear can be found in the Speedometer Section of the Parts Catalog.

TACHOMETER

An electrical or mechanical tachometer (not standard for all vehicles) is also located in the instrument cluster to record engine RPM (Revolutions Per Minute). This instrument enables driver to keep engine speed within an efficient operating range.

The mechanical tachometer is driven by a flexible shaft connected to an adapter or driving unit located on engine (distributor shaft for gasoline engines or air compressor injection pump, auxiliary shaft, etc. for diesel engines).

The electric tachometer reads the same as the mechanical unit but receives electrical impulses by wire instead of rotating cable. These impulses are received from a sender unit mounted on the engine and using the mechanical tachometer drive take off.

SPEEDOMETER AND TACHOMETER CABLES

A semi-rigid type cable is used for both speedometer and tachometer on S-Series Trucks.

This cable consists of (1) an outer case or cable assembly with nut and ferrule at lower end and a quick disconnect ferrule at upper end, and 2) a wire wou(lti flexible inner cable or core assembly with squared drive at upper end and floating tip (Fig. 14) at lower end. The floating tip which is detachable from cable allows core to float and thereby minimize thrust on speedometer or tachometer head. (Speedometer cable assemblies are sometimes made in two sections for assembly purposes.)

The cable outer case is formed from an inner nylon liner, an intermediate ply of wire braid and an outer polypropylene or polyethylene case (Fig. 15).

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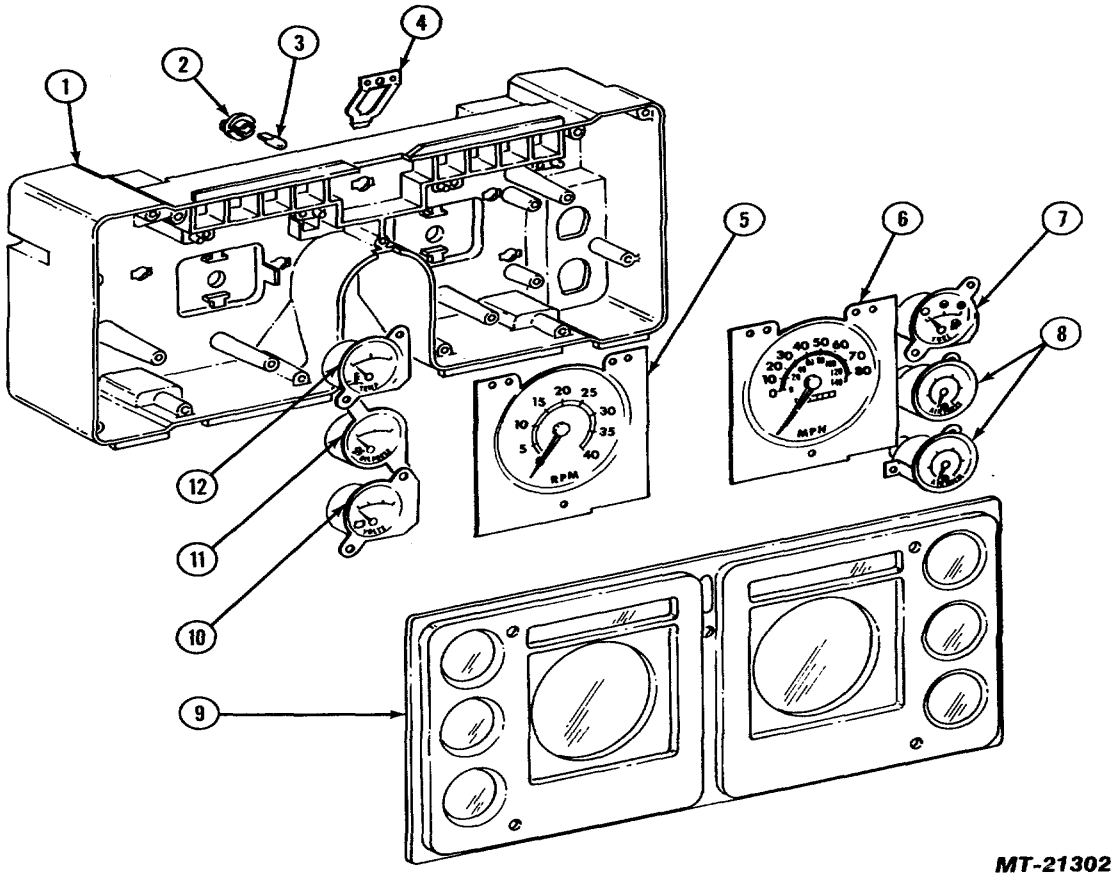


Fig. 13. Components of Instrument Cluster

Legend for Fig. 13.

Key	Description	Key	Description	Key	Description
1	CLUSTER, Asm. w/Printed Circuit	5	TACHOMETER	9	BEZEL
2	SOCKET, Bulb	6	SPEEDOMETER	10	VOLTMETER
3	BULB	7	GAUGE, Fuel Level	11	GAUGE, Oil Pressure
4	CLASP, Spring	8	GAUGE, Air	12	GAUGE, Water Temperature

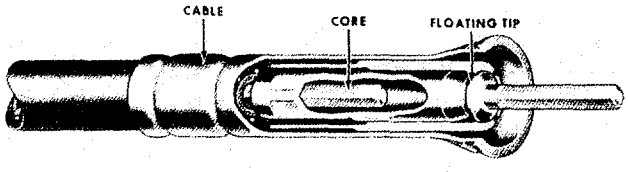


Fig. 14. Semi-Rigid Cable End Details

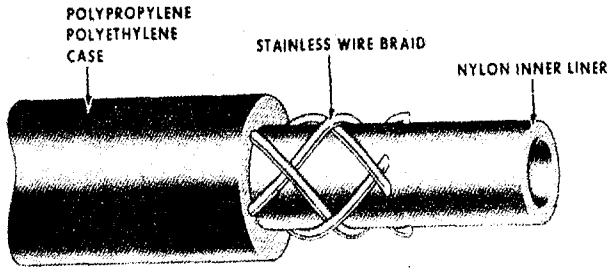


Fig. 15. Semi-Rigid Cable Outer Case

SPEEDOMETER, TACHOMETER AND CABLE TROUBLE SHOOTING V

Problem	Probable Cause	Solution
Inoperative	1. Cable disconnected. 2. Broken core. 3. Damaged speedometer or tachometer.	1. Connect cable. 2. Repair or replace. 3. Replace.
Indicator pointer fluctuates	1. Kinked core. 2. Cable improperly routed. 3. Cable improperly installed in speedometer or tachometer head.	1. Repair or replace. 2. Route cable correctly. 3. Install cable correctly.
Noisy, clicking or squealing .	1. Damaged or worn parts in speed-ometer or tachometer 2. Damaged core. 3. Cable improperly routed.	1. Replace. 2. Repair or replace. 3. Route cable correctly.
Reads incorrectly	1. Wrong adapter. 2. Cable improperly installed. 3. Speedometer or tachometer not calibrated.	1. Install correct adapter. 2. Install cable correctly. 3. Replace.

Remove

1. Disconnect upper end of speedometer or tachometer cable by removing four mounting screws from instrument cluster and detaching cluster enough to expose back of cluster.
2. Depress spring clasp on back of speedometer or tachometer and release cable (Fig. 4).
3. Unscrew cable lower or drive end from adapter at either transmission or engine component.
4. Unfasten cable from any ties or clips and remove complete cable assembly from chassis.

Inspect

1. Pull the flexible core out of case and check for kinks by rolling core on a flat surface.
2. A core kink will show up as a hop at kinked point.
3. Check for frayed spots by running core loosely through fingers.

Repair or Replace Core

Never reuse a kinked or frayed core. A kinked core will cause a fluctuation of speedometer or tachometer reading and a frayed core will fail completely a short time after being returned to service.

IMPORTANT

If replacement core is used, be sure core is not too long. A long core will cause a damaging thrust to head of speedometer or tachometer when installed.

Install

Apply a thin coat of lubricant (IH #251H EP) to core at reassembly as follows:

1. Place approximately 1 teaspoon of lube in one hand.

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2. Feed the core (lower end first) through the lube and into casing.

3. Keep last four inches of cable free of lube to prevent lube from entering the instrument head.

4. Install complete cable assembly in chassis and connect in reverse order of "Removal" procedure.

IMPORTANT

Avoid sharp bends when installing speedometer or tachometer cables. Under no circumstances should a casing have less than a six-inch radius bend. Route tachometer cable away from compressor discharge line and strap to stay rod to avoid cable damage.

GAUGE OPERATION - TROUBLE SHOOTING

Except for air pressure gauges which are mechanical--Bourdon tube type--all gauges are of the electro-magnetic air core type. In each system to be monitored (Fuel Level, Oil Pressure, Water Temperature, etc.) a sender uses a variable resistance to control current from the battery through a coil or coils in the gauge.

Gauge Tester

To assist in checking the electrical indicating type gauges a simple test procedure using a universal type Gauge Tester SE-2781 (Fig. 16) is suggested. This testing instrument eliminates time consuming trial and error methods of checking out the gauges.

IMPORTANT

To insure full power to all instruments in cluster, connector lock tabs on both sides of harness connector, must be solidly engaged with cluster socket.

Proper connector insertion and power to cluster is assured if the following indicators react when key switch is turned on:

1. Voltmeter pointer moves up scale.

2. Warning lights (except Anti-Lock) come on.

With power to cluster off, gauge pointers may move to any point on gauge scale. This is inherent to instrument and does not indicate a faulty part.

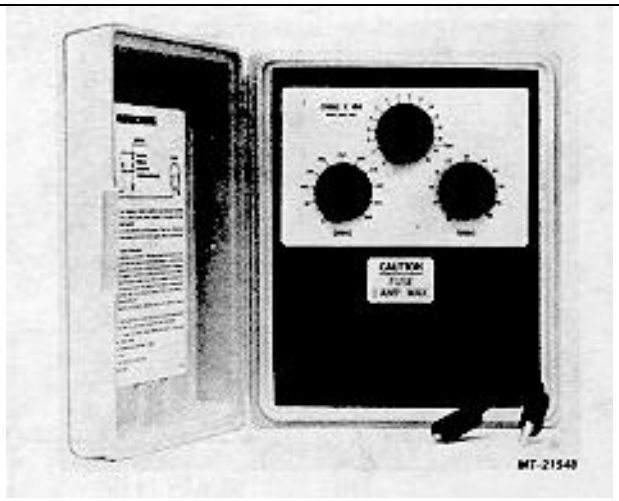


Fig. 16. Gauge Tester (SE-2781)

Test Application

Gauges can be tested on vehicle, without detaching them, by removing sender to gauge wire at sender unit and connecting in the SE-2781 Gauge Tester. Test continuity on gauge circuits with the SE-2060-4 Test Light. Details of this procedure are covered in later paragraphs.

FUEL LEVEL GAUGE

The electric fuel gauge system consists of two basic components--the instrument cluster mounted gauge and the fuel tank sending unit. The tank unit controls the gauge and the gauge registers the quantity of fuel in the tank. The two units are connected electrically as shown in Fig. 17.

This air core type fuel gauge consists of three (3) copper wire coils wound around a plastic bobbin containing a magnet and spindle assembly. Attached to the magnet and spindle assembly is a pointer which indicates fuel level. The fuel gauge requires a 0 to 90 ohm resistance sender to operate. The sender is the tank unit and consists of a float and arm assembly and a variable resistor. The sender's resistance is controlled by the position of float and arm assembly. A full fuel tank raises float to its highest position. At this position the variable resistor has a resistance of 88 ohms. With an empty fuel tank the float assumes its lowest position, creating a sender resistance of less than 1 ohm.

The fuel gage circuit diagram (Fig. 17) shows that with key switch "ON", current flows from the battery through a parallel circuit consisting of the empty coil and the fixed resistor and thence through another circuit composed of:

-the variable resistance fuel level sender and the bucking coil and the full coil.

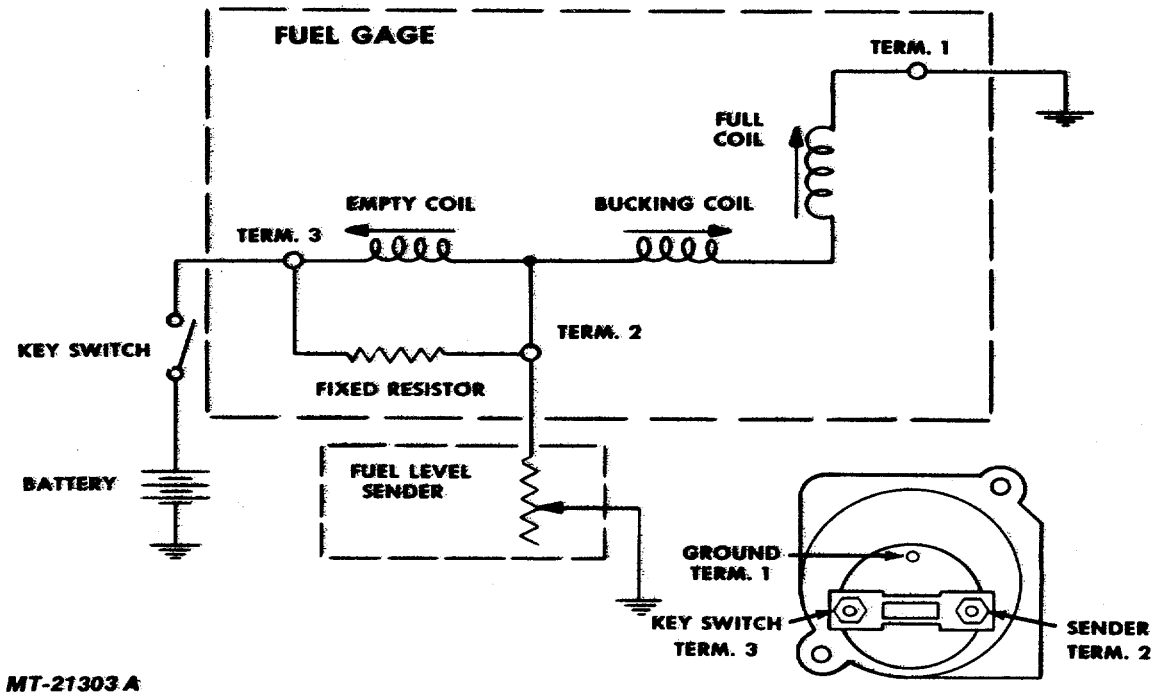


Fig. 17. Fuel Gauge Circuit Diagram

- the fuel level sender only when in its empty position.

It will be noted that variations in the position of the fuel level sender contact will vary the active portion of resistance element and thus control the amount of current flowing in the bucking and full coils. Maximum current in the bucking and full coils occurs with the tank unit in the full "F" position. Under this condition, the magnetic field of the bucking and full coils is at maximum and the pointer and armature assembly will align itself with the resultant magnetic field of the three coils the "Full" position. As the fuel is used, the fuel level sender contact position changes to reduce the current in the bucking and full coils and increases the current in the empty coil. This variation in current reduces the the magnetic field strength of the bucking and full coils from a maximum at "full" to zero at the empty or "E" position at which time the armature and pointer assembly is aligned with the magnetic field of the empty coil. Thus, the interaction of the magnetic field of the three coils produces a resultant magnetic field which controls the rotation and position of the armature, and pointer assembly.

The sender and key switch terminals are connected by a calibrating resistor (Fig. 18). The odd terminal is the ground terminal.

The sender terminal is the first terminal clockwise from ground terminal when viewed from back side of gauge.

IMPORTANT

The gauge is grounded to chassis through the ground terminal when plugged into instrument cluster printed circuit.

When the key switch is turned off, pointer will not necessarily return to the empty position. This is inherent in the instrument and does not indicate a faulty part.

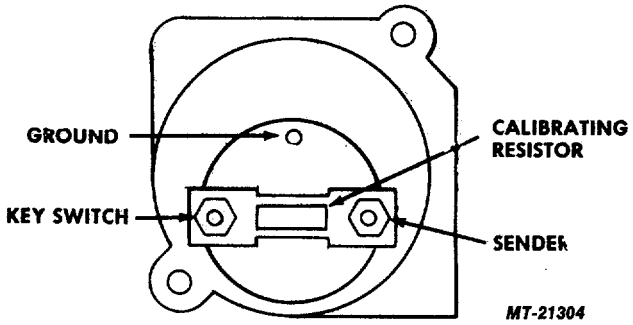


Fig. 18. Fuel Gauge (Rear View)

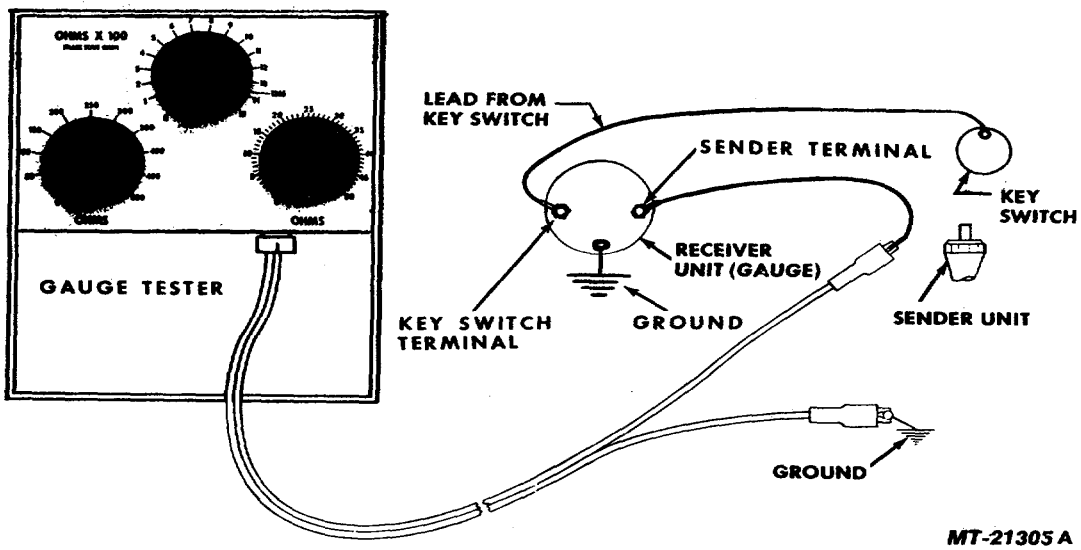


Fig. 19. Checking Fuel Level Gauge System with Gauge Tester

Test for faulty component as follows:

1. Disconnect wire at tank sender unit (Fig. 19)
2. Connect one lead of SE-2781 Gauge Tester to end of sender unit wire and second lead to ground (tester substitutes for sender unit).
3. Turn key switch "on".
4. Set gauge tester for 88 ohms (left hand control knob to "50" and right hand knob at "38"). Fuel gauge should read slightly above "full". (Pointer within ball).
5. Next set left hand knob at "0" and right hand knob at "44". Fuel gauge should read at "1/2" mark. (Pointer within ball).
6. Finally set left hand knob at "0" and right hand knob at "i". Gauge should now read "empty". (Pointer within ball).

If fuel gauge reads properly, gauge and wiring between gauge and sender is OK and trouble is in sender grounding or sender itself. Replace float assembly if proper grounding does not correct the problem.

If fuel gauge does not read properly, check continuity of circuit with standard test light (Fig. 12). If continuity is OK and gauge still does not respond, replace gauge. WATER TEMPERATURE GAUGE

The water temperature gauge system consists of two basic components--the instrument cluster gauge and the thermister sending unit. The gauge indicates water temperature while the sender controls the gauge reading. The two units are connected electrically as shown in Fig. 20.

The operating principle of the temperature indicating system can be understood by reference to the temperature gage circuit diagram (Fig. 20). With the ignition switch closed, current will flow from the battery through the bucking and "cold" coils and the fixed resistor to ground, and through the "Hot" coil and the variable resistance temperature sender to ground.

The temperature sender consists of a thermistor enclosed in a sealed threaded shell containing a heat transfer medium and equipped with an insulated terminal. With the temperature sender immersed in a cold liquid (100°F), its resistance is high and the current flowing through the "hot" coil is small; therefore, the magnetic field produced by the "hot" coil is negligible. At this time the pointer and armature assembly will align itself with the resultant magnetic field produced by the "cold" and bucking coils at the 1000 F position. The magnetic field of the "cold" and bucking coils is always a constant and serves as a reference. As the temperature of the liquid increases, the resistance of the sender decreases since the thermistor has a negative temperature

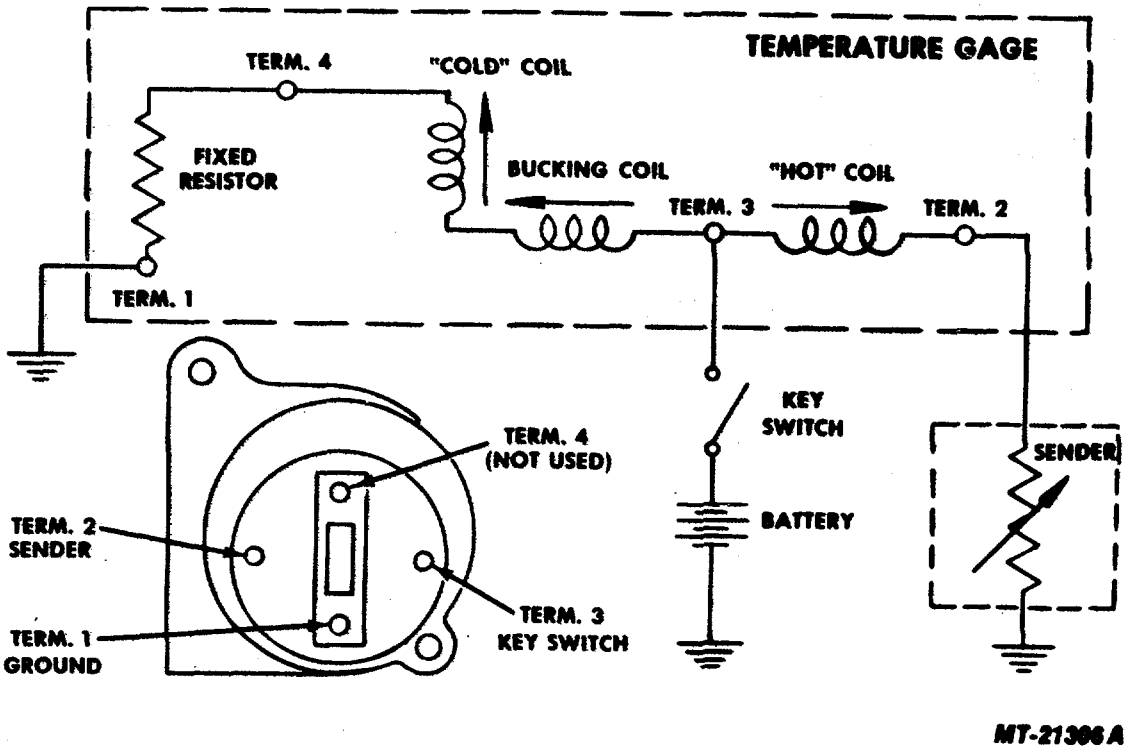


Fig. 20. Water Temperature Gauge Circuit Diagram

temperature coefficient. The decrease in sender resistance increases the current flowing in the "hot" coil, reaching a maximum at the full-scale temperature. With maximum current in the "hot" coil, the pointer and armature assembly will align itself with the resultant magnetic field produced by the three coils at the full-scale position. Thus, the interaction of the magnetic fields of the three coils produces a resultant magnetic field which controls the rotation and position of the armature and pointer assembly.

IMPORTANT

The gauge is grounded to chassis through the ground terminal when plugged into the instrument cluster printed circuit.

The sender terminal is the first terminal clockwise from ground terminal (when viewed from back side). The ignition terminal is directly opposite from sender terminal.

Check for faulty components as follows:

1. Disconnect sender wire at sender (Fig. 20).
2. Connect one lead of SE-2781 Gauge Tester to sender wire and the other lead to a good ground.
3. Set the gauge tester for 55 ohms (left knob at "50".and right knob at "5"). Turn key switch on and gauge should read at full scale. (Pointer within 2 pointer widths of hash mark).
4. Set gauge tester for 113 ohms (left knob at 100 and right knob at 13 ohms). Gauge should read at half scale. (Pointer within 2 pointer widths of hash mark).
5. Set gauge tester for 1365 ohms (center knob at "1365" and other knobs at "0"). The gauge should now read at low scale. (Pointer within 2 pointer widths of hash mark).

If results of Steps 3 thru 5 are satisfactory gauge is OK and sender must be replaced.

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IMPORTANT

Sometimes sealant or dirt on threads of sender (thermister) prevent a good electrical contact necessary for sender grounding. Check for this condition before replacing sender.

If results of Steps 3 thru 5 are unsatisfactory check continuity of circuit with a standard test light. If continuity is OK and gauge still does not respond, replace gauge.

OIL PRESSURE GAUGE

The oil pressure gauge is electrically actuated and consists of two basic components--the instrument cluster mounted gauge and the engine oil gallery mounted sending unit. The sending unit senses the pressure of oil in the engine oil gallery during engine operation and registers the pressure on the gauge.

The operation of the oil pressure gauge system (Fig. 21) is the same as for fuel level gauge except that sender is a diaphragm unit in oil gallery instead of a float.

Testing for a defective oil pressure system component is also the same. See FUEL LEVEL GAUGE for testing procedure.

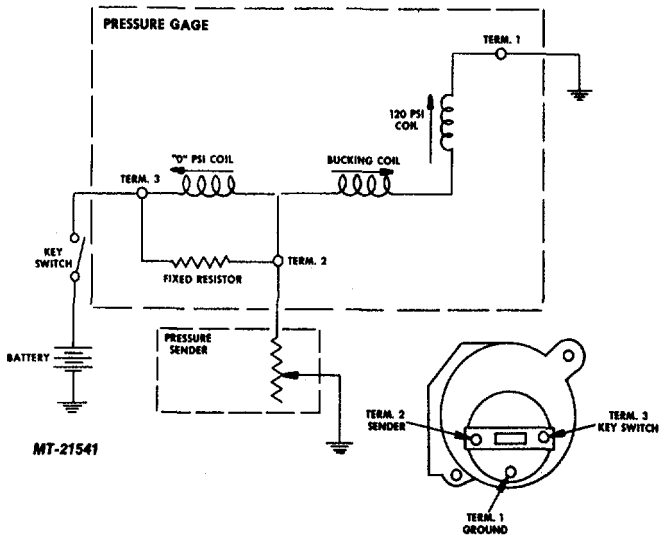


Fig. 21. Oil Pressure Gauge Circuit Diagram

OIL PRESSURE WARNING LAMP

A second or back-up oil pressure warning system is also used. This system uses a second oil pressure warning switch mounted on the engine.

When engine oil pressure is in its normal operating range (high) the pressure switch is held in its off position and no current is sent to warning light in the instrument cluster.

When engine oil pressure is below its normal operating range (low) the pressure switch will close to its "on" position and deliver current to warning light in instrument cluster and cause warning lamp to light.

OPTIONAL TEMPERATURE GAUGE

The optional temperature gauges (Fig. 22) are also electro-magnetic type and are actuated by sending units (variable resistance thermisters). Sending units are located in the component on which temperature monitoring is desired (engine, transmission, rear axles, etc.)

Operating and testing of optional temperature gauges is the same as for comparable temperature systems previously covered. See SPECIFICATIONS for variable resistance value (ohms) required for checking these gauges

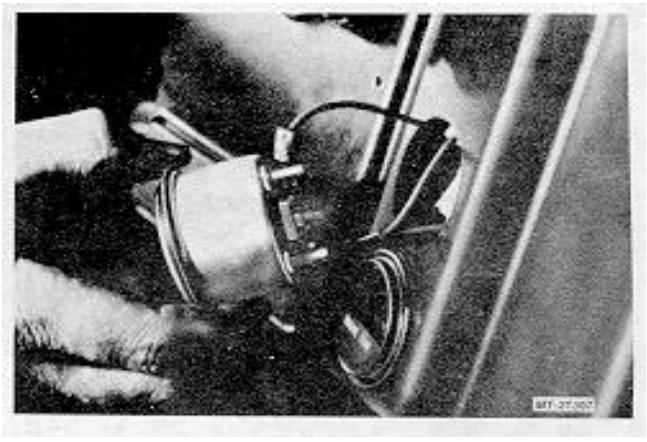


Fig. 22. Servicing Optional Gauge

AIR PRESSURE GAUGE

The air pressure gauges are the mechanical type and operate on the Bourdon tube principle.

When air system is pressurized, air enters the air pressure gauge and exerts pressure on theBourdon tube. As pressure increases, the Bourdon tube tends to straighten out and thus actuate the sector and pinion gear (Fig. 23) to which it is attached. This causes indicator to move across dial in an upscale direction. When pressure decreases, the Bourdon tube relaxes and pointer moves in a downscale direction. A steadily applied air pressure holds the Bourdon tube and pointer at a fixed scale reading corresponding to applied pressure.

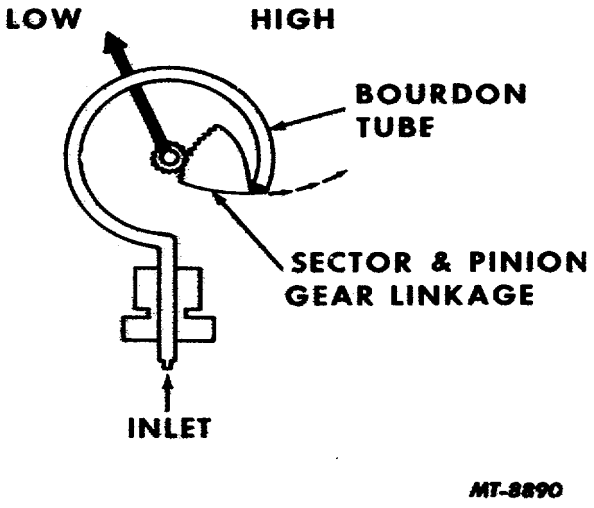


Fig. 23. Air Pressure Gauge Details

Remove

1. Detach instrument cluster and cluster bezel.
2. Unscrew air lines from fittings on rear of the two air gauge inlets on back of instrument cluster.
3. Remove gauge mounting screws and demount gauges from instrument cluster (Fig. 24).



Fig. 24. Removing Air Pressure Gauges

4. Separate individual gauges from bracket.

Test

1. If a suspected gauge has been reading high and does not return to zero when disconnected, Bourdon tube has been damaged. Service by replacing with a new gauge.
2. If gauge has been reading low or does not read at all, examine the inlet connection for dirt which might restrict air from entering gauge. Make a trial connection and if gauge still does not register correctly, replace gauge.

IMPORTANT

Always make a comparison test with a gauge known to be reading correctly before discarding a questionable gauge.

Install

Installation of air gauges is the reverse of removal procedure. Be sure to use non-hardening sealing compound on fitting threads to prevent leaks. Check installation so as to prevent kinks in air lines.

VOLTMETER

The voltmeter or battery-charging system gauge (Fig. 25) indicates the condition of battery and charging system. This gauge will monitor a voltage range between 10 and 16 volts. Color segments of this range also indicate system condition as follows:

GREEN - A well charged battery.

FIRE ORANGE - Either a too high or too low charged battery.

With key switch "on" but before starting engine, the voltmeter will show condition of battery. While starting engine, indicator will temporarily descend to "Fire Orange" segment but immediately return to "Green" segment when engine is operating. With engine running at operating speeds, the voltmeter indicator should remain in the "Green" segment. This is charging system's normal operating range and indicates alternator is charging.

If indicator ascends to "Fire Orange" segment, alternator voltage output is too high.

Constant reading in either high or low fire orange segments of the voltmeter indicates a

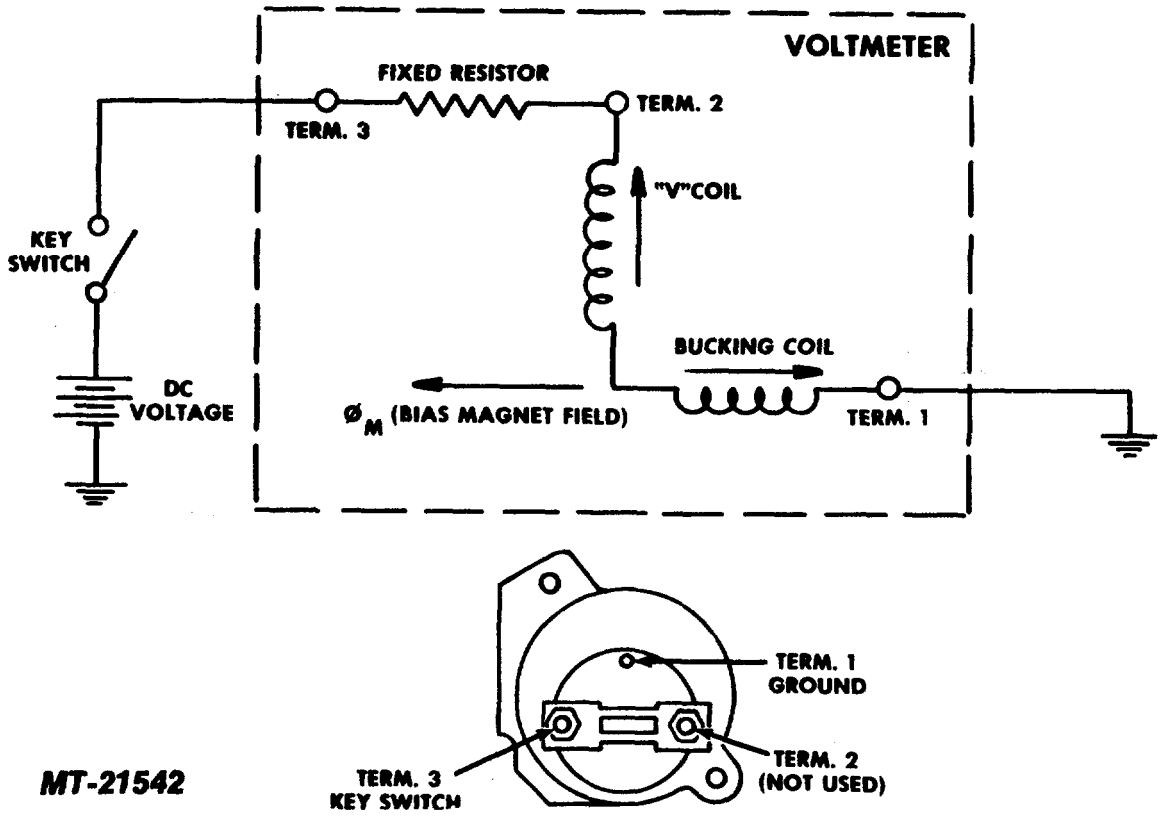


Fig. 25. Voltmeter Circuit Diagram

complete check of battery and charging system is required. See appropriate alternator section of Service Manual under ELECTRICAL.

If voltmeter does not read as expected, you can check operation of this instrument by connecting voltmeter terminals to an independent voltage source (12V Battery). The voltmeter should indicate the voltage supplied by battery + 0.5 volts.

If test is unsatisfactory, replace voltmeter.

If test is satisfactory, voltmeter is OK and problem is in wiring. Check continuity with test light.

GAUGE TESTING (TABLE A)

A summary of necessary gauge testing specifications is given in "Table A". When the service man becomes familiar with the SE-2781 Gauge Tester, this table will provide a handy reference.

QUICK CHECK (TABLE B)

If a universal gauge tester is not available, electrical gauges can also be "quick checked" to determine if they are functioning by a simple "Sender Disconnect and Ground Test", that is sometimes used for automotive gauge testing. While this is a quick test, it does have two disadvantages.

1. The test tells only that gauge is functioning. It does not determine if gauge is accurate.

2. The grounding of sender wire test for a temperature gauge will damage that unit.

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Gauge Testing Variable Resistance Values * (Ohms)				
		Gauge Reading		
Type Gauge		Low Scale	Half Scale	Full Scale
Fuel Level		1	44	88
Water Temperature		1365	113	55
Oil Pressure		1	47	88
Oil Temperature	(Engine)	1365	63	28
	(Transmission)	1365	63	28
	(Rear Axle)	1365	63	28
* For use with SE-2781 Gauge Tester				

TABLE A

Quick Check of Gauge Function (Disconnect and Ground Test)		
	Gauge Reading	
Type Gauge	Sender Wire Disconnected	Sender Wire Grounded
Fuel Level	Above Full Scale	Below Low Scale
Water Temperature	Below Low Scale	Do not Ground Will Burn Out Gauge
Oil Pressure	Above Full Scale	Below Low Scale
Oil Temperature		
(Engine)	Below Low Scale	Do Not Ground Will Burn Out Gauge
(Transmission)	Below Low Scale	Do Not Ground Will Burn Out Gauge
(Rear Axle)	Below Low Scale	Do Not Ground Will Burn Out Gauge

TABLE B

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LUBRICATION INSTRUCTIONS

FOR LUBRICATION INTERVALS REFER TO OPERATORS MANUAL

New vehicles are lubricated before they are delivered. After the vehicle is placed in operation, regular lubrication intervals, based on the type of service and road conditions, should be established. Thorough lubrication at definite intervals will add greatly to the service life of the vehicle and will reduce the overall operating expense.

The interval between lubrication periods, oil changes, etc., depends entirely upon operating conditions. The loads carried, speed, road and weather conditions all contribute to the frequency of lubrication periods. In some types of operation, and where operating conditions are extremely severe, the vehicle may require lubrication after every twenty-four (24) hours of operation.

In some operations, such as in deep water, mud, or unusually dusty conditions, the interval of inspection and lubrication should be more frequent than twenty-four (24) hours.

Only lubricants of the best quality, having proper body or viscosity, and supplied by reputable manufacturers, should be used. The use of inferior or non-compatible products might reduce the service life of the vehicle or result in failure of its components.

The International Harvester Company Truck Division does not attempt to specify any particular manufacturer's product. High-grade lubricants can be obtained from any reputable oil company.

The lubrication specifications refer only to the viscosity (SAE) and type to be applied. The viscosity numbers have been adopted by the Society of Automotive Engineers to classify lubricants according to "body" or "thickness" and do not cover any other properties.

IMPORTANT

When adding lubricant, it should be the same weight and viscosity which is already being used.

Definitions of symbols used in designation of type lubricants recommended in LUBRICATION INSTRUCTIONS.

Symbol	Type Lubricant
A	Light Weight Engine Oil
B	Cam and Ball Bearing Lubricant
C	IH 251 HEP Grease or equivalent NLGI #2 Multi-Purpose Grease
D	Stick Lubricant
E	SAE 85W-140 gear lubricant or SP type lubricant, SAE-90 viscosity year around, meeting MIL-L-2105B specification (SP must not contain zinc). For abnormally high temperature severe service (hot climate off highway operation where vehicle is in low speed heavy hauling for prolonged periods), use SAE-140. For traclok rear axles, add 20CC (2/3 ounce) of IH-LS additive for each .47 liter (pint) of SP lubricant, at every 10,000 miles 16,000 kilometers of operation.
F	**SPICER** Engine Oil (SE, CC, DD). SAE-30 Below -18 deg. C (0 deg. F) SAE-30, Above -18 deg. C (0 deg. F) 40, 50

Symbol	Type Lubricant
G	Dexron Automatic Transmission Fluid
H	SAE-10W Engine Oil for temperatures -18 deg. C (0 deg. F) and up. For temperatures below -18 deg. C (0 deg. F) use three parts SAE-10W engine oil to one part kerosene. The mixture can safely be used in temperatures up to 0 deg. C (32 deg. F).
J	Lock Oil
K	SAE-10W-40 Engine Oil
L	Super Heavy Duty "DOT 3"
M	SAE-85W-140 Gear Lubricant or SAE-90 SP Type Lubricant, meeting MIL-L-2105B Specification.
N	Penetrating Oil
O	**WARNER**

Engine Oil (SE, CC, CD)	SAE-30	Below	0 deg. C (+32 deg. F)
	SAE-50	Above	0 deg. C (+32 deg. F)
Mineral Gear Oil	SAE-80	Below	-18 deg. C (0 deg. F)
(Rust and Oxidation Inhibited)	SAE-80,90	Below	0 deg. C (+32 deg. F)
	SAE-90,140	Above	0 deg. C (+32 deg. F)

P	Use straight mineral oil SAE-90 for temperatures -18 deg. C (0 deg. F) and up. Use SAE-80 for temperatures below -18 deg. C (0 deg. F). Special recommendations: Where temperature is consistently below -18 deg. C (0 deg. F) and where parked vehicles are exposed to unusual cold for long periods, use SAE-75. Where temperatures are consistently above 32 deg. C (90 deg. F) or unusually hot, use SAE-140 straight mineral oil.
Q	**FULLER-NEW PROCESS**

Engine Oil (SE, CC, CD)	SAE-30	Below	-12 deg. C (+10 deg. F)
	SAE-40,50	Above	-12 deg. C (+10 deg. F)
Mineral Gear Oil	SAE-80	Below	-12 deg. C (+10 deg. F)
(Rust and Oxidation Inhibited)	SAE-90	Above	-12 deg. C (+10 deg. F)

R	SAE-30 heavy duty engine oil or rear axle gear lubricant.
S	SAE-20W-30 Engine Oil. Is compatible with symbol G.
T	Clean element when air restriction exceeds 51 cm (20 in.) of water or 3.8 cm (1.5 in.) of mercury.
	Air Pressure Cleaning: Compressed air can be used to blow outthe element from the clean air side out.
	Washing Procedure: . Filter element can be washed with any good non-sudsing, household detergent. Use warm water 49 deg. 60 deg. C (120 deg. 140 deg. F). Flush filter with gentle stream until drain water is clean. Air dry element before using. Also inspect after every cleaning for damage or rupture. Wipe all internal parts clean before reassembling. Replace gasket regularly.

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Symbol		Type Lubricant		
U	**CLARK**			
	Gear Lubricant	SAE-80,90	Above	-7 deg. C (+20 deg. F)
	Engine Oil	SAE-50	Above	-7 deg. C (+20 deg. F)
	Mineral Oil	SAE-80,90	Above	-7 deg. C (+20 deg. F)
	Gear Lubricant	SAE-80,90	-29 to 16 deg.	C (-20 deg. F to +60 deg. F)
	Engine Oil	SAE-30	-20 to 16 deg.	C (-20 deg. F to +60 deg. F)
	Mineral Oil	SAE-80,90	-29 to 16 deg.	C (-20 deg. F to +60 deg. F)
	Mineral Oil	SAE-75	Below	-18 deg. C (0 deg. F)
V	**IH**			
	Engine Oil (SE, CC, CD)	SAE-5W20 or 10W40	Below	-18 deg. C (0 deg. F)
		SAE-20, 20W30 or any of the above	Above	0 deg. C (+32 deg. F)
		SAE-30 10W40, 20W40	Above	32 deg. C (90 deg. F)

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Description	Type Lubricant (See symbol)
Accelerator Linkage	A
Air Cleaner (Dry Type)	T
Air Cleaner (Oil Bath)	Engine Oil (Same Viscosity as Crankcase)
Alternator	B
Brake Camshafts (Service)	C
Brake Hydraulic Booster Pump (Hy-Power - Dual Power) Not Master Cylinder	GM Power Steering Fluid
Brake Linkage (Mechanical)	A
Brake Master Cylinder	L
Brake Shoe Anchor Pins	C
Brake Shoe Camshafts	C
Brake Slack Adjusters	C
Cab Latch	A
Cab Lock Levers	C
Cab Tilt Pump	S
Clutch Control Cable	C
Clutch Master Cylinder	L
Clutch Pedal Linkage	A
Clutch Pedal Relay Shaft	C
Clutch Pedal Shoulder Bolt	C
Clutch Release Bearing	C
Clutch Release Fork Shaft	C
Clutch Release Sleeve Fork	C
Clutch Slave Cylinder Yoke Pin	A
Differential (Front And Rear Axles)	E
Door Check	A
Door Hinges	A
Door Latch	D
Door Latch Striker Plate Or Pin	D
Door Lock Cylinders	J
Drag Link Ends	C
Electronic Ignition System:	

Multi-wire connectors of the electronic ignition system are treated with a special conductive lubricating/sealing compound (grease). Its purposes are to lubricate the metal contact surfaces and to prevent entry of moisture into the connection. The lubricant/sealer should not be cleaned from the connector terminals.

At the time of the ignition system service, connectors should be protected by filling the female cavities of connectors with lubricant/sealer before assembly. The lubricant/sealer compound is available through IH parts outlets under part number 472141-C1.

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ENGINE:

Oil types and grades recommended for engines used in IH truck applications are as follow:

IH GASOLINE ENGINES

Temperature	Straight Viscosity Grade	Multi Viscosity Grade
20 to 120 F (-7 to 49 C)	SAE 30	SAE 10W-30, 10W-40, 20W-40, 20W-30
0 to 90 F (-18 to 32 C)	SAE 20W	SAE 10W-30, 10W-40, 20W-40, 20W-30
-10 to 70 F (-23 to 21 C)	SAE 10W	SAE 10W-30, 10W-40
Below -10 F (23 C)	--------	SAE 5W-20, 5W-30

Use engine oils meeting service classification "SE" or "CC" (MIL-L-46152).

IMPORTANT

When a universal engine oil (SE-CD) is preferred, the engine oil must have passed the Volvo B-20 cam and tappet test and contain a minimum 0.1% alkyl zinc.IH #1 engine oil meets this requirement.

IH D-150 D-170 D-190 DIESEL ENGINES

Temperature	Straight Viscosity Grade	Multi Viscosity Grade
20 to 120 F (-7 to 49 C)	SAE 30	SAE 10W-30, 10W-40, 20W-40, 20W-
0 to 90 F (-18 to 32 C)	SAE 20	SAE 10W-30, 10W-40, 20W-40
Below 0 F (-18 C)	------	SAE 5W-20, 5W-30

Use engine oils meeting API service classification "IH No. 1 (CD/CC/SE),", "SE", "CC (MIL-L-46152)" or "CD (MIL-L-2104C)".

IH DT-466 DIESEL ENGINE

Temperature	Straight Viscosity Grade
20 to 120 F (-7 to 49 C)	SAE-30
-10 to 70 F (-23 to 21 C)	SAE-10W
10 to -30 F (-12 to 34 C)	SAE-10W with a pour point 10 F (-12 C) below lowest ambient air temperature or SAE-10W diluted with 10% kerosene

Use engine oils meeting service classification "IH No. 1 (CD/CC/SE)", "CD/CC/SC (MIL-L-2104C)" or "CD (MIL-L-45199B)".

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DESCRIPTION	LUBRICANT
CATERPILLAR	Use oils meeting the following engine service classification: SC and SD (MS - Motor Severe Oils) CB (Supplement 1 Oils) CC (MIL-L-2104B Specification Oils) CD or (MIL-L-2104C) Use SAE 10W-30, 10W-40 or SAE 30 grade oils for temperatures above freezing. Use SAE 10W, 10W-30 or 10W-40 grade oils for temperatures below freezing. Below -23° C (-10° F) it may be necessary to warm the oil so the engine can be cranked and oil can circulate freely.
CUMMINS	

Light Service Only (Stop-and-Go) All Diesel Models	**Naturally Aspirated Diesel Models**	**Turbocharged Diesel Models**	**All Natural Gas Models All Service**
API Class CC/SC [2/5] 1.85% Maximum Sulfated Ash Content [3]	API Class CC [1] 1.85% Maximum Sulfated Ash Content [3]	API Class CC/CD [2] 1.85% Maximum Sulfated Ash Content [3]	API Class CC .03 to .85% Sulfated Ash Content [4]

[1] API classification CC and CD quality oils as used in turbocharged engines and API classification CC/SC quality oils as used for stop-and-go service are satisfactory for use in naturally aspirated engines.

[2] API classification CC/SC and CC/CD indicate that the oil must be blended to the quality level required by both specifications. The range of oil quality permitted by the CC classification is so broad that some oils that meet the classification will not provide adequate protection (varnish and ring sticking) for engines operated in certain applications. For example, turbocharged engines require the additional protection provided by the CD classification. Engines operated in stop and go service require the additional protection provided by the SC classification.

[3] A sulfated ash limit has been placed on all lubricating oils for Cummins engines because past experience has shown that high ash oils may produce harmful deposits on valves that can progress to guttering and valve burning.

[4] Completely ashless oils or high ash content oils, are not recommended for use in gas engines a range of ash content is specified.

[5] SD or SE may be substituted for SC.

Operating Temperatures Vs. Viscosity

Ambient Temperatures	Viscosity
-23° C (-1° F) and Below	See Table A
-23 to -1° C (-10 to 30° F)	10W
-7 to 16° C (20 to 60° F)	20-20W
4° C (40° F) and Above	30

Table A - Arctic Oil Recommendations

Parameter (Test Method)	Specifications
Performance Quality Level	API Class CC/SC or API Class CC/CD
Viscosity	10,000 Centistokes Maximum @ -34° C (-30° F) 5.75 Centistokes Minimum @ 99° C (210° F)
Pour Point (ASTM D-97)	At least -12° C (10° F) below lowest expected ambient temperature.
Ash, Sulfated (ASTM D-874)	1.85% by Weight Maximum

IMPORTANT

Due to extreme operating conditions, oil change intervals should be carefully evaluated paying particular attention to viscosity changes and total base number decrease. Oil designed to meet MIL-L10295-A, which is now void, and SAE 5W mineral oils should not be used.

DETROIT DIESEL

Detroit Diesel engines have given optimum performance and experienced the longest life with MIL-L2104B (API designation "CC"), SAE 40 oils with the following physical property limitations.

1. Sulfated ash (ASTM D-874) of 1.00 percent maximum weight, except lubricants that contain only barium detergent dispersants where 1.50 percent by-weight is allowed.

2. Zinc, as zinc diorganodithiophosphate, shall be a minimum of 0.07 percent by weight. SAE 40 grade oil is recommended for year-round use.

An SAE 30 oil should be used only when the ambient temperatures and engine cranking capabilities resalt in difficult starting. The use of lower viscosity oils (below 30 grade) or multigrade products will usually result in less than normal engine life.

Description	Type Lubricant (See symbol)
Hood Latch	C
Hood Linkage	A
Hood Pivot Bar Bracket	C
Hood Tilt Linkage	C
King Pin Bushings (Steering Knuckles)	C
Manifold Heat Control Valve	N
Power Divider	E
Power Divider Lock Yoke Pin	A
Power Steering Pump Reservoir (Sheppard)	SAE-10W-40 Engine Oil
Power Steering Pump Reservoir (Not Sheppard)	GM Power Steering Fluid
Power Take-Off Shift Control	A
Propeller Shaft Center Bearing	C
Propeller Shaft Slip Joint	C
Propeller Shaft Universal Joints	C
Radiator Shutter and Linkage:	
KYSOR Vehicles equipped with automatic modulated control radiator shutters (thermostat element mounted in bottom tank or radiator). Do not oil pins and sliding surfaces at frequent intervals. Vane bearings should be cleaned with light or penetrating oil and blown out with air only when servicing complete shutter assembly.	
CADILLAC	Do not oil Cadillac Shutters
Seat Adjuster Slides	C
Shift Motor (Two Speed Axle)	H
Shift Linkage (Front Drive Axle)	C
Speedometer Cable	C
Speedometer Head	A
Springs (Auxiliary)	C
Spring Pins	C
Spring Shackles	C
Spring Seat Connecting Tube Bearing	C
Starting Motor	K
Steering Column Flexible Coupling	C
Steering Column Mounting Bracket	C
Steering Column Slip Joint	C
Steering Column Universal Joint	C
Steering Drive Joints (Front Axle)	C
Steering Gear (Manual)	M
Steering Gear Relay Lever Pillar Block Bearing	C
Tachometer Cable	C
Tachometer Head	A

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Description	Type Lubricant (See symbol)
Tie Rod Ends	C
Transfer Case (Not Code 13143)	P
Transfer Case (Code 13143)	G
Transfer Case Shift Control	C
Transmission (Auto.)	G
Transmission - Clark	U
Transmission - Fuller (Main and Auxiliary)	Q
Transmission - IH (T-495, 496)	V
Transmission - New Process	Q
Transmission - Spicer (Main and Auxiliary)	F
Transmission - Warner Gear	O
Transmission Air Cylinder Shift Linkage	H
Transmission - Remote Control Rod	C
Transmission - Remote Control Rod Universal Joints	C
Transmission - Remote Control Shift Lever Housing	K
Winch	E
Winch Prop-Shaft Center Bearing	C
Winch Rollers	C
Winch Shift Linkage	C
Window Regulator	C
Wheel Bearings (Grease) (Front and Rear)	C
Wheel Bearings (Oil) (Front)	R
Wheel Bearings (Oil) (Rear)	E

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PROPELLER SHAFT

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FORWARD

This manual is presented as a guide in solving problems associated with drive shafts. No attempt has been made to discuss technical consideration of design or theory of vibrating systems .

In discussing installation of drive shafts, no hard and fast rule or fine dividing line has been drawn between satisfactory and unsatisfactory operation.

The limits set forth in this manual correspond with our own standards. Our long experience in the installation of drive shafts has proven these standards to be accurate.

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FUNCTION

In examining the drive line, it would be well to start with a review of drive shaft operation. A critical examination of why it is there and what it must do may be helpful in analyzing its effect on the entire drive line system. A driveshaft's functions can be briefly described as follows:

1. It must transmit torque from the transmission to the axle. This requirement makes it necessary that the driveshaft be capable of transmitting the maximum low gear torque developed by the engine and transmission ratio and any shock loads which may develop. It must also be capable of rotating at the maximum speed required for vehicle operation. This speed is often engine speed increased by an overdrive ratio in the transmission.

2. The driveshaft must operate through constantly changing relative angles between transmission driveshaft and axle.

3. The length of the driveshaft must be capable of changing while transmitting torque. Length changes are caused by necessary axle movement due to torque reaction, road deflections, braking loads, etc.

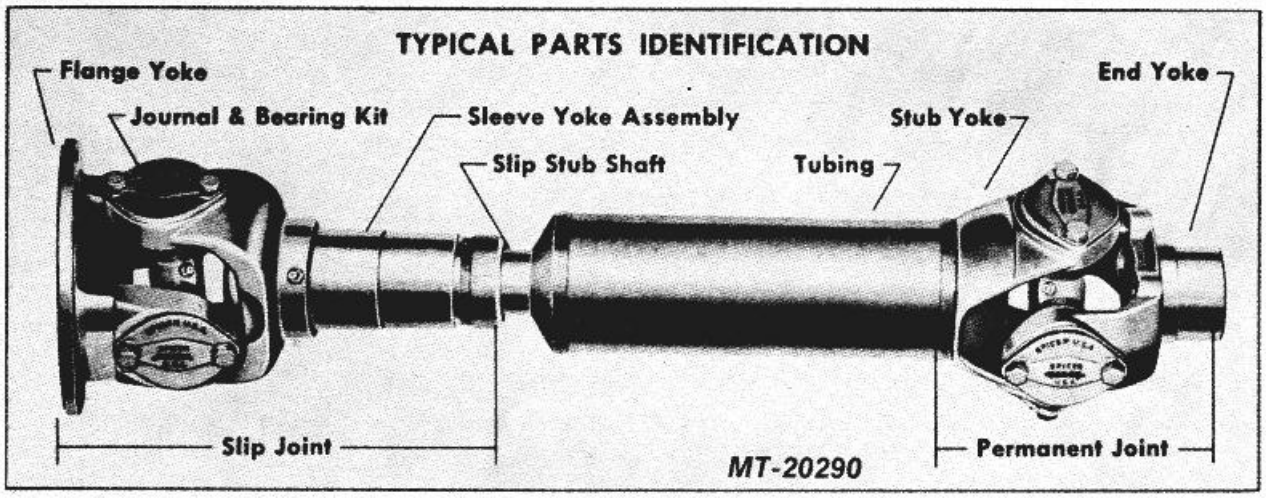


Fig. 1

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CONSTRUCTION

The basic functions having been designated, let's look at conventional universal joint and driveshaft construction.

To transmit required loads, the driveshaft must possess high strength. Forged steel, or high strength cast yokes are generally used to provide necessary strength and the rigidity required to maintain bearing alignment under torque loads and during high speed operation. Special high-strength tubing is used to provide maximum torque carrying capacity at minimum practical weight. This tubing must be securely welded to its end members, to provide the necessary torque capacity.

High quality anti-friction bearings are used to withstand required loads while oscillating at high speeds. These bearings on the journal cross carry vary high loads for their size. The full complement, roller-type (needle) bearings are generally used because of their high capacity in a limited space. Bearings are individually sealed to provide retention of required lubricants as well as to prevent the entry of foreign material. If lubricants become contaminated with water or abrasive material, needle bearing life is seriously affected.

Abrasive material is a major problem where a vehicle operates under conditions of extreme moisture and dirt. Off-highway installations are especially critical in this respect. Military trucks represent the extreme in this direction and were the first to show the shortcomings in the conventional cork seals used in universal joint bearings. It was found that an improved seal was required for this type of operation. Synthetic rubber-type seals were developed for these installations. These seals have been in use for many years on military vehicles and are now used in most commercial installations. The improved sealing shows increased life and a less critical re-lubrication cycle.

The sliding splines between slip joint and permanent joint must support the driveshaft and be capable of sliding under full torque loads. To provide adequate strength and wear resistance, hardened and ground splines are used. These splines are phosphate coated to resist galling and to reduce sliding friction.

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COMPONENTS

LEGEND FOR FIGS. 2, 3, 4, 5, 6, 7 & 8

Key	Description	Key	Description
2	FLANGE YOKE	27	STUB YOKE & TUBE ASSEMBLY
3	SLEEVE YOKE ASSEMBLY	28	STUB YOKE
4	END YOKE	30	TUBING
5	JOURNAL ASSEMBLY	40	SLIP STUD SHAFT, Welded Tube
6	BEARING ASSEMBLY	53	MIDSHIP STUB SHAFT, Center Bearing
7	SNAP RING	70	CAP & BOLT ASSEMBLY
14	DUST CAP	82	YOKE SHAFT
15	STEEL WASHER	94	U-BOLT ASSEMBLY
16	CORK WASHER		

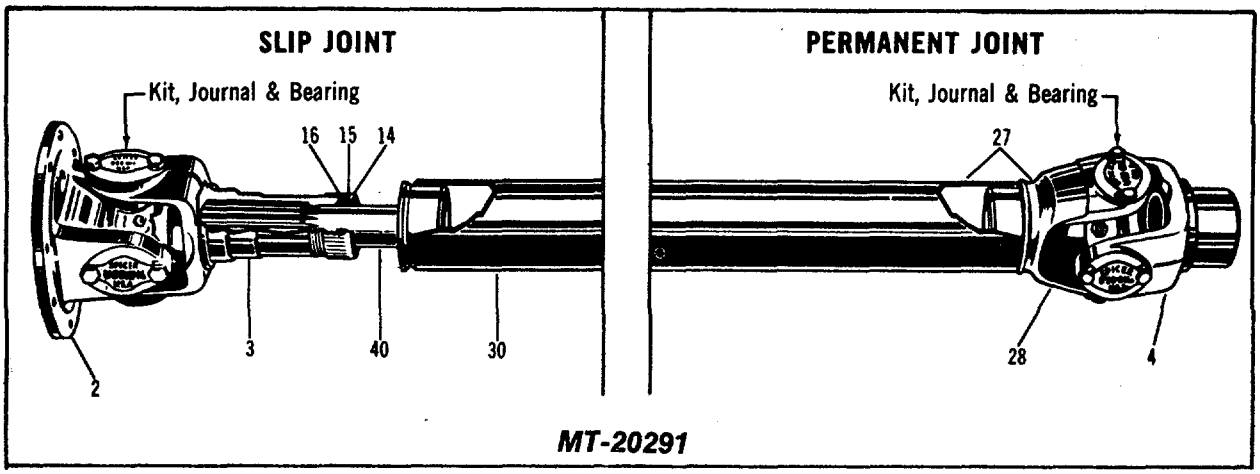
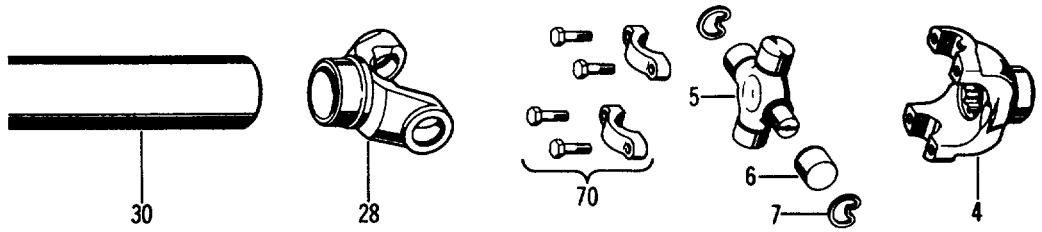


Fig. 2

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COMPONENTS
PERMANENT JOINT



MT-20292

Fig. 3

CENTER BEARING ASSEMBLY

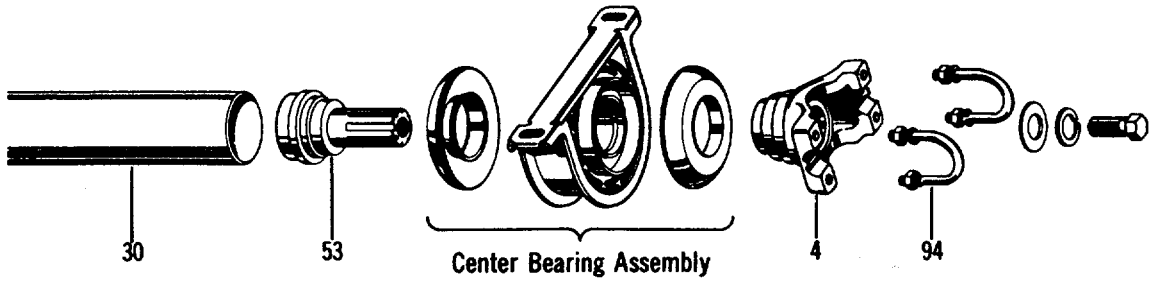


Fig. 4

SLIP JOINT

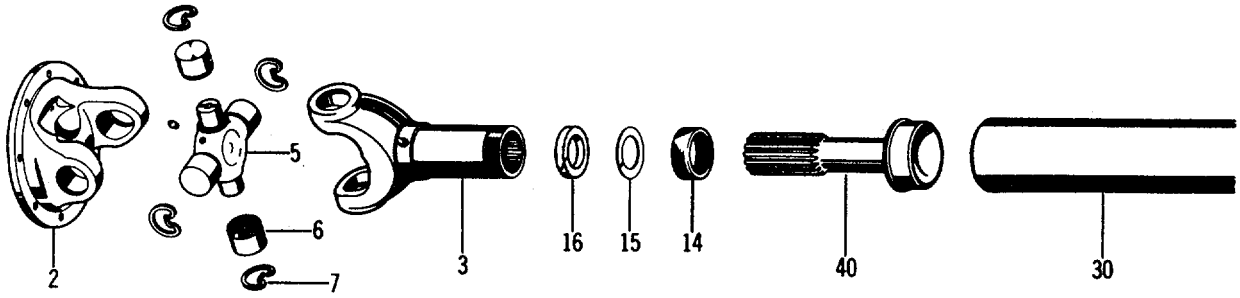
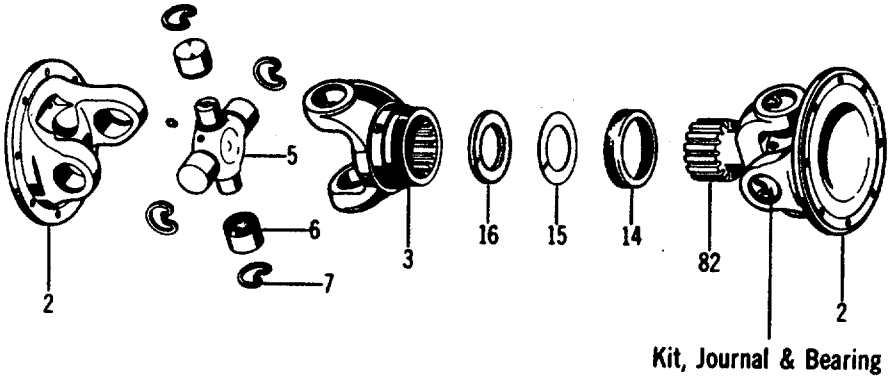


Fig. 5

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COMPONENTS

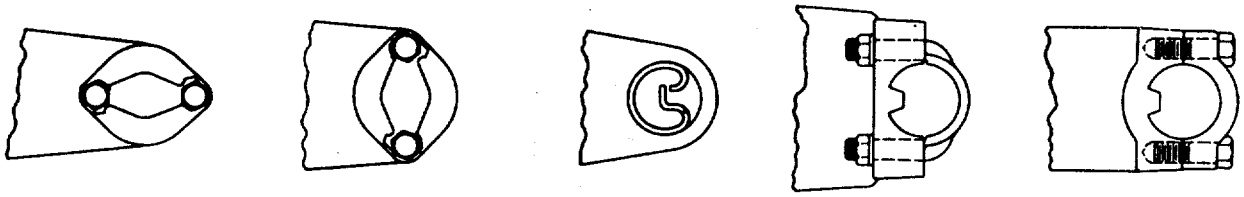
SHORT-COUPLED JOINT



MT-20295

Fig. 6

ALTERNATE YOKE CONSTRUCTIONS



MT-20296

Fig. 7

ALTERNATE COMPANION FLANGE-FLANGE YOKE



MT-20297

Fig. 8

UNIVERSAL JOINT SEALS

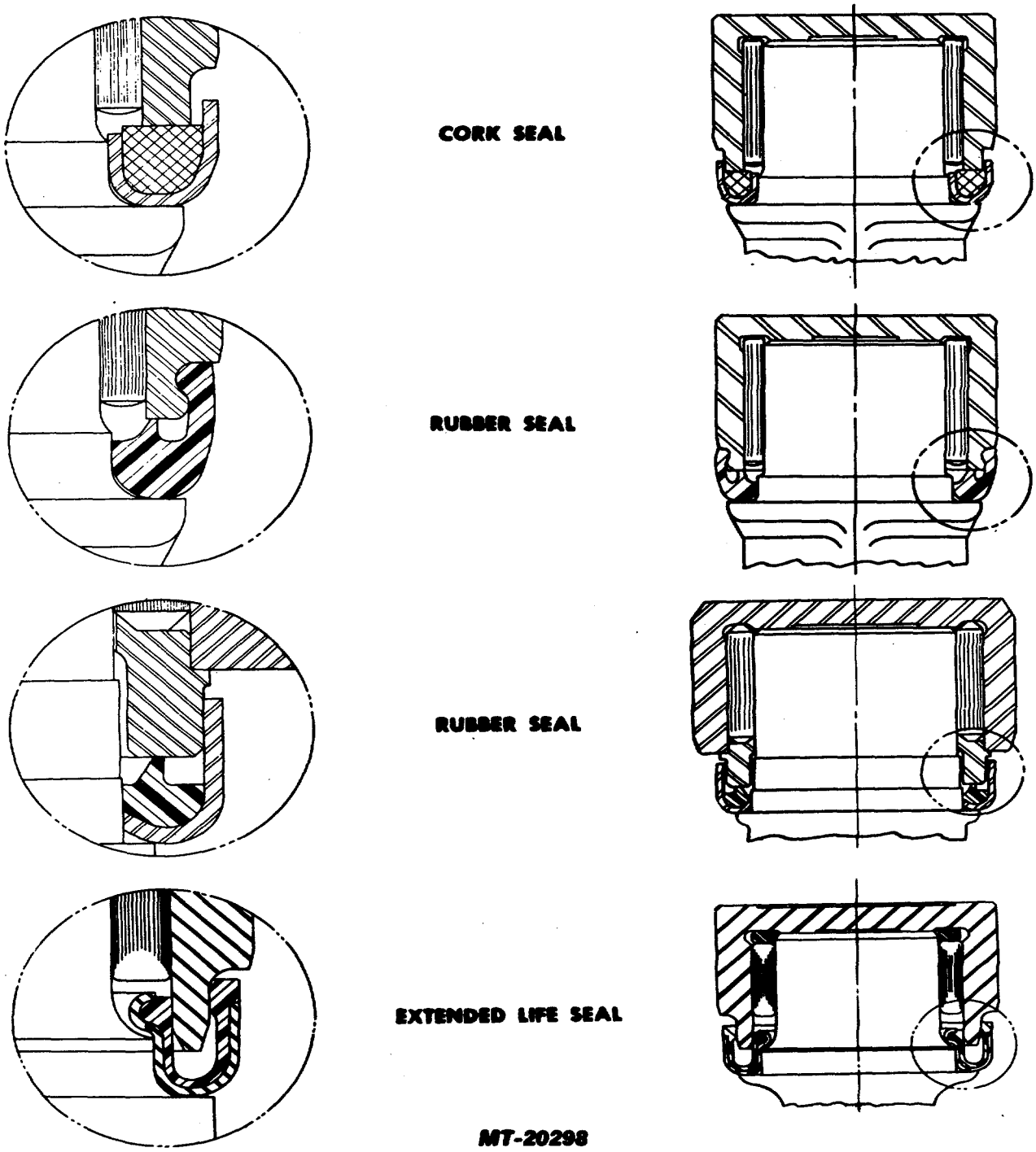


Fig. 9

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DON'T NEGLECT DRIVE SHAFT LUBRICATION!

Lack of adequate or proper lubrication is among the most common causes of U-Joint and drive shaft failure!

Proper servicing of the drive shaft is an essential part of vehicle maintenance and should not be overlooked in routine shop procedure.

UNIVERSAL JOINTS

IN THE VEHICLE OR APPLICATION

To insure proper lubrication of all four bearing assemblies on universal joints, it is essential that mechanics add lubricant until it appears at all journal cross bearing seals (Fig. 10). This assures removal of dirt particles and other contaminants that may find their way into the bearings and indicates to the mechanic that the bearings are fully lubricated.

Do not assume that bearing cavities have been filled with new lubricant unless flow is noticed around all four bearing seals!

Journal cross seals are designed to relieve. However, if all the seals do not "pop" when being lubed, move the driveshaft laterally in all four directions and pull or push on the drive shaft in the direction opposite to the journal cross seal not relieving while lube gun pressure is being applied to the alemite fitting. An increase in line pressure may also be necessary.

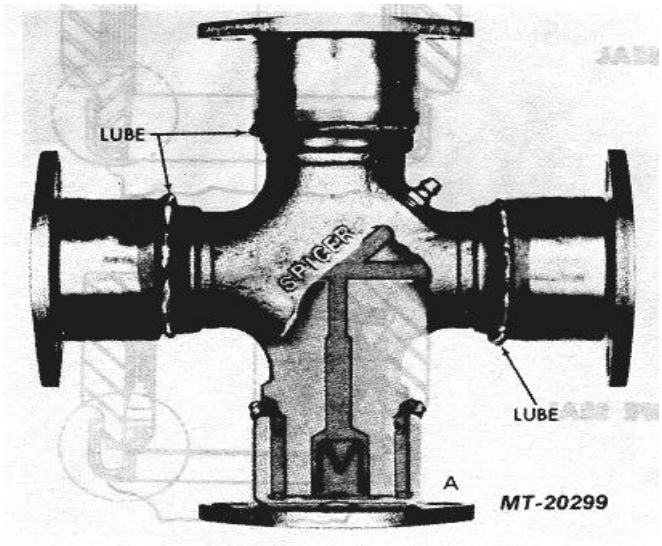


Fig. 10

DRIVE SHAFT ASSEMBLY

Factory assembled drive shafts are lubricated at the plant prior to shipment. However, shipping, handling and installation of the drive shaft assembly into the vehicle usually results in some loss of lube. Therefore, it is recommended that all universal joints be relubricated after installation of the drive shaft prior to putting vehicle in service.

JOURNAL AND BEARING KITS

Replacement universal joint kits contain only enough grease to provide needle bearing protection during storage. It is therefore necessary to completely lubricate each replacement kit prior to assembly into the drive shaft yokes. Each journal cross lube reservoir should be fully packed with a recommended grease and each bearing assembly should also be wiped with the same grease; filling all the cavities between the rollers and applying a liberal grease coating on the bottom of each race. After the kits are installed into the driveshaft yokes and prior to placing into service, they should be relubed, through the zerks, using the same grease.

LUBRICANT

For center bearings, slip joints and universal joints use IH 251 HEP grease or equivalent NLGI #2 multi-purpose grease.

RELUBE CYCLES

Relubrication cycles for driveshaft universal joints and slip splines will vary with service requirements and operating conditions. Refer to Operator's Manual.

SLIP JOINT LUBRICATION

Relube spline at intervals prescribed in Operator's Manual. Apply grease gun pressure to lubrication zerk until lubricant appears at pressure relief hole in welch plug at sleeve yoke end of spline (Fig. 11). At this point, cover pressure relief hole with finger and continue to apply pressure until grease appears at sleeve yoke seal (Fig. 12). This will insure complete lubrication of spline.

LUBE SPECS

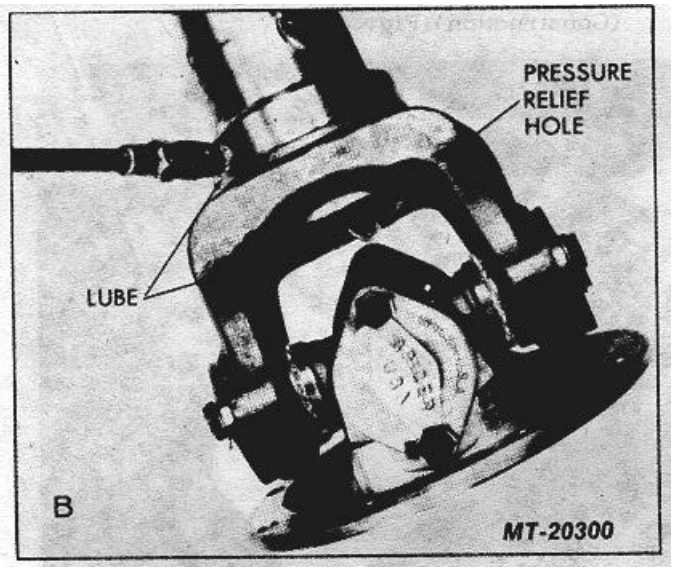


Fig. 11

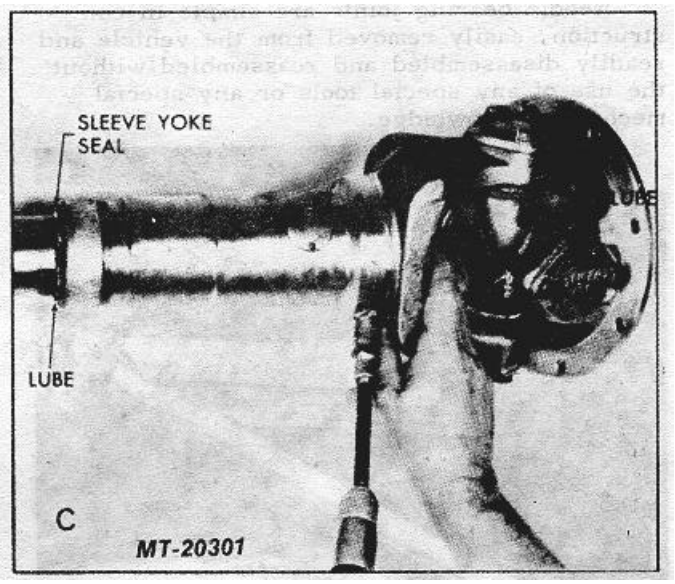


Fig. 12

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Needle bearing joints are simple in construction, easily removed from the vehicle and readily disassembled and reassembled without the use of any special tools or any special mechanical knowledge.

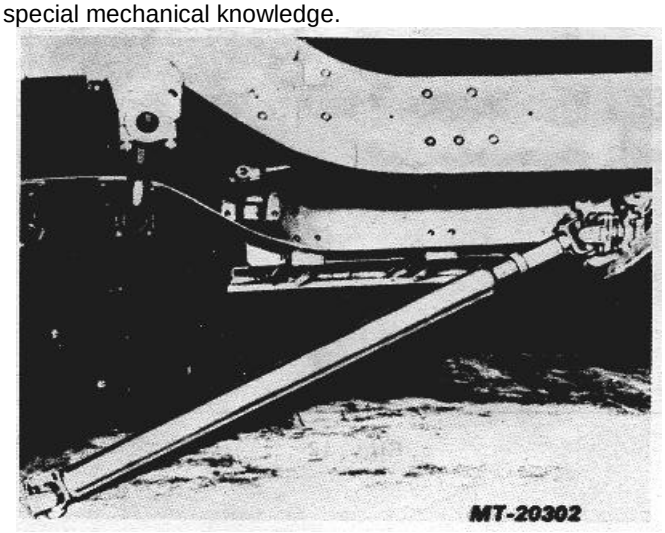


Fig. 13

REMOVAL FROM THE VEHICLE

1. Double Flange, Yoke Types (Bearing Cap and Snap Ring Construction)(Fig. 13)

All Double Flange Yoke Type Joints are removed as a complete assembly by removal of the Companion Flange Bolts, Nuts and Lockwashers, which allows the assembly to slip out from between the Companion Flanges.

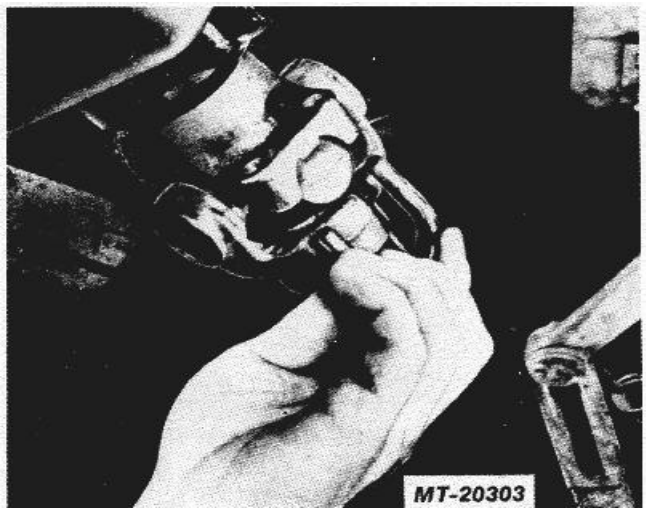


Fig. 14

2. Double End, Yoke Type (U-Bolt (Construction) (Fig. 14)

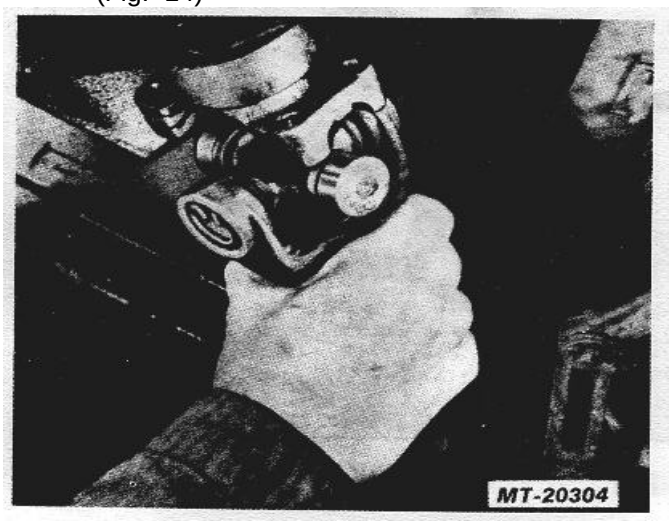


Fig. 15

Remove the U-Bolts, Nuts, and Lockwashers from the End Yokes. Slide the Sleeve Yoke toward the shaft to free the Bearings from their seats between the shoulders in the End Yokes (Fig. 15). Care should be taken not to drop the two Bearings from the trunnion ends of the Journal Cross at both ends of the driveshaft. The End Yokes remain on the vehicle.

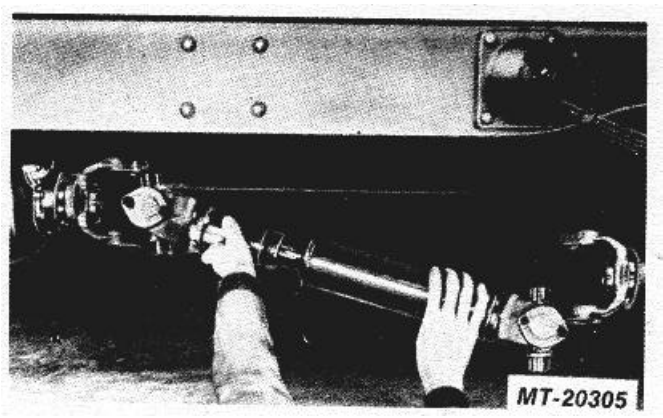


Fig. 16

3. Double End Yoke Type (Bearing Cap Construction) (Fig. 16)

Remove the capscrews, lock plates and bearing and retaining cap sub-assemblies, from the transmission and axle end yokes. Remove the driveshaft with the remaining journal crosses and bearings as a unit. The end yokes remain on the vehicle.

REMOVAL OF THE SLIP JOINT

1. Slip Joint (All Types). Unscrew the dust cap from the sleeve yoke and slide the joint off the driveshaft (Fig. 17).

2. ARROW MARKS Make sure arrow marks are stamped on the shaft and sleeve yoke before removing the slip joint (Fig. 18). If arrow marks are not readily seen, mark both members so that when reassembled they will be in exactly the same relative position, since the sleeve yoke lugs must be in the same plane as the stub ball yokes to prevent excessive vibration.

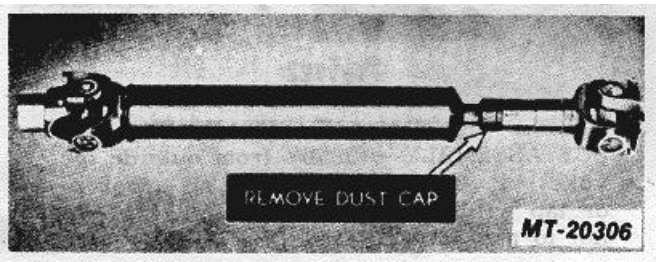


Fig. 17

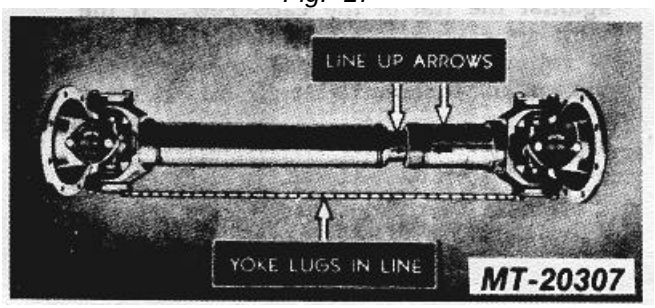


Fig. 18

DISASSEMBLING UNIVERSAL JOINT MEDIUM AND HEAVY DUTY

1. LOCK STRAP Bend down the locking lugs with a screwdriver and remove the capscrews.

2. NEEDLE BEARINGS & RETAINING CAP SUB-ASSEMBLY Remove by using a large pair of channel lock pliers on retaining cap edges, turn retaining cap and bearing subassembly at the same time lifting upward to remove the sub-assembly from the journal trunnion diameter and out of the yoke hole. Turn the joint over and tap the exposed end of the journal cross until the opposite needle bearing is free. Use a soft round drift with flat face about .79 mm (1/32") smaller in diameter than the hole in the yoke, otherwise there is danger of damaging the bearing (Fig. 19).

3. JOURNAL CROSS Remove by sliding it to one side of the yoke and tilting it over the top of the yoke lug (Fig. 20).

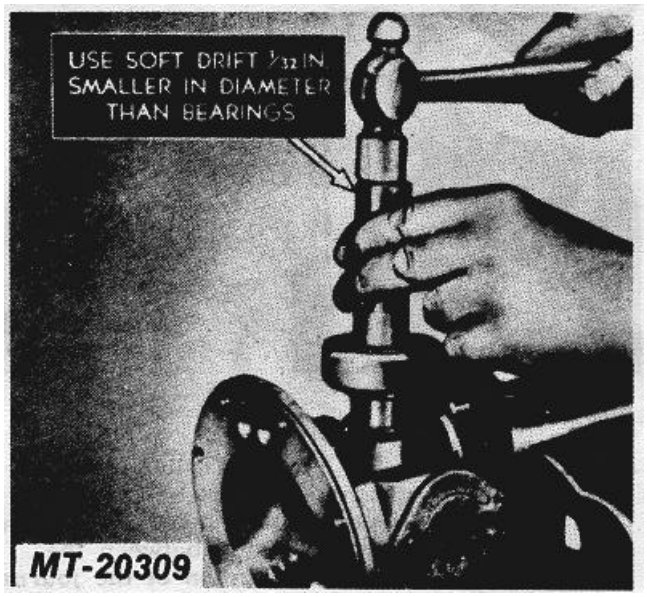


Fig. 19

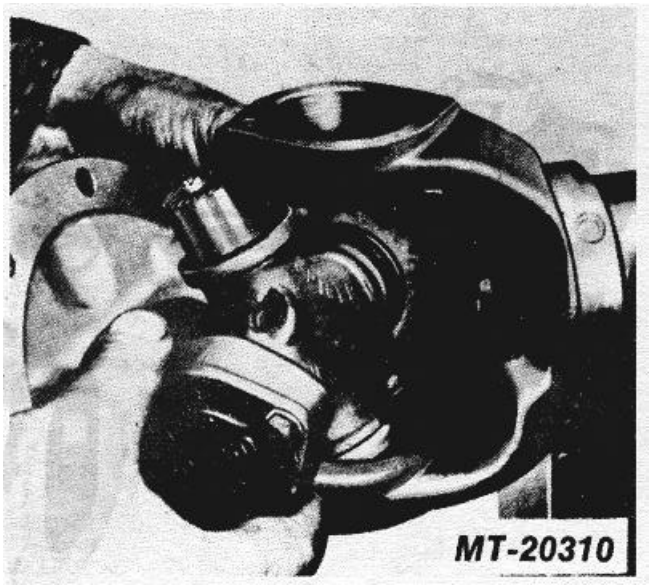


Fig. 20

SERVICE INSTRUCTIONS

ASSEMBLING UNIVERSAL JOINT MEDIUM AND HEAVY DUTY (Figs. 21, 22 and 23)

1. SEAL If necessary to install a new kit make sure that four new seals are installed in the journal retainers.

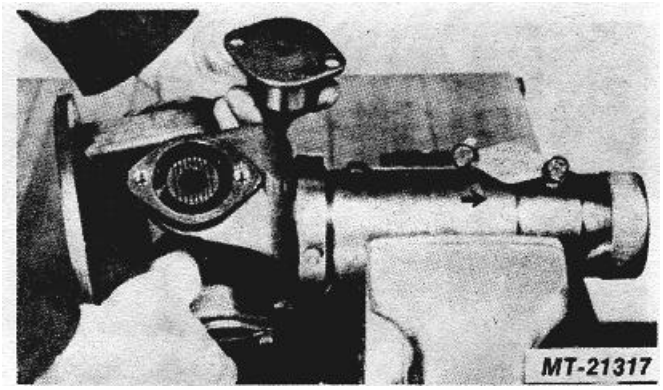


Fig. 21

2. JOURNAL CROSS With the relief valve facing the flange yoke, insert one trunnion of the journal cross into the bearing hole in the yoke lug from the inside between the lugs and tilt until the trunnion of the journal cross will clear the hole in the opposite yoke lug.

BEARING CAP CONSTRUCTION MEDIUM AND HEAVY DUTY

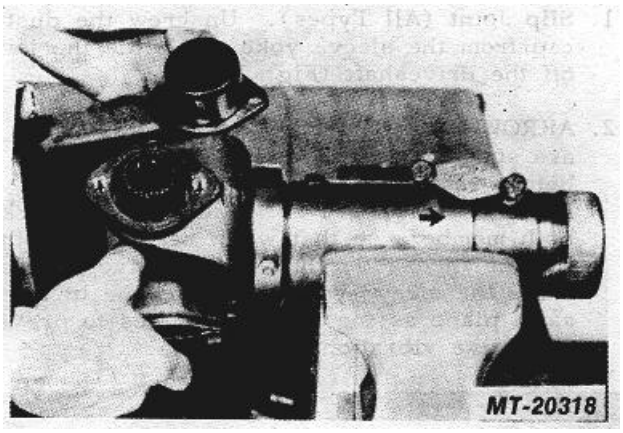


Fig. 22

3. NEEDLE BEARING AND RETAINING CAP SUB-ASSEMBLY Insert from outside of yoke. Press into place with an arbor press or tap with a soft round drift taking care not to mar any surfaces.

4. LOCK STRAP AND CAPSCREWS Assemble and bend the lugs of the lock strap up against the flat of the capscrew. If the joint appears to bind, tap the lugs lightly to relieve any pressure of the bearing on the end of the journal

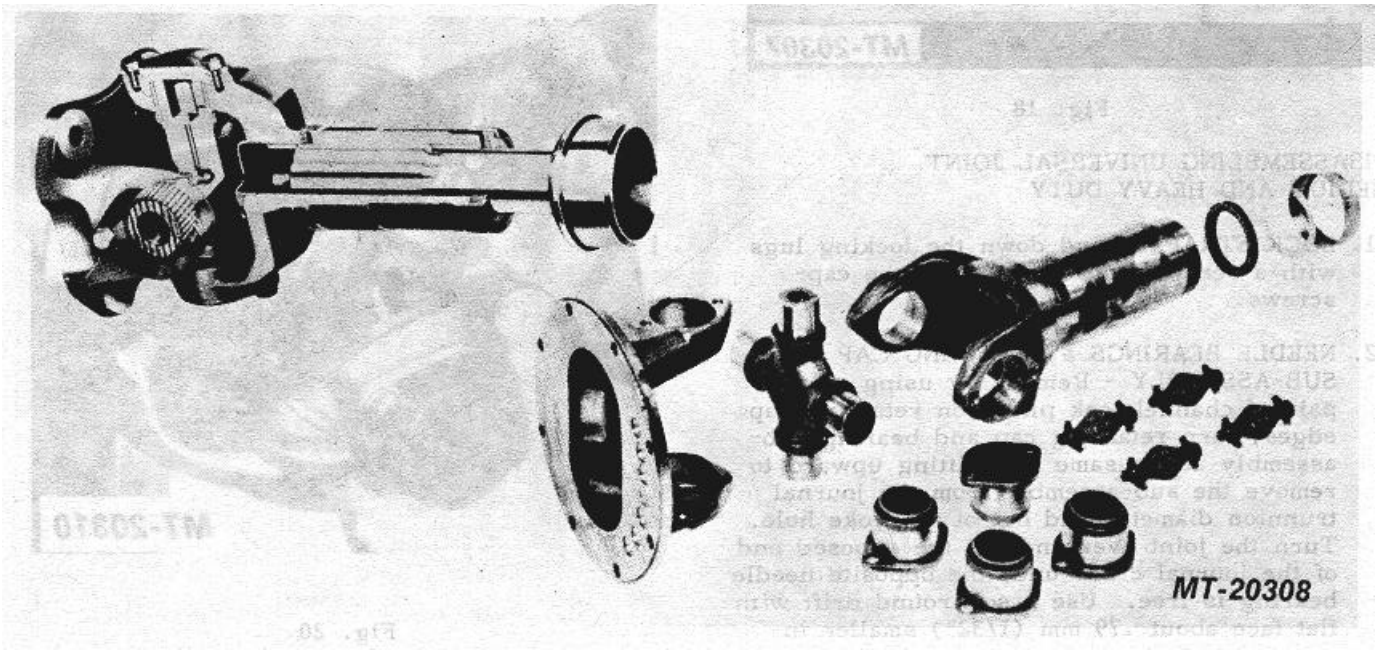


Fig. 23

DISASSEMBLING UNIVERSAL JOINT

1. SNAP RING - Remove by pinching the ends together with a pair of pliers. If a ring does not readily snap out of the groove in the yoke, tap the end of the bearing cap lightly to relieve the pressure against the ring (Fig. 24).

2. THRUST PLATE CONSTRUCTION (Fig. 25) - Remove capscrews and plate. The balance of the disassembly and assembly instructions are the same as those for snap ring joints.

3. NEEDLE BEARING CAP - Remove by driving on the end of one bearing cap until the opposite bearing cap comes out. Turn the joint over and tap the exposed end of the journal cross until the opposite needle bearing cap is free. Use a soft round drift with flat face about .79 mm (1/32") smaller than the hole diameter in the yoke, otherwise, there is danger of damaging the bearing.

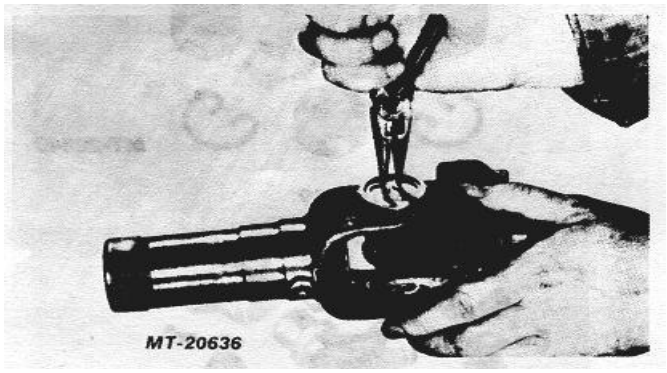


Fig. 24

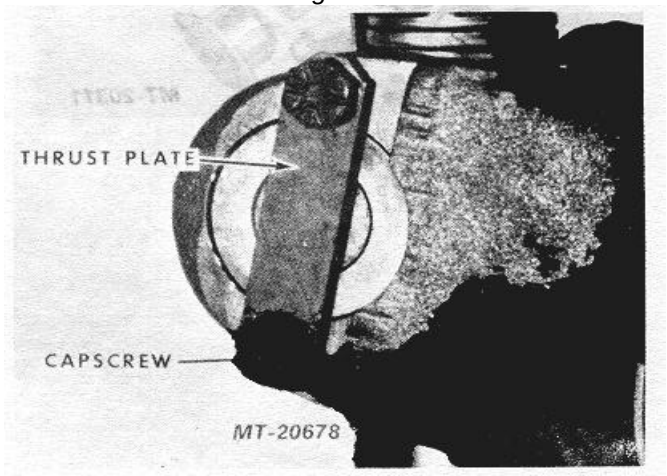


Fig. 25

4. JOURNAL CROSS - Remove by sliding it to the side of the yoke and tilting it over the top of the yoke lug (Fig. 26).

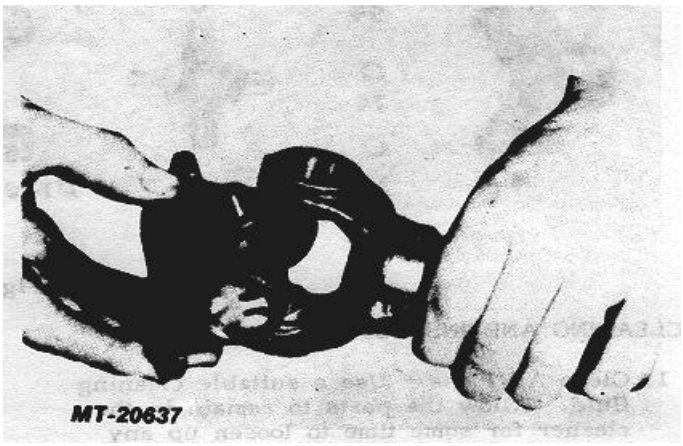


Fig. 26

ASSEMBLING UNIVERSAL JOINT

Reassembly is merely reverse order of the above operations. On joints without a lubrication fitting, repack reservoirs in the journal cross ends with the recommended lubricant. Make sure the reservoir in each trunnion is filled. With the rollers in the race, fill the race about 1/2 full (Fig. 27).



Fig. 27

U-BOLT CONSTRUCTION

U-Bolt joints are a combination of U-Bolt and snap ring construction (Fig. 28). Except that the U-Bolts are disassembled when the complete propeller shaft is removed from the vehicle, the balance of disassembly and assembly instructions are the same as those for snap ring joints.

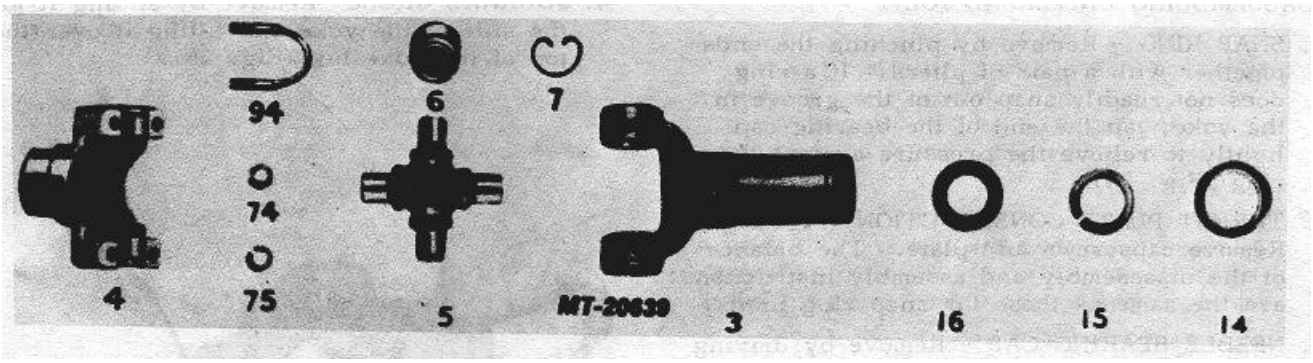


Fig. 28

CLEANING AND INSPECTION

1. Clean All Parts - Use a suitable cleaning fluid. Allow the parts to remain in the cleaner for some time to loosen up any particles of grease or foreign matter. Remove any burrs or rough spots from any machined surfaces.

2. Needle Bearings - Do not disassemble. Clean with short stiff brush and blow out with compressed air. Work a small quantity of lubricant into each bearing cap and turn the needle bearing on the trunnion to check wear. Replace if worn.

3. Journal Cross - Because worn needle bearings used with a new journal cross or new needle bearings used with a worn journal cross will wear more rapidly making another replacement necessary in a short time, always replace the journal cross and four needle bearing caps as a unit.

4. Journal and Bearing Kit (Figs. 29 and 30) - To facilitate the replacement of journals and bearings, a Journal and Bearing Kit is available. The use of the Kit insures having the correct individual parts when required and saves valuable time.

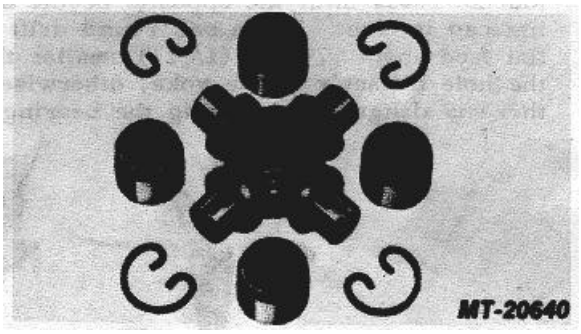


Fig. 29

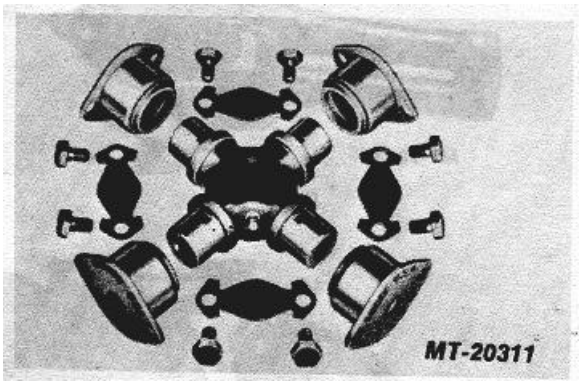


Fig. 30

TYPICAL FAILURES

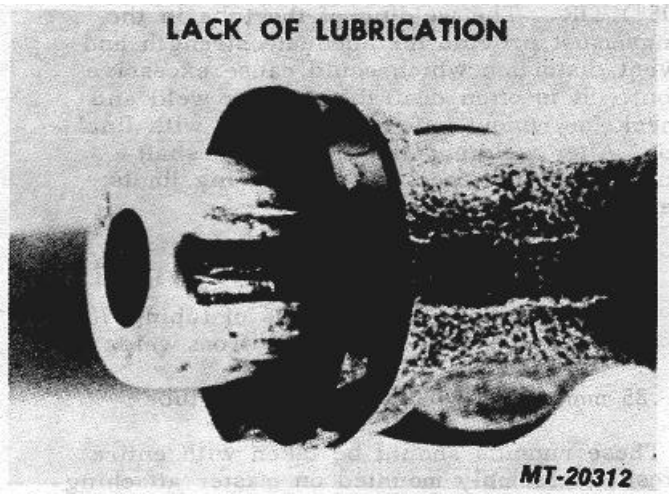


Fig. 31

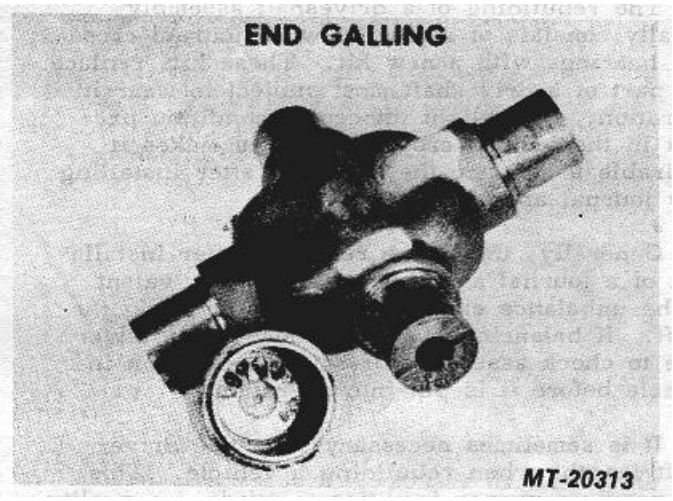


Fig. 32

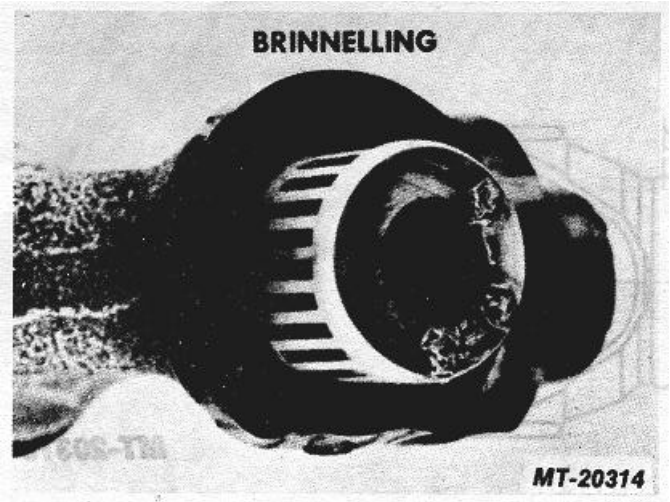


Fig. 33

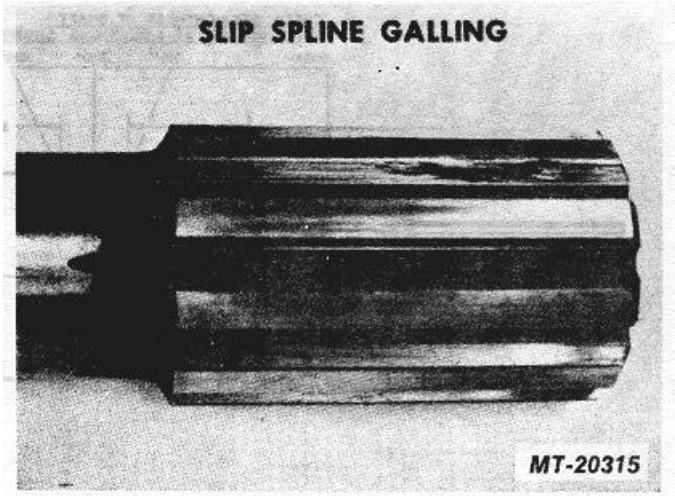


Fig. 34

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BALANCING

The rebuilding of a driveshaft assembly usually consists of replacing worn journal cross and bearings with a new kit. These kits replace the part of a driveshaft most subject to wear in operation. The slight off-center condition present in the journal cross assemblies makes it desirable to balance the assembly after installing new journal and bearing kits.

Generally, unbalance resulting after installation of a journal and bearing kit is equivalent to the unbalance existing after straightening the shaft. If balancing cannot be done, it is advisable to check assembly for smooth operation in vehicle before it is put into operation.

It is sometimes necessary to revise driveshaft lengths when rebuilding -a vehicle. This job requires proper facilities to produce a quality assembly. It is necessary to properly assemble fittings into the tube and straighten, before welding, to be sure parts are centralized. This can be done by mounting shaft assembly on center and straightening at fittings until ends of tube run concentric within about .12 mm (.005") TIR. The welding of the tube in the fittings must provide for adequate strength and prevent distortion which could cause excessive runout. It is often desirable to tack weld and recheck for runout before proceeding with final weld. After welding, the entire driveshaft should be straightened to the following limits: (See Fig. 35)

.12 mm (.005") TIR On shaft neck

.38 mm (.015") TIR On ends of tubing 76.2 mm (3") from welds

.25 mm (.010") TIR In center of tube

These runouts should be taken with entire driveshaft assembly mounted on master attaching flanges or yokes, selected for dynamic balance to eliminate as much unbalance as possible. During balancing, the driveshaft again should be mounted on these selected flanges or yokes.

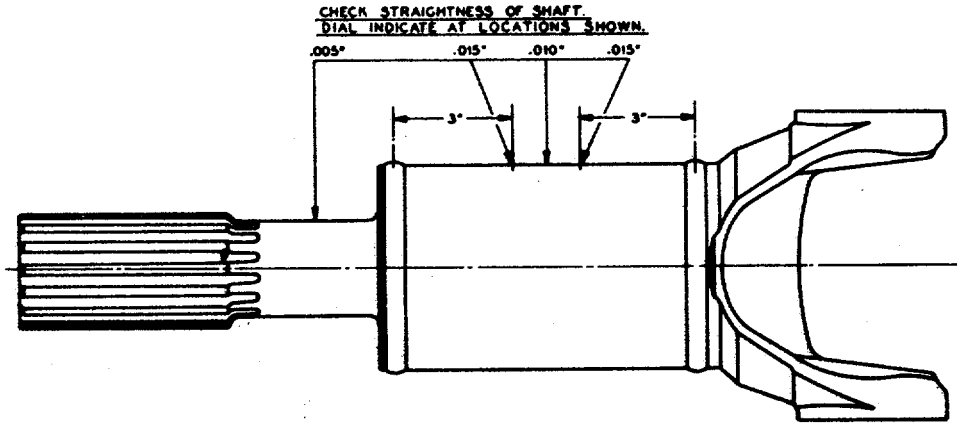


Fig. 35

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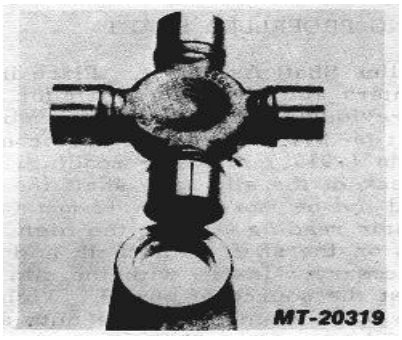


Fig. 36.

JOURNAL CAPS WITH LOCK FLATS (Fig. 36) - When installing new journal kit caps into yoke ear holes, the lock flat on two of the journal caps must be kept in alignment with the locking flats near the front of the yoke ears. Proper location of locking flats will assure that the journal cap will not rotate.

The installation of a driveshaft into the vehicle does not present any unusual mechanical difficulties. Before actual installation, the driveshaft should be checked for the following items:

1. No damage or dents on driveshaft tubing which could cause unbalance. If the dents are severe enough they can weaken the tube and a failure might occur under torque load.

2. Splines should slide freely with slight drag from spline seal.

3. Bearings should flex and be free from excessive bind. A slight drag is the most desirable condition on a new universal joint. This drag is from the bearing seals. When rotating, yoke lug deflections cause some additional clearance. Excessive looseness is not desirable due to the resulting unbalance.

4. Mounting flanges and pilots should be free from burrs, paint and foreign substances which would not allow proper seating at assembly.

The driveshaft is mounted using flange bolts, bearing capscrews, or "U" bolts depending upon the size and construction. These bolts must carry high torque loads and should be of quality material and properly torqued. The following reviews requirements on these bolts:

1. Flange Bolts: Flange bolts should be alloy steel equivalent to SAE Grade 8, high-strength bolts. These bolts used with spring lockwashers and nuts provide the capacity required. The nuts should be torqued to the following specifications:

	N.m	Ft.Lbs.
5/16"-24 Thread	29.8-32.5	22-24
3/8"-24 Thread	54.2-59.6	40-44
7/16"-20 Thread	85.4-94.9	63-70
1/2"-20 Thread	132.9-146.4	98-108

IMPORTANT

In cap and bolt construction joints (Fig. 7), be sure to torque the capscrews to 135.6 N.m (100 ft.lbs.). These joints are usually in the inter-axle assemblies.

2. U-Bolt Style Yokes: On smaller size universal joints, a "U" bolt style end yoke is used. This construction permits easier assembly where the smaller size bearings allow its use. The bearing race is seated in a half round hole and under locating ears. Be sure that mounting faces are cleaned of rust, paint and other foreign material. The "U" bolts are assembled over the bearing races to retain them in the end yokes. Spring lockwashers and nuts should be used with these "U" bolts at assembly. The following torque loads are suggested for use with these parts:

	N.m	Ft.Lbs.
5/16"-24 Thread	18.9-23.0	14-17
3/8"-24 Thread	27.1-32.5	20-24
7/16"-20 Thread	43.3-50.1	32-37

These torque loads are somewhat lighter than normally used with these thread sizes, however, the lower torques are required to prevent bearing race distortion.

ASSEMBLING SLIP JOINT ON SHAFT

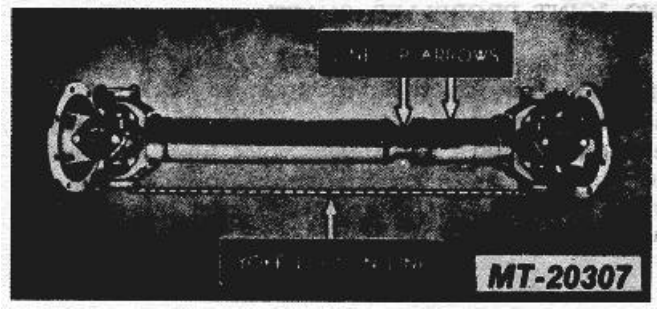


Fig. 37

INSTALLATION

Lubricate the splines thoroughly (refer to page 9) and assemble on the shaft. BE SURE that the arrows or marks on the shaft and slip joint are in line, since the sleeve yoke lugs must be in the same plane as the stud ball yoke lugs to prevent excessive vibration (Fig. 37).

The cork washer should be replaced is necessary before assembling with the dust cap and steel washer on the sleeve yoke.

INSTALLING PROPELLER SHAFT

1. Propeller Shaft Assembly Place in a pair of centers and check the shaft for runout if not previously done during assembly. The runout on the tube should not be more than .38 mm (.015") indicator reading, and on the neck of the slip stub shaft the runout should not be more than .12 mm (.005") indicator reading. Mark the high and low points on the shaft with chalk and straighten if necessary: Install with the slip joint nearest the source of power. Tighten the flange bolts evenly after the nuts and NEW lockwashers are in place.

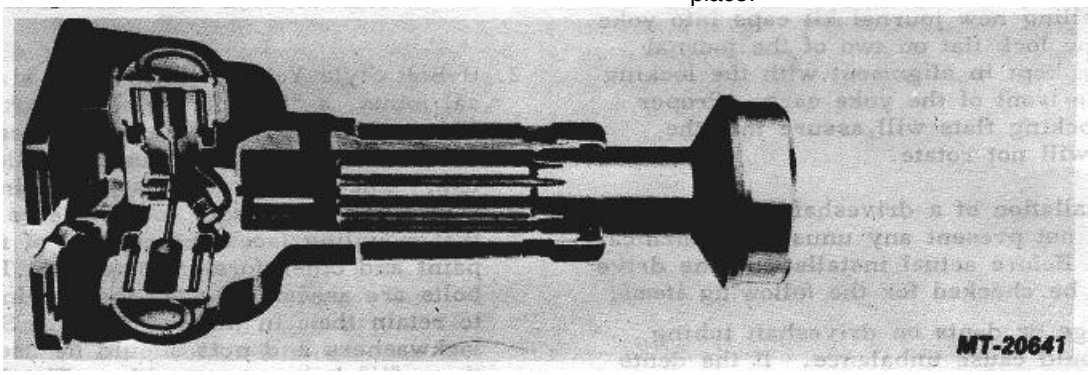


Fig. 38

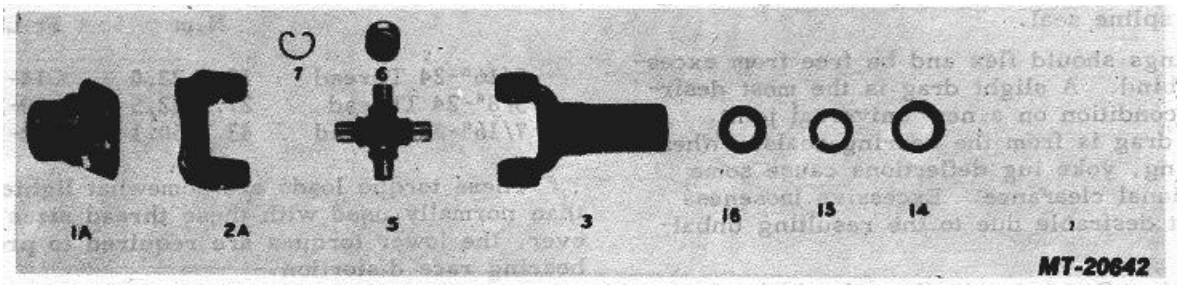


Fig. 39

TWO-JOINT PROPELLER SHAFT

It is of primary importance that universal joints of sufficient capacity be used. When assembling the slip joint on the shaft, care must be taken to place the sleeve yoke lugs (12) in the same plane as the shaft yoke lugs (13). Arrows will be found stamped on the sleeve and shaft for this purpose.

Install transmission so that the transmission mainshaft and axle pinion shaft are parallel or nearly so, in order to keep the angles (X) on both joints as nearly equal as possible. See Fig. 40. If this method results in angles (X) of more than 12 deg., use the method shown in Fig. 41, where the axle pinion shaft is tilted upward to enable the centerlines to intersect at a point midway between the joint centers, thus giving equal angles (Y).

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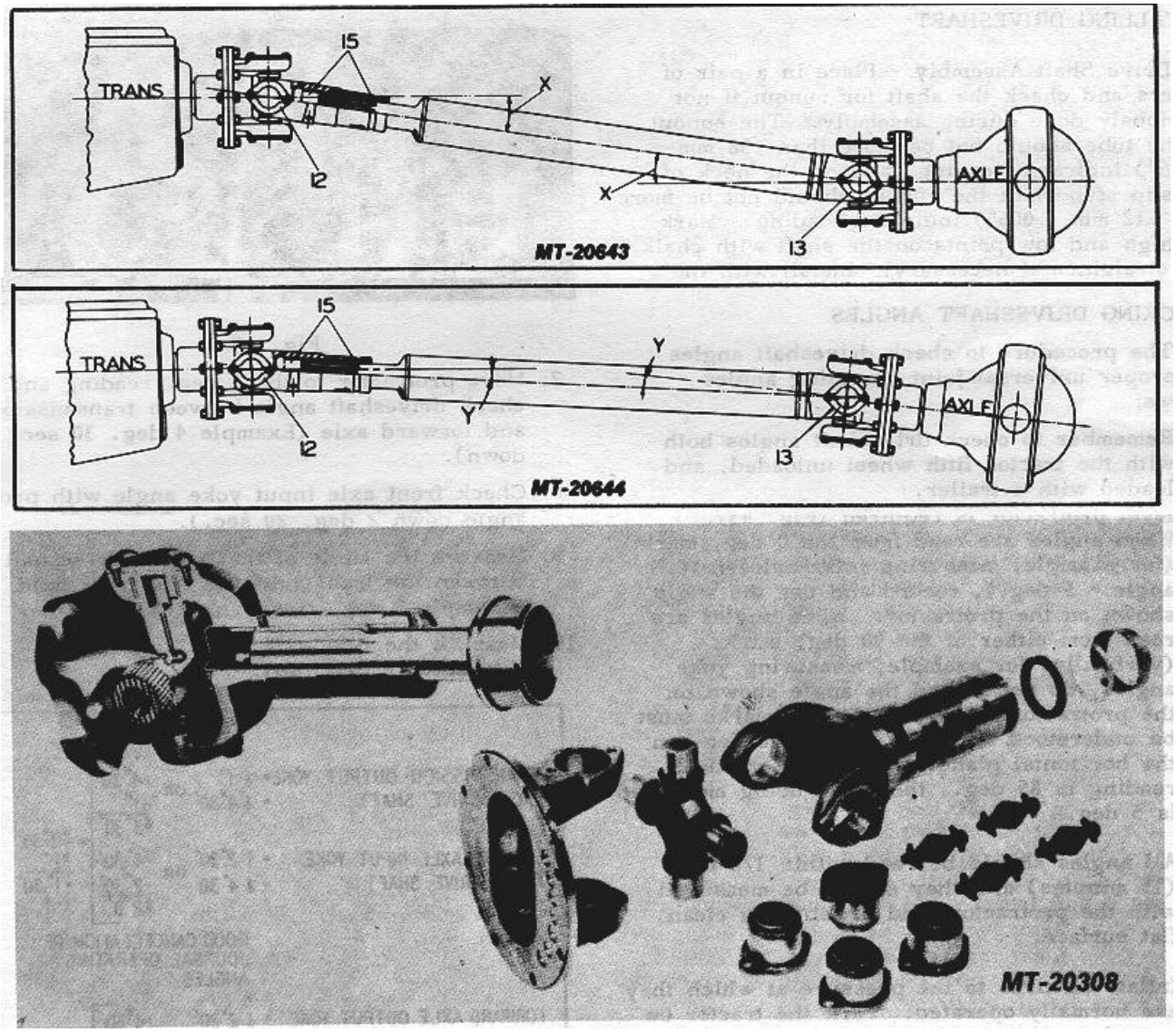


Fig. 42

UNIVERSAL JOINT PHASING (See Fig. 37)

When u-joints or yokes are assembled to their shafts in the same plane, they are in phase. When they are assembled to the shaft in different planes, they are out of phase. To obtain vibration free operation, check the following.

1. Yokes or flanges between the main and auxiliary transmission must be "In Phase".

2. In the case of a two-piece driveshaft assembly, between the transmission (Main or Auxiliary) and the forward rear axle, the joints on this shaft should be assembled "In Phase", unless otherwise specified by the manufacturer of the vehicle.

3. The inter-axle driveshaft yokes must be "In Phase".

4. If a vehicle has driveshafts that do not have intersecting angles but parallel angles throughout the drive line system, the yokes or flanges must be held parallel to within 1 deg. of each other.

INSTALLING DRIVESHAFT

Drive Shaft Assembly Place in a pair of centers and check the shaft for runout if not previously done during assembly. The runout on the tube should not be more than .38 mm (.015") indicator reading, and on the neck of the slip stub shaft the runout should not be more than .12 mm (.005") indicator reading. Mark the high and low points on the shaft with chalk and straighten if necessary. Install with the slip joint nearest the source of power. Tighten the flange bolts evenly after the nuts and NEW lockwashers are in place.

CHECKING DRIVESHAFT ANGLES

The procedure to check driveshaft angles for proper universal joint operating angles follows:

1. Remember to check driveshaft angles both with the tractor fifth wheel unloaded, and loaded with a trailer.

2. To determine driveshaft angles, a split level protractor is required (Fig. 43). When angles are read from the 0 deg. mark (for example, measuring inter-axle shaft angle 5 deg.), record and use the angle shown on the protractor. When angles are read from either of the 90 deg. marks (vertically) for example, measuring yoke angles, do not record the angle shown on the protractor since the 90 deg. marks must be understood to be the same as 0 deg. on the horizontal plane. Thus, if a vertical reading is 85 deg., the angle being measured is 5 deg.

3. All angles should be read within 1/4 deg. (15 minutes) and they should be measured with the protractor held plumb on a clean, fiat surface.

4. Inflate all tires to the pressure at which they are normally operated. Park the tractor on a surface which is as nearly level as possible both from front-to-rear and from side-to-side.

5. The tractor must be in its normal operating position. Do not attempt to level the truck by jacking up the front or rear axles to obtain a level condition.

6. Check and record the angle on the engine and main transmission. This reading can be taken at the rear of the main transmission on the output yoke or flange. Record this reading on a sketch similar to Fig. 44 (Example on Fig. 45, -1 deg. down).

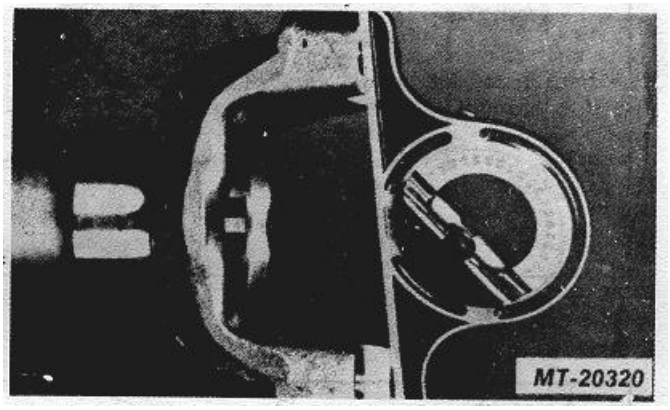


Fig. 43

7. Move protractor to the 0 deg. reading and check driveshaft angle between transmission and forward axle (Example 4 deg. 30 sec. down).
8. Check front axle input yoke angle with protractor (Example angle up 2 deg. 30 sec.), also check front axle output yoke (Example angle down 2 deg. 20 sec.).
9. Measure the angle of the tandem driveshaft between the front axle and first rear axle (Example 5 deg. down).

10. Measure the rear axle input yoke angle (Example 12 deg. up).

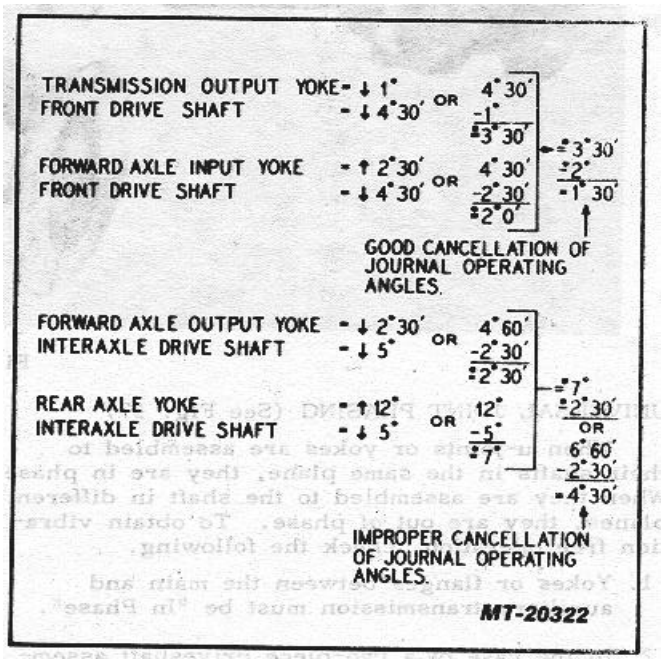


Fig. 44

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INSTALLATION

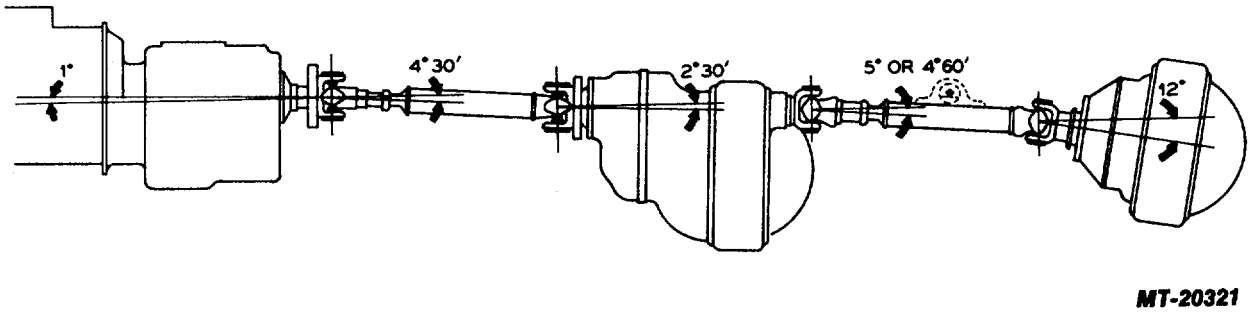


Fig. 45

11. With all the above angles recorded, these values are checked to obtain the journal cross operating angles of each driveshaft set to determine if they are operating to within a 3 deg. maximum of each other. If the operating angles or journals exceed 3 deg., it will cause early wear, and possi-seizure of the journal to the needle bearing in the journal cap.

TORQUE ARM SHIMMING

The adding or removing of shims from the rear torque arm will change the angle of the inter-axle driveshaft. Therefore, it is necessary to take the inter-axle driveshaft angle and the rear axle yoke angle after each adjustment is made, to determine the journal operating angle.

SHORT COUPLED JOINTS

Short coupled joints must be installed so that the front and rear joints will have equal angles which should not exceed 3 deg.

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CENTER BEARING

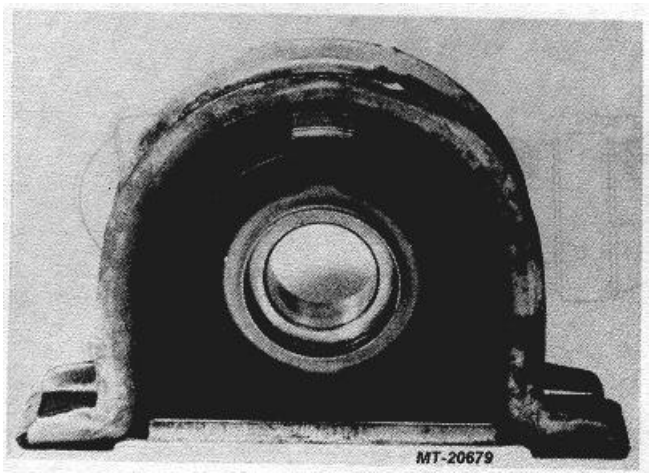


Fig. 46.

GENERAL

Center bearings (Fig. 46) are provided to support the propeller shaft assembly and to smooth out the power delivered to the rear axle assembly.

Loose center bearing assembly mounting bolts should be tightened. Deteriorated or oil soaked center bearing insulators should be replaced. These conditions can cause excessive drive line vibration if not corrected.

BALL BEARING TYPE

Description

The center bearing used on some vehicles utilizes a ball bearing with the bearing housing enclosed in rubber.

No lubrication for this center bearing is provided as the bearing is filled with a waterproof grease for life of bearing.

REMOVE

1. Set parking brake.
2. Disconnect rear propeller shaft assembly (universal joint) at center bearing.
3. Remove companion flange nut, then remove the yoke assembly.
4. Remove the center bearing bracket mounting bolts and separate center bearing mounting bracket with bearing from center bearing bracket (on frame crossmember).
5. Remove center bearing assembly and both slingers from stud shaft.
6. The center bearing is serviced as a complete assembly, therefore separating the "U" shape bracket from rubber cushion is not required.

REASSEMBLY

The reassembly procedure is the reverse of the disassembly procedure. Be sure to inspect the center bearing bracket (on frame crossmember) for damage.

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SPRINGS

SUSPENSION

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SPRINGS

CHAPTER I

SPRINGS, SHOCK ABSORBERS, SWAY BAR

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SPRING ASSEMBLIES

DESCRIPTION

Constant Rate

Constant rate springs are leaf-type spring assemblies that have a constant rate of deflection. For example, if 227 Kg (500 lbs.) deflect the spring assembly 2.54 cm (1 in.), then 454 Kg (1000 lbs.) would deflect the same spring assembly 5.08 cm (2 in.). Thus, the rate of deflection is constant.

Constant rate springs are mounted to the axle with U-bolts, nuts and lock washers. The front end of the spring is mounted to a stationary bracket while the rear end of the spring is mounted to a spring shackle. The shackle allows for variations in spring length during compression and rebound of the spring.

This type of spring assembly is used in both front and rear axle applications on IH vehicles.

Figs. 1 and 2 show typical views of constant rate spring assembly applications.

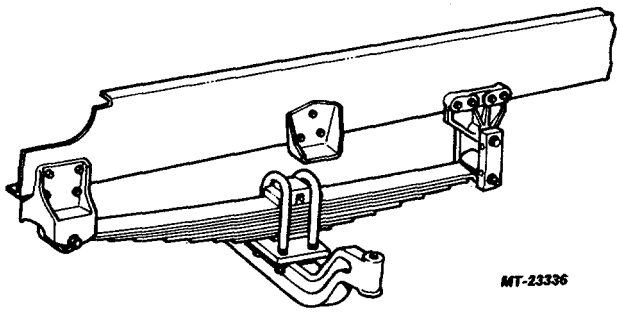


Fig. 1 Front Axle Application (Constant Rate)

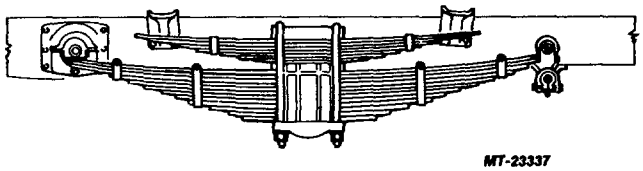


Fig. 2 Rear Axle Application (Constant Rate)

Taper Leaf

Taper leaf springs are leaf type spring assemblies that have spring leafs which are thicker in the center than the ends. This design results in a fewer number of leafs which provides lighter weight and softer ride due to lower inner leaf friction.

Taper leaf springs are mounted to the axle with U-bolts, nuts and lock washers. The front end of the spring is mounted to a stationary bracket while the rear end of the spring is mounted to a spring shackle. The shackle allows for variations in spring length during compression and rebound of the spring.

Taper leaf spring assemblies are used on front axles only. Figure 3 illustrates a Taper leaf assembly.

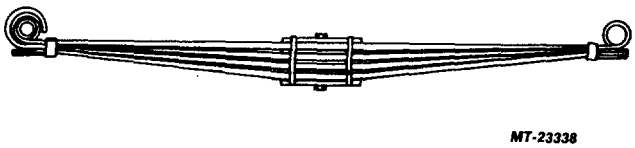


Fig. 3 Taper Leaf Spring Assembly

Auxiliary Springs

Auxiliary springs are leaf-type spring assemblies usually mounted on top of the vehicle rear spring assemblies. Auxiliary springs are only used when the vehicle is under heavy load. The auxiliary spring assumes part of the load by contacting special brackets attached to frame rail slides when the load is sufficient to compress the vehicle rear spring assemblies to the point of contact.

Fig. 4 illustrates an auxiliary spring assembly.

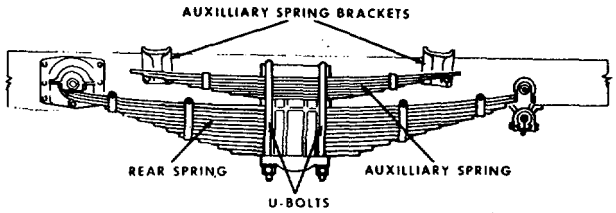


Fig. 4 Auxiliary Spring Assembly

Progressive (Vari-Rate)

Progressive (Vari-rate) springs are leaf-type spring assemblies with a variable deflection rate obtained by varying the effective length of the spring assembly. This is accomplished by using a cam-type bracket. As the spring assembly deflects, the point of contact on the bracket moves toward the center of the spring assembly shortening the effective length, Figure 5.

Vari-rate spring assemblies also incorporate a progressive feature in that the bottom spring leaves are separated at the ends.

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As the spring assembly deflects these leaves come in contact providing increased capacity and stiffness.

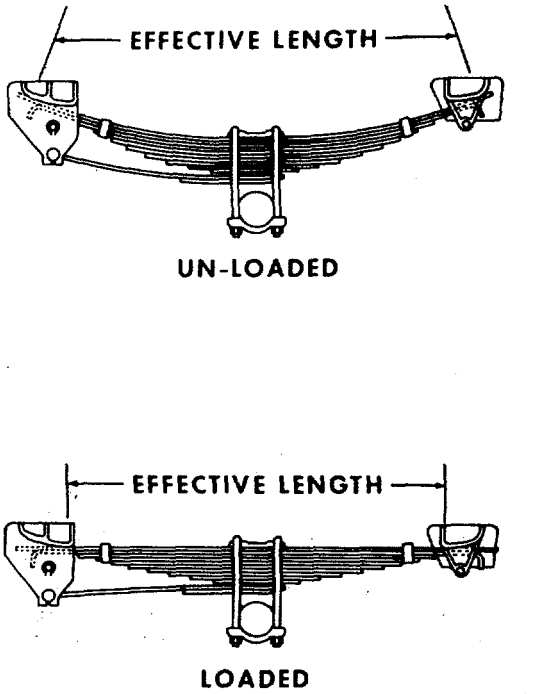


Fig. 5 Progressive Spring Assembly

MAINTENANCE

Lubrication

For lubrication intervals, refer to Operator's Manual. For types of lubricants recommended, refer to LUBRICATION, Section CTS-2412.

SERVICING

Although the exact servicing procedures are different for each type of spring assembly and spring assembly application, the basic procedures are similar. The following is a general outline for servicing all spring assemblies.

Removal

1. Place floor jack under truck frame and raise truck sufficiently to relieve weight from spring to be removed.
2. Remove shock absorbers where used.
3. Remover U-bolts, spring bumper and retainer or U-bolt seat.
4. Remove lubricators (not used on springs equipped with rubber bushings).
5. Remove nuts from spring shackle pins or bracket pins.
6. Slide spring off bracket pin and shackle pin.
7. If spring is rubber bushed, bushing halves may be removed from each side of spring and shackle eye.

Installation

Before reassembly, all shackle bolts, U-bolts, etc. should be cleaned and lubricated for proper installation.

While the actual installation procedures will vary with each spring type, the pivot end of spring is usually fastened to frame bracket first. Shackle end can then be fastened by aligning shackle to other frame bracket. When installing U-bolts for securing axles, do not final tighten until springs have been placed under normal load. See TORQUE CHART for U-bolt torque specifications. Spring failures may occur at the center bolt hole if U-bolts become loosened. These bolts must be kept tight and checked frequently. Spring pins should also be checked periodically.

Disassembly

1. Clamp spring end in vise and remove old bushing from spring eye.
2. Reposition spring in vise so that assembly will be clamped near center.
3. If bolted type rebound clips are used, remove nuts, bolts and spacers; where clinch type rebound clips are used, bend tabs of clips up, being careful not to break them. Heating clips with torch will help avoid breakage.
4. Remove nut from spring center bolt.

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5. Release vise to permit spring leaves to separate. Remove spring from vise and separate leaves from center bolt.

Cleaning, Inspection and Repair

1. Wash all parts in cleaning solvent or use steam cleaning equipment to remove grease and scale. Use a wire brush to hasten dirt removal.

Do not immerse rubber spring bushings in cleaning solvent. Use a non-petroleum base type rubber lubricant on a clean cloth to wipe these parts clean.

2. Inspect all spring leaves for breakage and cracks. Also compare arch of leaves with new leaves and if leaves are flattened out, replace.

3. Spring pins must be replaced if they are worn, corroded or cracked.

4. Spring eye bushing and spring shackle bushing must also be replaced if defective.

5. Check spring brackets for cracks or for wear around mounting bolt or rivet holes. Replace bracket if damaged.

6. Always use new center bolts at each overhaul.

Assembly

1. Lightly lubricate spring leaves with a thin coat of graphite grease. Place spring leaves in proper order and align center bolt hole with a long drift.

2. Compress spring leaves sufficiently for installing center bolt and nut.

3. Place spring assembly in vise and compress spring leaves fully.

CAUTION

When assembling spring leaves, be careful to prevent physical injury to personnel. The use of special holding fixtures or "C" clamps for holding spring leaves in place during assembly is strongly recommended.

4. Align spring leaves by tapping with hammer and position rebound clips on spring. If bolted type clips are used, install spacers, bolts and nuts. Tighten enough to hold leaves in alignment but not enough to restrict free movement. If clinch type clips are used, bend ends of clips down on top leaf. Heat clips with torch to help eliminate breakage.

SHOCK ABSORBERS

Shock absorbers are provided to control body sway and to eliminate excessive tire wear, front wheel shimmy and spring breakage. They also improve the riding qualities of the truck and are especially useful when the truck is empty or only partly loaded.

The direct acting type shock absorber (Fig. 6), sometimes called airplane type, has a sealed construction and requires no periodic maintenance. Shock absorbers of this type should be checked every 16,000 km (10,000 miles) however, to make sure they are functioning satisfactorily, that bushings are not worn, and that outer jacket has not been damaged by flying stones or debris from the road. If a shock absorber is leaking, fails to operate or develops unusual noises, the complete unit should be replaced. Direct acting shock absorbers are nonrefillable and service is limited to unit replacement.

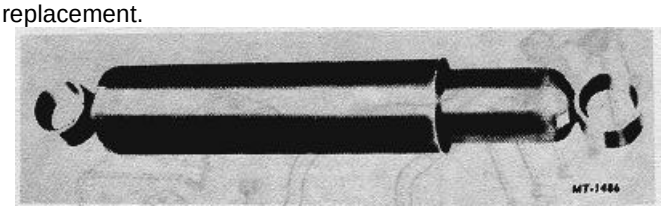


Fig. 6 Direct Acting Shock Absorber

MOUNTING AND LINKAGE

Loose, bent or broken shock absorber mountings or linkage should always be checked for and corrected when servicing the suspension system. Inspect all rubber bushings and grommets to see that they effectively keep metal from striking metal. Link or bushing wear can be checked by twisting link with pliers or by prying link connection with screwdriver or small pry bar. Outward appearance will usually indicate excessive wear.

SWAY BAR

Some body styles applicable to light or medium duty delivery trucks require a stabilizing device in the suspension system. This unit, known as a sway bar, supplements the spring by adding greater stability to the truck.

A sway bar is a U-shaped cross bar mounted transversely with the chassis frame.

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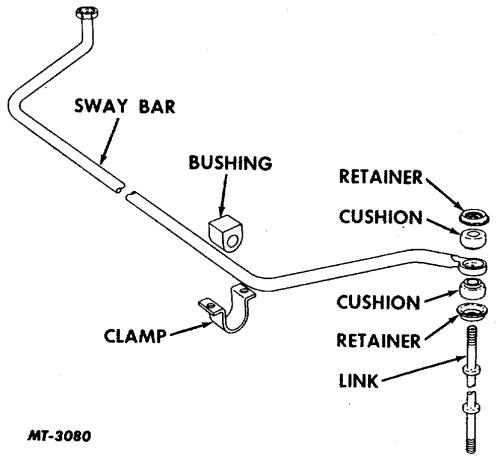


Fig. 7 Front Sway Bar

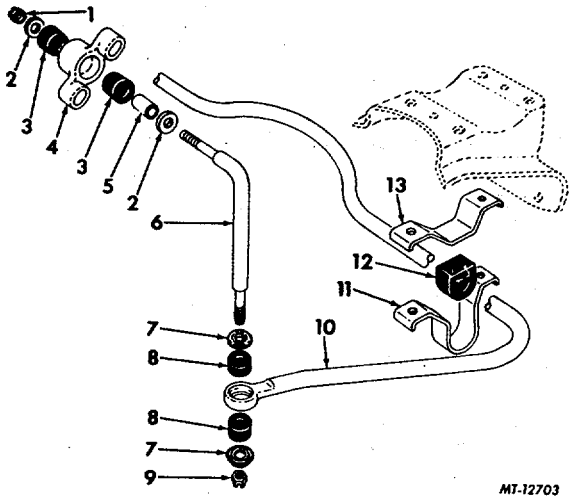


Fig. 8 Rear Sway Bar

Legend for Fig. 8

Key	Description
1	NUT
2	WASHER
3	BUSHING
4	BRACKET
5	SPACER
6	LINK, Sway Bar
7	RETAINER, Cushion
8	CUSHION
9	NUT
10	SWAY BAR
11	BRACKET
12	BUSHING
13	BRACKET

Sway bars are available for both front (Fig. 7) and rear (Fig. 8) suspension applications.

Simple in construction, these bars perform their stabilizing effect by twisting when spring height at opposite wheels becomes unequal. For example, if the wheel on one side drops into a chuck hole, the spring on that same side expands. At the same time the sway bar tends to expand the opposite spring and lift a the truck. Failing to do this, the bar twists and lessens the shock of the wheel dropping.

In like manner, if the wheel on one side hits an obstacle, the spring on that side compresses. The sway bar tends to compress the opposite spring and hold the truck down. Failing to do this, the sway bar twists and lessens the shock. This resistance to twisting in the sway bar is particularly useful in limiting sway or roll when the truck is rounding a curve or when it suddenly encounters a strong cross wind.

No service is necessary on the sway bar other than a periodic inspection to see that mounting parts remain secure. Rubber bushings should be replaced when they become deteriorated or permit metal to metal contact. Keep mounting bolts tight.

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TROUBLE SHOOTING

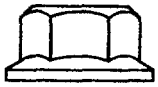
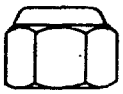
The following list covers the most frequent causes for troubles which may occur in the suspension system. However, several items may overlap similar complaints and causes that are common to axle and wheel alignment trouble shooting. For additional information on these related items of trouble shooting, see AXLE-FRONT, CTS-2052.

COMPLAINT	POSSIBLE CAUSE
1. Truck wanders.	a. Front axle shifted on springs. b. Broken spring. c. Out of alignment.
2. Truck bottoms.	a. Overloading. b. Too much lubricant on spring leaves. c. Broken spring leaves. d. Defective shock absorbers. e. Weak spring.
3. Truck lopsided.	a. Broken spring leaves. b. Wrong spring installed. c. Weak spring.
4. Frequent spring breakage.	a. Overloading or severe operation. b. Loose U-bolts. c. Loose center bolt. d. Defective shock absorbers. e. Improper adjustment on spring pin. f. Tight spring shackle. g. Too much lubricant on spring leaves.
5. Noisy springs.	a. Loose U-bolts. b. Loose center bolt. c. Loose rebound clips. d. Loose shackles. e. Worn shackle bushings. f. Loose, bent or broken spring brackets. g. Worn spring pins.
6. Erratic steering when braking.	a. Loose U-bolts. b. Loose center bolt.

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TORQUE CHART

FOR ASSEMBLY OF SUSPENSION U-BOLTS

RECOMMENDED WRENCH TORQUE						
U-Bolt Diameter and Thread	ALL STEEL LOCKNUT 		ALL STEEL FLANGE NUT 		NYLON INSERT NUT 	
CUT THREAD U-BOLTS (Prior to July 1974)						
	N.m	Ft Lbs	N.m	Ft Lbs	N.m	Ft Lbs
7/16" - 20	68 - 81	50 - 60	-	-	79 - 92	58 - 68
1/2" - 20	88 - 102	65 - 75	-	-	104 - 118	77 - 87
9/16" - 18	109 - 129	80 - 95	-	-	130 - 151	96 - 111
5/8" - 18	163 - 190	120 - 140	-	-	197 - 224	145 - 165
3/4" - 16	197 - 224	145 - 165	-	-	339 - 407	250 - 300
7/8" - 14	258 - 312	190 - 230	-	-	448 - 502	330 - 370
1" - 14	298 - 353	220 - 260	-	-	651 - 786	480 - 560
—	—	—	—	—	—	—
ROLLED THREAD U-BOLTS						
	N.m	Ft Lbs	N.m	Ft Lbs	N.m	Ft Lbs
1/2" - 20	68 - 81	50 - 60	88 - 109	65 - 80	-	-
5/8" - 18	142 - 170	105 - 125	176 - 217	130 - 160	-	-
3/4" - 16	237 - 292	175 - 215	298 - 325	220 - 240	-	-
7/8" - 14	-	-	-	-	305 - 373	225 - 275
1" - 14	-	-	-	-	441 - 543	325 - 400

U-BOLT NUT RETORQUE

Whenever U-Bolt nuts are loosened or removed when servicing a suspension, the U-Bolt nuts must be retorqued at the intervals and under the conditions described below.

1. After the chassis has been operating under load for 1000 miles, or six months whichever comes first, the U-Bolt nuts must be retorqued.
2. The U-Bolt nuts thereafter should then be retorqued every 36,000 miles.
3. The U-Bolt (joint) should be in a new or as new condition.

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IMPORTANT

In instances when checking U-Bolts to determine if looseness has occurred, torque values of 40% of the specifications would assure joint integrity, provided the U-Bolts and nuts were in like-new condition. ALWAYS RETORQUE TO ORIGINAL SPECIFICATIONS. Rusty joints must be disassembled, cleaned and lubricated to assure a like-new condition prior to retorque.

SPECIAL TOOLS

SE-2050 Torque Indicator Wrench (0-600 ft.lbs.)
SE-2059 Torque Indicator Wrench (0-150 ft.lbs.)

For additional information, refer to Service Tool Manual CTS-1147.

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SPRINGS

CHAPTER II

EQUALIZING BEAM SUSPENSION (HENDRICKSON)

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DESCRIPTION

Tandem drive axles require a special suspension which permits flexibility between the axles but still withstands rugged usage with long service life. The equalizing beam type suspension system described herein embodies these required characteristics. The types of Hendrickson equalizing beam suspensions used on International trucks are the leaf spring type and rubber load cushion type.

LEAF SPRING TYPE

The leaf spring type suspension (Fig. 1) uses semi-elliptic leaf springs to cushion load and road shocks. The springs are mounted on saddle assemblies above the equalizer beams and are pivoted at the front end on spring pins and brackets. Rear ends of springs have no rigid attachment to spring brackets, but are free to move forward and backward to compensate for spring deflection.

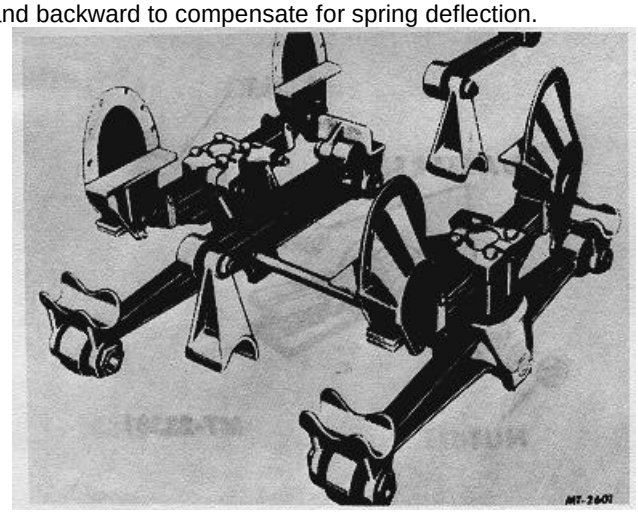


Fig. 1 Equalizing Beam Suspension (Leaf Spring Type)

The equalizing beams utilize the "lever" principle to distribute the load equally between axles and to reduce the effect of bumps and road irregularities. The torque rods permit complete absorption of torque, which is the tendency of the axles to turn backwards or forward on their axis due to starting or stopping inertia. The cross tube connecting the equalizing beams assures correct alignment of the tandem and prevents damaging load transfer.

RUBBER CUSHION TYPE

This type of suspension system (Fig. 2) uses rubber cushions in place of leaf springs to absorb load and road shock. On these units, rubber cushions are mounted on a saddle assembly at each side. Positive mounting between frame brackets and the suspension unit is secured by four rubber-bushed drive pins, one each of which passes through a rubber cushion.

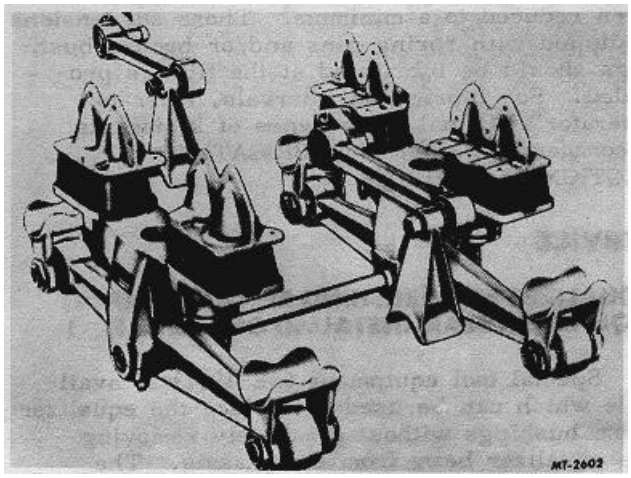


Fig. 2 Equalizing Beam Suspension (Rubber Cushion Type)

Without load, the unit rides on the outer edge of the load cushions. As the load increases, the crossbars of the cushions are progressively brought into contact to absorb the additional load. Cushioning and alignment are accomplished by the four drive pins encased in rubber bushings. The bushings permit the drive pins to move up and down in direct relation to movement of the load cushions. See Fig. 3.

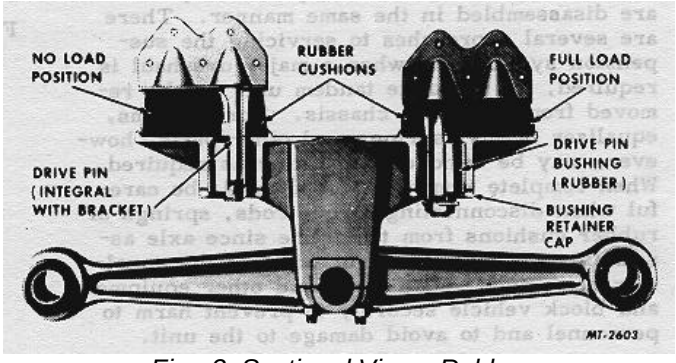


Fig. 3 Sectional View. Rubber Cushion Type Suspension

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MAINTENANCE

LUBRICATION

All oscillating parts with the exception of spring pins and optional bronze center bushings are rubber bushed. Since rubber bushings require no lubrication, lubrication points have been reduced to a minimum. Those suspensions equipped with spring pins and/or bronze bushings should be lubricated at the fittings provided. For lubrication intervals, refer to Operator's Manual. For types of lubricants recommended, refer to LUBRICATION SECTION CTS-2412.

SERVICE

EQUALIZER BEAM BUSHING REPLACEMENT (EQUALIZER BEAM INSTALLED ON VEHICLE)

Special tool equipment (SE-1931) is available which can be used to replace the equalizer beam bushings without completely removing the equalizer beam from the chassis. The SE-1931 tool can also be used to replace the bushings with the equalizer beams removed. Operating instructions are furnished with the equipment. However, the "Caution" notices pertaining to equalizer component replacement provided in this service manual should be followed.

DISASSEMBLY

Suspension

Except for different suspension (leaf springs or rubber cushions) and slight variations in size, all equalizing beam suspension systems are disassembled in the same manner. There are several approaches to servicing the suspension system, but when a major overhaul is required, the complete tandem unit can be removed from the truck chassis. Torque arms, equalizer beams, springs and other parts, however, may be removed separately as required. When complete removal is performed, be careful when disconnecting torque rods, springs or rubber cushions from the frame since axle assemblies are free to roll or pivot at the equalizer beam ends. Use jacks and other equipment and block vehicle securely to prevent harm to personnel and to avoid damage to the unit.

Suggested disassembly procedure is as follows:

1. Disconnect propeller shafts, inter-axle lock control linkage (or piping), and brake lines from axles.
2. Place both rear axles on floor stands and remove wheels and tires.
3. Using overhead crane, raise truck frame sufficiently to relieve weight from suspension system. Block frame securely.
4. Disconnect torque rods from axle housing by loosening locknuts and driving the shaft from the bushing and the axle housing bracket.
5. Disconnect equalizer beams from axle housings:

   Bolt type beam end mounting, Fig. 4 and Fig. 5.

   a. Remove equalizer beam end bolt.

   b. Drive bushing adapters and sleeve (if so equipped) out of bushing and axle housing brackets.

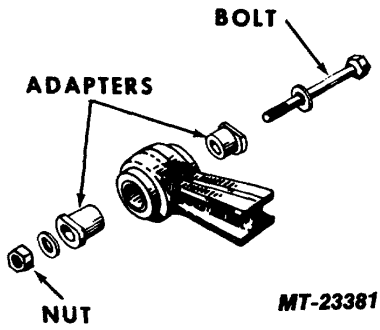


Fig. 4 Two Piece Adapter Bolt Type Beam End Mounting

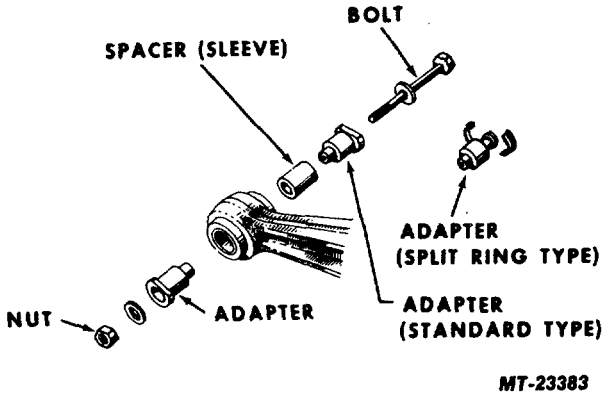


Fig. 5 Three Piece Adapter Bolt Type Beam End Mounting

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Tube Type Beam End Mounting, Fig. 6

a. Remove equalizer beam end tube nuts.

b. Pull or drive end tubes from axle housing brackets and beam end bushings. If end tube is frozen in bushing, install one nut on tube and tighten against bracket until tube breaks loose in bushing.

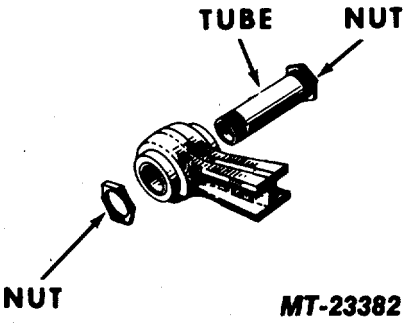


Fig. 6 Tube Type Beam End Mounting

6. Using roller jack, remove axle assemblies.

7. Support ends of equalizer beams and remove beam center bushing retainer caps from saddles. Remove equalizer beams and cross tube.

8. Separate equalizer beams from cross tube. Remove sealing compound or pipe plug from hole in outer end of beam center sleeve to break vacuum which may exist between center sleeve and cross tube

9. Remove saddle assemblies:

Leaf Spring Type

a. Support spring and saddle assembly on floor jack. Loosen locknut on spring pin draw key. Back off nut sufficiently to protect draw key threads, then strike nut with soft hammer to loosen draw key. Remove draw key and drive spring pin out of spring and spring bracket. Lower spring and saddle assembly from frame and remove from jack.

b. Loosen spring aligning set screws. Remove spring top pad to spring saddle bolts and nuts. Remove spring pad and top pad slide. Remove spring from saddle.

Rubber Cushion Type

a. Remove load cushion mounting brackets from chassis frame. Remove drive pin nuts and separate mounting brackets and load cushions from saddles.

Because drive pin nuts are staked, some difficulty may be experienced in removing them. It is suggested drive pin nuts be loosened before removing mounting brackets from the frame. In extreme cases, it may be necessary to cut drive pin nuts to remove them.

b. If replacement of drive pin bushings is required, remove bushing retainer caps and drive bushings from saddle.

Leaf Spring Assembly

1. Clamp spring end in vise and remove old bushing from spring eye.

2. Reposition spring in vise so that assembly will be clamped near center.

3. If bolted type rebound clips are used, remove nuts, bolts and spacers; where clinch type rebound clips are used, bend tabs of clips up, being careful not to break them. Heating clips with torch will help avoid breakage.

4. Remove nut from spring center bolt.

5. Release vise to permit spring leaves to separate. Remove spring from vise and separate leaves from center bolt.

CLEANING, INSPECTION AND REPAIR

Clean all dirt from suspension parts and inspect all parts carefully for cracks or damage. Inspect rubber bushings for damage or deterioration. If the vehicle has been in service for a long time, it is advisable to replace all bushings,

Most repairs to the suspension system consist of replacing worn or damaged parts. The major item which will concern the serviceman is removal and replacement of the rubber bushings.

While the bushings have long life and replacement will be limited, they can be replaced if damaged or deteriorated. Special service tools for performing this task are available and though recommended are not absolutely necessary. If press equipment is available, standard steel tubing having diameters to match the bushing sleeves (metal bands surrounding rubber bushings) can be used as adapters for removing and installing the bushings (see Adapter Chart). Press pressures required to remove the bushing and sleeve assemblies will generally be between 31 and 45 Mg (35 and 50 tons).

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CAUTION

When replacing equalizer beam bushings only the procedures outlined in this manual section should be exercised.

Welding, torching, drilling, tapping or attaching material to the equalizer beam must never be performed as such practice can result in equalizer beam failure. Equalizer beams are constructed of aluminum or nodular iron, metals which can easily become brittle with heat at quite low temperatures.

When replacing equalizer beam bushings the equalizer beams should be thoroughly inspected to ascertain if they have been heated, if cavities have been produced or otherwise damaged by improper servicing and if so, replace any components which are questionable.

Equalizer Beam End Bushing Replacement

1. Cut off rubber bushing flush with equalizer beam, as shown in Fig. 7. Rubber must be removed to permit adapter to contact bushing sleeve squarely.

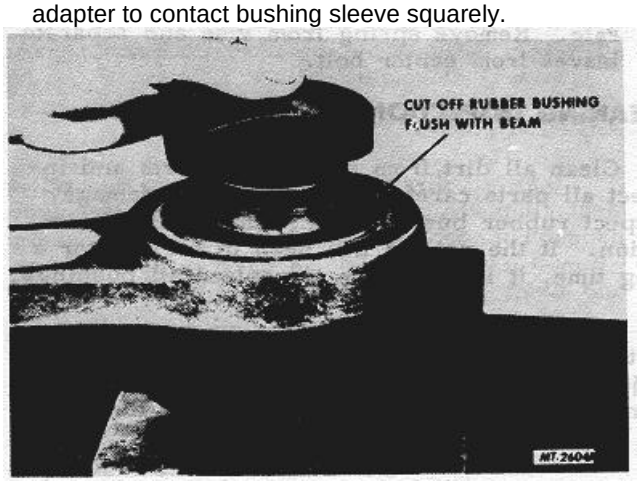


Fig. 7 Preparing for Removal of Beam End Bushing

2. Remove bushing set screw, if used.

3. Support beam in press. Using a piece of standard tubing (which will contact the bushing sleeve) as an adapter, press the bushing from the beam. See Fig. 8.

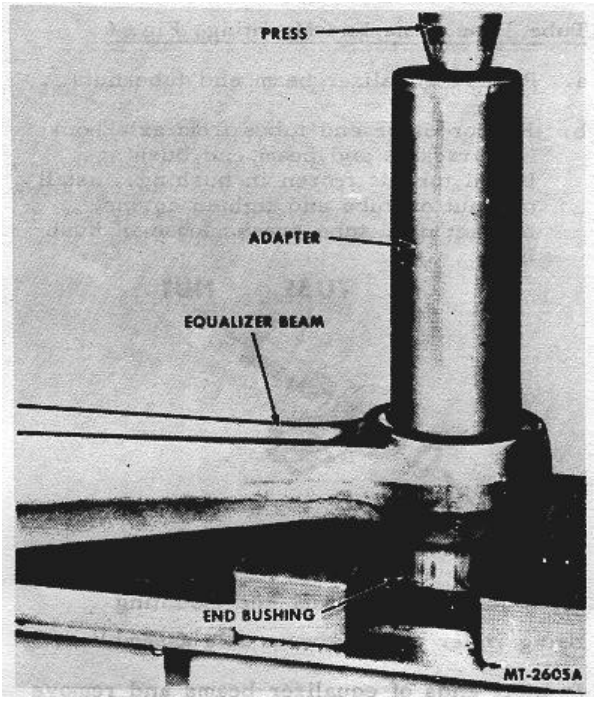


Fig. 8 Removing Equalizer Beam End Bushing

4. Apply a thin coat of white lead to outer diameter of bushing sleeve.

5. Install sheave puller over bushing and compress rubber until puller jaws will seat on the end of the bushing sleeve. Refer to Fig. 9.

6. Continue pressing until bushing is centered in beam.

7. Install bushing set screw, if used,

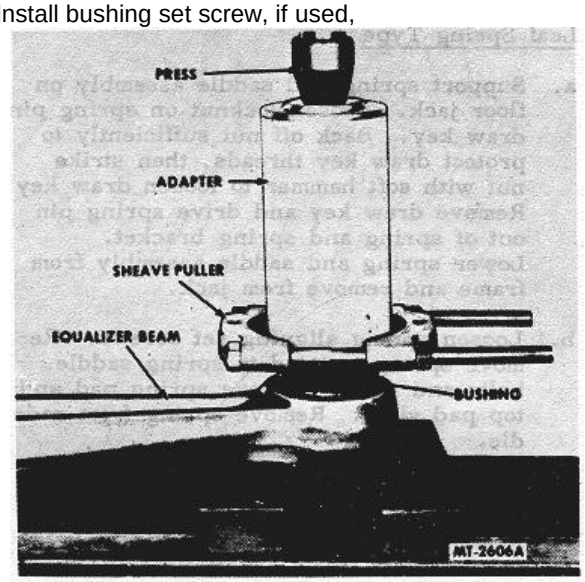


Fig. 9 Installing Equalizer Beam End Bushing

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Equalizer Beam Center Sleeve and Bushing

1. Support beam in press. Using adapter made from appropriate size standard tubing to fit against center sleeve and bushing assembly, press out bushing assembly. See Fig. 10.

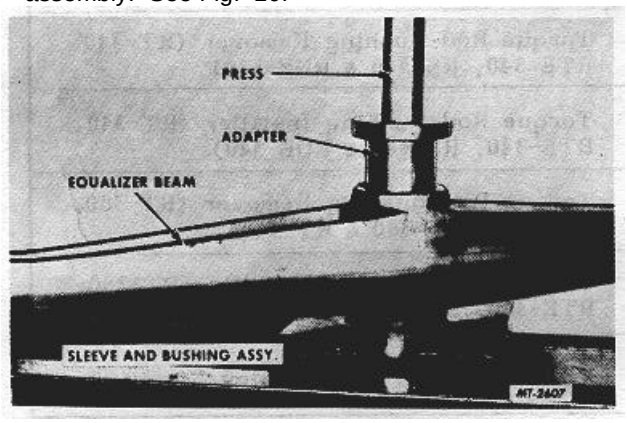


Fig. 10 Removing Equalizer Beam Center Sleeve and Bushing

2. Apply a thin coat of white lead to outside diameter of sleeve and bushing assembly.

3. Support beam in press. Using adapter, press bushing and sleeve assembly into beam. See Fig. 11. Bushing and sleeve assembly should be centered in beam.

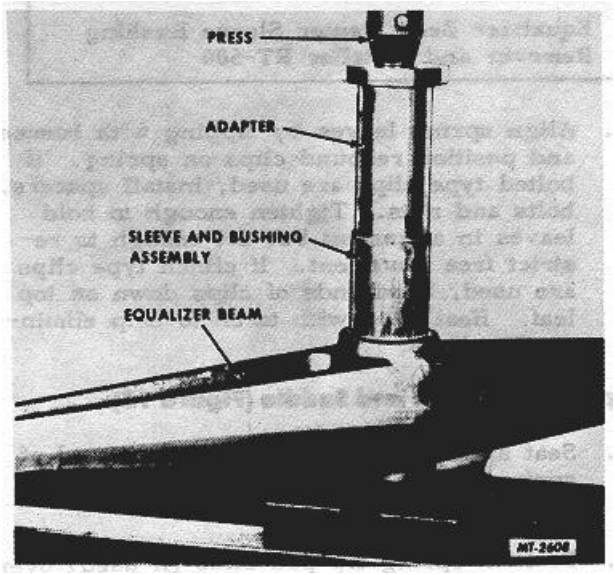


Fig. 11 Installing Center Sleeve and Bearing

Torque Rod Bushing Replacement

1. Cut off rubber bushing flush with torque rod, as instructed for equalizer end bushing removal. Refer to Fig. 7.

2. Support torque rod in press. Using a piece of tubing as an adapter, press bushing out of torque rod.

3. Apply a thin coat of white lead to outer diameter of bushing sleeve.

4. Install sheave puller over bushing and compress rubber until puller jaws will seat on end of bushing sleeve. Refer to Fig. 9.

5. Place adapter over end of bushing, resting on sheave puller. (See Fig. 12). Press bushing into torque rod until bushing is centered in bushing bore.

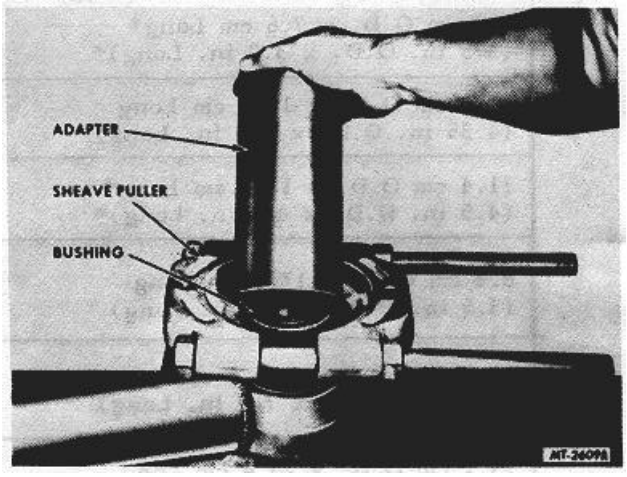


Fig. 12 Preparing to Press Bushing into Torque Rod

Leaf Spring Assembly

1. Wash all parts in cleaning solvent or use steam cleaning equipment to remove grease and scale. Use a wire brush to hasten dirt removal.

   Do not immerse rubber spring bushings in cleaning solvent. Use a non-petroleum base type rubber lubricant on a clean cloth to wipe these parts clean.

2. Inspect all spring leaves for breakage and cracks. Also compare arch of leaves with new leaves and if leaves are flattened out, replace.

3. Spring pins must be replaced if they are worn, corroded or cracked.

4. Spring eye bushing and spring shackle bushing must also be replaced if defective.

5. Always use new center bolts at each overhaul.

Adapter Chart

Adapters which can be made locally from standard tubing for removing and installing rubber bushings. *Adapters to be used with sheave puller.	
Adapter Size	Application
6.9 cm O.D. x 7.6 cm Long (2.75 in. O.D. x 3.0 in. Long)	Torque Rod Bushing Remover (RT-340, RTE-340, RS-340 & RUE-340)
7.6 cm O.D. x 7.6 cm Long* (3.0 in. O.D. x 3.0 in. Long)*	Torque Rod Bushing Installer (RT-340, RTE-340, RS-340 & RUE-340)
8.3 cm O.D. x 7.6 cm Long) 3.25 in. O.D. x 3.0 in. Long)	Torque Rod Bushing Remover (RT-380, RTE-380, RS-380 & RT-440)
8.9 cm O.D. x 7.6 cm Long* (3.5 in. O.D. x 3.0 in. Long)*	Torque Rod Bushing Installer (RT-380, RTE-380, RS-380 & RT-440)
11.0 cm O.D. x 10.2 cm Long (4.25 in. O.D. x 4.0 in. Long)	Equalizer Beam End Bushing Remover
11.4 cm O.D. x 10.2 cm Long* (4.5 in. O.D. x 4.0 in. Long)*	Equalizer Beam End Bushing Installer
8.9 cm O.D. x 17.8 cm Long) (3.5 in. O.D. x 7.0 in. Long)	Equalizer Beam Center Sleeve Bushing Remover and Installer (RT-340, RTE-340, RS-340 & RUE-340
11.61 cm O.D. x 17.8 cm Long (4.63 in. O.D. x 7.0 in. Long)	Equalizer Beam Center Sleeve Bushing Remover and Installer (RT-380, RTE-380, RS-380 & RT-440)
13.7 cm O.D. x 25.4 cm Long (5.38 in. O.D. x 10.0 in. Long)	Equalizer Beam Center Sleeve Bushing Remover and Installer RT-500

ASSEMBLY

Leaf Spring Assembly

1. Lightly lubricate spring leaves with a thin coat of graphite grease. Place spring leaves in proper order and align center bolt hole with a long drift.

2. Compress spring leaves sufficiently for installing center bolt and nut. Always use new center bolts at each overhaul.

3. Place spring assembly in vise and compress spring leaves fully. Torque center bolt to specified torque.

CAUTION

When assembling spring leaves, be careful to prevent physical injury to personnel. The use of special holding fixtures or "C" clamps for holding spring leaves in place during assembly is strongly recommended.

4. Align spring leaves by tapping with hammer and position rebound clips on spring. If bolted type clips are used, install spacers, bolts and nuts. Tighten enough to hold leaves in alignment but not enough to restrict free movement. If clinch type clips are used, bend ends of clips down on top leaf. Heat clips with torch to help eliminate breakage.

Spring Assembly and Saddle (Figure 13)

1. Seat spring in spring saddle with head of spring center bolt positioned in hole provided in saddle.

2. Position spring top pad slide (if used) over "cup" on main spring leaf.

3. Position spring top pad on spring making sure pad is properly seated.

4. Install saddle-to-top pad bolts and nuts. Run nuts up snug, but do not tighten completely at this time.

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5. To properly position the spring in the saddle, tighten the spring aligning set screws to specified torque (see "Torque Chart"). Tighten aligning screw locknuts.

6. Tighten saddle-to-top pad bolt nuts to specified torque (see "Torque Chart").

7. Using roller jack, position spring (with saddle) in front and rear spring mounting brackets.

8. Align spring eye with spring pin bore in front bracket. Install spring pin, aligning draw key slot in pin with draw key bore in bracket.

9. Install draw key, lock washer and nut. Tighten nut to specified torque (see "Torque Chart").

10. Install lubricator fitting in spring pin and lubricate.

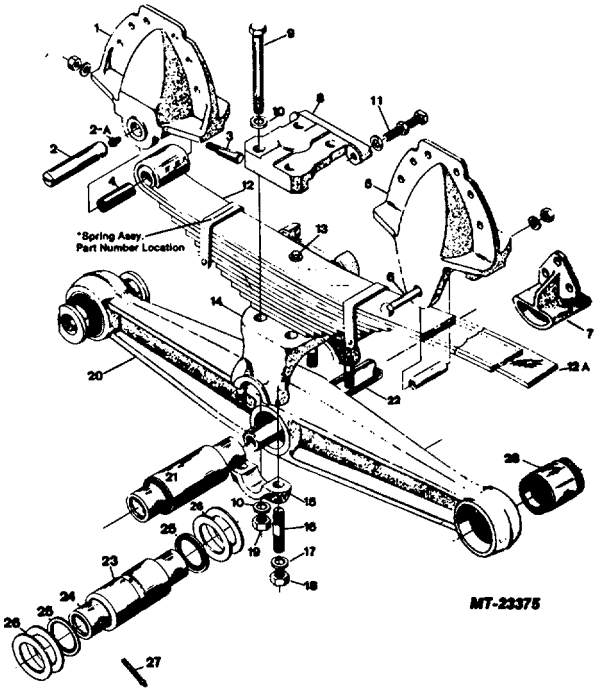


Fig. 13 Leaf Spring Type Suspension

Legend for Figure 13

1. Spring Bracket
2. Spring Pin
2a. Zerk Fitting
3. Drawkey
4. Bushing
5. Spring Bracket
6. Bolt w/spacer, Rebound
7. Spring Bracket (Extended Leaf Only)
8. Top Pad
9. Bolt, Top Pad
10. Washer
11. Set Screw
12. Leaf Spring Assembly
13. Center Bolt
14. Saddle Assembly
15. Saddle Cap
16. Stud
17. Washer
18. Nut
19. Nut
20. Equalizer Beam
21. Center Bushing
22. Cross Tube
23. Center Bushing Bronze
24. Sleeve
25. Seals
26. Washer
27. Zerk Fitting
28. End Bushing

Rubber Cushions and Saddle (Figure 14)

1. Press drive pin bushings into saddle. Install bushing retainer caps and tighten retainer cap bolts.

2. Position rubber load cushions on saddle.

3. Apply a light coat of grease to the drive pins on the frame brackets. Assemble the frame brackets to the saddle by inserting the drive pins through the load cushions and the drive pin bushings.

4. Install drive pin nuts and washers. Tighten nuts snug.

   Tighten nuts to specified torque after brackets have been assembled to chassis frame.

5. Assemble the preassembled saddles, load cushions and frame brackets to the chassis frame. Install mounting bolts, lock washers and nuts.

6. Tighten mounting bolt nuts to specified torque. (See Torque Chart).

7. Tighten drive pin nuts to specified torque. (See Torque Chart.)

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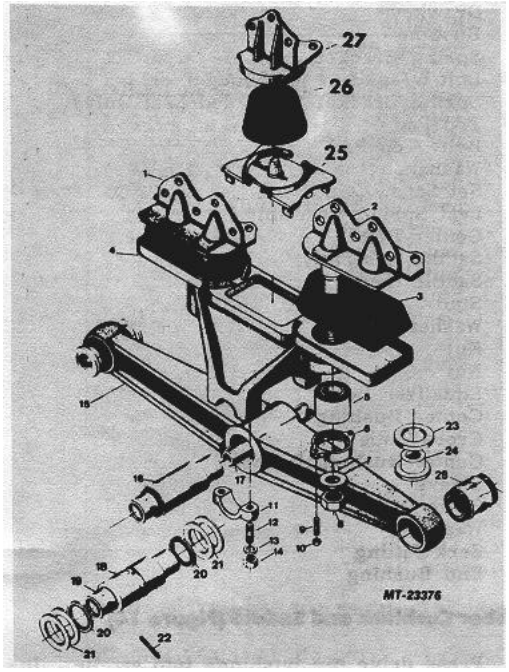


Fig. 14 Rubber Cushion Type Suspension

Legend for Fig. 14

1. Frame Hanger
2. Frame Hanger
3. Rubber Cushion
4. Saddle Assembly
5. Bushing
6. Cap
7. Washer
8. Nut
9. Stud
10. Nut
11. Cap
12. Stud
13. Washer
14. Nut
15. Equalizer Beam
16. Center Bushing
17. Cross Shaft
18. Center Bushing Bronze
19. Sleeve
20. Seal
21. Thrust Washer
22. Zerk Fitting
23. Rebound Bumper
24. Stop Nut
25. Plate (optional)
26. Rubber Cushion (optional)
27. Frame Hanger (optional)
28. End Bushing

Equalizer Beams and Cross Tube (Figures 13 & 14)

CAUTION

Three types of equalizer beams are utilized in the manufacturing of International trucks equipped with equalizer beam suspensions. Although the appearance of the equalizer beams is similar, there is a substantial difference in the material of which they are manufactured.

The materials of the equalizer beams involved are aluminum, cast iron and nodular iron. Aluminum and cast iron equalizer beams are manufactured such that they can be stressed in either direction. Nodular iron equalizer beams are manufactured such that they can be stressed in one direction only. Thus it is imperative that nodular iron equalizer beams be installed with the correct side up.

To aid in identification and facilitate installation of nodular iron beams, an arrow and the word UP have been molded on the side of nodular iron beams. Also, reinforcing gate pads have been designed into each end and middle of the top side of nodular iron beams.

Nodular iron equalizer beams must be installed with gate pads on top side of beam and the arrow molded on the beam side pointing upward.

IMPORTANT

When assembling suspension, equalizer beam end mounting nuts and equalizer beam saddle cap mounting nuts should have final torque applied with wheels of vehicle on ground.

1. Place one equalizer beam in position in trunnion of spring saddle and install bushing retainer caps and nuts. Tighten the nuts only until the caps fit snugly against the bushing. Do not tighten bushing retainer cap nuts to specified torque until axles have been connected to equalizer beams.

2. Place cross tube seal assemblies in position on ends of cross tube (bronzed bushed models only).

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3. Apply a light coat of chassis lubricant to the ends of the cross tube which fit into the beam center sleeves (bronze bushed models). On those models having rubber bushed center sleeves, wipe ends of cross tube clean and pack center bushing with approximately 56.7 grams (2 ounces) of chassis lubricant.

4. Place one end of cross tube into center sleeve of installed equalizer beam. Be sure tube seats into sleeve.

5. Assemble other equalizer beam to cross tube and position beam in spring saddle. Install bushing retainer caps and nuts. Tighten the nuts only until the caps fit snugly against the bushings.

6. Make sure cross tube seals assemblies are seated in equalizer beam center sleeves (bronzed bushed models only).

7. Install pipe plugs in ends of beam center sleeves or plug vent holes with sealing compound (Permatex No. 1 or equivalent).

Axle Assemblies (Figures 13 & 14)

1. Position axle assemblies under chassis frame.

2. Connect ends of equalizer beams to axle housing hanger brackets:

Tube Type Beam End Mounting, Fig. 6

a. Apply a light coat of grease to outer diameter of end tubes.

b. Align the beam end bushings with hanger brackets and insert end tubes. Center tubes in bushings so that ends of tubes equidistant from outer faces of hanger brackets.

c. Install end tube nuts. Make sure nuts are properly threaded on tubes. Tighten nuts evenly to specified torque (see "Torque Chart").

Bolt Type Beam End Mounting, Fig. 4

a. Align beam end bushings with hanger brackets and insert bushing adapters. Lubricate adapters with a light coat of waterproof grease. Flat surface on adapters must be in vertical position.

b. Tap adapters into bushing until adapter flanges contact outer faces of hanger brackets.

c. Install bolt and locknut. Tighten nut to specified torque (see "Torque Chart").

Bolt Type End Mounting with Split-Ring Type Adapters, Fig. 5

a. Place inner adapter (with split-ring) inside beam end bushing with grooved end of adapter toward bowl of axle housing. Lubricate adapter with a light coat of waterproof grease. Make sure nut is in position in lugs of adapter.

b. Align beam end bushing with hanger brackets and install outer adapter.

c. Start bolt through outer adapter, push inner adapter with bolt until groove in adapter appears past face hanger.

d. Install split-ring. Thread bolt into nut. Tighten bolt to specified torque (see "Torque Chart"). Place a bar between the lugs on the adapter to hold the nut while tightening the bolt with a wrench if so equipped.

3. Tighten saddle cap nuts to specified torque (see "Torque Chart").

IMPORTANT

Saddle cap nuts were not tightened completely when assembled to permit connecting of equalizer beams to axle housings. Therefore, nuts must be tightened after beams are connected to axles.

The cross center tube (44) is free to rotate or float in the bushing assemblies (47) at each side. However, in some cases where the vehicle has been operating in mud or perhaps water, the cross center tube may be seized. Whether it is loose or seized will have no effect upon its purpose. The function of the tube is to assure alignment between the left and right equalizer beams (43).

The saddle caps serve to secure sleeve with bushing (47). The clamping effect of the caps against the sleeve and bushing has no effect upon the movement of the cross center tube.

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4. Connect torque rods to axle housings and fame brackets, Fig. 15. Tighten shaft nuts to specified torque (see "Torque Chart").

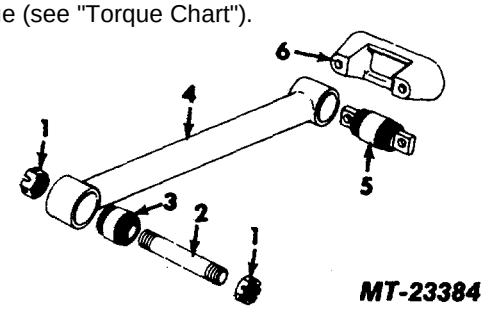


Fig. 15_ Torque Rod

Legend for Figure 15

1. Nut
2. Shaft
3. Bushing
4. Torque Rod
5. Shaft w/Bushing
6. Bracket

5. Install wheels and tires. Connect propeller shafts, brake lines, interaxle lock control linkage or piping, etc.

6. On vehicles equipped with hydraulic brakes, bleed brake system and check for leaks. On vehicles with air brakes, check brake piping for air leaks.

ALIGNMENT

Refer to CHAPTER 7, CTS-2680 For Alignment Information.

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TORQUE CHART

SUSPENSION SYSTEM TORQUE CHART (NEWTON METERS)

LOCATION	THREAD SIZE RECOMMENDED TORQUE
Torque Rod Stud Nuts	339 N-m (250 ft. lbs.)
Torque Rod Bracket Mounting Bolt Nuts	339-373 N-m (250-275 ft. lbs.)
Spring Center Bolt	7/16-20 1/2-20 68-81 N-m 88-102 N-m (50-60 ft. lbs.) (65-75 ft. lbs.)
Spring Pin Draw Key Nut	108-122 N-m (80-90 ft. lbs.)
Spring Rear Hanger Rebound Bolt Nut	95-108 N-m (70-80 ft. lbs.)
Top Pad to Spring (Spring Aligning Set Screw)	136-203 N-m (100-150 ft. lbs.)
Top Pad to Saddle Bolt Nut	373-407 N-m (275-300 ft. lbs.)
Saddle Cap Stud Nut	305-373 N-m (225-275 ft. lbs.)
Saddle Cap Retainer Bolt (RU Series Only)	420-461 N-m (310-340 ft. lbs.)
Saddle Cap Stud	75-88 N-m (55-65 ft. lbs.)
U-Bolt to Saddle (RU Series Only)	321-409 N-m (237-302 ft. lbs.)
Vertical Drive Pin Nut (RS Series Only)	237-305 N-m (175-225 ft. lbs.)
Vertical Bushing Retainer Stud Nut (RS Series Only)	136-169 N-m (100-125 ft. lbs.)
Vertical Bushing Retainer Stud (RS Series Only)	75-88 N-m (55-65 ft. lbs.)
Equalizer Beam End Bolt Nut	285-325 N-m (210-240 ft. lbs.)
Equalizer Beam End Tube Nuts	10-678 N-m (450-500 ft. lbs.)

To obtain maximum service life from the suspension system, mounting bolts and nuts should be checked periodically and tightened to specified torque.

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U-BOLT NUT RETORQUE

Whenever U-Bolt nuts are loosened or removed when servicing a suspension, the U-Bolt nuts must be retorqued at the intervals and under the conditions described below.

1. After the chassis has been operating under load for 1000 miles, or six months whichever comes first, the U-Bolt nuts must be retorqued.

2. The U-Bolt nuts thereafter should then be retorqued every 36,000 miles.

3. The U-Bolt (joint) should be in a new or as new condition.

IMPORTANT

In instances when checking U-Bolts to determine if looseness has occurred, torque values of 40% of the specifications would assure joint integrity, provided the U-Bolts and nuts were in like-new condition. However, ALWAYS RETORQUE TO ORIGINAL SPECIFICATIONS. Rusty joints must be disassembled, cleaned and lubricated to assure a like-new condition prior to retorque.

SPECIAL TOOLS

SE-2050 Torque Indicator Wrench (0-600 ft. lbs.)

SE-2059 Torque Indicator Wrench (0-150 ft. lbs.)

SE-2725 Equalizer Beam Bushing Service Set

For additional information, refer to SERVICE TOOL MANUAL CTS-1147.

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CHAPTER III

I.H. AIR SUSPENSION

CODES 03269, 03270 AND 14633

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DESCRIPTION.

The air suspension system used on IH vehicles was developed to meet the need for improved ride characteristics for highway transport vehicles. Ride characteristics were improved with the use of air springs while maintaining other suspension functions such as stability and flexibility.

The major components of the air suspension system, whether used on single or tandem axles, are as follows:

Trailing Arms

The trailing arms, Fig. 1, are of forged aluminum with an air spring support plate on top. The front end of the trailing arm is connected to the cast frame hanger bracket.

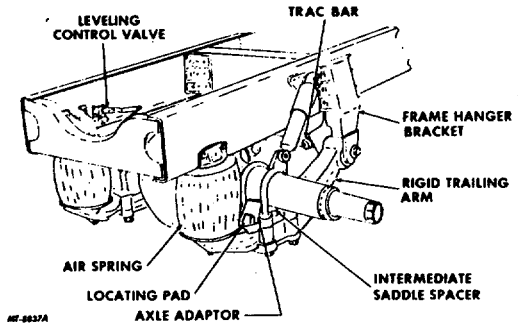


Fig. 1

Frame Hanger Brackets

The frame hanger brackets are cast and form the pivot point for each trailing arm. A rubber bushing and bolt are used to connect the trailing arm to the hanger bracket.

Shock Absorbers

The shock absorbers used in the air suspension are mounted at the frame and axle saddles, Fig. 1. These shock absorbers incorporate a hydraulic lock which reduces suspension shock by letting the suspension down easy when the axle is in its downward travel.

Trac Bar

The trac bar, Fig. 1, is designed to prevent lateral sway of the vehicle suspension. There is one (1) trac bar on chassis with single axle and on chassis with tandem axles there are two (2) trac bars.

The forward rear axle on chassis with tandem axle suspension trac bar is connected between the rear of the left forward trailing arm and the forward end of the right rear trailing arm at the frame hanger bracket.

On the tandem rear rear axle and single rear axle installations the trac bar is connected between the forward end of the left rear trailing arm at the frame hanger bracket and near the intermediate saddle spacer at the right end.

Air Springs

The rolling sleeve bag is mounted between the top plate and the piston. As the air spring (sleeve bag) is compressed, the air cell rolls over the piston. A rubber bumper is located internally to prevent metal-to-metal contact. The rubber bumper can either be located at the top or bottom of the air spring. Fig. 2 illustrates the bumper located at the bottom.

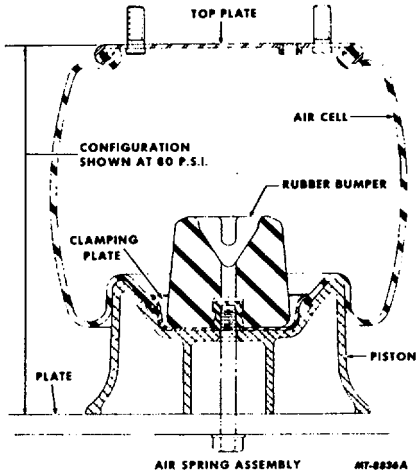


Fig. 2

To increase axle stability the air bags work in unison from front to rear--not side to side. This type installation prevents air transfer from one bag to another, which would result in axle roll.

Axle Connections

The axle adapters are welded to the round axle tube prior to assembly. Dowel pins are used in locating the axle adapters on the rectangular shaped axle tubes. The intermediate saddle spacer is located between the axle tube and trailing arm. This spacer determines the angular position of the axle housing.

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The saddle spacer is keyed in position with locating pads which are forged in the trailing arm to prevent longitudinal movement but does permit rotational movement on the resilient rubber axle pads that separate it from the trailing arm. A bracket is placed at the bottom of the trailing arm and is separated from the spacer by rubber pads like that used on top. The complete unit is clamped to the trailing arm with two U-bolts.

Refer to Fig. 4 for components mentioned.

Leveling Valves

The control (leveling) valve, Fig. 3, operates automatically. Valves control the flow of compressed air into or out of air springs. The body of each control (leveling) valve contains intake valve, exhaust valve and delay piston. Overtravel control body contains a springloaded nylon piston. Piston protects valve parts when overtravel lever is moved beyond normal operating range and also provides a delay in the action of the valve so air is not used during momentary bumps but only on load changes.

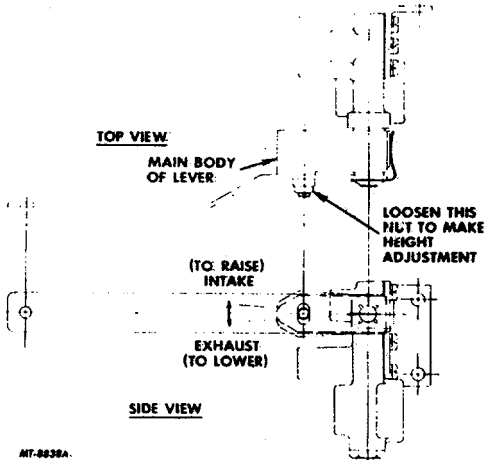


Fig. 3

OPERATION OF LEVELING VALVE

Loading

When loaded, body of vehicle settles. Since valve is linked to suspension and valve is bolted to vehicle body, valve moves downward with body during loading. As overtravel lever and control shaft turns, intake valve lever presses against pin of valve core. As pin is depressed, air pressure flows through control valve into air springs. Increased air pressure expands air springs and raises body of vehicle.

Intake valve is protected by check valve, which permits air to travel in one direction only.

Neutral Position

Increased pressure expands air springs lifting vehicle body and control valve. The overtravel lever returns to neutral as vehicle body approaches normal ride height. Intake valve lever also moves closing valve. The exhaust valve remains closed, and the check valve in intake adapter prevents air from escaping from valve body and air springs. This condition remains static until vehicle load is altered, moving overtravel lever from neutral for one or more seconds actuating intake or exhaust valves.

Unloading

When load is lightened, pressure in air springs raises vehicle body. Overtravel lever is pulled downward from neutral. This applies a force that slowly moves the delay piston. The exhaust valve lever, moving with delay piston, opens exhaust valve when lever moves beyond free travel range. Intake valve remains closed, thus allowing air from air springs to exhaust to atmosphere. As air is exhausted from air springs, the vehicle body is lowered until overtravel lever returns to neutral.

Overtravel Lever Free Travel

When vehicle is in motion with body at normal ride height, overtravel lever is in neutral position. Small movements of lever may occur without activating control valves, as it must move in excess of 4.8 mm (3/16 in.) before either valve is opened.

Hydraulic Delaying Action

The delay piston connected through a pin to overtravel shaft is contained in a cylinder of silicone type fluid. The slowing action of this fluid delays from 1 to 6 seconds the closing of one valve to the opening of the other. The flapper valves allow both valves to close from full-open position within 1 second.

The overtravel piston is held against shaft by two springs (one inside the other) and keeps shaft in proper position relative to overtravel lever. Purpose of the piston is to prevent damage of parts inside control valve if lever exceeds normal travel and to allow the lever to move without moving parts inside the valve.

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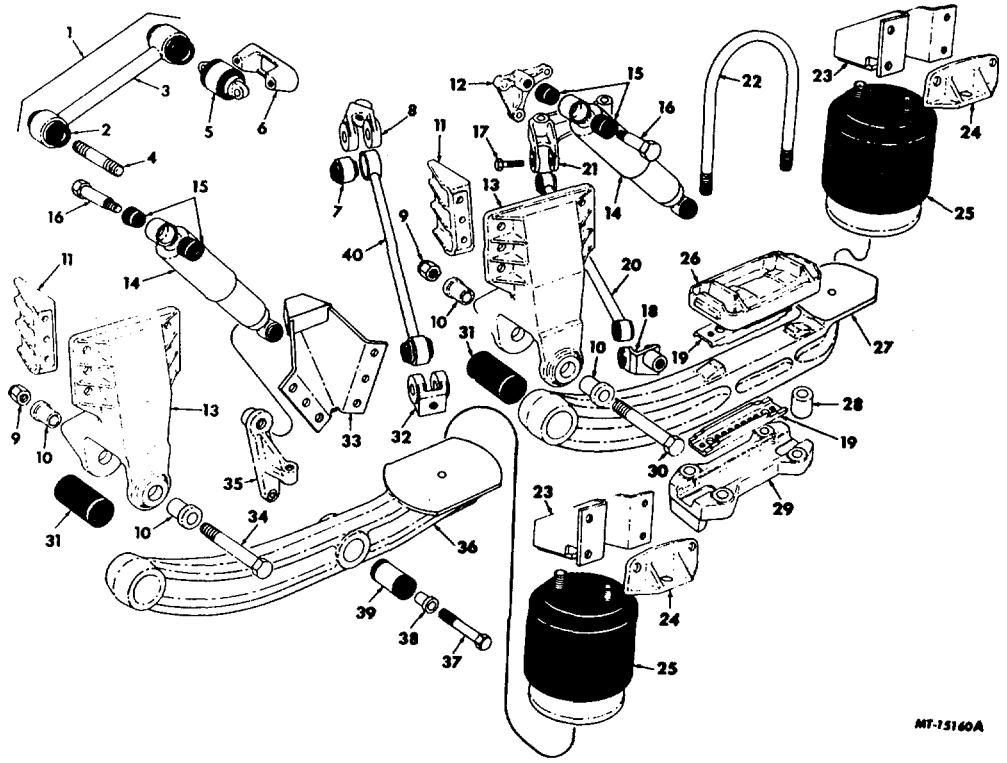


Fig. 4

Legend for Fig. 4

Key	Description	Key	Description
1	ROD, Torque, Assembly	21	YOKE, Right Rear Trac Bar Mounting
2	BUSHIING, Torque Rod	22	U-BOLT with NUTS
3	TUBE, Torque Rod	23	BRACKET, Air Spring Mounting
4	STUD, Torque Rod Mounting	24	BRACKET, Air Spring Mounting
5	SHAFT, Torque Rod	25	SPRING, Air Ride, Assembly
6	BRACKET, Torque Rod Mounting	26	SADDLE, Axle Mounting
7	BUSHING, Trac Bar	27	ARM, Rear Trailing, Assembly
8	YOKE, Right Front Trac Bar Mounting	28	SPACER, Saddle
9	NUT, Hex Lock, 1 NC	29	BRACKET, Saddle
10	ADAPTER, Bushing	30	BOLT, Hex Head, 1 NC x 8
11	BRACKET, Crossmember Mounting	31	BUSHING, Trailing Arm
12	BRACKET, Rear Shock Absorber Mtg.	32	YOKE, Left Front Trac Bar Mounting
13	BRACKET, Trailing Arm Mounting	33	BRACKET, Shock Absorber Mounting
14	ABSORBER, Shock, Assembly	34	BOLT, Hex Head, 1 NC x 10
15	BUSHING, Shock Absorber Mounting	35	BRACKET, Frt., Lwr. Shock Abs. Mtg.
16	BOLT, Hex Head, 3/4 NC x 3	36	ARM, Front Trailing
17	BOLT, Hex Head, 3/4 NC x 4	37	BOLT, Hex Head, 3/4 NF x 7-3/4
18	YOKE, Left Rear Trac Bar Mounting	38	ADAPTER, Bushing
19	PAD, Rear Axle Mounting	39	BUSHING, Front Trailing Arm Center
20	BAR, Rear Trac, Assembly	40	BAR, Trac, Assembly Front

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MAINTENANCE

Air Spring Pressure Balance

Air spring pressure imbalance on an unloaded IH air suspension is a normal condition, and unloaded trucks may be found having air springs with air pressures either in or out of balance. To assure proper performance from chassis having IH air suspension, you must follow the specified (leveling valve) spring height adjustment procedure outlined below and shown in Fig. 5.

The air spring pressure imbalance condition while unloaded causes no harm to suspension components so long as chassis remains unloaded. If, however, the imbalance continues after chassis is loaded, do not operate truck until cause for imbalance (incorrect spring height adjustment, air leaks, plugged or pinched air line, defective leveling control valve, etc.) has been found and corrected.

Again, we want to emphasize: Do not attempt to obtain a balanced air spring pressure condition by making a spring height adjustment at the leveling valve.

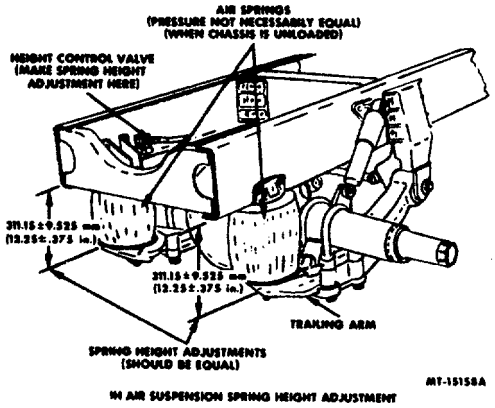


Fig. 5

Spring Height Adjustment

1. Start engine.

2. Wait until air brake pressure gauge indicates near maximum 586-621 KPa (85-90 psi).

3. Measure distance from top of trailing arm to bottom of frame at rear of air spring on one side only.

4. If distance is greater than 31.1 cm ñ .95 cm (12-1/4 in. ñ 3/8 in.), shorten linkage from height control valve arm to axle, wait 15 seconds, and remeasure. Repeat if necessary.

5. If distance is less than 31.1 cm ñ .95 cm (12-1/4 in. ñ 3/8 in.), lengthen linkage from height control valve to axle, wait 15 seconds, and remeasure. Repeat if necessary.

6. Repeat the above spring height adjustment for the opposite side of the vehicle.

Trailing Arm Bushing Installation

The trailing arm bushings must be installed to those dimensions shown in Figs. 6, 7 and 8. On both the left and right sides of the suspension the bushing is positioned to the dimension shown from the inboard side of the trailing arm.

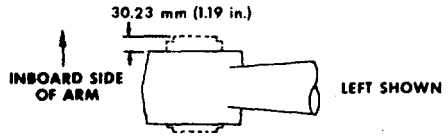


FIG. 6 FORWARD BUSHING (6 x 4 MODELS)

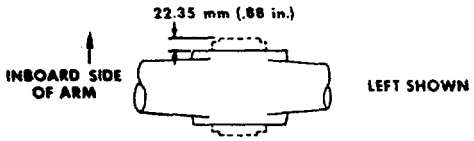


FIG. 7 CENTER BUSHING

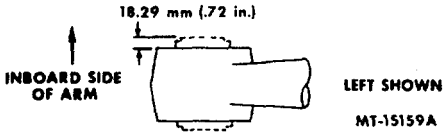


FIG. 8 REAR BUSHING (4 x 2 AND 6 x 4 MODELS)

Figs. 6, 7, and 8

To deviate from these bushing positions in the trailing arms can result in a misalignment condition, and in some instances when in a severe load-to-bump condition, the suspension shock absorber could puncture the air spring assembly.

Forward Trac Bar Installation

Fig. 9 illustrates the forward trac bar installed.

Torque Rod Installation

Fig. 10 illustrates the torque rod installed.

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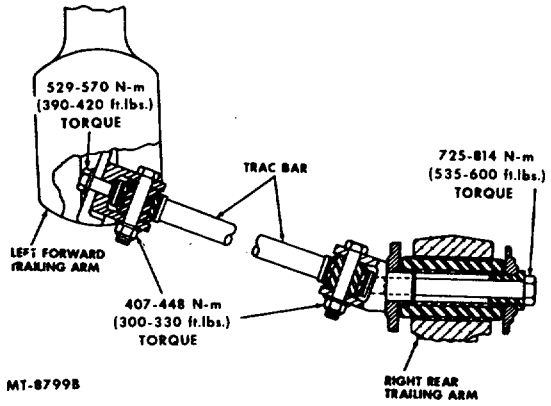


Fig. 9

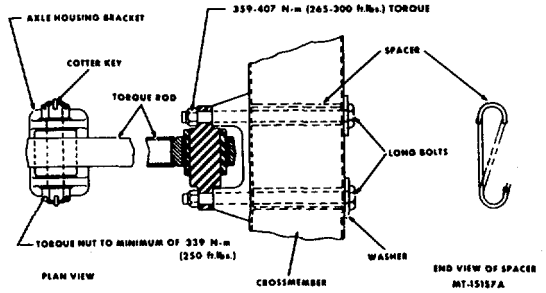


Fig. 10

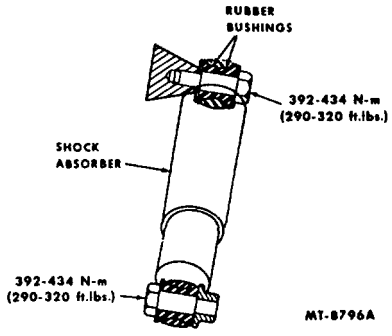


Fig. 11

Shock Absorber Bushings

Figs. 11 and 12 illustrate the shock absorber bushings installed.

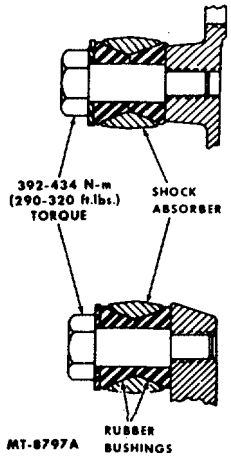


Fig. 12 Rear Rear Axle

Spring Pad Installation

Instructions for installing new rubber spring pads are as follows:

1. Apply rubber lubricant to spring pads.
2. Install top spring pad.
3. Install saddle and saddle bracket.
4. Install U-bolt.
5. Tighten U-bolt nuts to specified torque.
6. Remove U-bolts and saddle bracket.
7. Install lower spring pad.
8. Install saddle bracket.
9. Install U-bolt washers and nuts, then tighten to specified torque.

This procedure to compress new spring pads is required, since the thickness of the two pads will not allow the U-bolts to protrude through the saddle bracket far enough to allow nut installation should both pads be installed at the same time.

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Leveling (Control) Valve Removal

1. Securely block vehicle body to desired ground clearance.

2. Open drain cock in air tank and exhaust all air from system.

3. Disconnect overtravel lever from link and pull lever down to exhaust remaining air from air springs.

4. Disconnect both lines from control valve and cover ends with tape.

5. Remove bolts from mounting bracket and remove control valve.

Leveling (Control) Valve Air Leakage Check

NOTE:
With leveling (control) valve mounted, only air spring mountings and air lines can be checked.

With unit removed from vehicle the following air leak check procedure may be used:

1. Clean exterior of control valve thoroughly.

2. Connect pressure line to intake port and open air pressure 552-758 kPa (80-110 psi).

3. Submerge unit in water. No air should escape if overtravel lever is in neutral position. If bubbles escape from air spring port, air intake valve assembly must be replaced.

4. Shut off air pressure and detach pressure line from air intake port.

5. Connect pressure line to air spring port and open air pressure.

6. With overtravel lever in neutral position no air should escape. If bubbles appear at intake port, the intake check valve adapter must be replaced. If bubbles escape from exhaust port, the exhaust valve assembly must be replaced.

7. If air escapes around edge of cover plate, the gasket must be replaced.

8. Remove control valve from water. Actuate overtravel lever to expel any water from unit.

9. Shut off air pressure and remove line from air spring port.

10. Connect air spring to air intake port.

Turn on pressure and actuate overtravel lever to expel any remaining water from unit.

Leveling .(Control) Valve Adjustments

Three main adjustments are required and MUST be followed in proper sequence as indicated below:

1. Overtravel lever center position adjustment.

2. Air intake and exhaust valve lever gap adjustment.

3. Time delay check.

Remove control valve from vehicle to make these adjustments. Silicone fluid should also be drained before making adjustments 1 and 2.

Overtravel Lever Center Position Adjustment

1. Clean exterior of leveling (control) valve thoroughly.

2. Remove covers and drain silicone fluid from delay chamber.

3. Remove exhaust plug and filter.

4. Scribe a line 34.9 mm (1-3/8 in.) down on side of overtravel body, Fig. 13.

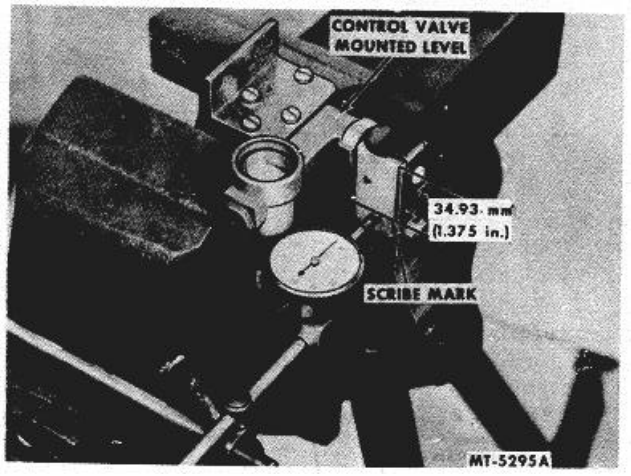


Fig. 13

5. With control valve held in vise, attach hose from vacuum source if available to exhaust port but do not apply vacuum.

6. Attach air pressure line to air intake port but do not apply pressure.

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7. Mount dial indicator in position shown. Move overtravel lever to exhaust position (delay piston will be flush with top of cover seat) without overtraveling (position "C, " Fig. 14). Relocate indicator push rod to touch 34.9 mm (1-3/8 in.) scribe mark on side of overtravel body. Reset indicator dial to zero at this point.

8. Move overtravel lever to air intake position without overtraveling (position "A, " Fig. 14). Delay piston will be at bottom of bore.

9. Take indicator reading. [This may vary from 4.1 to 4.8 mm (.160 in. to .190 in.)]

10. Repeat steps 7 and 8 to verify this reading. 11. Divide total indicator reading by two and move overtravel lever back this amount to center (position "B," Fig. 14).

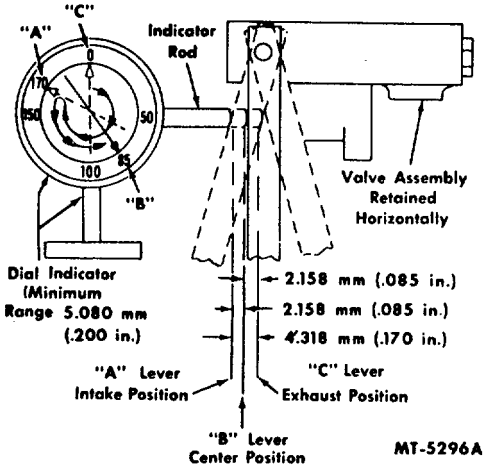


Fig. 14

11. Divide total indicator reading by two and move overtravel lever back this amount to center (position "B" Fig. 14).

NOTE:
Without disturbing lever center position, reset indicator dial to zero, then proceed with lever gap adjustment as follows:

Air Intake and Exhaust Valve Lever Adjustments

With overtravel lever in center position (position "B, " Fig. 14) two methods of adjustment are available:

1. Using both air pressure and vacuum.

2. Using air pressure only. (More time is involved in this method, as cover must be in place during test and removed during each adjustment of exhaust valve lever.)

Air Pressure and Vacuum Method:

1. Apply available vacuum and regulate air pressure to approximately 655 kPa (95 psi).

2. Move overtravel lever both directions several times and return to true center.

3. a. Slowly move lever (lowering delay piston) and listen for escaping air. Note reading on indicator dial when intake valve opens; it should be .64 to .69 mm (.025 in. to .027 in.) from lever center position (position "B", Fig. 14) just as air begins to escape.

   b. Using a spark plug gap setting tool adjust intake valve lever until reaching correct setting, Fig. 15.

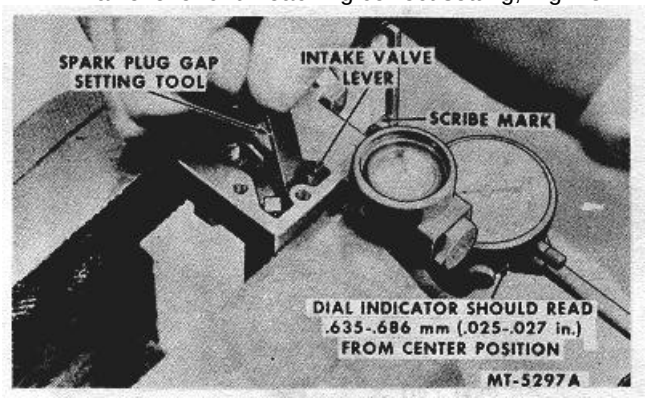


Fig. 15

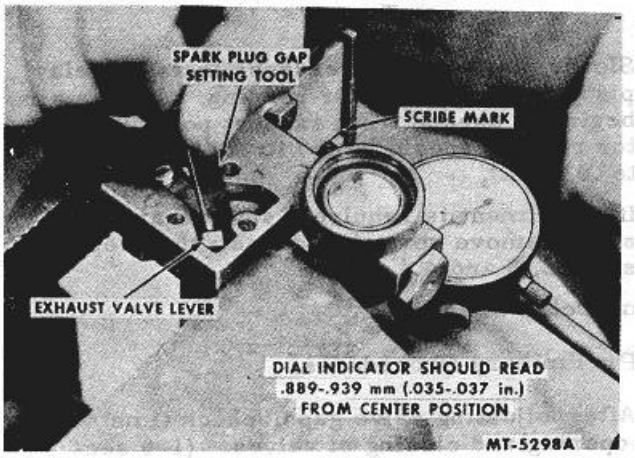


Fig. 16

4. a. Return overtravel lever to true center.

   b. Slowly move lever (raising delay piston) and note vacuum gauge reading. When exhaust valve opens causing loss of vacuum, overtravel lever should have moved .89 to .94 mm (.035 in. to .037 in.) from true center.

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c. Using a spark plug gap setting tool adjust exhaust valve lever until reaching correct setting, Fig. 16.

Air Pressure Method:
(Vacuum Source Not Available)

1. Apply air pressure regulated to approximately 655 kPa (95 psi) to inlet port. (Proceed with steps 2 and 3 of "Air Pressure and Vacuum Method.")

2. To adjust exhaust valve lever cap, install cover on height control valve using gasket.

3. Transfer air supply from inlet port to bellows port, Fig. 17, WITHOUT DISTURBING SETTING of overtravel lever.

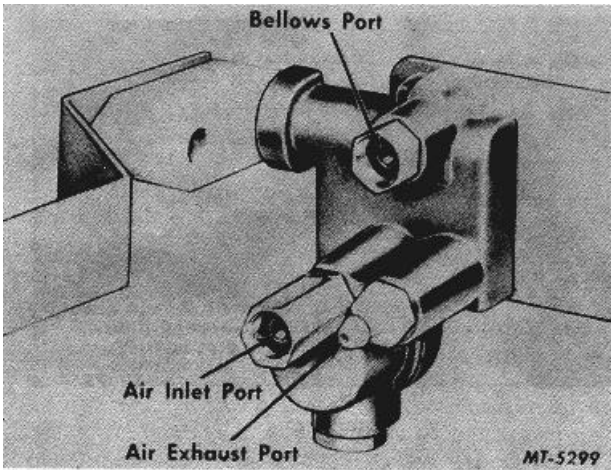


Fig. 17

4. Slowly move overtravel lever (raising delay piston) noting indicator reading. Just as air begins to escape from exhaust port, indicator reading should be .89 to .94 mm (.035 in. to .037 in.).

5. If adjustment is required, shut off air pressure, remove cover and adjust; then repeat steps 2, 3 and 4.

Time Delay Check:

Preliminary Procedures:

After adjusting valve gaps, check time delay for opening and closing of valves. (1-6 seconds from closing of one valve to opening of the other is recommended.) Valves should close from full-open position within one second.

1. Place new O-ring over delay plug and install plug. Tighten to 2.3-3.4 N-m (20-30 in. lbs.) torque.

2. Pour 5.5 cc ñ .25 cc of silicone fluid into delay piston chamber.

3. Hold valve body in vise with delay chamber elevated slightly, Fig. 18.Carefully operate lever to purge trapped air from fluid.

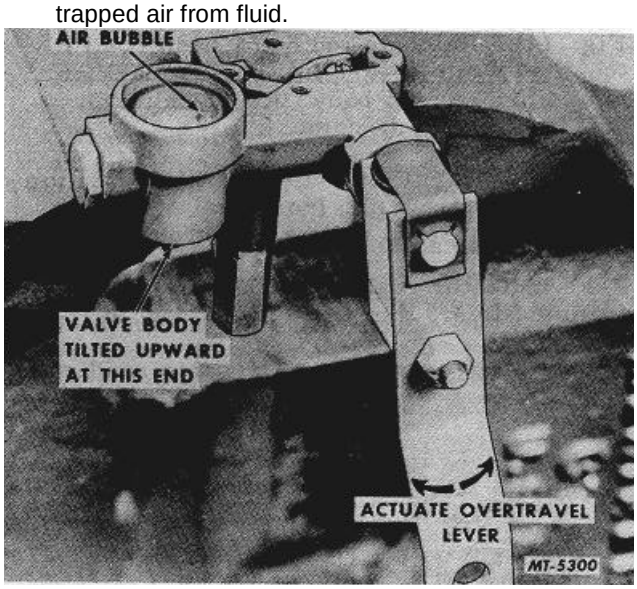


Fig. 18

4. Check fluid lever using depth gauge as shown in Fig. 19.

NOTE:
Fluid level height should be 7.9.mm (5/16 in.) below top edge of body. Add or remove fluid with an eye dropper until proper level is reached.

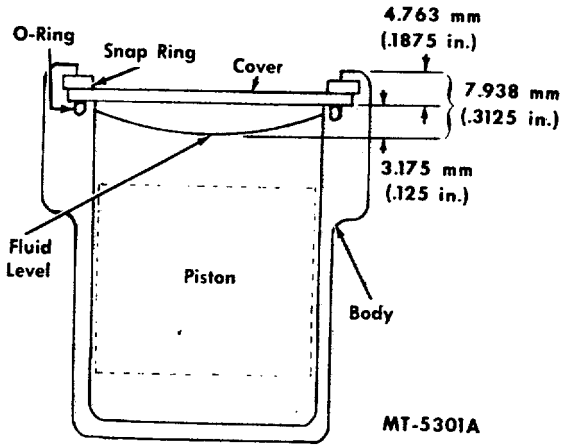


Fig. 19

5. Place new O-ring in groove around delay piston bore, install cover and secure with snap ring.

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6. Place height control valve vertically in vise, Fig. 20. Move overtravel lever up and down for one minute to vent air from delay piston pin chamber.

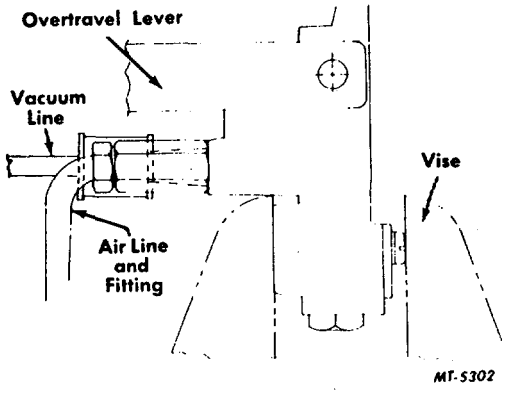


Fig. 20

Air Intake Time-Delay Check:

1. Connect pressure line to intake valve port and open air pressure 655 kPa (95 psi).

2. Quickly move overtravel lever upward two inches; simultaneously begin timing number of seconds before air starts to escape from air spring port. This delay should be from 1-6 seconds. Repeat check.

Air Exhaust Time Delay Check:
(Either Vacuum or Pressure Method)

Vacuum Method:

1. Apply available vacuum to exhaust port.

2. Quickly move overtravel lever downward two inches; simultaneously begin timing number of seconds before vacuum gauge starts to drop off. This delay should be 1-6 seconds. Repeat check.

Air Pressure Method:

1. Install cover plate on height control valve using gasket.

2. Connect pressure line to air spring port and open air pressure 655 kPa (95 psi).

3. Quickly move overtravel lever downward two inches; simultaneously begin timing number of seconds until air begins to escape from exhaust port. This delay should be 1-6 seconds. Repeat check.

NOTE:

If time delay is not within 1-6 seconds range, first recheck fluid level in time delay chamber. If level is satisfactory, valve lever gap is too large; less than 1 second would indicate valve lever gap is too small.

If valve adjustments are satisfactory, continue as follows:

1. Install valve cover using new gasket.

2. Install new screen in air spring port followed by adapter using new O-ring.

3. Place tape over all ports until valve is installed.

Leveling (Control) Valve Overhaul

The control valve is a precision built mechanism. All parts should be carefully handled and assembled. Use only recommended special tools and take care to prevent entrance of any dirt during the overhaul.

NOTE:

For physical identity of nomenclature, refer to exploded view, Fig. 21, to become familiar with their location.

1. Remove intake adapter and check valve assembly.

2. Remove air spring port adapter and screen.

3. Remove adapter O-ring and air line fitting gasket.

4. Remove cover and gasket.

5. Position valve with delay plug at top. Remove plug and drain silicone fluid from chamber. Remove O-ring from plug.

6. Unscrew and remove delay piston pin.

7. Remove retainer ring and cover from delay chamber.

8. Remove O-ring and delay piston from chamber.

9. Remove screw, lockwasher and Y shaped valve lever.

10. Carefully remove lock clip from exhaust valve stem. Spread locking arms to free clip from stem.

11. Withdraw overtravel control shaft from valve body.

12. Remove intake and exhaust valve cores using SE-2073 Remover, Fig. 22.

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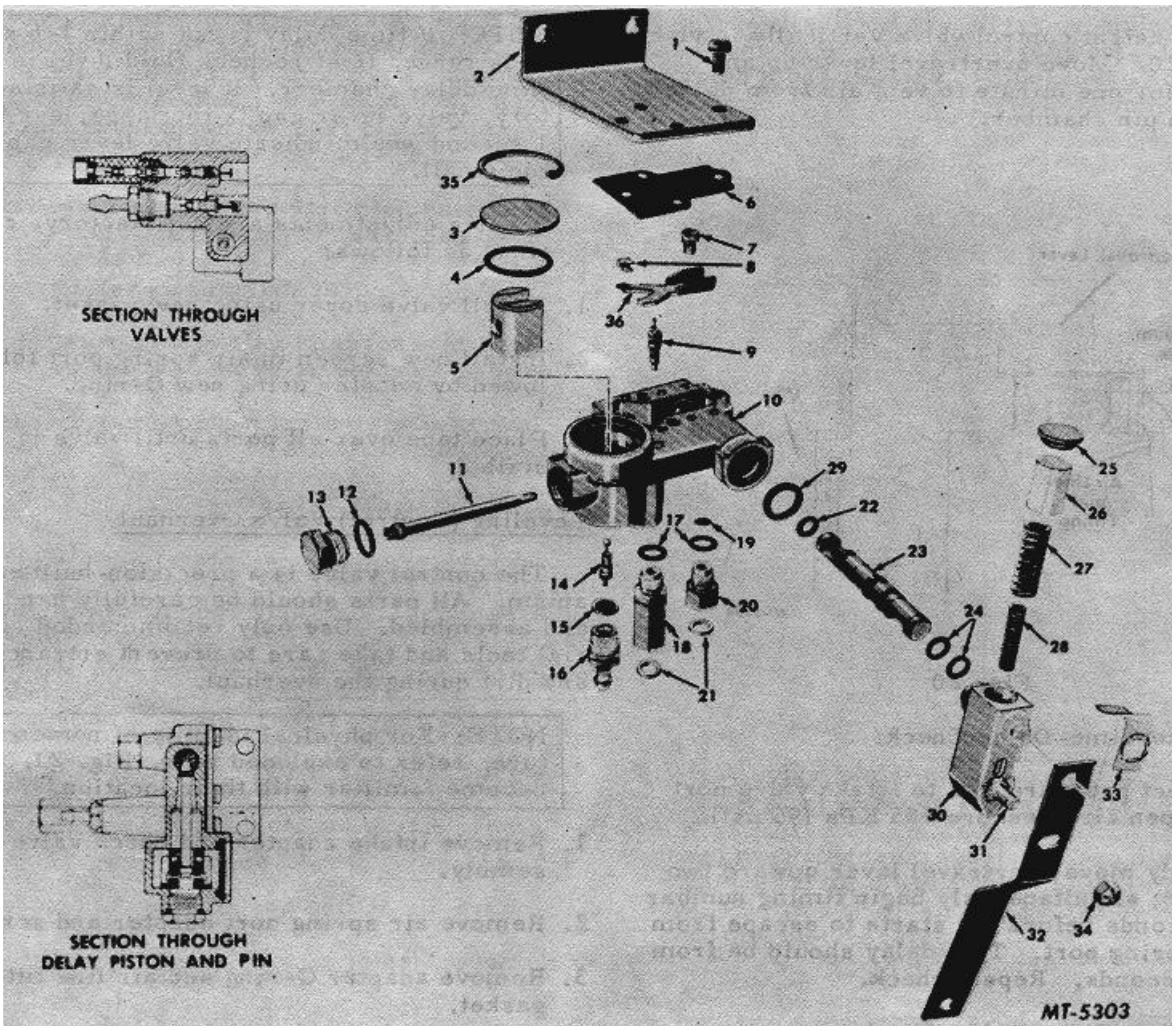


Fig. 21

Legend for Fig. 21

Key	Description	Key	Description
1	COVER SCREW and LOCKWASHER	19	SCREEN, Outlet Adapter
2	COVER and BRACKET	20	ADAPTER, Outlet
3	COVER, Delay	21	GASKET, Fitting
4	O-RING, Delay Cover	22	O-RING, Shaft (Medium)
5	PISTON, Delay	23	SHAFT, Overtravel Control
6	GASKET, Cover	24	O-RING, Shaft (Large)
7	SCREW, Valve Lever	25	PLUG, Overtravel Body
8	CLIP, Lock, Valve Stem	26	PISTON, Overtravel
9	CORE, Intake Valve	27	SPRING, Overtravel (Large)
10	BODY, Valve	28	SPRING, Overtravel (Small)
11	PIN, Piston	29	SEAL, Control Body
12	O- RING, Plug	30	BODY, Control
13	PLUG, Delay	31	STUD, Lever
14	CORE, Exhaust Valve	32	LEVER, Overtravel
15	SCREEN, Exhaust	33	RETAINER, Plug
16	FITTING, Exhaust	34	NUT, Lever Stud
17	O-RING, Adapter	35	RING, Snap, Delay Cover
18	ADAPTER, Inlet, with Check Valve Assy.	36	LEVER, Intake and Exhaust Valve

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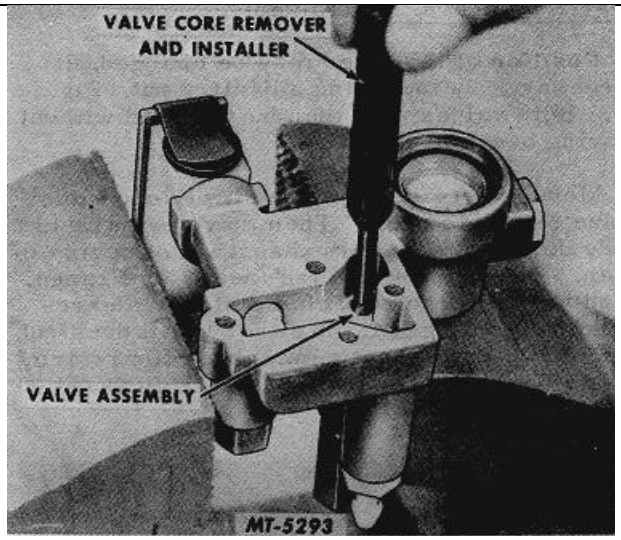


Fig. 22

13. Remove plug spring retainer from overtravel control body by cutting retainer near nylon hub. Avoid damaging nylon.

14. Remove overtravel body plug.

15. Using SE-2074 piston compressor compress springs in overtravel control body, Fig. 23. Apply just enough pressure to free control shaft. DO NOT OVERCOMPRESS SPRINGS. Remove shaft and seal.

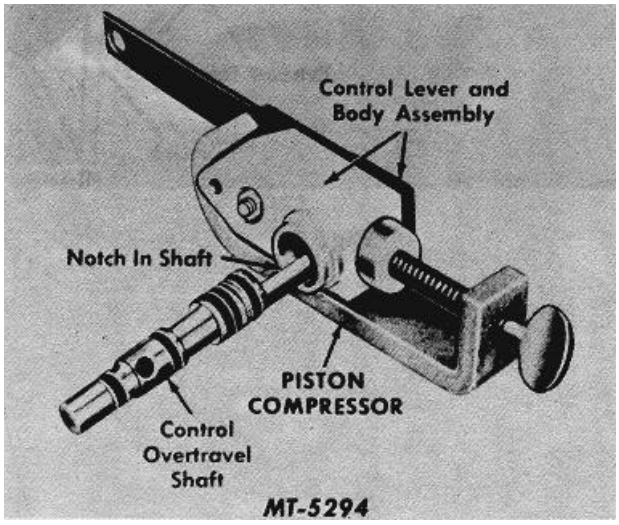


Fig. 23

16. Remove O-rings from shaft. Remove compressor tool from control body and remove piston and two springs. Detach lever.

Cleaning and Inspection

1. Clean all metal parts in solvent. Blow dry with compressed air.

2. Inspect all bearing and rubbing surfaces for scoring, cracks or excessive wear. Replace all worn or broken parts.

Assembly

NOTE:
Control valve parts must be kept free from dirt and moisture.

1. Install intake and exhaust valve cores using SE-2073 Installer, Fig. 22. Tighten to .28 to .34 N-m (2-1/2 3 in. lbs.) torque.

2. Lubricate overtravel body with multipurpose grease. Assemble as follows:

   a. Attach overtravel lever. Tighten nut on stud to 7.9 to 9.0 N-m (70-80 in. lbs.) torque.

   b. Place both overtravel springs inside piston and insert piston in body.

   c. Place 0rings on overtravel shaft and lubricate both shaft and 0-rings using multipurpose grease.

   d. Using SE-2074 Piston Compressor carefully apply pressure to compress springs. Apply only enough pressure to allow overtravel shaft to be inserted. Flat of shaft is to be against piston, Fig. 23.

   e. Insert plug and hold in place using new spring fastener pressed in position over nylon pivot on side of overtravel body.

   f. Place new seal on shoulder of overtravel body. Insert shaft into height control valve body taking care not to damage new O-rings. NOTE: Valve adjusting lever screw will lock shaft in place.

Time delay assembly may be installed as follows:

   a. Place delay piston in valve body with free end of flapper valve toward overtravel shaft.

   b. Align pin openings in piston and shaft. Tapered side of threaded hole in shaft must face delay piston. Tighten pin into shaft using .9 to 1.1 N-m (8-10 in. lbs.) torque.

   c. Place intake and exhaust (Y-shaped) valve lever in position on overtravel shaft.

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d. Place new clip over exhaust valve core stem high enough so that valve stem will not be held open. Clip must rotate freely on stem.

e. Insert valve lever screw and tighten to .9 to 1.1 N-m (8-10 in. lbs.) torque.

4. Install air intake and check valve assembly using new O-ring.

5. Make all valve assembly adjustments as explained under "Height Control Valve Adjustments."

Leveling (Control) Valve Installation

Before installing control valve, inspect air line fittings. Replace rubber gaskets in adapters if required. Keep adapter free from any dirt or foreign matter to prevent damage to valves.

1. Attach control valve to mounting bracket.

2. Connect and tighten air supply line to intake adapter and also the line from air spring to the air spring port.

3. Connect and tighten link to end of overtravel lever.

4. Remove blocks from under vehicle body and build up normal operating air pressure in system.

5. Check all line connections for leaks.

Overtravel Lever Adjustment

Position of the lever may be changed, If necessary, by loosening adjusting nut, Fig. 24. Both valves may then be actuated without moving overtravel lever.

Move overtravel body up slowly until inlet valve begins to open. Then move overtravel body down slowly until exhaust valve begins to open. This distance is the free travel range. Find the centerpoint of this distance and retighten adjusting nut. If either valve does not function during adjustment, check for restricted air lines. Refer to "TROUBLE SHIOOTING" chart.

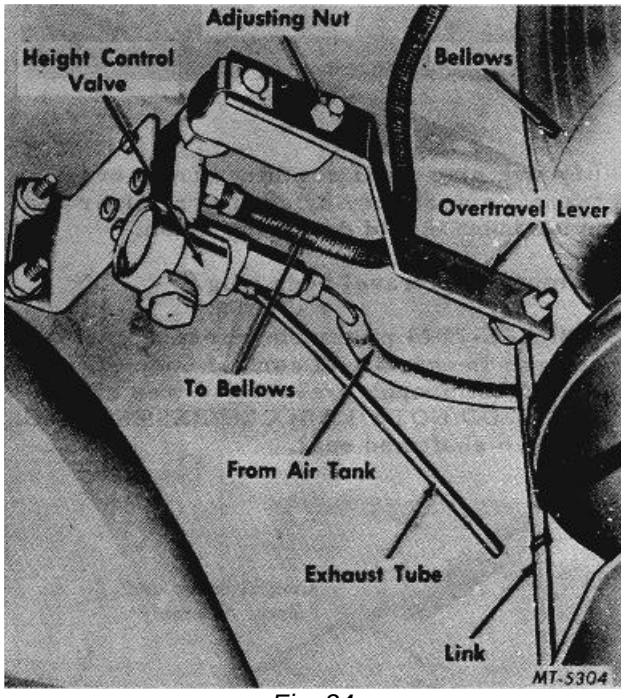


Fig. 24

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TROUBLE SHOOTING CONTROL VALVE

PROBLEM	PROBABLE CAUSE	CORRECTION
1. Air Springs Deflate Overnight	a. Defective check valve assembly. b. Defective exhaust valve assembly. c. Leak in air line and/or air springs. d. Defective cover gasket.	a. Replace check valve assembly. b. Replace exhaust valve. c. Replace air line or air springs. d. Replace gasket.
2. Air Springs Raise to Full Height But Fail to Exhaust	a. Exhaust filter clogged. b. Combination clogged exhaust filter and effective air inlet valve assembly.	a. Remove and clean filter. b. Clean filter and replace air inlet valve assembly.
3. Intermittent Hissing Noise from Control Valve During Operation	Loss of fluid from delay valve chamber.	Remove control valve from vehicle. Replace O-ring at plug. Remove delay cover and refill chamber with fluid as outlined under "Time Delay Check" and replace O-ring. Install cover and retaining ring. Remount unit on vehicle.
4. Erratic Valve Action	a. Dirt or foreign matter in air valve lever chamber. b. Defective valves.	a. Detach unit from mounting bracket cover and remove dirt from chamber. Replace gasket and remount unit to cover. b. Overhaul control valve assembly.
5. Vehicle Body Fails to Level to Satisfactory Ride Height	Overtravel lever not adjusted properly.	Adjust lever as directed in "Overtravel Lever Adjustment" instructions.

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U-BOLT NUT RETORQUE

Whenever U-Bolt nuts are loosened or removed when servicing a suspension, the U-Bolt nuts must be retorqued at the intervals and under the conditions described below.

1. After the chassis has been operating under load for 1000 miles, or six months whichever comes first, the U-Bolt nuts must be retorqued.

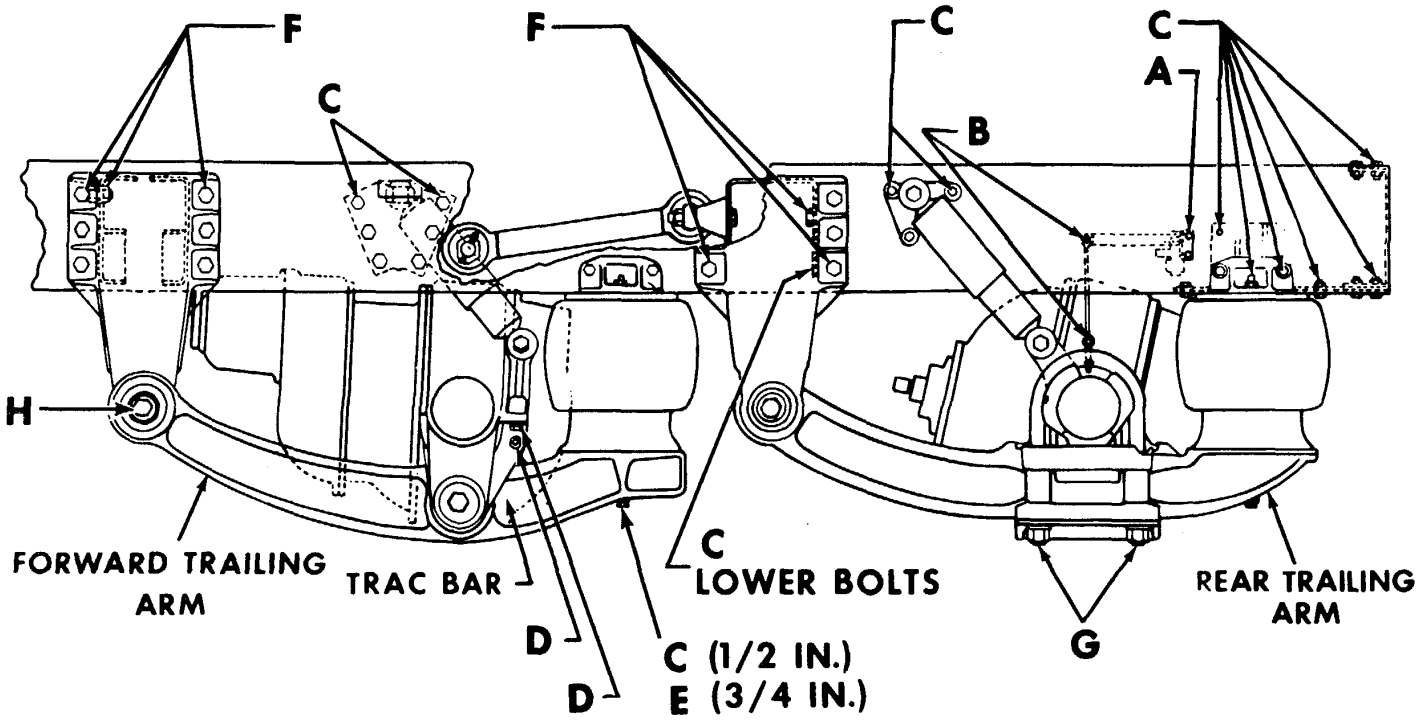
2. The U-Bolt nuts thereafter should then be retorqued every 36,000 miles.

3. The U-Bolt (joint) should be in a new or as new condition.

IMPORTANT

In instances when checking U-Bolts to determine if looseness has occurred, torque values of 40% of the specifications would assure joint integrity, provided the U-Bolts and nuts were in like-new condition. However, ALWAYS RETORQUE TO ORIGINAL SPECIFICATIONS. Rusty joints must be disassembled, cleaned and lubricated to assure a like-new condition prior to retorque.

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A. 10-11 N-m (7-8 FT.LBS.)
B. 14-16 N-m (10-12 FT.LBS.)
C. 115-136 N-m (85-100 FT.LBS.)
D. 224-258 N-m (165-190 FT.LBS.)
E. 339-407 N-m (250-300 FT.LBS.)
F. 407-448 N-m (300-330 FT.LBS.)
G. 644-712 N-m (475-525 FT.LBS.)
H. 725-814 N-m (535-600 FT.LBS.)

MT-8793B

Fig. 25 Torque chart

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SPRINGS

CHAPTER IV

DAYTON FOUR-SPRING SUSPENSION

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DESCRIPTION

The Dayton four-spring suspension used on International Harvester trucks is simple in construction consisting of only two major components: leaf spring assemblies and torque rods.

As in any conventional tandem suspension the leaf spring assemblies carry the axles. On the Dayton four-spring suspension the leaf spring assemblies are mounted at three different locations on each side of the chassis, distributing the load over a greater area of the frame rail (Fig. 1).

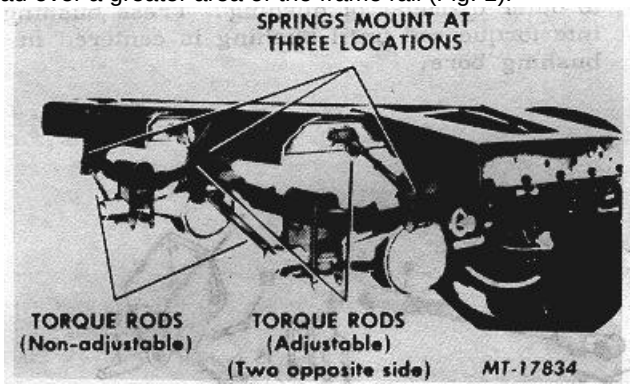


Fig. 1 Spring & Torque Rod Mountings

The six torque rods (Fig. 1) of the Dayton four-spring suspension (two non-adjustable and four adjustable) serve a dual purpose. The torque rods provide a means of suspension alignment as well as permit the axles to accept complete driveline torque by minimizing axle windup and the resulting load transfer during braking.

MAINTENANCE

Since the Dayton four-spring suspension requires no lubrication, maintenance is limited to periodic inspections to insure that specified torque values are maintained (see TORQUE CHART), leaf spring assemblies are securely seated on spring pads and proper clearance exists between spring ends and equalizer bosses. A minimum of 19 mm (.75") must exist between the end of the spring and equalizer boss (Fig. 2).

Performing the described inspections regularly will insure maximum service life of the suspension.



Fig. 2 Spring End Clearance

SERVICE

DISASSEMBLY

Refer to Figure 3 to aid disassembly and assembly operations.

Before performing any service, remove all dirt or road debris from axle and suspension.

Suspension

1. Place a jack under vehicle frame and raise sufficiently to relieve weight from leaf spring assemblies. Remove wheels.
2. Remove U-bolts, spring top seat and U-bolt plate.
3. Remove shoulder bolts from rear spring bracket and equalizer bracket.
4. Remove leaf spring assembly from suspension.
5. If it is desired to remove the torque rods, block the axle assemblies to restrict their movement and remove torque rod mounting bolts and torque rods.

Leaf Spring

1. Position spring assembly in vise such that assembly will be clamped near center.

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2. Remove rebound clip nuts, bolts and spacer.

3. Remove nut from spring assembly center bolt.

4. Release vise to permit spring leaves to separate, Remove spring assembly from vise and separate spring leaves from center bolt.

CLEANING, INSPECTION AND REPAIR

1. Wash all parts in cleaning solvent or use steam cleaning equipment to remove grease and scale.

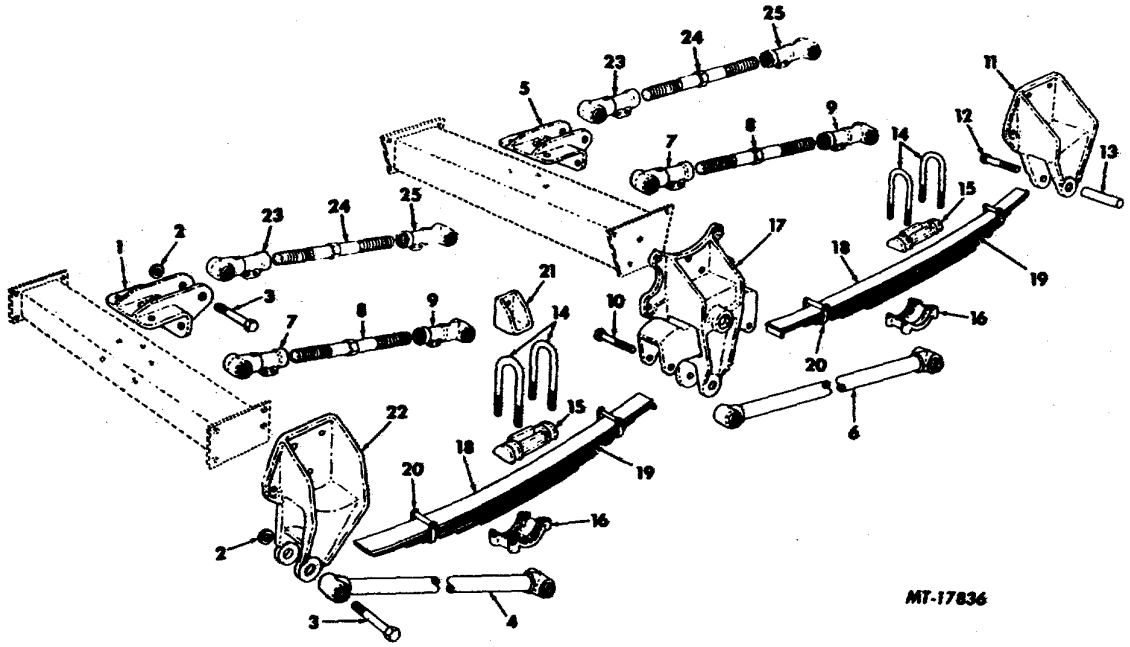
   Do not immerse torque rod rubber bushings in cleaning solvent if they are not to be replaced. Use a non-petroleum base type rubber lubricant on a clean cloth to wipe rubber bushings clean.

2. Inspect spring leaves for breakage or cracks. Also compare arch of spring leaves with new spring leaves if available. Spring leaves which have lost arch or are cracked or broken should be replaced.

Torque Rod Bushing Replacement

1. To remove torque rod bushings, support torque rod end in press and press bushing from torque rod.

2. When installing torque rod bushings, apply a thin coat of a non-petroleum base lubricant to outer diameter of bushing. Press bushing into torque rod until bushing is centered in bushing bore.



Legend for Fig. 3

Key	Description	Key	Description
1	BRACKET, Torque Rod	14	U-BOLT, Spring
2	WASHER, Torque Rod	15	SEAT, U-bolt
3	BOLT AND NUT, Torque Rod	16	PLATE, U-bolt
4	ROD, Torque, Lower Left Front	17	BRACKET, Equalizer
5	BRACKET, Torque Rod	18	LEAF, Spring
6	ROD, Torque, Lower Left Rear	19	SPRING ASSEMBLY
7	END, Torque Rod	20	CLIP, Spring
8	ROD, Torque, Lower Adjustable	21	STOP, Axle
9	END, Torque Rod	22	BRACKET, Rear Spring Front
10	BOLT, Shoulder	23	END, Torque Rod
11	BRACKET, Rear Spring Rear	24	ROD, Torque Upper Adjustable
12	BOLT, Shoulder	25	END, Torque Rod
13	NOT USED		

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ASSEMBLY

Leaf Spring Assemblies

1. Lightly lubricate spring leaves with a thin coat of graphite grease. Place spring leaves in proper order and align center bolt hole with a long drift.

2. Compress spring leaves sufficiently for installing center bolt and nut. Always use new center bolts at each overhaul.

3. Place spring assembly in vise and compress spring leaves fully. Torque center bolt to specified torque.

> CAUTION
>
> When assembling spring leaves, be careful to prevent physical injury to personnel. The use of special holding fixtures or "C" clamps for holding spring leaves in place during assembly is strongly recommended.

4. Align spring leaves by tapping with hammer and position rebound clips on spring. Install spacers, bolts and nuts. Tighten enough to hold leaves in alignment, but not enough to restrict free movement.

Suspension

When assembling suspension, all bolts are to be installed with bolt heads to the inside of frame unless otherwise specified.

1. Install leaf spring assemblies on bottom spring seats with hook ends of spring assemblies facing equalizer brackets.

2. Install shoulder bolts in rear spring brackets and equalizer brackets. Torque shoulder bolt nut to specified torque.

3. Place top spring seat in place and install U-bolt plates. Tighten U-bolt nuts securely.

> IMPORTANT
>
> U-bolt nuts must be final tightened to the torque specified with weight of vehicle on wheels.

4. Install torque rods and tighten torque rod mounting bolts to specified torque. Non-adjustable torque rods must be installed on the road side of vehicle and adjustable torque rods on curb side.

5. Install wheels and tires.

6. After suspension has been assembled, it must be aligned before returning to service (refer to CHAPTER 7, CTS-2680).

ALIGNMENT

Refer to CHAPTER 7, CTS-2680 for alignment information.

TORQUE CHART

Location		Recommended Torque	
		Newton Meters	Ft. Lbs.
Leaf Spring Assembly Center Bolt		68-81	50-60
Torque Rod Clamp Nuts		34-48	25-35
Torque Rod End Bolt Nuts		387-427	285-315
Torque Rod Bracket-to-Crossmember Bolt Nuts		271-325	200-240
Spring Brackets-to-Frame Mounting Bolt Nuts		271-325	200-240
Equalizer Bracket-to-Frame Mounting Bolt Nuts		271-325	200-240
Axle Stop-to-Frame Mounting Bolt Nut		271-32q	200-240
Spring Bracket Shoulder Bolt Nuts		68-81	50-60
Equalizer Bracket Shoulder Bolt Nuts		29-37	21-27
U-Bolt Nuts	3/4 in.	271-325	200-240
	7/8 in.	305-373	225-275

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U-BOLT NUT RETORQUE

Whenever U-Bolt nuts are loosened or removed when servicing a suspension. the U-Bolt nuts must be retorqued at the intervals and under the conditions described below.

1. After the chassis has been operating under load for 1600 km (1000 miles), or six months whichever comes first, the U-Bolt nuts must be retorqued.

2. The U-Bolt nuts thereafter should then be retorqued every 58,000 km (36,000 miles).

3. The U-BoIt (joint) should be in a new or as new condition.

IMPORTANT

In instances when checking U-Bolts to determine if looseness has occurred, torque values of 40% of the specifications would assure joint integrity, provided the U-Bolts and nuts were in like-new condition. However, ALWAYS RETORQUE TO ORIGINAL SPECIFICATIONS. Rusty joints must be disassembled, cleaned and lubricated to assure a like-new condition prior to retorque.

SPECIAL TOOLS

SE-2050 Torque Indicator Wrench (0-600 ft. lbs.)
SE-2059 Torque Indicator Wrench (0-150 ft. lbs.)

For additional information, see Service Tool Manual CTS-1147.

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CHAPTER V

REYCO 101 SUSPENSION

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DESCRIPTION

The Reyco 101 suspension installed on International trucks is a four-spring tandem suspension. As in any conventional tandem suspension the leaf spring assemblies carry the axles. The leaf spring assemblies mount at three different locations on each side of the chassis distributing load over a large area of the frame rail (Fig. 1).

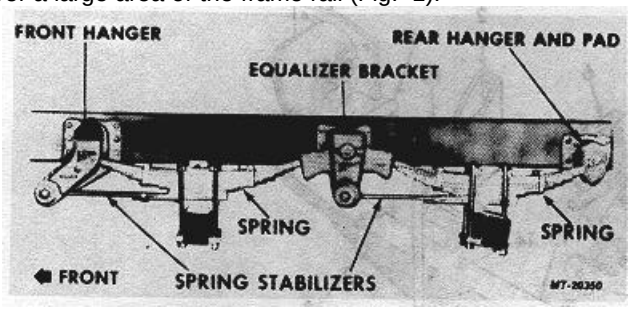


Fig. 1 Suspension Components

The Reyco suspension differs from other four-spring suspensions in that the Reyco utilizes torque leaves rather than torque rods to maintain suspension alignment and stability (Fig. 2).

Torque leaves provide stability by minimizing axle wind-up caused by driveline torque and the resulting load transfer during braking.

Suspension alignment is accomplished by adjustment of eccentric bushings located at the torque leaf mounting eyes.

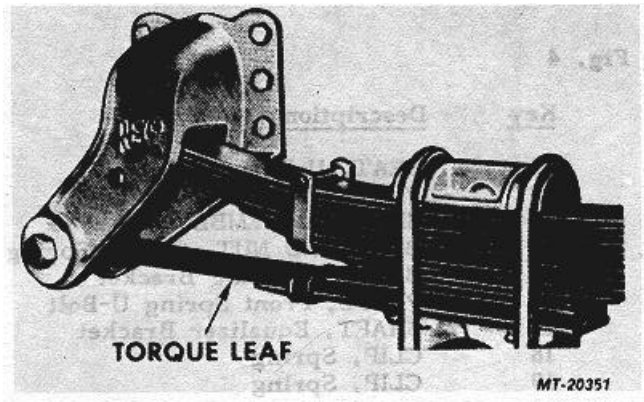


Fig. 2 Torque Leaf

MAINTENANCE

Since the Reyco suspension requires no lubrication, maintenance is limited to periodic inspections to insure specific torque values are maintained (see TORQUE CHART) and proper spring end clearance exists. As illustrated in Figure 3, spring ends must not be in contact with sides of equalizer or hanger brackets.

Performing the described inspections will insure maximum service life of the suspension.

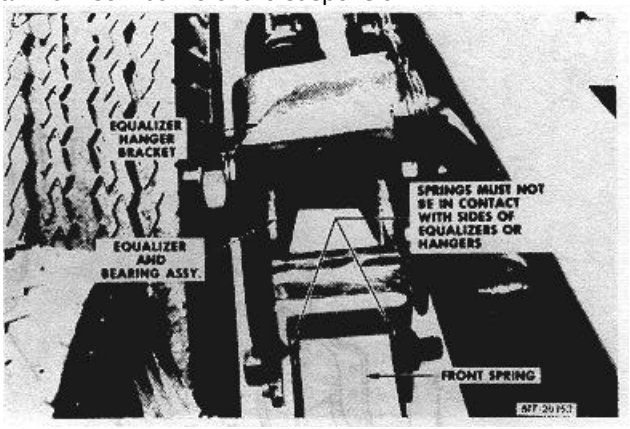


Fig. 3 Spring End Clearance

SERVICE

DISASSEMBLY

Refer to Figure 4 to aid in the disassembly and reassembly procedures. Before performing any service remove all dirt or road debris from axle and suspension.

Suspension

1. Place a jack under vehicle frame and raise sufficiently to relieve weight from leaf spring assemblies. Remove wheels.

2. Block axle assemblies to restrict movement and remove eccentric bushings from torque leaves.

3. Remove U-bolts, spring top seat and U-bolt plate.

4. Remove shoulder bolts from spring brackets and equalizer brackets.

5. Remove leaf spring assemblies from suspension.

Leaf Spring Assembly

1. Position spring assembly in vise such that assembly will be clamped near center.

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2. Remove rebound clip nuts, bolts and spacer.

3. Remove nut from spring assembly center bolt.

4. Release vise to permit spring leaves to separate. Remove spring assembly from vise and separate spring leaves from center bolt.

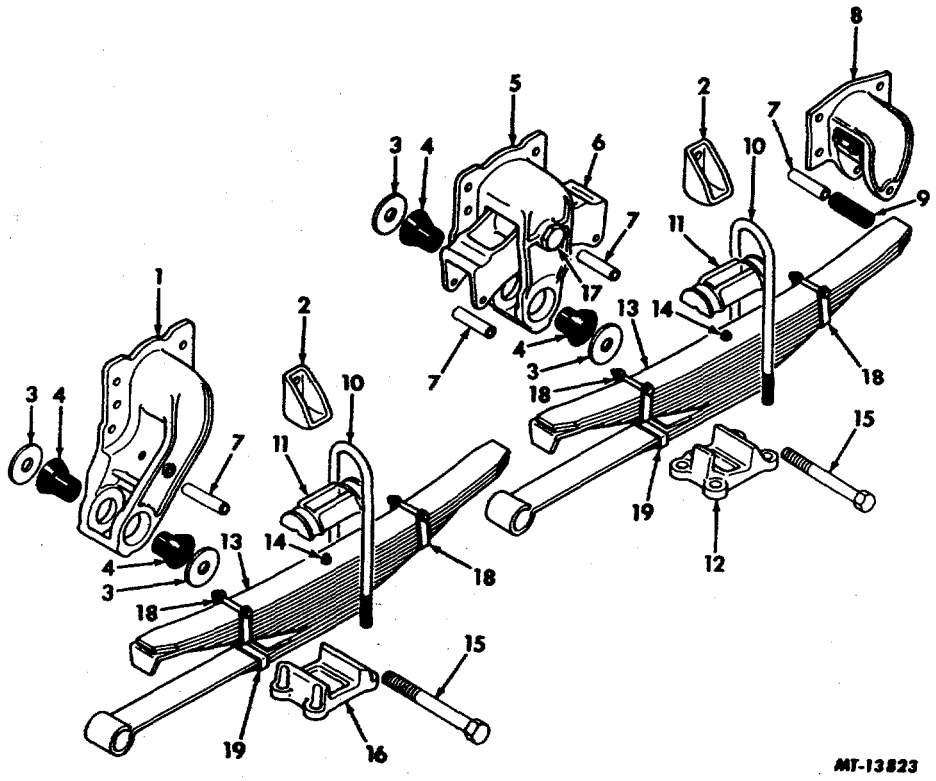


Fig. 4

Legend for Fig. 4

Key	Description	Key	Description
1	BRACKET, Spring, Front	11	SEAT, U-Bolt
2	STOP, Axle	12	PLATE, Rear Spring U-Bolt
3	WASHER, Compression	13	SPRING ASSEMBLY
4	BUSHING, Torque Leaf	14	BOLT AND NUT, Center Spring
5	BRACKET, Center Mounting	15	BOLT, Mounting Bracket
6	BRACKET, Equalizer	16	PLATE, Front Spring U-Bolt
7	ROLLER, Spring	17	SHAFT, Equalizer Bracket
8	BRACKET, Spring, Rear	18	CLIP, Spring
9	BUSHING, Roller	19	CLIP, Spring
10	U-BOLT		

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CLEANING, INSPECTION AND REPAIR

1. Wash all parts in cleaning solvent or use steam cleaning equipment to remove grease and scale.

> **IMPORTANT**
>
> Do not immerse torque leaf rubber bushings in cleaning solvent if they are not to be replaced. Use a nonpetroleum base type rubber lubricant on a clean cloth to wipe rubber bushings clean.

2. Inspect spring leaves for breakage or cracks. Also compare arch of spring leaves with new spring leaves if available. Spring leaves which have lost arch or are cracked or broken should be replaced.

Torque Leaf Bushing Replacement

1. To remove torque leaf bushings, support torque leaf end in press and press bushing from torque leaf.

2. When installing torque leaf bushings, apply a thin coat of a non-petroleum base lubricant to outer diameter of bushing. Press bushing into torque leaf until bushing is centered in bushing bore.

ASSEMBLY

Leaf Spring Assemblies

1. Lightly lubricate spring leaves with a thin cost of graphite grease. Place spring leaves in proper order and align center bolt hole with a long drift.

2. Compress spring leaves sufficiently for installing center bolt and nut. Always use new center bolts at each overhaul.

3. Place spring assembly in vise and compress spring leaves fully. Torque center bolt to specified torque.

> **CAUTION**
>
> When assembling spring leaves, be careful to prevent physical injury to personnel. The use of special holding fixtures or "C" clamps for holding spring leaves in place during assembly is strongly recommended.

4. Align spring leaves by tapping with hammer and position rebound clips on spring. Install spacers, bolts and nuts. Tighten enough to hold leaves in alignment, but not enough to restrict free movement.

TORQUE CHART

Location	RECOMMENDED TORQUE	
	Newton Meters	Ft Lbs
Spring Brackets-to-Frame Mounting Bolt Nuts	298	220
Equalizer Bracket-to-Frame Mounting Bolt Nuts	298	220
Axle Stop-to-Frame Mounting Bolt Nuts	298	220
Equalizer Bracket Shaft Nut	814	600
Leaf Spring Center Bolt Nut	75	55
Spring and Equalizer Bracket Shoulder Bolt Nuts	75	55
U-Bolt Nuts	407	300
Torque Leaf Bolt Nuts	217	160

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Suspension Assembly

1. Install leaf spring assemblies on bottom spring seats.

2. Install shoulder bolts in spring brackets and equalizer brackets. Torque shoulder bolt nut to specified torque.

3. Place top spring seat in place and install U-bolts and U-bolt plates. Tighten U-bolt nuts securely.

   U-Bolt nuts must be final tightened to the torque specified with weight of vehicle on wheels.

4. Jack up torque leafs and install eccentric bushings arrow up. Do not torque retaining nuts until suspension alignment has been performed.

5. Install wheels and tires.

6. After suspension has been assembled it must be aligned before returning to service (refer to Chapter 7 CTS-2680).

ALIGNMENT

Refer to Chapter 7 CTS-2680 for alignment information.

U-BOLT NUT RETORQUE

Whenever U-bolt nuts are loosened or removed when servicing a suspension, U-bolt nuts must be retorqued at intervals and under conditions described below.

1. After chassis has been operating under load for 1600 km (1000 miles) or six months, whichever comes first, U-bolt nuts must be retorqued.

2. U-bolt nuts thereafter should then be retorqued every 58,000 km (36,000 miles).

3. U-bolt (joint) should be in a new or as new condition.

IMPORTANT

In instances when checking U-bolts to determine if looseness has occurred, torque values 40% of specifications would assure joint integrity, provided U-bolts and nuts were in like-new condition. However, always retorque to original specifications. Rusty joints must be disassembled, cleaned and lubricated to assure a like-new condition prior to retorque.

SPECIAL TOOLS

SE-2050 Torque Indicator Wrench (0-600 ft. lbs.)

SE-2059 Torque Indicator Wrench (0-150 ft. lbs.)

For additional information, see Service Tool Manual CTS-1147.

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SPRINGS

CHAPTER VI

IH FOUR-SPRING SUSPENSION

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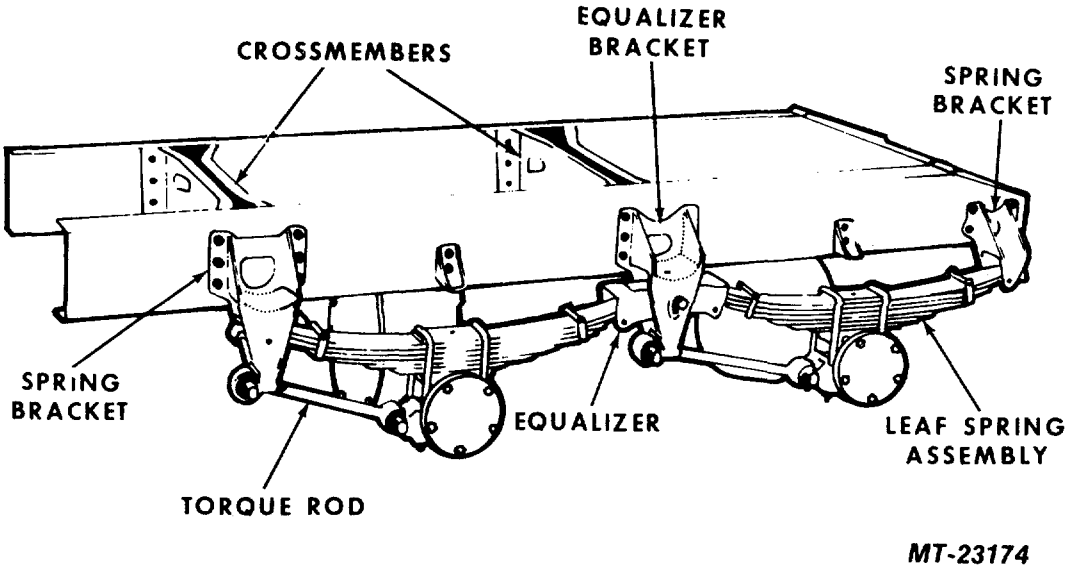


Fig. 1

DESCRIPTION

The International 4-Spring suspension, as its name implies, is a four-spring tandem suspension. As in any conventional tandem suspension the leaf spring assemblies carry the axles.

Construction is simple consisting of only two major components, leaf spring assemblies and torque rods. The leaf spring assemblies mount at three different locations on each side of the chassis, distributing the load over a large area of the frame rail. Leaf spring assembly brackets and frame cross-members are fastened to the frame rail with the same hardware resulting in the suspension being an integral part of the chassis.

Torque rods provide stability by minimizing axle wind-up caused by driveline torque and the resulting load transfer during braking.

Suspension alignment is accomplished by inserting shims at the torque rod end mounting.

MAINTENANCE

Since the International 4-Spring suspension requires no lubrication, maintenance is limited to periodic inspections to insure torque values are maintained (see torque chart) and proper spring end clearance exists. As illustrated in Figure 2 spring ends must not be in contact with sides of equalizer or hanger brackets. Spring end contact indicates that spring assemblies are not seated on axle housing or the need for suspension alignment. Check U-Bolt seats, U-Bolts, spring assemblies, etc. for proper installation. If suspension alignment is required, refer to Chapter 7, CTS-26S0 for alignment information.

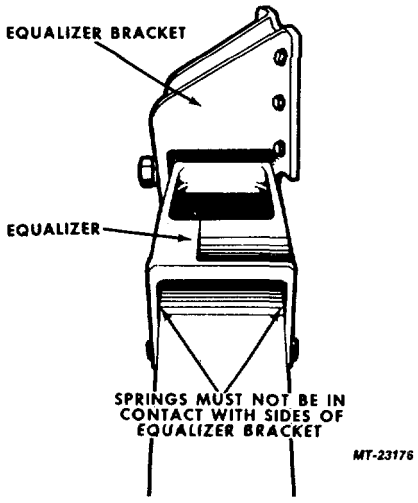


Fig. 2 Spring End Clearance

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Performing the described inspections regularly will insure maximum service life of the suspension.

SERVICE

Refer to Figure 4 to aid service procedures.

EQUALIZER BEARING REPLACEMENT SUSPENSION ASSEMBLED

Equalizer bearings may be replaced without disassembling the suspension. Proceed as follows.

1. Remove front and rear spring retaining pins from equalizer.
2. Raise vehicle frame sufficiently to relieve weight from leaf spring assemblies allowing spring ends to drop clear of equalizer.
3. Remove equalizer pivot bolt, nut and lockwasher from equalizer bracket, Figure 3.
4. Remove adapter retainer and retainer bot, Figure 3. Tap or pry on back side of equalizer to produce clearance between equalizer and adapter.

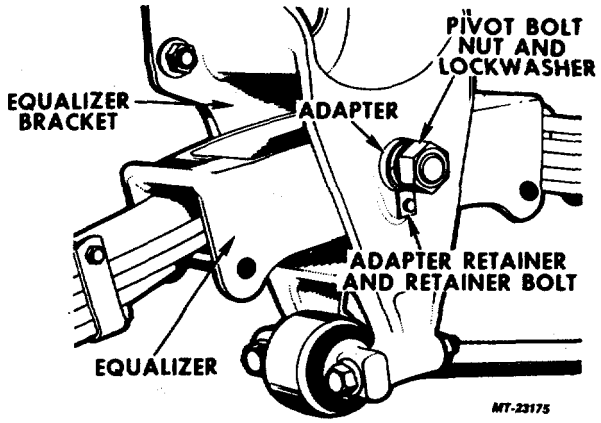


Fig. 3 Equalizer Components

5. Remove equalizer from equalizer bracket. To replace bearing refer to Equalizer Bearing Replacement in the CLEANING, INSPECTION AND REPAIR section of this manual.
6. Reverse preceding operations for installation and assembly.

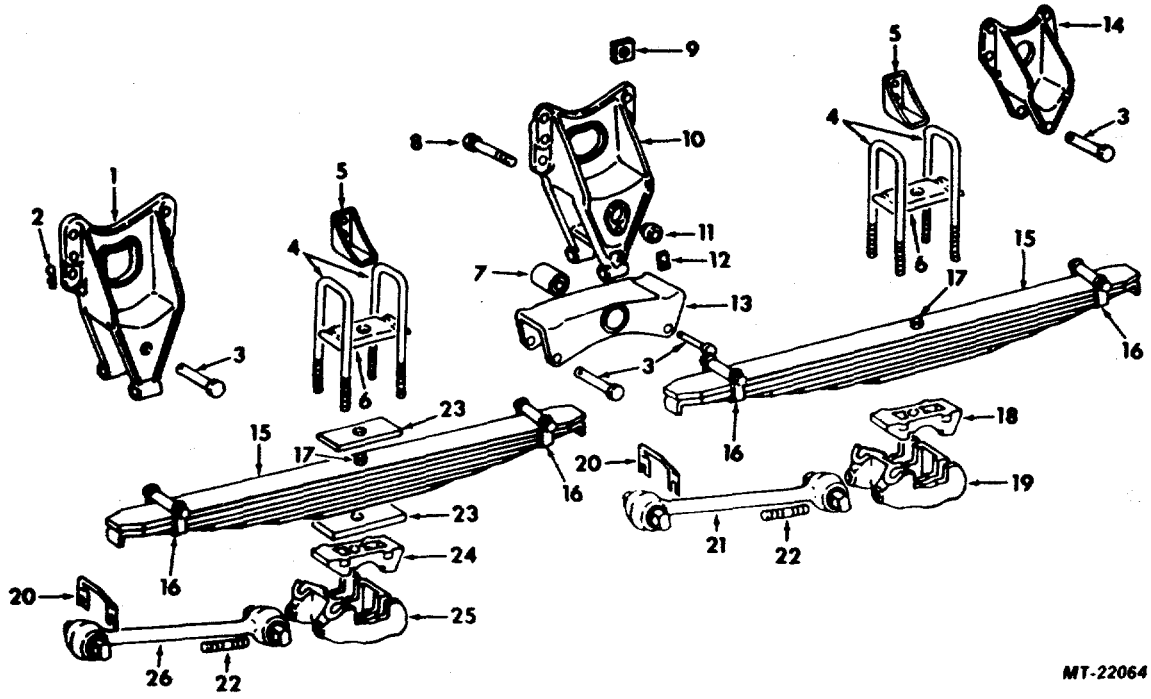


Fig. 4 International 4-Spring Suspension

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Legend for Figure 4

1.	Bracket, Spring Forward Rear	14.	Bracket, Spring Rear Rear
2.	Pin, Cotter	15.	Spring Assembly
3.	Pin, Spring Retaining	16.	Clip, Spring
4.	U-Bolt	17.	Bolt, Spring Center
5.	Stop, Axle	18.	Seat Spring Rear Rear
6.	Seat, U-Bolt	19.	Plate, Assembly U-Bolt
7.	Bearing, Equalizer	20.	Shim, Alignment
8.	Bolt, Equalizer Pivot	21.	Rod, Torque
9.	Bar, Spacer	22.	Stud, Torque Rod Mounting
10.	Bracket, Equalizer	23.	Spacer, Spring
11.	Adapter, Equalizer	24.	Seat, Spring Forward Rear
12.	Retainer, Adapter	25.	Plate, Assembly U-Bolt
13.	Equalizer	26.	Rod, Torque

DISASSEMBLY

Suspension

1. Place a jack under vehicle frame and raise sufficiently to relieve weight from leaf spring assemblies. Remove wheels.

2. Block axle assemblies to restrict their movement and remove torque rods. Tag alignment shims found at torque rod end mountings so they may be installed at the same location upon reassembly.

3. Remove U-bolt nuts, U-bolts and top U-bolt seat.

4. Remove spring retaining pins from spring brackets and equalizer bracket. Remove leaf spring assembly. Tag spacers found beneath or above leaf spring assembly so they may be installed at the same location upon reassembly.

5. Remove equalizer pivot bolt, nut and lockwasher from equalizer bracket, Figure 5.

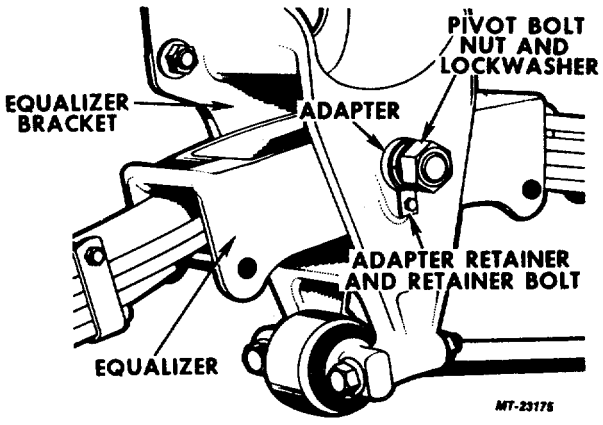


Fig. 5 Equalizer Components

6. Remove adapter retainer and retainer bolt, Figure 5. Tap outward on backside of equalizer to produce clearance between equalizer and adapter. Remove equalizer from bracket.

Leaf Spring Assemblies

1. Position spring assembly in vise such that assembly will be clamped near center.

2. Remove rebound clip nuts, bolts and spacer.

3. Remove nut from spring assembly center bolt.

4. Release vise to permit spring leaves to separate. Remove spring assembly from vise and separate spring leaves from center bolt.

CLEANING, INSPECTION AND REPAIR

1. Wash all parts in cleaning solvent or use steam cleaning equipment to remove grease and scale.

IMPORTANT

Do not immerse torque rod or equalizer bearing rubber bushings in cleaning solvent if they are not to be replaced. Use a non-petroleum base type rubber lubricant on a clean cloth to wipe rubber bushings clean.

2. Inspect spring leaves for breakage or cracks. Also compare arch of spring leaves with new spring leaves if available. Spring leaves which have lost arch or are cracked or broken should be replaced.

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IMPORTANT

If torque rod mounting studs are removed or replaced, apply Loctite No. 277 to the stud threads when installing stud in the U-bolt plate.

Equalizer Bearing Replacement

1. To remove equalizer bearing, support equalizer in press and press bearing from equalizer using a 63 mm (2.5 in.) adapter. Adapters may be made locally from standard size tubing.

IMPORTANT

When removing or installing equalizer bushing, press on bearing outer sleeve only.

2. To install equalizer bearing, apply a light coat of lubricant to outside diameter of bearing assembly, support equalizer in press and press bearing into equalizer. Bearing must be centered in equalizer.

ASSEMBLY

Leaf Spring Assemblies

1. Lightly lubricate spring leaves with a thin coat of graphite grease. Place spring leaves in proper order and align center bolt hole with a long drift.

2. Compress spring leaves sufficiently for installing center bolt and nut. Always use new center bolts at each overhaul.

3. Place spring assembly in vise and compress spring leaves fully. Torque center bolt to specified torque. Cut off excess length of center bolt so that bolt is flush with top of nut.

CAUTION

When assembling spring leaves, be careful to prevent physical injury to personnel The use of special holding fixtures or "C" clamps for holding spring leaves in place during assembly is strongly recommended.

4. Align spring leaves by tapping with hammer and position rebound clips on spring. Install spacers, bolts and nuts. Tighten enough to hold leaves in alignment, but not enough to restrict free movement.

Suspension

When assembling suspension, all bolts are to be installed with bolt heads to the inside of frame unless otherwise specified.

1. Install leaf spring assemblies on bottom U-bolt seat with short end of spring assembly toward equalizer. Install spacers in same location from which they were removed in disassembly.

2. Install spring retaining pins in spring brackets and equalizer bracket.

3. Assemble top U-bolt seat, U-bolts and U-bolt plate. Install U-bolt nuts and tighten securely.

IMPORTANT

U-bolt nuts must be final tightened to the torque specified with weight of vehicle on wheels. Final tighten U-bolts diagonally.

4. Install torque rods. Position alignment shims in the locations from which they were removed in disassembly. Tighten torque rod mounting bolts and nuts to specified torque.

5. Install wheels and tires.

6. Final tighten U-bolts diagonally and evenly (see Torque Chart). Refer to the U-BOLT RETORQUE section of this manual.

7. After suspension has been assembled, it must be aligned before returning to service (refer to ALIGNMENT section of this manual for alignment procedures).

ALIGNMENT

Refer to CHAPTER 7, CTS-2680 for alignment information.

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TORQUE CHART

LOCATION	RECOMMENDED TORQUE	
	NEWTON METERS	FT. LBS.
CROSSMEMBER CENTER BOLT	271-325	200-240
CROSSMEMBER (REAR, REAR) MOUNTING BOLT	136-163	100-120
EQUALIZER BRACKET MOUNTING BOLT NUT	271-325	200-240
EQUALIZER PIVOT BOLT NUT	576-712	425-525
EQUALIZER ADAPTER RETAINER BOLT	10-12	90-110 (in. Lbs.)
SPRING BRACKET MOUNTING BOLT NUT	271-325	200-240
SPRING ASSEMBLY CENTER BOLT NUT	95-115	70-85
SPRING ASSEMBLY CLIP BOLT NUT	41-52	30-38
TORQUE ROD MOUNTING BOLTS	271-325	200-240
U-BOLT NUT	271-325	200-240

U-BOLT NUT RETORQUE

Whenever U-bolt nuts are loosened or removed when servicing a suspension, the U-bolt nuts must be retorqued at the intervals and under the conditions described below.

1. After the chassis has been operating under load for 1000 miles or six months, whichever comes first, the U-bolt nuts must be retorqued.

2. The U-bolt nuts thereafter should then be retorqued every 36,000 miles.

3. The U-bolt (joint) should be in a new or as new condition.

IMPORTANT

In instances when checking U-bolts to determine if looseness has occurred, torque values of 40% of the specifications would assure joint integrity, provided the U-bolts and nuts were in like-new condition. However, ALWAYS RETORQUE TO ORIGINAL SPECIFICATIONS. Rusty joints must be disassembled, cleaned and lubricated to assure a like-new condition prior to retorque.

SPECIAL TOOLS

SE-2050 Torque Indicator Wrench (0-600 ft. lbs.)
SE-2059 Torque Indicator Wrench (0-150 ft. lbs.)

For additional information, see Service Tool Manual CTS-1147.

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SPRINGS
CHAPTER VII

SUSPENSION ALIGNMENT

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GENERAL

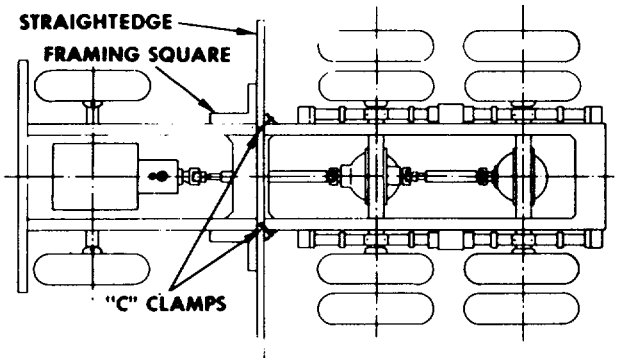
Before performing axle alignment or upper torque rod adjustment, remove road debris from suspension and perform the preliminary procedures listed below.

1. Park vehicle on a level floor.
2. Release parking brake.
3. Check rear wheels for runout and correct if necessary.
4. Move vehicle forward and rearward several times to relieve internal stress.
5. Turn wheels in a straight ahead position.

AXLE ALIGNMENT

The following alignment check (measuring of the suspension) applies to all tandem suspensions covered in this manual. In the event axle adjustment is necessary, refer to the AXLE ADJUSTMENT portion of this chapter and the appropriate procedure for the suspension being serviced.

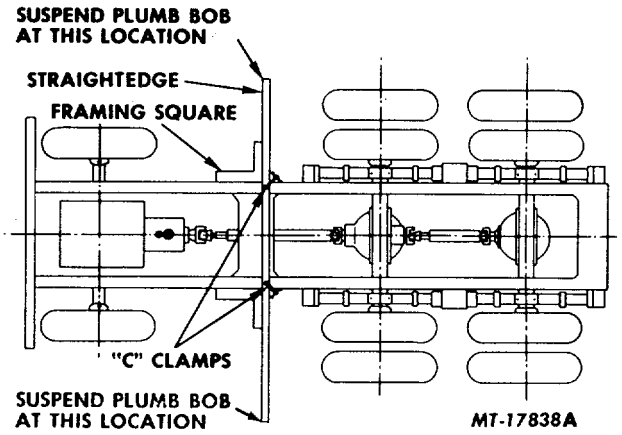
1. Clamp a straightedge to top of frame rail ahead of forward rear able. Use a framing square against straightedge and outside surface of frame sidemember to insure straightedge is perpendicular to frame, Fig. 1.



MT-17837

Fig. 1 Straightedge Location on Frame

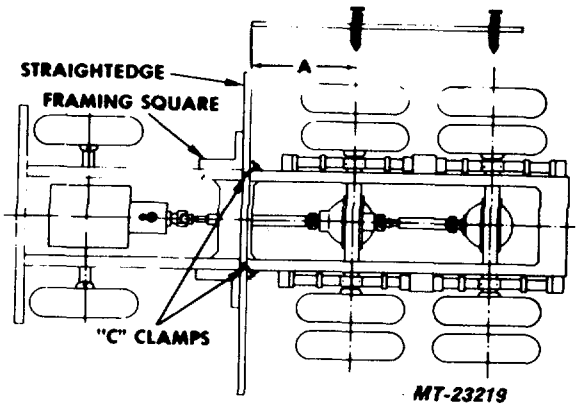
2. Suspend a plumb bob from the straightedge in front of the tire and on outboard side of the forward rear axle, Fig. 2.



MT-17838

Fig. 2 Plumb Bob Location

3. Position a slotted bar such that pointers are engaged in center hole of both rear axles.
4. Measure distance between cord of plumb bob and pointer on forward rear axle and record (dimension "A" in Fig. 3).



MT-23219

Fig. 3 Measure Dimension "A"

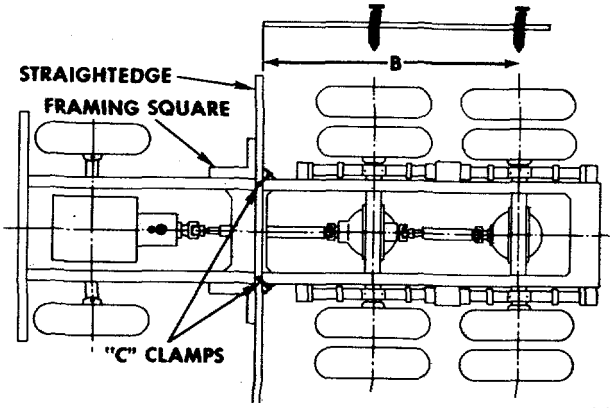
5. Position slotted bar on opposite side of vehicle with same pointer being used on forward rear axle for both sides and measure distance between cord of plumb bob and pointer on forward rear axle. Record dimension.
6. Any difference in dimensions from side to side must be equalized if difference exceeds 3.175 mm (.125 in.).

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7. Refer to the AXLE ADJUSTMENT portion of this chapter for procedures to equalize differences in dimensions which exceed 3.175 mm (.125 in.).

8. Position slotted bar one side of vehicle such that pointers are engaged in center hole of both rear axles.

9. Measure distance between cord of plumb bob and pointer on rear rear axle and record (dimension "B" in Fig. 4).



MT-23218

Fig. 4 Measure Dimension "B"

10. Position slotted bar on opposite side of vehicle with the same pointer being used on rear rear axle for both sides and measure distance between cord of plumb bob and pointer on rear rear axle. Record dimension.

11. Any difference in dimensions from side to side must be equalized if difference exceeds 3.175 mm (.125 in.).

12. Refer to AXLE ADJUSTMENT portion of this chapter for procedures to equalize differences in dimensions which exceed 3.175 mm (.125 in.).

13. It is recommended that vehicle be driven a short distance and alignment rechecked.

AXLE ADJUSTMENT

Hendrickson

The design of Hendrickson suspensions does not provide for axle adjustment for alignment purposes. If the axles are measured to be significantly out of alignment, the following areas should be investigated as the possible cause.

1. Severely worn walking beam center or end bushings.

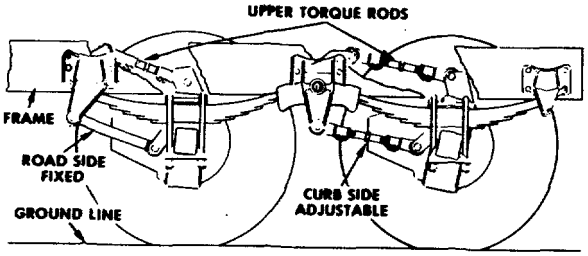
2. Worn spring pins.

3. Proper location of frame brackets on frame.

4. Any other worn or damaged parts.

Dayton Four-Spring

Adjustment of axle location for alignment purposes on the Dayton Four-spring suspension is accomplished by means of adjustable lower torque rods as shown in Fig. 5.



MT-17841

Fig. 5 Torque Rod Location

Adjust as follows:

1. Equalize dimension "A" in alignment procedure by loosening clamp bolts on the lower adjustable torque rod on forward rear axle and adjusting length of rod.

IMPORTANT

Before adjusting lower torque rods, remove one end of both upper torque rods to relieve any stress which may be present due to an improperly adjusted upper torque rod.

2. Retorque clamp bolts to specified torque.

3. Equalize dimension "B" in alignment procedure by loosening clamp bolts on lower adjustable torque rod on rear rear axle and adjusting length of rod.

4. Retorque clamp bolts to specified torque.

5. Upon completion of axle alignment the upper torque rods should be adjusted. Improper upper torque rod adjustment can impose unnecessary strain on vehicle crossmembers, torque rod mounting brackets and torque rods.

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Proceed as follows:

a. If not already disconnected, disconnect forward and rear upper torque rods at frame crossmembers.
b. If vehicle is equipped with an adjustable fifth wheel, place fifth wheel in normal operating position.
c. Apply maximum rated load on suspension assembly to obtain full deflection of leaf spring assemblies when adjusting torque rods.
d. To settle suspension to normal operating position, move vehicle to a level area bringing vehicle to an easy stop using trailer brakes only. Keep vehicle in a straight ahead position. Apply trailer parking brakes.
e. Loosen torque rod clamp bolts and lengthen or shorten torque rods as required to obtain bolt hole alignment permitting easy installation of torque rod end bolts.
f. Retorque mounting and clamp bolts to specified torque.

Reyco 101

Adjustment of the axle location for alignment purposes on the Reyco 101 suspension is accomplished by means of eccentric bushings located at the torque leaf mounting eyes.

1. Equalize dimension "A" in alignment procedure by loosening torque leaf bolt nuts enough to free rubber bushings in castings. Mark adjusting bolt, washer and front hanger with chalk or paint, Fig. 6. This provides a means of visually identifying eccentric bushing movement.

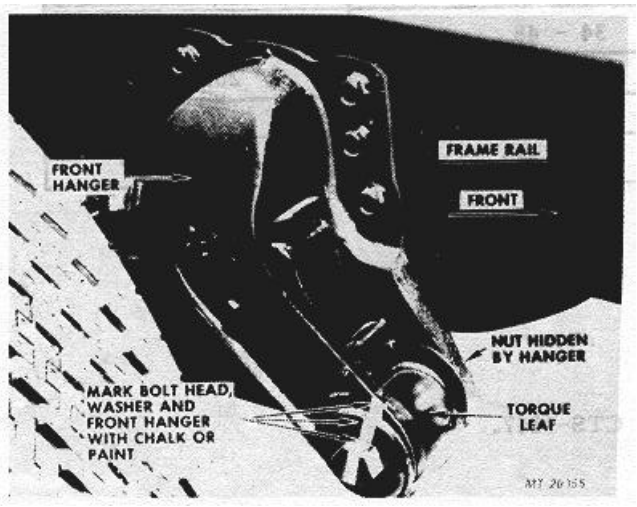


Fig. 6 Mark Eccentric Bushing

2. To adjust, place a crescent wrench on torque leaf bolt and turn bolt in the opposite direction of desired axle movement. Maximum adjustment is 11.11 mm (.4375 in.) on each side of axle.

3. After adjustment is made, tighten torque leaf bolt nuts to specified torque and recheck alignment dimensions on forward rear axle.

4. Equalize dimension "B" in alignment procedure by loosening torque leaf bolt nut at equalizer bracket enough to free rubber bushings in castings. Mark adjusting bolt, washer and equalizer bracket with chalk or paint, Fig. 7. This provides a means of visually identifying eccentric bushing movement.

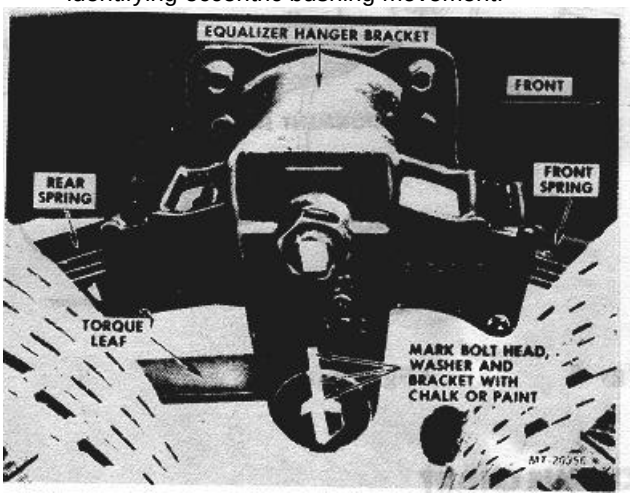


Fig. 7 Mark Eccentric Bushing

5. To adjust, place a crescent wrench on torque leaf bolt and turn bolt in the opposite direction of desired axle movement. Maximum adjustment is 11.11 mm (.4375 in.) on each side of axle.

6. After adjustment is made, tighten torque leaf bolt nuts to specified torque and recheck alignment dimension on rear rear axle.

Reyco 102

Construction of the Reyco 102 suspension is similar to that of the Dayton Four-Spring suspension with the exception of adjustable upper torque rods. Thus the adjustment procedure for the Dayton suspension excluding upper torque rod adjustment should be followed when aligning a Reyco 102 suspension.

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IH Four-Spring

Adjustment of the axle location for alignment purposes on the IH Four-Spring suspension is accomplished by means of shims installed at the torque rod end mounting.

1. Equalize dimension "A" in alignment procedure by installing or removing shims at the forward rear axle torque rod end mounting, Fig. 8. Installation of shims at the torque rod forward end mounting moves the axle forward. Installation of shims at the torque rod axle end mounting moves the axle rearward. Tighten torque rod mounting nuts to specified torque and check alignment dimensions on forward rear axle.

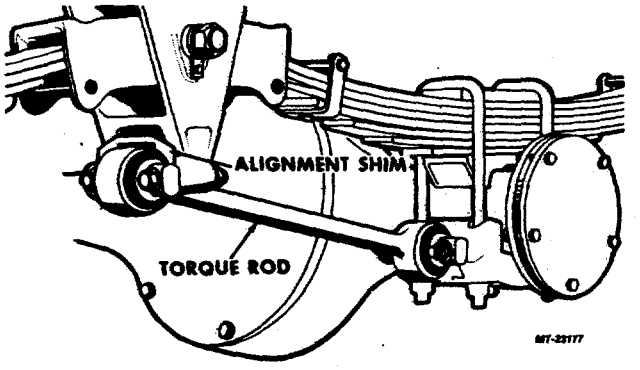


Fig. 8 Alignment Shim

IMPORTANT

Following installation of alignment shims. inspect the torque rod mounting nuts. A minimum of two threads of the mounting bolt must extend through the nut to allow the mounting nut locking feature to function properly.

IMPORTANT

When performing axle alignment it is preferred to have alignment shims installed at the torque rod forward mounting. However, if axle alignment cannot be obtained by installing shims at the forward mounting, it is permissible to install additional shims at the axle end mounting.

2. Equalize dimension "B" in alignment procedure by installing or removing shims at the rear rear axle torque rod end mounting, Fig. 8. Installation of shims at the forward end mounting moves the axle forward. Installation of shims at the torque rod axle end mounting moves the axle rearward. Tighten torque rod mounting nuts to specified torque and check alignment dimensions on rear rear axle.

   Adhere to the IMPORTANT notices in step 1 of this adjustment procedure.

TORQUE CHART

LOCATION	NEWTON METERS	(FT. LBS.)
Torque Rod Clamp Bolt Nuts (Dayton)	34-48	25-35
Torque Rod End Bolt Nuts (Dayton)	387-427	285-315
Torque Leaf Bolt Nuts (Reyco)	217	160
Torque Rod Mounting Bolt Nuts (IH)	271-325	200-240

SPECIAL TOOLS

SE-2050Torque Indicator Wrench (0-600 ft. lbs.)
SE-2059Torque Indicator Wrench (0-150 ft. lbs.)

For additional information, see Service Tool Manual CTS-1147.

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STEERING GEARS

GEMMER

IH Model	IH Code
S-108	05108
S-109	05109
S-161	05161
S-165	05165

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SPECIFICATIONS

IH MODEL	S-161	S-165	S-108	S-109
IH CODE	05161	05165	05108	05109
LEVERSHAFT DIAMETER MM.....	34.874 (1.373 in.) 34.899 (1.374 in.)			
LEVERSHAFT BUSHING DIAMETER (After Honing) MM.....	34.925 34.899 (1.375 in.) (1.374 in.)	34.899 34.976 (1.3745 in.) (1.3770 in.)	34.925 34.950 (1.375 in.) (1.376 in.)	44.437 44.500 (1.7495 in.) (1.7520 in.)
RUNNING CLEARANCE MM.....	.025 (.001 in.)	.013 (.0005 in.)	.038 (.0015 in.)	.064 (.0025 in.)
CAM PRELOAD* NEWTON METERS WITHOUT COLUMN SEAL....	.57-1.24 (5-11in.lbs.)	.57-1.13 (5-10in.lbs.)	.57-1.13 (5-10in.lbs.)	.79-1.58 (7-14in.lbs.)
WITH COLUMN SEAL.....	.79-1.58 (7-14in.lbs.)	.68-1.24 (6-11in.lbs.)	.68-1.24 (6-11in.lbs.)	1.02-1.81 (9-16in.lbs.)
LEVERSHAFT OR TOTAL PRELOAD* NEWTON METERS WITHOUT COLUMN SEAL....	1.81-3.16 (16-28in.lbs.)	1.58-3.16 (14-28in.lbs.)	1.58-3.16 (14-28in.lbs.)	2.26-3.50 (20-31in.lbs.)
WITH COLUMN SEAL.....	2.03-3.39 (18-30in.lbs.)	1.70-3.28 (15-29in.lbs.)	1.70-3.28 (15-29in.lbs.)	2.60-3.84 (23-34in.lbs.)
LUBRICANT CAPACITY.....	680 Grams (1 lb. 8 oz.)	510 Grams (1 lb. 2 oz.)	652 Grams (1 lb. 7 oz.)	510 Grams (1 lb. 2 oz.)

*Linkage Disconnected

TORQUE CHART (IN NEWTON METERS)

IH MODEL	S-161	S-165	S-108	S-109
IH CODE	05161	05165	05108	05109
LEVER SHAFT ADJUSTING SCREW JAM NUT.....	22-27 (16-20ft.lbs.)	22-27 (16-20ft.lbs.)	22-27 (16-20ft.lbs.)	27-34 (20-25ft.lbs.)
SIDECOVER TO HOUSING BOLT	41-48 (30-35ft.lbs.)	41-48 (30-35ft.lbs.)	41-48 (30-35ft.lbs.)	61-75 (45-55ft.lbs.)
LOWER COVER TO HOUSING BOLT	24-30 (18-22ft.lbs.)	24-30 (18-22ft.lbs.)	24-30 (18-22ft.lbs.)	61-75 (45-55ft.lbs.)
STEERING ARM CLAMP BOLT LUBRICATED..... DRY.....	109-122 (80-90 Ft. Lbs.) 136-163 (100-120 Ft. Lbs.)			
STEERING GEAR MOUNTING BOLTS	224-255 (165-188 Ft. Lbs.)			
STEERING GEAR MOUNTING BRACKET TO FRAME BOLTS...	76-87 (56-64 Ft. Lbs.)			

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DESCRIPTION

The steering gears covered in this section are of the triple roller levershaft design. The tube with cam assembly is supported on each end by tapered roller bearings or ball bearings. The levershaft assembly is supported on one side by the side cover and on the opposite end by a bushing pressed into the housing.

The tube with cam assembly preload is controlled by shims located between the lower cover and the housing. The levershaft lash adjustment is maintained by a screw located in the side cover.

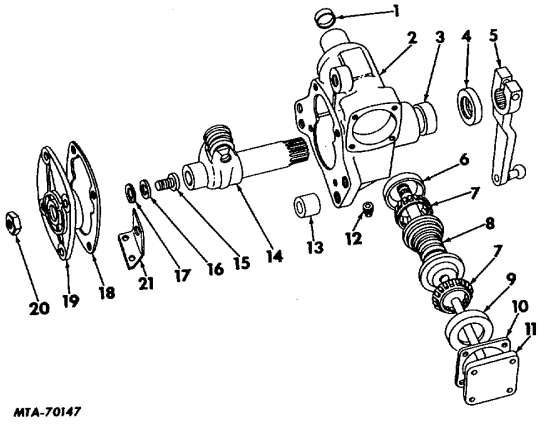


Fig. 1 Steering Gear (Exploded View Typical)

Legend for Fig. 1

Key	Description
1.	SEAL, housing upper oil
2.	HOUSING
3.	BUSHING, housing
4.	SEAL, housing side oil
5.	ARM, steering
6.	BEARING, upper cup
7.	BEARING, cone
8.	TUBE with cam
9.	BEARING, lower cup
10.	SHIM, housing lower cover
11.	COVER, housing lower
12.	PLUG, housing filler
13.	SPACER, steering gear mounting
14.	LEVERSHAFT
15.	SCREW, levershaft adjusting
16.	WASHER, thrust
17.	RING, snap
18.	GASKET, housing side cover
19.	COVER, housing side
20.	NUT, hex. jam
21.	BRACKET, steering gear mounting

DISASSEMBLY

1. Drain lubricant from steering gear.
2. Loosen steering arm clamp bolt.
3. Remove steering arm (5) from levershaft (14).
4. Remove levershaft adjusting jam nut (20) from adjusting screw (15).
5. Remove four bolts from housing side cover (19).
6. Lightly tap serrated end of levershaft (14) with soft mallet to break side cover (19) loose from housing (2).
7. Remove side cover (19) and gasket (18) from housing (2).
8. Remove levershaft (14) from housing (2).
9. Remove four bolts securing housing lower cover (11) to housing (2).
10. Remove cover (11) and shims (10) from housing (2).
11. Remove lower cam bearing cup (9) and bearing (7) by pressing on end of tube (8). NOTE: If bearing cup cocks do not use force, tap bearing cup in place and repeat procedure.
12. Remove tube with cam assembly (8) from housing (2).
13. Remove upper bearing cone (7).
14. Remove housing upper oil seal (1) from housing (2), using suitable puller.
15. Remove bearing cup (6) from housing (2), using suitable puller.
16. Remove housing side oil seal (4) from housing (2), using suitable puller.
17. Remove bushing (3) from housing (2), using proper adapter.

CLEANING, INSPECTION AND REPAIR

Use clean solvent to wash grease, oil and dirt from steering gear parts. Dry parts with compressed air being especially careful to avoid spinning bearings.

Careful visual inspection of the steering gear parts is very important. These visual checks may uncover conditions not evident during operation.

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Cam and Tube

1. Check the cam groove for chipping, scoring or brinelling.

2. Check condition of bearing surface on 0.D. at each end of cam.

3. Check cam roller bearings for wear.

4. Check condition of splines on stub shaft.

Levershaft

1. Check for burrs on splines, twisted splines, wear on bearing surfaces.

2. Check levershaft roller for nicks, flat spots, or spalling.

Housing

1. Check for strain at mounting flanges.

2. Check bushing in housing for wear or out-of round.

3. Check levershaft oil seal.

REASSEMBLY

1. Using proper adapter install levershaft bushing (3) into housing (2). Do not distort bushing. After installation, hone bushing to dimensions shown in "Specifications ".

2. Install new oil seal (4) in housing (2) using proper adapter.

3. Install oil seal (1).

4. Install bearing (6) to housing (2).

5. Position upper roller bearing cone (7) on tube with cam assembly (8).

6. Place tube with cam (8) into position in housing (2). NOTE: Do not damage seal lip with stub shaft serrations.

7. Install lower roller bearing (7) on tube with cam (8).

8. Install bearing cup (9) in housing (2).

9. Position shims (10) and housing lower cover (11) on housing. Secure with four bolts. Do not torque bolts immediately. Rotate tube with cam assembly with one hand while tightening bolts with the other hand to prevent damaging the bearing surfaces if the initial amount of shims is inadequate. Once a light preload is obtained, torque lower cover bolts. The worm preload should be as shown in "Specifications". If above or below this figure, add or remove shims accordingly.

10. Insert levershaft assembly (14) into housing (2). NOTE: Do not damage seal lip with levershaft serrations.

11. Position side cover (19) and gasket (18) to housing (2) and secure with four bolts, Tighten bolts to value shown in "Torque Chart ".

12. Install levershaft adjusting screw jam nut (20). NOTE: Do not tighten nut at this time.

13. Centralize the steering gear by turning tube with cam (8) through full travel and counting the number of turns. Starting at the end of travel, turn the tube back half this number of turns, placing the cam and roller in center position. Rotate the tube with a torque wrench approximately 1800 through center.

    NOTE: A 1.02 N-m (9 in. lbs.) minimum differential between cam preload and total preload should be maintained.

    The procedure for establishing levershaft or total preload is as follows:

    A. Loosen lock nut (20).

    B. Turn slotted adjusting screw (15) clockwise to increase preload.

    C. Turn slotted adjusting screw counterclockwise to decrease preload.

    D. Repeat procedure until total preload is within specified limits.

    E. Hold adjusting screw (15) in place and tighten x ., (20) to value shown in "Torque Chart".

14. Install steering arm (5) on levershaft (14). NOTE: Mark or steering arm to be in alignment with slot on levershaft, Fig. 2. Install steering arm retaining bolt and tighten to value shown in "Torque Chart".

CAM PRELOAD ADJUSTMENT (Gear in Vehicle)

Disconnect linkage from steering arm

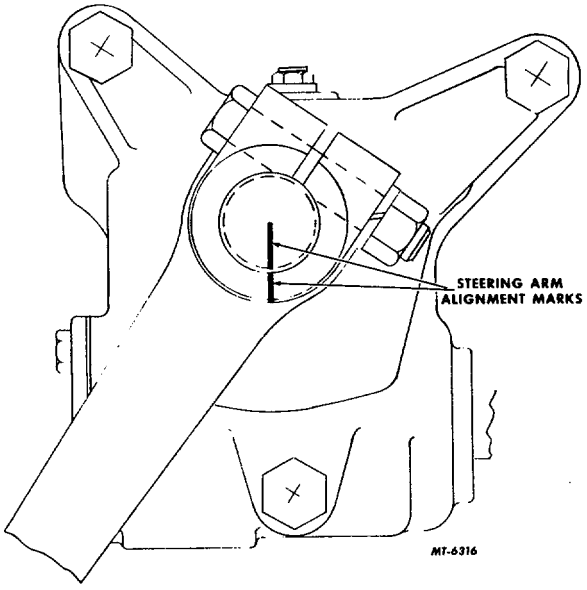


Fig. 2 Steering Arm Alignment Marks.

(5) for satisfactory inspection. Turn tube with cam (8) to end of travel in either direction. Note lash condition between levershaft (14) and tube with cam (8). In the lash area, check the cam bearing preload by rotating tube approximately one quarter of a turn. The torque required to turn tube should be as shown in "Specifications".

The procedure for correcting the cam preload is as follows:

1. Drain lubricant.
2. Remove four lower cover bolts.
3. Use a knife to separate the top shim. Remove only this shim, taking care not to mutilate the remaining shims.
4. Reinstall and tighten lower cover bolts to value shown in "Torque Chart".
5. Recheck preload.
6. Repeat procedure if necessary.
7. Refill with lubricant.

LEVERSHAFT OR TOTAL ADJUSTMENT (Gear in Vehicle)

1. Support front end of vehicle on floor stands.
2. Centralize the steering gear by turning tube with cam (8) through full travel and counting the number of turns. Starting at the end of travel, turn the tube back half this number of turns, placing the cam and roller in center position.

   Rotate the steering wheel approximately 180° through center. The preload should be as shown in "Specifications".

   The procedure for correcting levershaft or total preload is as follows:

A. Loosen lock nut (20).

B. Turn slotted adjusting screw (15) clockwise to increase preload.

C. Turn slotted adjusting screw counterclockwise to decrease preload.

D. Repeat procedure until total preload is within specified limits.

E. Hold adjusting screw (15) in place and tighten nut (20) to value shown in "Torque Chart".

F. Check lubricant level. Fill to plug level.

GENERAL INSPECTION

Jack up the front wheels of vehicle and inspect the linkage from the pitman arm to and including the wheel bearings for excessive lash.

Turn steering wheel about one turn to right from straight ahead driving position. Secure in this position to prevent any oscillation when front wheels are shaken violently. Shake front wheels from side to side. This will enable any end play in cam bearings to be felt at steering wheel hub. If any end play exists, cam bearings need adjusting.

NOTE: Be sure end play is felt and not confused with play or give in upper column bearing.

Cam bearing adjustment should be correct before further inspection of gear is made.

LUBRICATION

For type of lubricant refer to Lubrication Section CTS-2412.

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STEERING GEARS

(ROSS)

IH Model	IH Code	IH Model	IH Code
S-3	05003	S-39	05039
S-11	05011	S-40	05040
S-13	05013	S-41	05041
S-15	05015	S-42	05042
S-21	05021	S-43	05043
S-23	05023	S-44	05044
S-25	05025	S-45	05045
S-26	05026	S-60	05060
S-31	05031	S-61	05061
S-33	05033	S-62	05062
S-34	05034	S-63	05063
S-35	05035	S-65	05065
S-38	05038		

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INTRODUCTION

The twin stud levershaft construction as outlined in this section is explained as follows.

Both studs of the twin lever gear engage the cam for normal straight-ahead driving. As the steering action moves away from the normal driving position into the parking range, one of the studs disengages the cam. The effective leverage of this single stud increases so rapidly, however, that in full parking the leverage is 45 percent greater than with a single stud type steering gear. Actually the driver has at his disposal a dual ratio gear which automatically changes from one ratio to another to suit the requirements of steering stability at high speeds and easy wheel turn for sharp turns in parking. A valuable safety factor is a lessening of the tendency to oversteer on curves and when passing other vehicles at high speed.

The basic design of the steering gears used in these trucks is similar, and the method of servicing applies generally to all units used. For illustrative purposes, assemblies of the more common type are used. Except for position of the levershaft in the housing, the steering gear details are similar and are serviced in the same manner.

ADJUSTMENTS

When making adjustments, free the steering gear of all load.

1. Adjustment of Ball Thrust Bearings on Cam.

    a. Before making this adjustment, loosen the housing side cover adjusting screw (10) to free the studs in the cam groove (Fig. 1).

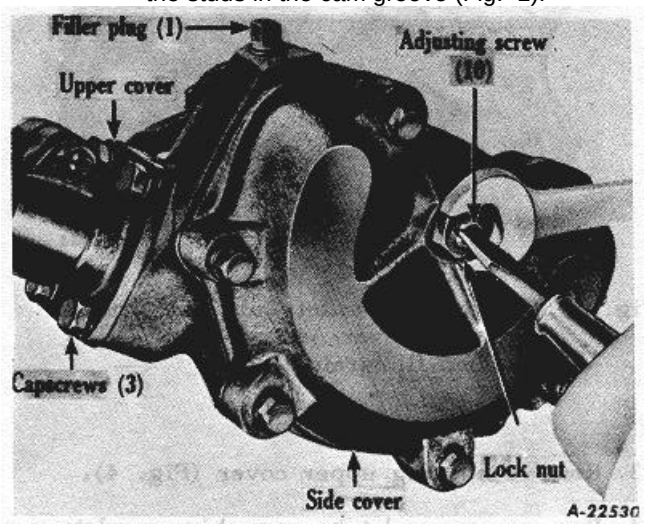


Fig. 1 Illustrates Location of Adjusting Screw and Locknut

    b. Adjustment should be made so there is a very slight drag but not so much that steering wheel cannot be turned from extreme left to extreme right by lightly gripping with thumb and forefinger.

    c. Loosen the four screws (3)(Fig. 1) and raise the housing upper cover to permit removal of shims (Fig. 2).

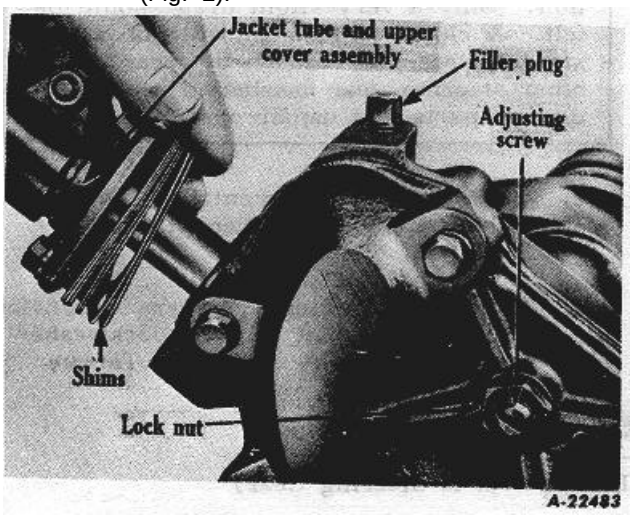


Fig. 2 Showing Location of Shims Under Upper Housing Cover Used to Adjust End Play on Cam

    d. Cut and remove a thin shim or more as required and draw cover down tight against shims.

    e. Test as outlined in paragraph "b" and if necessary, remove or replace shims until adjustment is correct.

2. Adjust Levershaft Studs in Cam Groove for Backlash.

    a. Backlash at this point shows up as end play of levershaft, also as backlash at steering wheel and at ball on steering arm.

    b. The groove is purposely cut deeper in ends of cam than in mid-position. This produces a high range through midposition and makes grooves narrower through this range. This permits take-up of backlash in mid-position after normal wear of groove without causing a bind in ends (Fig. 1).

    c. Adjust to this mid-position high range. Do not adjust in end positions. Play in end position is not objectionable.

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d. Tighten side cover adjusting screw (10) until a very light drag is felt through the mid-position high range when turning steering wheel slowly from extreme left to extreme right positions (Fig. 1).

IMPORTANT

Steering gear must not bind in any position. Only a very slight drag should be felt. A closer adjustment will not correct steering looseness caused by wear in other steering gear members, but will damage parts and impair operation.

e. When proper adjustment has been made, tighten locknut and then give gear a final test.

f. Make sure steering gear arm is tight on splined levershaft and that lockwasher and nut are tight also. See Torque Chart.

Torque Chart
(Pitman Arm to Steering Gear)

Bolt Size	Torque N.m
1/2 Hex Hd	102-115 (75-85 ft. lbs.)
5/8 Hex Hd	217-237 (160-175 ft. lbs.)
5/8 Flanged Hd	298-325 (220-240 ft. lbs.)

3. Steering Column Alignment.

After adjustments have been made and lockscrew tightened, turn steering wheel to see if any stiffness exists. If so, steering gear has been adjusted too tightly or steering column is out of alignment. Misalignment of the column places a bend in the column; consequently, the wheel tube must undergo reverse bending stresses during each revolution. This is a serious condition and must be avoided. THE STEERING COLUMN MUST NOT BE SPRUNG IN ANY DIRECTION. (This does not apply to jointed column type gears; however, the stud-shaft must not be sprung either.)

DISASSEMBLY AND REASSEMBLY

Disassembling Steering Gear (Not S-21 or S-31 Steering Gears).

1. Remove housing side cover and pull out levershaft (Fig. 3).

2. Loosen clamp collar and remove jacket tube (Solid column only)(Fig. 4).

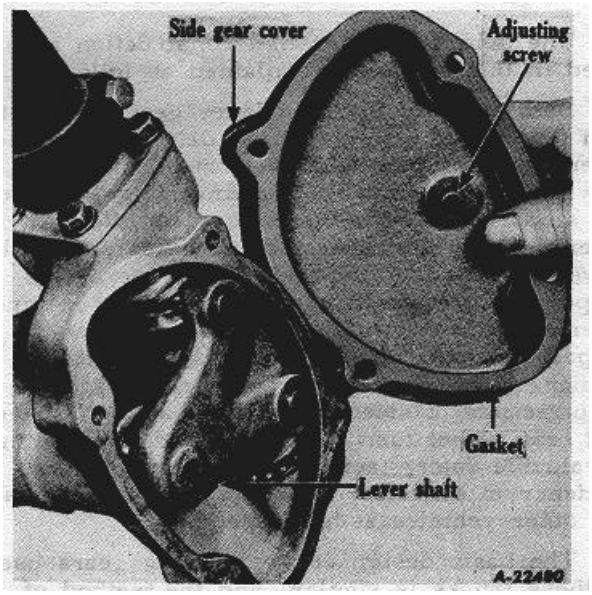


Fig. 3 Removal of Housing Side Cover Revealing Levershaft

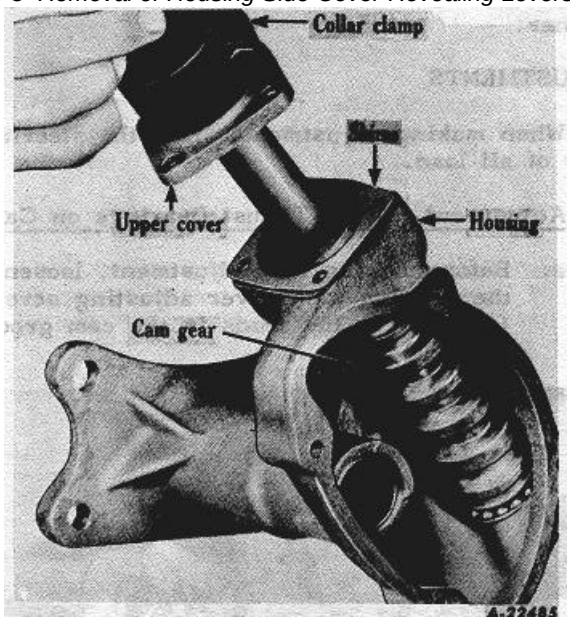


Fig. 4 Removal of Jacket Tube and Upper Housing Cover Assembly-Solid Column Illustrated.

3. Remove housing upper cover (Fig. 4).

4. Remove cam and tube assembly complete with bearings from housing (Fig. 5).

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5. Remove levershaft oil seal and clean the counterbore in the gear housing.

6. Remove levershaft bushings if worn or damaged.

Reassembling Steering Gear (Not S-21 or S-31 Steering Gears).

1. Install new levershaft bushings and seal. Position oil seal in housing with side stamped "Fluid Side" toward bottom of counterbore. Using hammer, tap lightly on end of socket wrench or adapter (cold rolled stock) having a slightly smaller outside diameter than oil seal. It is important that seal bottoms in counterbore of housing (Fig. 6).

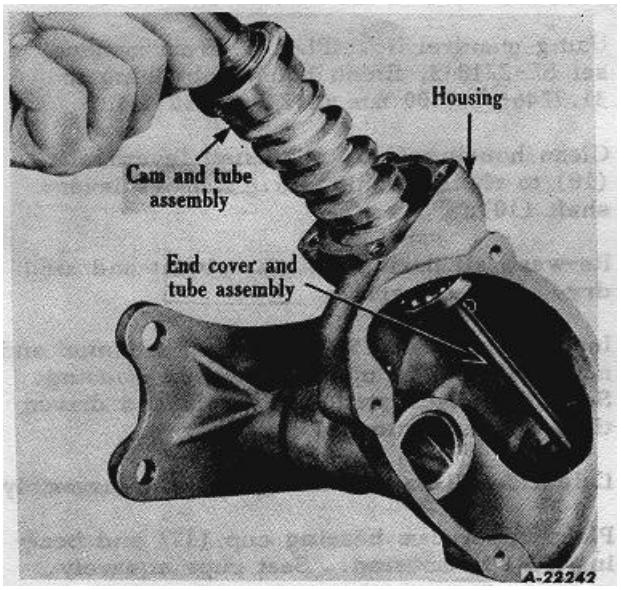


Fig. 5 Removing Cam and Tube Assembly with Bearings

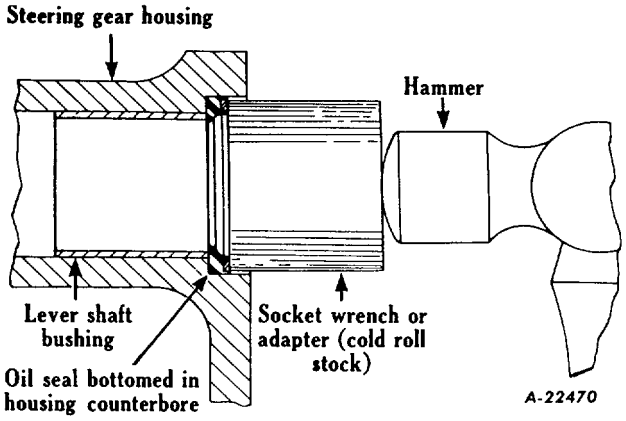


Fig. 6 Location and Installation of Levershaft Oil Seal

2. Place cam and tube assembly with bearings in the housing (Fig. 5).

3. Assemble housing upper cover with shims and make proper bearing adjustments.

4. Install levershaft in housing and assemble housing side cover, first loosening the adjusting screw (Fig. 3). Draw side cover screws tight.

5. Adjust levershaft stud in cam groove for backlash and lock adjustment with lock nut.

Disassembly (S-21 and S-31 Only) Refer to Fig. 7

Replacement of the levershaft bushing (16) in the housing must be done in conjunction with installation of new side cover assembly and dowel bolts.

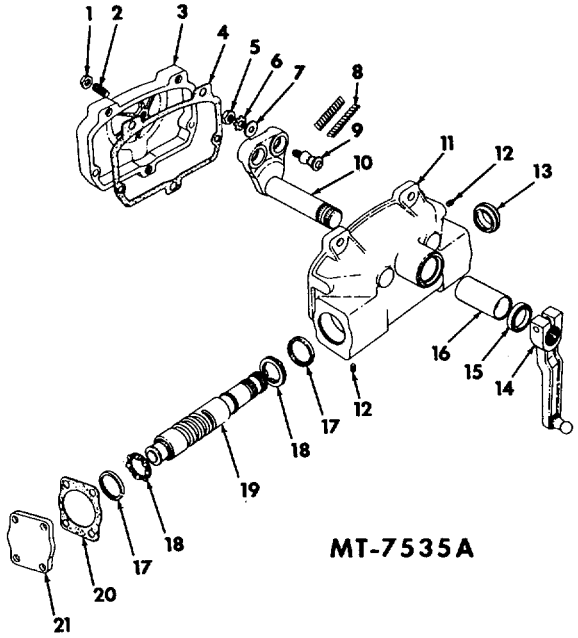


Fig. 7 Exploded View

Legend for Fig. 7

1. NUT, adjusting
2. SCREW, adjusting
3. COVER, side
4. GASKET, side cover
5. NUT
6. WASHER, pronged
7. WASHER
8. BEARING, lever-shaft roller
9. STUD w/BEARINGS
10. LEVERSHAFT
11. HOUSING
12. PLUG
13. SEAL, housing
14. ARM, steering
15. SEAL, oil housing
16. BUSHING
17. CUP, bearing
18. BEARING
19. CAM
20. GASKET
21. COVER. end

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1. Remove steering gear from chassis and clean exterior.
2. Drain lube from gear.
3. Remove side cover capscrews and free fit bolt.
4. Press out dowel bolts. Discard oil dowel bolts and side cover (3) if bushing is to be replaced.
5. Check portion of levershaft (10) extending through trunnion and remove all nicks or burrs with fine abrasive. Remove shaft from housing (11).
6. Remove four (4) capscrews from end cover (21).
7. Remove cover (12), shim pack (20), cam (19) and bearings (18).
8. Remove housing trunnion seal (15) and housing upper seal (13). Discard seals. Do not damage seal counterbore.
9. Wash all parts thoroughly in cleaning solvent and air dry before inspecting.

Inspection (S-21 and S-31 Only) Refer to Fig. 7.

1. Inspect cam (19) for any brinelling from shock loads.
2. Check bearing races on cams for corrosion, pitting or brinelling. Replace if necessary.
3. Inspect cam bearings (18) and cam bearing cups (17).
4. Inspect levershaft (10) for wear.
5. Check levershaft stud bearings (8) for smoothness and preload. Readjust if necessary.
   Levershaft stud and bearings must be rereplaced in pairs.

Levershaft Stud Bearing Preload Adjustment.

1. Stud bearings must be clean and lightly lubricated when adjustment is made.
2. Before adjustment, break off old lockwasher tangs which have been used or use new locking washers. Rotate stud several turns in each direction to seat properly before checking torque.
3. Adjust rolling torque with thrust nut to .282 to .678 N•m (2.5 to 6 in. lbs.). Bend one tang of locking washer up against hex nut flat.
   Stud may be restrained from rotating while thrust nut is adjusted by holding locking washer with spanner wrench or battery pliers.

Reassembly (S-21 and S-31 Only) Refer to Fig. 7.

1. Using a suitable driver, press old bushing (16) out of housing (11). If a correct size driver is not available, make one locally.
2. Press a new bushing (16) from trunnion side until it is 1.588-.794 mm (1/16-1/32 in) below bottom of oil seal counterbore. Use care to assure correct position and alignment of new bushing.
3. Using mandrel No. 4PL-1219 from mandrel set SE-2218-3, finish housing bushing to 31.7246-31.7500 mm (1.249-1.250 in).
4. Clean housing (11) and install levershaft (10) to check bushing fit. Remove levershaft (10).
5. Re-wash all parts in clean solvent and air dry. Inspect parts.
6. Install new seal (15) in housing trunnion and new seal (13) in upper portion of housing. Seals must be installed squarely and driven tight against bottom of counterbore.
7. Lubricate all parts with oil before reassembly.
8. Place upper cam bearing cup (17) and bearing (18) in housing. Seat cups squarely.
9. Install cam (19), lower bearing (18) and cup (17).
10. Assemble shims (20) and end cover (21) on housing (11),
11. Install capscrews and tighten finger tight,
12. Rotate cam while tightening capscrews to 34-48 N•m (25-35 ft. lbs.).
13. Adjust cam bearing preload S-21 .226 to .678 N•m (2-6 in. lbs.) S-31, S-44 .452 to .904 N•m (4-8 in. lbs.) by adding or removing shims.
14. Install levershaft (10) in housing (11).
15. Assemble new gasket (4) and side cover (3) to housing (11) with capscrews. Tighten to 34-48 N•m (25-35 ft. lbs.).

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16. Install free fit bolt in boss and tighten to 115-136 N•m (85-35 ft. lbs.) torque.

17. Rotate cam (19) through travel to check for binding. If binding exists, loosen all bolts and cap screws. and retighten while rotating camshaft.

18. Using expansion reamer SE-1592-1 ream dowel bolt holes from housing side to 13-462-13.513 mm (.530-.532 in).

19. Press dowel bolts into position and torque to 115-136 N•m (85-100 ft. lbs.). Recheck gear for freedom of rotation through full travel.

20. Install side cover adjusting screw (2) and jam nut (1).

Adjust Levershaft Stud in Cam (Output Shaft Adjustment)

Loosen side cover adjusting screw jam nut. Oscillate cam through center of travel while turning adjusting screw clockwise. Turn adjusting screw in until a drag is felt across the center (high spot) of cam travel. Lock jam nut and recheck drag over center. Optimum adjustment is not less than .452 N•m (4 in. lbs.) increase over cam bearing preload or more than 2.034 N•m (18 in. lbs.) maximum.

LUBRICATION

For type of lubricant, refer to Lubrication, CTS-2412.

TROUBLE SHOOTING

Trouble	Possible Cause
Hard Steering	1. Low tire pressure. 2. Improper front end alignment. 3. Insufficient lubrication. 4. Bent steering knuckle or linkage. 5. Worn steering gear or linkage. 6. Steering column misaligned.
Loose Steering	1. Steering gear out of adjustment. 2. Worn tie rod ends.
Truck Wanders	1. Incorrect front end alignment. 2. Broken spring. 3. Tight steering gear or linkage. 4. Loose spring shackles. 5. Unequal tire inflation.
Truck Pulls to One Side	1. Dragging brake. 2. Tight or dry wheel bearing.
3. Unequal tire inflation.	
Shimmy (Low Speed)	1. Incorrect front end alignment. 2. Loose wheel bearings. 3. Weak or broken springs. 4. Worn tie rod ends. 5. Worn knuckle pins or bushings.
Shimmy (High Speed)	1. Unequal tire inflation. 2. Wheels or tires eccentric or out of balance. 3. Any of the possible causes for shimmy at low speed (see above).

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SPECIFICATIONS

IH Model	IH Code	Levershaft Diameter	Levershaft Bushing Diameter	Running Clearance	Lubricant Capacity
S-3	05003	25.3619 mm (.9985 in) / 25.3365 mm (.9975 in)	25.4000 mm (1.000 in) / 25.3746 mm (.9990 in)	.0127 mm (.0005 in) to .0635 mm (.0025 in)	.5386 kg (1 lb 3 oz)
S-11	05011	28.5369 mm (1.1235 in) / 28.5242 mm (1.1230 in)	28.5496 mm (1.124 in) / 28.5750 mm (1.125 in)	.0127 mm (.0005 in) to .0508 mm (.002 in)	1.004 kg (1 lb 14 oz)
S-13	05013	25.3619 mm (.9985 in) / 25.3365 mm (.9975 in)	25.4000 mm (1.000 in) / 25.3746 mm (.9990 in)	.0127 mm (.0005 in) to .0635 mm (.0025 in)	.5386 kg (1 lb 3 oz)
S-15	05015	28.5369 mm (1.1235 in) / 28.5115 mm (1.1225 in)	28.5750 mm (1.1250 in) / 28.5496 mm (1.1240 in)	.0127 mm (.0005 in) to .0635 mm (.0025 in)	.6803 kg (1 lb 8 oz)
S-21	05021	31.7119 mm (1.2485 in) / 31.6992 mm (1.2480 in)	31.7246 mm (1.249 in) / 31.7500 mm (1.250 in)	.0127 mm (.0005 in) to .0508 mm (.002 in)	.7938 kg (1 lb 12 oz)
S-23	05023	31.7119 mm (1.2485 in) / 31.6865 mm (1.2475 in)	31.7500 mm (1.2500 in) / 31.7246 mm (1.2490 in)	.0127 mm (.0005 in) to .0635 mm (.0025 in)	.7938 kg (1 lb 12 oz)
S-25	05025	34.8869 mm (1.3735 in) / 34.8615 mm (1.3725 in)	34.9250 mm (1.3750 in) / 34.8996 mm (1.3740 in)	.0127 mm (.0005 in) to .0635 mm (.0025 in)	1.021 kg (2 lb 4 oz)
S-26	05026	34.8869 mm (1.3735 in) / 34.8615 mm (1.3725 in)	34.9250 mm (1.3750 in) / 34.8996 mm (1.3740 in)	.0127 mm (.0005 in) to .0635 mm (.0025 in)	1.021 kg (2 lb 4 oz)
S-31	05031	31.7119 mm (1.2485 in) / 31.6992 mm (1.2475 in)	31.7246 mm (1.249 in) / 31.7500 mm (1.250 in)	.0127 mm (.0005 in) to .0508 mm (.002 in)	.7938 kg (1 lb 12 oz)
S-33	05033	38.0492 mm (1.498 in) / 38.0238 mm (1.497 in)	38.1000 mm (1.500 in) / 38.0476 mm (1.499 in)	.0254 mm (.001 in) to .0762 mm (.003 in)	1.644 kg (3 lb 10 oz)
S-34	05034	38.0492 mm (1.498 in) / 38.0238 mm (1.497 in)	38.1000 mm (1.500 in) / 38.0476 mm (1.499 in)	.0254 mm (.001 in) to .0762 mm (.003 in)	1.644 kg (3 lb 10 oz)

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SPECIFICATIONS

IH Model	IH Code	Levershaft Diameter	Levershaft Bushing Diameter	Running Clearance	Lubricant Capacity
S-35	05035	38.0492 mm (1.498 in) 38.0238 mm (1.497 in)	38.1000 mm (1.500 in) 38.0476 mm (1.499 in)	.0254 mm (.001 in) to to .0762 mm (.003 in)	1.644 kg (3 lb 10 oz)
S-38	05038	38.0619 mm (1.4985 in) 38.0492 mm (1.4980 in)	38.0619 mm (1.4985 in) 38.1000 mm (1.500 in)	.000 mm (.000 in) to to .0508 mm (.002 in)	1.927 kg (4 lb 4 oz)
S-39	05039	44.3992 mm (1.7480 in) 44.3865 mm (1.7475 in)	44.4500 mm (1.7500 in) 44.4264 mm (1.7490 in)	.0381 mm (.0015 in) to to .0508 mm (.002 in)	1.644 kg (3 lb 10 oz)
S-40	05040	44.3992 mm (1.7480 in) 44.3738 mm (1.7470 in)	44.4500 mm (1.7500 in) 44.4119 mm (1.7485 in)	.0127 mm (.0005 in) to to .0762 mm (.003 in)	2.892 kg (6 lb 6 oz)
S-41	05041	44.3992 mm (1.7480 in) 44.3738 mm (1.7470 in)	44.4500 mm (1.7500 in) 44.4119 mm (1.7485 in)	.0127 mm (.0005 in) to to .0762 mm (.003 in)	2.892 kg (6 lb 6 oz)
S-42	05042	44.3992 mm (1.7480 in) 44.3865 mm (1.7475 in)	44.4373 mm (1.7495 in) 44.4119 mm (1.7485 in)	.0127 mm (.0005 in) to to .0508 mm (.002 in)	2.892 kg (6 lb 6 oz)
S-43	05043	38.0492 mm (1.498 in) 38.0238 mm (1.497 in)	38.1000 mm (1.500 in) 38.0476 mm (1.499 in)	.0254 mm (.001 in) to to .0762 mm (.003 in)	1.644 kg (3 lb 10 oz)
S-44	05044	44.3992 mm (1.7480 in) 44.3865 mm (1.7475 in)	44.4119 mm (1.7485 in) 44.4373 mm (1.7495 in)	.0127 mm (.0005 in) to to .0508 mm (.002 in)	1.899 kg (4 lb 3 oz)
S-45	05045	41.2242 mm (1.6230 in) 41.1988 mm (1.6220 in)	41.2750 mm (1.6250 in) 41.2369 mm (1.6235 in)	.0127 mm (.0005 in) to to .0762 mm (.003 in)	2.579 kg (5 lb 11 oz)
S-60	05060	28.5369 mm (1.1235 in) 28.5242 mm (1.1230 in)	28.5750 mm (1.1250 in) 28.5496 mm (1.1240 in)	.0127 mm (.0005 in) to to .0508 mm (.002 in)	.7654 kg (1 lb 11 oz)
S-61	05061	31.7119 mm (1.2485 in) 31.6992 mm (1.2480 in)	31.7500 mm (1.2500 in) 31.7246 mm (1.2490 in)	.0127 mm (.0005 in) to to .0508 mm (.002 in)	.7938 kg (1 lb 12 oz)

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IH Model	IH Code	Levershaft Diameter	Levershaft Bushing Diameter	Running Clearance	Lubricant Capacity
S-62	05062	34.8869 mm (1.3735 in) 34.8742 mm (1.3730 in)	34.8742 mm (1.3750 in) 34.8996 mm (1.3740 in)	.0127 mm (.0005 in) to to .0508 mm (.002 in)	1.417 kg (3 lb 2 oz)
S-63	05063	38.0619 mm (1.4985 in) 38.0492 mm (1.4980 in)	38.1000 mm (1.5000 in) 38.0949 mm (1.4998 in)	.0330 mm (.0013 in) to to .0508 mm (.002 in)	1.644 kg (3 lb 10 oz)
S-65	05065	44.3992 mm (1.7480 in) 44.3865 mm (1.7475 in)	44.4246 mm (1.749 in) 44.4500 mm (1.750 in)	.0254 mm (.001 in) to to .0635 mm (.0025 in)	----------

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POWER STEERING GEARS
ROSS

IH Model	IH Codes
S-243	05243
S-253	05253
S-258	05258

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SPECIFICATIONS

IH Model	S-243, S-253, S-258
IH Code	05243, 05253, 05258
Levershaft Dia.	38.049 mm (1.498 in.) 38.024 mm (1.497 in.)
Levershaft Bushing Dia.	38.100 mm (1.500 in.) 38.075 mm (1.499 in.)
Running Clearance	.05 mm (.002 in.)
Lubricant Capacity	1.02 kg (2 lb, 4 Oz.)

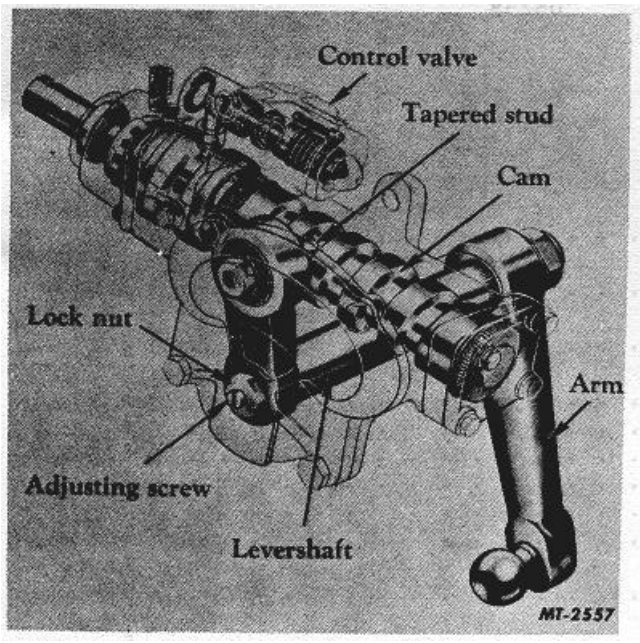


Fig. 1 Hydraulic Power Steering Gear With Integral Valve-Toggle Type.

DESCRIPTION

The gear, Fig. 1, is a semi-integral hydraulic steering gear which incorporates a hydraulic control toggle type valve on a single stud cam and lever mechanical steering gear.

OPERATION

The action of the steering gear is both manual and hydraulic in effect. When the cam is turned to the left or right, by the driver's effort on the steering wheel, the stud of the inner lever is moved through the groove of the cam (worm), thus rotating the levershaft and providing angular movement of the steering gear pitman arm. Whenever the driver's effort at the steering wheel exceeds the preload of the centering springs, the control valve is actuated and the hydraulic power is applied to provide the driver with power steering.

The valve spool is moved axially as the cam is moved axially although these parts are restrained from axial movement by the centering springs in the actuator. The effect of the springs is to center the actuator and valve spool (unless the steering force is great enough to overcome the spring load in which case the actuator and spool are moved axially).

When the valve is in the center position, the oil pressure at its two cylinder ports is low and equal and produces ineffective forces in the cylinder. This results in no movement of the piston and no circulation of oil in the lines to the cylinder, however, oil is circulating from the pump through the control valve to the reservoir with sufficient pressure only to overcome friction of lines and fittings.

Whenever the driver's effort at the steering wheel overcomes the centering effect of the springs, the valve spool is moved axially restricting one of the return passages to the outlet port thus causing an immediate increase in pressure at one of the cylinder ports and in one end of the cylinder. At the same time, the other return passage is enlarged, allowing the oil from the discharging end of the cylinder free passage to the outlet port and return to the reservoir. The immediate effect is increased pressure in one end of the cylinder to actuate the piston which applies hydraulic power directly to the steering gear pitman arm or linkage part to which

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the cylinder is attached. Full travel is obtained with a spool travel of about fifty thousandths of an inch. The slightest movement results in a pressure differential.

NOTE: To eliminate pump heat and belt squeal problems, the power cylinder should have unloading or poppet valves incorporated as a part of the cylinder piston assembly. In order that these valves will function correctly a correct installation must be made of the unit to allow the poppet to touch and the piston to bottom in each end of the cylinder at the extreme turn positions.

Whenever the effort at the steering wheel is released, the valve spool is returned to the center position.

If the steered wheels are subjected to shock loads, the pitman arm, acting through the inner arm of the gear, shifts the cam and control valve spool axially in the appropriate direction thus directing the fluid to the proper side of the piston to resist the shock forces.

This blocking action prevents kickbacks at the steering wheel.

The operation of the valve can be better understood by referring to Fig. 2, in which view "A" shows the valve in the centered position, view "B" and "C" show fluid flow for displacement of the spool for either left or right turn.

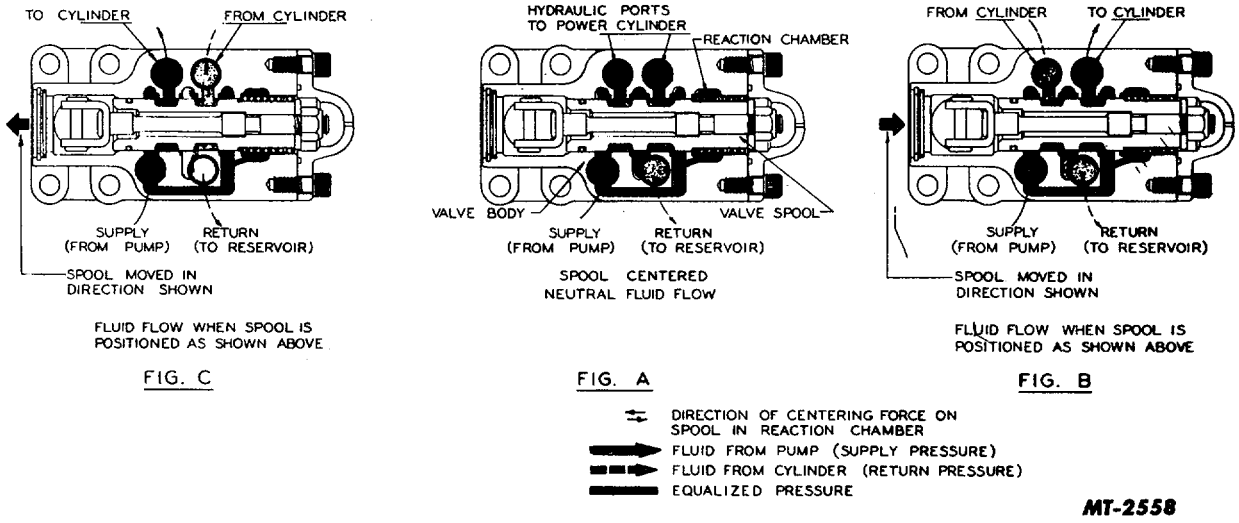


Fig. 2 Control Valve Operation.

ADJUSTMENTS

There are two principal adjustments on the steering gear and a supplemental adjustment on the stud-roller bearing unit in the levershaft. Neither of the adjustments is indexed, but can be set at the most desirable point.

Principal adjustments are:

1. Adjustment of needle thrust bearings on the camshaft on each side of the valve actuator.
2. Adjustment of tapered stud in cam groove for backlash.

The supplemental third adjustment on stud roller bearing unit is seldom required.

When making adjustments, free the steering gear of all load.

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Thrust Bearing

It is preferable to have the gear removed from the vehicle, but if the gear is readily accessible on the vehicle it may only be necessary to disassemble those parts which will permit the removal of the upper cover so that the adjusting nut on the camshaft is accessible. Adjust as follows:

1. Before adjusting thrust bearings turn gear off its center position to free the stud in the cam groove.

2. Remove clamp bolt, nut and lockwasher from yoke on stub shaft.

3. Remove yoke and joint assembly from stub shaft.

4. Remove woodruff key from stub shaft.

5. Remove capscrews holding upper cover and remove cover.

6. Reassemble screws in actuator housing with 9.5 mm (3/8 in.) thick spacers under heads of screws. This is to hold the actuator and cam assembly in the gear when making the adjustment.

7. Straighten prong of lockwasher. Remove adjusting nut, tongued washer, and upper thrust washers and thrust bearing.

8. Insure that the threads of the nut and camshaft are free of interference by running the nut onto the camshaft, using only the fingers to drive the nut. If the nut can not be driven all the way with finger torque, the threads are fouled and must be cleaned with a thread file or other means until the nut goes on freely.

9. Reassemble thrust washers and thrust bearing, tongued washer (with internal lug) and pronged washer (with thirteen external prongs), and adjusting nut.

10. Tighten adjusting nut to 14 N-m (10 ft. lbs.) torque. Back off nut 10°-20° which can be done by moving the nut relative to the pronged washer approximately 1-1/2 width of a lug. Observe lug nearest in alignment with a notch in the adjusting nut and bend the lug tight against the notch root.

11. Reassemble upper cover and jacket tube assembly and other parts to the gear.

Stud In Cam Groove

NOTE: Backlash of the stud in the cam groove shows up as backlash at steering wheel and at ball on steering arm.

The groove of the cam is purposely cut shallower, therefore, narrower in the midposition range of stud travel to provide close adjustment where usually the straight ahead driving action takes place.

Adjust through mid-position to the high spot. Do not adjust in an end position. Backlash in the end positions is normal and not objectionable.

A shim pack is used between the lever and housing to prevent the taper stud from being pulled into the cam groove by external forces on the levershaft. The shim pack consists of .08 mm (.003 in.) .25 mm (.010 in.) .51 mm (.020 in.) shims between two washers. When compressed solid the shim pack should be of sufficient thickness to hold the taper stud out of the cam groove but not so thick as to prevent adjusting to the high spot.

The adjustment procedure is as follows:

1. Tighten side cover adjusting screw until a very slight drag (high spot) is felt when turning the gear through mid-position. If the high spot can not be felt, remove shims from shim pack until it can. NOTE: Remove only enough shims to permit feel of high spot. When adjusted to positive high spot, back off adjusting screw 1/16 turn and lock adjustment with lock nut. Hold adjusting screw with screwdriver while tightening nut. See item 3.

2. If the high spot can be felt without removal of shims, additional shims may be needed in the shim pack. The only positive way of knowing is to add shims until high spot can not be felt then remove shims and adjust as outlined in item 1.

3. After adjustment is locked with lock nut, turn gear through full travel (extreme left turn to extreme right turn or vice versa) to check adjustment.

4. After this adjustment, reconnect the gear at all points loosened prior to making the adjustment. Also check tightness of mounting flange bolts and nuts, steering arm on levershaft, and nut on the levershaft.

Stud-Roller Bearing

The foregoing adjustments will suffice in nearly every instance, but in some cases it may be necessary to adjust the stud-roller bearing unit in the levershaft. In order to make this adjustment the shaft must be removed from the gear.

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The roller bearing should be preloaded at all times. Adjust to a noticeable drag.

Factory adjustments on new units are set to .11-.23 N•m (1-2 in. lbs.) of torque to revolve stud. Used or replacement units should also be set to approximately .11-.23 N•m (1-2 in. lbs.) of torque.

NOTE: Operation of a correctly adjusted unit may feel rough to the hands but under steering load it will be properly distributed, which will assure normal service life. The stud should be rotated several full turns and reversed before checking rolling torque.

Stud-Roller Bearing adjustment is made as follows:

1. Wash bearings in cleaning solvent and revolve stud to check for damage. Should any roller be damaged or lost, replace with a complete new set. Do not make a partial replacement.

2. Use a new locking washer. (If old washer must be used, break off bent prong to prevent using again).

3. Tighten stud nut to .34 N-m (3 in. lbs.). (Hold stud from turning by using spanner wrench or washer.)

4. Revolve stud several complete turns and reverse and test adjustment.

5. Lock adjustment by bending over locking washer prong that is at right angle to a side of the nut. Do not use the washer twice unless the prong used has been removed.

6. Lubricate stud-roller bearing with same lubricant as used in gear.

Control Valve

There is no adjustment on this control valve, Fig. 3, however, when clamped to the actuator housing the spool of the valve must not be pulled off center. See item 8 for proper mounting procedure listed under "Reassembly of Control Valve".

Column Alignment

Where universal joints are used in the steering column the possibilities of binding in the column are remote. However, the main point to remember is that steering column must not be sprung in any direction from its free position. A bind in the wheel tube due to column misalignment will prevent the control valve spool from centering in neutral position. NOTE: The stub-shaft must not be sprung either.

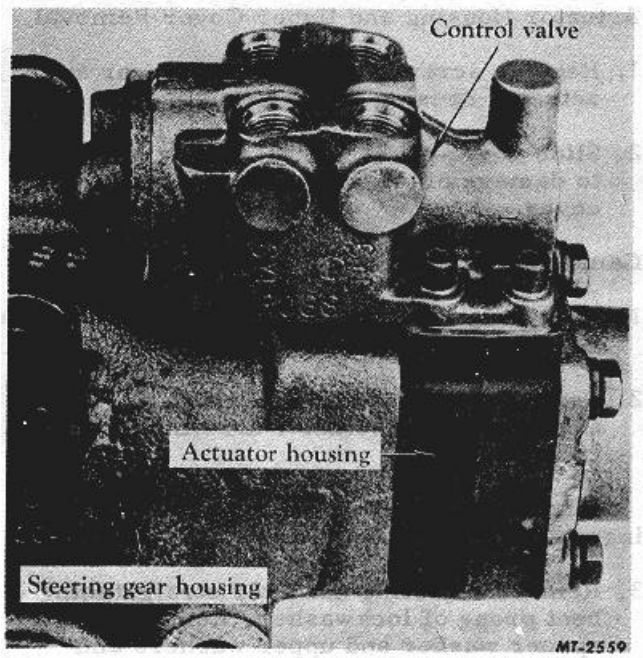


Fig. 3 Control Valve Mounted On Steering Gear.

GEAR REMOVAL

Before removing a gear, always note the hook-up of the hydraulic lines. Identify by tagging connecting lines and marking the valve ports into which each connects.

GEAR DISASSEMBLY

Levershaft Removal

1. Loosen lock nut and unscrew adjusting screw a few turns.

2. Remove housing side cover.

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3. Slide levershaft from housing having first made sure there are no burrs on the outer end of shaft to damage the bushing and seal in the housing. Keep shim pack intact,

Control Valve Removal

1. Remove four screws holding valve to actuator housing and remove valve.

   NOTE: For disassembly of valve see cleaning and inspection, items 1 through 7 under heading "Control Valve Disassembly".

2. Pull out actuator lever.

Actuator Housing and Upper Cover Removal

1. Remove screws holding upper cover and actuator housing to gear housing.

2. Slide cover off camshaft, taking care not to damage oil seal in counterbore of upper cover.

Cam and Tube Assembly Removal

1. Unlock actuator retainer screw and remove actuator housing.

2. Remove whole assembly of cam and stub shaft and valve actuator assembly as a unit from housing.

Further disassembly of actuator and bearings can be made as follows:

3. Remove adjusting nut after straightening bent prong of lockwasher. Remove tongued spacer washer and upper washers and needle bearing.

4. Remove upper centering washer from end of actuator and remove actuator being careful not to lose springs that are in the actuator.

5. Remove lower centering washer, thrust washer and needle bearing.

CLEANING AND INSPECTION

Use clean solvent to wash grease, oil, and dirt from all metal parts of the steering gear. Highly machined parts should be cleaned individually to avoid damage due to bumping together of parts. Lint free cloths should be used in the cleaning of valve ports. Dry other parts with compressed air being especially careful to avoid spinning bearings,

Because solvents are likely to deteriorate rubber parts, these should be cleaned by wiping away dirt or grease accumulations with a clean cloth or shop towel.

A careful visual inspection of all steering gear parts is most important. Special note should be made on the following.

Cam and Tube

1. Check the cam groove for chipping, scoring or brinelling. (The cam is copper plated for initial service. The operation of the stud in the cam groove will wear away the copper plating. This is a normal condition.)

2. Check condition of bearing surface on O.D. at each end of cam,

3. Check condition of splines and threads on stub shaft.

Levershaft

1. Check for burrs on splines, twisted splines, wear on bearing surfaces.

2. Check levershaft stud for nicks, flat spots, or spalling.

3. Check adjustment of stud-roller bearing.

Housing

1. Check for strain at mounting flanges.

2. Check condition of needle bearing in each end of housing.

3. Check fit of cam in needle bearings.

4. Check bushings in housing for wear or out-of-round.

5. Check levershaft oil seal,

Miscellaneous Parts

Inspect all other parts carefully, giving special attention to spline in steering arm and the steering arm ball. Replace all defective parts,

CONTROL VALVE DISASSEMBLY

NOTE: The valve is the control center of the hydraulic system. The major parts, which are the body and spool, are machined to very close limits and with precision machined edges. The spool and valve body are selectively fitted according to size of O.D. of spool and I.D. of body, therefore, these two parts are not supplied separately. If either needs replacing, the whole valve assembly

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must be replaced. Good performance of power steering is not assured if "mismatched" spool and body are used.

Care should be exercised in the handling of the parts to prevent damage. Sealing edges of the valve sleeve and the spool should not be broken. The result would be excessive leakage and reduced hydraulic power.

1. Remove retainer ring, cover plate, and 0-ring seal.
2. Remove end cover and O-ring seals from valve body.
3. Remove elastic stop nut and washer from end of flexure rod and pull flexure rod out of spool.
4. Push spool out in same direction to permit removal of centering washers, O-ring, and centering spring.
5. Remove O-ring from spool. (Use pointed instrument but be careful not to damage seal).
6. By-pass valve parts, plug assembly, spring, and ball, may be removed, if desired.
7. Inspect spool. Inspect body internally. Check for scoring due to dirt in the system. It is impractical for the mechanic to measure wear. Wear should be negligible because the spool operates in circulating oil.

GEAR REASSEMBLY

Before reassemblying the steering gear, obtain replacements for all defective parts. Make sure replacement parts are also inspected carefully. Use new gaskets and seals throughout.

1. If needle bearings in ends of housing have been removed, replace them. Take care not to press bearing too hard against retaining ring.
2. Pre-assemble actuator assembly on cam and stub shaft and adjust.
   (a) First insure that the threads of the nut and camshaft are free of interference by running the nut on to the camshaft using only the fingers to drive the nut. If the nut cannot be driven all the way with finger torque, the threads are fouled and must be cleaned with a thread file or other means until the nut goes on freely.
   (b) Assemble needle bearing over stub shaft and seat against upper end of cam.
   (c) Assemble other parts in this order:
      1. Thrust washer.
      2. Centering washer.
      3. Actuator.
      4. Springs in actuator.
      5. Centering washer.
      6. Thrust washer.
      7. Needle bearing.
      8. Thrust washer.
      9. Tongued washer.
      10. New lock washer (with thirteen external lugs).
      11. Adjusting nut.
   (d) Adjust bearings as outlined under "Thrust Bearing".
3. Assemble cam in housing. Be certain cam rotates and oscillates freely in housing.
4. Assemble gasket to top of housing.
5. Assemble actuator housing over actuator.
6. Position actuator housing for location of valve mounting. Assemble retainer screw and washer. Be sure screw engages horizontal slot in actuator.
7. Assemble gasket to actuator housing.
8. Assemble upper cover.
9. Fasten upper cover and actuator housing to gear housing with long mounting screws.
10. Assemble shim pack to levershaft and install shaft in housing. Use care not to damage oil seal in end of housing trunnion.
11. Assemble gasket and side cover to housing.
12. Assemble adjusting screw and lock nut.
13. Adjust screw in side cover per "STUD IN CAM GROOVE".

CONTROL VALVE REASSEMBLY

1. Assemble O-ring on spool.
2. Assemble spool in valve body, being sure end with O-ring is toward clevis end of valve. When assembling spool in body a twisting motion applied to the spool will be helpful. Before assembling, be sure all parts have been thoroughly cleaned. Light lubricating oil should be applied to spool and 0-rings.

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3. Assemble into the body: centering washer, spring, centering washer, O-ring, centering washer.

4. Assemble flexure rod in spool.

5. Assemble washer and nut to flexure rod and tighten nut to 14.1-16.9 N•m (125-150 in. lbs.) torque.

6. If by-pass valve parts were removed, replace O-ring on plug before reassembling in body. Assemble ball, spring and plug in body.

7. Assemble actuator lever in actuator housing making sure stud end of lever seats in groove of actuator and position slot in other end of lever so that pin in clevis of flexure rod will fit freely into it when mounting valve.

8. Place gasket on actuator housing and mount valve making sure clevis pin fits freely into slot of actuator lever. Start all four mounting screws and tighten lightly in rotation before applying the final tightening torque of 14-20 N•m (10-15 ft. lbs.). Careless tightening may cause valve spool to be pulled off center by actuator lever interference with clevis pin.

9. Be sure spool actuates (moves axially in both directions) before assembling end covers. This can be done as follows:

    a. Place steering gear arm on levershaft.

    b. Move steering arm against stop.

    c. Apply sufficient effort to actuate spool.

    d. Reverse arm against opposite stop to actuate in other direction.

10. Assemble O-rings on end of body and assemble end cover and tighten to valve body.

11. Assemble O-ring, cover plate, and retaining ring.

GEAR INSTALLATION IN CHASSIS

While there may be slight variations for installing the steering gear on the different models the general procedure will be as follows:

1. Place steering gear on frame side rail and fasten securely.

2. Place woodruff key in stud end of steering gear and install yoke on steering gear stub shaft. Secure with bolt and nut.

3. Center steering gear. Count number of turns of steering wheel from extreme left turn to extreme right turn. Turn the wheel back half this number of turns to the mid-position.

4. Set the front wheels straight ahead, parallel with the frame rails. To insure this wheel position, measure from each rail to a corresponding point on each tire and note that dimension is the same on both sides.

5. Install steering arm on levershaft. If arm and shaft splines do not align, turn steering wheel left or right 1/4 turn until they do. Tighten clamp bolt to 169-203 N•m (125150 ft. lbs.).

6. Connect drag link to ball on steering arm.

7. Install hydraulic lines to control valve.

8. Fill steering gear housing with lubricant.

FILLING AND BLEEDING THE SYSTEM

1. Fill reservoir with fluid to indicated level. Replace cap.

2. Start engine and idle turning wheels to full left and right three times. Shut off engine and refill reservoir.

3. Repeat operation in step 1"2" but run engine at faster speed for approximately five minutes. This will bleed system of air. Refill reservoir to indicated level.

LUBRICATION

For lubricant type refer to Lubrication Section CTS-2412.

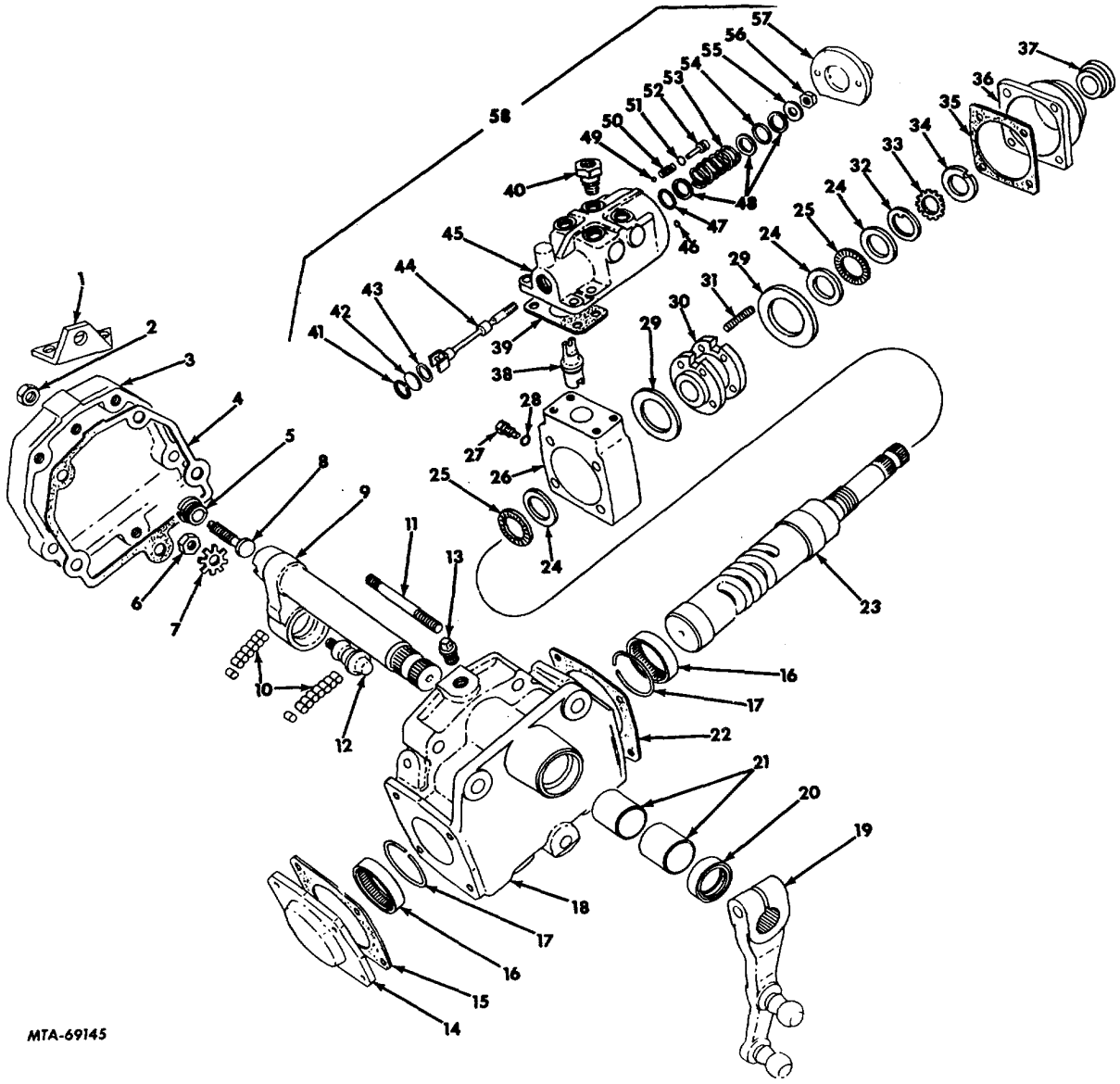


Fig. Exploded View of Steering Gear and Valve Assembly W/Jointed Column.

Key	Description
1.	BRACKET, steering gear mounting
2.	NUT, adjusting screw
3.	COVER, side
4.	GASKET, side cover
5.	RETAINER, adjusting screw
6.	NUT, levershaft stud
7.	WASHER, lock
8.	SCREW, adjusting
9.	LEVERSHAFT
10.	BEARING, (Not Serviced Separately)
11.	STUD, housing
12.	STUD, levershaft
13.	PLUG, housing vent
14.	COVER, lower housing
15.	GASKET, lower housing cover
16.	BEARING, needle cam
17.	RING, snap
18.	HOUSING PLUG, hex-hd 3/8
19.	ARM, steering
20.	SEAL, housing oil
21.	BUSHING, housing

Legend for Fig. 4 (Continued)

Key	Description
22.	GASKET, actuator to housing
23.	TUBE
24.	WASHER, thrust
25.	BEARING, thrust
26.	HOUSING, actuator
27.	BOLT, actuator adjusting
28.	WASHER, lock
29.	WASHER, centering
30.	ACTUATOR, steering gear valve
31.	SPRING, actuator valve
32.	WASHER, tongued
33.	WASHER, lock thrust
34.	NUT, slotted bearing lock
35.	GASKET, upper cover
36.	COVER, upper housing
37.	SEAL, upper housing oil
38.	LEVER, actuating valve
39.	GASKET, control valve
40.	CONNECTOR, hose to valve
41.	RING, valve end plate retaining
42.	PLATE, valve end
43.	SEAL, valve end plate O-ring
44.	ROD, valve
45.	HOUSING (Not Serviced Separately)
46.	SEAL, valve upper cover O-ring
47.	SEAL, valve spring lower O-ring
48.	WASHER, valve centering
49.	BALL, steel
50.	SPRING, valve plug relief
51.	SEAL, valve plug O-ring
52.	PLUG, relief
53.	SPRING, valve
54.	SEAL (Not Serviced Separately)
55.	RETAINER, O-ring seal
56.	NUT, hex. lock 5/16 NF
57.	COVER, valve end
58.	VALVE, control, assy.
	WASHER, lock 5/16 medium

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STEERING GEARS

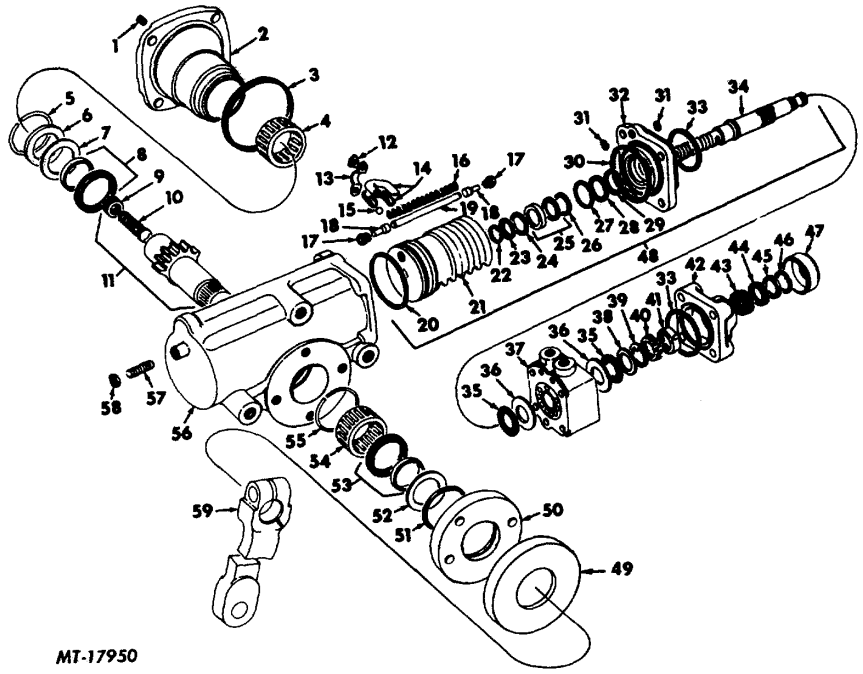
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Model	Code
S-266	05266
S-276	05276
S-299	05299

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Legend for Fig. 1

Key	Description	Key	Description
1	PLUG, Vent	30	SEAL, O-Ring
2	COVER with BEARING, SEAL and RETAINER	31	SEAL, O-Ring
		32	ADAPTER, Gear Cover
3	SEAL, O-Ring	33	SEAL, O-Ring
4	BEARING	34	SHAFT
5	RING, Retaining	35	BEARING, Thrust
6	WASHER, Backup, Outer	36	WASHER, Thrust
7	WASHER, Backup, Inner	37	VALVE, Steering Gear
8	SEAL with RING, Shaft	38	WASHER, Thrust
9	RETAINER, Adjusting Screw	39	WASHER, Tongued
10	SCREW, Adjusting	40	WASHER, Lock
11	SHAFT with SCREW, Adjusting	41	NUT, Lock
12	CLIP, Lock	42	COVER with BEARING
13	CLIP, Guide	43	BEARING, Needle
14	GUIDE, Ball Retainer	44	SEAL, Bearing
15	BALL	45	SPACER, Bearing
16	SPRING, Poppet	46	RING, Retainer
17	SEAT, Poppet Valve	47	SEAL, Boot
18	VALVE, Poppet	48	PISTON with WORM, ADAPTER & COVER
19	ROD, Poppet Valve	49	BOLT, Trunnion Housing
20	RING, Piston	50	RETAINER with SEAL
21	PISTON	51	SEAL, O-Ring
22	RING, Retaining	52	WASHER, Backup
23	WASHER, Retaining Ring	53	SEAL, Shaft
24	WASHER, Seal Retaining	54	BEARING, Needle
25	SEAL, Oil	55	RING, Retainer
26	WASHER, Seal Retaining	56	HOUSING with BEARING and RETAINER
27	RING, Retaining	57	SCREW, Adjusting
28	SEAL, Oil	58	NUT, Jam
29	WASHER, Backup	59	ARM, Steering Gear

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DESCRIPTION

These units are fully integral steering gears incorporating a hydraulic control valve, a power cylinder and a mechanical means of steering control. The power of the cylinder is transmitted to the steering gear output shaft by means of gear teeth on the piston mating with gear sector on the output shaft. The flow of oil from the pump is directed to the power cylinder via the control valve. The valve is located concentric with the input shaft. Fig. 2 illustrates the power steering gears described herein.



Fig. 2

OPERATION

The action of the steering gear is both manual and hydraulic in effect. When the input shaft is turned, by the driver's effort on the steering wheel, the piston is caused to move by the interaction of balls spaced between an external groove on the shaft and an internal groove inside the piston. Whenever the driver's effort at the steering wheel exceeds the force of the centering springs and the "hydraulic reaction" provided by the control valve, the valve is actuated and the power of the system is applied to provide the driver with power steering. Power steering control valves (see Fig. 3) generally utilize the hydraulic pressure in the steering system to urge the valve spool to its neutral position. This is called "hydraulic reaction. " As the pressure in the hydraulic cylinder builds up, the hydraulic centering force increases. Thus, the driver's effort on the steering wheel, in turning a corner, is greater than for a straight-ahead road correction. Because the hydraulic pressure is low in the straight-ahead driving, it is necessary to add centering springs to assist the valves hydraulic reaction in giving the system "road feel. " The feel and steering effort created by the centering springs is constant for any steering condition.

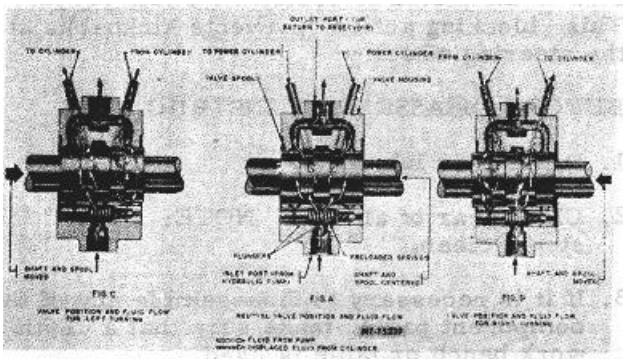


Fig. 3

When the valve is in the center position, the oil pressure at its two cylinder ports is low and equal and produces ineffective forces in the cylinder. This results in no movement of the piston and no circulation of oil in the lines to the cylinder; however, oil is circulating from the pump through the control valve to the reservoir with sufficient pressure only to overcome friction of lines and fittings.

Whenever the driver's effort at the steering wheel overcomes the valve centering springs and hydraulic reaction, the valve spool is moved axially restricting one of the return passages to the outlet port, thus causing an immediate increase in pressure at one of the cylinder ports and in one end of the cylinder. At the same time, the other return passage is enlarged, allowing the oil from the discharging end of the cylinder free passage to the outlet port and return to the reservoir. The immediate effect is increased pressure in one end of the cylinder to actuate the piston, thereby applying hydraulic power directly to the steering gear pitman arm. The slightest movement of the valve spool from center position results in a pressure differential at the valve ports. (See Fig. 3.)

NOTE: To assist in the elimination of pump heat and belt squeal problems, the power cylinder has an unloading (or poppet) valve incorporated in the piston, so that at each end of the piston stroke the pressure may be reduced. An adjusting screw is provided to enable the pressure relieving point to be varied slightly in one direction.

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Whenever the effort at the steering wheel is released, the valve spool is returned to the center position.

If the wheels are subjected to shock loads, the pitman arm, acting through the inner parts of the gear, shifts the input shaft worm and control valve spool axially in the appropriate direction, thus directing the fluid to the proper side of the piston to resist the shock forces. This "blocking action" prevents kickbacks at the steering wheel.

BEFORE DISASSEMBLY INSTRUCTIONS

1. Drain gear lubricant.
2. Clean gear of all dirt. NOTE: Do not steam clean.
3. If it is necessary to disassemble any of the component parts, make sure that a clean work bench or table is used.
4. All internal parts should be cleaned in clear, clean solvent and blown dry with clean air. Keep each part separate to avoid nicks and burrs. NOTE: Avoid wiping valve parts with cloth, as lint may actually cause binding and sticking of the closely fitted parts.

DISASSEMBLY INSTRUCTIONS (See Fig. 1 for Reference Numbers)

1. Rotate input shaft (34) so that index mark on end of sector shaft (11) is perpendicular to the centerline of the gear (straight-ahead position).
2. Remove four bolts from gear cover (2).
3. With a soft hammer tap lightly on end of sector shaft (11) to disengage side cover seal (3) and let drain.
4. Remove side cover and sector shaft as a unit.
5. Remove sector shaft seal adapter (50) by removing four bolts.
6. Remove four screws from control valve adapter (32).
7. Remove as a subassembly upper cover (42), control valve (37), control valve adapter (32), input shaft (34) and piston (21). After pulling subassembly from housing, let drain.
8. Remove side cover adjustment screw retainer (9) and disengage side cover (2) from sector shaft (11) by turning adjustment screw (10) clockwise.
9. Remove sector shaft seal (8), leather backup washers (6) and (7) from side cover.
10. Remove poppet seat (17), poppet valve (18), spring (16) and rod (19) from piston (21).
11. Position piston (21) with ball retainer guide (14) on a clean surface and remove retainer guide and balls.
12. Remove input shaft (34).
13. Inspect grooves in piston and input shaft for excessive wear or scoring. Inspect teeth for pits, wear or scoring.
14. If either piston or input shaft needs replacing, both must be replaced, as they are a matched assembly.
15. Clamp input shaft in padded vise jaws.
16. Cut seal (26).
17. Remove retaining rings, washers and seals, items (22) thru (26).
18. Remove upper cover seal (47) and four bolts from cover (42).
19. Remove cover from control valve (37).
20. Unstake adjustment nut lock washer (40).
21. Remove thrust bearing adjustment nut (41) and items (35), (36), (38), (39) and (40).
22. Remove hydraulic control valve adapter (32).
23. From counterbore of valve adapter (3Z), remove items (27), (29) and (30). IMPORTANT: Do not disassemble the valve unless absolutely necessary.

    The valve is the control center of the hydraulic system. The major parts, which are the body and spool, are machined to very close tolerances and with precision machined edges. The spool and valve body are selectively fitted at the factory, and, therefore, these two parts are not separately replaceable. If either is damaged or excessively worn, the whole valve assembly should be replaced; good performance of power steering is not assured if "mismatched" valve spool and body are used. Care should be exercised in the handling of these parts to prevent damage. Sealing edges of the valve bore and the spool should not be broken.

    This will result in excessive leakage and reduced hydraulic power.

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ASSEMBLY INSTRUCTIONS

1. Install sector shaft bearing retaining ring (55) into housing (56).

2. Place the housing (56) on a wooden block to protect side cover face and carefully press bearing (54) into housing until flush.

   NOTE: The bearing should be positioned so that it is pressed on the numbered end. Check freedom of rolls in the bearing after assembling.

3. Carefully clamp the housing into a convenient assembly position and inspect the large piston bore for scratches or damage.

4. Coat the adjusting valve 0-ring liberally with clean grease or oil and force it carefully over the non-threaded end of adjusting screw (57) and into the groove provided.

5. Insert the assembly into the tapped hole provided and thread into the housing leaving 7/8" exposed thread.

6. Assemble the jam nut (58) on the adjusting screw and torque to 23 to 30 N-m (17-22 ft. lbs.).

7. Carefully clamp input shaft (34) into a soft-jawed vise to permit access to the serrated and threaded end.

8. Assemble needle bearing (35), thrust washer (36), valve assembly (37), thrust washer (36), needle bearing (35), thrust washer (38), internal tang washer (39), external tang washer (40) and bearing adjustment nut (41).

9. Assemble backup washer (29), seal (28) and lock ring (27) into valve adapter (32). NOTE: Care must be taken to assemble the lips of the seal (28) toward the lock ring (27). Using clean grease for retention, assemble seal (33) and two seals (31) into the recesses in the face adjacent to the valve.

10. Reclamp the worm shaft (34) on the serrated end using a soft-jawed vise. Assemble the adapter (32) over the worm shaft, engage the pilot flange on the valve (37), and retain with one bolt through the valve into the adapter. (This bolt is only used to facilitate assembly and need only be finger tight.)

11. Assemble washer (26), a new rubber seal (25) (counterbore side toward seal), brass washers (24) and retainer washer (23) on worm shaft. Compress washer and seal assembly and install retaining ring (22). Use care to insure complete seating of the ring in the groove and that the ring (22) has entered the recessed area of retainer washer (23).

12. Using a soft-jawed vise, clamp the piston (21) in a horizontal position with the ball guide holes facing upward. Inspect bores and outer ground surfaces for damage and stone off any burrs.

13. Carefully expand ring (20) and install in ring groove at end of piston.

14. Clean threaded hole in face of large end of piston (21) with clear, clean solvent and blow dry with clean, dry air. Apply Locquic grade "T" primer to threads; allow to dry 10 minutes. Insert items (18), (19), (16) and (18) in the threaded hole. Apply Locquic grade "T" primer to threads of seat (17); allow to dry 10 minutes. Apply stud lock to threads in piston and to threads of seat. Insert seat and torque to 27 to 34 N-m (2Q-25 ft. lbs.); allow to dry 20 minutes.

15. Coat cup seal (23) at end of worm shaft with clean grease and enter into lubricated piston bore.

6. Assemble guide with balls (14) and torque bolts to 11 to 14 N-m (8-10 ft. lbs.).

17. Clamp the sector shaft (11) into a soft-jawed vise by gripping the serrated end. Coat the expanded end of sector adjusting screw (10) with suitable grade of wheel bearing grease, and insert into recess in end of shaft. Thread a new sector shaft screw retainer (9) into the shaft and adjust to permit free rotation of the sector shaft adjusting screw without perceptible end play.

18. Stake the new retainer into the two slots provided and again check freedom of adjusting screw movement.

19. Assemble snap ring (5), steel backup washer (6), leather backup washer (7), seal (8), into side cover (2). NOTE: Seal (8) has oil side molded in the face and must be visible after assembly.

20. Coat the end of the sector shaft with clean grease and insert the shaft in the side cover to the point of contact of the sector shaft

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adjusting screw and the inner cavity of the side cover. Using a screwdriver turn the sector shaft adjusting screw counterclockwise to engage the threads and rotate the screw until a firm stop is reached. NOTE:, Observe shaft seal to make sure it has not fallen from bore.

21. Inspect adapter (50) for damage and assemble leather backup washer (52) and position seal with the words "oil side" to be visible after assembly. Coat seal (51) with clean grease and install.

22. If the input shaft needle bearing (43) has been removed from the valve cover (42), a suitable pressing mandrel must be fabricated which will pilot on the inner diameter of the bearing and have clearance in the bearing bore. The bearing must be pressed on the numbered end and positioned 29 mm (1-1/8 in.) from the face of the valve cover. (After pressing, check for freedom of the needles in the bearing.)

23. Assemble input shaft seal (44) with the seal lip toward the needle bearing; assemble the backup washer, after coating it with grease, and the retaining ring. Check to insure proper seating of the retaining ring (46) in the groove. Pack seal (47) with suitable Lubriplate or wheel bearing grease to inhibit water and assemble.

24. Clamp the housing (56) as before to permit access to all bores. Assemble new lubricated seal (30) and two new seals (31) in the recesses provided in adapter (32) using grease for retention and set aside.

25. Insert piston (21) into the housing and position teeth to be visible through the housing side cover opening. As the piston enters the lubricated bore, compress piston ring (20) and force into assembled position.

26. Re-check the position of the seals in the adapter, aligning the oil transfer holes, and carefully move the adapter into contact with the housing.

27. Assemble four bolts and plain washers through adapter and torque to 61 to 75 N-m (45-55 ft. lbs.). (Remove bolt previously assembled through valve.)

28. Lightly coat the ground portion of the input shaft (34) with oil and carefully install the control valve cover assembly over the input shaft.

29. Assemble four bolts and plain washers and torque to 34 to 48 N-m (25-35 ft. lbs.).

30. Coat seal with clean grease and assemble in recessed groove provided in side cover (2).

31. By observation thru the side cover opening, align the rack piston center tooth with the sector shaft center space and assemble the sector shaft (11) and side cover (2) into the housing.

32. Assemble four bolts and plain washers and torque to 61 to 75 N-m (45-55 ft. lbs.).

33. Adjust screw in side cover.

34. Cover the serrations on the sector shaft with an assembly thimble or a single layer of cellophane tape and assemble the lubricated sector shaft seal adapter assembly over the lightly greased shaft.

35. Assemble four bolts through seal adapter and torque to 27 N-m (20 ft. lbs.). Before assembly of pitman arm, pack seal with suitable grade of wheel bearing grease to inhibit water.

36. After rotating the input shaft through its full travel for a minimum of five cycles, re-check the sector shaft adjustment. No rotational lash or bind of the sector shaft in center position is permissible.

37. If the gear is properly assembled and adjusted, the input torque should not exceed 1.7 N-m (15 in. lbs.) over full travel of the output shaft.

38. Reverse torque applied to output shaft for full gear travel should not exceed 68 N-m (50 ft. lbs.).

GEAR ADJUSTMENTS

Adjustment of Valve Thrust Bearings (Worm Shaft) (Refer to Fig. 1)

1. Clamp the input shaft (34) in a soft-jawed vise to permit access to the serrated and threaded shaft end.

2. After assembling needle bearing (35), thrust washer (36), valve assembly (37), thrust washer (36), needle bearing (35), thrust washer (38), internal tang washer (39), external tang washer (40) and bearing adjustment nut (41), adjust valve by tightening nut (41) to 14 to 20 N-m (10-15 ft. lbs.). When components are at solid height, back off approximately 200 or one tang of washer. Bend one tang of washer into matching slot in nut.

NOTE: Valve to rotate with torque of .23 to .4 N-m (2 to 3-1/2 in. lbs.).

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Adjustment of Pressure Relief Screw (Refer to Fig. 1)

The proper adjustment of the pressure relief screw (poppet) can only be made with the steering gear installed on the vehicle and while under load. Thus, allowances can be made for the variations in the other components that make up the linkage system.

Adjustment on Vehicle:

1. Install a suitable pressure gauge in the line between the pump and steering valve pressure port.

2. Actuate steering to provide full travel to wheel stops and note pressure value. Adjust pressure relief screw (57) in a clockwise direction to provide a minimum of 400 psi below value noted in specifications.

   NOTE: Care must be exercised not to hold pressure for longer than 15 seconds while this adjustment is being made, or heat damage to the pump will result.

Adjustment of Sector Shaft Screw (Subassembly of Shaft) (Refer to Fig. 1)

1. Clamp the sector shaft (11) in a soft-jawed vise by gripping the serrated end.

2. Coat the expanded end of sector adjusting screw (10) with suitable wheel bearing grease into recess in end of shaft.

3. Thread the sector shaft screw retainer (9) into the shaft and adjust to permit free rotation of the sector shaft adjusting screw without perceptible end play. [Maximum of .05 mm (.002 in.) end play.]

4. Stake securely the retainer (9) into the two slots provided and check to assure freedom of screw movement.

Adjustment of Sector Shaft (Gear in Center of Travel) (Refer to Fig. 1)

Adjust screw (10) in side cover (2) to engage gear teeth in a "no lash, " "no bind" condition; assemble nut and tighten. Then adjust per following procedure.

After rotating the input shaft (34) through its full travel for a minimum of five cycles, adjust sector shaft adjusting screw (10) to provide 2.3 to 3.1 N-m (20-25 in. lbs.) torque as input shaft is rotated 900 each side of center. Back out adjusting screw one turn and note torque required to move input shaft 900 each side of center position. Move adjusting screw in to provide an increase in torque of .23 to .45 N-m (2-4 in. lbs.) at a point within 450 each side of center after adjusting screw jam nut is first tightened snug and then final torque to 27 to 34 N-m (20-25 ft. lbs.).

NOTE: Input torque of the completely assembled gear minus hydraulic oil should not exceed 1.7 N-m (15 in. lbs.) for full travel of the output shaft.

MAINTENANCE OF STEERING GEAR SYSTEM

1. Always check for wear in steering linkage and other system components first before making adjustments to steering gear assembly.

2. Prevent internal bottoming of steering gear. Carefully check axle stops.

3. Make periodic checks of lube level for steering gear and components to prevent malfunction due to inadequate lubrication.

4. Make routine and/or periodic checks for proper front end alignment.

5. Maintain correctly inflated tires.

6. Always use a puller; never use a torch or hammer to remove steering arms.

7. Always carefully examine all steering parts which have been subject to "impact" and replace any that are questionable.

8. Investigate immediately and correct cause of any play, rattle or shimmy in any part of the linkage or steering mechanism.

9. Remove cause of steering column misalignment and, if necessary, elongate support bracket holes at dash.

10. Encourage all drivers to report any malfunction or accident that could have damaged the steering mechanism.

11. Do not attempt to weld any broken steering component. (Replace only with original equipment.

12. It is not recommended to severely cold straighten any steering system part.

13. It is not recommended to hot straighten or bend any steering system part.

14. Always use new seals and 0-rings during repairs and overhauls.

15. Replacement of single bearing assemblies or balls, if one or more make a "set," is not recommended.

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16. Excessive heat will develop if any power steering gear is held in an extreme right or left turn longer than a few seconds.(Heat developed can damage seals and/or pump.)

17. Prevent dirt or foreign particles from entering hydraulic steering systems.(Always clean off around filler caps before removing to check oil supply.)

18. Use care to prevent even minor hydraulic leaks from continuing.

TROUBLESHOOTING

PROBLEM	POSSIBLE CAUSE	REMEDY
Hard Steering	1. Pump belt slipping.	Tighten belt. Replace belt if worn.
	2. Insufficient pump pressure.	Check pump pressure with gauge. If insufficient, check for cause: belt slipping, sticky relief valve in pump or flow control, defective pump.
	3. Sticky relief valve in pump or flow control. (Prevents pressure buildup.)	Replace relief valve. May require total replacement.
	4. Low fluid level. (Loss of hydraulic oil due to leaks or damaged lines.)	Repair to eliminate leaks and re-fill system and reservoir.
	5. Spool in valve sticking.	Disassemble valve and inspect for sticking. Clean; reassemble valve or replace and reinstall on gear. Check adjustment of thrust bearings. (Check for equal amount of end movement of spool each way from center.)
	6. Input shaft bent or sprung.	Replace bent parts.
	7. Improper front end alignment.	Align to specifications.
	8. Sector shaft adjustment too tight.	Adjust.
	9. Broken piston or piston rings in power cylinder.	Replace. Check condition of cylin-der wall.
	10. Low tire pressure.	Inflate to proper pressure.
No Recovery from Turn to Straight Ahead	1. Insufficient caster.	Increase caster.
	2. Tight ball socket connections and other linkage connections.	Loosen connections but keep them snug.
	3. Tight front axle spindles.	Free up.
	4. Bind in input worm and fol-lower shaft (prevents center-ing of valve).	Eliminate bind.

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PROBLEM	POSSIBLE CAUSE	REMEDY
Shimmy	1. Loose ball socket connections.	Tighten.
	2. Wheels out of balance.	Balance.
	3. Badly worn and unevenly worn tires.	Replace.
	4. Excessive caster. checked to specifications.	Correct and have front alignment
	5. Looseness in steering gear.	Adjust gear and repair if necessary.
	6. Air in system.	Bleed system.
Lost Motion at Steering Wheel	1. Loose ball socket connections or other linkage connections.	Tighten.
	2. Loose adjustments.	See "Adjustment of Sector Shaft" on page 7.
	3. Steering wheel loose on steering tube.	Tighten wheel nut.
	4. Pitman arm loose on output shaft.	Tighten clamp bolt.
	5. Steering housing loose on frame.	Tighten.
	6. Insufficient pump flow.	See "Hard Steering."
Noise	1. Pump belt out of adjustment.	Adjust.
	2. Low level of hydraulic oil. level of oil.	Check for leaks; maintain proper
	3. Air in system.	Check all connections for tightness.
	4. Dirt and sludge in pump.	Drain system and clean.
	5. Pump worn. (Not producing specified pressure.)	Replace or repair.

BLEEDING THE STEERING GEAR

1. With engine running CAUTION: System under high pressure!

   a. Back out bleed screw 1/4 turn.

   b. Execute several full left and right turns while observing air and fluid mixture being emitted from bleed port. When air bubbles and fluid foam stops, tighten bleed screw to 3.4 N-m (30 in. lbs.).

NOTE: Fluid level must be maintained in reservoir.

   c. Replace lost fluid in system. Use Dexron automatic transmission fluid.

2. Double check system by observing any change in reservoir fluid level while executing left and right turns (chassis wheels on the ground). The fluid level should not change more than 4.7 mm (3/16 in.). If the fluid level changes more than 4.7 mm (3/16 in.), air is still trapped in the system.

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SPECIFICATIONS

Model	S-266	S-276	S-299
Code	05266	05276	05299
Lubricant Type		Dexron Automatic Transmission Fluid	
Maximum System Operating Pressure		1500 psi	

TORQUE CHART

Description	Item No. (See Fig.1)	Torque, Newton Meter
Nut, Sector Shaft Adjusting Screw Lock	10	27-34 N.m (20-25 ft. lbs.)
Nut, Pressure Unloader Valve Adjusting Jam	58	23-30 N.m (17-22 ft. lbs.)
Seat, Piston Poppet	17	27-34 N.m (20-25 ft. lbs.)
Capscrew for Side Cover	2	61-75 N.m (45-55 ft. lbs.)
Capscrew for Upper Cover	42	34-48 N.m (25-35 ft. lbs.)
Bolt for Pitman Arm	59	190-217 N.m (140-160 ft. lbs.)
Capscrew for Control Valve Adapter	32	61-75 N.m (45-55 ft. lbs.)
Capscrew, Clip Guide	12	9.6-10.7 N.m (85-95 ft. lbs.)
Steering Gear to Frame Mounting Bolts		353-380 N.m (260-280 ft. lbs.)

All Torque Values are based on lubricated threads.

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STEERING GEARS

ROSS

IH Model	IH Code	IH Model	IH Code
S-261	05261	S-322	05322
S-277	05277	S-323	05323
S-301	05301	S-325	05325
S-302	05302	S-326	05326
S-320	05320	S-328	05328
S-321	05321	S-329	05329

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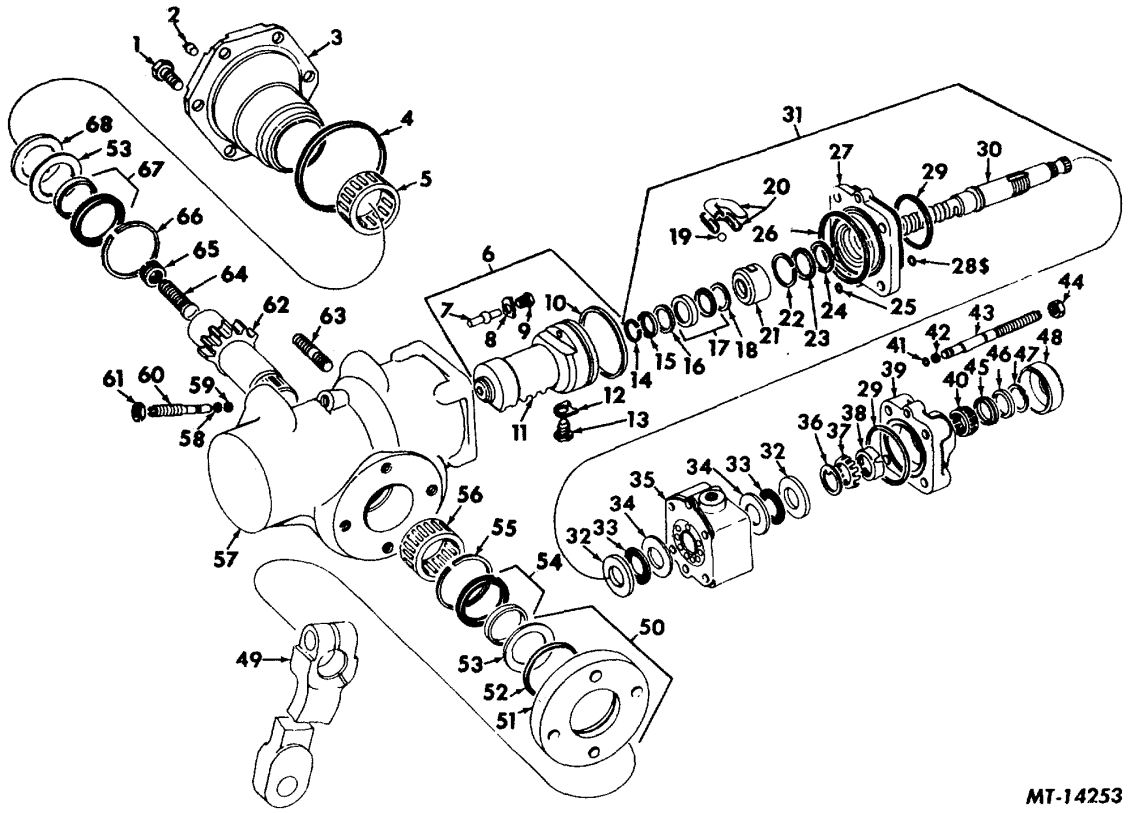
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Legend for Fig. 1

Key	Description
1	BOLT, Cover
2	PLUG, Vent
3	COVER, W/Brg. Seal and Retainer, Gear
4	SEAL, O-ring Cover
5	BEARING - Not Serviced Separately -
6	PISTON, W/Ring and Poppet Valve, Gear
7	VALVE, Poppet
8	WASHER, Lock
9	SCREW, Poppet Valve
10	RING, Piston
11	PISTON - Not Serviced Separately -
12	WASHER, Lock
13	SCREW, Set
14	RING, Snap
15	WASHER, Retainer
16	WASHER, Back-Up - Bronze -
17	SEAL, Oil
18	WASHER, Back- Up - Steel -
19	BALL - Not Serviced Separately -
20	GUIDE, Ball - Not Serviced Separately -
21	NUT, Ball - Not Serviced Separately
22	RING, Snap
23	SEAL, Oil Adapter
24	WASHER, Back-Up
25	SEAL, O-ring
26	SEAL, O-ring
27	ADAPTER, w/Washer, Seal and Ring. Cover
28	SEAL, O-ring
29	SEAL, O-ring
30	SHAFT, Input - Not Serviced Separately -
31	SHAFT, Input w/Adapter and Seals, Gear
32	WASHER, Thrust
33	BEARING, Thrust WASHER, Spacer
34	WASHER, Thrust
35	VALVE, Steering Gear, Assy.
36	WASHER, Tongued
37	WASHER, Lock
38	NUT, Lock
39	COVER, w/Brg. and Adjusting Screw, Hsg.
40	BEARING, Needle, Assy.
41	SEAL, O-ring
42	WASHER, Back-Up
43	SCREW, Adjusting
44	NUT, Hex. Jam 5/16

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Key Description

45 SEAL, Oil, Assy.
46 WASHER, Back-Up
47 RING, Snap
48 SEAL, Piston Rod
49 ARM, Steering
50 RETAINER, w/Seal, Housing
51 RETAINER - Note Serviced Separately
52 SEAL, O-ring
53 WASHER, Leather
54 SEAL, w/Ring, Oil
55 RING, Snap
56 BEARING, Roller
57 HOUSING, w/Bearing and Retainer, Gear
58 WASHER, Back-Up
59 SEAL, O-ring
60 SCREW, Poppet Valve Adjustment
61 NUT, Jam 7/16 NF
62 SHAFT, Steering Gear Output
63 STUD, Steering Gear Mounting
64 SCREW, Adjusting
65 RETAINER, Adjusting Screw
66 RING, Snap
67 SEAL, w/Ring Shaft
68 WASHER, Back-Up

DESCRIPTION

These units are fully integral steering gears incorporating a hydraulic control valve, a power cylinder and a mechanical means of steering control. The power of the cylinder is transmitted to the steering gear output shaft by means of gear teeth on the piston mating with gear sector on the output shaft. The flow of oil from the pump is directed to the power cylinder via the control valve. The valve is located concentric with the input shaft. Fig. 2 illustrates the power steering gears described herein.

OPERATION

The action of the steering gear is both manual and hydraulic in effect. When the input shaft is turned, by the driver's effort on the steering wheel, the piston is caused to move by the interaction of balls spaced between an external groove on the shaft and an internal groove inside the piston. Whenever the driver's effort at the steering wheel exceeds the force of the centering springs and the "hydraulic reaction" provided by the control valve, the valve is actuated and the power of the system is applied to provide the driver with power steering.

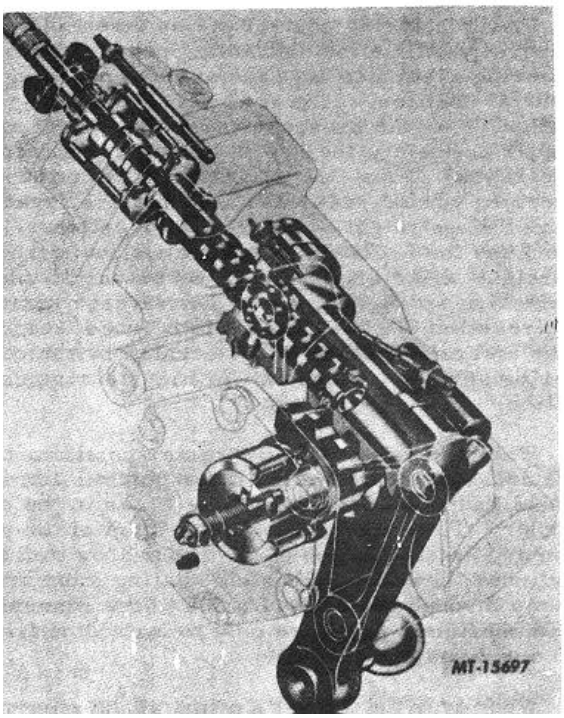


Fig. 2
HF64 OIL FLOW ILLUSTRATION

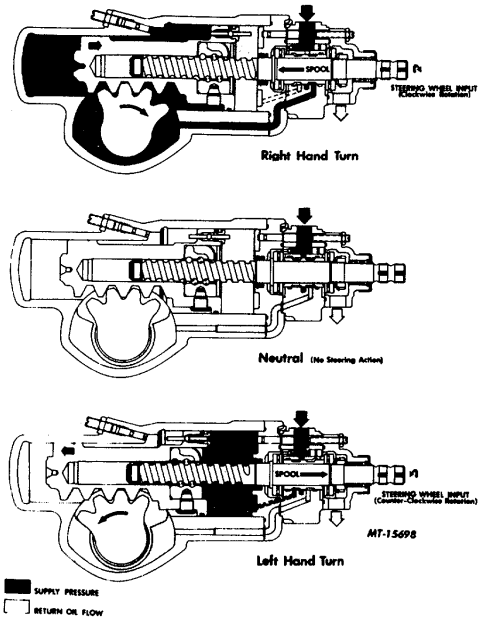


Fig. 3

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Power steering control valves (see Fig. 3) generally utilize the hydraulic pressure in the steering system to urge the valve spool to its neutral position. This is called "hydraulic reaction." As the pressure in the hydraulic cylinder builds up, the hydraulic centering force increases. Thus, the driver's effort on the steering wheel, in turning a corner, is greater than for a straight-ahead road correction. Because the hydraulic pressure is low in the straight-ahead driving, it is necessary to add centering springs to assist the valves hydraulic reaction in giving the system "road feel." The feel and steering effort created by the centering springs is constant for any steering condition.

When the valve is in the center position, the oil pressure at its two cylinder ports is low and equal and produces ineffective forces in the cylinder. This results in no movement of the piston and no circulation of oil in the lines to the cylinder; however, oil is circulating from the pump through the control valve to the reservoir with sufficient pressure only to overcome friction of lines and fittings.

Whenever the driver's effort at the steering wheel overcomes the valve centering springs and hydraulic reaction, the valve spool is moved axially restricting one of the return passages to the outlet port, thus causing an immediate increase in pressure at one of the cylinder ports and in one end of the cylinder. At the same time, the other return passage is enlarged, allowing the oil from the discharging end of the cylinder free passage to the outlet port and return to the reservoir. The immediate effect is increased pressure in one end of the cylinder to actuate the piston, thereby applying hydraulic power directly to the steering gear pitman arm. The slightest movement of the valve spool from center position results in a pressure differential at the valve ports. (See Fig. 3.)

Whenever the effort at the steering wheel is released, the valve spool is returned to the center position.

If the wheels are subjected to shock loads, the pitman arm, acting through the inner parts of the gear, shifts the input shaft worm and control valve spool axially in the appropriate direction, thus directing the fluid to the proper side of the piston to resist the shock forces. This "blocking action" prevents kickbacks at the steering wheel.

NOTE: To assist in the elimination of pump heat and belt squeal problems, the power cylinder has an unloading (or poppet) valve incorporated in the piston, so that at each end. of the piston stroke the pressure may be reduced. An adjusting screw is provided to enable the pressure relieving point to be varied slightly.

BEFORE DISASSEMBLY INSTRUCTIONS

1. Drain gear lubricant.

2. Clean gear of all dirt. NOTE: Do not steam clean.

3. If it is necessary to disassemble any of the component parts, make sure that a clean work bench or table is used.

4. All internal parts should be cleaned in clear, clean solvent and blown dry with clean air. Keep each part separate to avoid nicks and burrs. NOTE: Avoid wiping valve parts with cloth, as lint may actually cause binding and sticking of the closely fitted components.

DISASSEMBLY MAJOR SUB-ASSEMBLIES FIG. 1

1. Rotate input shaft (30) so that index mark on end of output shaft (62) is perpendicular to the centerline of the gear (straight-ahead position).

2. Remove six side cover cap screws (1).

3. Tap lightly with a soft-faced hammer on end of shaft (62) to disengage side cover seal (4) and let drain.

4. Remove as a unit the side cover (3) and shaft (62).

5. Remove output shaft seal retainer (51) by removing four cap screws.

6. Remove four cap screws from control valve adapter (27).

7. Rotate input shaft (30 until control valve adapter (27) moves out of housing 19.1 mm (3/4 in.) and let drain.

8. Remove sub-assembly from the housing and lay aside.

SIDE COVER AND CROSS-SHAFT ASSEMBLY FIG. 1

1. Remove side cover adjustment screw lock nut and disengage side cover (3) from shaft (62) by turning adjustment screw (64) clockwise.

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2. Remove snap ring (66), shaft seal (67) leather backup washer (53), and steel backup washer (68) from side cover.

RACK FROM WORM AND BALL NUT (Figs. 1, 4 and 5)

1. Unstake lock washer (8) and remove set screw (9) from piston rack (11).

2. Pre-position piston rack so that the rack teeth are in down position and disengage rack slowly until approximately 25.4 mm (1 in.) of ball nut (Fig. 4) is exposed.

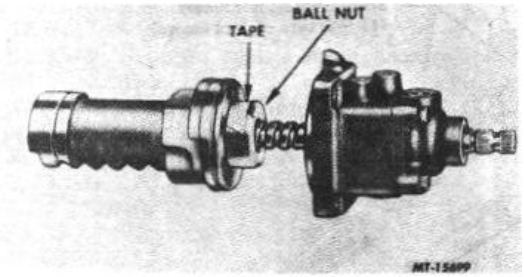


Fig. 4

3. Wipe dry surface and place tape over the crossover ball tube opening in ball nut to prevent loss of steel balls. Fig. 5.

4. Remove rack piston. Fig. 5

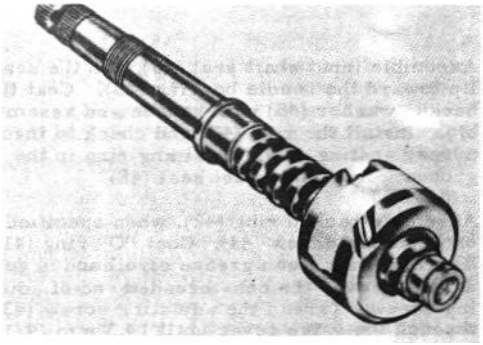


Fig. 5

BALL NUT FROM WORM (Figs. 1 thru 5)

1. Cut worm seal (17) and seal cup and remove.

2. Remove worm retaining ring (14) and remove worm seal components and lay aside in same order and position.

VALVE AND ADAPTER (Figs. 1 thru 6)

1. Remove upper cover water seal (48) and the four cap screws from the upper cover (39).

2. Remove upper cover from control valve (35).

3. Unstake adjustment nut lock washer (37).

4. Remove thrust bearing adjustment nut (38) and following pieces (32, 33, 34, 36 & 37).

5. Remove control valve assembly from shaft.

6. Remove hydraulic control valve adapter (27).

NOTE: The valve is the control center of the hydraulic system. The major parts, which are the body and spool, are machined to very close tolerances and with precision machined edges. The spool and valve body are selectively fitted at the factory and therefore these two parts are not separately replaceable. If either is damaged or excessively worn, the whole valve assembly should be replaced good performance of power steering is not assured if "mismatched" valve spool and body are used. Care should be exercised in the handling of these parts to prevent damage. Sealing edges of the valve bore and the spool should not be broken. This will result in excessive leakage and reduced hydraulic power. Should valve spool be removed from valve body the spool should be assembled with the end, having the internal groove, toward the valve adapter (Fig. 6).

HOUSING (Fig. 1)

1. Assemble bearing retaining ring (55) in groove of bearing (56). Place the housing (57) on a wooden block to protect the side cover face and carefully press the bearing into the housing until retaining ring contacts housing. 2., Carefully clamp the housing into a convenient assembly position and inspect the large rack-piston bore for scratches or damage.

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HF SERIES CONCENTRIC VALVE
(Assembly Instructions)

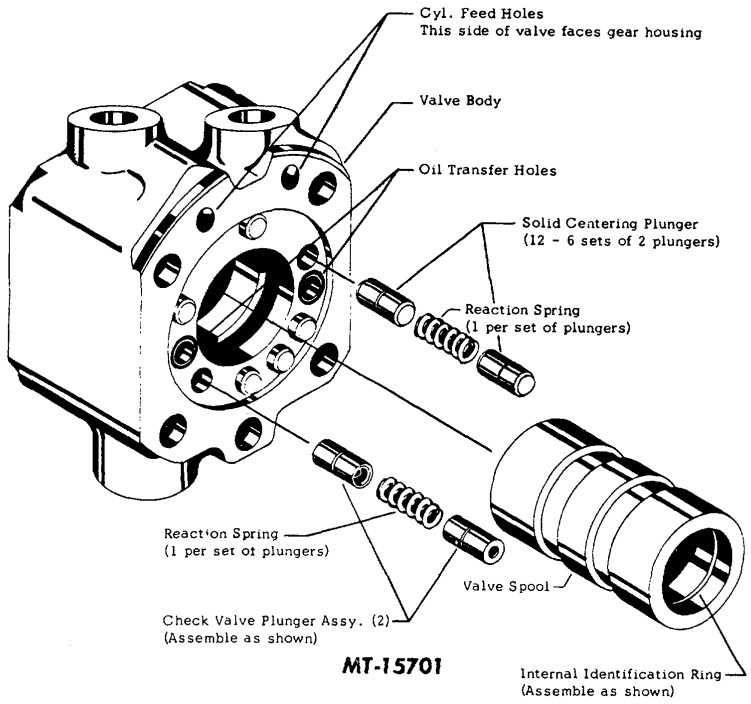


Fig. 6

3. Assemble backup seal (59), when specified, on adjusting screw (60). Coat "O" ring (58) liberally with clean grease or oil and urge it carefully over the non-threaded end of adjusting screw and into the groove provided.

4. Insert the above assembly into the tapped hole provided and thread into the housing leaving 22.2 mm (7/8 in.) exposed thread.

5. Assemble the jam nut (61) on the adjusting screw and tighten nut to specified torque.

CONTROL VALVE COVER (Fig. 1)

1. If the input shaft needle bearing (40) has been removed from the valve cover (39) a suitable pressing mandrel must be fabricated which will pilot on the inner diameter of the bearing and have clearance in the bearing bore. The bearing must be pressed on the numbered end and positioned 28.6 mm (1-1/8 in.) from the valve face of the cover. (After pressing, check for freedom of the needles in the bearing.)

2. Assemble input shaft seal (45) with the seal lip toward the needle bearing (45). Coat the backup washer (45) with grease and assemble. Install the ring (47) and check to insure proper seating of the retaining ring in the groove. Assemble dust seal (48).

3. Assemble backup ring (42), when specified, on adjusting screw (43). Coat "O" ring (41) liberally with clean grease or oil and urge it carefully over the non-threaded end of adjusting screw. Thread the adjusting screw (43) through the valve cover until 14.3 mm (9/16 in.) of thread is exposed beyond the boss.

4. Assemble nut (44) on threaded portion of adjusting screw and tighten nut to specified torque.

ADAPTER, WORM SHAFT, VALVE AND VALVE COVER (Fig. 1)

1. Assemble backup washer (24), seal (23) and spiral lock ring (22) into valve adapter (27);

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care must be taken to assemble the lip of the seal toward the lock ring. Using clean grease for retention, assemble seal (29) and two seals (25) into the recesses provided in the face adjacent to the valve.

2. Assemble the adapter (27) over the bottom end of the worm shaft.

3. Clamp carefully the worm shaft into a vise with soft faced jaws to permit access to the serrated and threaded end. Assemble heavy thrust race (32), washer, needle bearing (33), light thrust washer (34), valve assembly (35), light thrust washer (34), spacer, needle bearing (33), heavy thrust washer (32), internal tank washer (36), new external tang washer (37) and bearing adjustment nut (38). Carefully tighten adjusting nut, noting that the bearings (33) are located over the spacers. Adjust.

4. Cover the serrations on the worm shaft with an assembly thimble or a single layer of cellophane "scotch" tape. Lightly coat remaining portion of worm shaft with oil. Recheck the position of the seal (29) in control valve cover (27) and seals (29) and (25) in valve adapter. Carefully install the control valve cover assembly over the input shaft, noting that the adjusting screw passes through the valve and engages the adapter.

5. Assemble four bolts and plain washers and tighten bolts to specified torque.

6. Assemble ball nut.

7. Assemble washer (18), a new rubber seal (23), a new teflon cup (17), (c'bore side toward seal), brass washer (16) and retainer washer (15) on worm shaft. Compress washer and seal assembly and install retaining ring (14). Use care to insure that the ring is completely seated in the groove and has entered the recessed area of retainer washer (15).

8. Carefully rotate the ball nut for its full travel, checking for bind and insuring that all balls are in the correct recirculating path.

RACK PISTON (Figs. 1, 7 and 8)

1. Using a soft-faced vise, clamp the rack piston (11) in a horizontal position with the teeth facing up. Carefully inspect the bores and outer ground surfaces for damage and stone off any burrs. Carefully expand piston ring (19) and install in ring groove at the large end of rack piston.

2. NOTE: Do not remove Items 7, 8 and 9 unless there is evidence of damage. If parts are removed, clean threaded hole in face of large end of rack piston with clear, clean solvent and blow dry with clean dry air. Apply Locquic grade "T" primer (Allow to dry 10 minutes.) Insert new pressure unloader valve (33 Fig. 7) in the threaded hole. Apply Locquic grade "T" primer to the threads of the new pressure unloader valve screw (9). (Allow to dry 10 minutes.) Apply "Stud Lock" to the new pressure unloader seat threads and the threads of the rack piston. Assemble the new pressure unloader valve screw and new lock washer (8) and screw into threaded hole in the rack piston and torque to 27 N-m (20 ft. lbs.). Bend lock washer tab as shown in Fig. 7. Allow "Stud Lock" 20 minutes to dry before adding oil to gear).

3. Clean threaded hole on top of rack piston with clear-clean solvent and blow dry with clean dry air. Apply Locquic grade "T" primer to threads and allow to dry 10 minutes. Coat cup (17) at end of worm shaft with clean grease and enter into rack piston bore. As the ball nut approaches the large bore, align the conical hole in the ball nut with the threaded locking screw hole, slip into rack piston bore until about 25.4 mm (1 in.) of the ball nut is not engaged. Remove the tape clip from the ball nut and slip into the bore of rack piston. Clean threads on locking screw and apply Locquic grade "T" primer to thread and allow to dry 10 minutes. Apply "Loctite Hydraulic Sealant" to threads of locking screw. Assemble locking screw with new lock washer (36A-Fig. 8) into rack piston and torque to 41 to 48 N-m (30-35 ft. lbs.). Bend lock washer against one flat of hex. head on locking screw (Fig. 8). Allow "Loctite Hydraulic Sealant" 20 minutes to dry before adding oil to gear.

SECTOR SHAFT AND SIDE COVER (Fig. 1)

1. Clamp the sector shaft (62) into a soft-faced vise by gripping the serrated end. Coat the expanded end of sector adjusting screw (64) with suitable grade of wheel bearing grease and insert into recess in end of shaft. Thread new sector shaft screw retainer (65) into the shaft adjusting screw without perceptible end play.

2. Stake the retainer into the two slots provided and again check freedom of adjusting screw movement.

3. If vent (2) is to be replaced press in new plug flush.

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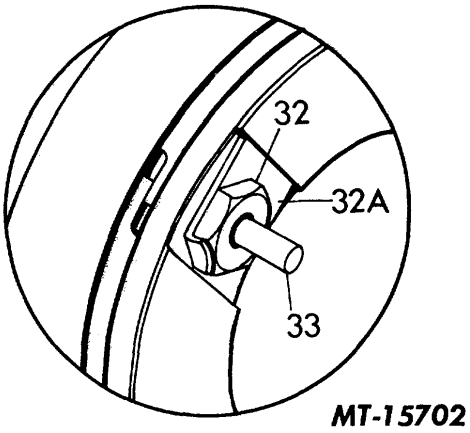


Fig. 7

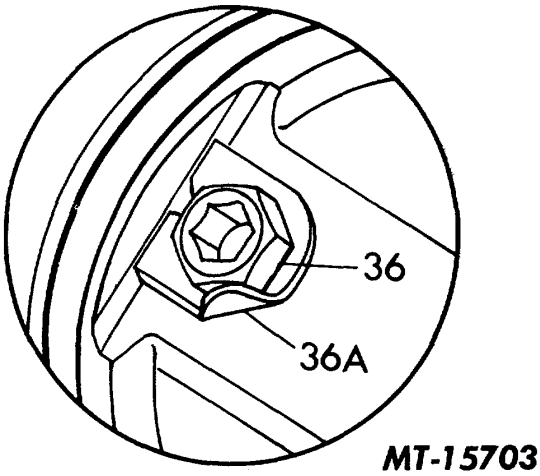


Fig. 8

4. Assemble washer (68), leather back-up (53), and two-piece seal (67) and snap ring (66) into side cover (3). NOTE: Seal (67) has "oil side" molded in the face and must be visible after assembly.

5. Coat the end of the sector shaft with clean grease and insert the shaft in the side cover to the point of contact of the sector shaft adjust screw and the inner cavity of the side cover. Using a screw driver, turn the sector shaft adjusting screw counter-clockwise to engage the threads and rotate the screw until a firm stop is reached.

SECTOR SHAFT SEAL ADAPTER (Fig. 1)

1. Inspect adapter (51) for damage and assemble leather backup washer (53) and position seal (54) with the words "oil side" to be visible after assembly.

FINAL ASSEMBLY (Fig. 1)

1. Clamp the housing as before, to permit access to all bores. Assemble seal (26) and seal (25) in the recessed provided in adapter (27) using grease for retention.

2. Insert rack piston into the housing and position teeth to be visible through the housing side cover opening. As the rack piston enters the lubricated bore, compress piston ring (10) and urge into assembled position.

3. Recheck the position of the seals in the adapter, align the oil transfer holes, and move the adapter into contact with the housing.

4. Assemble four bolts with plain washers thru adapter and tighten to specified torque.

5. Coat seal (4) with clean grease and assemble in recessed groove provided in side cover (3).

6. By observation thru the side cover opening, align the rack piston (identification mark on centerline) and assemble side cover and the sector shaft into housing. Note that the center of the sector shaft must engage the center of the rack piston.

7. Assemble six bolts and tighten to specified torque.

8. Adjust screw in side cover.

9. Cover the serrations on the sector shaft with an assembly thimble or a single layer of cellophane "Scotch" tape. Coat the seal (53) with clean grease and place over bearing retaining ring (55). Assemble the lubricated sector shaft seal adapter assembly over the lightly greased shaft. Care must be taken to insure that the seal (52) is properly positioned over the ring (55).

10. Assemble four bolts thru seal adapter and tighten to specified torque. Before assembly of pitman arm, pack seal with suitable grade of Lubriplate or wheel bearing grease to inhibit water and install over sector shaft seal adapter.

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FINAL CHECKS

1. After rotating the input shaft thru its full travel for a minimum of five cycles, recheck the sector shaft adjustment. No rotational lash or bind of the sector shaft in center position is permissible.

2. If the gear is properly assembled and adjusted, the input torque should not exceed 1.7 N-m (15 in. lbs.) over full travel of 950 at the output shaft.

3. Reverse torque applied to output shaft for full gear travel should not exceed 68 N-m (50 ft. lbs.)

ADJUSTMENTS

VALVE THRUST BEARINGS (WORM SHAFT) Fig. 1)

1. Tighten adjusting nut (38) noting that the bearings (33) are located over the spacers (33) until all components are snug and at a solid height. Back off the nut approximately 200 and bend one tang of lock washer (37) into a matching slot in nut (38).

2. Check for free rotation of valve on shaft and for perceptible end play. NOTE: The above assembly should rotate at .34 to .57 N-m (3-5 in. lbs.)

SECTOR SHAFT (GEAR IN CENTER OF TRAVEL (Fig. 1)

Adjust screw (64) in side cover (3) to provide a 1.7 to 2.3 N-m (15-20 in. lbs.) torque at the input shaft as the gear is moved 900 each side of center. Back out the adjusting screw one turn and note torque required to move through 900 each side of center. Move adjusting screw in to provide a rise in torque of .23 to .45 N-m (2-4 in. lbs.) at a point within 450 each side of center after jam nut is locked to specified torque.

NOTE: Input torque of the completely assembled gear, minus hydraulic oil should not exceed 1.7 N-m (15 in. lbs.) over full travel of 950 at the output shaft.

PRESSURE RELIEF SCREWS (Fig. 1)

1. Assemble lower (housing) adjusting screw.

2. Assemble upper (valve end) adjusting screw.

3. Adjustment on Vehicle:

   a. Install a suitable pressure gage in the line between the pump and steering valve pressure port.

   b. Actuate steering to provide full travel to wheel stops and note pressure on gage. Adjust pressure relief screw (64) in a clockwise direction to provide a pressure at least 2758 KPa (400 P.S.I.) below maximum operating pressure. During this adjustment the oil temperature should be approximately (130°F) 54°C. (If conditions other than 15 1.P.M. (4 G.P.M.) flow and (1300F) 540C temperatures are present, the 2758 KPa (400 P.S.I.) figure will change and will have to be determined.) NOTE: Care must be exercised to not hold pressure for longer than 15 seconds while this adjustment is being made or damage to the pump, from heat may result.

   c. Repeat above procedure for other direction of steering.

LUBRICATION

For type of lubricant refer to Lubrication Section CTS-2412.

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TROUBLE SHOOTING

Trouble	Cause	Remedy
Hard Steering	1. Insufficient pump pressure.	Check pump pressure with gauge. If insufficient, check for cause- belt slipping, sticky relief valve in pump or flow control, defective pump.
	2. Pump belt slipping.	Tighten belt. Replace belt if worn.
	3. Sticky relief valve in pump or flow control. (Prevents pressure build up.)	Replace relief valve - may require total replacement.
	4. Low fluid level. (Loss of hydraulic oil due to leaks or damaged lines,)	Repair to eliminate leaks and refill system and reservoir.
	5. Spool in valve sticking.	Disassemble valve and inspect for sticking. Clean. Reassemble valve or replace and reinstall on gear, check Adjustment of Thrust Bearings. Check for equal amount of end movement of spool each way from center.
	6. Input shaft bent or sprung.	Replace bent parts.
	7. Improper front end alignment.	Align to specifications.
	8. Sector shaft adjustment too tight.	Adjust.
	9. Broken piston or piston rings in power cylinder.	Replace.Check condition of cylinder wall.
	10. Low tire pressure.	Inflate to proper pressure.
No Recovery From Turn to Straight-ahead	1. Insufficient caster.	Increase caster.
	2. Tight ball socket connections and other linkage connections.	Loosen connections but keep them snug.
	3. Tight front axle spindles.	Make free.
	4. Bind in input worm & follower shaft (prevents centering of valve).	Eliminate bind.
	5. Spool in valve sticking (prevents centering of valve).	Same as #5 - Hard Steering above.
Shimmy	1. Loose ball socket connections.	Tighten.
	2. Wheels out of balance.	Balance.
	3. Badly worn and unevenly worn tires.	Replace.
	4. Excessive caster.	Correct and have front alignment checked to specifications.
	5. Looseness in steering gear.	Adjust gear, and repair, if necessary.
	6. Air in system.	Bleed system.

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Lost Motion at Steering Wheel	1. Loose ball socket connections or other linkage connections.	Tighten.
	2. Loose adjustments.	See Torque Chart.
	3. Steering wheel loose on steering tube.	Tighten wheel nut.
	4. Pitman arm loose on output shaft.	Tighten clamp bolt.
	5. Steering housing loose on frame.	Tighten.
	6. Insufficient pump flow.	See Hard Steering.
Noise	1. Pump belt out of adjustment.	Adjust.
	2. Low level of hydraulic oil.	Check for leaks; maintain proper level of oil.
	3. Air in system.	Check all connections for tightness. Operate several minutes to bleed from system.
	4. Dirt and sludge in pump.	Drain system and clean.
	5. Pump worn.	Replace or repair.

MAINTENANCE OF STEERING GEAR SYSTEM

1. Always check for wear in steering linkage and other system components first, before making adjustments to steering gear assembly.
2. Prevent internal bottoming of steering gear. Carefully check axle stops.
3. Make periodic checks of lube level for steering gear and components to prevent malfunction due to inadequate lubrication.
4. Make routine and/or periodic checks for proper front end alignment.
5. Maintain correctly inflated tires.
6. Always use a "puller"; never use a torch or hammer to remove steering arms.
7. Always carefully examine all steering parts which have been subject to "impact" and replace any that are questionable.
8. Investigate immediately, and correct cause of any play, rattle, or shimmy in any part of the linkage or steering mechanism.
9. Remove cause of steering column misalignment and if necessary, elongate support bracket holes at dash.
10. Encourage all drivers to report any malfunction or accident that could have damaged the steering mechanism,
11. Do not attempt to weld any broken steering component. (Replace only with original equipment.)
12. It is not recommended to severely cold straighten any steering system part.
13. It is not recommended to hot straighten or bend any steering system part.
14. Always use new seals and "O" rings during repairs and overhauls.
15. Replacement of single bearing assemblies, or balls, if one or more make a "set" is not recommended.
16. Excessive heat will develop if any power steering gear is held in an extreme right or left turn longer than a few seconds. (Heat developed can damage seals and/or pump.)
17. Prevent dirt or foreign particles from entering hydraulic steering systems. (Always clean off around filler caps, before removing to check oil supply.)
18. Use care to prevent even minor hydraulic leaks to continue.

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TORQUE CHART

Subject	Torque
Nut, Pressure Unloader Valve Adj. 5/16-24 Hex. Nut	20-27 N.m (15-20 ft. lbs.)
Nut, Sector Shaft Adj. Screw Lock 1/2-20 Hex. Nut	27-34 N.m (20-25 ft. lbs.)
Nut, Pressure Unloader Valve Adj. Jam 7/16-20 Hex. Nut	27-34 N.m (20-25 ft. lbs.)
Seat, Piston Poppet	34-41 N.m (25-30 ft. lbs.)
Screw, Worm Follower Locking	41-48 N.m (30-35 ft. lbs.)
Capscrew, Sector Shaft Seal Adapter 5/16-18 x Socket Head	18-31 N.m (13-23 ft. lbs.)
Capscrew, Side Cover	
7/16-14 Hex. Head	61-75 N.m (44-55 ft. lbs.)
9/16-18 Hex. Head	203-231 N.m (150-170 ft. lbs.)
Capscrew, Upper Cover	
3/8-16 Hex. Head	34-48 N.m (25-35 ft. lbs.)
Bolt, Pitman Arm Clamp	373-407 N.m (275-300 ft. lbs.)
Capscrews, Control Valve Adapter 1/2-13	95-109 N.m (70-80 ft. lbs.)

All Torque Values are based on lubricated threads.

SPECIFICATIONS

Maximum System Operating Pressure (psi) 1750	All Gears

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STEERING GEAR

(ROSS)

IH MODEL	IH CODE
S-335	05335
S-336	05336
S-337	05337
S-338	05338

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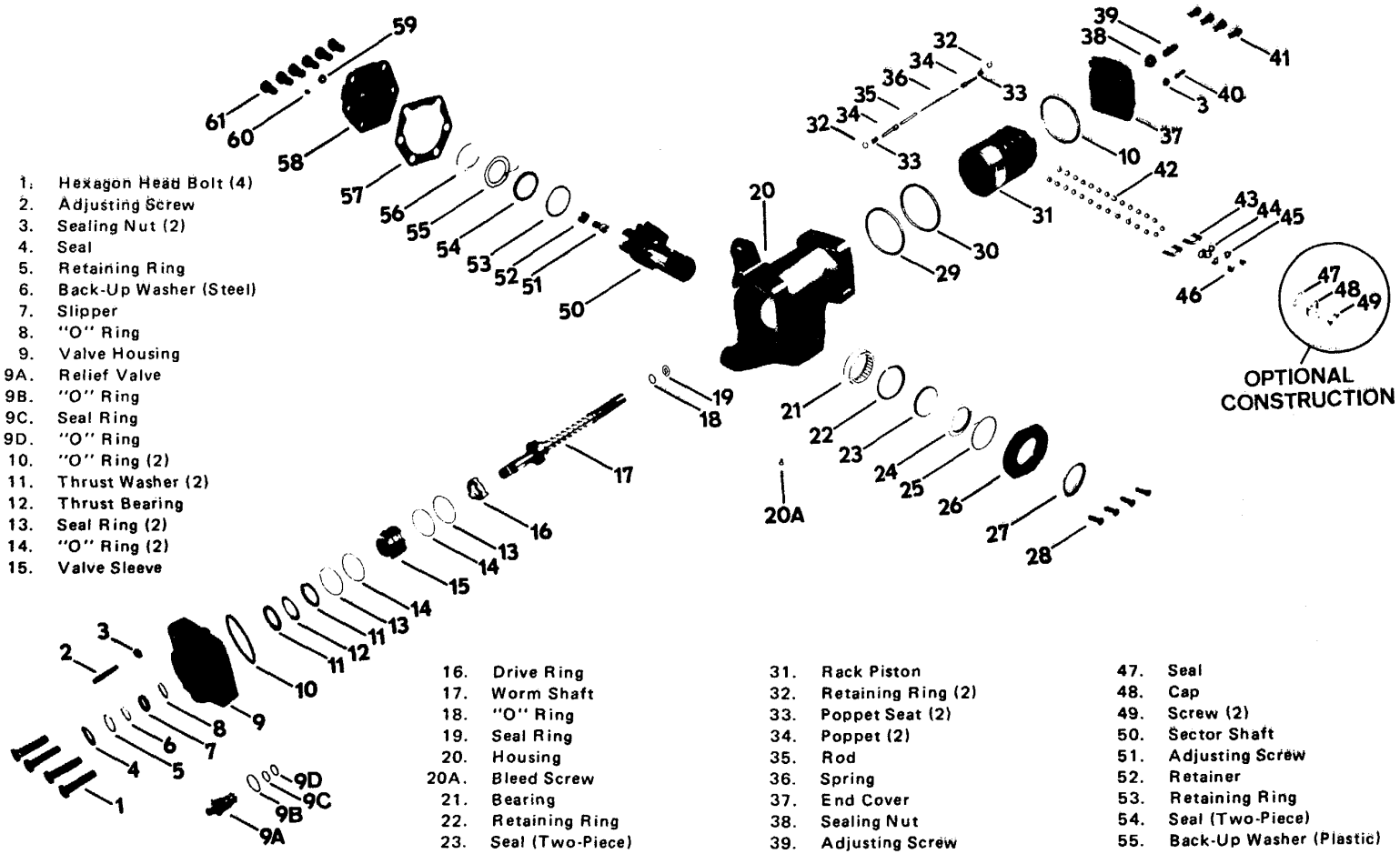
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1. Hexagon Head Bolt (4)
2. Adjusting Screw
3. Sealing Nut (2)
4. Seal
5. Retaining Ring
6. Back-Up Washer (Steel)
7. Slipper
8. "O" Ring
9. Valve Housing
9A. Relief Valve
9B. "O" Ring
9C. Seal Ring
9D. "O" Ring
10. "O" Ring (2)
11. Thrust Washer (2)
12. Thrust Bearing
13. Seal Ring (2)
14. "O" Ring (2)
15. Valve Sleeve
16. Drive Ring
17. Worm Shaft
18. "O" Ring
19. Seal Ring
20. Housing
20A. Bleed Screw
21. Bearing
22. Retaining Ring
23. Seal (Two-Piece)
24. Back-Up Washer
25. Seal
26. Trunnion Cover
27. Seal
28. Screw (4)
29. Seal Ring
30. "O" Ring
31. Rack Piston
32. Retaining Ring (2)
33. Poppet Seat (2)
34. Poppet (2)
35. Rod
36. Spring
37. End Cover
38. Sealing Nut
39. Adjusting Screw
40. Adjusting Screw
41. Hexagon Head Bolt (4)
42. Ball (27)
43. Ball Return Guide (2)
44. Clip
45. Lock Washer
46. Screw (2)
47. Seal
48. Cap
49. Screw (2)
50. Sector Shaft
51. Adjusting Screw
52. Retainer
53. Retaining Ring
54. Seal (Two-Piece)
55. Back-Up Washer (Plastic)
56. Washer
57. Side Cover Gasket
58. Side Cover
59. Nut
60. Vent Plug
61. Special Bolt (6)

Fig. 1

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DESCRIPTION

This steering gear (Fig. 1) is a fully integral power steering unit incorporating a hydraulic control valve, a hydraulic power cylinder and a manual steering mechanism into a single compact package. The control valve is a rotary design which combines simplicity of construction with desirable performance characteristics. Flow of oil from an engine driven pump is directed to the power cylinder by the control valve.

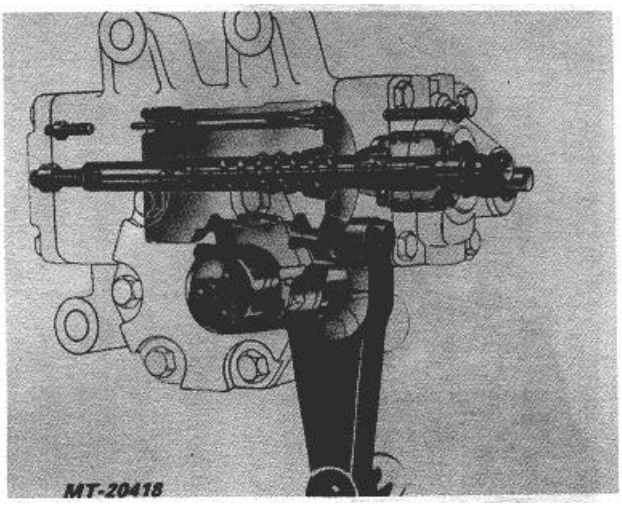


Fig. 2

DISASSEMBLY (For callouts, refer to Fig. 1)

Thoroughly clean off all outside dirt before disconnecting hoses. (Port holes should be plugged immediately after disconnecting hoses and before removing from the vehicle.)

All parts should be cleaned in clear, clean solvent and blown dry with air. Keep each part separate to avoid nicks and burrs.

IMPORTANT

Avoid wiping valve parts with cloth, as lint may actually cause binding and sticking of the closely fitted parts. Never steam clean or high pressure wash hydraulic steering gear assemblies. Do not force or abuse closely fitted parts, as damage may result.

1. Position steering gear in a vise with worm shaft (17) in a horizontal position. Check timing mark located on end of sector shaft (50), position this mark in vertical direction with steering gear in center of steering gear travel.

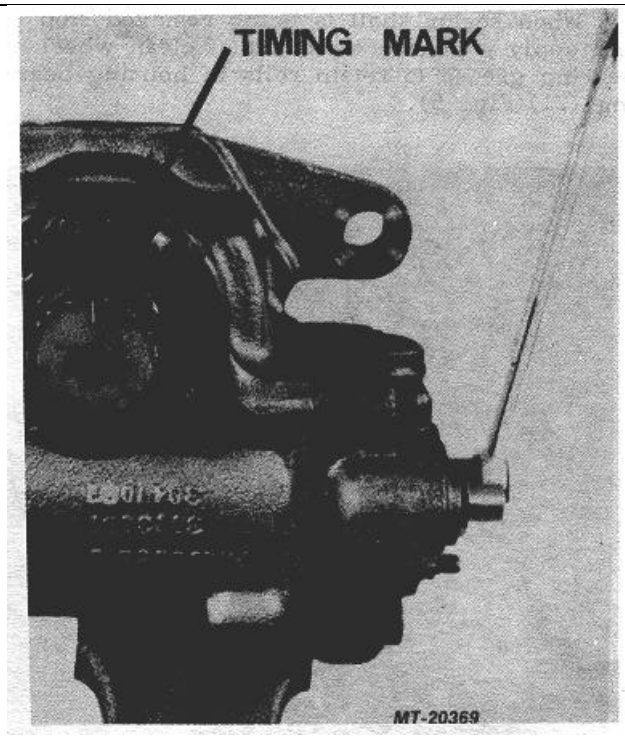


Fig. 3

2. Remove any paint or corrosion from serrated end of sector shaft (50) and loosen jam nut (59) on sector shaft adjusting screw (51).

3. To drain steering gear fluid remove six "special ring head" bolts (61) from side cover (58). These bolts have a special ring located on bolt head for sealing purposes, if these bolts are replaced, they must be replaced with same "special" type and length of bolt.

4. Remove side cover (58) and sector shaft (50). A soft hammer or wooden handle may be used to remove sector shaft (Fig. 4).

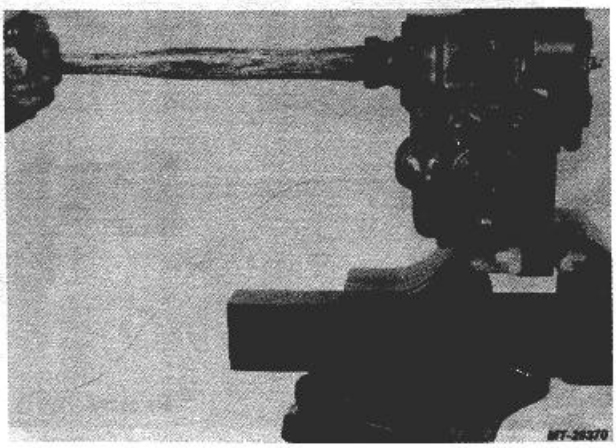


Fig. 4

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When sector shaft is being removed stop and apply a generous amount of clean wheel bearing grease to retain rolls in housing bearing (21)(Fig. 5).

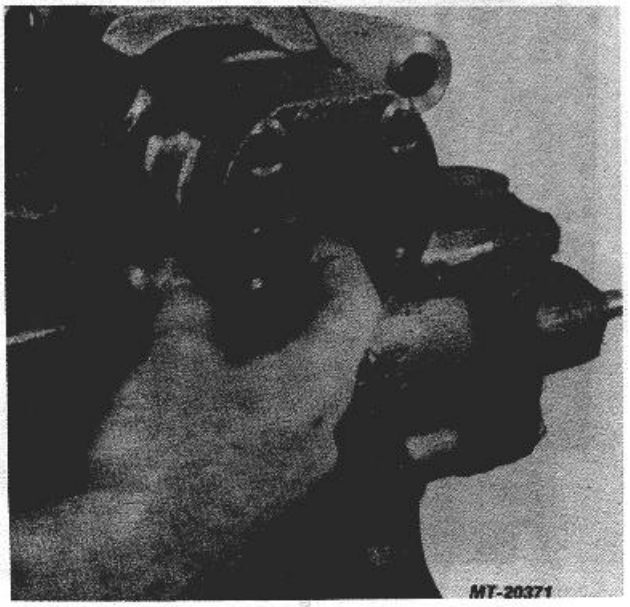


Fig. 5

5. Check to make sure all bearing (21) rolls are in place after sector shaft (50) is removed.

6. Remove sector shaft adjusting screw nut (59).

7. Screw sector shaft adjusting screw (51) thru side cover (58) with a screwdriver and remove shaft(50)(Fig. 6)

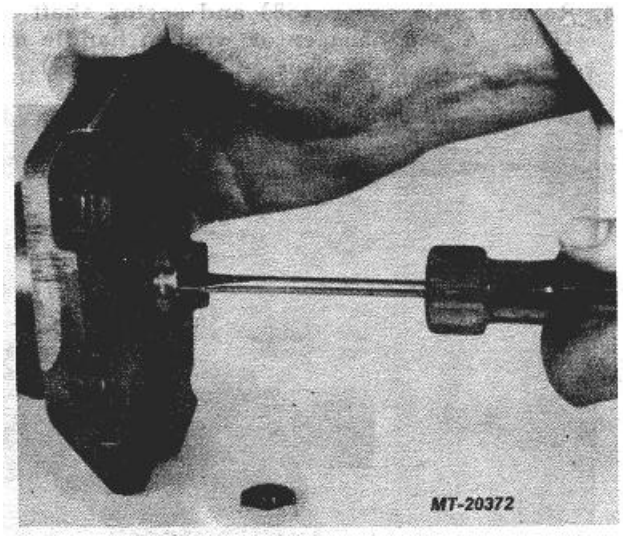


Fig. 6

8. Inspect sector shaft (50) bearing areas and tooth surfaces for wear marks, pitting or brinelling. If any of these conditions exist, replace sector shaft (Fig. 7)

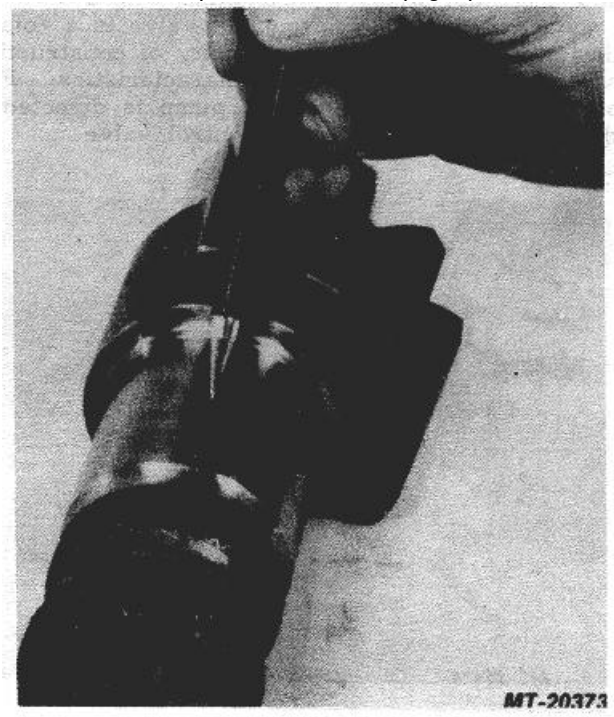


Fig. 7

9. Remove retaining ring (52), two-piece seal (54), (plastic) back-up washer (55) and (steel) back-up washer (56) from side cover (58).

10. Remove bearing rolls from side cover (58), inspect for wear marks; replace bearing if required. Bearing and bearing rolls cannot be replaced without replacing side cover

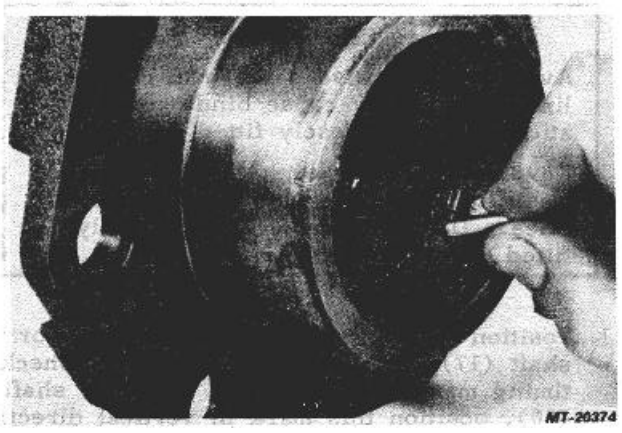


Fig. 8

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11. Remove seal (27) from trunnion cover (26) with a screwdriver and remove four screws (28) from trunnion cover and remove trunnion cover (Fig. 9).

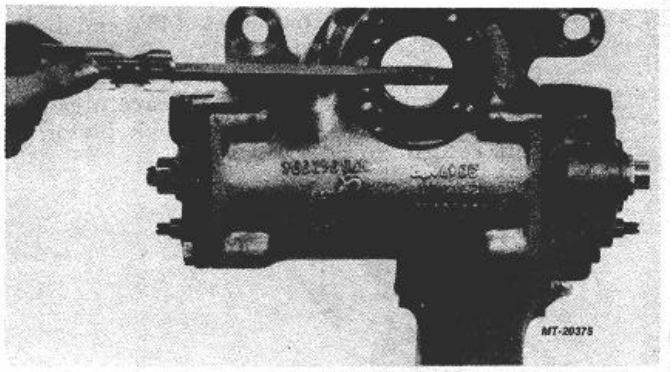


Fig. 9

12. Remove seal (25), two-piece seal (23) and back-up washer (24) from trunnion cover (26).

13. Loosen adjusting screw sealing nut (38) and adjusting screw (39) approximately two turns with a screwdriver and socket.

14. Remove four bolts (41) and remove end cover (37)(Fig. 10). Loosen nut (3) and adjusting screw (40) approximately two turns.

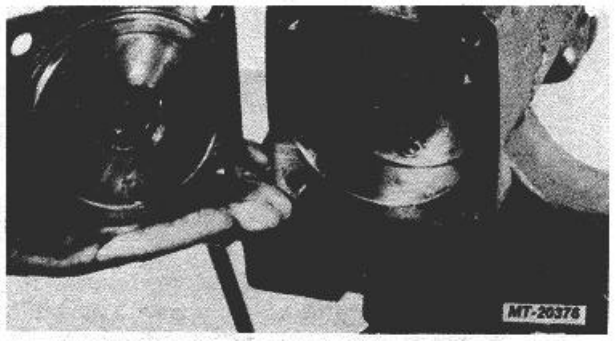


Fig. 10

15. Remove "O" ring (10) from end cover (37).

16. Remove relief valve (9A) from valve housing (9). Remove "O" rings (9B) and (9D) and seal ring (9C) from relief valve.

17. Remove four bolts (1) from valve housing (9) and remove valve housing.

IMPORTANT

Proper valve function depends on valve sleeve (15) and wormshaft (17) being reassembled in their original assembled position. Timing marks have been added to these parts so they can be reassembled in their original position (Fig. 11).



Fig. 11

18. Do not remove drive ring (16) from worm shaft (17) or attempt to unbend tangs which hold drive ring in place on worm shaft.

19. Remove valve sleeve (15) from valve housing (9).

20. Remove thrust washers (11) and thrust bearing (12) from valve housing (9).

21. Remove "O" ring (10) from valve housing (9).

22. Remove seal (4), retaining ring (5), back-up washer (6), slipper (7) and "O" ring (8) from valve housing (9).

23. Inspect thrust bearing (12) and thrust washers (11) for wear marks or brinelling, replace if damaged (Fig. 12).

24. Remove seal rings (13) and "O" rings (14) from valve sleeve (15).

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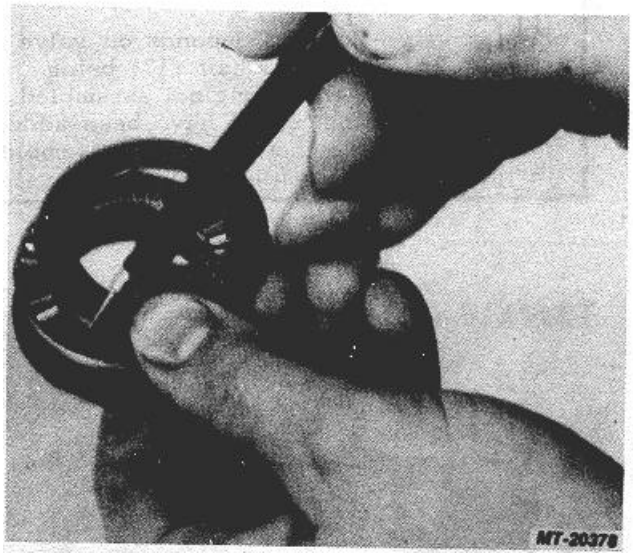


Fig. 12

25. Loosen sealing nut (3) and adjusting screw (2) in valve housing (9) approximately two turns.

26. Remove rack piston (31) and worm shaft (17) assembly from housing (20) (Fig. 13).

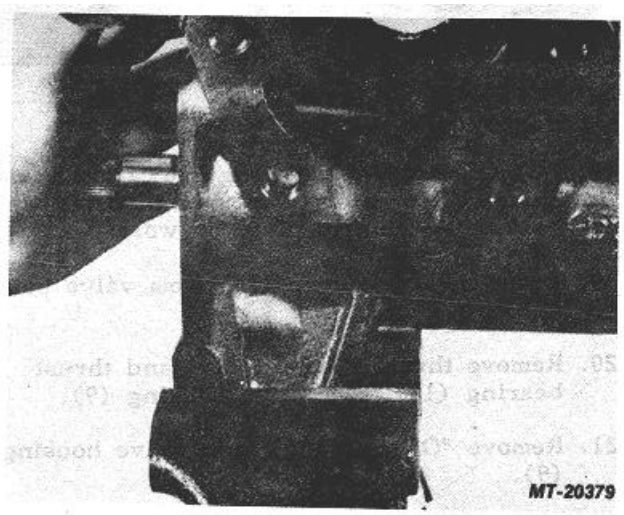


Fig. 13

27. Lay rack piston (31) and worm shaft (17) assembly on a clean rag to keep from rolling and to catch balls (42) as they come out. Bend locking tabs down on lockwashers (45), if applicable, some models of steering gears will not have lockwashers.

28. Remove two screws (46) or (49), if applicable.

29. Remove clip (44) or cap (48), if applicable.

30. Remove seal (47) from cap (48), if applicable.

31. Remove ball return guides (43) and balls (42) from rack piston (31). Ball return guides are closely fitted into rack piston and may have to be removed by carefully inserting a screwdriver between rack piston and ball return guides (Fig. 14).

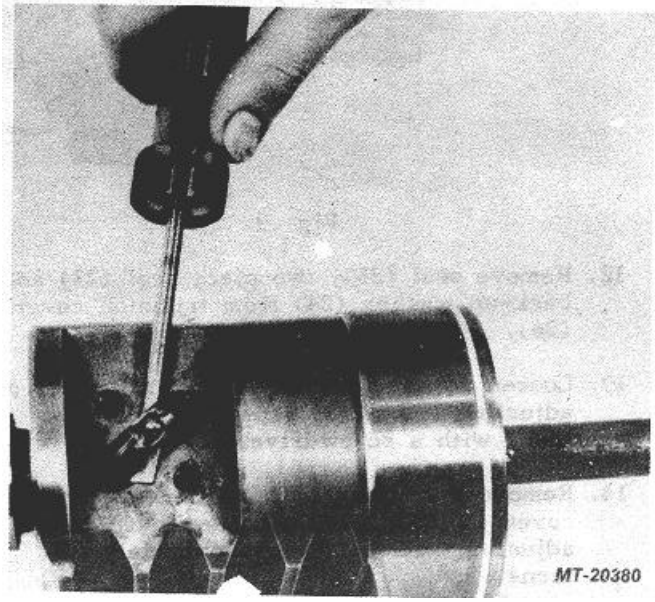


Fig. 14

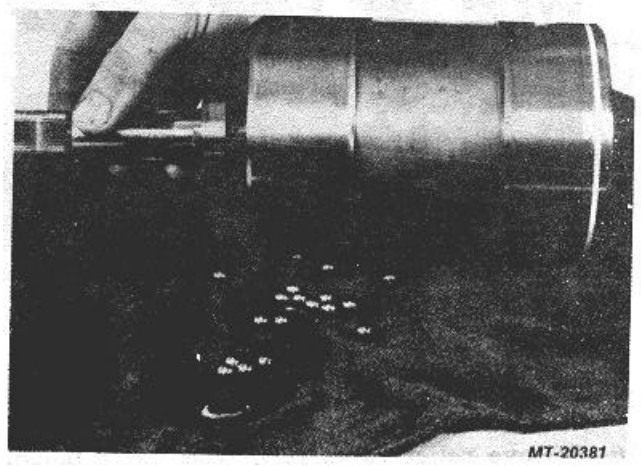


Fig. 15

32. To remove balls, turn rack piston over so balls can roll out as worm shaft is rotated in each direction by small amounts. Assembly contains a set of twenty-seven matched balls,

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special care must be exercised to not lose them. A complete new matched set of balls will be required if any balls are lost (Fig. 15).

33. Remove worm shaft (17) from rack piston.

34. Clamp rack piston (31) in a vise to remove retaining rings (32), poppet seats (33), poppets (34), rods (35) and spring (36). Do not remove these parts unless there is evidence of damage (Fig. 16).

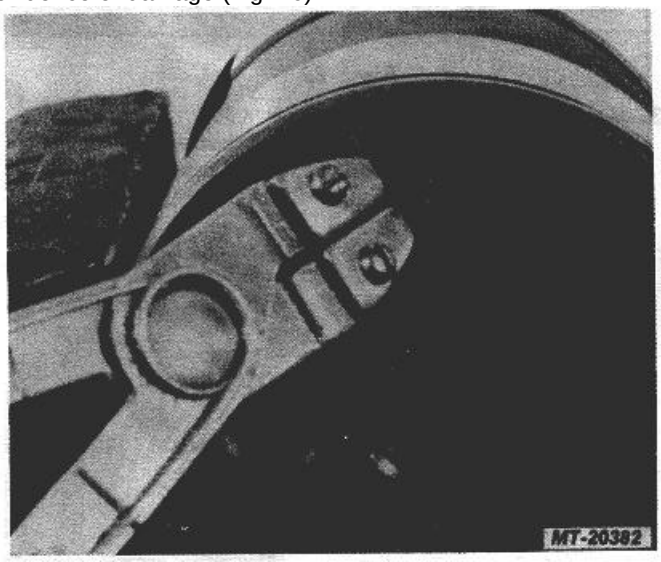


Fig. 16

35. Inspect rack piston (31) teeth and worm groove for excessive wear marks (Figs. 17 and 18).

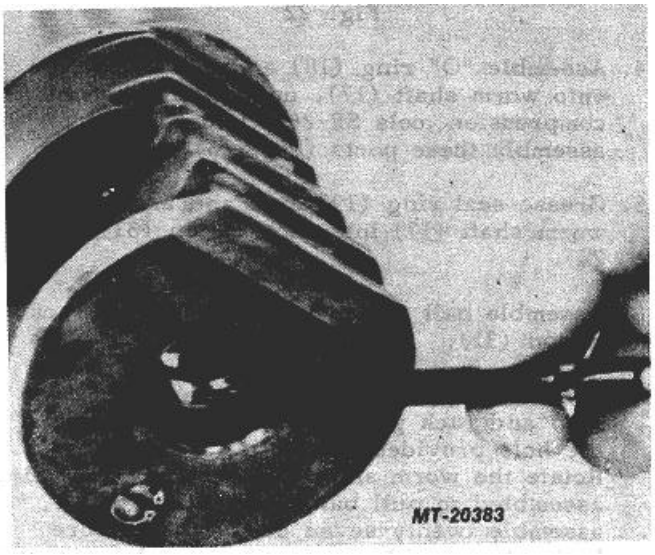


Fig. 17

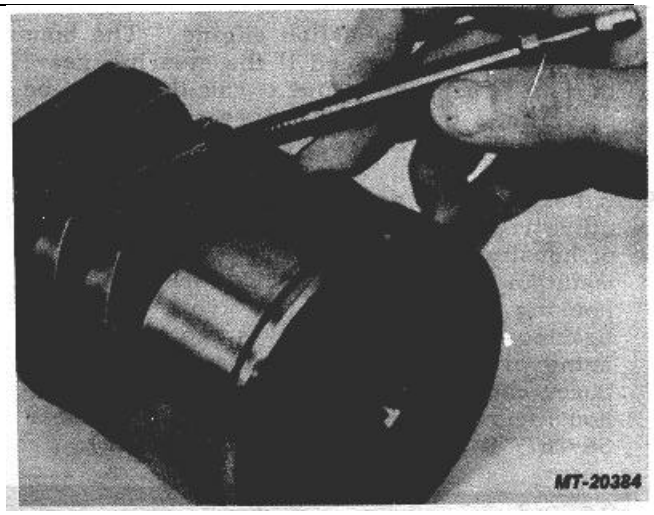


Fig. 18

36. Remove seal ring (29) and "O" ring (30) from rack piston (31).

37. Inspect worm shaft (17) helical groove for brinelling (Fig. 19). If this condition is visible the rack piston (31), valve sleeve and worm shaft must be replaced. Remove seal ring (19) and "O" ring (18) from worm shaft.

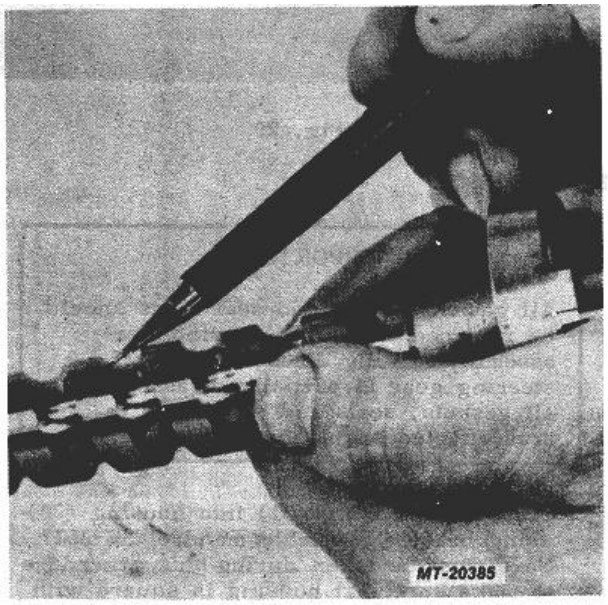


Fig. 19

38. Inspect housing (20) for abnormal wear, scoring or damage. The housing should not be replaced simply because the cylinder bore may exhibit considerable scoring, this scoring should not be rated in any manner relative to the type scoring which is critical

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to an internal combustion engine. The housing should be replaced if the steering gear is tested thoroughly and it can definitely be determined that cylinder bore scoring is responsible for excessive internal leakage.

39. If bearing, (21) and retaining ring (22) require replacement they must be pressed out of housing (20). Care must be taken to maintain a good square relationship between housing and press base, to avoid damaging bearing bore. If bearing is "cocked" while being pressed out, it may burnish housing bore, causing it to be oversize and require housing replacement. Use bearing mandrel SE-2677 to press bearing out (Fig. 20).



Fig. 20

REASSEMBLY

IMPORTANT

All gaskets, seals and seal rings should be replaced each time steering gear assembly is fully disassembled. If steering gear is partially disassembled all gaskets, seals and seal rings in area effected should be replaced.

1. Press new bearing (21) into housing (20) using bearing assembly mandrel SE-2677. Care must be taken during this procedure to make sure that housing is square with press base and that bearing is not in a " cocked" position. Apply a generous amount of clean wheel bearing grease to bearing race to retain bearing rolls; assemble forty four bearing rolls, grease must retain rolls (Fig. 21).

2. Assemble "O" ring (30) and seal ring (29) onto rack piston (31).

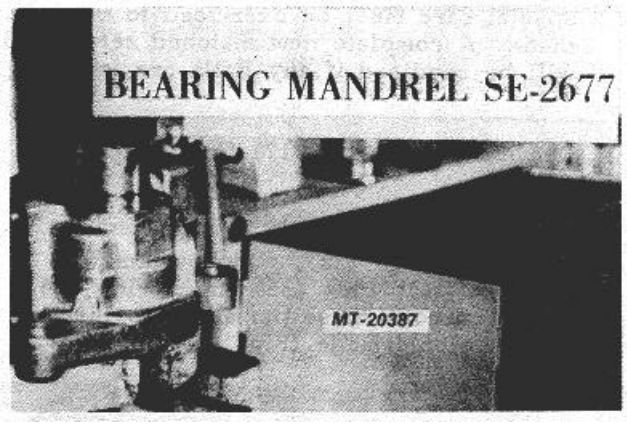


Fig. 21

3. Assemble spring (36), rod (35), poppets (34), poppet seals (33) and retaining ring (32) into rack piston (31). Torque poppet seats to 27-34 N•m (20-25 ft. lbs.)(Fig. 22).

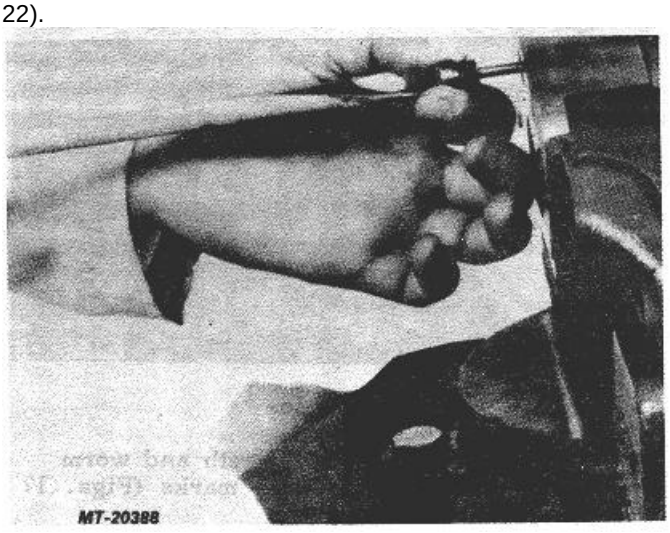


Fig. 22

4. Assemble "O" ring (18) and seal ring (19) onto worm shaft (17), use installation and compression tools SE-2673 and SE-2674 to assemble these ports (Fig. 23).

5. Grease seal ring (19) area and assemble worm shaft (17) into rack piston (31)(Fig. 24).

6. Assemble ball return guides (43) into rack piston (31).

7. Assemble balls (42) into ball return guides (43) and rack piston (31); drop balls thru the hole provided in the ball return guides. Rotate the worm shaft (17) as balls are being assembled to pull balls down into groove, assemble twenty-seven balls. Make sure ball return guides stay down in place in rack piston while assembling balls (Fig. 25).

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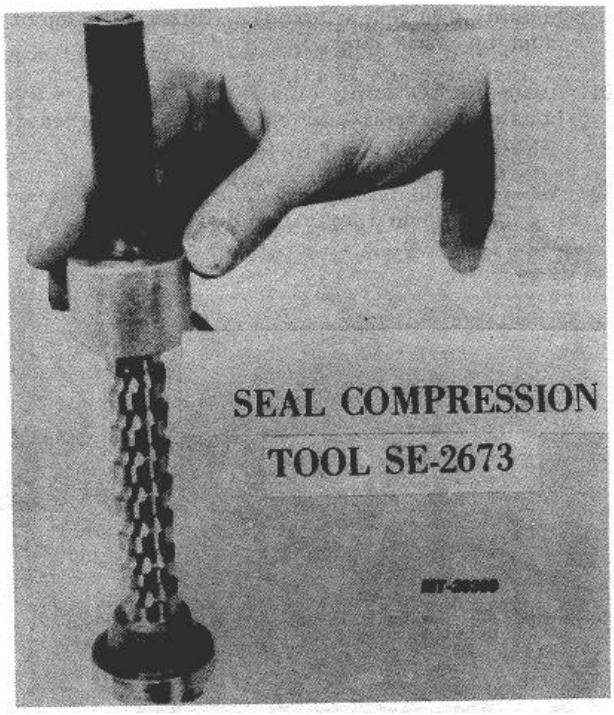


Fig. 23

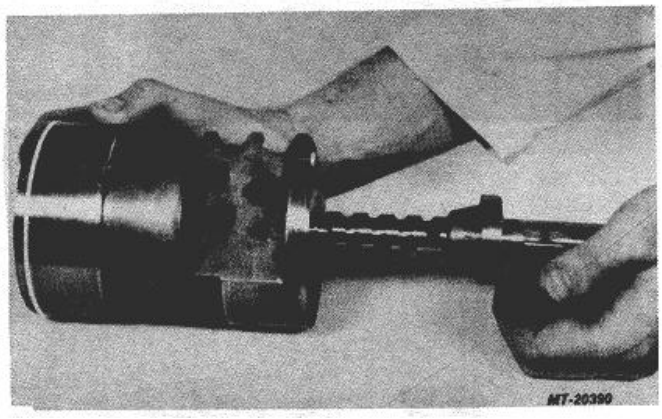


Fig. 24

8. Assemble clip (44) or seal (47) and cap (48) onto rack piston (31).

9. Assemble two lockwashers (45), if applicable.

10. Assemble two screws (46) or (49). Torque screws (46) to 15-20 N•m(11-15 ft. lbs.), torque screws (49) to 20-26 N•m (15-19 ft. lbs.). Screws (49) have a locking feature and lockwashers (45) are not required.

11. Bend tabs on two lockwashers (45) up against flat on screws (46)(Fig. 26).

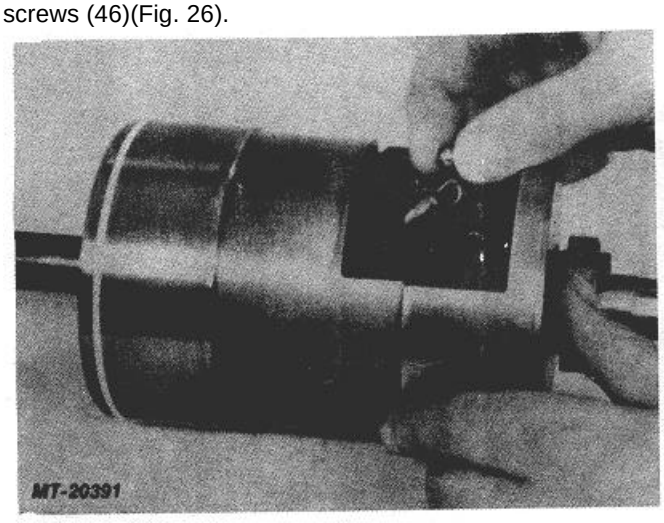


Fig. 25

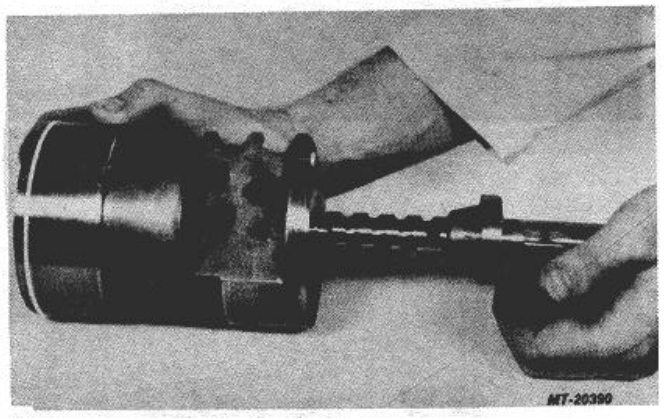


Fig. 26

12. Apply a generous amount of clean grease to seal ring (29) area of rack piston (31) and assemble rack piston and worm shaft assembly into housing (20)(Fig. 27).

13. Assemble sealing nut (38) onto adjusting screw (39) with sealing side to be against end cover (37)(Fig. 28).

14. Assemble adjusting screw (39) into end cover (37) a few turns. (Final adjustment must be made later.)

15. Assemble sealing nut (3) onto adjusting screw (40) with sealing side to be against end cover (37).

16. Assemble adjusting screw (40) into end cover (37) a few turns. (Final adjustment must be made later.)

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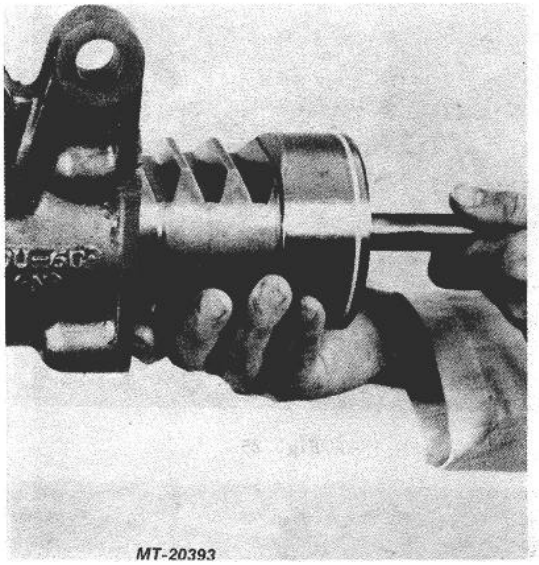


Fig. 27

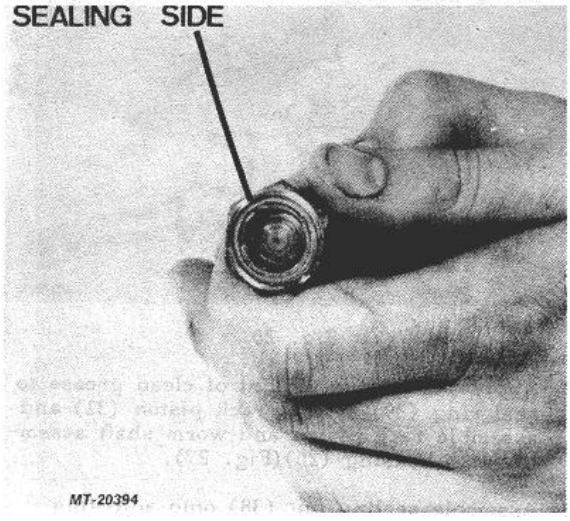


Fig. 28

17. Assemble "O" ring (10) into groove on end cover (37) and lubricate with clean grease to hold "O" ring in place.

18. Assemble end cover (37) onto housing (20) with four bolts (41). Torque bolts to 142-156 Nm (105-115 ft. lbs.).

19. Assemble sealing nut (3) onto adjusting screw (2) with sealing side to be against valve housing (9).

20. Assemble adjusting screw (2) into valve housing (9) a few turns. (Final adjustment must be made later.)

21. Assemble "O" ring (10) into groove on valve housing (9) and lubricate with clean grease to hold "O" ring in place.

22. Assemble thrustwasher (11) and thrust bearing (12) down into valve housing (9)(Fig. 29).

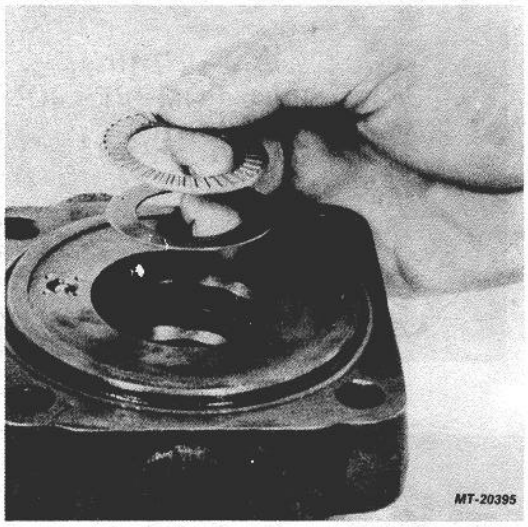


Fig. 29

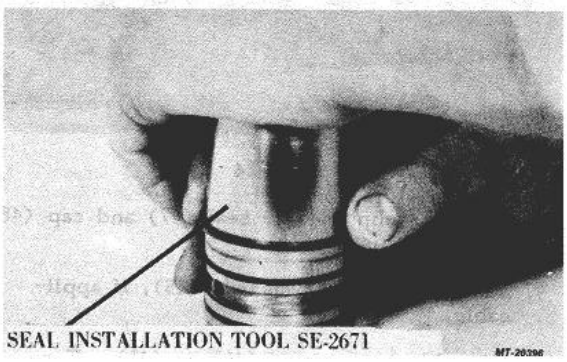


Fig. 30

23. Assemble "O" rings (14) and seal rings (13) onto valve sleeve (15), use installation and compression tools SE-2671 and SE-2672 (Figs. 30 and 31).

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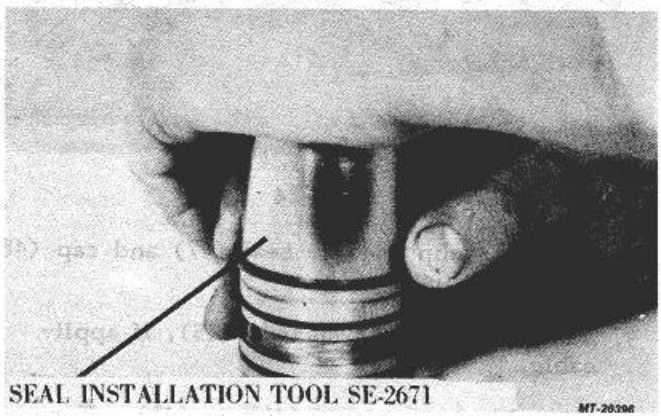


Fig. 31

24. Apply clean grease to seal ring (13) areas of valve sleeve (15).

25. Apply clean grease to end of valve sleeve (15) and assemble thrust washer (11) onto end of valve sleeve, grease must hold thrust washer in place (Fig. 32).



Fig. 32

26. Assemble valve sleeve (15) with thrust washer attached down into valve housing (9). When valve sleeve is down into place in valve housing, it should measure approximately 10.2 mm (.4 in.) from face of valve housing to face of valve sleeve (Fig. 33).

27. Align timing marks on valve sleeve (15) and worm shaft (17) and assemble valve housing (9) onto worm shaft. Make sure drive ring (16) teeth engage notches in valve sleeve (15). Use a box end wrench to rotate worm shaft to pull valve housing (9) down against housing (20)(Fig. 34).

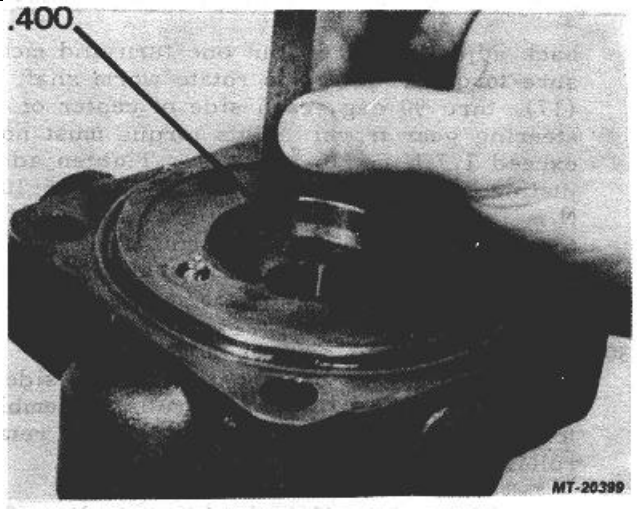


Fig. 33

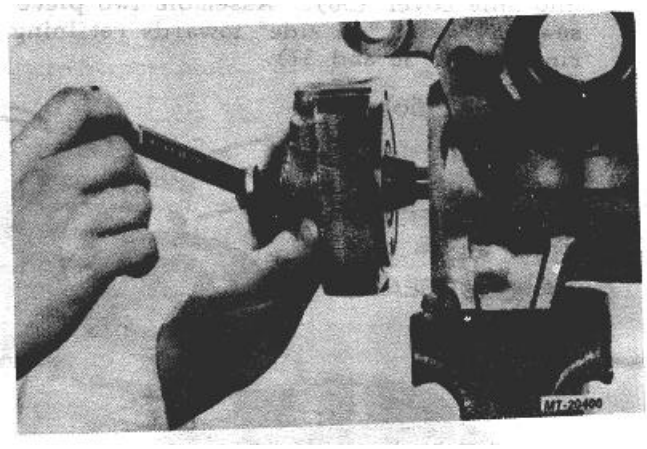


Fig. 34

28. Assemble four bolts (1) into housing (20) and torque to 142-156 N•m (105-115 ft. lbs.).

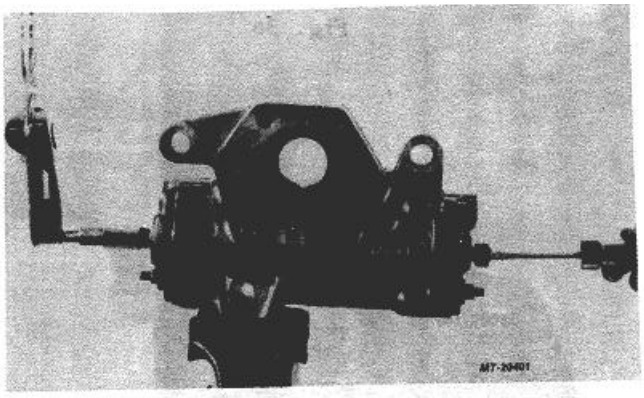


Fig. 35

29. With rack piston (31) near center of steering gear travel, screw adjusting screw (39) into solid height. 14 N•m (10 ft. lbs.) maximum

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back adjusting screw out one turn and measure torque required to rotate worm shaft (17), thru 90 deg. each side of center of steering gear travel. This torque must not exceed 1.7 N•m (15 in. lbs.). Tighten adjusting screw and torque nut (38) to 95-109 N•m (70-80 ft. lbs.), after tightening nut torque to rotate worm shaft must rise .45-.79 N•m (4-7 in. lbs.) above torque checked previously (Fig. 35).

30. Apply a generous amount of clean wheel bearing grease to bearing race inside side cover (58) to retain bearing rolls; assemble forty-four bearing rolls. Grease must retain rolls.

31. Assemble washer (56), back-up washer (55) two-piece seal (54) and retaining ring (53) into side cover (58). Assemble two-piece seal (54) with "oil side" towards retaining ring (Figs. 36 and 37).



Fig. 36



Fig. 37

32. Apply clean grease to short bearing area of sector shaft (50) and insert into side cover (58); screw adjusting screw (51) into side cover until it reaches solid height. The side cover should rotate freely on sector shaft with no appreciable axial movement (Fig. 38).

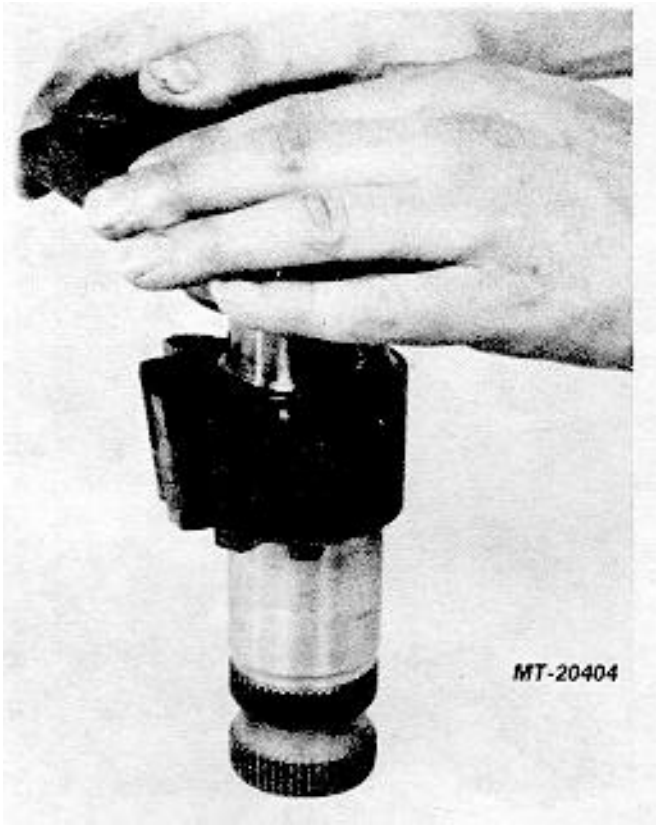


Fig. 38

33. Assemble nut (59) onto adjusting screw (51) a few threads. (Final adjustment must be made later.)

34. Assemble vent plug (60) in hole provided in side cover (58), press vent plug in flush with side cover.

35. Apply clean grease to side cover gasket (57) and assemble onto side cover (58). Grease must hold side cover gasket in place.

36. Rotate worm shaft (17) to position rack piston (31) in center of steering gear travel. Align center tooth on sector shaft (50) with third notch from seal ring (29) end on rack piston and assemble sector shaft with side cover attached into housing (20); care must be taken to not pinch side cover gasket and to be certain that sector shaft goes thru housing bearing (21) without knocking out bearing rolls (Figs. 39 and 40).

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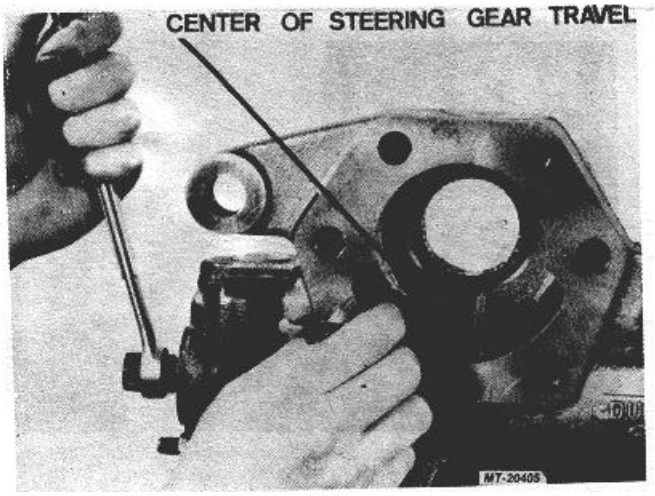


Fig. 39

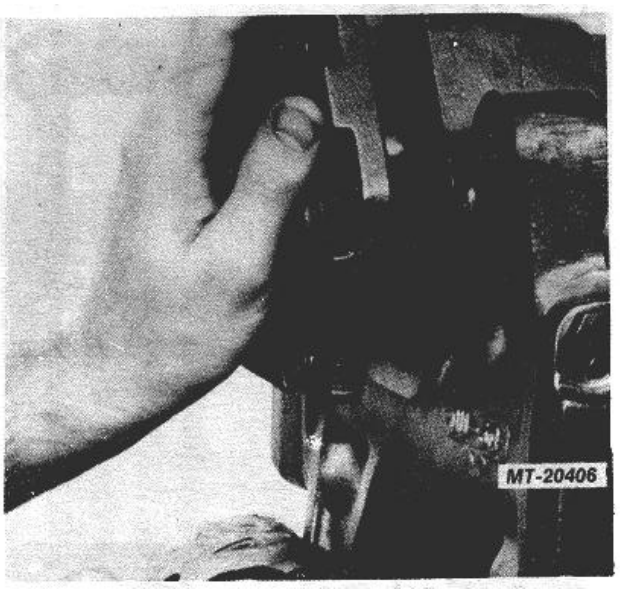


Fig. 40

37. Assemble six special bolts (61) and torque to 298-325 N•m (220-240 ft. lbs.).

38. Adjust side cover adjusting screw (51) to provide a 2.6-3.2 N•m(23-28 in. lbs.) torque at worm shaft (17) as steering gear is moved 90 deg. each side of center. Back out the adjusting screw one turn and note torque required to move thru 90 deg. each side of center. Move adjusting screw in to provide a rise in torque of .23-.45 N•m(2-4 in. lbs.) at a point within 45 deg. each side of center. After tightening nut (59) to 54-61 N•m (40-45 ft. lbs.) torque to rotate worm shaft must not exceed 2.9 N•m (26 in. lbs.) at any point in steering gear travel (Fig. 41).

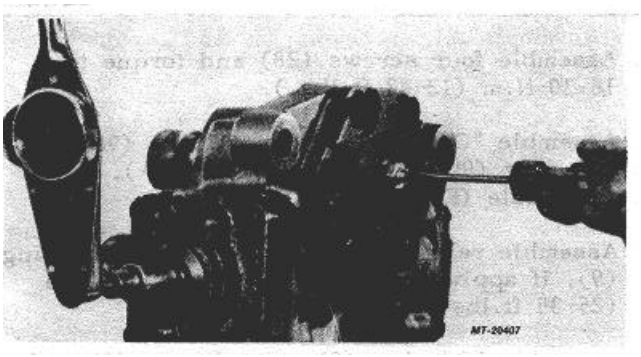


Fig. 41

39. Assemble back-up washer (24), two-piece seal (23) and seal (25) into trunnion cover (26). Assemble two-piece seal (23) with "oil side" towards housing (20).

40. Cover serrations on sector shaft (50) with tape and assemble trunnion cover (26) (Fig. 42).

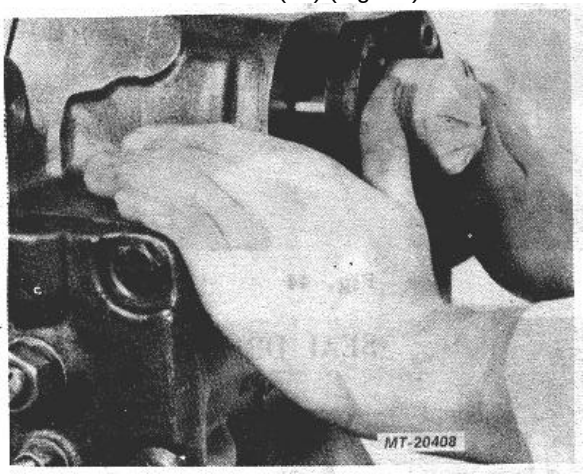


Fig. 42

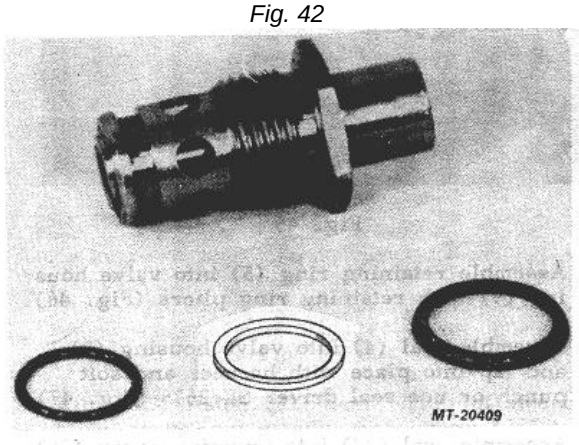


Fig. 43

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41. Assemble four screws (28) and torque to 16-30 N•m (12-22 ft. lbs.).

42. Assemble "O" ring (9B), seal ring (9C) and "O" ring (9D) onto relief valve (9A), if applicable (Fig. 43).

43. Assemble relief valve (9A) into valve housing (9), if applicable and torque to 34-48 N•m (25-35 ft. lbs.).
44. Assemble "O" ring (8) onto slipper (7) and assemble both parts (with flat side of slipper out) into valve housing (9). Assemble (steel) back-up washer (6) into valve housing (9), use seal driver to push parts into valve housing SE-2676 (Figs. 44 and 45).

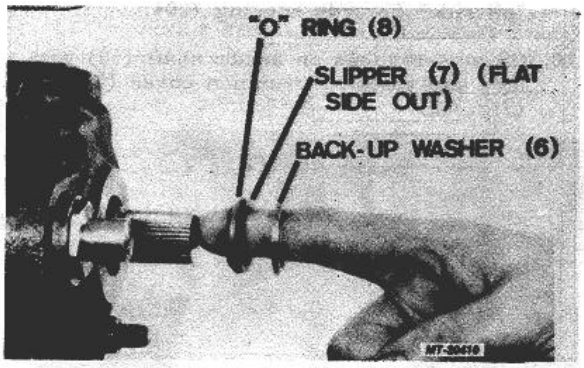


Fig. 44

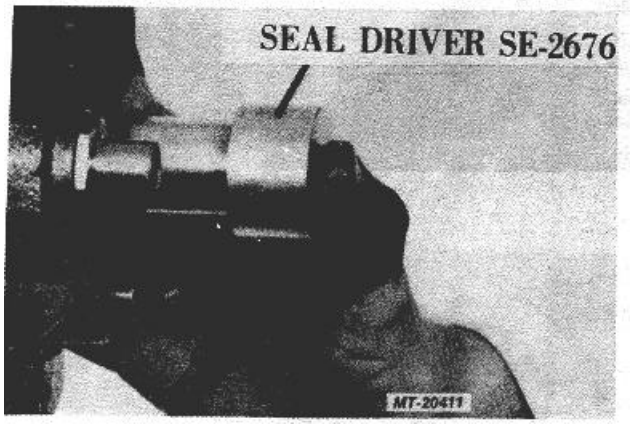


Fig. 45

45. Assemble retaining ring (5) into valve housing (9) with retaining ring pliers (Fig. 46).

46. Assemble seal (4) into valve housing (9) and tap into place with hammer and soft punch or use seal driver SE-2675 (Fig. 47).

47. Assemble seal (27) into trunnion cover (26) and tap into place with hammer and soft punch (Fig. 48)

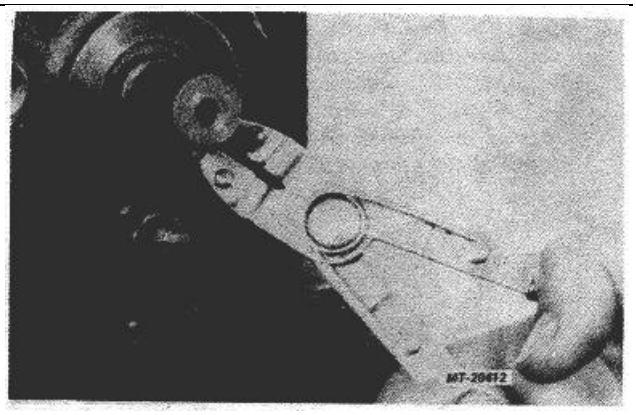


Fig. 46

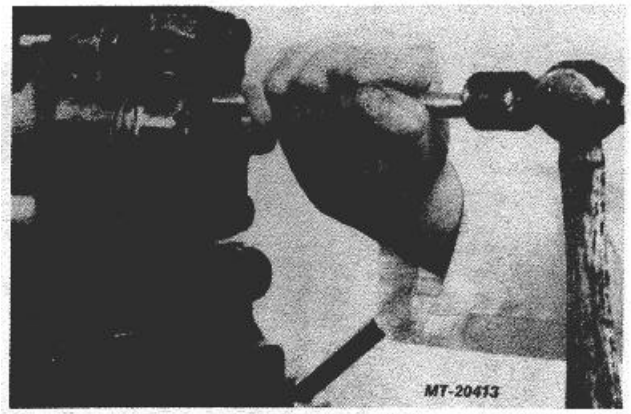


Fig. 47

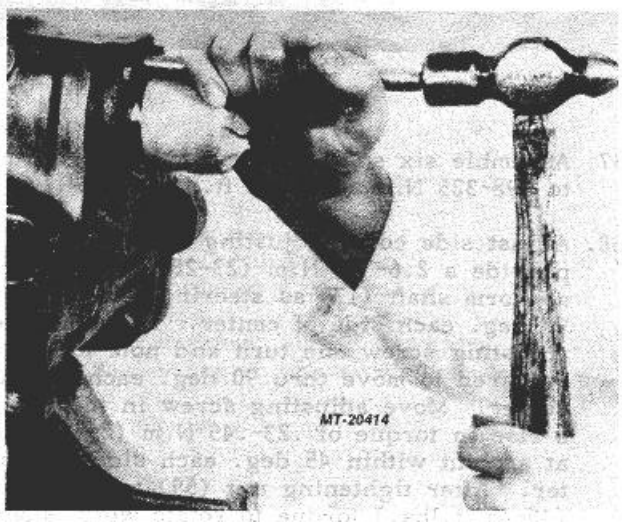


Fig. 48

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48. Assemble bleed screw (20A) into housing (31), if applicable and torque to 3.0-3.7 N•m (27-33 in. lbs.).

ADJUSTMENT OF POPPET ADJUSTING SCREWS (WITH STEERING GEAR INSTALLED ON VEHICLE)

1. Install a suitable pressure gage in the line between the pump and steering valve pressure port.

2. Actuate steering to provide full travel to wheel stops and note pressure on gage. Adjust adjusting screw (40) in a clockwise direction to provide a pressure at least 2757 kPa (400 psi) below pressure noted above. During this adjustment the oil temperature should be approximately 54.4 deg. C (130 deg. F).

   Care must be exercised to not hold pressure for longer than 15 seconds while this adjustment is being made, or damage to pump, from head, may result.

3. Repeat above procedure for other direction of steering. During the above procedure, observe for any tendency of the gear to self steer or motorize. If self steering does occur, check steering column, slip joint(s) and universal joint(s) for binding or excessive friction. If no problem is found in these areas, the gear should be checked as follows:

   A. Is upper thrust bearing package (items 11 (2 pcs) and 12) properly installed? If the gear has been assembled with these components out of position they probably will be damaged and should be replaced.

   B. Is valve sleeve (15) "sticky" on worm shaft (17)? These two parts are fitted very closely and a nick or burr on either part can cause the valve assembly to be sticky. Minor damage can be corrected by polishing with crocus cloth. If major damage is evident, the valve sleeve (15), drive ring (16) and worm shaft (17) should be replaced.

   C. If (A) and (B) above do not stop the tendency to self steer, the worm shaft (17) and valve assembly should be replaced.

ADJUSTMENTS & REPAIRS WITH STEERING GEAR ON VEHICLE

Removal of the steering gear from most vehicles is difficult and time consuming. It is suggested that after becoming proficient in servicing the gear on a bench as described in this manual, consideration be given to performing adjustment and minor repairs without removing the gear from the chassis. On some vehicles access to the gear may be so restricted that it must be removed for service.

1. Adjustments: Remove input coupling and pitman arm or drag link. Leave plumbing connected in normal manner. Engine should be running while adjustments are being made.

   A. Adjust sector shaft.

   B. Worm Preload Adjustment. Loosen jam nut (38), tighten adjusting screw (39) to 2.8-3.4 N•m (25-30 in. lbs.) and retighten the jam nut to 95-109 N•m (70-80 ft. lbs.) while holding the adjusting screw so that it does not rotate when the jam nut is tightened. Purpose of this adjustment is to put a light preload on the worm thrust bearing package items (11 and 12). After the adjustment has been made, there should be no perceptible in and out movement of the input shaft when it is oscillated from right turn to left turn and back. The input shaft should rotate smoothly and without binding thru full travel of the gear with a maximum torque of 3.7 N•m (33 in. lbs.).

2. Repairs

   A. On many installations the trunnion cover (26) can be removed from the gear allowing service of the output shaft seal package (23 and 24) and the trunnion cover seal (25). Remove the pitman arm and clean gear in area of trunnion cover so dirt will not get into gear while trunnion cover is removed. Remove dirt seal (27), clean dirt and paint from shaft. Remove trunnion cover and shaft seal package. Clean portion of shaft now exposed using fine emery paper if necessary.

      Cover shaft serrations with cellophane tape and reassemble using new shaft seal package (23 and 24), seal (25) and dirt seal (27). Add fluid to reservoir and bleed system if necessary.

   B. If the input shaft area is accessible, the input shaft seal assembly, items (7) and (8) can be replaced with a minimum of effort by the following procedure. Remove the input coupling and clean the area of the gear around the input shaft. Remove supply and return hoses from gear and plug hoses. Remove fittings

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from gear and plug lower most port to minimize loss of fluid. Install special fitting (or combination of fittings) in other port to allow connection to shop air. Remove dirt seal (4) and retaining ring (5). Clean dirt and paint from input shaft using fine emergy paper if necessary. Place a shop rag over input shaft area of gear and connect shop air to special fitting. Air pressure should cause seal assembly items (7) and (8), back-up washer (6) and some fluid to come out of gear. Be sure shop rag is in place and be prepared to disconnect air as soon as the seal assembly is out of the cavity.

Apply clean grease to O.D. and I.D. of seal and to input shaft. Install seal assembly (items 7 and 8) and back-up washer with flat side of seal assembly out. Press against back-up washer with soft (brass) probe until back-up washer is just inside retaining ring groove. Install retaining ring taking care that it is properly seated in groove. Pack cavity above retaining ring with grease and install dirt seal. Add fluid to reservoir and bleed system if necessary.

C. Other parts of the gear which may be serviceable on the vehicle are the end cover (37) and the valve housing (9) areas. Familiarity with the gear should be gained by bench disassembly and reassembly before attempting to service these areas. The portion of the gear to be disassembled should always be cleaned so that dirt is not introduced into the gear. Also, whenever the end cover or valve housing is removed for service, care must be taken to position the worm thrust bearing package (items 11, 12 and 11) properly upon reassembly. Anytime the end cover is removed, the worm adjusting screw should be backed out to avoid jamming of components when end cover is reassembled.

Always check fluid level in the reservoir after servicing the gear. If a significant amount of fluid is added, the system should be bled.

FILLING AND AIR BLEEDING THE SYSTEM

1. Fill reservoir nearly full. Be ready to add oil when engine is started. Do not let oil drop below outlet to power pump, to insure that power pump will not suck air into system.

2. Start engine, and let idle. Immediately add oil to reservoir as needed to keep reservoir full.

3. Steer vehicle from full right turn to full left turn several times. Poppets (34) must be adjusted so they relieve pressure at full right and full left turns in order to remove air from system. This procedure should remove all air from system unless steering gear is invert mounted.

4. To remove air from inverted mounted steering gears, see steps 1, 2 and 3, then determine which direction of steering wheel rotation is required to pressurize bleed screw (20A). Turn steering wheel slowly in this direction and loosen bleed screw a few turns. When all air is removed from system, tighten bleed screw 3.4 ± .33 N•m (30 ± 3 in. lbs.).

   If bleed screw (20A) is not tight when steering gear is rotated in opposite direction, air will be sucked into system.

LUBRICANT

For type of lubricant refer to LUBRICATION CTS-2412.

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TROUBLE SHOOTING INFORMATION

NORMAL NOISE

1. A "hissing" noise may be heard from the control valve when it is actuated during a steering maneuver.
2. Fluid being bypassed thru the poppets at full turn may cause noise.
3. Noise may be heard from the system relief valve when it is required to actuate.
4. Pump "growl" may be heard from some types of power steering pumps.

ABNORMAL NOISE

1. If the power steering pump is belt driven, a "squealing" noise during steering may indicate that the belt(s) should be tightened or replaced.
2. A "clicking" noise heard when initiating a steering maneuver or when changing directions of turn may indicate that some component is loose and is shifting under load.
3. A change in the normal noise from the power steering pump may indicate that an excessive amount of air has been trapped in the fluid or that the fluid level is low. Also check for dirt, sludge, or other foreign material-trapped in filter, screen, or other passages in the hydraulic system.
4. Excessive noise from the power steering pump may indicate that it is worn or defective. See "Pump Pressure Test" and Pump Flow Test.

ROAD WANDER

1. Components in steering linkage such as ball sockets on drag link or axle arm loose or worn.
2. Tire pressure incorrect or unequal left to right.
3. Wheel bearings improperly adjusted or worn.
4. Steering gear mounting bolts loose on frame.
5. Front end alignment out of specification.
6. Steering gear center adjustment improperly adjusted. (See adjustment procedure)
7. Dry fifth wheel or poor finish on fifth wheel or trailer plate.
8. Steering geometry incorrect (pitman arm and/or axle arm ball position).
9. Worm preload improperly adjusted. (See adjustment procedure).

NO RECOVERY

1. Front end alignment incorrect.
2. Ball sockets or other linkage connections too tight or not lubricated.
3. Pump Flow insufficient.
4. Tire pressure low.
5. Fifth wheel dry.
6. Control valve spool or sleeve sticking.
7. Tight front axle spindles.
8. Steering column binding.
9. Sector shaft adjustment too tight. (See adjustment procedure).
10. Worm preload too tight.

SHIMMY

1. Front end alignment incorrect.
2. Air in hydraulic system.
3. Wheels out of balance.
4. Components in steering linkage such as ball sockets on drag link or axle arm loose or worn.
5. Badly worn or unevenly worn tires.
6. Wheel bearings improperly adjusted or worn.

EXTERNAL OIL LEAKAGE

1. No external leakage is acceptable at steering gear.
2. Rubber relief plug (60) leaking at side cover indicates failure of sector shaft oil seal (54) in side cover.
3. Finding location of leak may be difficult since oil may "run" away from leak and drip from a low point on the gear or chassis.

DARTING OR TENDENCY TO OVERCORRECT

1. Front end components binding.
2. Sector shaft adjustment too tight (see adjustment procedure).
3. Control valve spool or sleeve sticking.
4. Steering geometry incorrect (pitman arm and/or axle arm ball position).
5. Steering column binding.

HIGH STEERING EFFORT

1. Vehicle overloaded.
2. Inadequate flow (See Pump Flow Test)
3. Inadequate pressure (See Pump Pressure Test).
4. Excessive internal leakage in steering gear (see Steering Gear Internal Leakage Test).
5. Low hydraulic fluid level
6. Low tire pressure.
7. Restriction in supply line or supply line too small.
8. High back pressure caused by restriction in return line or clogged filter.
9. Binding or lack of lubrication in linkage components or in steering column.
10. Poppet adjustment improper (if high effort occurs near end of travel in one or both directions of turn

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LOST MOTION AT STEERING WHEEL

1. Loose ball socket connections or other linkage connections.
2. Loose steering gear adjustment - Side cover adjustment and/or worm adjustment.
3. Steering wheel loose on shaft.
4. Pitman arm loose on output shaft.
5. Steering gear loose on frame.
6. Loose connections between steering column and steering gear.

EXCESSIVE HEAT

1. Restriction in pressure or supply line due to severe bend, kink, or clogging by dirt, sludge, or other impurities. Should be accompanied by high back pressure.
2. Undersize line, hose or fitting.
3. Vehicle overloaded causing pump relief valve to operate excessively during docking or other maneuvers.
4. Poppets not properly adjusted to relieve pressure at full turn in each direction.
5. Overheating can damage seals in both pump and steering gear.
6. Overheating may be evidenced by seals becoming hard, discoloration of internal parts of the gear and an offensive odor from the hydraulic fluid.

"TIPS" FOR MAINTENANCE OF STEERING GEAR SYSTEMS

1. Always check for wear in steering linkage and other system components first, before making adjustments to steering gear assembly

2. Prevent internal bottoming of steering gear . .Carefully check axle stops

3. Make periodic checks of lube level for steering gear and components to prevent malfunction due to inadequate lubrication.

4 Make routine and/or periodic checks for proper front end alignment.

5. Maintain correctly inflated tires.

6. Always use a "puller," never use a torch or hammer to remove steering arms.

7. Always carefully examine all steering parts which have been subject to "impact" and replace any that are questionable.

8. Investigate immediately, and correct cause of any play, rattle, or shimmy in any part of the linkage or steering mechanism.

9. Remove cause of steering column misalignment, and if necessary elongate support bracket holes at dash.

10. Encourage all drivers to report any malfunction or accident that could have damaged the steering mechanism.

11. Do not attempt to weld any broken steering component. (Replace only with original equipment.)

12. Do not cold straighten, hot straighten or bend any steering system part.

13. Always use new seals and "O"-rings during repairs and overhauls.

14. Replacement of single bearing assemblies, or balls, if one or more make a "set" is not recommended.

15. Excessive heat will develop if any power steering gear is held in an extreme right or left turn longer than a few seconds. (Heat developed can damage seals and/or pump.)

16. Prevent dirt or foreign particles from entering hydraulic steering systems. (Always clean off around filler caps, before removing to check oil supply.)

17. Use care to prevent even minor hydraulic leaks to continue.

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TORQUE CHART

SUBJECT	NUMBER (See Fig. 1)	NEWTON METERS	FT. LBS.
Hexagon Head Bolt	1	142-156	105-115
Sealing Nut	3	16-24	12-18
Relief Valve	9A	34-48	25-35
Bleed Screw	20A	37-45	27-33
Auxiliary Cylinder Fitting	-	34-48	25-35
Screw	28	16-30	12-22
Poppet Seat	33	27-34	20-25
Nut	38	95-109	70-80
Hexagon Head Bolt	41	142-156	105-115
Screw	46	15-20	11-15
Screw	49	20-26	15-19
Nut	59	54-61	40-45
Special Bolt	61	298-325	220-240
Bolt (Pitman Arm Clamp)	Lubricated or Plated	406-434	300-320

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STEERING GEAR

(SAGINAW)

I.H. Model	I.H. Code
S-57	05057
S-58	05058

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DESCRIPTION

The S-57 steering gear assemblies are the recirculating-ball-nut type. The mechanical element of these steering gears is a low-friction, high-efficiency recirculating ball system in which steel balls act as a rolling thread between the steering worm and ball nut. The rack of the ball-nut meshes with the sector of the pitman shaft. The ball nut, mounted on the worm, is driven through steel balls which circulate in helical grooves between the worm and nut. Ball return guides, attached to the nut, serve to recirculate the two sets of balls.

The teeth on the sector of the pitman shaft, and the ball nut are so designed that a tighter fit exists between the two when the front wheels are straight ahead. Preload adjustment between the pitman shaft sector gear and the rack teeth of the ball nut is maintained by a preload adjuster, screw threaded through the side cover, which moves the pitman shaft endwise. The worm bearing adjuster plug is threaded and provided with a lock nut to provide proper preloading of the worm between the upper and lower worm thrust bearings.

The S-57 (Fig. 1) and S-58 (Fig. 2) steering gear assemblies have lip-type grease seals at steering gear worm shaft and pitman shaft, threaded lash adjuster for adjustment of pitman shaft preload and bushings in gear housing and side cover. A back-up adjuster is used on some S-57 and all S-58 steering gears to prevent the steering gear worm shaft from flexing. (Fig. 1 & 2 - Item 6)

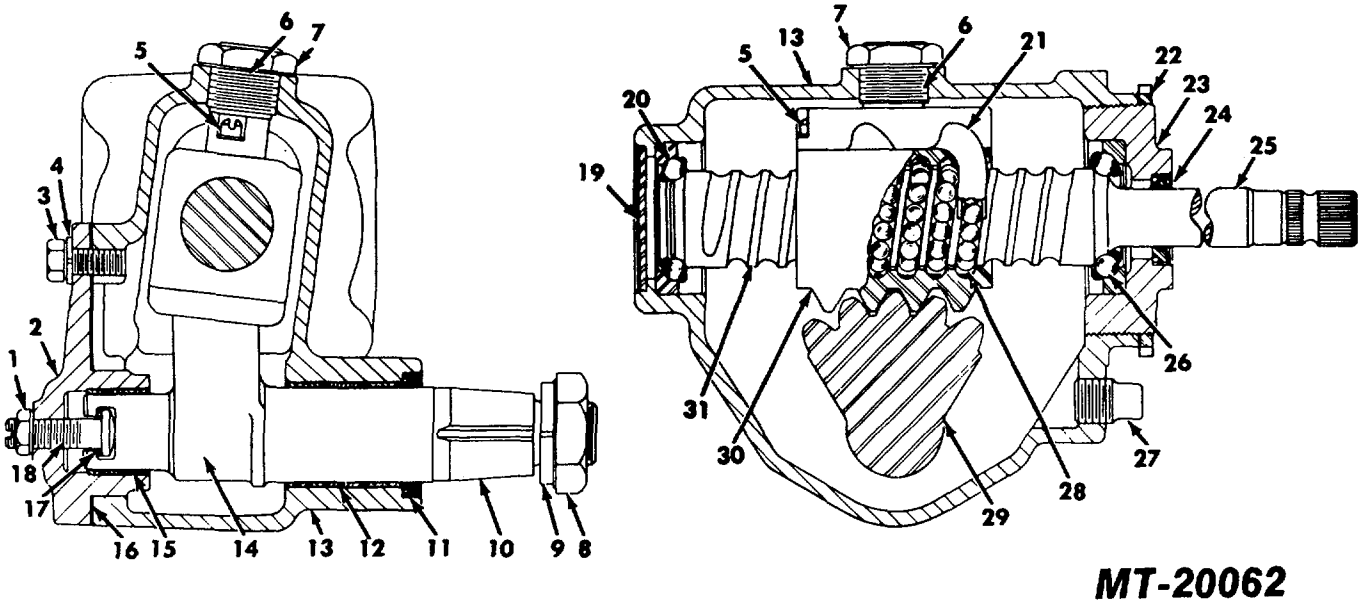


Fig. 1 S-57 Steering Gear Assembly

LEGEND FOR FIGURE 1

1. Preload Adjuster Lock Nut
2. Side Cover
3. Side Cover Bolt
4. Lock Washer
5. Clamp Retainer Screw
6. Back-up Adjuster
7. Back-up Adjuster Lock Nut
8. Pitman Arm Nut
9. Lock Washer
10. Pitman Shaft
11. Pitman Shaft Grease Seal
12. Housing Bushing
13. Steering Gear Housing
14. Pitman Shaft Sector Gear
15. Side Cover Bushing
16. Side Cover Gasket
17. Preload Adjuster Shim
18. Preload Adjuster
19. Expansion Plug
20. Worm Thrust Bearing (Lower)
21. Ball Guide
22. Adjuster Lock Nut
23. Cup and Adjuster Plug
24. Adjuster Worm Thrust Bearing Grease Seal
25. Steering Gear Worm Shaft
26. Worm Thrust Bearing (Upper)
27. Filler Plug
28. Worm Balls
29. Ball Nut
30. Worm

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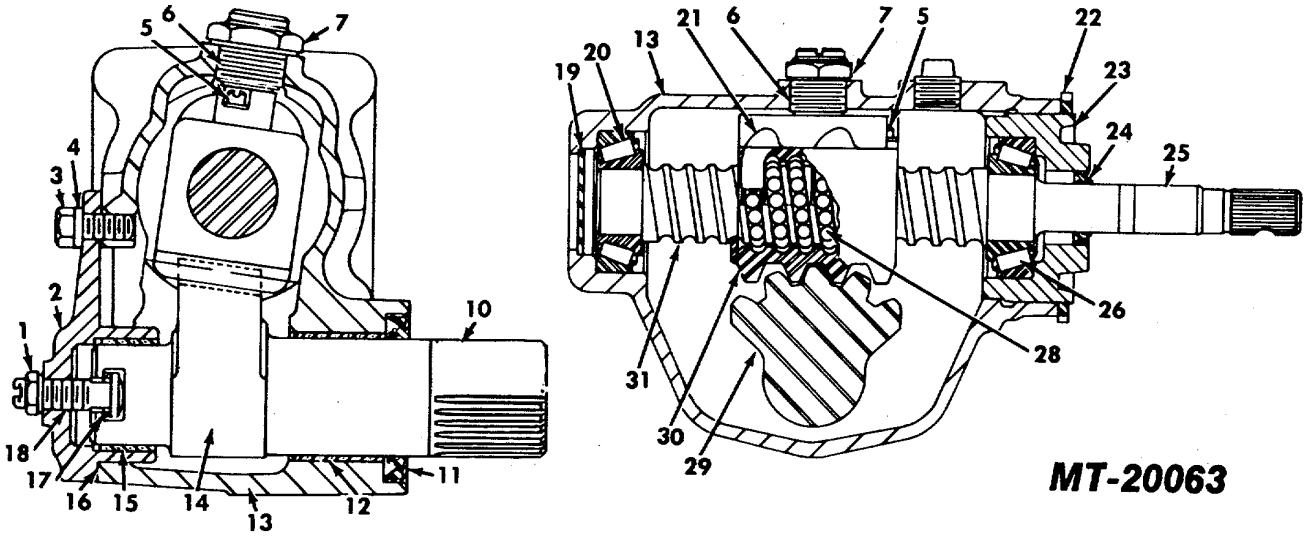


Fig. 2 S-58 Steering Gear Assembly

LEGEND FOR FIGURE 2

1. Preload Adjuster Lock Nut
2. Side Cover
3. Side Cover Bolt
4. Lock Washer
5. Clamp Retainer Screw
6. Back-up Adjuster
7. Back-up Adjuster Lock Nut
10. Pitman Shaft
11. Pitman Shaft Grease Seal
12. Housing Bushing
13. Steering Gear Housing
14. Pitman Shaft Sector Gear
15. Side Cover Bushing
16. Side Cover Gasket
17. Preload Adjuster Shim
18. Preload Adjuster
19. Expansion Plug
20. Worm Thrust Bearing (Lower)
21. Ball Guide
22. Adjuster Lock Nut
23. Cup and Adjuster Plug
24. Adjuster Worm Thrust Bearing Grease Seal
25. Steering Gear Worm Shaft
26. Worm Thrust Bearing (Upper)
27. Filler Plug
28. Worm Balls
29. Ball Nut
30. Worm

DISASSEMBLY

As with any ball bearing unit the steering gear parts must be kept free of dirt. Clean paper or rags should be spread on the work-bench before starting disassembly of the steering gear.

1. Place the steering gear in a vise, clamping onto one of the mounting tabs. The steering gear worm shaft should be in a horizontal position.

2. Loosen the preload adjuster lock nut. Turn the preload adjuster a few turns counterclockwise. This will remove the load from the worm bearings caused by the close meshing of the rack and sector teeth.

3. On gears equipped with back-up adjuster, loosen the ball nut back-up adjuster lock nut, then remove adjuster. Refer to items 6 and 7, Fig. 1 & 2.

4. On gear models having steering shaft bearing adjuster plug (item 23, Fig. 1 & 2), loosen lock nut, then turn adjuster plug outward a few turns.

5. Remove the bolts attaching the side cover to housing.

6. Tap lightly on the end of the pitman shaft with a plastic hammer and lift the side cover and pitman shaft assembly from the gear housing (Fig. 3).

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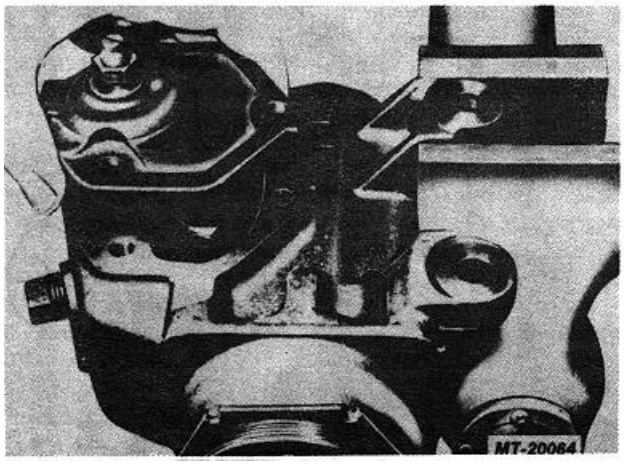


Fig. 3. Removing Pitman Shaft and Cover

If the sector does not clear the opening in the housing easily, turn the steering gear wormshaft by hand until the sector will pass through the opening in the housing.

7. Remove the adjuster plug and lock nut (items 22 and 23, Fig. 1 & 2), then draw the steering gear wormshaft and ball nut assembly from the housing.

IMPORTANT

Use care that the ball nut does not run down to either end of the worm. Damage may be done to the ends of the ball guides if the nut is allowed to rotate until stopped at end of the worm.

8. Remove the upper bearing from the steering gear wormshaft and the lower bearing from the housing.

9. Remove the lock nut from the preload adjuster screw in the side cover. Remove the preload adjuster screw from the side cover by turning the screw clockwise.

Slide adjuster screw and shim out of the slot in the end of the pitman shaft.

INSPECTION

1. With the steering gear completely disassembled, wash all parts in cleaning solvent. Dry them thoroughly with air. With a magnifying glass inspect bearings and bearing cups for signs of indentation. Check for any signs of chipping, cracking or breakdown of the surface. Any parts that show signs of damage should be replaced.

2. Inspect all seals. Any seal that is worn or has been removed should be replaced.

3. Inspect the pitman shaft for wear. Check steering gear wormshaft assembly for being bent or damaged in any way. Check especially for brinell marks on the worm thread or bearing cones of the worm. Check the ball nut for brinell marks or cracks. Never attempt to salvage steering parts by welding or straightening. Check fit of the pitman shaft in the housing and side cover bushing or bearing. The housing bushings can be replaced; however, if the side cover bushing indicates need for replacement, the entire side cover assembly must be replaced.

REPAIR

Pitman Shaft or Steering Gear Wormshaft Seal Replacement

The pitman shaft and steering gear wormshaft seals should be replaced each time a defective seal is indicated or the steering gear is disassembled.

1. Pry out the old seal using a screwdriver, taking care not to injure bearings or bushings.

2. Before installing a new seal, check the condition of the pitman shaft bushing(s) or bearings and/or the upper steering gear wormshaft bearing cup.

3. Install new seals by pressing on the outer diameter of the seal with a suitable socket. Avoid contact with sealing lip.

Pitman Shaft Bushing Replacement

1. Support the steering gear in an arbor press (Fig. 4) and press the pitman shaft bushing(s) from the housing using Tool SE-2634 with Handle SE-2635.

2. Press new bushings into the housing using Tool SE-2634 with Handle SE-2635 until they are flush. Note bushing locations as shown in Figures 1 and 2.

Service pitman shaft bushings are diamond bored to size and should not be scraped or reamed.

Side Cover Bushing Replacement

The entire side cover assembly, including bushing, is serviced as a unit when it is necessary to replace the bushing.

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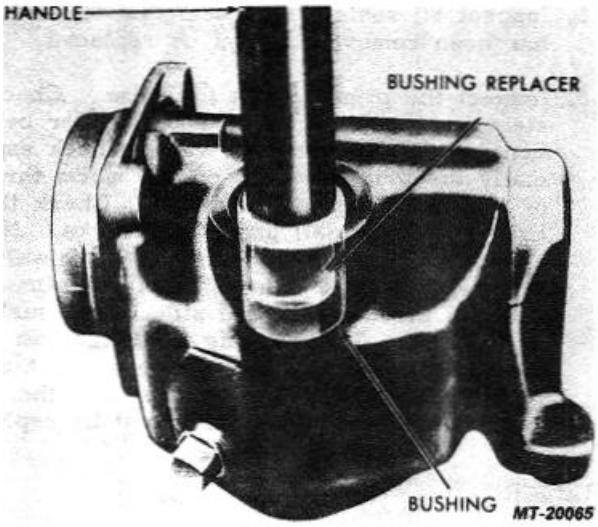


Fig. 4. Replacing Pitman Shaft Bushing

Steering Gear Wormshaft Bearing Replacement
(S-57 Gears)

The steering gear wormshaft upper bearing is removed from housing with wormshaft. The lower bearing remains loose in housing.

To replace wormshaft bearings, lift upper bearing off wormshaft and lift lower bearing from housing.

(S-58 Gears)

1. Position ban nut at center of wormshaft and secure in position.
2. Place the assembly in an arbor press and press the bearing cones from either end of the steering gear wormshaft.
3. If the ball nut pin stops are damaged, they should be replaced.
4. Press the new bearing cones onto the steering gear wormshaft.

   If an inspection of the ball nut indicates need of replacement, this should be done while the bearings are removed from the steering gear wormshaft.

Steering Gear Wormshaft Bearing Cup Replacement

(Bearing Cup Installed in Gear Housing)

1. Examine the expansion plug first to determine if it must be pressed out from inside or outside in order to remove bearing cup. Place steering gear housing in an arbor press. Using a suitable size socket, press the sheet metal expansion plug and bearing cup out of housing (Fig. 5).

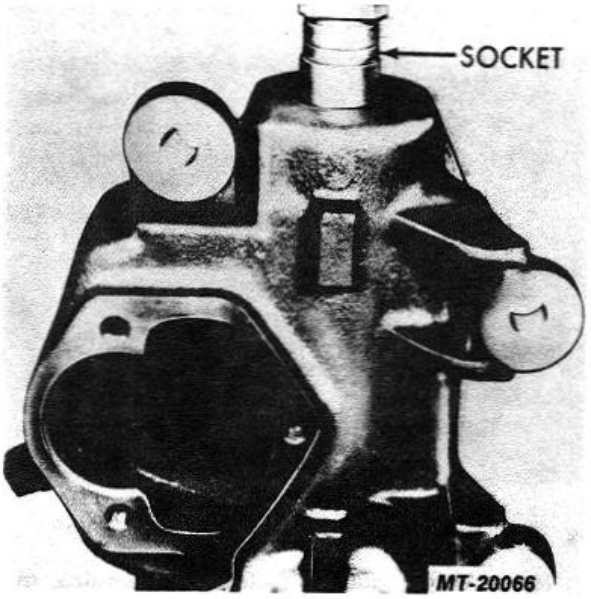


Fig. 5. Removing Expansion Plug and Lower Worm Thrust Bearing Cup

2. On some gear models, install a new expansion plug. in the lower end of the housing. Press on center of plug to deform it outward and secure it in the housing. Make sure that the plug is tight in the housing or lubricant leakage could occur.

3. Position the new bearing cup squarely over the recess in the gear housing and press the cup in until it is firmly and evenly seated. Use an old cup to press the new cup into place.

(Bearing Cup Installed in Adjuster Plug or End Cover)

Pry out seal (discard) with screwdriver, taking care not to damage seal bore.

1. Using a suitable punch and hammer, drive the upper bearing cup from the adjuster plug.

2. If removing cup from cover, place the cover in a vise and using Puller SE-1746, remove the bearing cup.

3. Position the new bearing cup squarely over the recess in the adjuster plug or end cover and press the cup in until it is firmly and evenly seated. Use an old cup to press the cup into position on adjuster plug, press new seal in place using suitable sized socket.

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Preload Adjuster Replacement

1. Position the preload adjuster (with shim) in the slotted end of the pitman shaft. Check the end clearance it should not be greater than .05 mm (0.002 in.) nor should it bind (Fig. 6). If clearance is greater than .05 mm (0.002 in.), a steering gear preload adjuster shim unit is available. It contains four shims 1.60 mm (0.063 in.), 1.65 mm (0.065 in.), 1.70 mm (0.067 in.) and 1.75 mm (0.069 in.) thick.

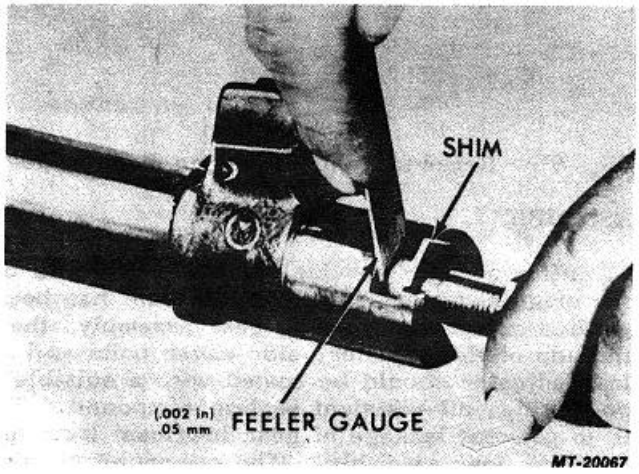


Fig. 6. Checking Preload Adjuster End Clearance

Ball Nut Servicing

Generally, the ball nut and worm assembly need not be disassembled. Wash off the assembly with solvent and visually inspect the worm thrust races and ball rides. If dented, or surface cracks are in evidence, the ball nut and worm should be replaced.

If the assembly appears normal, hold ball nut and turn the worm from stop to stop.

IMPORTANT

Do not let the ball nut free fall on the worm as the ball guide pick-up fingers could be damaged.

If binding or roughness is felt when the worm is being turned, the unit should be disassembled.

(To Disassemble)

1. Remove the screws and clamp retaining the ball guides in the nut. Draw the guides out of the nut.
2. Turn the nut upside down and rotate the steering gear wormshaft back and forth until all balls have dropped out of the nut into clean pan. With the balls removed, the ball nut can be pulled endwise off the worm.
   The upper and lower bearing cone with ball nut stop must be removed before the ball nut can be removed from the steering gear wormshaft.
3. With the ball nut and worm disassembled, wash all parts with solvent. Inspect both the worm and ball nut ball rides for fretting (appears rusted), surface cracks, excessive wear, etc. Replace as required.

(To Assemble)

1. Place the steering gear worm flat on the bench and slip the ball nut over the worm with the ball guide holes up and the shallow end of the rack teeth to the left from the steering wheel position. Align the grooves in the worm and ball nut by sighting through the ball guide holes.
2. Count out the total number of balls to be installed Divide this total in half and put into separate containers as shown in Fig. 7.

Gear Assemblies	Total No. of Balls	No. of Balls Per Circuit
S-57	106	53
S-58	96	48

Drop the balls into one of the guide holes while turning the worm gradually away from that hole. (Fill only one circuit at a time.) Continue until that ball circuit is full from the bottom of one guide hole to the bottom of the other or until stopped by reaching the end of the worm.

In cases where the balls are stopped by the end of the worm, hold down those balls already dropped into the ball nut with the blunt end of a clean rod or punch (Fig. 7) and turn the worm in the reverse direction a few turns. The filling of the circuit can then be continued. It may be necessary to work the worm back and forth, holding the balls down first in one hole then the other. Close up the spaces between the balls and fill the circuit completely.

3. Lay one-half of the ball guide, groove up, on the bench and place the remaining balls in it (Fig. 8). The number of balls remaining should just fill the guide.

4. Close this half of guide with the other half. Hold the two halves together the plug each open end with grease so the balls will not drop out while installing the guide.

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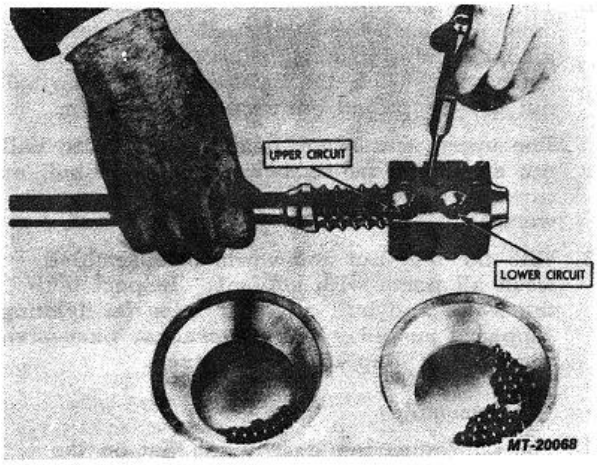


Fig. 7. Filling Ball Nut Circuits

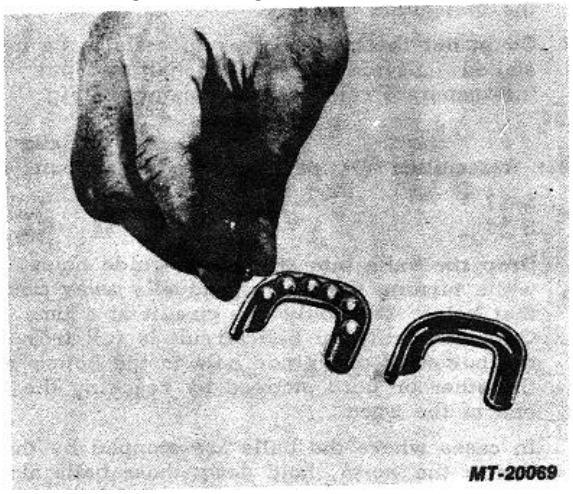


Fig. 8. Filling Ball Guides

5. Push the guide into the guide holes of the nut (Fig. 9). This completes one circuit of balls. If the guide does not push all the way down easily, tap it lightly into place with the handle of a screwdriver or plastic hammer.

6. Fill the second ball circuit in the same manner as described for the first ball circuit.

7. Assemble the ball guide clamp to the nut, then tighten the screws securely.

8. On S-58 gear assemblies, install bearing cone to steering gear wormshaft.

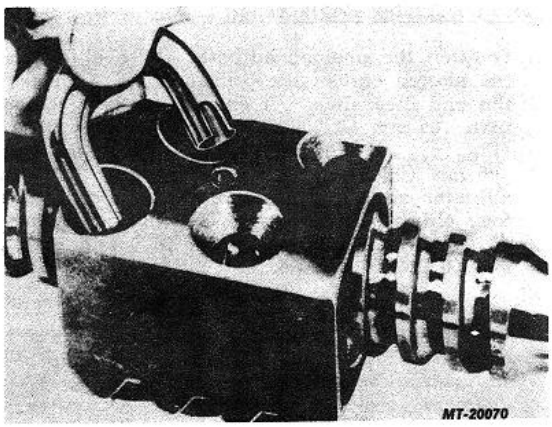


Fig. 9. Removing and Replacing Ball Guides

ASSEMBLY

After a major service overhaul where all of the original factory installed lubricant has been washed out of the steering gear assembly, the threads of the adjuster, side cover bolts and lash adjuster should be coated with a suitable nondrying, oil-resistant sealing compound. This is to prevent leakage of gear lubricant from the steering gear assembly. The compound should not be applied to female threads and care should be exercised in applying this compound to the bearing adjuster, as the compound must be kept away from the bearing race. Apply grease to the bearings, bushings and ball nut teeth.

1. Place the steering gear housing in a vise with the steering gear wormrshaft horizontal and the side cover up.

2. Check that the pitman shaft and steering gear wormshaft seals, pitman shaft bushings or bearings and steering gear wormshaft bearing cups are installed. The ball nut should be installed on the steering gear worm shaft.

3. On S-57 Gear Assemblies (Fig. 1)

   a. Place steering gear wormshaft bearing in the housing cup. Slide the other bearing and the adjuster plug assembly over the upper end of the wormshaft.

   b. Insert the ball nut and wormshaft assembly into the housing, inserting the lower end of the worm in the housing bearing.

      Keep the ball nut away from the end of the worm threads.

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c. Thread the adjuster plug into the housing until nearly all end play is removed from the steering gear wormshaft.

4. On S-58 Gear Assemblies (Fig. 2)

   a. The bearing cones should be installed in their proper location on the steering gear wormshaft assembly.
   b. Place the steering gear wormshaft assembly in the housing until the lower cone is inserted into lower bearing cup.
   c. Slide the threaded adjuster on the wormshaft Engage adjuster to housing by turning adjuster clockwise.

5. Start the pitman shaft into the side cover bushing Then, using a screwdriver, through the hole in the side cover, turn the preload adjuster counterclockwise to pull the pitman shaft into the side cover bushing as far as it will go, and then back clockwise approximately one-half turn.

6. Rotate the steering gear wormshaft by hand until the ball nut is about in the center of travel. This is to make sure that the ball nut and sector will engage properly with the center tooth of the sector entering the center tooth space of the ball nut.

7. Pack clean lubricant into gear housing.

8. Tape the serrations on the end of the pitman shaft (to prevent seal damage). Install a new gasket on the side cover and carefully lower the pitman shaft assembly part way into the housing. Install the remaining portion of gear lubricant and then lower the pitman shaft assembly the rest of the way into the housing.

9. After making sure that there is some lash between the ball nut and sector teeth, assemble and tighten the side cover bolts to specified torque.

BENCH ADJUSTMENTS

Worm Bearing Adjustment

1. With the preload adjuster backed off, tighten the adjuster plug until all end play has been removed.
2. Using a 12-point socket on splined end of the steering gear wormshaft and an inch pound torque wrench, carefully turn the steering gear wormshaft all the way to one stop and then back one turn.
3. Measure the amount of torque required to keep the shaft in motion. Rotate the adjuster plug until the proper preload of 1.6-2.0 N.m (14-18 in. lbs.) is obtained.
4. Tighten plug lock nut to specified torque.
5. Recheck worm bearing preload adjustment to make sure that it remains within specification after lock nut is tightened.

6. Readjust if necessary.

Pitman Shaft Preload Adjustment

1. Turn the steering gear wormshaft from one stop all the way to the other, counting the number of turns; then turn back exactly half the number of turns to the center position.

2. Turn the preload adjuster screw clockwise to remove all lash between ball nut and sector teeth. Tighten the lock nut.

3. Again using the 12-point socket on splined end of shaft and an inch-pound torque wrench, observe the highest reading while the gear is turned through center position. Adjust the preload adjuster to obtain preload adjustment .9-1.4 N.m (8-12 in. lbs.) in excess of the worm thrust bearing preload, but not to exceed 3.4 N.m (30 in. lbs.).
4. Tighten the lock nut to specified torque and again check torque reading through center of travel. If necessary, readjust preload adjuster screw to obtain proper torque, and tighten lock nut to specified torque.

5. On models so equipped, install the back-up adjuster with gear on center. Screw the adjuster in until it bottoms, back it off 1/8 to ¼ turn and tighten lock nut.

ADJUSTMENTS ON VEHICLE

The steering gear assembly is designed to provide adjustment to compensate for normal wear at worm bearings, pitman shaft and mating parts.

Before adjustments are made to the steering gear in an attempt to correct such conditions as shimmy, loose or hard steering and road shocks, a careful check should be made of front end alignment, shock absorbers, wheel balance and tire pressure for possible causes. Refer to TROUBLE SHOOTING section of this manual.
Before making any steering gear adjustment, tighten all mounting bolts to recommended torque.

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Procedures for checking and adjusting the steering gear must be performed in sequence given in the following paragraphs:

Always check worm bearing preload adjustment first, and adjust if necessary, before making pitman shaft preload adjustment.

Before making any adjustments on the steering gear, loosen back-up adjuster lock nut then loosen back-up adjuster.

Checking Worm Bearing Adjustment

1. Disconnect drag link or connecting rod from pitman arm. Note relative position of linkage and pitman arm so parts may be reassembled in same relative position.
2. Loosen lock nut and turn preload adjuster (Fig. 10) a few turns counterclockwise to relieve over center preload adjustment and provide clearance between the sector gear and worm ball nut.
3. Turn steering wheel GENTLY in one direction to end of travel, then back one full turn

IMPORTANT

DO NOT turn steering wheel hard against "stops" when linkage is disconnected from pitman arm as damage to the gear may result.

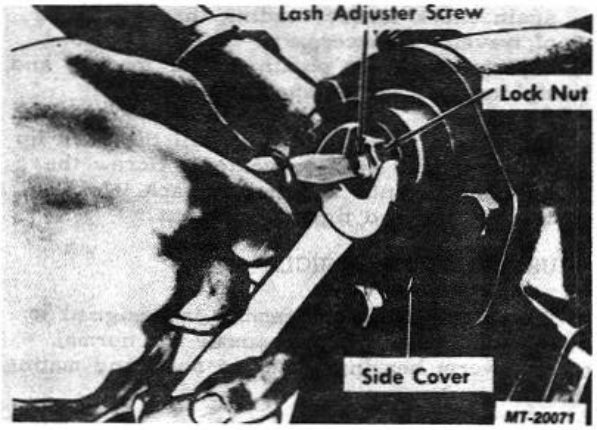


Fig. 10. Adjusting Pitman Shaft Preload

4. Attach a spring scale at rim of wheel as shown in Fig. 11. Pull on scale in a line at right angle to wheel spoke and measure the amount of pull required to keep the wheel moving. If worm bearings are properly adjusted and steering column bearings are free, reading on spring scale should be between 6.6-8.9 Newtons (1.5-2.0 lbs.) or 1.6-2.0 N.m (14-18 in. lbs.).

   If pull is not within 6.6-8.9 Newtons (1.52.0 lbs.) or 1.6-2.0 N.m (14-18 in. lbs.) worm bearings require adjustment. If "rough" or "lumpy" action is noted during check, worm bearings are probably damaged. Steering gear should then be removed from vehicle, disassembled and bearings examined. If worm bearings do not require adjustment, adjust pitman shaft preload as described later in this section. Adjust worm bearings as follows:

Worm Bearing Adjustment

1. Loosen adjuster lock nut (22)(Fig. 1) at shaft end of steering gear and turn worm bearing adjuster plug (23) clockwise until there is no perceptible end play in the worm.

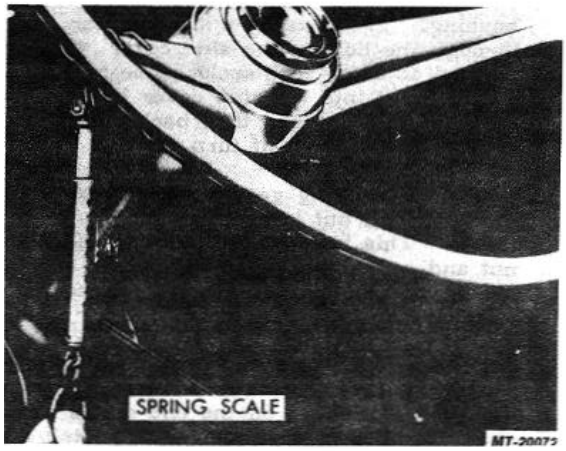


Fig. 11. Checking Steering Wheel Rim Pull

2. Using a spring scale, check the steering wheel rim pull as outlined previously. Turn adjuster plug until a pull of 6.6-8.9 Newtons (1.5-2.0 lbs.) or 1.6-2.0 N.m (14-18 in. lbs.) is obtained on spring scale at steering wheel.
3. Tighten adjuster plug lock nut to specified torque.
4. Recheck worm bearing preload adjustment to make sure that it remains within specifications after lock nut is tightened.
5. Readjust if necessary.

Pitman Shaft Preload Adjustment

IMPORTANT

DO NOT turn steering wheel hard against "stops" when linkage is disconnected from pitman arm as damage to the gear may result.

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1. Center steering gear by turning steering wheel from extreme right to extreme left positions, counting the exact number of turns. Turn wheel back exactly half-way, to center position. Mark wheel at top or bottom center with a piece of tape.

2. Loosen preload adjuster lock nut and turn adjuster clockwise to remove all lash between gear teeth Tighten lock nut to 34-48 N.m (25-35 ft. lbs.) torque, then check steering wheel rim as outlined previously. Measure greatest pull as wheel is pulled through center position. Rim pull should be 12.2-14.5 Newton (2.75-3.25 lbs.) or 2.7 to 3.4 N.m (24-30 in. lbs.).

3. If rim pull is not within specified limits, loosen lock nut and turn adjuster to obtain proper wheel rim pull.

4. On vehicles with gears equipped with back up adjuster plugs, turn back-up adjuster plug in (with worm shaft and ball nut on center position) until it bottoms, then back off 1/8 to 1/4 turn. Tighten back-up adjuster lock nut to specified torque.

5. After all adjustments have been completed, reconnect drag link or connecting rod to pitman arm.

LUBRICATION

For lubrication intervals, refer to Operator's Manual. For types of lubricants recommended, refer to LUBRICATION, Section CTS-2412.

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TROUBLE SHOOTING

CONDITION	POSSIBLE CAUSE	CORRECTION
Steering Wanders	1. Lack of lubrication in linkage and king pins.	1. Lubricate. Free up any components which are frozen and will not take lubrication.
	2. Tires badly worn, edge of tires are rounded off.	2. Install new tires, and check alignment; abnormal tire wear may indicate improper alignment.
	3. Toe-in out of adjustment, or tie rod ends worn. Toe-out causes steering to wander.	3. Replace tire rod ends if worn, adjust to correct toe-in, and inspect steering arm and tie rod for bent condition. Repair or replace as required.
	4. All steering components worn and loose.	4. Replace or adjust loose or worn parts as necessary.
	5. Front end out of alignment.	5. Align steering complete, caster, camber and toe-in. Inspect spring components for condition and wear.
	6. Steering gear requires readjustment of preloads.	6. Adjust steering gear pre-loads to specifications.
Excessive Road Shock	1. Tire air pressure too high.	1. Deflate to correct pressure.
	2. Wheel bearings loose.	2. Adjust bearings to specifications.
	3. Camber adjustment incorrect - (negative camber contributes to road shock).	3. Adjust camber to specifications.
	4. Weak or broken front spring.	4. Replace spring.
	5. Defective shock absorbers.	5. Replace shock absorber(s).
	6. Loose suspension components.	6. Inspect, adjust or repair and replace parts as necessary.
Snapping or Chucking in Steering Column or Wheel	1. Steering gear incorrectly adjusted.	1. Adjust steering gear to specifications.
	2. Steering shaft stop clamp loose, this permits excessive up and down movement of steering shaft in column.	2. Adjust steering shaft stop clamp using prescribed procedure.
	3. Loose steering gear at frame.	3. Tighten mounting bolts.

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TROUBLE SHOOTING

CONDITION	POSSIBLE CAUSE	CORRECTION
Snapping or Chucking in Steering Column or Wheel (Continued)	4. Worn steering shaft universal joints. 5. Worn steering linkage components. The effect of wear may be transmitted through steering system and felt at steering wheel.	4. Repair and replace joints as necessary. 5. Adjust, repair or replace components.
Steering Pulls to Left or Right	1. Low air pressure in right or left tire. Steering will pull to side having low air pressure. 2. Camber incorrectly adjusted adjusted. Steering will generally pull to side of axle having greatest positive camber. 3. Front or rear axle loose at spring. U-bolts, if shifted on one side, will cause steering to pull.	1. Inflate tire to correct pressure, check for air leak and repair as required. 2. Adjust camber to correct specifications. 3. Align rear axle and replace defective parts, if any. Tighten U-bolts to proper torque.
Hard Steering	1. Fire pressure too low. 2. Steering gear adjusted too tight, or binding con--dition in steering column. 3. Lack of lubrication -- frozen king pins or ball joints. 4. Improper or excessive positive caster.	1. Inflate tires to proper pressure. Check for leak and repair as required. 2. Adjust steering gear as described in this manual. Inspect steering column. 3. Lubricate, and free up king pins. Make certain all fittings take lubricant properly. 4. Adjust caster to correct specifications.
Vibration or Shimmy	1. Tires, wheels (Oil brake drums out of balance. 2. Bent wheel or out of round tire. 3. Loose steering linkage components. 4. Disc-type wheel - loose on hub.	1. Balance tires and wheels, preferably with on-vehicle type balancer, as this method balances entire wheel and drum assembly. 2. Replace wheel, and remount tire or replace. 3. Adjust, tighten and repair linkage as necessary. 4. Inspect wheel bolt holes for damage, and tighten to specified torque.

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TROUBLE SHOOTING

CONDITION	POSSIBLE CAUSE	CORRECTION
Vibration or Shimmy (Continued)	4a. Cast steel wheel - wheel nuts tightened unevenly.	4a. Loosen attaching wheel nuts nuts, then tighten evenly the full circumference.
	5. Drive line universal joints rough, or defective. This condition may be confused with steering vibration.	5. Repair drive line using prescribed procedure.
	6. Engine misses or is out of balance, this may also be confused with steering shimmy.	6. Correct miss in engine, or repair out of balance condition, clutch, pressure plate or harmonic balancer, etc.
	7. Defective shock absorbers.	7. Replace shock absorbers.

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SPECIFICATIONS

TYPE	WORM & BALL NUT
Preload Adjustments:	
Worm Thrust Bearing	1.6-2.0 N.m (14-18 in. lbs.)
Over Center Sector Shaft*	.9-1.4 N.m (8-12 in. lbs.)
Total Gear Preload	3.4 N.m (30 in. lbs.) Max.
* In excess of Worm Thrust Bearing Preload.	

TORQUE CHART

DESCRIPTION	NEWTON METERS	FOOT POUNDS
Preload Adjuster Screw	41	30
Side Cover to Housing Bolt	48	35
End Cover to Housing Bolt	52	38
Worm Bearing Adjuster Plug Nut	115	85
Back-up Adjuster Plug Nut	54	40
Pitman Arm to Shaft Nut S-57 Only	115	85
Pitman Arm to Shaft Nut S-58 Only	149	110

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STEERING GEARS
SHEPPARD

IH Model	Gear Model	IH Code	IH Model	Gear Model	IH Code
S-236	M-39	05236	S-295	M-392	05295
S-267	M-39	05267	S-296	M-392	05296
S-268	M-39	05268	S-297	M-392	05297
S-269	M-59	05269	S-298	M-292	05298
S-270	M-491	05270	S-311	M-292	05311
S-271	M-59	05271	S-312	M-392	05312
S-272	M-491	05272	S-313	M-292	05313
S-273	M-59	05273	S-318	M-392	05318
S-274	M-592	05274	S-319	M-392	05319
S-283	M-492	05283	S-327	M-39	05327
S-284	M-492	05284	S-331	M-382	05331
S-285	M-491	05285	S-332	M-292	05332
S-286	M-592	05286	S-339	M-252	05339
S-287	M-592	05287	S-340	M-352	05340
S-289	M-292	05289	S-341	M-382	05341
S-290	M-39	05290	S-342	M-252	05342
S-291	M-39	05291	S-343	M-392	05343
S-292	M-39	05292	S-344	M-372	05344
S-293	M-392	05293	S-349	M-392	05349

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CHAPTER II

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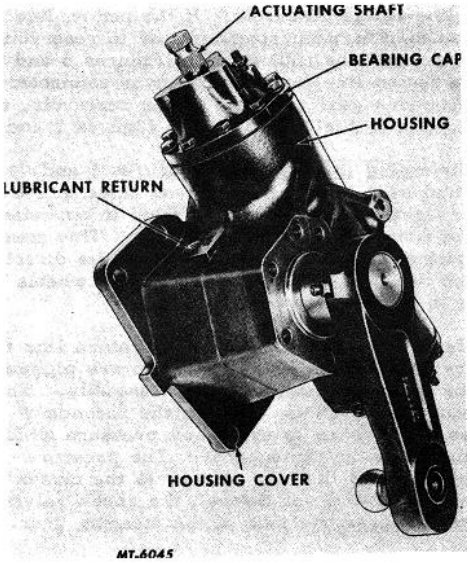


Fig. 1.

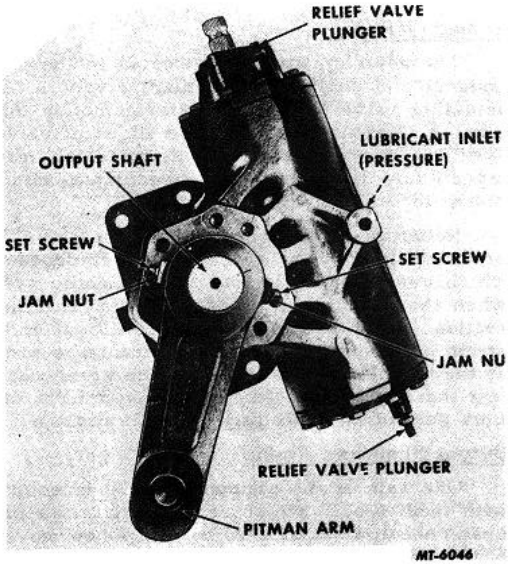


Fig. 2.

DESCRIPTION

The power steering gear unit is a self-contained assembly utilizing an integral power cylinder and control valve in the gear housing. Figures 1 and 2 are external view of the steering gear.

Dual power steering when used is comprised of a main steering gear and a secondary (slave) gear.

OPERATION

There are four basic parts in the main steering gear assembly. They are the actuating shaft, valve, piston and output shaft and pinion gear assembly (Fig. 3). Refer to Figures 3 and 4 for operational views of steering gear assembly.

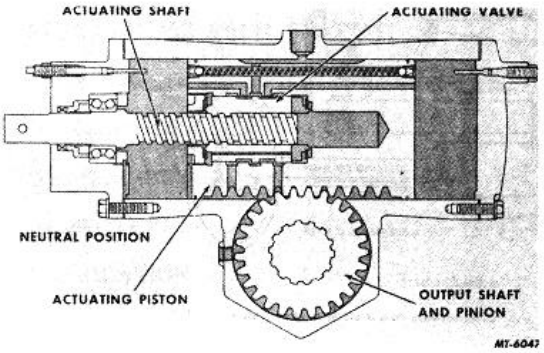


Fig. 3. Sectional View of Steering Gear Assembly in *Centered Position*

The secondary gear assembly differs from the main steering gear assembly in that it does not have an actuating shaft nor does the piston have an actuating valve assembly.

Actuating Shaft

The steering column is connected to actuating shaft. This shaft is threaded with an Acme type thread. It is also retained in the bearing cap by locking nuts and operates on a heavy duty ball bearing.

Actuating Valve

The actuating valve is threaded to accommodate the actuating shaft. The valve moves on the threads of actuating shaft when shaft is turned. The valve is housed in the piston and retained there by a large indexed locking nut.

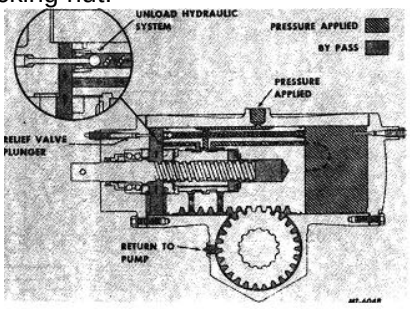


Fig. 4. Sectional View of Steering Gear Assembly in Applied Position

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Actuating Piston

The actuating piston is located in the gear housing and contains the actuating valve. As the actuating valve moves, in a linear motion through turning of actuating shaft, the edges of valve overlap mating edges on inside of piston, directing oil flow to either end of the piston causing piston to move in the housing.

Relief valve plungers (adjustable stops) are provided at the bearing cap and cylinder head which automatically unload the hydraulic system when the wheels are turned to either extreme direction. This protects the mechanism from undue strain and damage in that a clearance is provided at the wheel stops (Fig. 4). The plungers contact the relief valve (ball), lifting it from its seat thus permitting unloading of hydraulic system.

Output Shaft and Pinion

One side of the piston assembly is equipped with teeth (rack) which are engaged with pinion gear on output shaft. When the piston moves back and forth within the housing, the gear turns providing rotating action of the pitman arm which is connected to steering linkage.

Secondary (Slave) Gear Assembly

Two types of secondary (slave) gears have been used. To identify these gears, inspect return line to the reservoir. If the return line is connected from main steering gear to reservoir, the application is illustrated in Figures 5 and 6. If the return line from main gear is connected to secondary gear and then to the reservoir, the application is that illustrated in Figures 7 and 8.

Referring to schematics (Figures 5 and 7) of the dual gear installation, the oil lines to secondary gear housing are connected to opposite end of main steering gear housing. This permits the pitman arm to rotate in the opposite direction on the two gear assemblies permitting wheels to pivot in same relative direction.

In addition, the openings for return line to reservoir and inlet line from pump are plugged on the secondary steering gear assembly. The pressure relief check valve in the secondary piston is designed to expel any pressure which builds up in the pinion area. The pressure passes through the oil passages to the center of the piston and out through the check valving to the low pressure side of the steering gear.

When the return line is connected between the main gear to the secondary gear outlet port, and then to the reservoir, the pressure is expelled before it has a chance to build up in the pinion area (Figures 7 and 8).

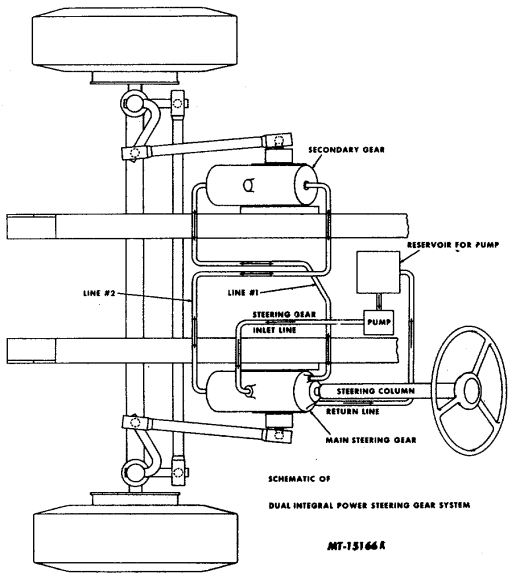


Fig. 5.

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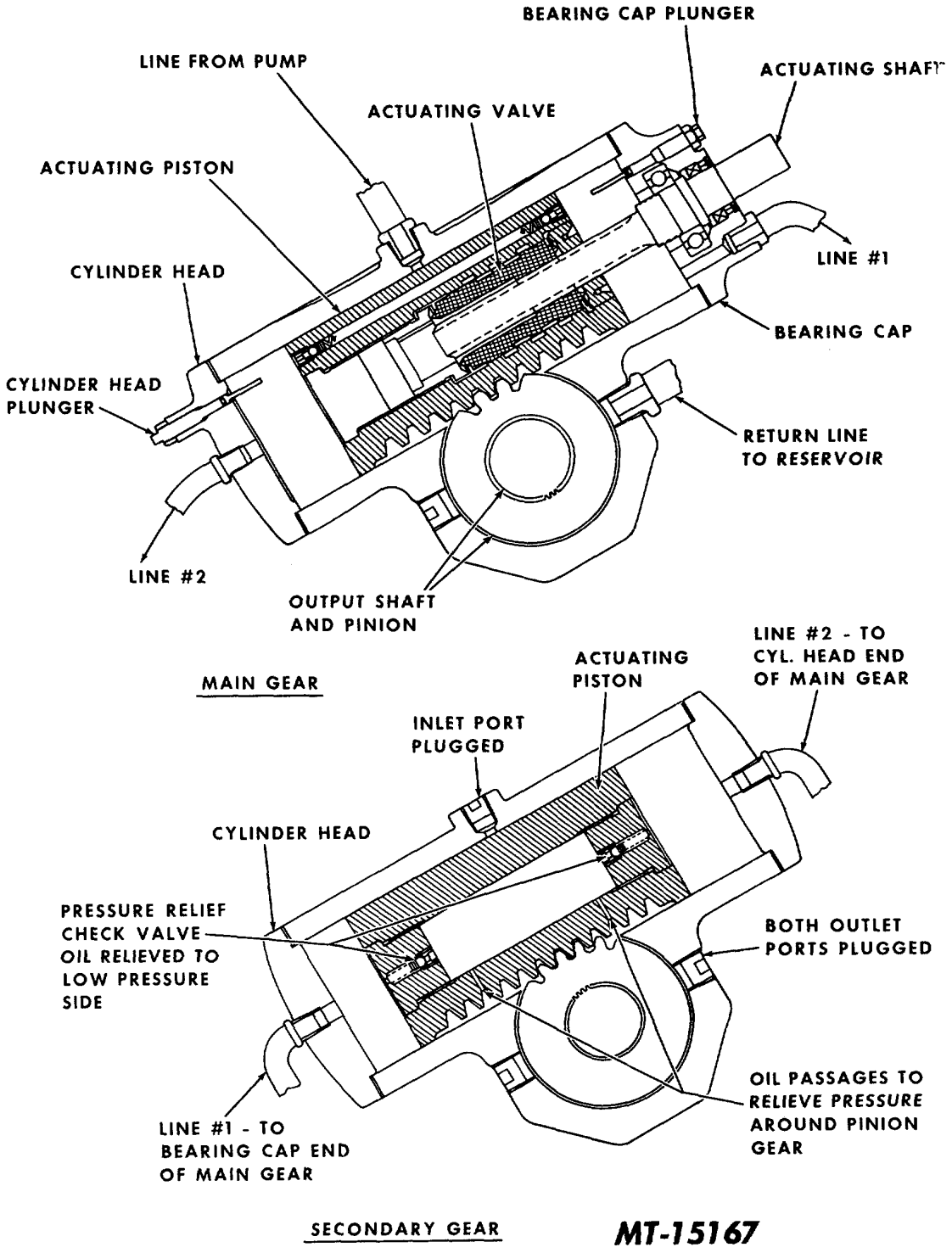
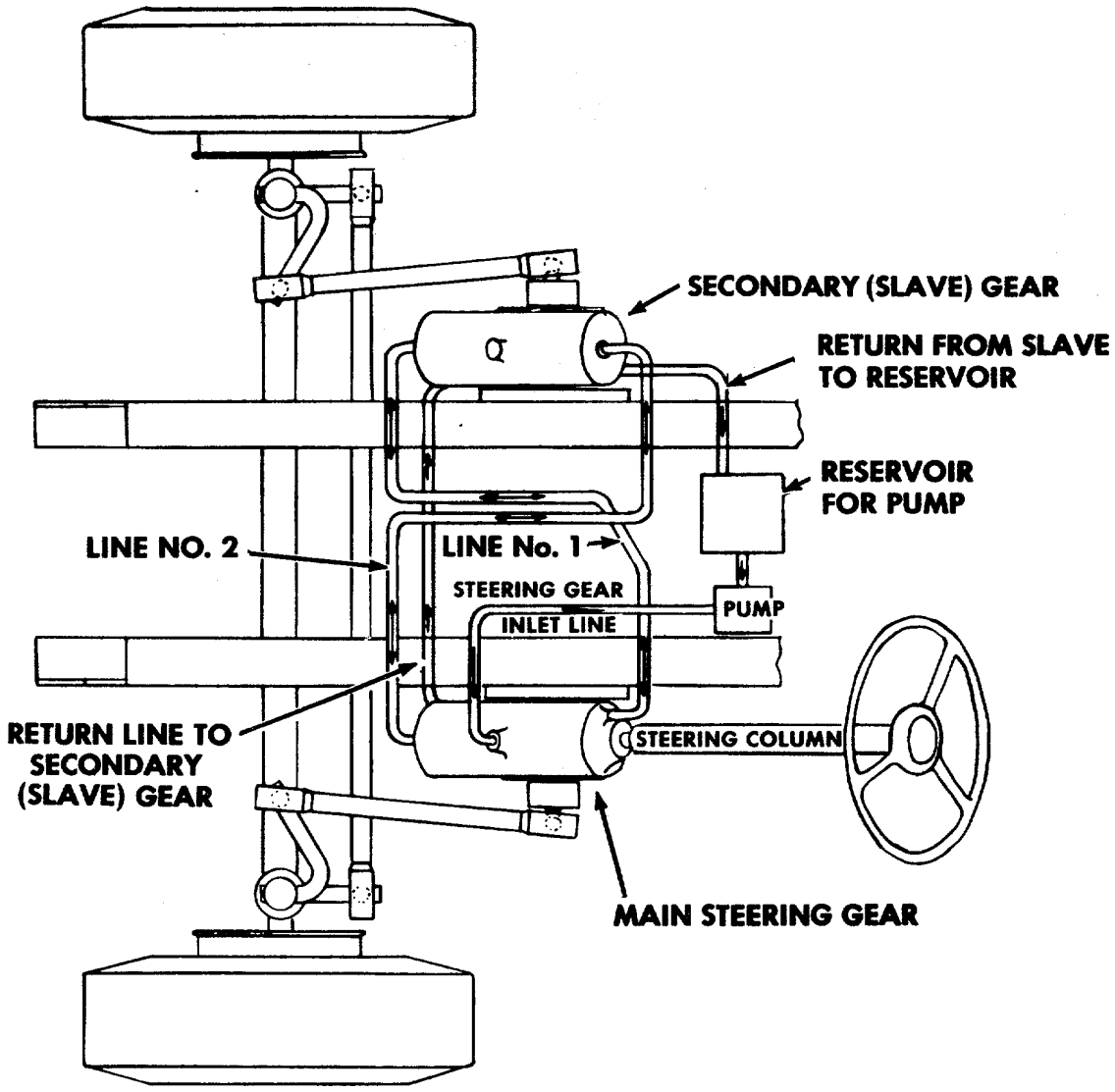


Fig. 6.

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SCHEMATIC OF DUAL INTEGRAL POWER STEERING GEAR SYSTEM

Fig. 7.

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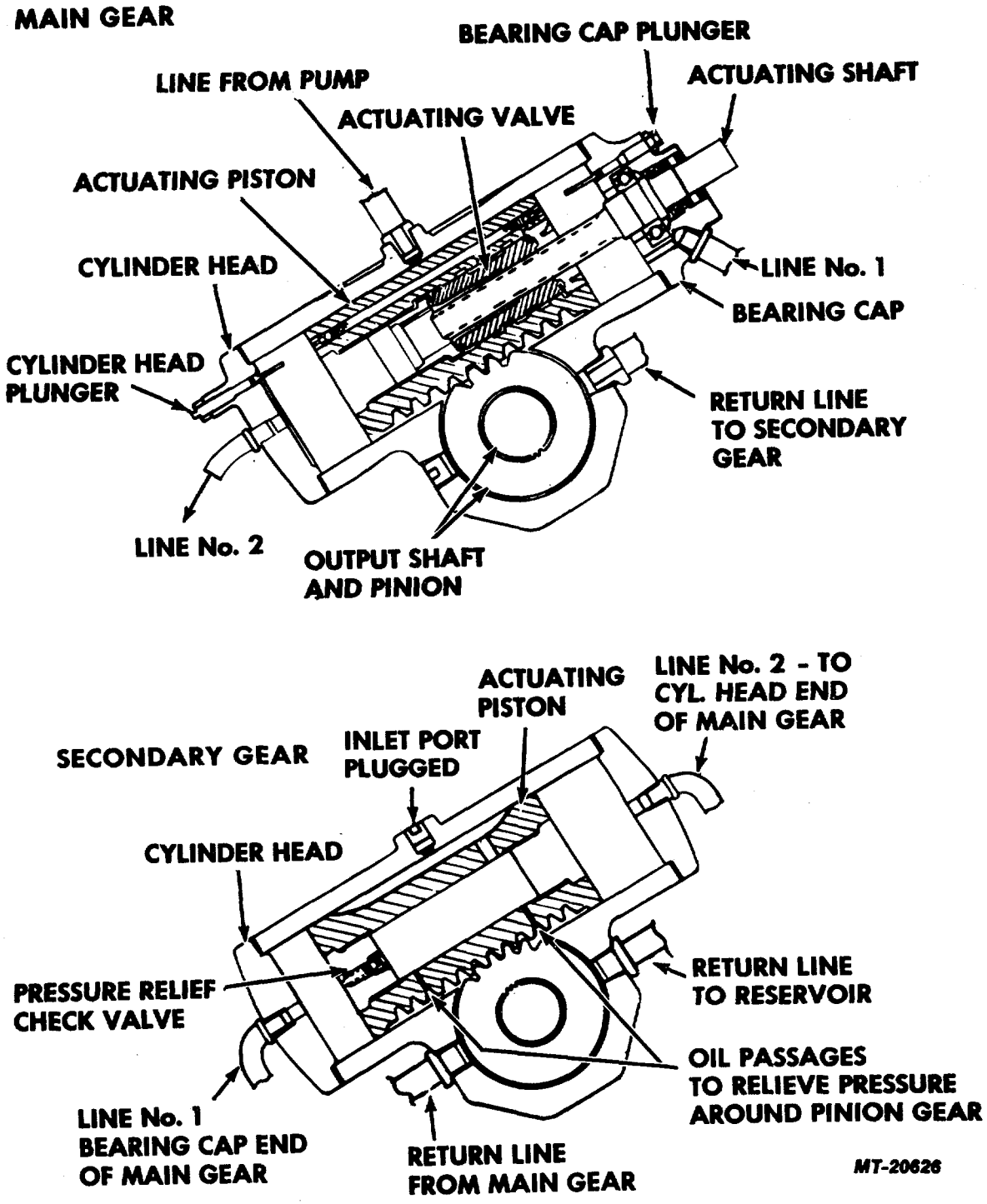


Fig. 8

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PITMAN ARM REMOVAL
(Pitman Arm Positioned Away From Frame)

Using pitman arm puller SE-2394 (Fig. 9), remove pitman arm from output shaft as follows. The puller is applied to the arm as shown in Fig. 10. With puller screw contacting end of levershaft, turn hex flanged nut to remove pitman arm. Additional pulling effort can be obtained by turning both flanged nut and forcing screw. Where necessary, install adapter at levershaft to provide a seat for forcing screw.

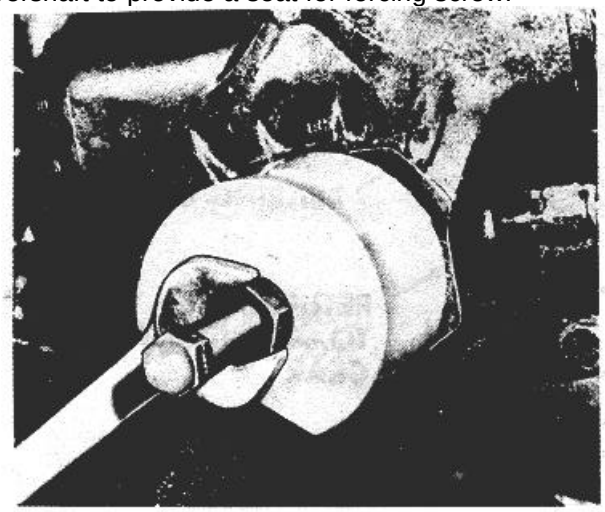


Fig. 9 Pitman Arm Puller Consisting of:
SE-2394-1 Puller Body (Fig. Ref. 1)
SE-2394-2 Hex Flange Nut (Fig. Ref. 2)
SE-2394-3 Forcing Screw (Fig. Ref. 3)
SE-2394-4 Adapter (Fig. Ref. 4)

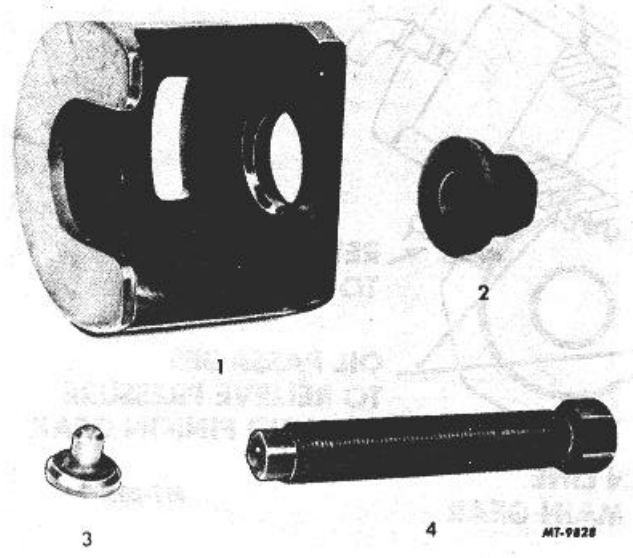


Fig. 10

PITMAN ARM REMOVAL
(Pitman Arm Positioned Toward Frame)

With this type of installation the steering gear is normally mounted on a "U" shaped bracket with gear output shaft passing through bracket with pitman arm located between bracket and frame. To remove proceed as follows.

1. Remove steering column U-joint yoke from steering gear input shaft.
2. Disconnect drag link from pitman arm and remove pitman arm retaining nut.
3. Remove steering gear mounting bolts. Insert three equally spaced alignment studs through steering gear mounting bracket into steering gear mounting bolt holes to hold gear in alignment during pitman arm removal.
   Studs may be made locally by removing the heads from three 1/2x20 UNF x 5" bolts. Stud length should be approximately 4-1/2" long.
4. Install a safety sling on steering gear and support from an overhead crane.
5. Slide gear outward from chassis on studs until pitman arm contacts inside of steering gear mounting bracket.
6. Position a 3/4x16 UNF x 3" bolt and nut between sector shaft end and frame rail (Fig. 11). Lubricate area where the nut will contact the frame rail.
7. Back off nut to apply pressure against sector shaft. With pressure applied, rap pitman arm sharply to remove.
   Pressure may have to be reapplied several times to take up slack between frame rail, bolt, pitman arm, mounting bracket, etc. when pitman arm is rapped.

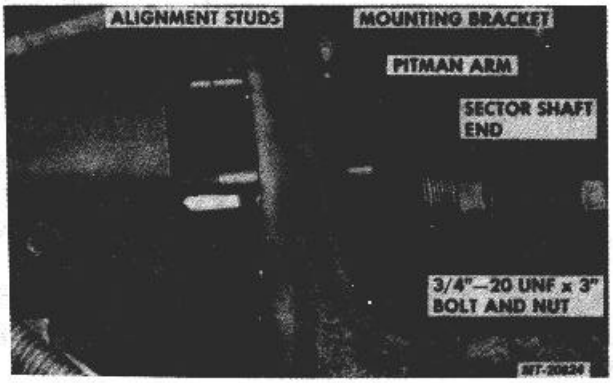


Fig. 11

STEERING GEAR STEERING GEAR REMOVAL

1. Position oil drain pan under steering gear assembly and disconnect return hose at gear housing which is routed to the pump. Turn steering wheel or actuating shaft completely to the right and then to the left. This will drain most oil from steering gear assembly. Disconnect remaining oil lines. Be sure to tag for identification at reinstallation.
2. Disconnect drag link from pitman arm.
3. Disconnect steering column from actuating shaft. If the unit being removed is a secondary gear, this operation will not be required.
4. Loosen and remove gear assembly mounting bolts and remove gear from vehicle.

DISASSEMBLY

1. Clean outer circumference of output shaft with crocus cloth to remove dirt, rust or small burrs which may damage seats.
2. Variations will be found between relief valve plungers.

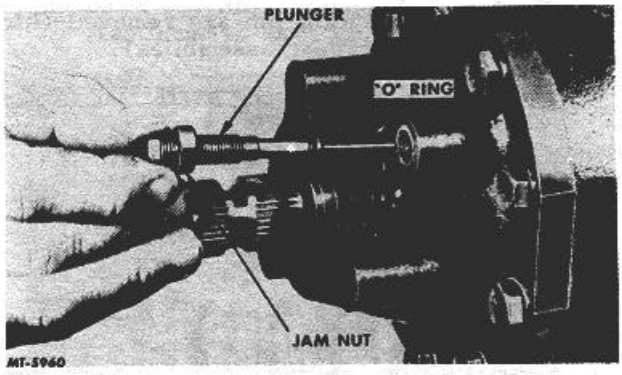


Fig. 12

a. Relief valve plunger with jam nuts. Loosen jam nut on plungers and remove plungers from each end of gear (Fig. 12).
b. Relief valve plunger recessed in bearing cap and cylinder head. Use a screwdriver to back out plungers from each end of gear (Fig. 13). "O" ring interference may prevent extraction of plunger at this time. Plungers can be pushed out of cylinder head and bearing cap after they are removed.
3. Remove housing cover from steering gear assembly (Fig. 14). Use a soft hammer and tap on end of output shaft to loosen cover. The output shaft and gear assembly may be removed with cover. Observe timing mark on rack which is located on center tooth of piston. This mark should be in alignment with the timing mark on pinion gear when reassembly is performed (Fig. 15)

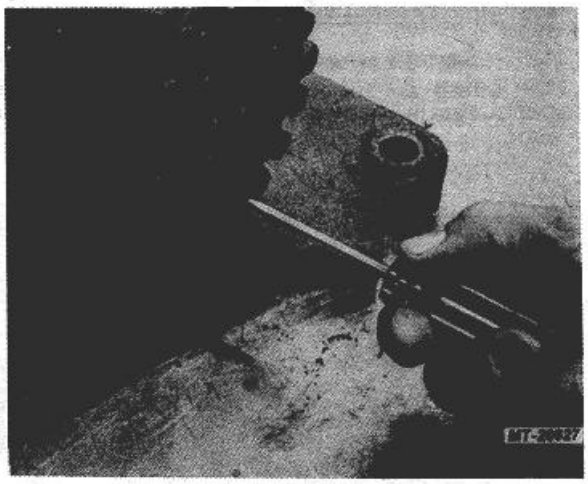


Fig. 13

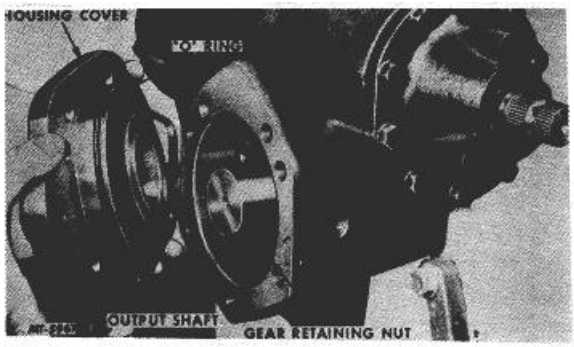


Fig. 14

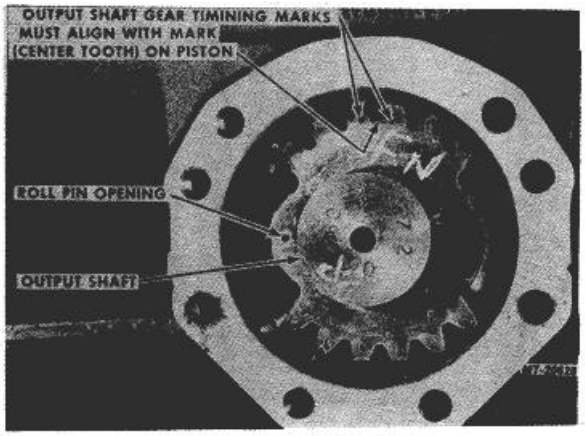


Fig. 15

4. Variations in methods of retaining output shaft (pinion) gear to output shaft have been utilized. Low pressure series gears (M-39, M-59 and M-491 models) utilize a retaining nut; all other steering gear models utilize a retaining pin and roll pin.

   a. Low Pressure Gears
   Remove capscrews from output shaft gear using an Allen wrench. Then the gear retaining nut may be removed by turning it counterclockwise from output shaft (Fig. 16).

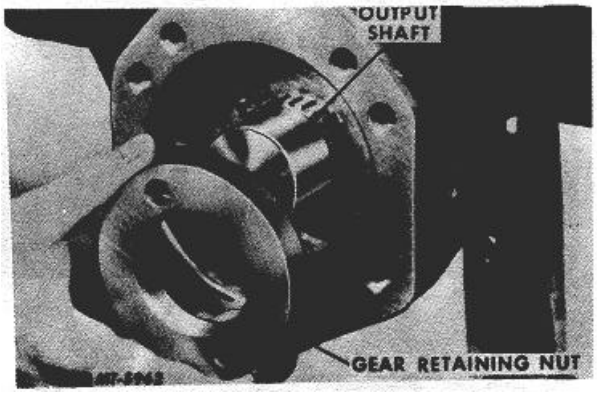


Fig. 16

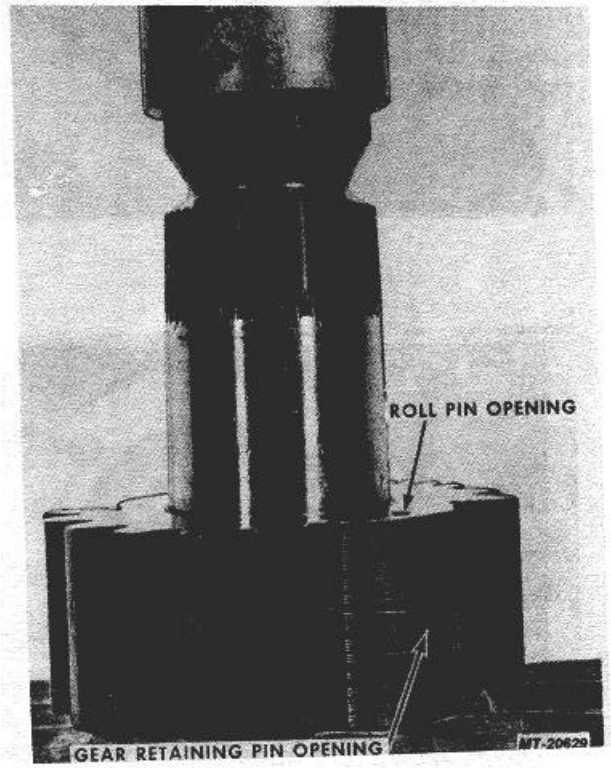


Fig. 17

   b. High Pressure Gears
   After output shaft and gear assembly has been removed from housing (Fig. 17), remove roll pin using a small drift. When gear is pressed from shaft, the retaining pin will be sheared. (Previous instructions were to drill the retaining pin. Since the retaining pin is hardened it is almost impossible to drill the pin.)

5. Lift output shaft and gear assembly from the housing (Fig. 18). Fig. 18

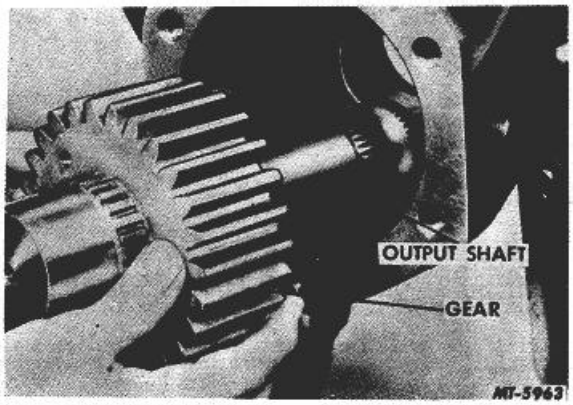


Fig. 18

6. If repairs are necessary, press output shaft (pinion) gear from shaft (Fig. 19). Be sure all pieces of retaining pin are removed (high pressure steering gear assemblies). Fig. 19

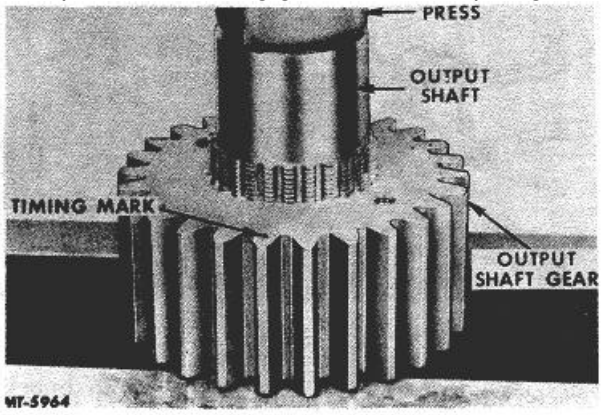


Fig. 19

7. Make reference marks on cylinder head, bearing cap and gear housing for reassembly purposes (Fig. 20).
8. Remove cylinder head, gasket and plunger.
9. Remove bolts from bearing cap; then turn actuating shaft and bearing cap assembly out / of actuating valve (Fig. 21).

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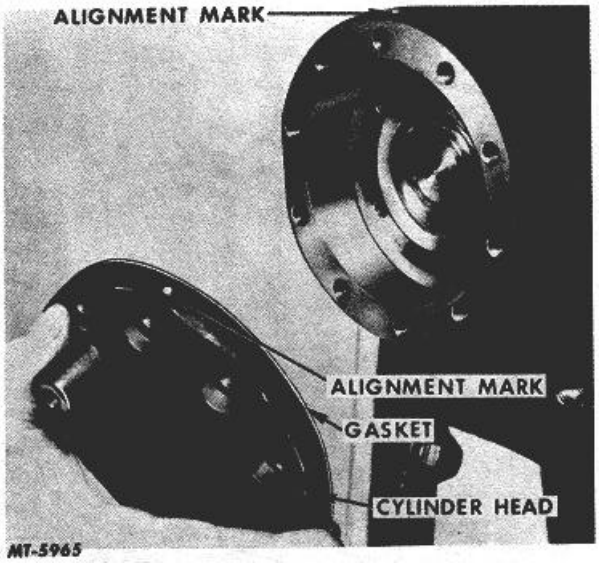


Fig. 20

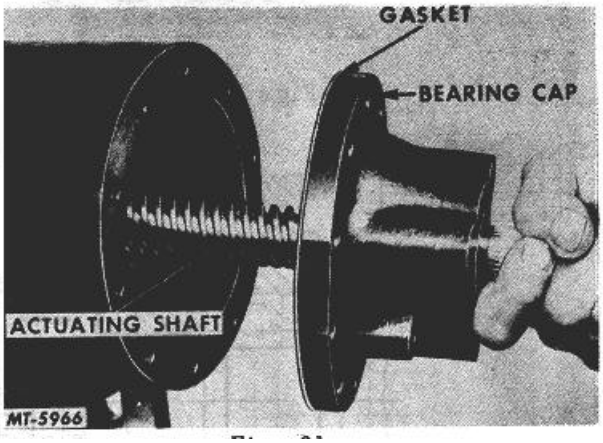


Fig. 21

Place plungers in a safe place so that they are not damaged while steering gear is disassembled. Refer to CHAPTER II for Removal and Disassembly of Miter Gear Box.

10. Remove lock pin from bearing retaining nut (Fig. 22).

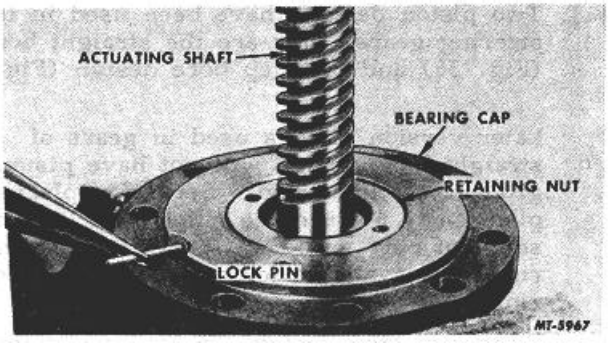


Fig. 22

11. Use a spanner wrench to loosen bearing retainer nut; then remove nut (Fig. 23). An optional way to remove bearing retaining nut is to insert a drift punch in one of the spanner wrench holes and tap drift counterclockwise.

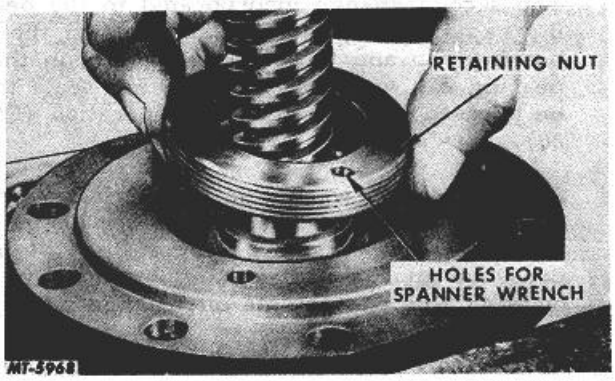


Fig. 23

12. Press actuating shaft from bearing cap (Fig. 24). Do not dismantle actuating shaft as it is only furnished as an assembly. Fig. 24

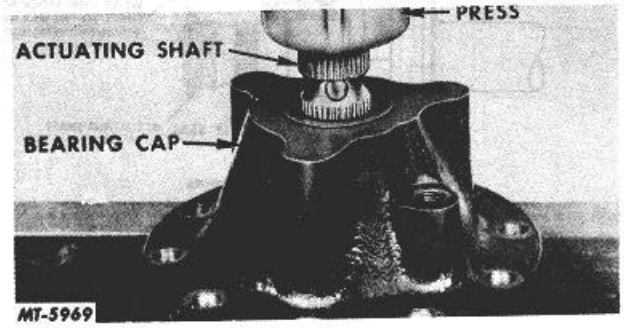


Fig. 24

13. Improvements have also been made to actuating shaft seals in bearing cap assembly. Originally, bearing cap was equipped with an oil seal and dirt seal. Seal removal of original design is shown in Fig. 25.

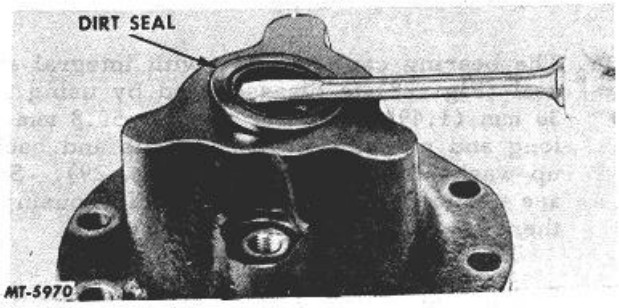


Fig. 25

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i. First improvement to seals was the addition of a salt seal contained in a separate retainer. The retainer is equipped with a lube fitting (Fig 26). Identification of this improvement is the separate retainer with lube fitting installed on bearing cap.

The second change incorporated in the bearing cap assembly was the salt seal in the bearing cap and the bore restriction in the bearing cap was removed allowing seals to be pressed out of cap in one operation (Fig. 26).

A seal back-up washer is used. It is very <u>important</u> that this back-up washer be installed in this version Proper fit of high pressure oil seal will not be obtained by omitting this washer, as oil leakage will result.

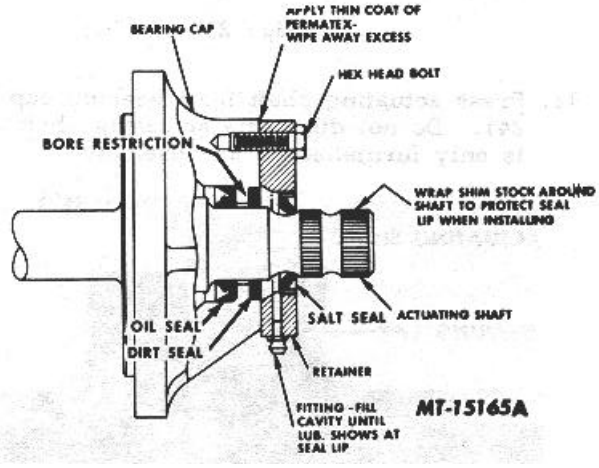


Fig. 26

15. Removal of seals is as follows:

Original design bearing cap and bearing cap with retainer require removing dirt seals and salt seals by prying them out of retainer and cap. Then remove oil seal from bearing cap using a hammer and drift punch (Fig. 27). Small holes are provided in bore restriction to permit inserting punch.

16. The bearing cap assembly with integral salt seal (Fig. 28) is disassembled by using a 38 mm (1.49") diameter adapter 50.8 mm (2") long and pressing all three seals and backup washer out bearing end (Fig. 29). Seals are not to be pressed from inside housing as there is a step in the bore.

17. Pull piston assembly from gear housing (Fig. 30).

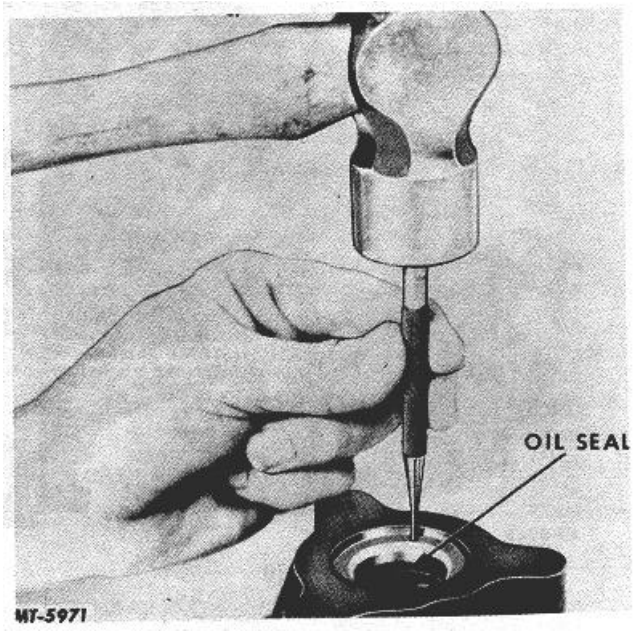


Fig. 27

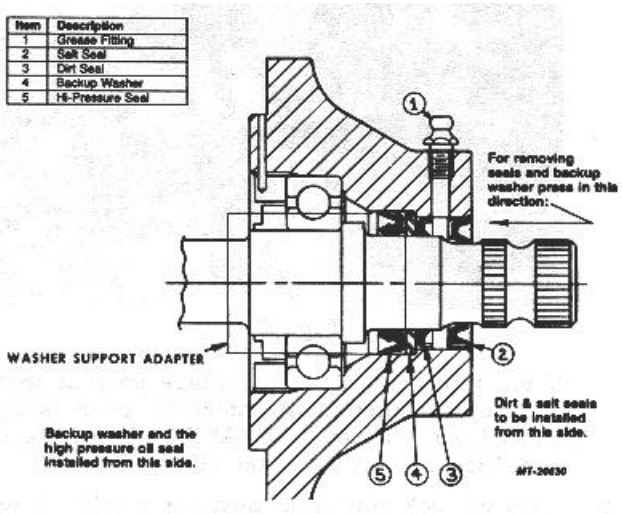


Fig. 28

18. Two piston designs have been used in these steering gears; they are the straight bore (Fig. 36) and the step bore design (Fig. 31).
Later version pistons used in gears of straight bore design will not have piston ring grooves as illustrated. Service replacement piston may not require rings with the absence of ring grooves. Service replacement rings are available for pistons which require rings.
Pistons of step design are equipped with one ring and ring groove at large end of piston.

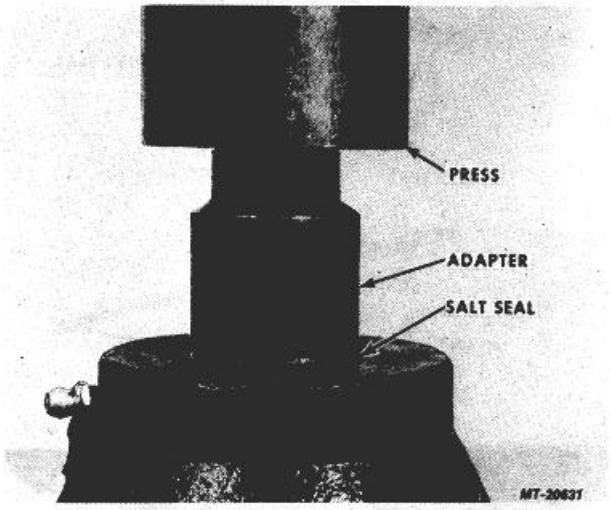


Fig. 29

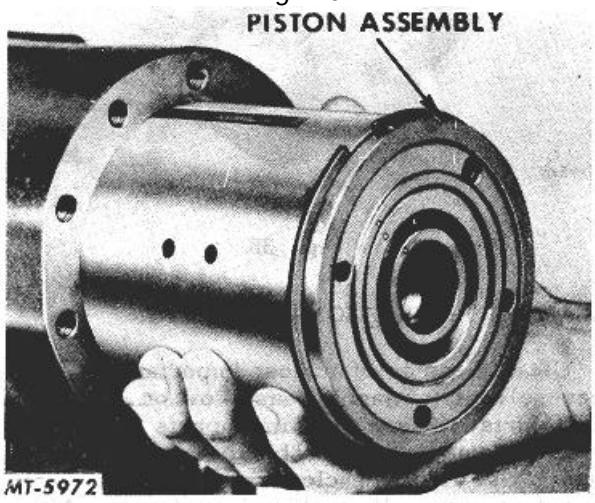


Fig. 30

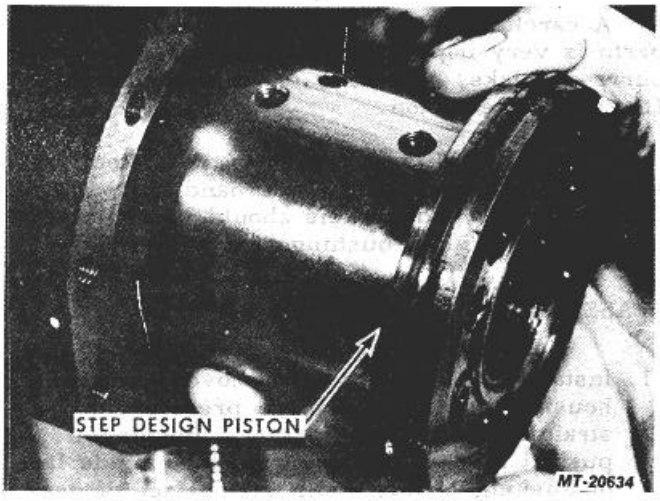


Fig. 31

19. Make reference marks on piston and adjustment nut. Then remove locking pin from valve adjusting nut (Fig. 32).

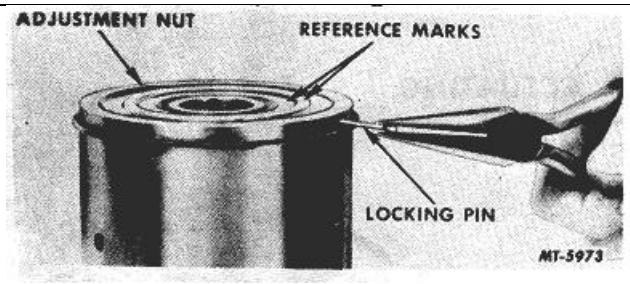


Fig. 32

20. Remove valve adjustment nut from piston (Fig. 33.

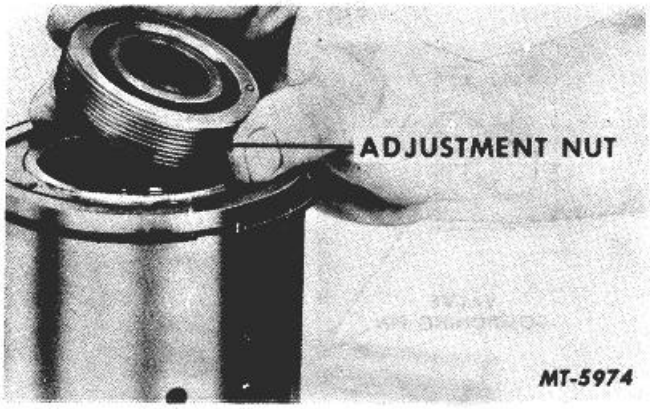


Fig. 33

21. Lift reversing spring from actuating valve (Fig. 34).

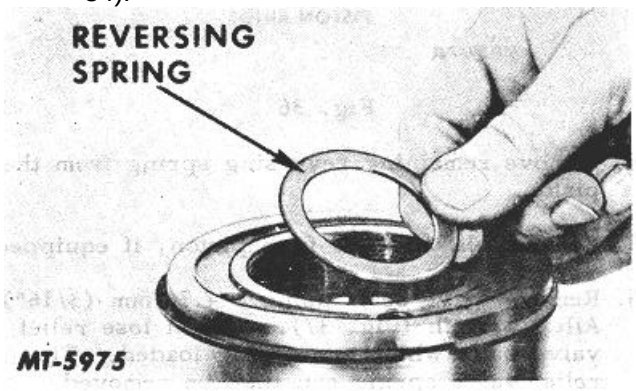


Fig. 34

22. Pull actuating valve from piston. Do not force valve from piston assembly (Fig. 35).
23. Remove valve positioning pin from piston using a screwdriver (Fig. 36). Later version positioning pin will be equipped with an "O" ring as can be seen in Fig. 36 insert.

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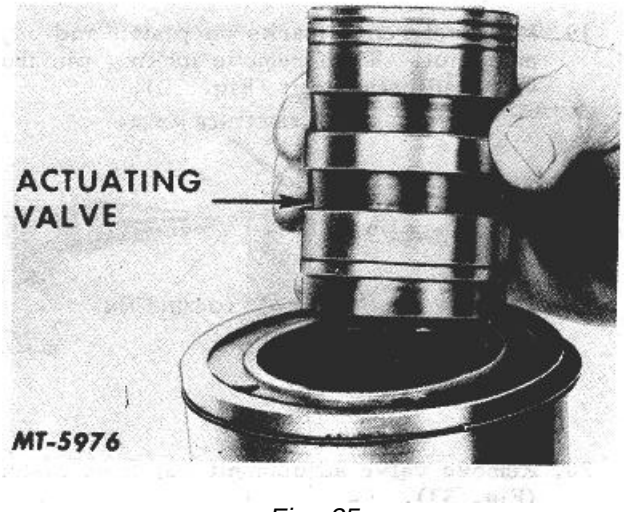


Fig. 35

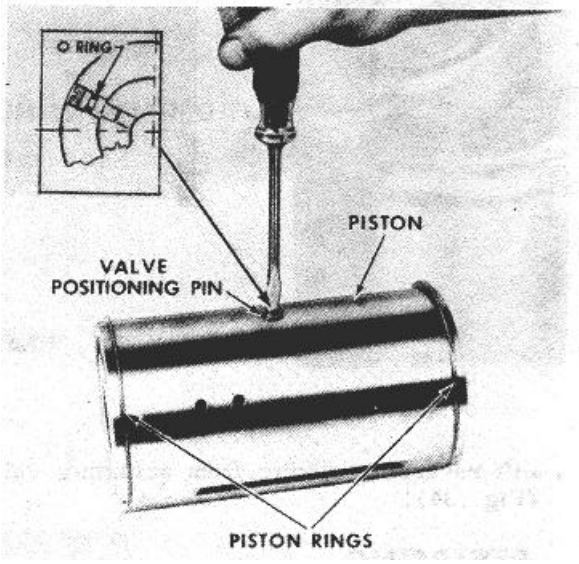


Fig. 36

24. Remove remaining reversing spring from the piston.
25. Remove piston rings from piston, if equipped.
26. Remove valve seats using a 4.76 mm (3/16") Allen wrench (Fig. 37). Do not lose relief valve balls which are spring loaded. The relief valve spring can then be removed. Valve seats at each end of piston may be removed except in the M-252 model. The piston in M-252 model has one removable seat. The second seat is machined in the relief valve bore.
27. Remove seal (4u-ring) from output shaft bore (Fig. 38).
28. If bushings in housing or cover need replacing, they may be removed using a puller.

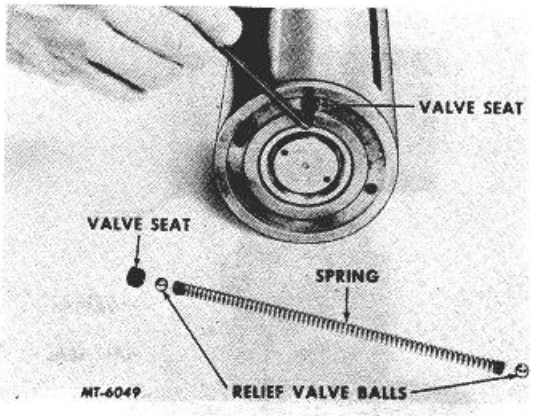


Fig. 37

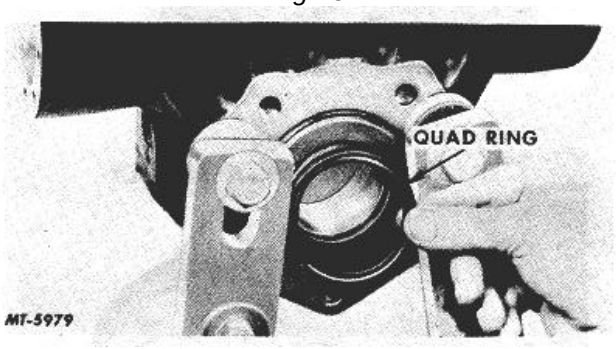


Fig. 38

(CLEANING, INSPECTION AND REPAIR

Cleanliness is of utmost importance. Use clean solvent to wash grease, oil or dirt from all metal parts. Clean machined parts individually to avoid damage due to "bumping" together of parts. Use lint-free cloths dipped in a clean solvent to clean all machined surfaces. After all parts are cleaned, dry parts with compressed air.

A careful visual inspection of steering gear parts is very important. Inspect components for burrs or nicks, especially on or near the rack (teeth) on the piston.

If a raised burr is found on the piston, it should be removed with a fine hand stone. All O-rings, seals and gaskets should be replaced. Inspect output shaft bushings for wear.

REASSEMBLY

1. Install new bushings (if removed) in gear housing and cover using a press and a straight line pushing action. Bushing is pushed into gear housing so that inside face of bushing is flush with inside face of gear housing (Fig. 39).

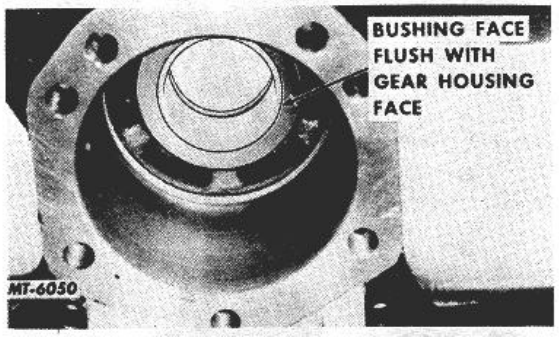


Fig. 39

When a new bushing is pressed into cover, the face of bushing must be flush with cover (Fig. 40). Exception: Model 592 bushing recessed 7.9 mm (5/16"), and Models 252, 382, 392 and 492 bushings recessed 12.7 mm (1/2") from cover face.

When reinstalling bushing in output shaft bore of housing, if it goes in easily and heavy press resistance is not encountered, carefully remove bushing. Thoroughly clean bushing of oil and grease and clean bore of foreign material by scraping with a piece of brass sheet. Bushing and bore should then be completely washed and dried. Coat exterior of bore and bushing with Loctite high strength retainer compound. Reinstall bushing and allow a minimum of six hours curing time. When curing time has elapsed, any excess Loctite in quad ring groove or elsewhere should be removed by washing with naphtha.

2. Install a new quad ring in groove in gear housing.
3. Position relief valve spring and one relief valve ball into valve bore. Using a 4.76 mm (3/16") Allen wrench, install one valve seat. Valve seats must be tight and flush with or slightly below end surface of piston. Exception: M-252 model gear has only one removable seat; therefore, both relief valve balls and spring must be reinstalled from same end.

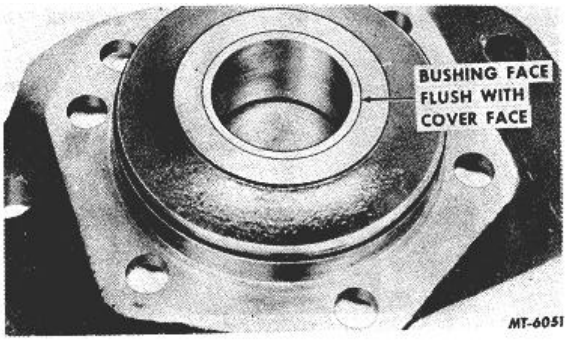


Fig. 40

4. Install second relief valve ball seat in same manner.
5. Position one reversing spring in bottom of valve bore. Be sure spring is centered. End of valve must enter inside diameter of spring.
6. Install a new "O" ring on positioning pin, if equipped with an "O" ring groove. Then install valve positioning pin in piston. Turn pin inward with a screwdriver until it is below outside surface of piston. The flats must enter into piston 6.4 mm (1/4") to engage the mating slot in valve.
7. Carefully slide actuating valve into piston so that slot on end of valve is positioned over pin.
8. Position remaining reversing spring on shoulder of valve end.
9. Reinstall valve adjusting nut turning it clockwise into piston until it is against spring. Align reference marks on nut and piston. Then lock nut in place by installing locking pin. Be sure pin is below outside edge of piston.
10. Install piston rings, if required. If piston rings are tapered on one side, install taper outward to piston end. If rings are marked "top" on one side, also assemble these rings with marked side outward to piston end. Rings which are neither marked nor tapered are not required to be installed on piston in any special manner.
11. Coat piston and cylinder walls with oil and install piston assembly using a ring compressor at each end. Fig. 41 illustrates ring compressor on second ring. Be sure piston is installed with actuating shaft opening facing bearing cap end.

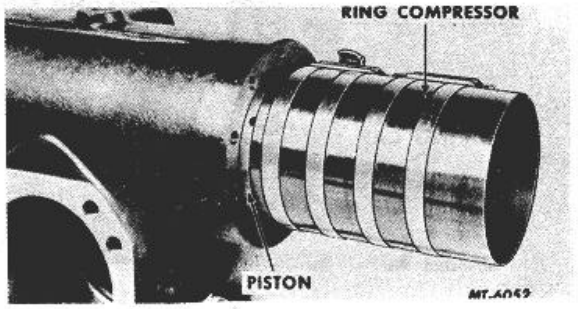


Fig. 41

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12. Using a new gasket or "O" ring, reinstall cylinder head. (If bearing cap and cylinder head have a groove on mating surface of gear housing, "O" rings are to be used.) The alignment marks will aid in reinstalling head in the correct position. The opening for the plunger must be in alignment with relief valve in piston. Check torque chart for bolt tightening.

13. Press seals in bearing cap and seal retainer, if equipped.

    a. Press oil seal into original design bearing cap using a 41 mm (1.615") diameter adapter approximately 50.8 mm (2") long until seal contacts bore restriction. Lip of seal must be toward gear housing mounting surface.
    Turn bearing cap over and press dirt seal in cap flush with face of casting (Fig. 42). Seal in seal retainer is installed in the same manner.
    Lip of dirt and salt seals should be toward outside surface of castings.

    b. The bearing cap with integral salt seal is assembled in the following manner.
    Position back-up washer in bore of bearing cap with undercut toward step in bore. Then support washer with a 41 mm (1.615") adapter about 50.8 mm (2") long. Position bearing cap in press and press dirt seal with lip out from opposite end until seal contacts back-up washer.
    Then press salt seal with lip out into bearing cap until it is flush with outer surface of bearing cap (Fig. 43). Fig. 43

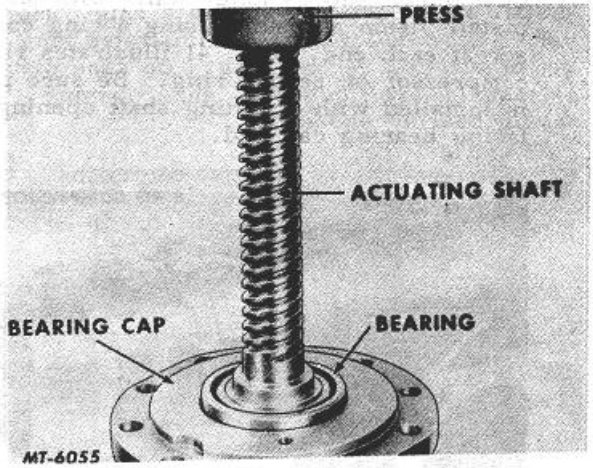


Fig. 42

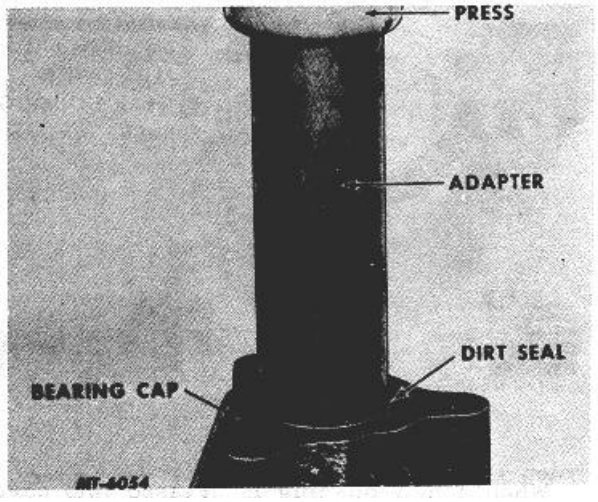


Fig. 43

Turn bearing cap assembly over and press high pressure oil seal from bearing end until it rests against back-up washer. Lip of seal must be toward gear housing mounting surface.

14. Lubricate surface between seals with IH 251H EP grease or equivalent NLGI #2 multi-purpose lithium grease prior to installing actuating shaft assembly.

IMPORTANT

For reassembly and installation of Miter Gear Box refer to CHAPTER II.

15. Press actuating shaft assembly into bearing cap (Fig. 44).

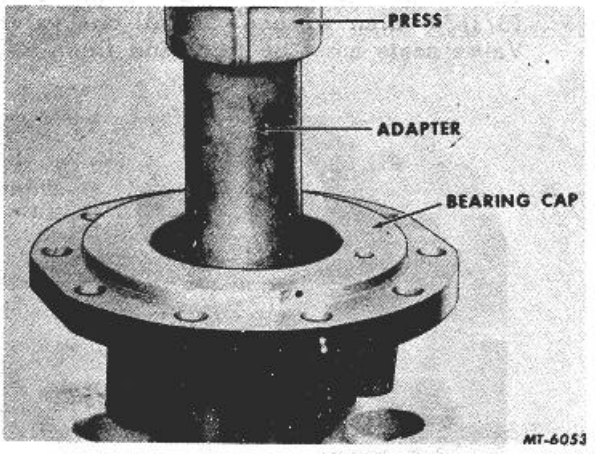


Fig. 44

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16. Install bearing retaining nut using a spanner wrench. Insert locking pin through hole in bearing cap and into hole in nut. If a new nut is being used, drill a 2.38 mm (3/32") hole in nut. The nut must be in place to drill this hole. Drill through locking pin hole in bearing cap and 4.76 mm (3/16") into the nut.
17. Using a new gasket or "O" ring on bearing cap thread actuating shaft into valve. Line up punch marks on gear housing and bearing cap. Turn shaft until cap comes into place on end of cylinder. Check plunger hole alignment with valve seat in piston. Tighten bolts to specified torque.
18. On low pressure gears (M-39, M-59 and M-491 models) align timing mark on output shaft gear with marked spline on output shaft and reassemble. Use a press if necessary (Fig. 45).
19. On high pressure steering gear assemblies (all gear models except M-39, M-59 and M-491), align retaining pin hole in output shaft and gear. Use a press if necessary. Then install retaining pin securing gear to shaft. Use a drift punch and tap pin in deep enough (bottomed) to allow roll pin to be installed.

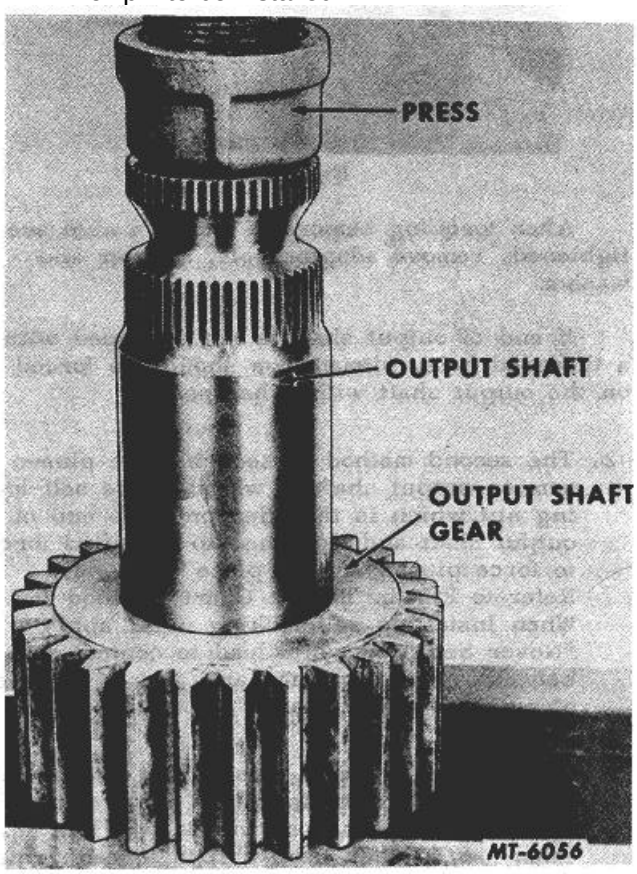


Fig. 45

20. Insert output shaft in gear housing aligning mark on center tooth on pinion rack with mark on output shaft gear. Be very careful so that gear tooth and rack tooth are properly aligned. If a tooth on pinion strikes the ground outside diameter surface of piston, a burr will be raised which will score cylinder wall. This burr should be removed with a fine hand stone before further assembly.
21. Install gear retaining nut on low pressure gears. The nut must be tight against output shaft gear. The capscrews are then installed in retaining nut. If holes do not line up with gear, back nut off until they do. Tighten capscrews with an Allen wrench.
22. Position a new "O" ring seal on housing cover. Install cover assembly. It may be necessary to use a soft hammer to tap cover in place.
23. Install cover bolts and torque to proper specifications.
24. Apply a thin coating of non-hardening sealing compound similar to Permatex #3 to seal retainer (if equipped) and install retainer. Torque bolts to specifications.
25. Install relief valve plungers (with jam nuts if equipped) using new "O" rings. Turn them in approximately six turns.

IMPORTANT

Final adjustment of relief valve plungers is performed after steering gear assembly is installed on vehicle.

26. Fill bearing cap (also seal retainer if equipped) through lube fitting with ball bearing lubricant (IH 251H E.P. grease or equivalent NLGI #2 multi-purpose lithium grease).

REINSTALL

1. Assemble steering gear assembly to frame or gear mounting bracket. Be sure to torque mounting bolts to proper value as listed in TORQUE CHART.

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2. Assemble pitman arm on steering gear output shaft as outlined in PITMAN ARM INSTALLATION.
3. Reassemble steering column.
4. Connect oil lines to steering gear assembly. For special attention in connecting steering gear oil lines on vehicles with slave or secondary gear assemblies, refer to OPERATION, Secondary (Slave) Gear Assemblies for connecting oil lines.
5. Bleed air from system (refer to BLEEDING AIR FROM SYSTEM).
6. Connect drag link.
7. Adjust relief valve plungers as outlined elsewhere in this text.

IMPORTANT

Refer to FINAL ADJUSTMENTS for additional steering gear installation instructions.

PITMAN ARM INSTALLATION

To provide proper alignment of pitman arm to output shaft, an arrow is stamped on arm and in some instances on end of output shaft. A slot or indentation will also be found on end of some output shafts for alignment purposes.

These marks must always be in alignment when pitman arm is installed on output shaft.

There are three methods utilized in retaining pitman arm on output shaft.

1. Two setscrews are threaded into pitman arm and are tightened into a "V" type groove in output shaft. Setscrews are either equipped with a Nylock insert or jam nut to secure setscrews in place (Fig. 46).

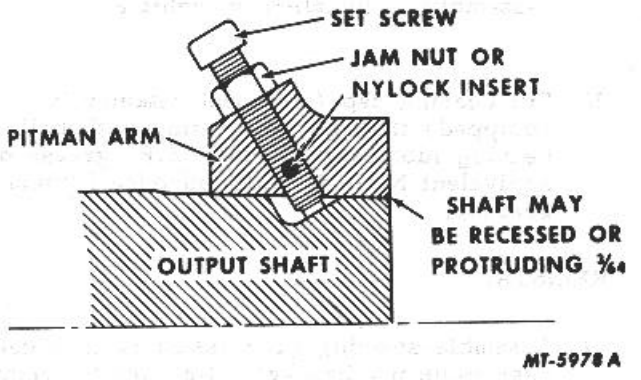


Fig. 47

With this method of retaining pitman arm on output shaft, two procedures are used when installing the arm.

If output shaft is equipped with a threaded hole in end, a bolt about 110 mm (4-1/4") long, an adapter such as a large socket and flat washer can be assembled on output shaft as shown in Fig. 47. Apply "Never Seez" or white lead between washer and adapter, and tighten bolt to specified value listed in Pitman Arm Torque Chart, Method I. Apply "Never Seez" or white lead to threads of setscrews; then install them. Tighten screws to specified torque. After torquing shaft, it may be recessed or protruding 1.2 mm (3/64") maximum from outer face of pitman arm (Fig. 47). Tighten jam nuts if used.

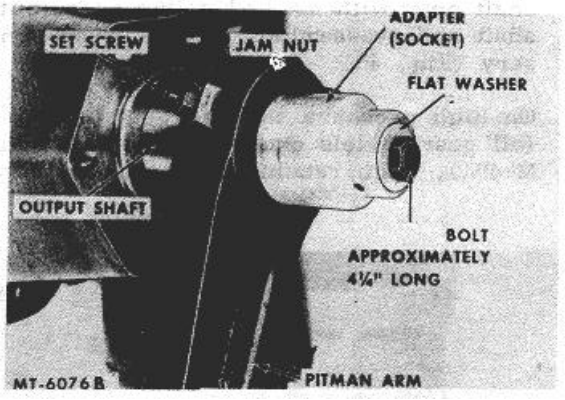


Fig. 47

After torquing setscrews and jam nuts are tightened, remove adapter bolt, adapter and washer.

If end of output shaft is not equipped with a threaded hole, pitman arm should be forced on the output shaft with a hammer.

2. The second method of securing the pitman arm on output shaft is with a large self-locking nut which is threaded onto the end of output shaft and tightened to specified torque to force pitman arm in place (Fig. 48). Refer to Pitman Torque Chart, Method II. When Installing self-locking nuts, apply "Never Seez" or white lead to contact area between nut and pitman arm and to threads of nut and output shaft.
3. Method number three of securing the pitman arm to output shaft is with a large nut which is slotted across the flats of hex sides. Then a 5/16" hex head bolt is threaded into the end of the nut (Fig. 49). When the socket head bolt is tightened, it locks the nut in place on output shaft.

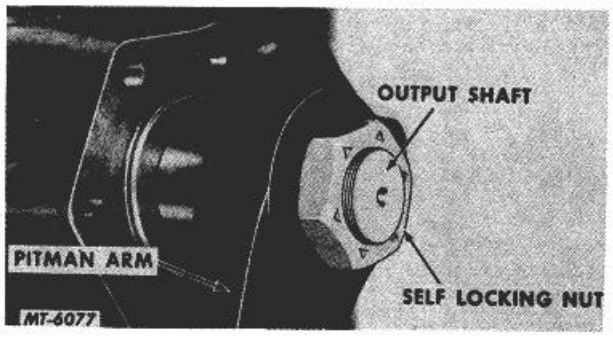


Fig. 48

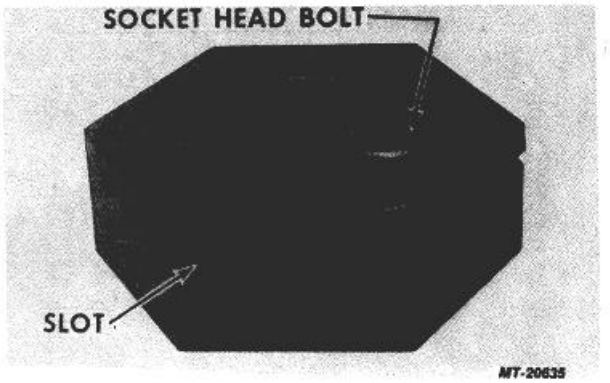


Fig. 49

BLEEDING AIR FROM SYSTEM

1. Fill pump reservoir with recommended lubricant. It will be necessary to continue filling after staring engine and during bleeding operation until correct oil level is maintained.
2. Set parking brake and disconnect drag link/s.
3. Remove bleeder plug from secondary gear assembly (Fig. 6) on system with oil return line from main steering gear to reservoir. Steering gear systems with one main gear or dual gear system with oil return line from secondary gear to reservoir (Fig. 7) do not require removal of any breather.
4. Steering System with Single Gear

   With engine running, turn steering wheel from left to right and return making three complete cycles to remove all air from steering system. Then connect drag link. Do not move pitman arm by hand as air may be pulled back into system.

Steering System with Dual Gears

a. With engine running, turn steering wheel to left and hold until secondary gear pitman arm moves the full travel. Then turn to the right and hold until secondary gear pitman arm again moves full travel. Repeat this process at least three times or more.
b. Connect drag link to main steering gear only. Do not connect drag link to secondary gear at this time. Turn steering wheel to left and hold until secondary gear pitman arm moves full travel. Then turn to right and hold until secondary gear again moves to full travel. Repeat this procedure at least three times or more.
c. Reinstall bleeder plug, if removed.
d. Turn steering wheel until secondary gear pitman arm lines up with drag link and install drag link. Do not move pitman arm by hand as air may be pulled back into system. 5. Stop engine. 6. Recheck lubricant level.

When installing the pitman arm retaining nut apply "Never Seeze" or white lead to contact area between nut and pitman arm and to threads of socket head capscrew. Refer to Pitman Arm Torque Chart, Method III for torque values of pitman arm retaining nut and locking bolt.

ADJUSTING RELIEF VALVE PLUNGERS
(Adjustable Stops)

Relief valve plungers are adjusted after pitman arm is installed and drag link is connected.

1. Turn bearing cap plunger and cylinder head plunger into gear until they bottom.
2. Start engine and allow it to operate at fast idle speed.
3. With full weight of vehicle on all wheels, turn steering wheel until bearing cap plunger opens relief valve. Do not force steering wheel. You can feel the valve open as the turning effort is increased. Adjust bearing cap plunger outward and continue to turn steering wheel until about 3.2 mm (1/8") clearance is maintained at the wheel stops. Do not change wheel stop adjustment. Lock plunger with jam nut, if equipped. The same procedure is repeated for cylinder head plunger.
4. Vehicle is now ready for road testing.

LUBRICATION

Keep power steering pump reservoir filled to indicated level. When filling, start engine. With engine running, turn steering wheel from left to right and continue filling until proper level is maintained.

For type of lubricant, refer to LUBRICATION Section, CTS-2412.

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DISASSEMBLY

1. Remove cover attaching bolts, then remove cover with input shaft and bearing assembly. Check to be sure that shaft and gear have timing marks.

2. Drive retaining pin out of input gear; then remove gear (Fig. 1).

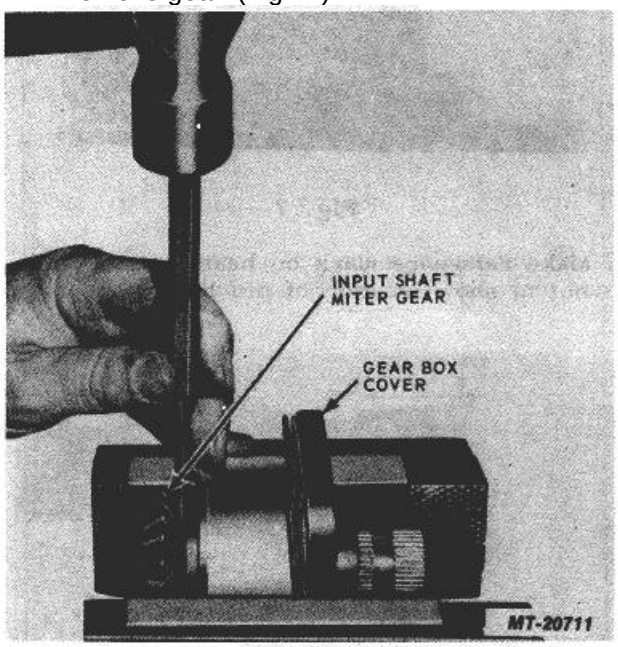


Fig. 1

3. Pull bearing retaining nut lock pin from gearbox cover (Fig. 2).

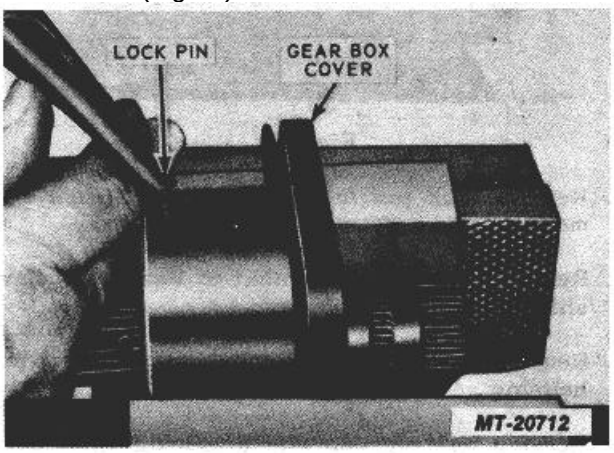


Fig. 2

4. With spanner wrench remove bearing retainer nut from gearbox cover by turning counterclockwise.

5. Remove bearing and input shaft assembly from cover. Drive out with a soft hammer or use a press, if necessary (Fig. 3)

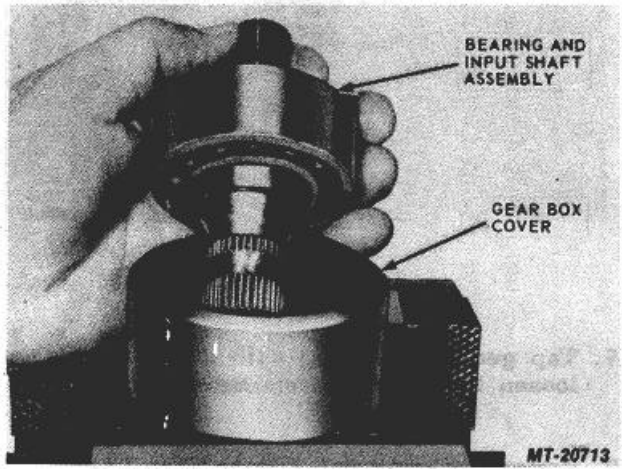


Fig. 3

6. The shaft can be driven out of the bearing (Fig. 4). If difficulty is experienced in driving, use a press.

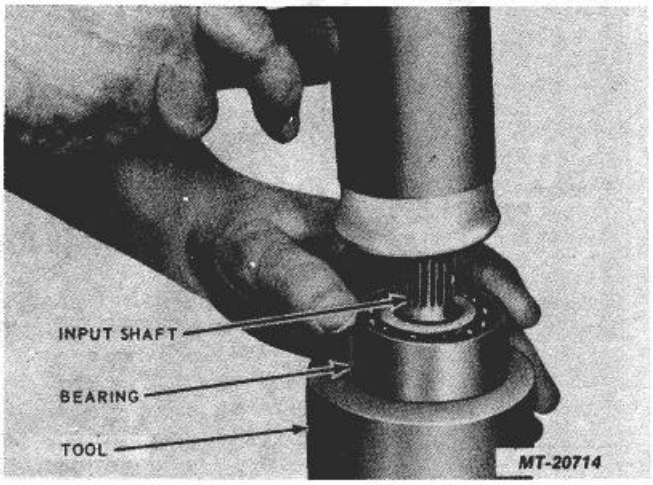


Fig. 4

7. Remove seal from cover.

8. Remove screws that attach gearbox housing to bearing cap. Note that one is reached from inside of housing (Fig. 5).

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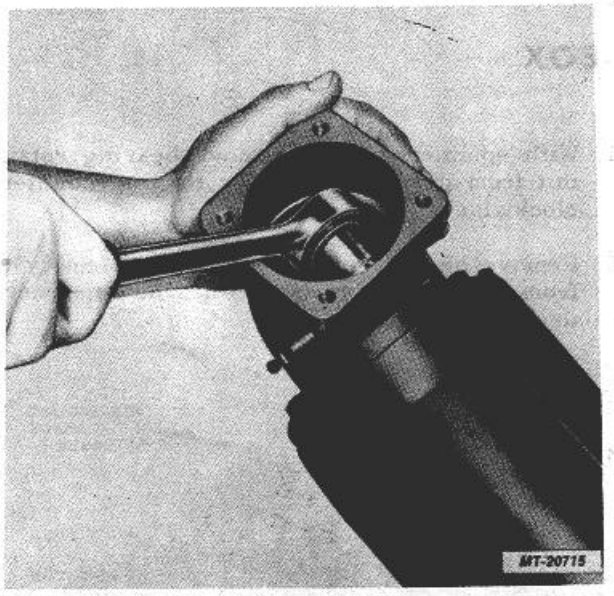


Fig. 5

9. Tap gearbox housing with a soft hammer to loosen it; then lift from bearing cap.

10. Remove bearing cap O-ring (Fig. 6).

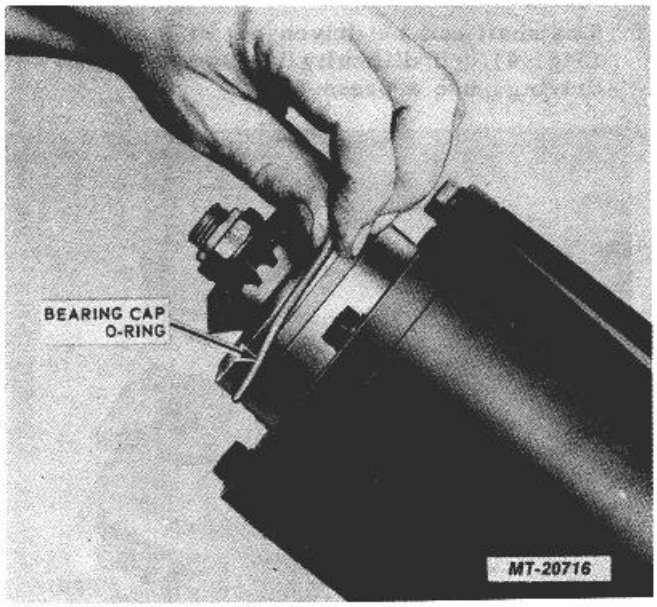


Fig. 6

11. Remove gear retaining nut and washer from actuating shaft (Fig. 7). Pull gear off actuating shaft.

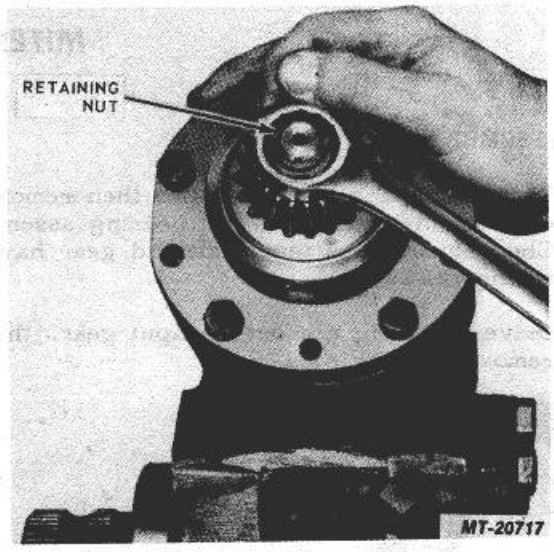


Fig. 7

12. Make reference mark on bearing retaining nut to show location of pin hole (Fig. 8).

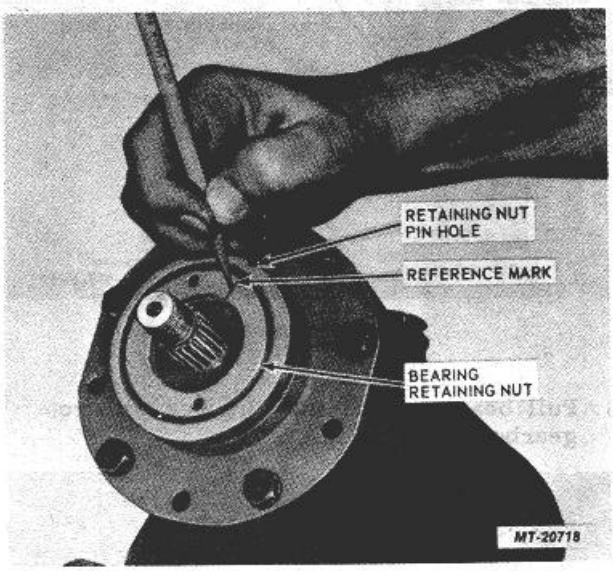


Fig. 8

13. Remove lock pin from bearing cap; then remove bearing retaining nut (Fig. 9).

14. Remove shims located next to bearing. Save shims for reassembly.

15. Remove screws which attach bearing cap to housing.

16. Remove bearing cap and actuating shaft assembly by turning shaft assembly so as to

CHAPTER III

TROUBLE SHOOTING

Power Steering Trouble Shooting

A thorough and orderly trouble shooting procedure will help you diagnose power steering troubles quickly.

Troubles occur and show up in various ways; but with the trouble shooting chart you can eliminate many possibilities quickly, narrow down the cause of trouble, then make the correct repairs promptly.

Trouble shooting procedure should be followed in a three step organized manner:

1. Define the complaint.
2. External inspection.
3. Hydraulic system check.

Cause of Bad Steering Outside of Steering System

1. Soft tires.
2. Loose king pins.
3. Low pressure in one or more tires, particularly rear tires.
4. Swinging load.
5. Improper fifth wheel location.
6. Sheared off spring leaf bolt on steering gear side of truck.
7. Improper front end alignment (caster, camber and toe-in).

TROUBLE SHOOTING CHART

PROBLEM	POSSIBLE CAUSE	REMEDY
1 Oil forcing out of filler a in reservoir	Dirty cartridge in reservoir	Change oil and cartridge Replace cap vent hole filter cartridge at short interval if necessary to clean up system.
	b Loose belts	Tighten belts.
	c Air in system	Bleed system and check adjustable stops.
	d Malfunctioning pump	Refer to pump servicing instructions.
2 Oil leakage at pump pulley shaft	Worn oil seal	Replace oil seal (change oil and filter cartridge at more frequent intervals).
3 Oil leaking between reservoir and pump	Overheating or age	Replace O-ring between reservoir and pump.
4 Oil leaking at actuating shaft of steering gear	a Worn or damaged oil seal	Replace oil seal
	b Worn or damaged actuating shaft	Replace with actuating shaft assembly
5 Oil leaking at output a shaft of steering gear	Worn or damaged output shaft	Replace output shaft
	b Restricted oil return line	Check for obstructions and sharp bends in line.
	c Clogged filter	Change oil and cartridge Replace filter cartridge at shorter intervals.
	d Worn or damaged quad ring	Replace quad ring.
	e Worn cover bushing and/or output shaft bushing	Replace bushings

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	PROBLEM		POSSIBLE CAUSE	REMEDY
6	Excessive pump pressure with steering gear in neutral position.		Kink in oil return line	Relocate line to remove kink
7	Erratic steering or no steering at all	a	Insufficient volume of oil being metered by flow divider to steering gear induced by foreign particles on flow divider valve, causing the valve to hang up in the bore.	Polish flow divider valve to re move foreign particles and burrs Refer to pump servicing instruc-tions
		b	Flow divider spring takes per-manent set because of fatigue, thereby allowing flow divider valve to move easily and reduce oil volume.	Replace flow divider spring Refer to pump servicing instructions
		c	Broken bypass spring in flow divider	Replace with flow divider valve as sembly, which includes bypass spring Refer to pump servicing instructions
8	Side motion in steering wheel		Broken jacket bearing in steering column.	Replace jacket bearing
9	Excessive backlash	a	Worn universal joint	Replace universal joint.
		b	Worn pins and keys, universal joint to actuating shaft and universal joint to steering shaft.	Replace pins and keys
		c	Low oil volume	Check flow divider and pump speed belt(s)
		d	Pitman arm ball worn "egg-shaped.	Replace pitman arm assembly " where riveted or ball only where bolted ball is used
		e	Improperly adjusted drag link, pitman arm to drag link and steering arm to drag link	Adjust drag link, drag link to pitman arm and drag link to steering arm.
		f	Loose bracket, frame to bracket or bracket to gear	Remove bracket, clean frame and bracket; check radius of frame making sure bracket is not bearing on radius surface; check bracket for wear from working Replace bracket and tighten to recommended torque rating according to size and grade of bolts If necessary, replace bracket with new one
		g	Worn or damaged actuating valve	Replace with actuating piston and valve assembly.
		h	Rack or piston worn or dam-aged	Replace with actuating piston and valve assembly.
		i	Worn or damaged pinion gear on output shaft.	Replace pinion gear

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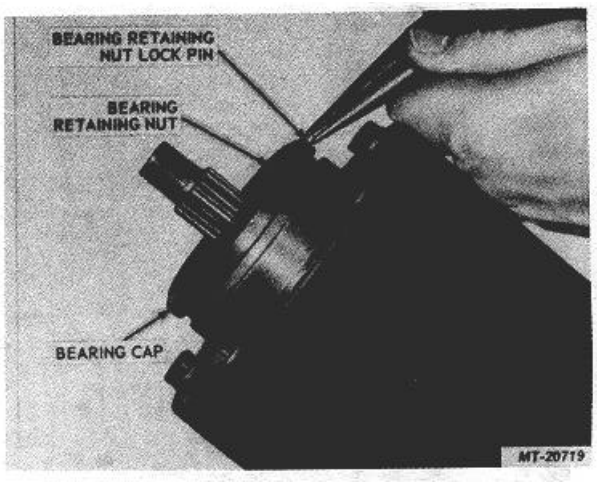


Fig. 9

screw shaft out of actuating valve. Note timing marks on shaft and valve for reassembly.

17. Remove actuating shaft and bearing assembly from bearing cap by tapping with soft hammer or pressing, if necessary.
18. The fixed plunger can be removed from bearing cap by prying lock pin out of cap far enough to be gripped with pliers, then withdrawn completely. Do not remove unless damaged (Fig. 10).
19. Remove oil seal from bearing cap. This is done either by prying or, on current production models, driving out with a punch utilizing holes in cap provided for this purpose.

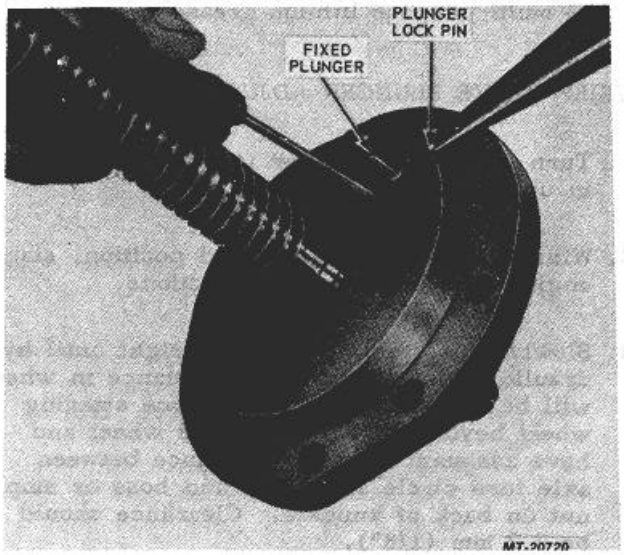


Fig. 11

INSPECTION

All parts should be cleaned thoroughly in solvent. Parts should be washed individually to preclude possibility of striking each other and damaging the critically fitted parts. A clean lint-free cloth should be used.

Visually inspect all parts for burrs, nicks, etc. Burrs can be removed by use of a fine hand stone. Check shaft for wear. Check gear teeth for cracks, chips and wear pattern. Check housing for cracks and straightness of flanges.

REASSEMBLY

1. Press a new oil seal into bearing cap. Position seal so that lip faces piston side of cap.
2. If fixed plunger was removed, insert in bearing cap and install retaining pin. Be sure pin is below surface of bearing cap.
3. Press bearing on actuating shaft if removed previously. Press shaft and bearing assembly into bearing cap. Do not damage oil seal while installing shaft.
4. Turn actuating shaft into actuating valve, taking care to align timing marks (Fig. 11). Fig. 11

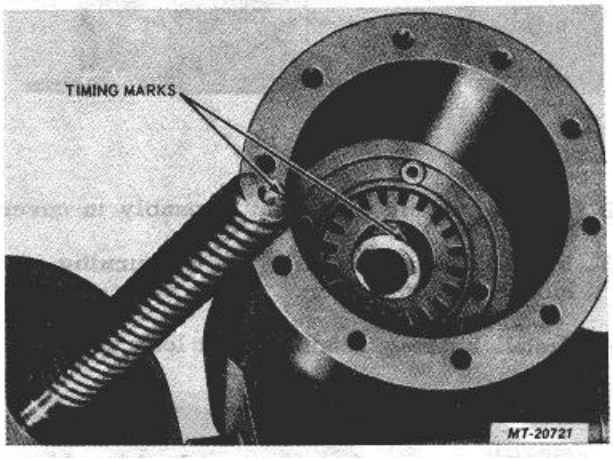


Fig. 11

5. Install bearing cap attaching bolts and tighten to specified torque. 6. Place shims over bearing and install bearing retaining nut. Turn nut down against bearing. Align reference marks on nut (made in Step 12 of DISASSEMBLY) with lock pin hole and install pin.
7. Place miter gear on actuating shaft; then install washer and nut.

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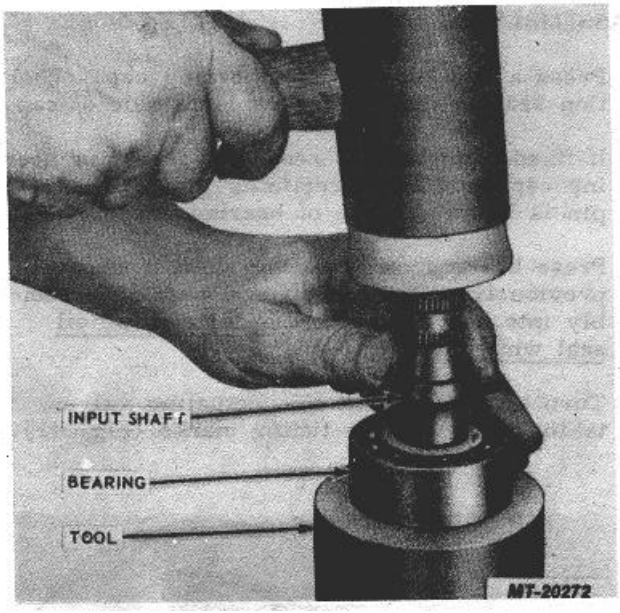
8. Install new O-ring in bearing cap groove.

9. Position gearbox housing on bearing cap and tap into place with a soft hammer. Install lockwashers and screws. Do not overlook screw located inside housing.

10. Install new seal in cover.

11. Drive input shaft into bearing with a soft hammer or, if necessary, use a press (Fig. 12).

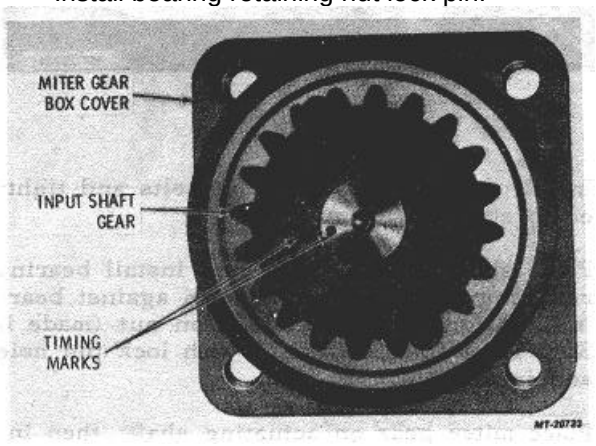
Fig. 12

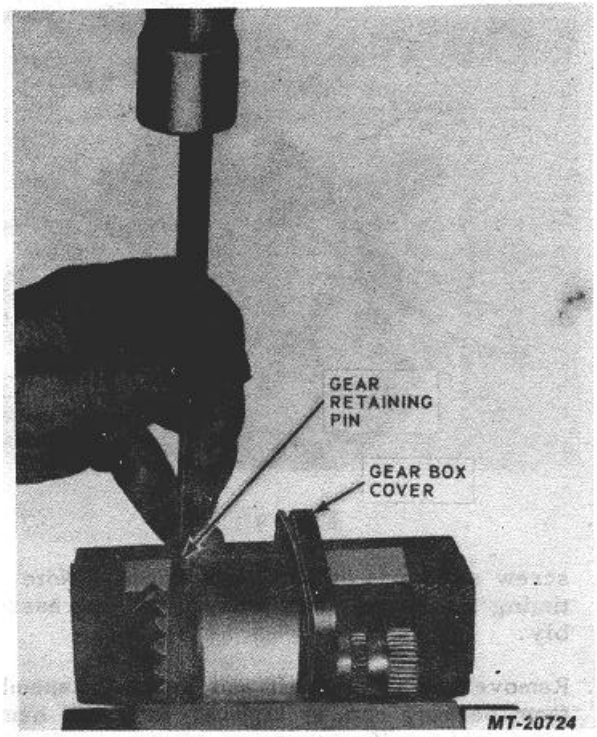


12. Install bearing and shaft assembly to cover.

13. Install bearing retainer nut by turning it clockwise into cover.

14. Install bearing retaining nut lock pin.





15. Place miter gear on input shaft being sure that reference marks are in alignment (Fig. 13). Drive retaining pin into place (Fig. 14).

16. Install cover assembly and shim on gearbox housing.

17. Fill gearbox housing with ball bearing lubricant (IH 251H EP grease or equivalent NLGI #2 multi-purpose lithium grease).

RELIEF VALVE PLUNGER ADJUSTMENT

1. Turn adjustable plunger (in cylinder head) in until it bottoms.

2. With wheels in straight-ahead position, start engine so power steering functions.

3. Slowly turn steering wheel to right until hydraulic assist is stopped (resistance in wheel will be noticeable). Do not force steering / wheel beyond this point. Hold wheel and have assistant measure clearance between axle turn circle stopscrew and boss or stop nut on back of knuckle. Clearance should be 3.2 mm (1/8").

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TORQUE CHART
CHAPTER IV

Application	Size	TORQUE N.m	TORQUE Ft Lbs
Cylinder Head and Bearing Cap	5/16 - 24 NF	27	20
Cylinder Head and Bearing Cap	3/8 - 24 NF	45	33
Bearing Cap Seal Retainer	1/4 - 20 NC	48	35
Steering Gear Cover (Mounted)	7/16 - 20 NF	72	53
Steering Gear Cover (Mounted)	1/2 - 20 NF	113	83
Steering Gear Cover (Mounted)	9/16 - 18 NF	165	122
Steering Gear Cover (Mounted)	5/8 - 18 NF	227	167
Steering Gear Cover (Mounted)	5/8 - 11 NC	206	152
Steering Gear Cover (Standard)	7/16 - 20 NF	49	36
Steering Gear Cover (Standard)	1/2 - 20 NF	76	56
Steering Gear Cover (Standard)	9/16 - 18 NF	110	81
Steering Gear Cover (Standard)	5/8 - 18 NF	152	112
Steering Gear Cover (Standard)	5/8 - 11 NC	136	100
Pitman Arm Setscrews	5/16 - NC	16	12

PITMAN ARM - METHOD I

Steering Gear Model No.	Adapter Bolt Size	TORQUE N.m	TORQUE Ft Lbs
M-39, 252, 292, 352, 372, 382, 392, 491	1/2 - 20 UNF *	115	85
M-59	9/16 - 18 UNF *	170	125
M-492	9/16 - 18 UNF *	217	160
M-592	5/8 - 18 UNF *	230	170
All Models	Setscrew	16	12

* - Grade 5

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PITMAN ARM - METHOD II

Steering Gear Model No.	TORQUE N.m	TORQUE Ft Lbs
M-39	556	410
M-292, 392, 491	610	450
M-59	678	500

PITMAN ARM - METHOD III

Steering Gear Model No.	TORQUE N.m	TORQUE Ft Lbs
M-39, 252	373	275
M-292, 352, 372, 382, 392	386	285
M-59	590	435
M-492	814	675
M-592	949	775
All Models - Lock Bolt Socket Head	24 - 27	18 - 20

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PROBLEM	POSSIBLE CAUSE	REMEDY
10. Wheel steering hard in one direction.	Broken reversing springs in steering gear.	Replaces reversing springs.
11. Wheel steering hard in one or both directions.	a. Metal or foreign material caught in actuating valve. Actuating valve worn or chipped by dirt.	Remove actuating valve, clean and check parts for damage. If damage is excessive, replace with actuating piston and valve assembly.
	b. Bent or damaged king pins and tie rods.	Repair or replace king pins and tie rods. Refer to servicing instructions.
	c. Front end load too great for rated axle capacity.	Lighten load or install larger steering gear.
	d. Fatigued bypass valve spring in pump.	Replace with flow control valve assembly. Refer to pump servicing instructions.
12. Hard steering.	a. Loose belts.	Tighten or replace belts.
	b. Worn pulley(s) due to belt slippage.	Replace pulley(s) and belts (keep belt tight).
	c. Improper belt.	Replace with IH replacement part.
	d. Low oil level in steering system.	Fill oil reservoir as required. See "Lubrication. "
	e. Air in system.	Bleed system and check for cause of air.
	f. Caster and camber degree incorrect.	Correct to "Specifications."

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POWER STEERING
EATON
HYDRAULIC PUMP - ROLL VANE TYPE

INDEX

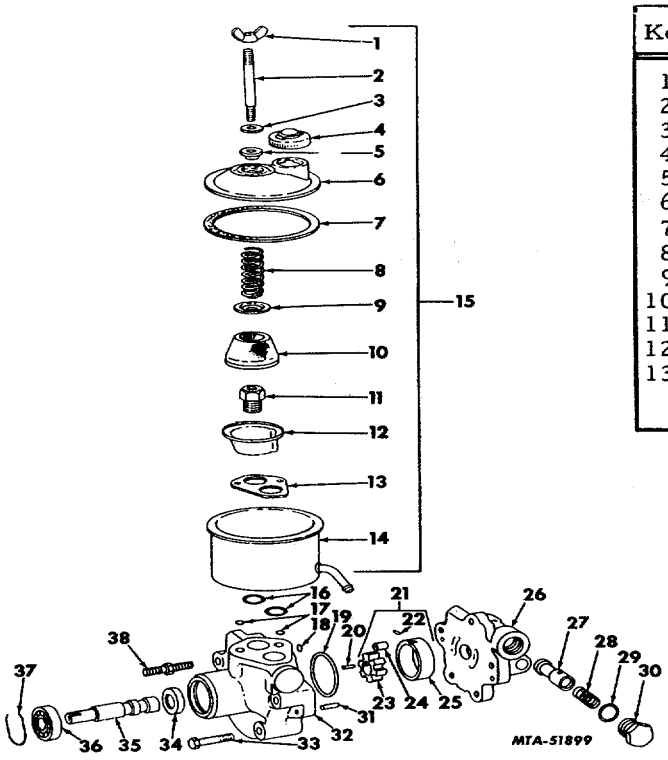
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SPECIFICATIONS

PUMP TYPE	Roll Vane
MANUFACTURER	Eaton
DRIVE	Belt
MOUNTING	Bracket
RELIEF VALVE SETTING	*
END CLEARANCE (Carrier and Rolls to Cover)	.05 mm (.002 in.)

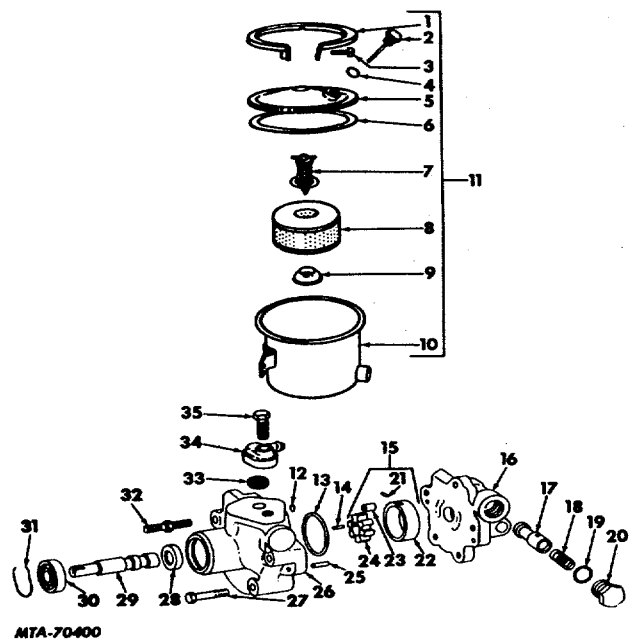
* Relief valve pressure setting varies with truck model and axle application. This is factory set and not adjustable.

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Key	Description	Key	Description
1.	Wing nut.	14.	Reservoir.
2.	Stud.	15.	Reservoir, assy.
3.	Washer.	16.	"O" ring seal.
4.	Cap, filler.	17.	"O" ring seal.
5.	Gasket.	18.	"O" ring seal.
6.	Cover.	19.	"O" ring seal.
7.	Gasket.	20.	Pin, drive.
8.	Spring.	21.	Kit, repair.
9.	Seat, spring.	22.	Pin, retaining.
10.	Element, filter.	23.	Carrier.
11.	Stud, support.	24.	Vane, roll.
12.	Support.	25.	Cam.
13.	Plate, reinforcing.	26.	Cover, pump body
		27.	Valve, control.
		28.	Spring.
		29.	"O" ring seal.
		30.	Cap, valve.
		31.	Pin, dowel.
		32.	Body, pump.
		33.	Screw.
		34.	Seal.
		35.	Shaft.
		36.	Bearing.
		37.	Ring, retaining.
		38.	Stud.

Fig. 1 Exploded View of Hydraulic Pump Assembly With Integral Reservoir



Key	Description	Key	Description
1.	Ring, clamp.	14.	Pin, drive.
2.	Dipstick.	15.	Carrier, cam & van
3.	Nut, clamp		assembly.
4.	Gasket	16.	Cover.
5.	Cover.	17.	Valve, Control.
6.	Gasket.	18.	Spring.
7.	Spring, holddown	19.	"O" ring seal.
8.	Element, filter.	20.	Cap, valve.
9.	Seat, filter	21.	Pin, retaining.
10.	Reservoir.	22.	Cam.
11.	Reservoir, assy.	23.	Vane, roll
12.	"O" ring seal.	24.	Carrier.
13.	"O" ring seal.	25.	Pin, dowel.
		26.	Body, pump.
		27.	Bolt.
		28.	Seal.
		29.	Shaft.
		30.	Bearing.
		31.	Ring, retaining
		32.	Stud.
		33.	"O" ring seal.
		34.	Manifold.
		35.	Bolt.

Fig. 2 Exploded View of Hydraulic Pump Assembly-Separate Mounted Reser

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HYDRAULIC PUMP

DESCRIPTION

The hydraulic pump (Fig. 1 & 2) covered in this section is a roll vane type of unit. Its pumping principle is based on the action of carrier rotated roll vanes or rollers which follow the surface of a cam ring when drive shaft turns. Oil from a reservoir which is either integral or mounted away from the pump is forced along between the roll vanes and delivered under pressure to the pump outlet. Pressure relief and flow control are incorporated within the pump. Bracket mounted to the engine, the pump is belt driven from the engine crankshaft.

OPERATION

First of all, the pump continuously circulates oil to the steering control valve at predetermined flow control rate. The oil returning from the steering valve enters the reservoir through the return tube brazed into the side. The oil goes through the tube into the center of the filter element through the element into the reservoir body. The oil enters the pump through the opening in the bottom of the reservoir, and the matching hole in the pump body. The oil is then pumped by the roll vanes out the discharge passage which terminates at the discharge hose connection. In passing through the tube seat at this connection, the oil goes through an orifice of predetermined size. This is the primary orifice and controls the flow rate. Forcing oil through this orifice creates a pressure in this circuit which presses against the valve. At the point where the output of the pump starts to exceed, relief valve spring tension, the pressure is great enough to open the valve and allow the excess to flow directly back to the intake port in the pump and recirculate. When an excessive predetermined pressure is exerted on the discharge oil in the pump, this pressure is communicated through another orifice on the side of the tube seat through a passage to the back of the valve (spring end) where the pressure opens the small pilot ball in the valve. The opening of the pilot ball allows a pressure drop behind the valve which allows the valve to open as a relief valve. During complete shut-off (discharge), the oil just circulates from discharge through the valve to intake.

TROUBLE SHOOTING

An understanding of the complete steering system, mechanical and hydraulic, is necessary before it can be determined what is faulty. In the mechanical part of the steering system, many of the troubles which can affect a manual steering system can also affect a power steering system. In the hydraulic system, trouble can show up in the control valve, the power cylinder or the hydraulic pump. This means that an orderly trouble shooting procedure should be followed to find which system or component requires service. For the complete trouble shooting procedures on the steering system or any one of its components, see specific power steering section of the Service Manual.

REMOVAL

1. Before pump is removed, drain hydraulic fluid from reservoir. This is important for pumps having an integral reservoir. On pumps with separately mounted reservoirs, disconnect lines at pump and seal off or support lines so that only a minimum amount of fluid will be lost.

2. Loosen adjusting bolt, pivot pump, and remove pump belt.

3. Remove bracket to pump bolts and take off pump.

DISASSEMBLY

The following procedure which may be used as a guide for pump disassembly has been illustrated with a pump having an integral reservoir. However, once the reservoir is removed, the balance of the disassembly is the same for both types of pumps.

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NOTE: Thoroughly clean exterior of pump and reservoir assembly using care so that dirt does not enter the pump or reservoir upon disassembly.

During all assembly operations, extreme caution should be used to prevent any dirt from entering pump. All parts should be lightly oiled with Dexrone automatic transmission fluid before assembly.

1. Clamp mounting bracket of pump and reservoir assembly in vise.

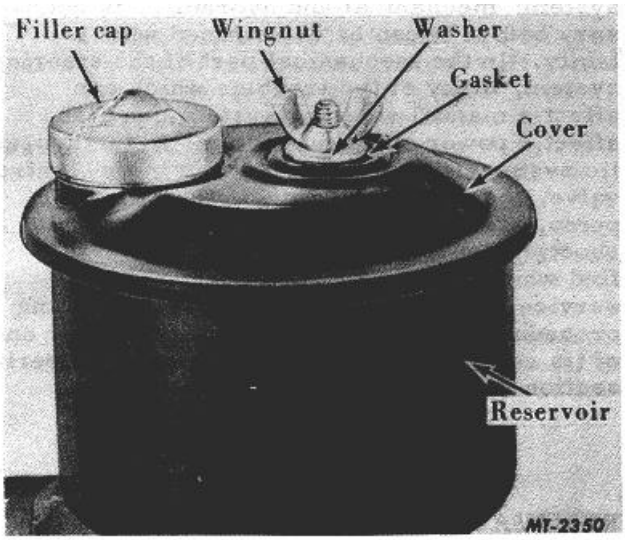


Fig. 3

2. Remove wing nut, washer, and gasket that secures reservoir cover to reservoir, Fig. 3.

3. Remove reservoir cover, Fig. 3 .

4. Remove reservoir cover gasket.

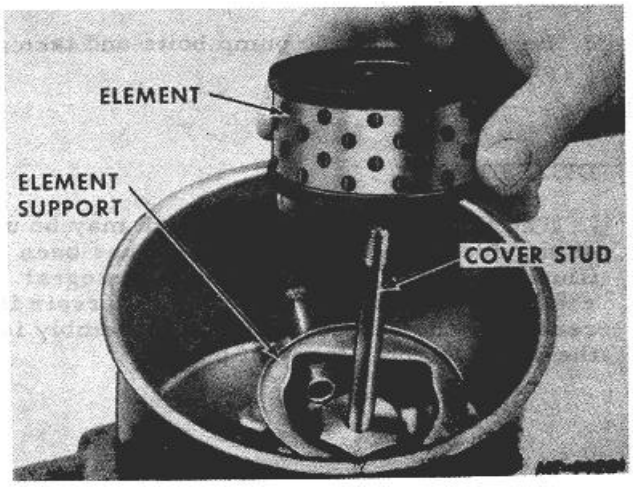


Fig. 4

5. Remove element hold down spring, and filter element, Fig. 4.

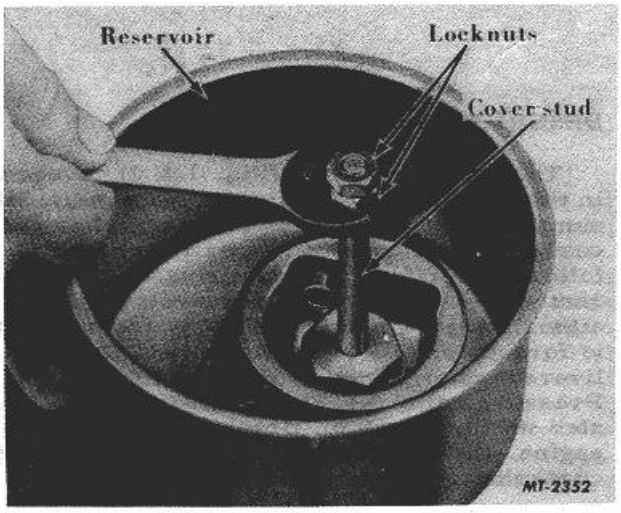


Fig. 5

6. Remove 5/16" stud with stud puller or two nuts, Fig. 5.

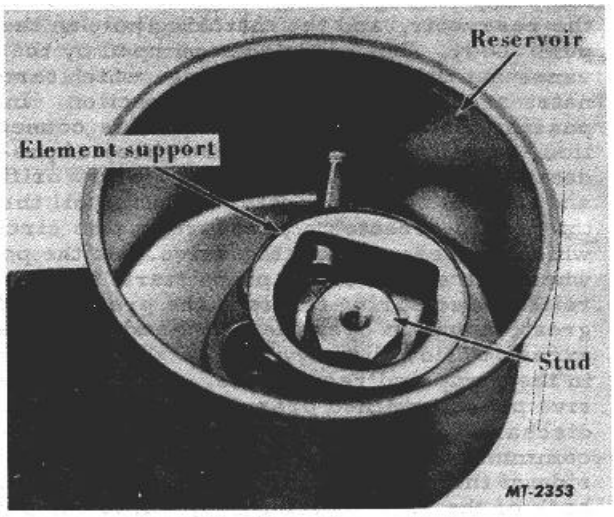


Fig. 6

7. Remove the stud that retains the element support, using 1" socket, Fig. 6.

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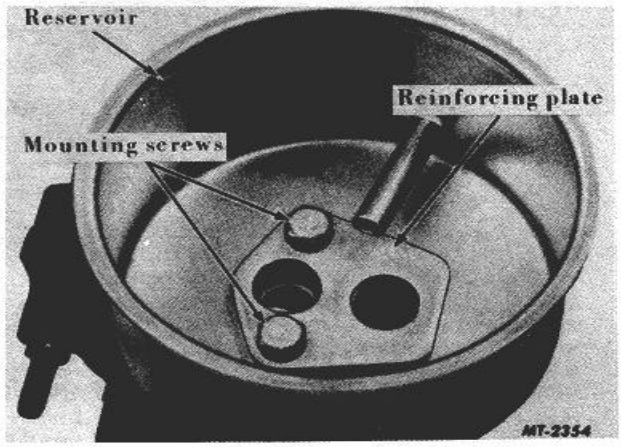


Fig. 7

8. Remove reservoir to body mounting screws and lock washers, Fig. 7.

9. Remove reinforcing plate and reservoir from pump, Fig. 7.

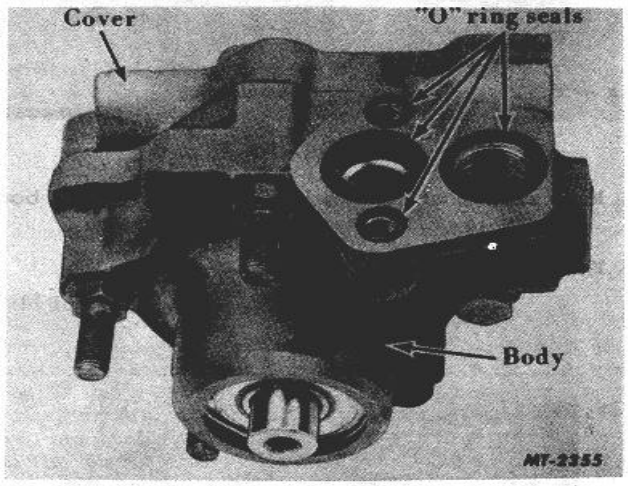


Fig. 8

10. Remove the four "O" ring seals between the reservoir and pump body and discard, Fig. 8.

11. Remove the cover to body mounting screws and studs, Fig. 9. Separate the cover from the body, Fig. 10, lifting cover vertically from body to prevent internal parts from falling out.

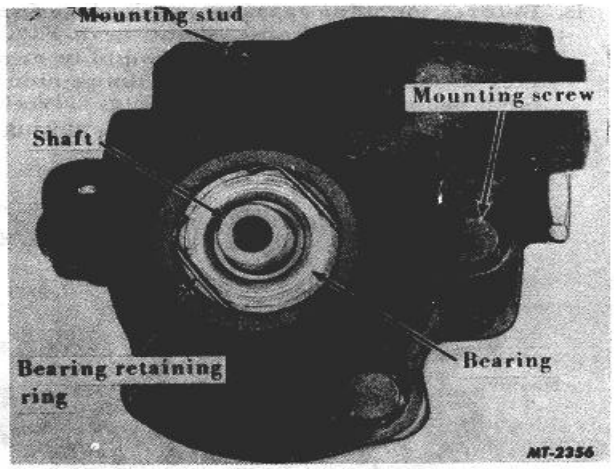


Fig. 9

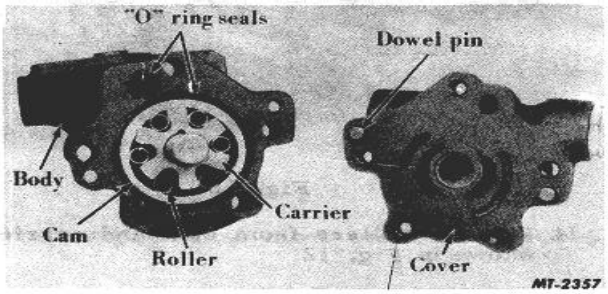


Fig. 10

12. Remove "O" ring seals from grooves in pump body housing, Fig. 10, and discard seals.

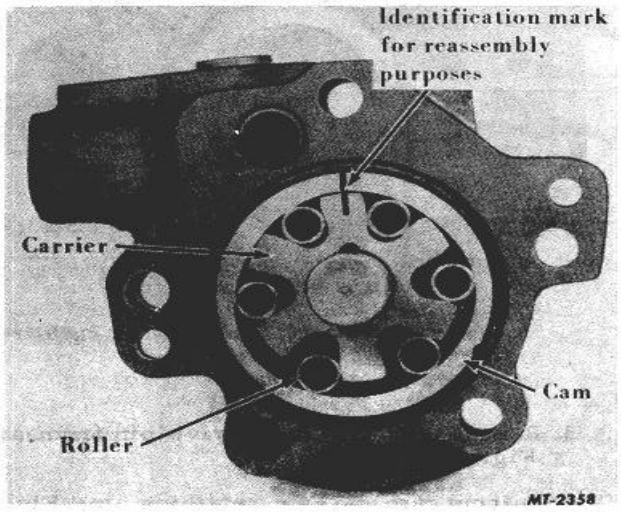


Fig. 11

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13. Before removing carrier, mark a line across the carrier and cam as shown in Fig. 11. This will permit correct reassembly of carrier to cam, as carrier has a drive side and must be installed as shown in Fig. 11. Note: Do not scratch the surfaces when making the markings.

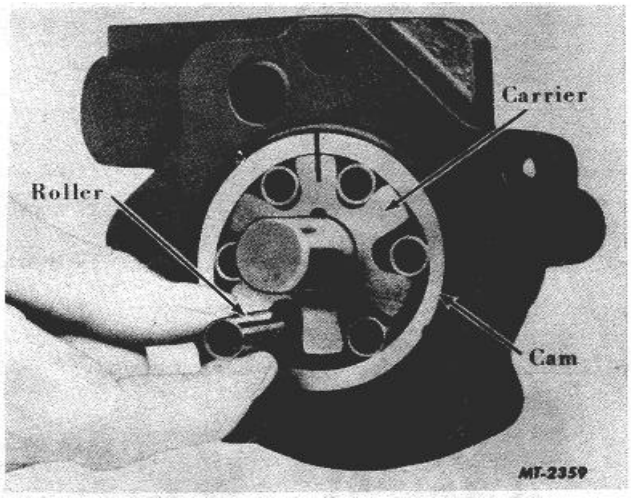


Fig. 12

14. Remove rollers from cam and carrier as shown in Fig. 12.

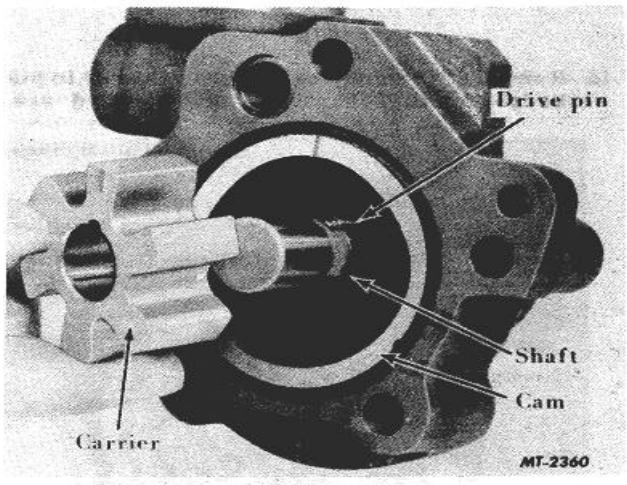


Fig. 13

15. Remove carrier and drive pin from shaft, Fig. 13.

16. Lift out cam and cam retaining pin, Fig. 14.

17. Remove bearing retaining ring. Fig. 9.

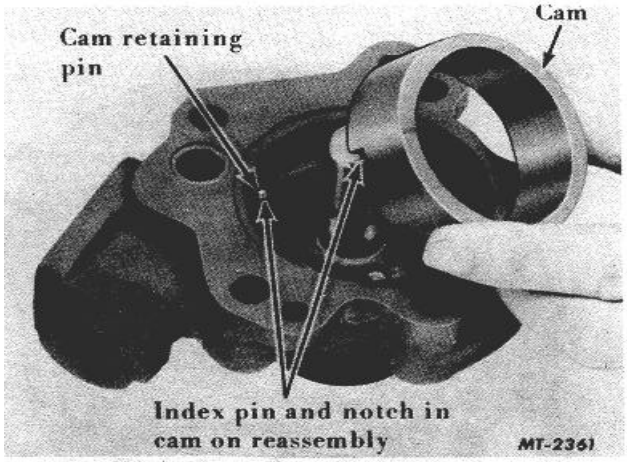


Fig. 14

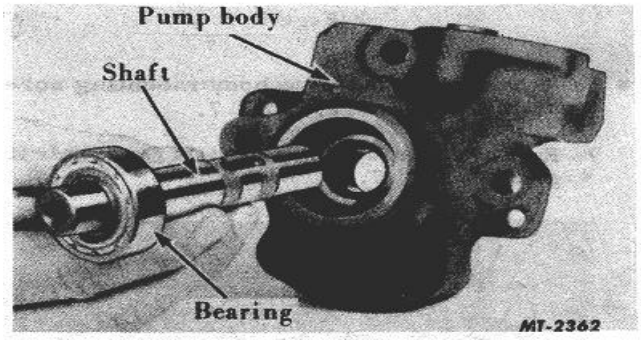


Fig. 15

18. Remove shaft and bearing from pump body, Fig. 15.

19. Press bearing from shaft.

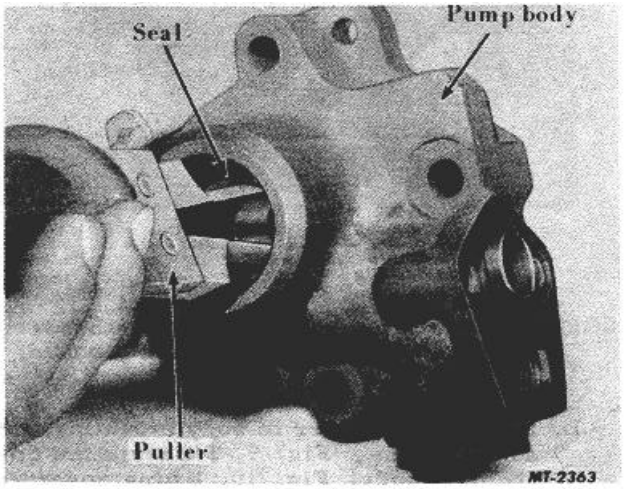


Fig. 16

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20. Remove seal, Fig. 16, from pump body using puller SE-1746 and discard seal.

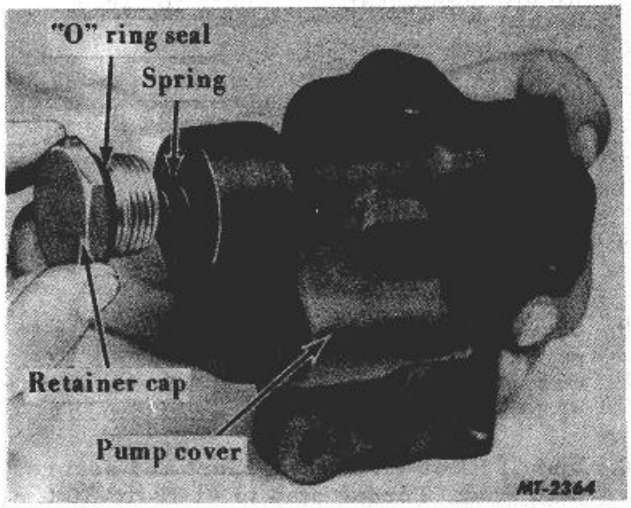


Fig. 17

21. To remove the combination flow control and relief valve in pump cover, r em ov e the spring retainer cap and circular section rubber "O" ring seal, Fig. 17, and discard seal.

22. Lift out flow control valve spring, Fig. 17.

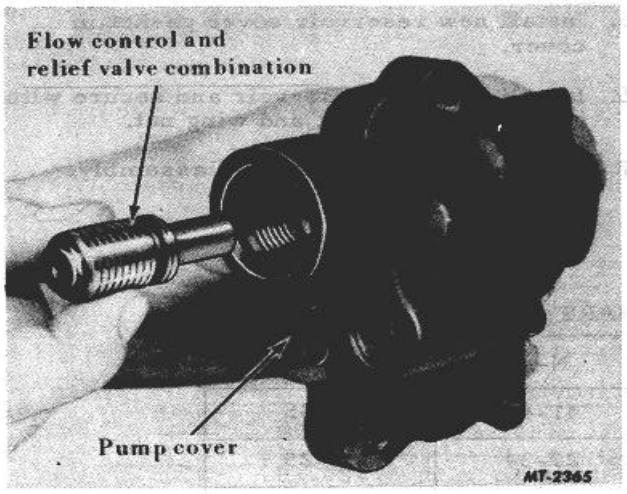


Fig. 18

23. Tap cover on wooden block to remove the combination flow control and relief valve, Fig. 18. NOTE: Relief valve is an internal part of the flow control valve and is not to be disassembled.

REASSEMBLY

It is important that all parts be clean. (Do not wipe with cloths). Coat all parts with a light film of oil as they are assembled. This will assure prelubrication of parts.

1. Install flow control valve into pump cover making sure exposed ball end enters bore first.

2. Install flow control valve spring.

3. Install new "O" ring seal on flow control valve retainer cap and install into pump cover. Torque retainer cap.

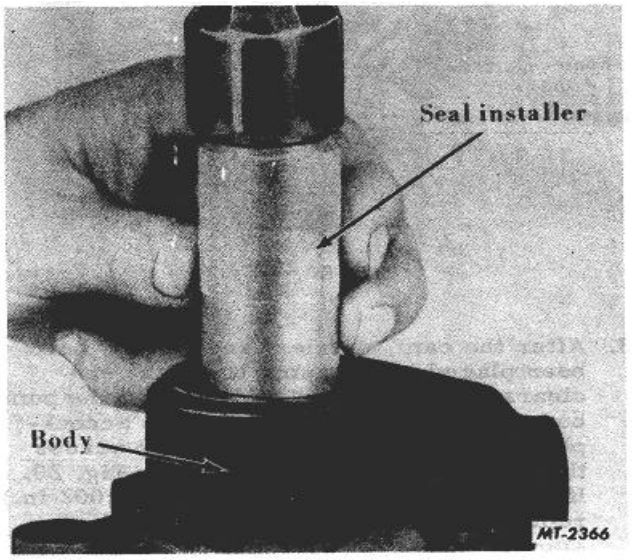


Fig. 19

4. Install new seal with lip toward carrier into pump body using seal installer SE-1878-3, Fig. 19.

5. Press bearing onto pump shaft until bearing seats against shoulder on shaft.

6. Install shaft and bearing assembly into pump body.

7. Install bearing retaining ring in groove in body making sure ring is seated properly.

8. Install cam retaining pin into pump body.

9. Install cam into pump body making sure notch in cam indexes with retaining pin and cam is seated firmly in pocket, Fig. 4.

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10. Install carrier drive pin into groove in pump shaft.

11. Install carrier into pump body making sure line previously marked on carrier indexes with line marked on cam.

12. Install rollers into pockets of carrier.

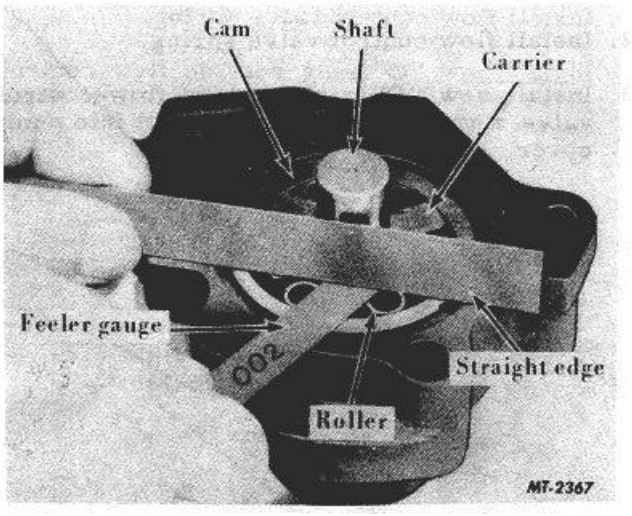


Fig. 20

13. After the cam, carrier, and rollers have been placed in the pump body, the end clearance of carriers and rolls in the pump body should be checked. This is accomplished by placing a straightedge across the cam and carrier as shown in Fig. 20. If end clearance exceeds .05 mm (.002 in.), replace carrier or rolls.

14. Install new "O" ring seals in body.

15. Position the cover on the pump body and attach cover with screws, studs, and lock washers. Torque screws and studs to 27 N-m (20 ft. lbs.)34 N-m (25 ft. lbs.). Rotate pump shaft and check for free rotation.

16. Position four new "O" ring seals on pump body to mount reservoir.

17. Position reservoir over the four "O" ring seals and pump body.

18. Place reservoir reinforcing plate in position.

19. Secure reservoir and reinforcing plate to pump body with two screws and lock washers. Torque mounting screws to 41 N-m (30 ft. lbs.) 47 N-m (35 ft. lbs.).

20. Install filter element support and secure with stud. Torque stud to 41 N-m (30 ft. lbs.) 47 N-m (35 ft. lbs.).

21. Install 5/16" stud into support stud and torque to 4.5 N-m (40 in. lbs.) 7 N-m (60 in. lbs.).

22. Place new filter element on support.

23. Position spring seat on top of filter element.

24. Install spring over stud and onto spring seat.

25. Install new reservoir cover gasket in cover.

26. Install cover to reservoir and secure with gasket, flat washer, and wing nut.

27. Install reservoir filler cap assembly.

TORQUE CHART

Location	N-m	Ft. Lbs.
Relief Valve Retainer Cap	41-47	30-35
Pump Cover to Body	27-34	20'-25
Reservoir to Pump Body	41-47	30-35
Filter Element Support Stud	41-47	30-35
Filter Cover Stud	4-7	3-5
Manifold to Pump Body	41-47	30-35

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POWER STEERING PUMP

SAGINAW 125 SERIES (LIGHT DUTY) AND 235 SERIES (MEDIUM AND HEAVY DUTY) HYDRAULIC VANE-TYPE PUMPS

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POWER STEERING PUMP INFORMATION

CHAPTER 2

125 SERIES PUMP SERVICE INFORMATION

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235 SERIES PUMP SERVICE INFORMATION

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POWER STEERING PUMP INFORMATION
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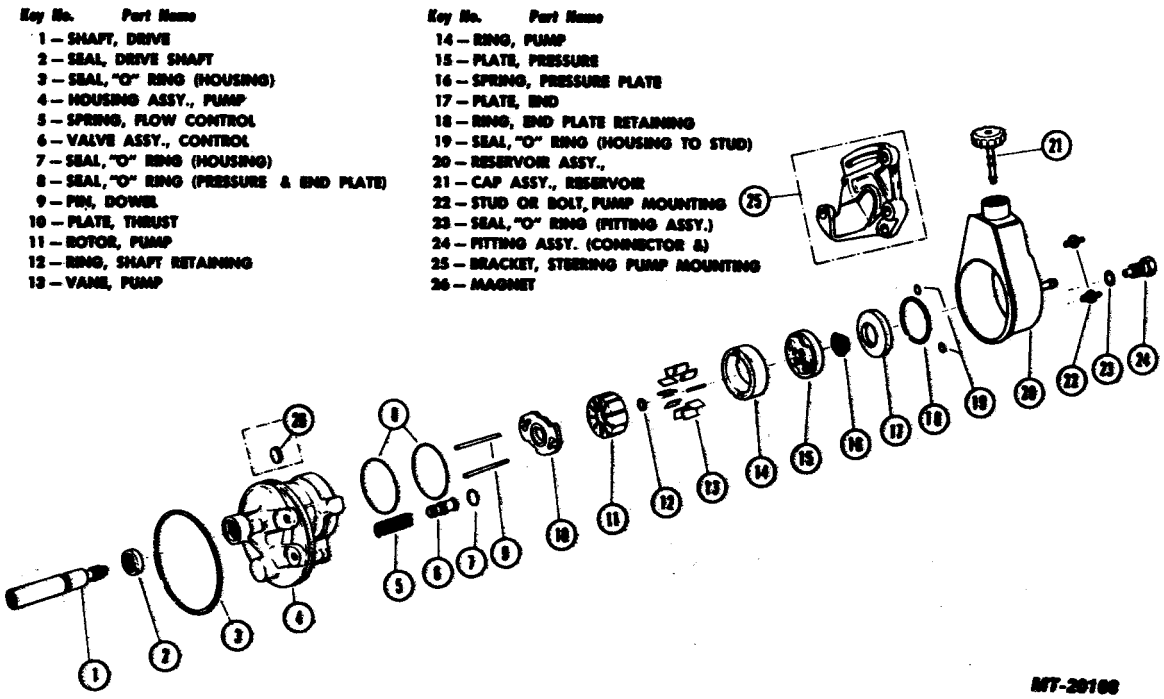


Fig. 1 125 Series Hydraulic Pump Assembly

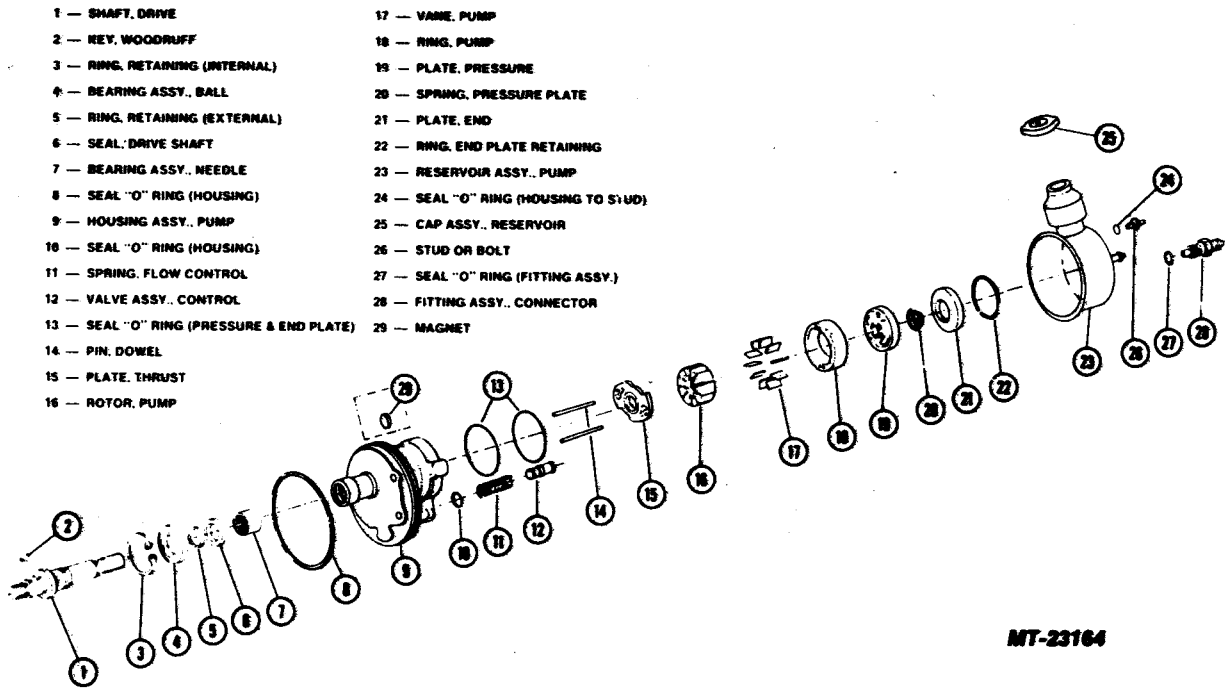


Fig. 2 235 Series Hydraulic Pump Assembly

DESCRIPTION

The housing and internal parts of the pump are inside the reservoir so that the pump parts operate submerged in oil. The reservoir is sealed against the pump housing, leaving the housing face and the shaft hub exposed. The reservoir has a filler neck fitted with a cap. On the 125 series pump, a shaft bushing and seal are pressed into the housing from the front. The drive shaft is inserted through this seal and bushing. On the 235 series pump, the shaft is supported in the front with a ball bearing and in the back with a needle bearing. The drive shaft seal is pressed into the housing and located behind the ball bearing. A large hole in the rear of the housing contains the functional parts; namely ring, rotor, vanes and plates. A smaller hole contains the control valve assembly and spring.

The thrust plate (Figs. 1 & 2) is located on the inner face of the housing by two dowel pins. This plate has four central blind cavities for undervane oil pressure. The two outer blind cavities direct discharge oil through the two cross-over holes in the pump ring (Fig. 3), through the pressure place and into cavity 1 (Fig. 4). The two outside indentations in the thrust plate are for intake of the oil from the suction part of the pump.

The pump ring (Fig. 3) is a plate having the mating surfaces ground flat and parallel. The center hole is a two-lobed cam in which the rotor and vanes operate. The ring is placed next to the thrust plate and located with the same dowel pins.

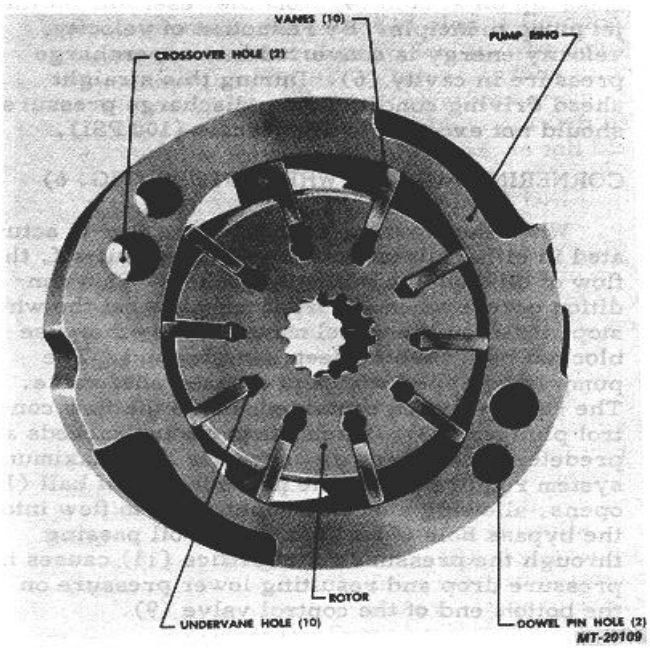


Fig. 3 Pump Ring and Rotor

The pressure plate is fitted against the ring and located with the same two dowel pins. This plate has six through ports. The four central through ports connect from cavity 1 (Fig. 4) to supply undervane oil pressure. The two outer ports pass oil under discharge pressure to cavity 1. The two indentations are for oil intake from the suction part of the pump, cavity 6 (Fig. 5) into the rotor.

The reservoir is for oil storage. It receives and directs the return oil back to the make-up passage of the pump.

The drive shaft is fitted with a pulley and is belt driven from the crankshaft. The rotor is loosely splined to the drive shaft and secured with a retaining ring. It is located centrally within the ring and between the thrust and pressure plates. The ten vanes are mounted in radial slots in the rotor (Fig. 3).

OPERATION

The mode of operation of the power steering pump is based upon the demand of the power steering system. The various major modes of operation are: slow cornering, moderate to high speed straight ahead driving, and cornering against the wheel stop. The pump is designed to recognize these conditions as required by the steering gear valve and compensate for them internally.

As the drive shaft turns the rotor, the vane tips follow the inner cam surface of the pump ring, moving outward and inward twice during each revolution. This results in a complete pumping cycle every 180 degrees of rotation (Fig. 3). Oil is moved in the spaces between the vanes. As the vane tips move outward, oil is sucked into the inter-vane spaces through four suction ports in the pressure and thrust plates. The pressure of the oil is raised, and the oil is discharged from the pump ring, as the vane tips move inward. High pressure oil discharges into cavity 1, (Fig. 4), through two open ports in the pressure plate, and through two blind ports in the thrust plate, which are connected to cavity 1 by the cross-over holes in the ring. A portion of this oil is circulated through the central port system in the pressure plate, forcing the vanes to follow the cam surface of the ring. The ring-rotor leakage oil 12 (Fig. 4) is used for bushing lubrication and then bled to the reservoir.

SLOW CORNERING (FIG. 4)

During slow cornering maneuvers, the oil pressure required will usually not exceed 2760 kilopascals (400 PSI) RPM of the pump is not high enough to require internal bypassing of oil; therefore, the pump bypass port to (5) remains closed.

The high pressure discharge oil (7) is slightly lower in pressure than the internal high pressure oil (1). The drop in pressure occurs as oil flows through the flow control orifice (2). This reduces the pressure at the bottom end of the pump control valve (9) because the orifice (11) is connected by passage (8) to (9) resulting in a pressure unbalance on the valve. The flow control valve moves away from the discharge fitting, but due to the force of the flow control spring (10) the valve remains closed to the bypass hole (5). The oil pressure does not build up high enough to cause the pressure relief valve to actuate, because the oil pumped through the steering gear is allowed to recirculate through the entire system.

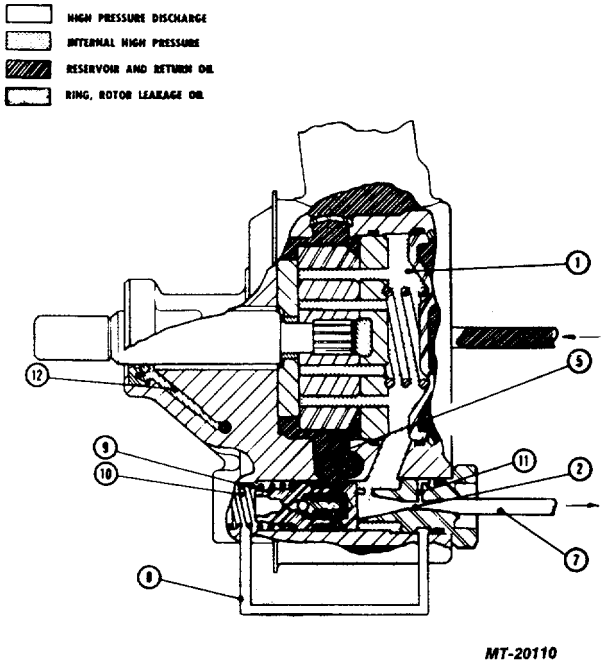


Fig. 4 Slow Cornering

MODERATE TO HIGH SPEED OPERATION (FIG. 5)

When operating at moderate to high speed, it is desirable to limit the temperature rise of the oil. This is done by flow controlling. The control valve in the steering gear is an open center rotary valve. When this valve is in the straight ahead position, oil flows from the pump through the open center valve and back to the pump reservoir without traveling through the power steering gear. When this flow exceeds the predetermined system requirements, oil is bypassed within the pump. This is accomplished by the pressure drop which occurs across the flow control orifice (2). The pressure is reduced at the bottom of the flow control valve (9) because the orifice (11) is connected by (8) to the bottom of valve (9).

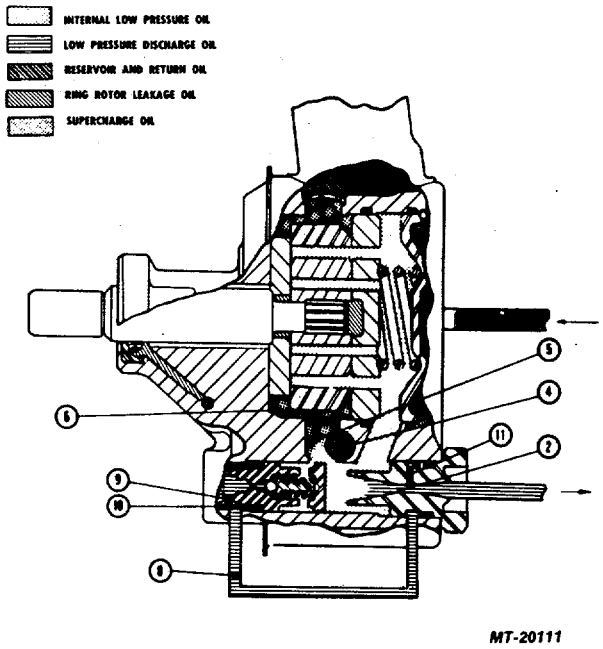


Fig. 5 Flow Controlling

The pressure unbalance of the valve is sufficient to overcome the force of the spring (10), allowing the valve to open the bypass hole (5), and diverting oil into the intake chamber (6). Supercharging of the intake chamber occurs under these conditions. Oil at high velocity discharging past the valve into the intake chamber picks up make-up oil at hole (4) from the reservoir on the jet pump principle. By reduction of velocity, velocity energy is converted into supercharge pressure in cavity (6). During this straight ahead driving condition, the discharge pressure should not exceed 690 kilopascals (100 PSI).

CORNERING AGAINST WHEEL STOPS (FIG. 6)

When the steering gear control valve is actuated in either direction to the point of cut-off, the flow of oil from the pump is blocked. This condition occurs when the front wheels meet the wheel stop, or when the wheel movement is otherwise blocked by a curb or deep sand or mud. The pump is equipped with a pressure relief valve. The relief valve is contained inside the flow control plunger (13). When the pressure exceeds a predetermined pressure, (greater than maximum system requirements) the pressure relief ball (14) opens, allowing a small amount of oil to flow into the bypass hole (5). This flow of oil passing through the pressure relief orifice (11) causes a pressure drop and resulting lower pressure on the bottom end of the control valve (9).

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The pressure unbalance then causes the valve to compress the spring (10) allowing the major portion of the oil to bypass into the intake chamber (from 3 to 6) in the same manner as is accomplished by flow controlling. Relief pressures are usually between 5170 and 9995 kilopascals (750 and 1450 PSI) depending on the vehicle requirements.

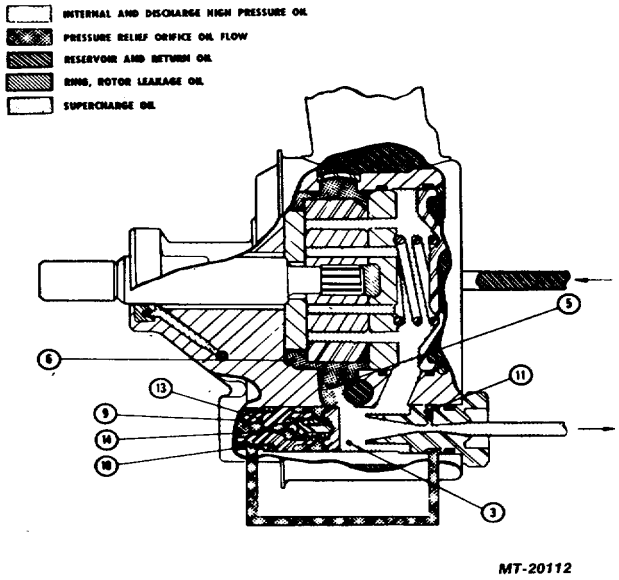


Fig. 6 Pressure Relief

MAINTENANCE

FLUID LEVEL

1. Run engine until power steering fluid reaches normal operating temperature, approximately 80°C (170°F), then shut engine off. Remove reservoir filler cap and check oil level.

2. If oil level is low, add power steering fluid to proper level and replace filler cap. For lubrication intervals refer to operator's manual. For types of lubricant recommended refer to Lubrication Section CTS-2412.

3. When checking fluid level after the steering system has been serviced, air must be bled from the system. Proceed as follows:

    a. With wheels turned all the way to the left, add power steering fluid to level indicated on reservoir.
    b. Start engine, and running at fast idle, recheck fluid level. Add fluid if necessary.
    c. Bleed system by turning wheels from side to side without hitting stops. Maintain fluid level just above internal pump casting. Fluid with air in it will have a light tan or milky appearance. This air must be eliminated from fluid before normal steering action can be obtained.
    d. Return wheels to center position and continue to run engine for two or three minutes, then shut engine off.

    e. Road-test vehicle to make sure steering functions normally and is free from noise.

    f. Recheck fluid level as described in steps 1 and 2.

BELT TENSION

A belt that has been previously tensioned is considered to be a used belt and should be tightened to from 245 to 311 Newtons (55 to 70 lbs.) A belt that has never been tensioned is considered to be a new belt and should be tightened to 445 Newtons (100 lbs.).

Place Belt Tension Gage SE-2312 or equivalent, midway between the pulleys on drive belt being checked.

BELT ADJUSTMENT

When adjusting a power steering pump belt, never pry against the pump reservoir or pull against the filler neck. To increase belt tension move the pump outward by prying against the bracket pry lugs or against the pump housing casting extension directly behind the pump drive pulley.

1. When power steering pump is driven by a single belt:

    a. Loosen the pump attaching bolts and adjust the belt to correct tension by moving the pump outward, away from the engine.
    b. Snug all pump mounting bolts and remove pry bar.
    c. Tighten all pump mounting bolts to specified torque.
    d. Check belt tension.

2. When the power steering pump is driven by two belts in a matched set:

    a. Follow same checking and adjusting procedure as 1 above, but if it is necessary to replace one belt, both must be replaced by a new matched set to equalize belt tension in both belts. Check tension in both belts.

3. When the power steering pump pulley is driven by one primary belt and is used as an idler for a second belt driving some other accessory:

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a. Follow same checking and adjusting procedure for the primary power steering pump drive belt as for above.

b. Recheck and adjust as necessary the pump belt tension after adjusting tension on belt driving the other accessory.

DIAGNOSTIC INFORMATION

GENERAL INFORMATION

Complaints of faulty steering are frequently the result of problems other than the pump. Those areas of the steering system which can be easily checked and quickly corrected without disassembly and overhaul of any major components should be attempted first.

Conditions such as hard or loose steering, road shock or vibrations are not always due to the steering gear or pump, but are often related instead to such factors as low tire pressure and front end alignment. These factors should be checked and corrected before any adjustment or disassembly of the power steering pump is attempted.

Many factors affect proper operation of the steering system, of which the most common are:

1. Fluid level and condition.
2. Drive belt tension.
3. Loose component mountings.
4. Loose pump pulley nut.

These factors must be checked and corrected before making any further diagnosis of the steering system. The need for proper. diagnosis cannot be overemphasized.

After the source of the problem has been found, determine the cause. For example, if the oil level in the reservoir is found to be low, refill and check the entire hydraulic system for oil leaks. Refilling the reservoir will not necessarily correct problem.

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DIAGNOSTIC CHARTS

Use the following diagnostic charts to determine cause and correction of problem. Refer to the appropriate chapter for the gear being serviced for detailed repair procedures.

CONDITION	POSSIBLE CAUSE	CORRECTION
Chirp noise in steering pump.	1. Loose belt.	1. Adjust belt tension to specification.
Belt squeal (Particularly noticeable at full wheel travel and standstill parking).	1. Loose belt.	1. Adjust belt tension to specification.
Growl noise in steering pump.	1 Excessive back-pressure in hoses or steering gear caused by restriction.	1. Locate restriction and correct. Replace part if necessary.
Growl noise in steering pump (particularly noticeable at standstill parking).	1. Scored pressure plates, thrust plate or rotor. 2. Extreme wear of cam ring and vanes.	1. Replace parts and flush system. 2. Replace parts.
Groan noise in steering pump.	1. Low oil level. 2. Air in the oil. Poor pressure hose connection.	1. Fill reservoir to proper level. 2. Tighten connector to specified torque. Bleed system by operating steering from right to left-full turn.
Rattle or knock noise in steering pump.	1. Loose pump pulley nut.	1. Tighten nut to specified torque. If pulley is still loose, both the pulley and pump shaft must be replaced.
Rattle noise in steering pump.	1. Vanes not installed properly.	1. Install properly. 2. Free up by removing burrs, varnish or dirt.
Momentary increase in effort when turning wheel fast to right or left.	1. Low oil level in pump. 2. Pump belt slipping 3. High internal leakage. Valve or cylinder assembly.	1. Add power steering fluid as required. 2. Tighten or replace belt. 3. Check pump pressure.

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CONDITION	POSSIBLE CAUSE	CORRECTION
Steering wheel surges or jerks when turning with engine running especially during parking.	1. Low oil level. 2. Loose pump belt. 3. Insufficient pump pressure. 4. Sticky flow control valve. 4. inspect for varnish or damage, replace if necessary.	1. Fill as required. 2. Adjust tension to specification. 3. Check pump pressure. (See pump pressure test. Replace relief valve if defective.
Hard steering or lack of assist especially in parking.	1. Loose pump belt. 2. Low oil level in reservoir. 3. Steering gear to column misalignment. 4. Lower coupling flange rubbing against steering gear adjuster plug 5. Tires not properly inflated.	1. Adjust belt tension to specification. 2. Fill to proper level. If excessively low, check all lines and joints for evidence of external leakage. Tighten loose connectors. 3. Align steering column. 4. Loosen pinch bolt and assemble properly. 5. Inflate to recommended pressure.
Note: If checks 1 through 5 do not reveal cause of hard steering, follow the procedure below to determine fault	Further possible causes could be: 6. Sticky flow control valve. 7. Insufficient pump pressure output. 8. Excessive internal pump leakage. 9. Excessive internal system leakage.	In order to diagnose conditions such as listed in 6, 7, 8, & 9, a test of the entire power steering system is required.

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CONDITION	CORRECTION
POWER STEERING SYSTEM TEST PROCEDURE	1. Disconnect pressure hose at union of pump, use a small container to catch any fluid which might leak. 2. Install SE-2780 power steering analyzer, between union and pressure hose (See Figure 7). 3. Open hand valve on analyzer. 4. Start engine, allow system to reach operating temperatures, and check fluid level-adding any fluid if required. When engine is at normal operating temperature, the initial pressure read on the gauge (valve open) should be in the 550-860 Kilopascals (80-125 PSI) range. Should this pressure be in excess of 1035 Kilopascals (150 PSI)-check the hoses for restrictions and for proper routing. 5. Close valve fully 3 times. Record the highest pressures attained each time. (Note: Do not leave valve fully closed for more than 5 seconds as the pump could be damaged internally.) (a) If the pressures recorded are within the listed specifications and the range of readings are within 345 Kilopascals (50 PSI) the pump is functioning within specifications. Example: Specifications 6205-6895 Kilopascals (900-1000 PSI)-readings 6375-6720-6620 Kilopascals (925-975-960 PSI). (b) If the pressures recorded are high, but do not repeat within 345 Kilopascals (50 PSI), the flow-controlling valve is sticking. Remove the valve, clean it and remove any burrs using crocus cloth or fine hone. If the system contains some dirt, flush it. If it is exceptionally dirty, both the pump and accompanying system must be completely disassembled, cleaned, and reassembled before further usage. (c) If the pressures recorded are constant, but more than 690 Kilopascals (100 PSI) below the low listed specification, replace the flow-control valve and recheck. If the pressures are still low, replace the rotating group in the pump. 6. Shut off engine, remove analyzer, reconnect pressure hose and check fluid level or make needed repairs.

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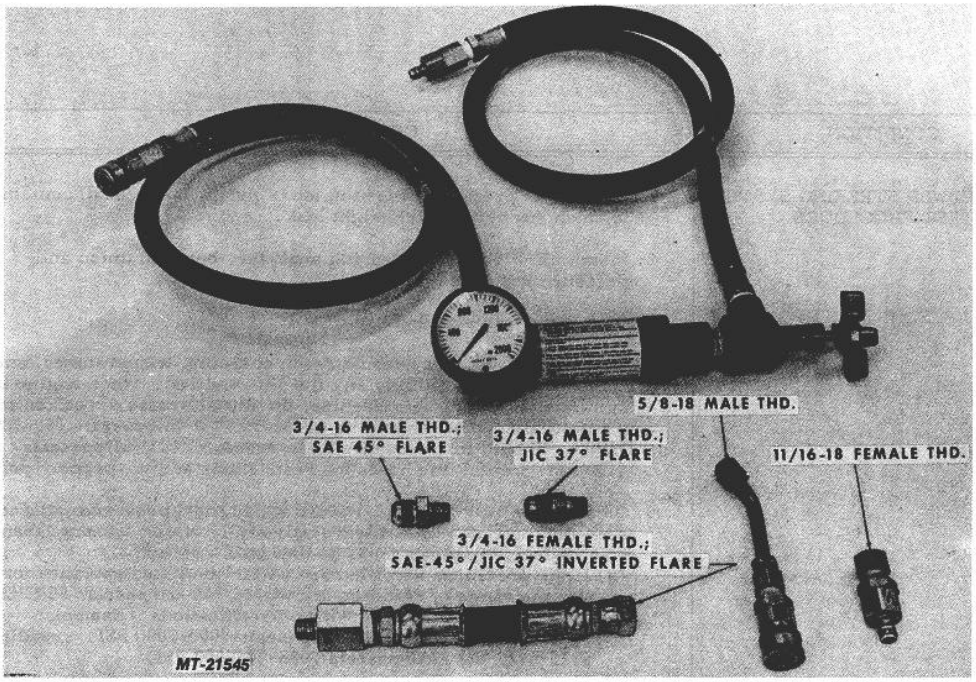


Fig. 7 SE-2780 Power Steering Analyzer

CONDITION	POSSIBLE CAUSE	CORRECTION
Foaming milky power steering fluid, low fluid level and possible low pressure	1. Air in the fluid, and loss of fluid due to internal pump leakage causing overflow.	1. Check for leak and correct. Bleed system. Extremely cold temperatures will cause system aeration should oil level be low. If oil level is correct and pump still foams, remove pump from vehicle and separate reservoir from housing. Check welsh plug and housing for cracks. If plug is loose or housing is cracked, replace housing.
Low pressure to steering pump	1. Flow-control valve stuck or inoperative 2. Pressure plate not flat	1. Remove burrs or dirt, replace. 2. Correct. against cam ring.

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CONDITION	POSSIBLE CAUSE	CORRECTION
	3. Extreme wear of cam ring and vanes.	3. Replace parts. Flush system.
	4. Scored pressure plate, thrust plate or rotor.	4. Replace parts. (If rotor, replace with rotating group kit.) Flush system.
	5. Vanes not installed properly.	5. Install properly.
	6. Vanes sticking in rotor slots.	6. Free-up by removing burrs, varnish or dirt.
	7. Cracked or broken thrust or pressure plate.	7. Replace part.

EXTERNAL LEAKAGE DIAGNOSIS

The following diagrams have been prepared to show the potential areas of leakage. If leakage occurs in the areas shown, perform the operation described. Refer to the appropriate chapter for the pump being serviced for detailed repair procedures.

EXTERNAL LEAKAGE 125 SERIES PUMP

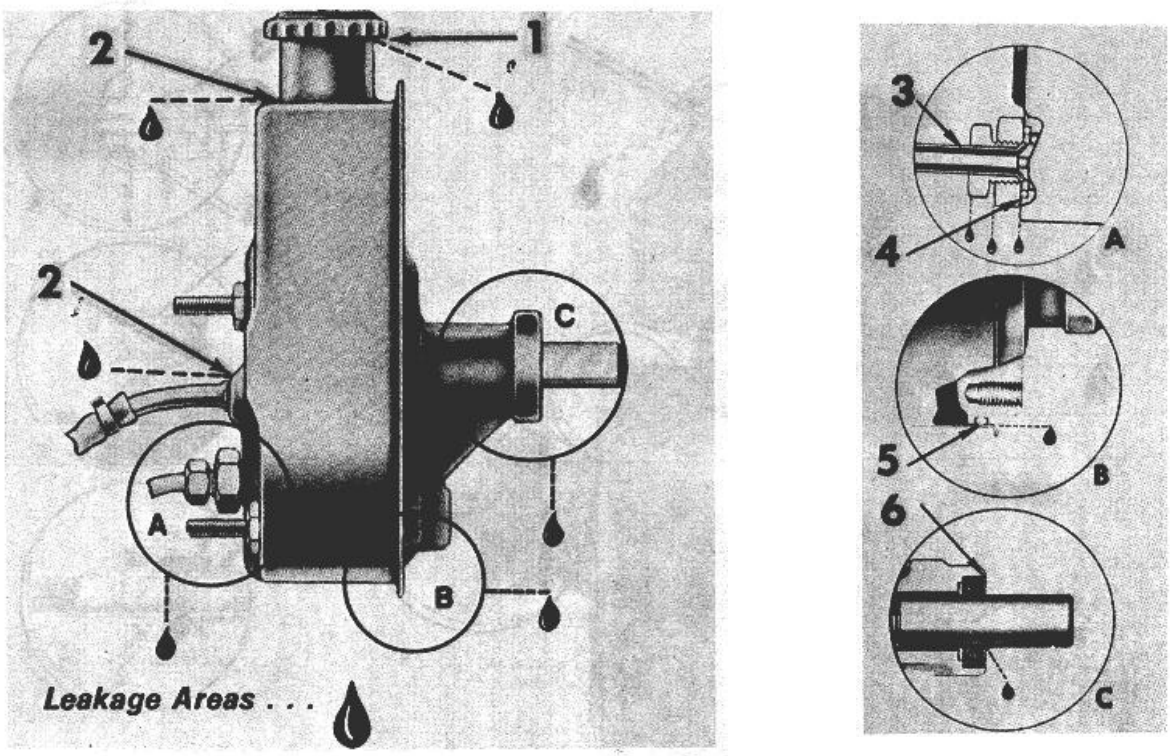


Fig. 8 Suspected Leakage Areas

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1. Check oil level. An overfilled pump reservoir can be a cause for leakage. The oil in the steering system expands as heated during normal usage. If overfilled the excess is forced through the reservoir cap vent. Operate the engine and steering system until normal operating temperature is obtained. Remove the reservoir cap and check level. Adjust the oil level as required.

   If leakage persists with the oil level correct and the cap tight, replace the cap.

   Air in the system can also cause the fluid level to rise, especially after system repair. Bleed the system as described in the MAINTENANCE section of this chapter.

2. Replace reservoir.

3. If leakage persists upon tightening the fitting nut to specified torque:

   a. Loosen the nut and rotate tubing to reseat with brass connector. Tighten nut again and recheck. If leakage still persists, proceed to 3b.

   b. Remove the hose and check the sealing face for cracks. If a cracked flare is found, replace the hose. If no cracks are observed, proceed to 3c.

   c. Replace the brass connector and reface the tube flare. Also, check the threads in the pump housing and on the fitting nut. If nut threads are damaged, replace the nut. If pump housing threads are damaged, replace both the housing and the nut. If either the return hose or the pressure hose leaks, other than at the nut connections, replace the hose.

4. Tighten fitting to specified torque. If leakage persists, replace both "O" ring seals.

5. Replace reservoir "O" ring.

6. Replace drive shaft seal after inspecting and thoroughly cleaning the sealing surface. Replace drive shaft if severe pitting is found. If the corrosion in the lip seal contact zone is slight, clean the surface of the shaft with crocus cloth first. Always replace the seal if the shaft is replaced.

EXTERNAL LEAKAGE 235 SERIES PUMP

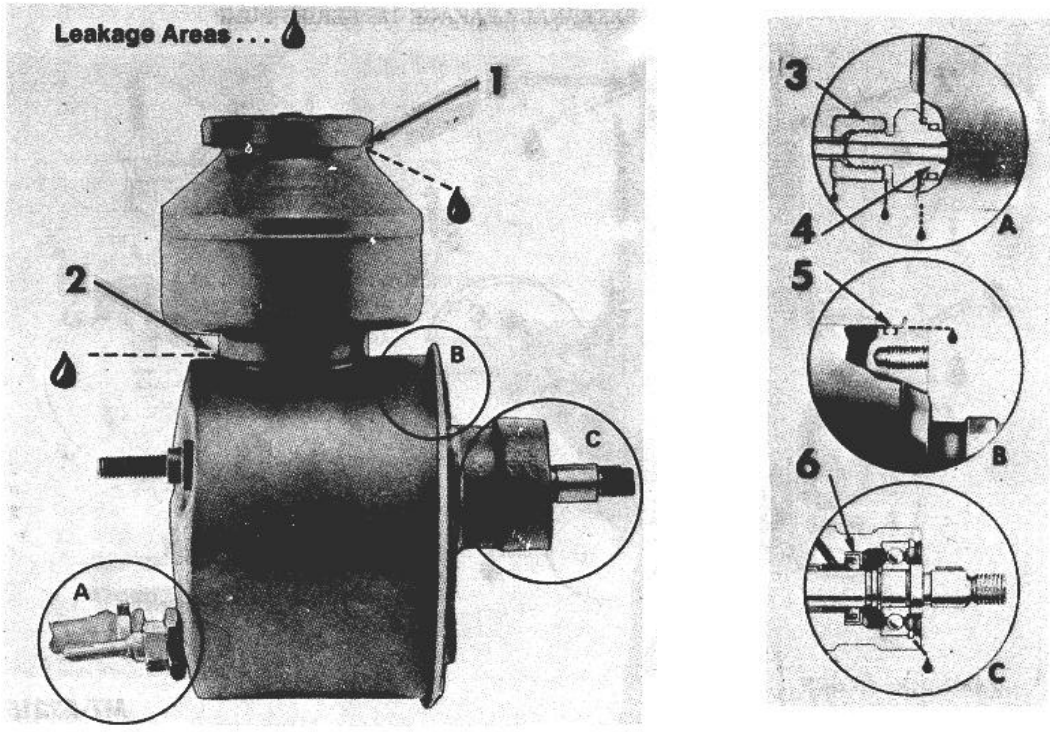


Fig. 9 Suspected Leakage Areas

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1. Check oil level. An overfilled pump reservoir can be a cause for leakage. The oil in the steering system expands as heated during normal usage. If overfilled the excess is forced through the reservoir cap vent. Operate the engine and steering system until normal operating temperature is obtained. Remove the reservoir cap and check level. Adjust the oil level as required.

   If leakage persists with the oil level correct and the cap tight, replace the cap.

   Air in the system can also cause fluid level to rise, especially after system repair. Bleed the system as described in the MAINTENANCE section of this chapter.

2. Replace reservoir.

3. Tighten hose fitting nut to specified torque. If leakage persists, replace discharge fitting and reface hose tube flare or replace hose as required.

   If either the return hose or the pressure hose leaks, other than at the nut connections, replace the hose.

4. Tighten fitting to specified torque, If leakage persists, replace both "O" ring seals.

5. Replace reservoir "O" ring seal.

6. Replace drive shaft seal after inspecting and thoroughly cleaning the sealing surface. Replace drive shaft if severe pitting is found. If the corrosion in the lip seal contact zone is slight, clean the surface of the shaft with crocus cloth. Always replace the seal if the shaft is replaced.

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CHAPTER 2

125 SERIES PUMP SERVICE INFORMATION

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INSTALLATION AND REMOVAL

INSTALLATION

1. Position pump assembly on mounting bracket with holes lined up and install bolts loosely.

2. On pumps equipped with pressed on pulleys draw pulley on shaft using pulley puller SE-2577.

IMPORTANT

Do not hammer pulley on. As this will damage internal pump parts.

On pumps equipped with threaded drive shafts slide pulley on shaft and install retaining nut finger tight.

3. Connect and tighten hose fittings to specified torque.

4. Fill reservoir. Bleed pump by turning pulley backward (counter-clockwise as viewed from front) until air bubbles cease to appear.

5. Install pump belt over pulley.

6. Adjust belt tension and tighten mounting bolts to specified torque. See BELT TENSION and BELT ADJUSTMENT sections of Chapter 1.

7. Where equipped, tighten pulley retaining nut to specified torque.

8. Bleed system per FLUID LEVEL section of Chapter 1.

REMOVAL

1. Disconnect both hoses at pump, taking care not to bend hoses any more than absolutely necessary. (With time and temperature exposure, hoses may take a "set" and will not have the flexibility of a new hose.) When both hoses are disconnected, secure ends in raised position to prevent drainage of oil.

2. Install caps at both pump fittings to prevent drainage of oil from pump.

3. Loosen necessary bolts to ease belt tension.

4. Remove pump belt.

5. On pumps equipped with pressed on pulleys, remove pulley from drive shaft using pulley puller SE-2578.

IMPORTANT

Do not hammer pulley off shaft as this will damage internal pump parts.

6. On pumps equipped with threaded drive shafts, remove pulley retaining nut and slide pulley off shaft.

7. Remove bracket-to-pump bolts or bracket-to engine bolts and remove pump.

SERVICE

FLOW CONTROL VALVE (WITHOUT PUMP REMOVAL)

1. Disconnect high pressure hose from pump union and drain oil.

2. Remove union and withdraw flow control valve and spring with a magnet.

3. Flow control valve must slide freely in housing bore. If sticking occurs, check for dirt or burrs.

4. Check cap screw in the end of valve for looseness; if loose, tighten, being careful not to damage machined surfaces.

5. If the flow control plunger is suspected of being faulty, install new valve. This is serviced as a unit and is factory calibrated.

6. To install, reverse the above procedure and install a new "O" ring seal on the union.

PUMP SHAFT OIL SEAL REPLACEMENT (PUMP ASSEMBLED)

The pump shaft oil seal can be replaced without disassembling the pump as follows:

1. Remove pump pulley (see INSTALLATION AND REMOVAL section of this chapter.) Bend a piece of .12mm (.005 in.) shim stock (approximately 63.5mm-2.5 in. long) into a cylindrical shape and push the shim stock past the seal until it bottoms in pump body. Figure 1. The use of the shim stock around the pump shaft will prevent damage to the machined surface of the shaft when removing seal.

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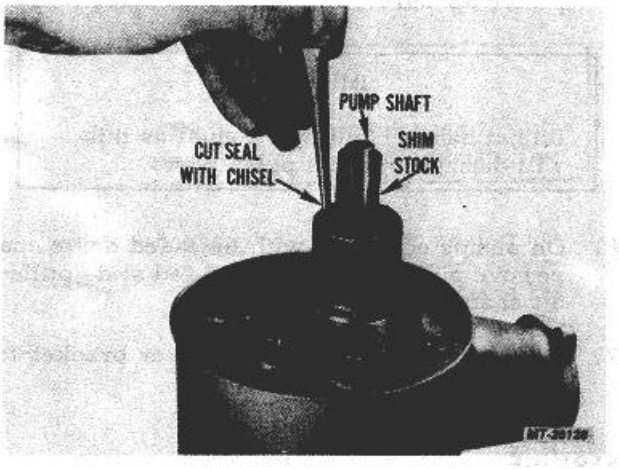


Fig. 1 Cut Pump Seal

2. Cut metal body of seal with a small chisel as shown in Figure 1.

3. Tear metal body approximately 25mm (1 in.) with diagonals. Force an awl between the pump body and the O.D. seal to collapse the seal, then pry seal from pump body (Figure 2). Remove shim stock.

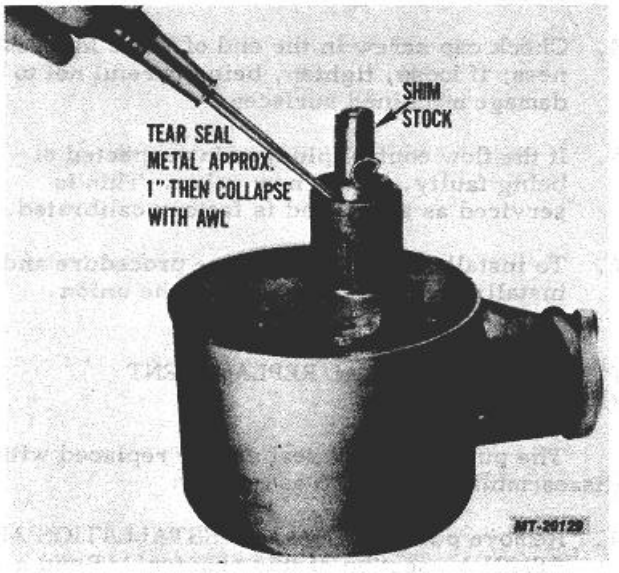


Fig. 2 Remove Pump Seal

4. Lubricate the sealing lip of a new seal, then install seal over pump shaft with metal side of seal outboard.

5. Install new seal using a 25 mm (1 in.) socket with an arbor press or hammer. 6. Install pump pulley (See INSTALLATION AND REMOVAL section of this chapter).

DISASSEMBLY

Before disassembly of pump, remove reservoir filler cap and drain oil from reservoir by inverting the pump so oil may drain out the filler hole.

After oil is drained from reservoir, cap should be replaced and the entire pump assembly washed in a non-toxic solvent to remove all dirt and prevent any foreign matter from contaminating pump components.

IMPORTANT

Examine exposed part of drive shaft. If it is corroded, use crocus cloth to remove corrosion (Fig. 3) before disassembling pump. This will prevent damage to the shaft bushing which might require replacement of the entire housing.

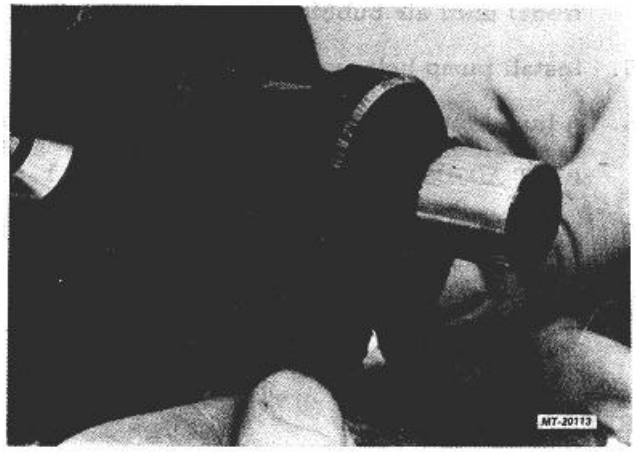


Fig. 3 Clean Corroded Area with Crocus Cloth

1. Clamp front hub of pump in vise so that the extending portion of shaft is directed downward, being careful not to clamp vise too tight as this may distort the bearing (Fig. 4).

2. Remove union and "O" ring assembly and both mounting studs from back of reservoir. Discard all seals and "O" rings (Fig. 4).

3. Reservoir may then be removed from housing by rocking it slightly back and forth to unseat the "O" ring. Remove "O" ring and discard.

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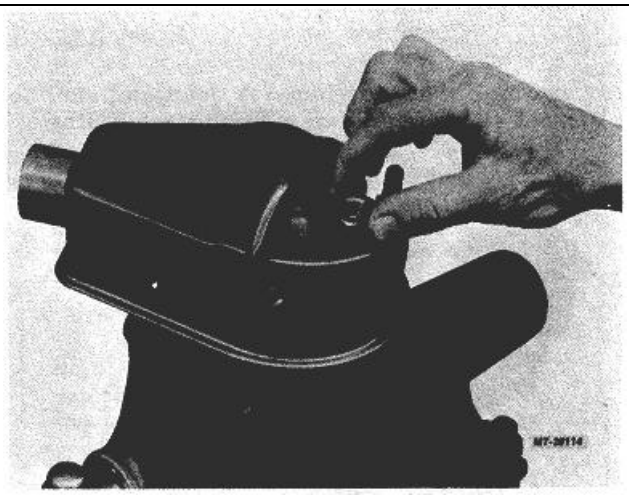


Fig. 4 Remove Studs and Union

4. Remove both mounting stud and union seals from counterbored spaces between reservoir and housing. Discard these seals also (Fig. 5).

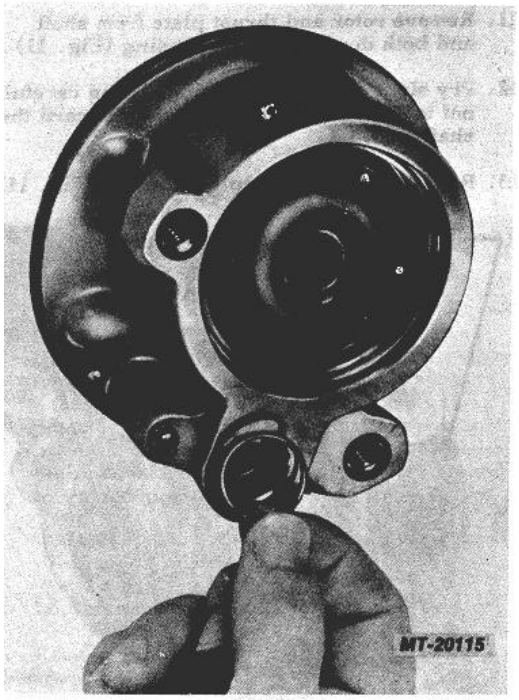


Fig. 5 Remove Stud and Union Seal

5. Remove the end plate retaining ring by inserting a small punch in the 3.2 mm (.125 in.) diameter hole in the housing side opposite the flow control valve hole. Compress the retaining ring with the punch and remove by inserting a screwdriver under the ring and twisting the screwdriver (Fig. 6).

6. Remove end plate and end plate "O" ring. End plate is spring loaded and will generally sit above the housing level for ease of removal. If sticking should occur, a slight rocking action of the end plate should be used to free it (Fig. 7).

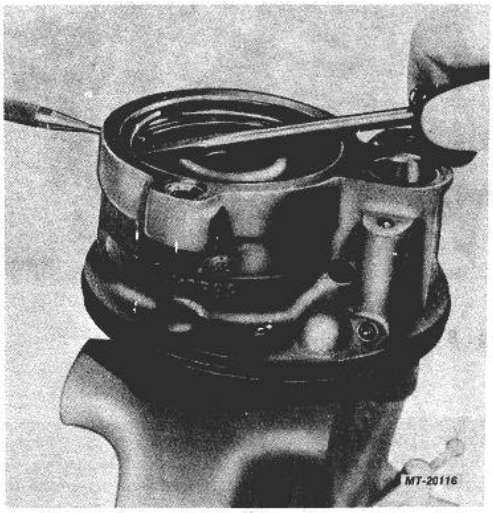


Fig. 6 Remove End Plate Retaining Ring

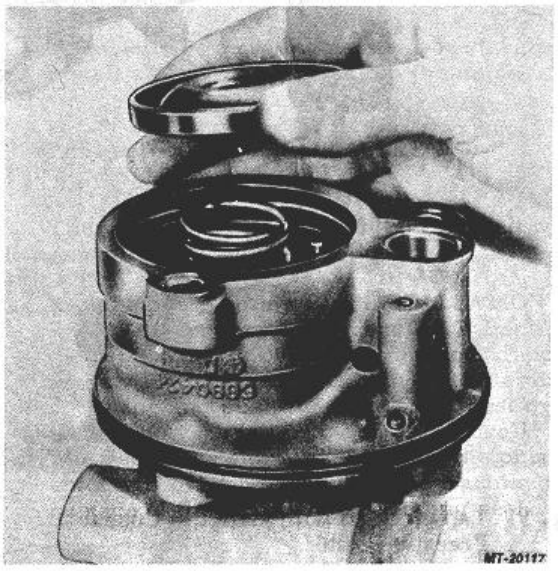


Fig. 7 Remove End Plate

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7. Remove pump from vise and invert. Flow control valve and valve spring will fall free (Fig. 8).

8. With end cover "O" ring removed, tap very lightly on end of shaft, only until pressure plate falls free (Fig. 9).

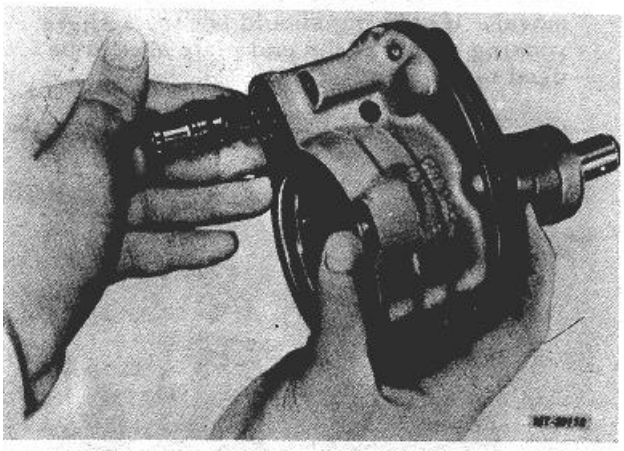


Fig. 8 Remove Relief Valve

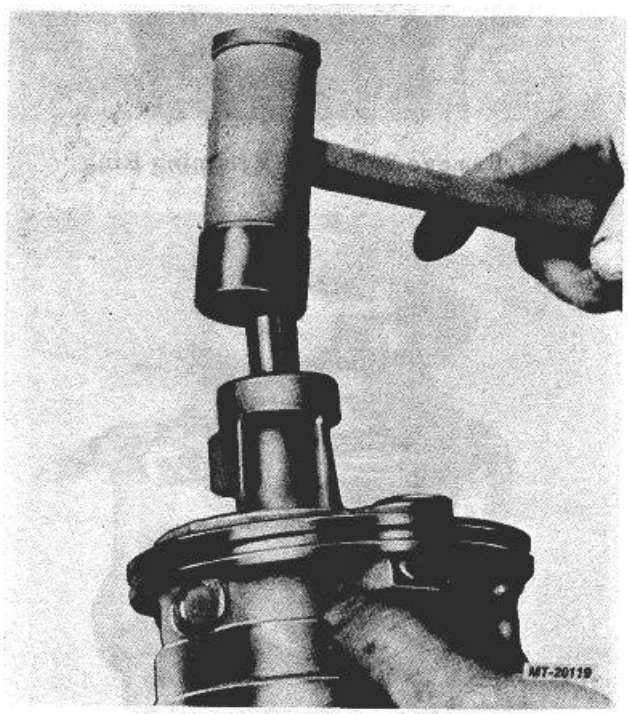


Fig. 9 Tap on Shaft with Mallet to Unseal Pressure Plate

9. Remove pressure plate, shaft, pump ring, vanes and rotor (Fig. 10).

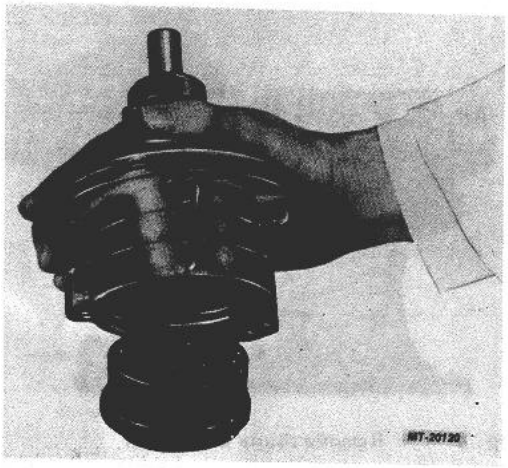


Fig. 10 Remove Shaft, Pressure Plate, Plate Pump Ring, Vanes and Rotor

10. Remove shaft retaining ring and discard. (Some models do not have retaining rings.)

11. Remove rotor and thrust plate from shaft and both dowl pins from housing (Fig. 11).

12. Pry shaft seal out of housing, being careful not to damage the housing bore; discard the shaft seal.

13. Remove, clean and replace magnet (Fig. 11).

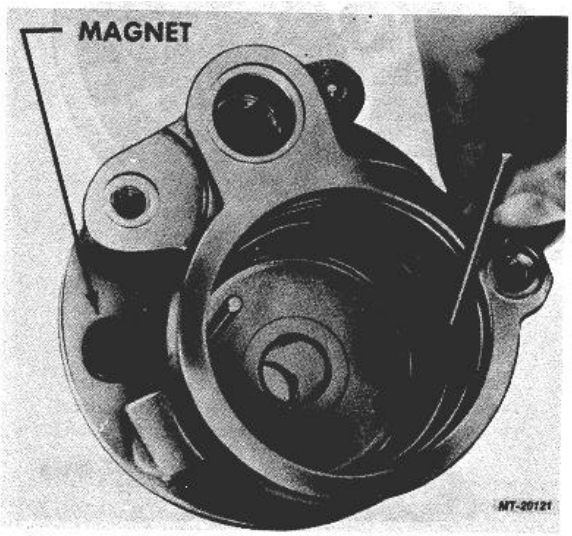


Fig. 11 Remove Dowel Pins

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CLEANING, INSPECTION AND REPAIR

Clean all metal parts in a non-toxic solver

Pump Shaft Seal Installation

1. Install new pump shaft seal using a 25 mm (1 in.) socket with an arbor press or hammer (Fig. 12).

IMPORTANT

Do not use any more force than necessary to seat the seal as seal could be damaged.

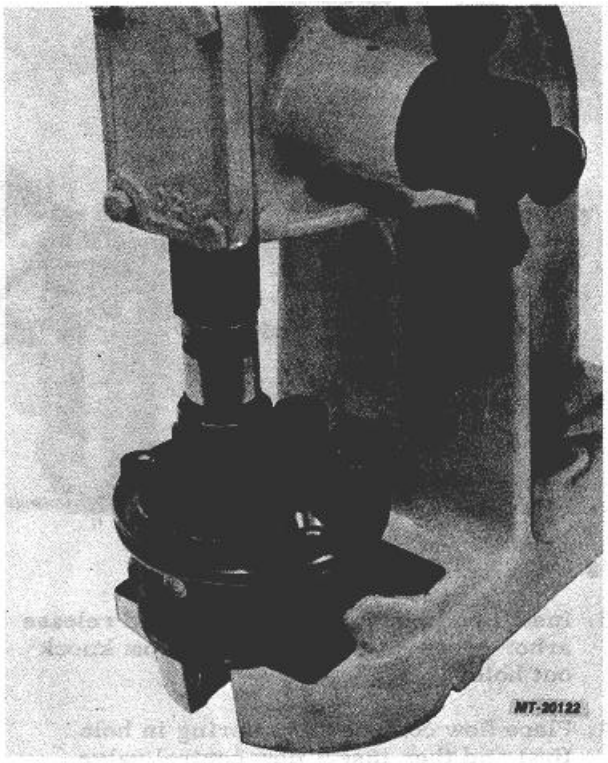


Fig. 12 Shaft Seal Installation

ASSEMBLY

1. Lubricate new pressure plate "O" ring with Power Steering Fluid, and install in third groove from rear of housing.

2. Clamp end of housing in vise in same position as before and insert both dowel pins (Fig. 11).

IMPORTANT

Do not overtighten the vise. Damage to the bearing could occur.

3. Insert shaft through thrust plate and rotor, and install new snap ring on shaft. Open the snap ring just enough to slide over the end of shaft. (Rotor must have counter sunk side toward thrust plate.) (Fig. 13)

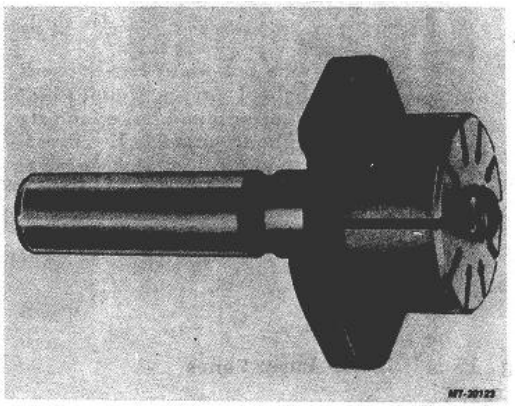


Fig. 13 Shaft with Thrust Plate and Rotor in Position (Not in Housing)

5. Insert shaft in housing, making sure thrust plate slides properly on dowel pins.

6. Install pump ring on dowel pins with the arrow toward rear of housing (Fig. 14).



Fig. 14 Position Pump Ring Showing Arrow Toward Rear of Housing

7. Install all ten vanes in rotor slots with rounded edge of vanes outward (Fig. 15). Vanes should slide freely.

8. Lubricate pressure plate with Power Steering Fluid so as not to damage pressure plate "O" ring.

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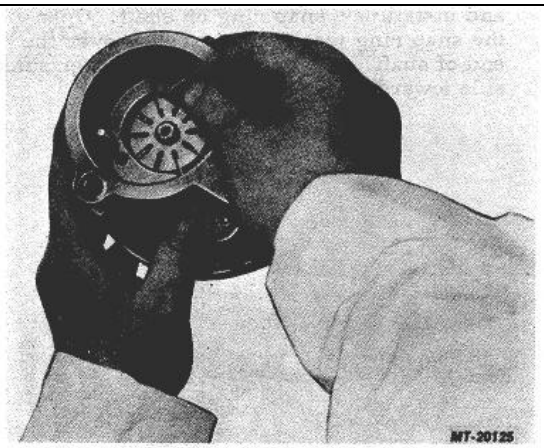


Fig. 15 Install Pump Vanes

9. Install pressure plate on dowel pins with circular depression for spring toward rear of housing. Pressure plate must be pressed about 1.6 mm (.0625 in.) over the "O" ring to seat (Fig. 16).

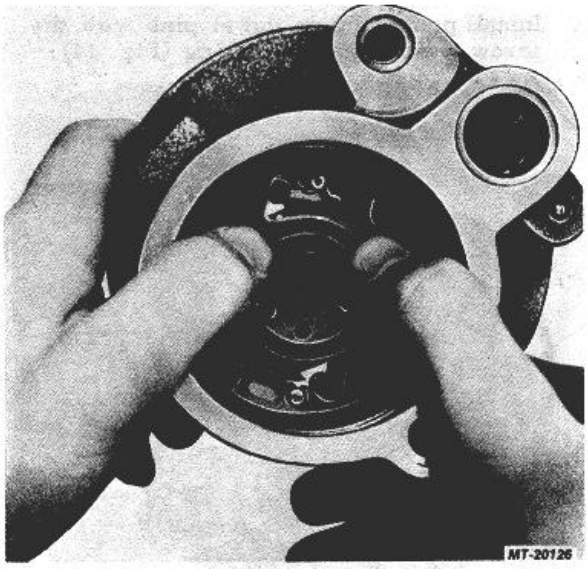


Fig. 16 Install Pressure Plate

10. Lubricate new end plate "O" ring with Power Steering Fluid and install a second groove from rear of housing.

11. Install end plate spring in groove provided in pressure plate (Fig. 7). 12. Lubricate end plate with Power Steering Fluid so as not to damage "O" ring and press into housing with an arbor press (Fig. 17). Depress only far enough to enable retaining ring to seat properly in groove.

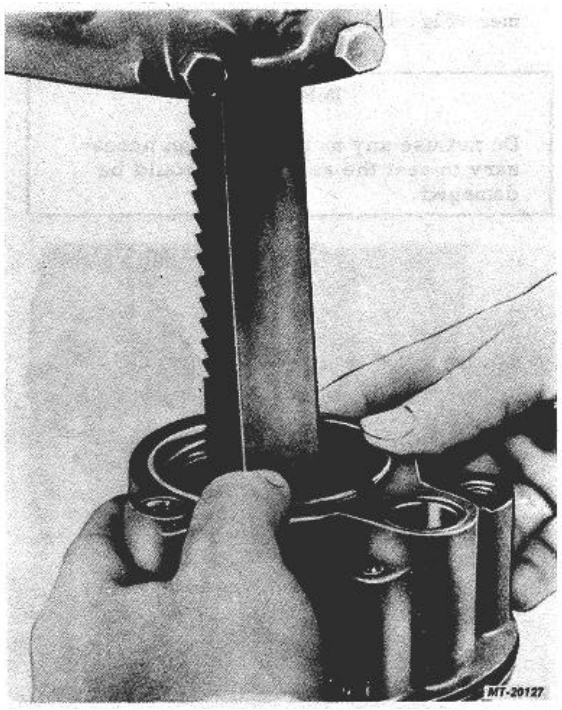


Fig. 17 Install End Plate

13. Install end plate retaining ring and release arbor press. (Ring gap away from knockout hole.)

14. Place flow control valve spring in hole first and then insert flow control valve with screened end toward front of housing.

15. Install new stud seals and union seals in counter sunk holes, lubricate with Power Steering Fluid and install new reservoir "O" ring in housing (Fig. 5).

16. Lubricate inside edge of reservoir with Power Steering Fluid and install on housing being careful to align holes at the same time.

17. Insert both stud bolts and tighten to specified torque (Fig. 4).

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18. Install new "O" ring on union and lubricate with Power Steering Fluid. Make sure "O" ring is in the groove next to the head hex. Insert union in flow control valve hold in back of reservoir and tighten to specified torque (Fig. 4).

SPECIFICATIONS

Pump Type	Vane
Manufacturer	Saginaw
Drive	Belt
Mounting	Bracket
Reservoir	Integral
Thrust Taken By	Thrust Plate
Relief Valve Pressure. Setting *	7584-8274 kPa (1100-1200 PSI)

* Pressure is measured with an engine RPM of 1000 to 1500.

TORQUE CHART

LOCATION	NEWTON METERS	FT. LBS.
Pump Mounting Bolt	48	35
Reservoir Bolt	48	35
Flow Control Fitting Assembly	48	35
Pressure Hose	48	35
Pulley Retaining Nut	48-61	35-45

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CHAPTER 3

235 SERIES PUMP SERVICE INFORMATION

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INSTALLATION AND REMOVAL

INSTALLATION

1. Position pump assembly on mounting bracket with holes lined up and install bolts loosely.

2. Slide pulley on shaft over key.

IMPORTANT

Do not hammer pulley on as this will damage internal pump parts.

3. Install pulley nut finger tight against pulley. (Always use a new nut.)

4. Connect and tighten hose fittings to specified torque.

5. Fill reservoir. Bleed pump by turning pulley backward (counter-clockwise as viewed from front) until air bubbles cease to appear.

6. Install pump belt over pulley.

7. Move pump until belt is tight; then tighten mounting screws. See BELT TENSION and BELT ADJUSTMENT sections of Chapter 1.

8. Tighten pulley nut to specified torque.

9. Bleed system per FLUID LEVEL section, Chapter 1.

REMOVAL

1. Disconnect both hoses at pump. When both hoses are disconnected, secure ends in raised position to prevent drainage of oil.

2. Install caps at both pump fittings to prevent drainage of oil from pump.

3. Remove attaching nut on pump drive pulley.

4. Loosen necessary bolts to loosen belt tension.

5. Remove pump belt.

6. Slide pulley from shaft using pulley puller SE-2578.

IMPORTANT

Do not hammer pulley off shaft as this will damage internal pump parts.

7. Remove bracket-to-pump bolts or bracket to engine bolts and remove pump.

SERVICE

DISASSEMBLY

Before disassembly of pump, remove reservoir filler cap (when used) and drain oil from reservoir by inverting the pump so oil may drain out the filler hole.

After oil is drained from reservoir, cap should be replaced and the entire pump assembly washed in a non-toxic solvent to remove all dirt and prevent any foreign matter from contaminating pump components.

1. Clamp front hub of pump in vise so that the extending portion of shaft is directed downward, being careful not to clamp vise too tight as this may distort the bearings. Use soft jaws in vise if available.

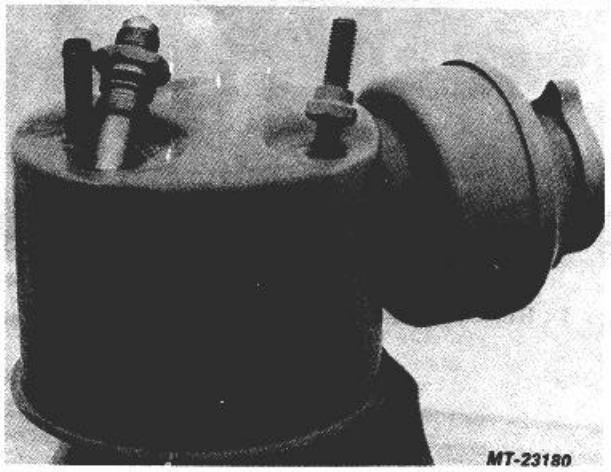


Fig. 1 Remove Stud and Union

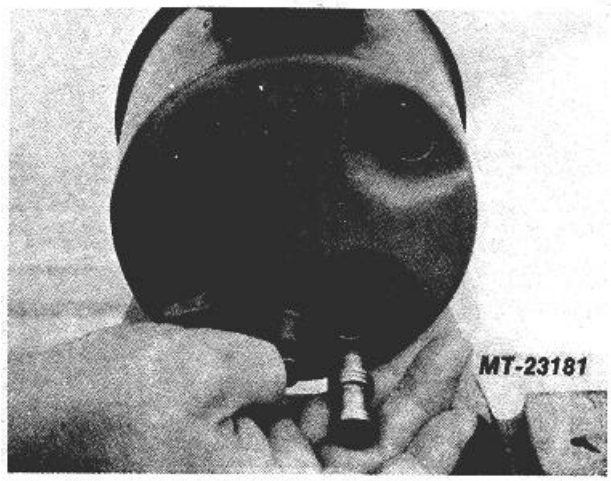


Fig. 2 Remove Flow Control Valve and Spring

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2. Remove stud and union-11/16 box (stud) and 1 inch deep well socket (union), (Fig. 1). Tip pump to remove flow-control valve and spring. (Fig. 2)

3. Replace reservoir. Reservoir may be removed from, housing by rocking it back and forth to unseat the' "O" ring (Fig. 3). Remove housing and union "O" ring and discard (Fig. 4).

4. Remove magnet from housing and clean with solvent (Fig. 5).

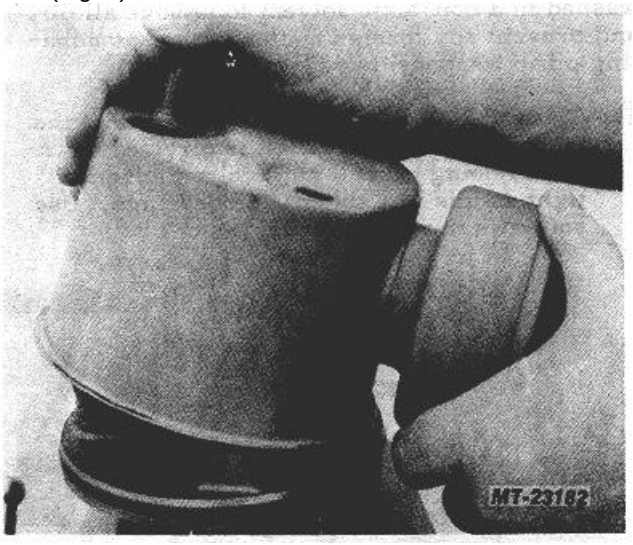


Fig. 3 Remove Reservoir



Fig. 4 Remove Housing and Union "O" Rings



Fig. 5 Remove Magnet

5. Rotate retaining ring with blunt-nosed punch until the ring opening is approximately 6 mm (1/4 in.) from knock-out hole in pump housing (Fig. 6).

6. Insert needle-nosed punch into knock-out hole and tap with hammer until ring is forced away from housing. Insert screwdriver beneath retaining ring and pry away the full diameter until the ring is free (Fig. 7).

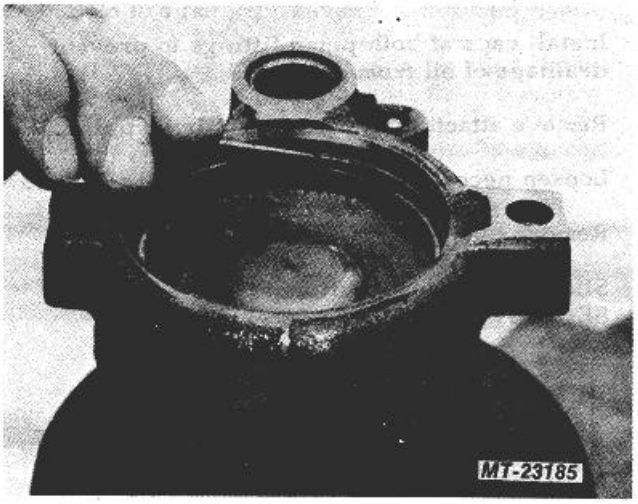


Fig. 6 Rotate Retaining Ring

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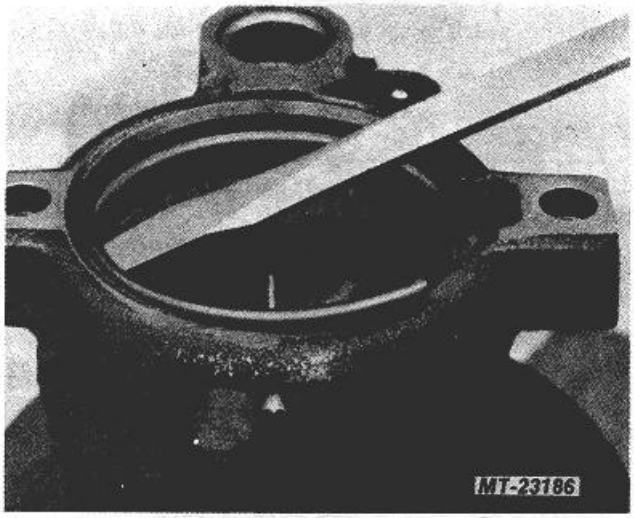


Fig. 7 Remove Retaining Ring

7. Remove end plate and end plate "O" ring. End plate is spring loaded and will generally sit above the housing level for ease of removal. If sticking should occur, a slight rocking of the end plate should be used to free it (Fig. 8).

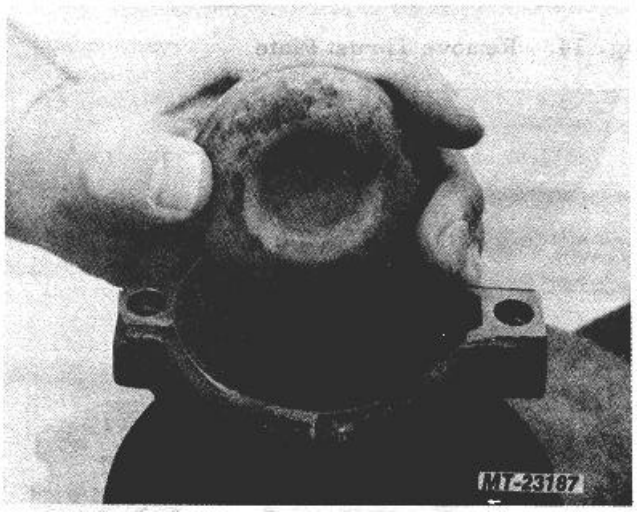


Fig. 8 Remove End Plate

8. Remove pressure plate spring and end plate "O" rings (Figs. 9 and 10).

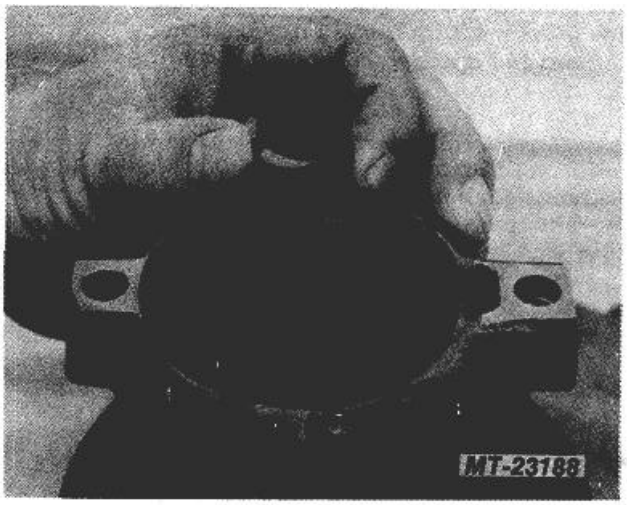


Fig. 9 Remove Spring



Fig. 10 Remove End Plate "O" Ring

9. Release pump housing from vise. Invert housing and bump bench sharply (Fig. 11). (Use clean shop towel to catch parts.) The impact should free the entire rotating group. If it does not, bump again!

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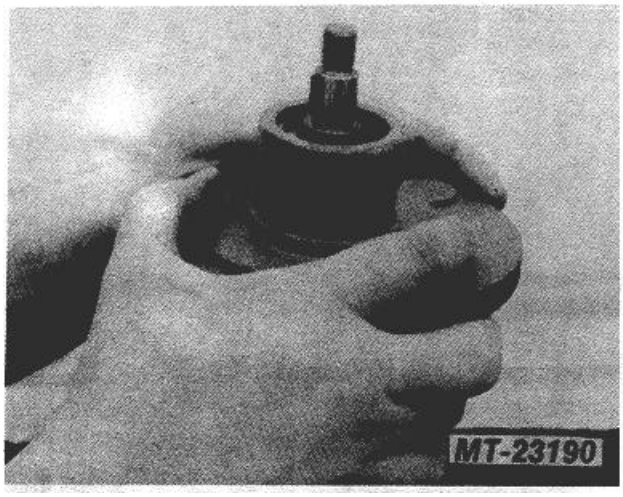


Fig. 11 Separate Rotating Group From Housing

10. Remove and discard pressure plate "O" ring (Fig. 12).

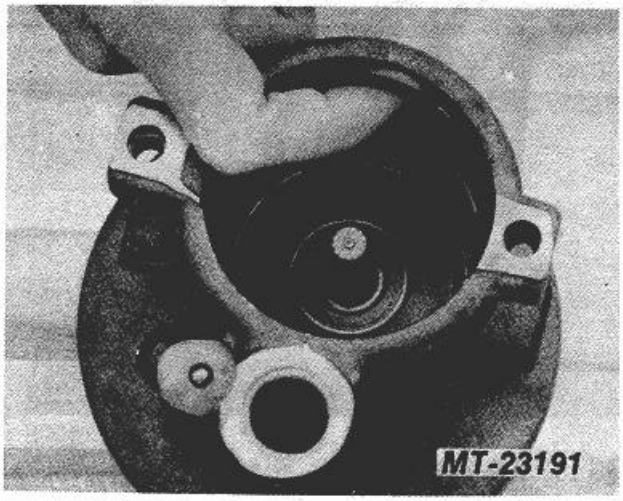


Fig. 12 Remove Pressure Plate "O" Ring

11. Disassemble pump rotating group as shown in Figure 13 through Figure 16.

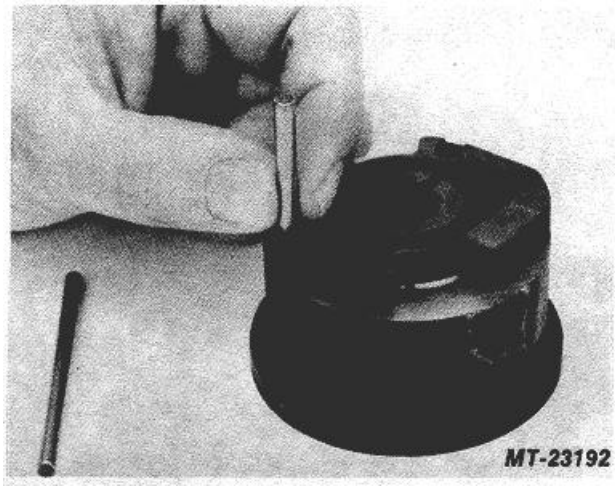


Fig. 13 Remove Dowel Pins

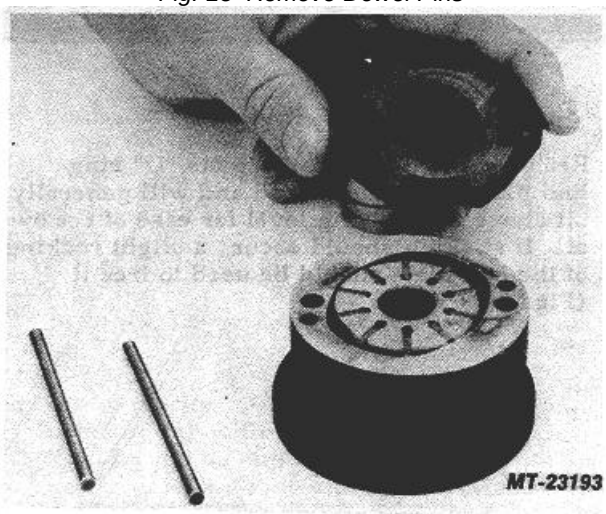


Fig. 14. Remove Thrust Plate

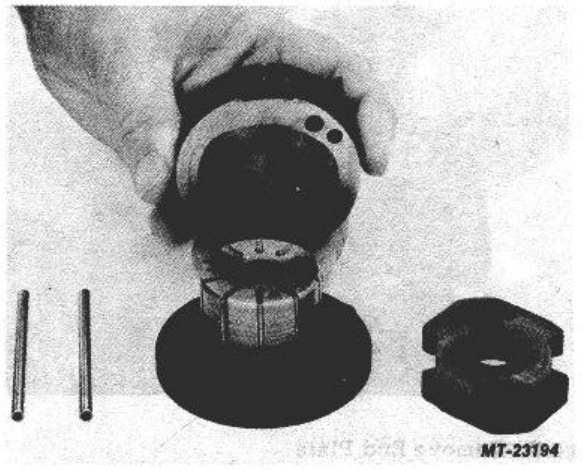


Fig. 15 Removing Pump Ring

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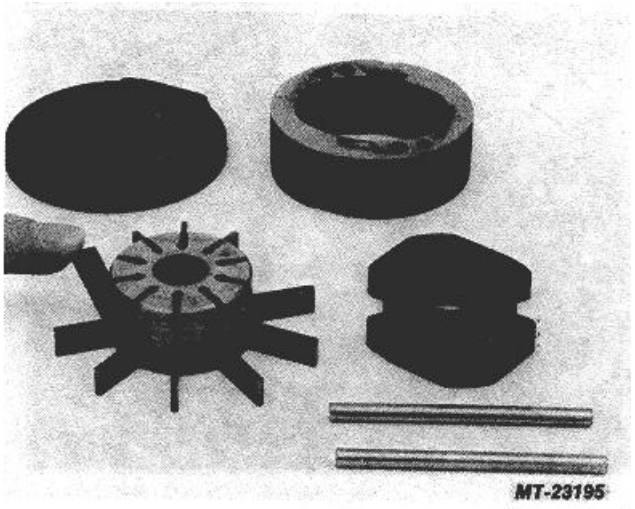


Fig. 16 Remove Vanes From Rotor

12. Remove retaining ring and shaft assembly (Fig. 17). The shaft assembly can be removed with the hands alone (Fig. 18).

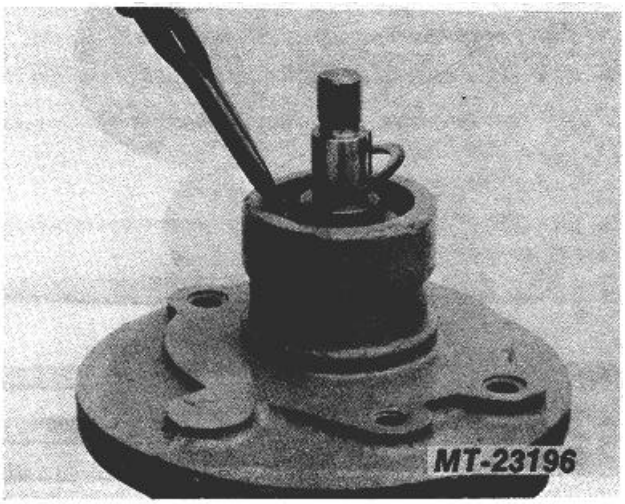


Fig. 17 Remove Retaining Ring

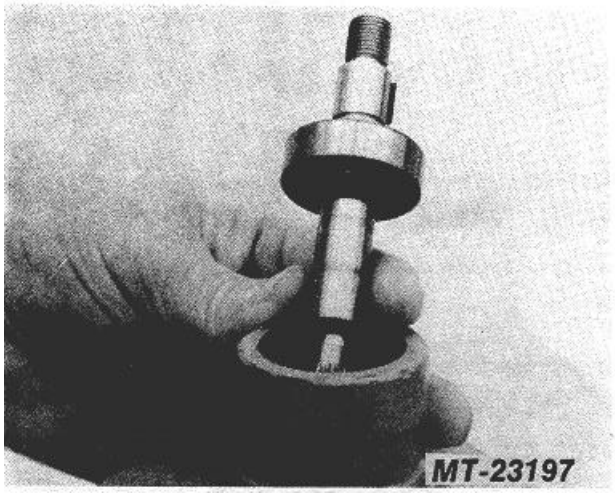


Fig. 18 Remove Shaft Assembly

CLEANING, INSPECTION AND REPAIR

Clean all metal parts in a nontoxic solvent.

1. Wash and inspect rotating group. Check ring cam, wear surfaces of thrust and pressure plates, and vane tips for heavy or unusual wear. If heavy wear is present, the entire rotating group (pump ring, rotor, vanes, thrust and pressure plates) must be replaced.

2. Inspect the needle and seal ride areas on the pump shaft. Should fretting, or some other surface irregularities be present, the shaft and more than likely the needle bearing should be replaced.

3. If shaft or bearing is to be replaced: (a) Remove retaining ring (Fig. 19). (b) Press shaft out of bearing (Fig. 20). (c) Press new shaft into bearing (Fig. 21). (d) Replace retaining ring (Fig. 19).

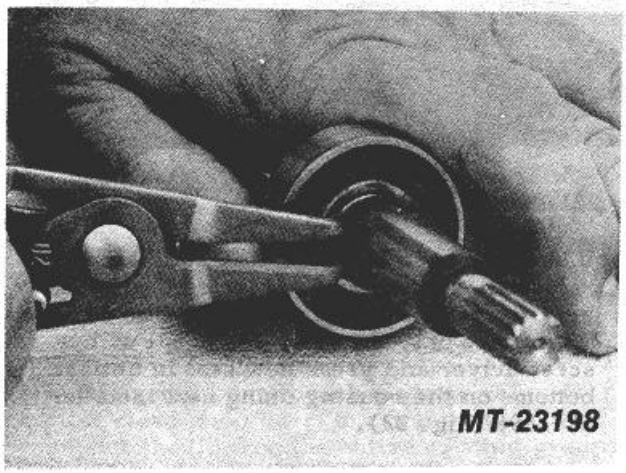


Fig. 19 Remove Bearing Retaining Ring

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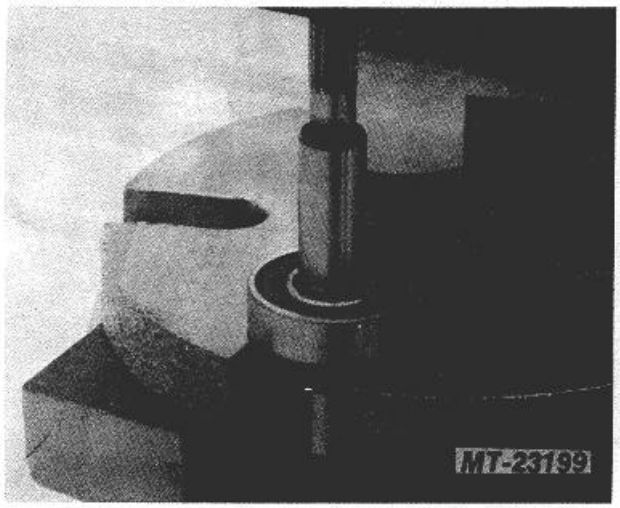


Fig. 20 Press Shaft From Bearing

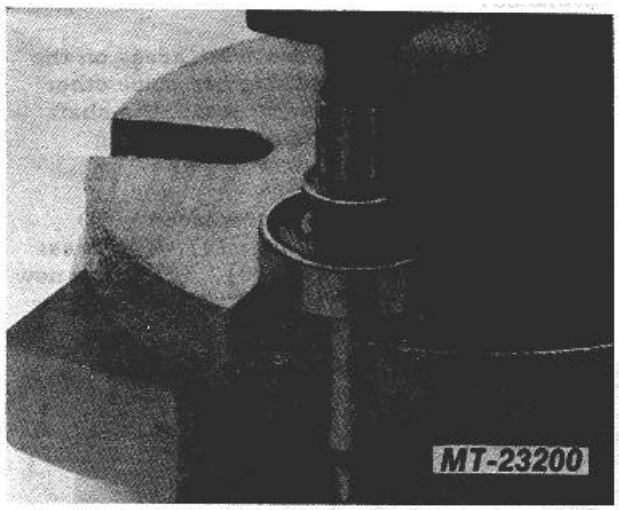


Fig. 21 Press Shaft Into Bearing

4. If seal has been leaking, the shaft has been replaced, or the pump subjected to extremely high temperature, the seal should be replaced. To replace only the seal, pry it out with a screwdriver and press new seal in until it bottoms on the housing using seal installer SE-2806 (Fig. 22).

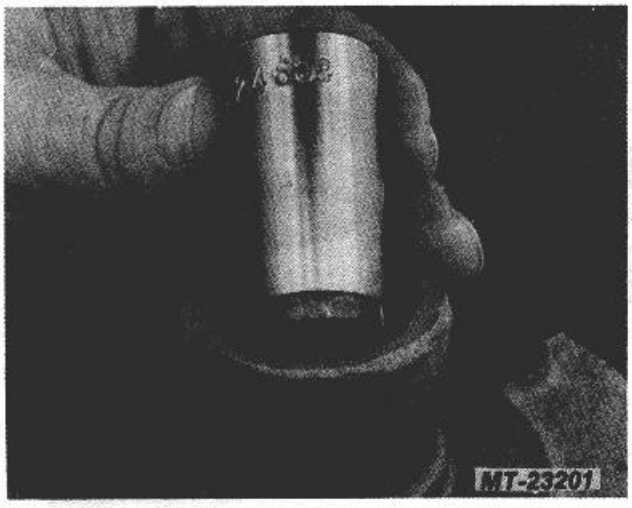


Fig. 22 Install New Pump Seal

5. If the bearing ride surface on the pump shaft is scuffed or fretted, or the needle bearing appears damaged, replace both the seal and needle bearing. Remove bearing and seal with Tool SE-2805 (Fig. 23). Press new bearing in place using Tool SE-2804 (Fig. 24). Bottom shoulder of tool on pump housing to seat bearing correctly.

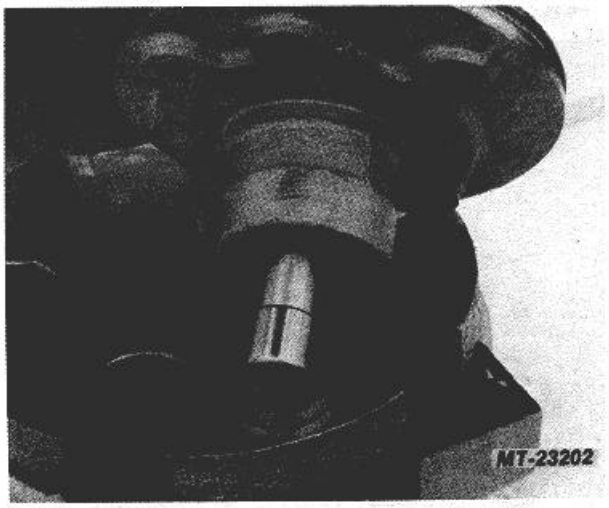


Fig. 23 Remove Needle Bearing and Seal

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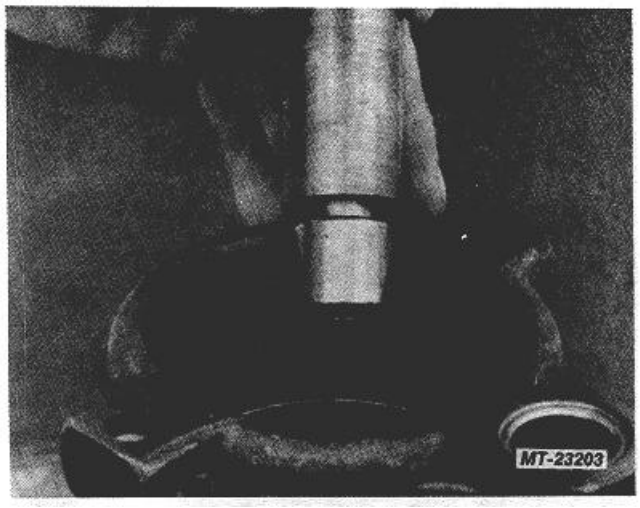


Fig. 24 Install New Needle Bearing

ASSEMBLY

1. Install shaft and bearing assembly (Fig. 18). Secure with retaining ring (Fig. 17).

2. Lubricate the reservoir, pressure-plate, and end-plate "O" rings with power steering fluid and install into pump housing (Figs. 4, 10 and 12).

3. Insert two dowel pins into housing-press on pins to seat fully (Fig. 25).

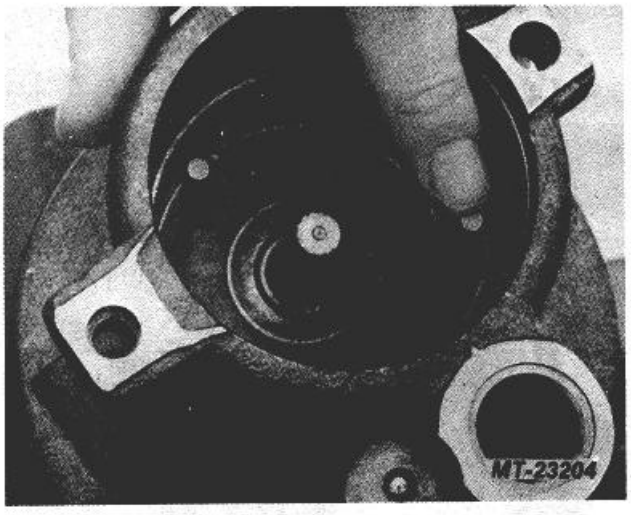


Fig. 25 Install Dowel Pins

4. Pilot thrust plate on dowel pins and push down until thrust plate bottoms on housing (Fig. 26).

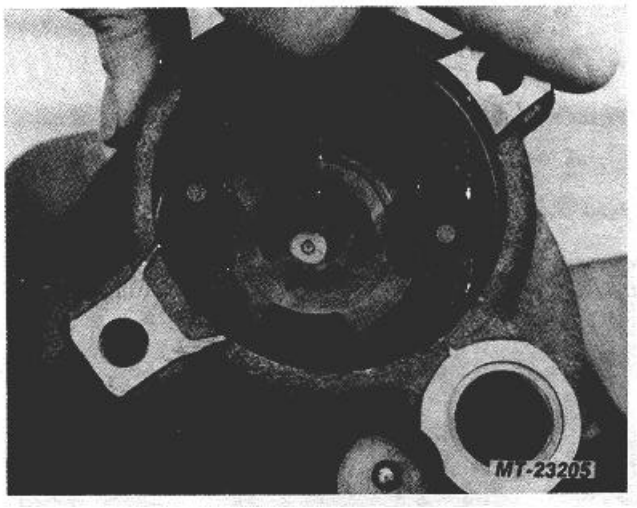


Fig. 26 Install Thrust Plate

5. Guide pump ring onto dowel pins and seat against thrust plate (Arrows on ring up) (Fig. 27).

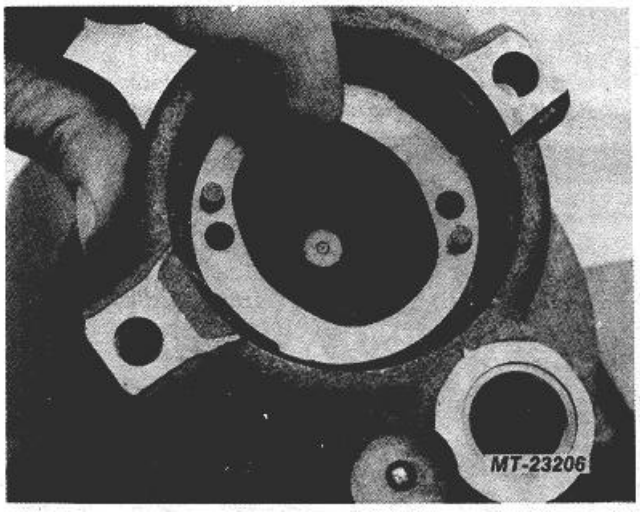


Fig. 27 Install Pump Ring

6. Slide rotor onto drive shaft splines, then assemble ten vanes into rotor slots with rounded edges of vane out. Rounded edges must ride against ring cam (Fig. 28).

7. Squirt power steering fluid onto vanes and rotor and ring cam (Fig. 29) (Lubrication prevents internal damage at initial start).

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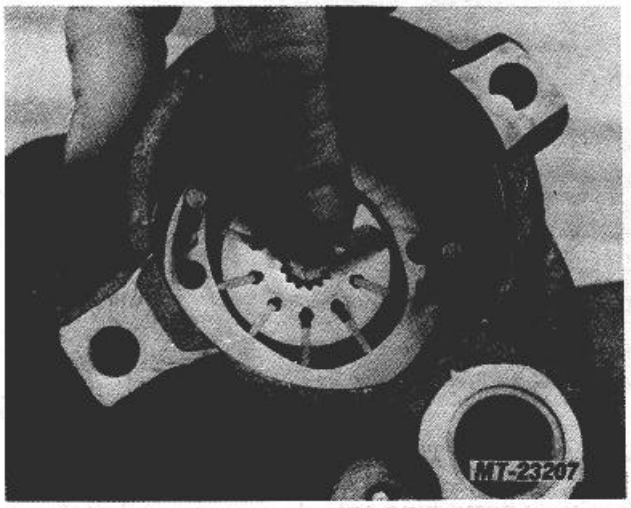


Fig. 28 Install Vanes

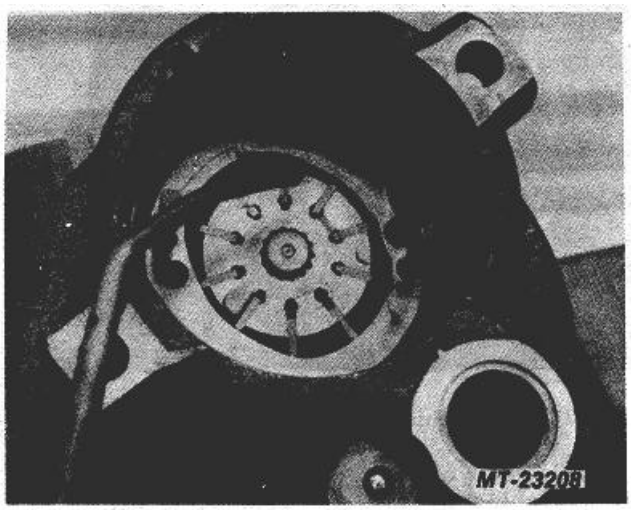


Fig. 29 Lubricate Rotating Group

8. Lubricate pressure plate with power steering fluid. Locate plate on dowel pins. Press down to force plate past pressure-plate "O" ring (Fig. 30).

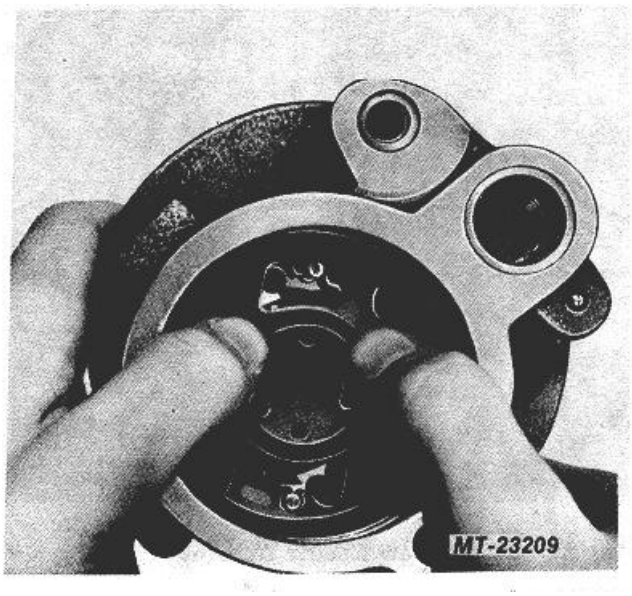


Fig. 30 Seat Pressure Plate

9. Place spring in groove on pressure plate (Fig. 9).

10. Position end plate on housing. (Lip on endplate up.) Force housing down using arbor press until retaining ring groove is visible.

11. Install end-plate retaining ring (ring gap 1800 from knock-out hole in housing) and release arbor press (Fig. 31).

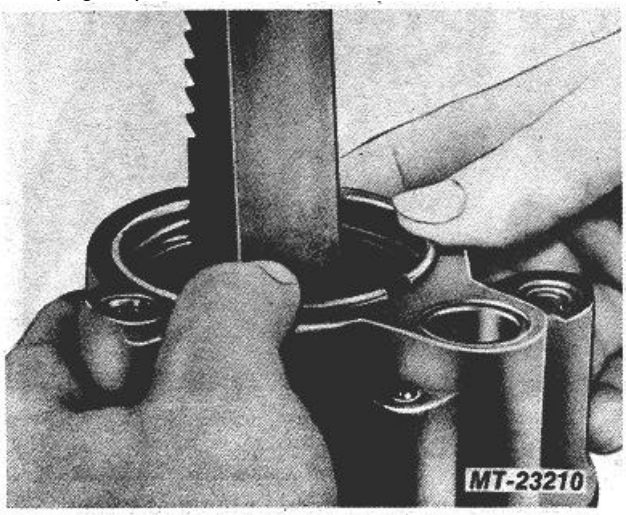


Fig. 31 Install End Plate Retaining Ring

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- Replace magnet in area shown (Fig. 5).
- Place flow control valve spring into hole first and then insert flow control valve (Fig. 2).

4.. Install union seal on housing (Fig. 4).

5. Lubricate inside edge of reservoir with power steering fluid and install on housing. Be careful to align union and stud holes (Fig. 3).

6. Install new "O" rings on union and stud. Insert union and stud and tighten to specifications (Fig. 1).

SPECIFICATIONS

Pump Type	Vane
Manufacturer	Saginaw
Drive	Belt
Mounting	Bracket
Reservoir	Integral
Thrust Taken By	Thrust Plate

TORQUE CHART

DESCRIPTION	NEWTON METERS	(FT. LBS.)
Pulley Nut	81	60
Pump Mounting Bolt	48	35
Flow-Control Fitting Assembly	48	35
Pressure Hose	48	35

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POWER STEERING PUMP

(VICKERS)

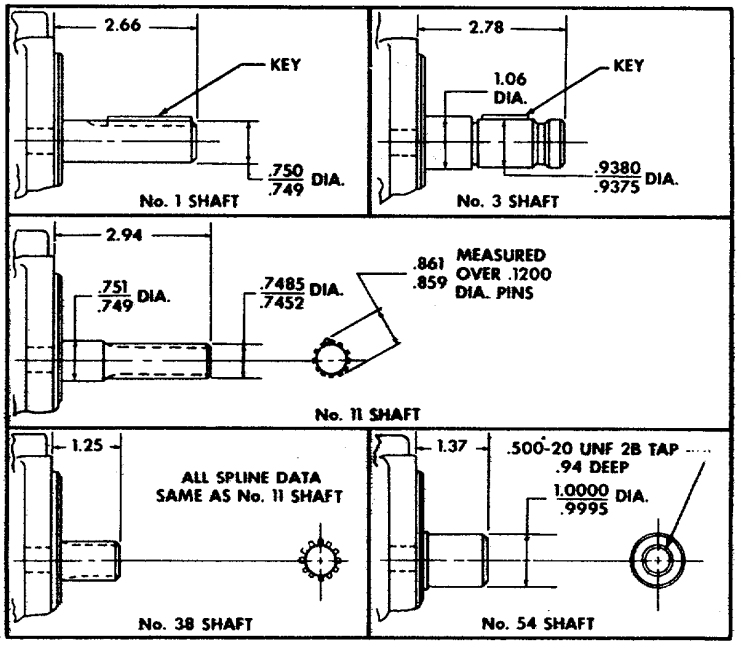
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Identification of Numbers and Letters

Which Appear on Body of Vickers Power Steering Pumps



V 20F 1 R 9 P 54 C

- V = VANE TYPE
- 20F = MODEL SERIES
- 1 = TYPE MOUNTING 1 = TWO BOLT FLANGE 4 = SIX SCREW ADAPTER
- R = INLET PORT CONNECTION
- 9 = FLOW CONTROL AT 1200 RPM AND 100 P.S.I. 9 = NINE GALLON PER MINUTE ETC.
- P = OUTLET PORT CONNECTION
- 54 = SHAFT TYPE (# 1-3-11-38-54 SEE FIG. 2)
- C = OUTLET PORT POSITION A = OPPOSITE SIDE OF INLET (COVER END) B = 90° COUNTERCLOCKWISE FROM INLET C = IN LINE WITH INLET (SAME SIDE)

6E 11 008 L

- 008 = PRESSURE PORT 3/8 NPT INSTEAD OF STANDARD 3/4-16 NF
- 11 = MODIFICATIONS 0 = NONE 1 = ONE ETC.
- 11 = DESIGN 1 = FIRST 2 = SECOND ETC.
- 6E = RELIEF VALVE PRESSURE (P.S.I.) C = 750 D = 1000 E = 1250 F = 1500 G = 1750
- 6E = GALLONS FLOW PER MINUTE 6 = SIX GALLONS 8 = EIGHT GALLONS ETC.
  NOTE: RELIEF VALVES HAVE A CODE STAMPED ON THE END OF THE VALVE PLUG. THESE CODES ARE DEFINED AS FOLLOWS 07 = 750 P.S.I. 10 = 1000 P.S.I. 15 = 1500 17 = 1750
- L = ROTATION L = LEFT HAND ROTATION VIEWED FROM SHAFT END. NO MARKING DESIGNATES RIGHT HAND ROTATION

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DESCRIPTION

The pump illustrated in Fig. 1 consists principally of a ported body, a drive shaft supported by two ball bearings, a pumping cartridge and a pressure plate. The components of the cartridge are an elliptical ring, a slotted rotor splined to the drive shaft and twelve vanes fitted to the rotor slots. As the rotor is driven by the drive shaft, the vanes generate fluid flow by carrying fluid around the elliptical ring contour. Fluid enters the cartridge through the inlet port in the body and is discharged through the pressure plate to the outlet port in the cover.

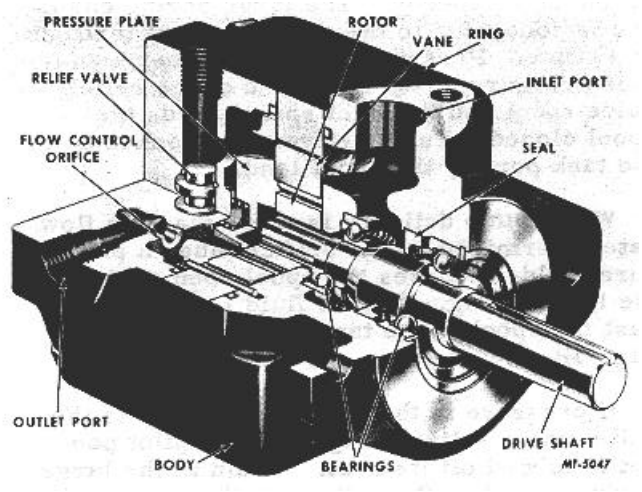


Fig. 1 Cutaway of Pump

The pump cover incorporates the integral Flow Control and Relief Valve. This limits the fluid flow in the system to a maximum prescribed rate and prevents excessive pressure build-up. Fluid not required in the system is recirculated to tank.

OPERATION

The action of the pumping cartridge is illustrated in Fig. 2. The rotor is driven within the ring by the drive shaft, which is coupled to a power source. As the rotor turns, centrifugal force on the vanes causes them to follow the elliptical inner surface of the ring.

Radial movement of the vanes and turning of the rotor cause the chamber between the vanes to increase as the vanes pass the inlet section of the ring. This results in a low pressure condition which allows atmospheric pressure to force fluid into the chambers. (Fluid outside the inlet is at atmospheric pressure or higher).

This fluid is trapped between the vanes and carried past the large diameter or dwell section of the ring. As the outlet section is approached, the ring diameter decreases and the fluid is forced out into the system. System pressure is fed under the vanes, assuring their sealing contact against the ring during normal operation.

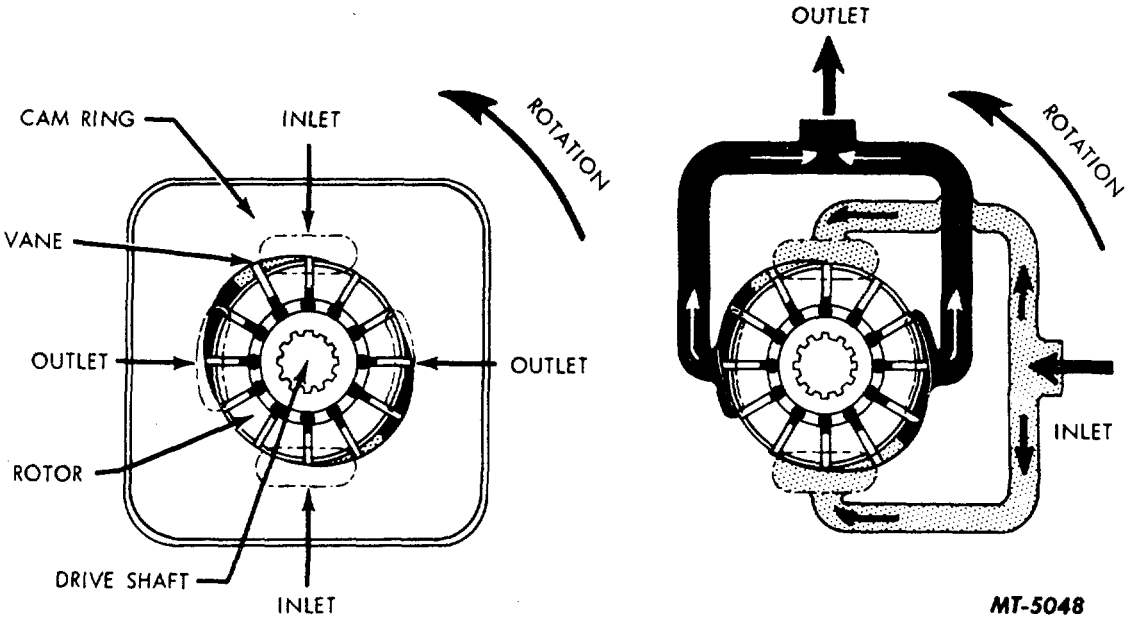


Fig. 2

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The pump ring is shaped so that the two pumping chambers are formed diametrically opposed. Thus, hydraulic forces which would impose side loads on the shaft cancel each other out.

The pressure plate seals the pumping chamber as shown in Fig. 3. A light spring holds the plate against the cartridge until pressure builds up in the system. System pressure is effective against the area at the back of the plate, which is larger than the area exposed to the pumping cartridge. Thus, an unbalanced force holds the plate against the cartridge, sealing the cartridge and providing the proper running clearance for the rotor and vanes.

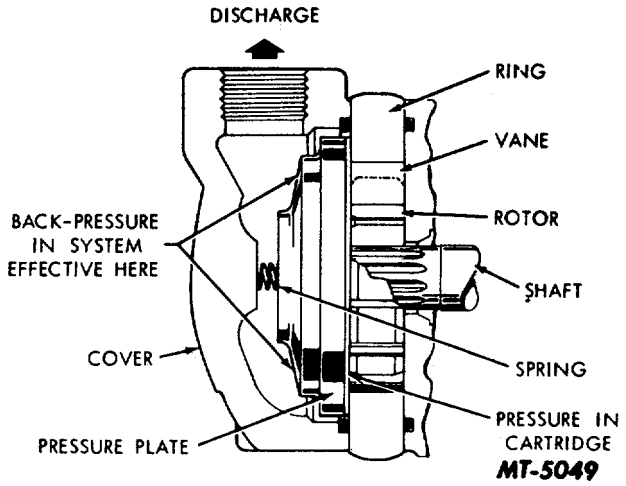


Fig. 3

Maximum pump delivery and maximum system pressure are determined by the integral flow control and relief valve located in the cover. This feature is illustrated schematically in Fig. 4.

An orifice in the cover limits maximum flow. A pilot-operated type relief shifts to divert excess fluid delivery to tank, thus limiting the system pressure to a prescribed maximum.

Fig. 4A shows the condition when the total pump delivery can be passed through the orifice. This condition usually occurs only at low drive speeds. The large spring chamber is connected to the pressure port through an orifice. Pressure in this chamber equalizes pressure at the other end of the relief valve spool and the light spring holds the spool closed. Pump delivery is blocked from the tank port by the spool land.

When pump delivery is more than the flow rate determined by the orifice plug, a pressure build-up forces the spool open against the light spring. Excess fluid is throttled past the spool to the tank port as shown in Fig. 4B.

If pressure in the system builds up to the relief valve setting, Fig. 4C, the pilot poppet is forced off its seat. Fluid in the large spring chamber flows through the spool and out of the tank. This flow causes a pressure differential on the spool, shifting it against the light spring. All pump delivery is thus permitted to flow to tank.

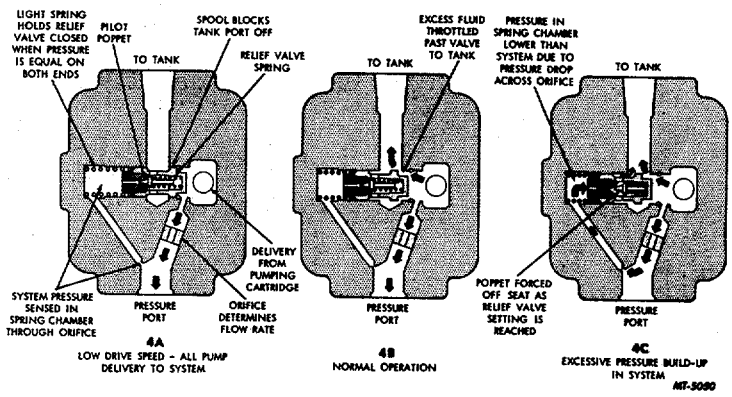


Fig. 4

DISASSEMBLY

During disassembly, pay particular attention to identification of the parts, for correct reassembly. Pump bearings are pressed in the body or on the shaft and should not be removed unless defective. Fig. 5 is an exploded view which shows the proper relationship of the parts for disassembly and reassembly.

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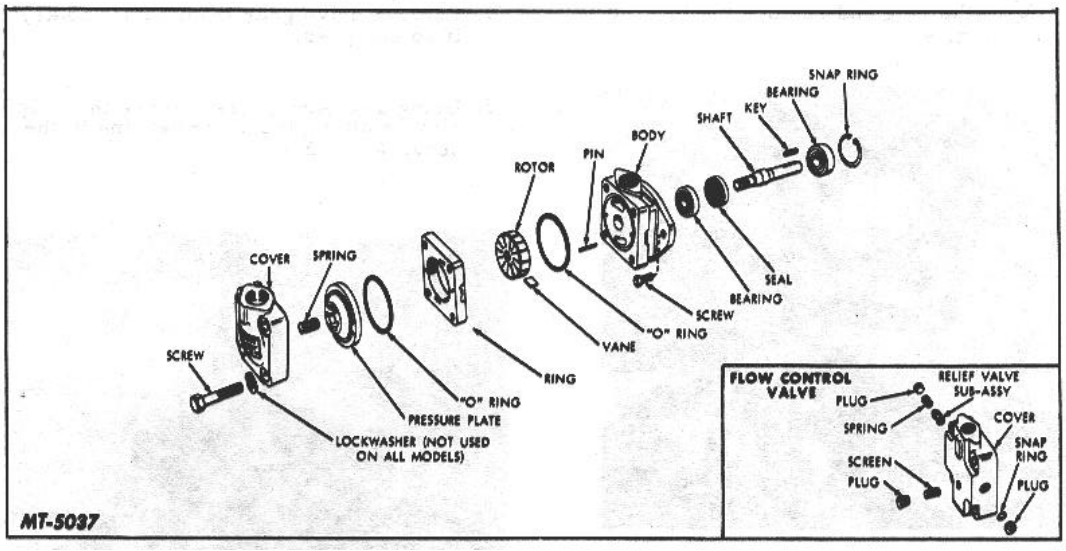


Fig. 5 Exploded View of Pump.

1. NOTE: Before disassembly scribe a line across the cover, ring and body as shown in Fig. 6. This will assure correct reassembly.

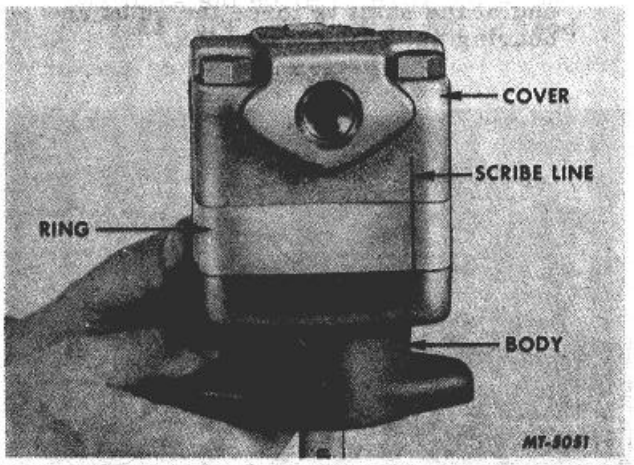


Fig. 6

2. Clamp the pump body in a vise (not too tightly) cover end up, and remove the four cover screws, cover and "O" ring, Fig. 7

3. Remove the pressure plate and spring, Fig. 8.

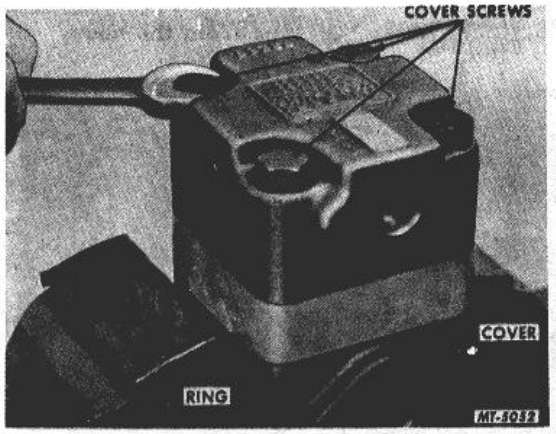


Fig. 7

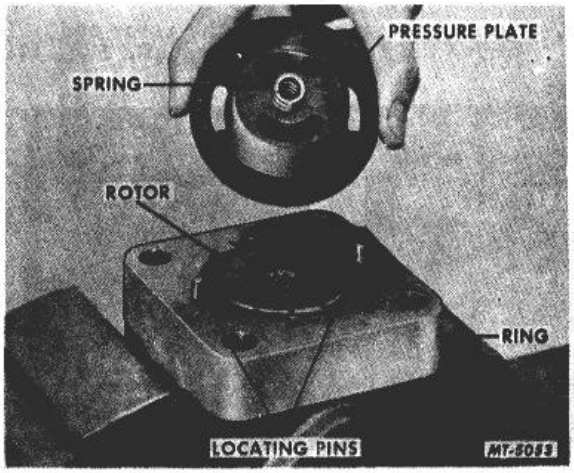


Fig. 8

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4. Lift off the ring and remove the locating pins, Fig. 9.

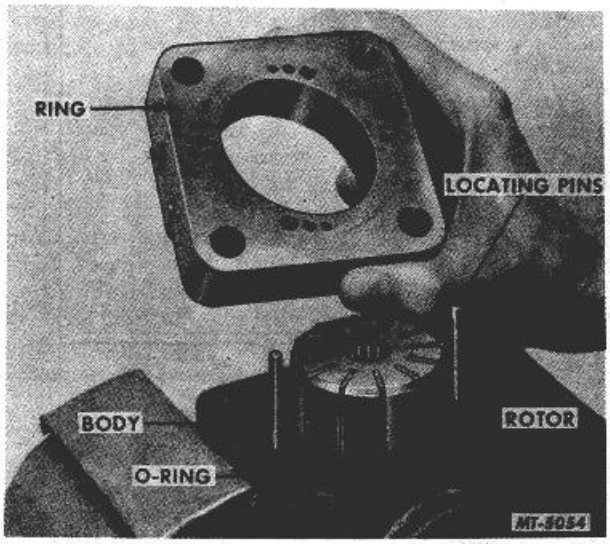


Fig. 9

5. Remove the "O" ring from the body, Fig. 10.

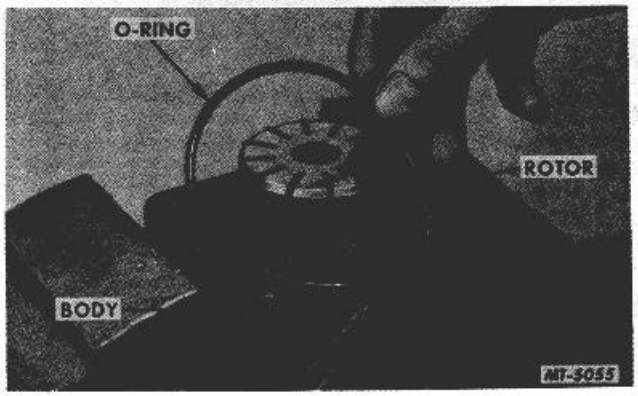


Fig. 10

6. Separate the vanes from the rotor and remove the rotor from the shaft, Fig. 11.

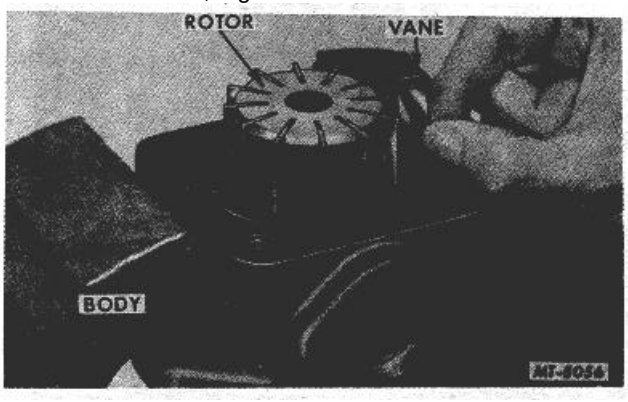


Fig. 11

7. Remove drive gear from shaft and key if so equipped.

8. Using Tru-Arc pliers remove the snap ring retaining the outer bearing in the body, Fig. 12.

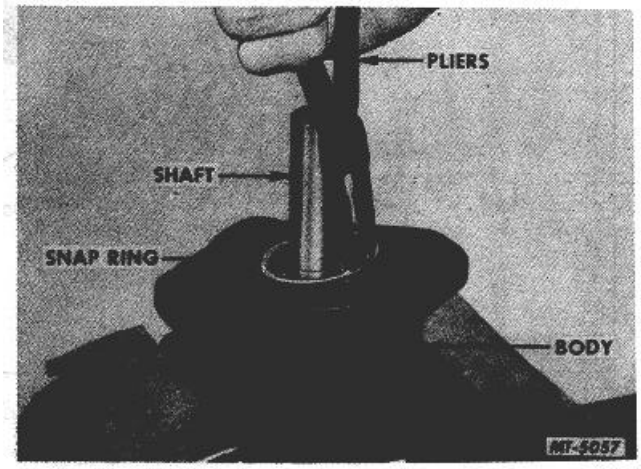


Fig. 12

9. With a soft hammer tap on the splined end of the shaft to force the shaft and bearing out of the body, Fig. 13.

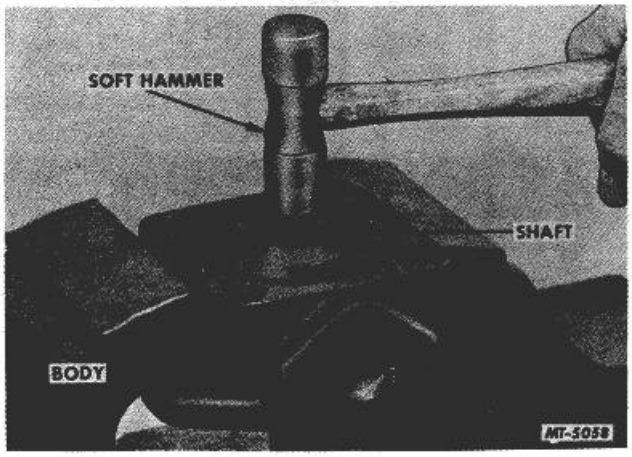


Fig. 13

10. Support the bearing inner race and press the shaft out of the bearing, Fig. 14.

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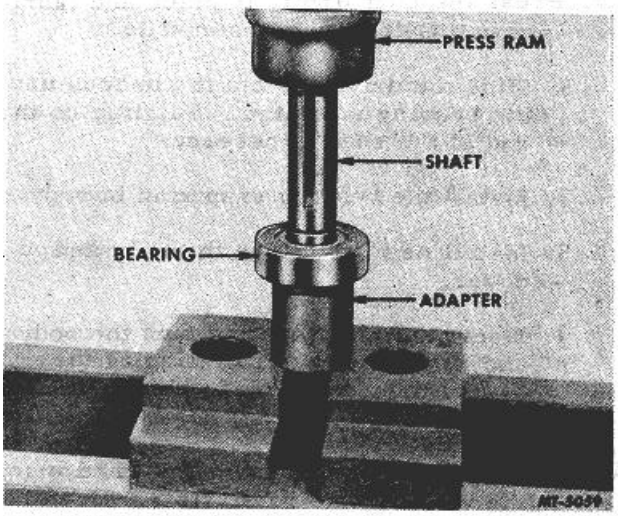


Fig. 14

11. Using puller remove shaft seal from body, Fig. 15.

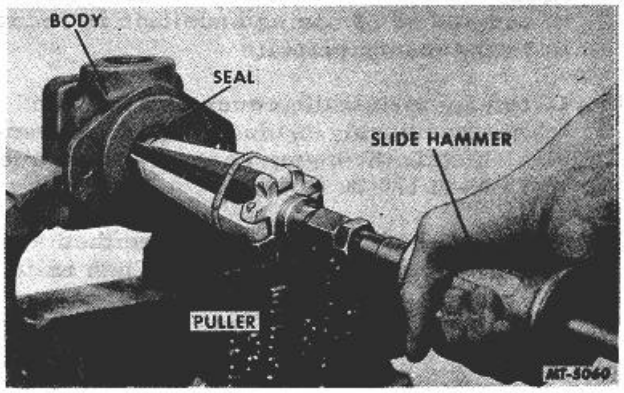


Fig. 15 Removing Shaft Seal Using Puller.

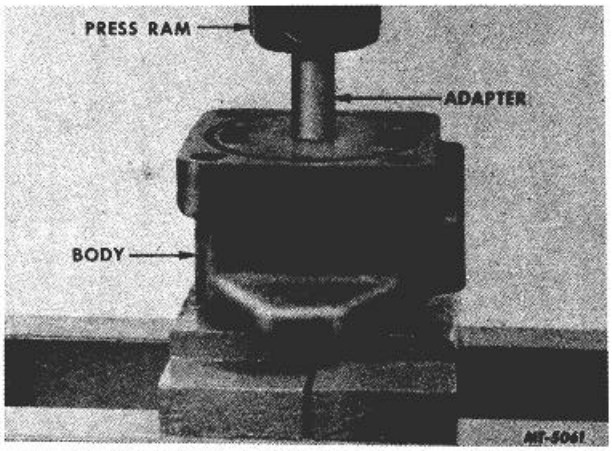


Fig. 16

12. With a suitable adapter press out the inner bearing from the body, Fig. 16.

13. Remove the plug and pull out the screen (see insert Fig. 5). Do not remove the orifice plug unless it is necessary.

14. Check whether there is a plug at each end of the relief valve bore in the cover. If the bore is blind, remove the plug and snap ring to release the valve and spring as shown in the insert in Fig. 5. If the bore is through the cover, remove only the one plug to release the spring and valve, Fig. 17. Leave the snap ring and the other plug in the cover.

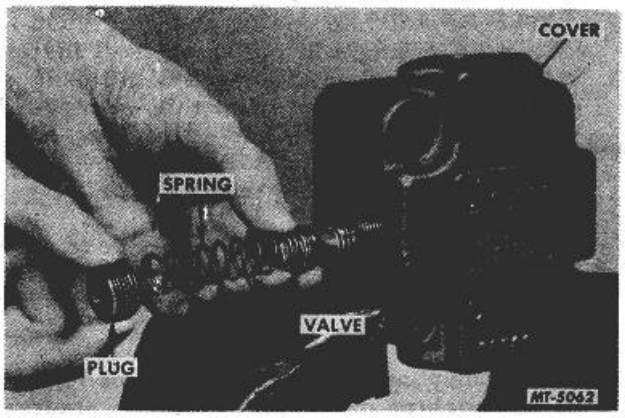


Fig. 17

INSPECTION AND REPAIR

Discard the used shaft seal and all "O" rings. Wash the metal parts in mineral oil solvent, blow them dry with compressed air and place them on a clean surface for inspection.

Check the wearing surfaces of the body, pressure plate, ring and rotor for scoring and excessive wear. Remove light score marks by lapping. Replace any heavily scored or badly worn parts.

Inspect the vanes for burrs, wear and excessive play in the rotor slots. Replace the rotor if the slots are worn.

Check the bearings for wear and looseness. Rotate the bearings while applying pressure to check for pitted or cracked races.

Inspect the oil seal mating surface on the shaft for scoring or wear. If marks on the shaft cannot be removed by light polishing, replace the shaft.

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Check the relief valve sub-assembly for free movement in the cover bore. Remove burrs from the valve by polishing, but do not round off the corners of the lands. Do not attempt to rework the valve bore. If the bore is damaged, replace the cover.

REASSEMBLY

Coat all parts with hydraulic fluid to facilitate reassembly and provide initial lubrication. Use small amounts of petroleum jelly to hold "O" rings in place during assembly.

1. If the cover has a through bore, insert the valve in the bore, small land first. Then install the spring and plug. On pumps having a blind bore, first install the spring, then the valve with hexagon head end first. Follow this with the snap ring being certain it is firmly seated in the groove, then install the plug. Install the screen and plug in the cover.

2. Press the shaft into the front bearing while supporting the bearing inner race.
NOTE: Bearing should seat against shoulder on shaft.

3. Press the inner bearing into the body, using a driver or adapter which contacts the outer race only. NOTE: Make sure the bearing is firmly seated in the body.

4. Before assembling the shaft seal, determine the correct position of the seal lip. Double lip seals are assembled with the spring toward the rotor end of shaft. Single lip seals have two pressure holes, which are assembled toward the drive end of the shaft.

5. Press the seal firmly in place and lubricate the lip with petroleum jelly.

6. Slide the drive shaft into the body until the bearing is seated. Tap lightly on the end of the shaft if necessary.

7. Install the bearing snap ring in body.

8. Install new "O" rings in the body and cover.

9. Insert the ring locating pins in the body and assemble the ring aligning the scribe marks previously made before disassembly.

10. Install the rotor on the shaft and insert the vanes in the rotor slots. Be certain the radius edges of the vanes are toward the cam ring.

11. Place the pressure plate on the locating pins and flat against the ring.

12. Apply a small amount of petroleum jelly to one end of spring and position in recess in the pressure plate.

13. Carefully install the cover aligning the marks previously made before disassembly. Install the cover screws and torque to 95 N-m (70 ft. lbs.).

14. Turn the shaft by hand to insure that there is no internal binding. Then install the shaft key if so equipped.

LUBRICATION

For type of lubricant refer to Lubrication Section CTS-2412.

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FILLING THE PUMP RESERVOIR

1. Fill reservoir to indicated level and replace cap.

2. Start engine and idle, turning wheels to the full left and right three times. Shut off engine and refill reservoir to indicated level.

3. Continue operation in step "2" until system maintains its proper indicated oil level.

4. Run engine at faster speed and continue turning wheels slowly from full left to full right and back again for approximately five minutes to check for leaks. This will bleed the system of air. Again refill the reservoir to the indicated level or to 38. 1 mm (1-1/2 in.) below top of filler neck on reservoir without dipstick attached to filler cap.

   NOTE: THE ABOVE INSTRUCTIONS ARE IMPORTANT.

BELT TENSION

Check and maintain belt tension using tension gauge SE-2312.

TROUBLESHOOTING PROCEDURE

A. A thorough and orderly troubleshooting procedure will help you diagnose power steering troubles quickly. Troubles occur in many places, show up in various ways; but with this procedure, you can eliminate many possibilities immediately, narrow down the cause of trouble, then make correct repairs promptly.

1. We have arranged the troubleshooting procedure into three steps:

   a. Define the complaint.
   b. External inspection.
   c. Hydraulic system check.

2. This procedure is an overall one. By following it step by step, you should be able to identify nearly every trouble which may occur in a hydraulic power steering system. As you become more familiar with troubleshooting, you can leave out some steps on some jobs.

B. The first step in finding trouble is to define the complaint. Properly identifying the complaint will let you eliminate many possible causes at once. Just like a doctor, you must know what and where the trouble is before you can correct it.

1. When a driver brings in his truck with a complaint, ask him to explain the trouble in his own words. (Sometimes a driver expects easier steering than his system is designed to give.) As you talk with him, make notes of his comments, look the system over for obvious defects. You may spot at first glance such things as uneven tire wear, evidence of leakage or a frame out of line. Determine the type and arrangement of the power steering system.

   Here are some sample questions you should ask the driver:

   a. How does the steering act?
   b. Does it act this way all the time?
   c. Does it occur in only one direction?
   d. Under what conditions does it usually occur?
   e. Is it accompanied by unusual noises?

2. If after talking with the driver you are still unable to define the complaint, ask him to accompany you and drive the vehicle yourself. Observe steering action, think, visualize the system in operation. Perform actions in which the driver said trouble occurred; try other steering actions too, to give you a complete and accurate definition of the trouble. You may want to try these steering actions:

   a. Turn steering wheel while standing or moving slowly. (Standing with vehicle loaded, hydraulic power may not be sufficient.)
   b. Steer in both directions while moving.
   c. Turn steering wheel rapidly one or two turns in both directions.
   d. Observe action when traveling straight ahead.

C. The second step is an external inspection. Look for the obvious defects first to save time.

1. Check hydraulic fluid reservoir for correct level. Insufficient oil will cause loss of pressure and hard steering. An extremely low supply may allow air to enter the system causing a "growling" noise and a 'lump" in steering. A reservoir overflow means it is too full, the filter is out of place or in bad condition.

2. Check tire pressure and tire wear due to improper alignment or balance. Faulty tires can cause hard steering and other undesired steering actions.

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3. Check hydraulic pump "V" drive belt for correct tension or glazing because of slippage. A loose belt may make a squealing noise and prevent enough fluid from being pumped through the system, which results in hard steering. Intermittent slippage can cause jerks or surges in steering action. Slippage also shortens belt life.

4. Check system over for external leakage. Leakage is usually indicated by an oil-wetted area, oil dripping or oily dirt accumulation. Since air and fan draft have probably spread leaking oil, clean the entire system off thoroughly, then operate and watch for leakage. Usual points for leaks are around fittings or along hoses which have burst or split under stress and strain. Leakage can cause the same troubles as a low oil supply in the reservoir and a "lump" or hard spot in steering. Air occasionally causes shimmy too.

D. The third step is to check pump pressure.

PRESSURE CHECKING THE POWER STEERING PUMP SYSTEM

To check the hydraulic system, we use a pressure gauge and high pressure shutoff valve. Here is the specially designed testing equipment. Use standard hydraulic hose connections with the testing equipment.

The special equipment as shown in Fig. 18 is designated as SE1985 and consists of the following:

1. SE-1985-1 Pressure Gauge
2. SE1985-2 Shutoff Valve
3. SE19853 90' Angle Tube Line Assembly
4. SE1985-7 Flared Plug
5. SE-1985-8 Inverted Flared Cap

First check the entire system for pressure, then the components to isolate a malfunction.

1. Insert the pressure gauge and shutoff valve between the pump and control valve.

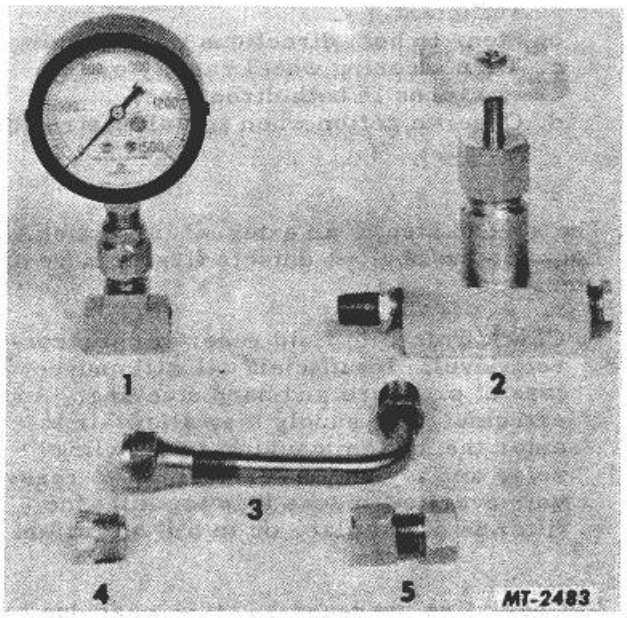


Fig. 18 Special Testing Equipment

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a. With the engine running above idle, shutoff valve open, read the gauge while someone turns the steering wheel. If the correct pump relief valve pressure registers on the gauge when the wheels reach the end of full travel, the hydraulic system checks satisfactorily, and it is not necessary to go any further with hydraulic check. Trouble is probably mechanical or due to other causes such as abnormal front-end weight.

NOTE: System with a shuttle valve in the cylinder may register a sharp drop-off in pressure at end of wheel travel; this is normal.

b. If the specified relief valve pressure is not reached and steering is hard, our system is failing somewhere.
c. If our first check indicates low hydraulic pressure, we must test the components to pinpoint the place of trouble. Leave the pressure gauge and shutoff valve installed, front wheels stationary.

2. Check the pump first:
   a. Gradually close the shutoff valve; pressure gauge should register relief valve pressure just before or just at closing of the valve. If it does, the pump is working correctly.

NOTE: Do not keep shutoff valve closed longer than 15 seconds; oil may overheat and damage pump and seals.

b. If the correct pressure does not register, the pump is faulty. Trouble may be any of the following: seized or "frozen" surfaces, scoring on end faces of gears or housing, binding, scored or damaged teeth, rotors or vanes, dirt or stickiness of flow control valve or pressure relief valve, a leaky pump shaft seal.
c. A hydraulic pump requires finely machined surfaces for operation. A clean workbench must be used for disassembly and repair. (Clean wrapping paper makes a good, disposable workbench top.) Clean pump off with clear, clean solvent before disassembly; blow dry with clean air. Lint from wiping rags can destroy the exact fit required of some surfaces.

3. If the pump is okay, check the steering control valve:
   a. Disconnect the hydraulic hose at one cylinder port; cap the end of the hose using cap SE-1985-8 and plug the port using plug SE-1985-7. Leave the shutoff valve open, engine running above idle; from a straight-ahead position have someone turn the front wheels approximately 1/4 turn to the left or until you feel pressure buildup; check the pressure gauge. Approximately 1/4 steering wheel turn to the right check gauge again. The specified relief valve pressure should register for both directions, indicating the steering control valve is okay.

b. If the specified pressure is not reached, the valve is faulty; we may have hard steering in either or both directions.
c. Valve trouble is usually internal leakage-most often caused by worn seals. Rusting, pitting or scoring of surfaces with which they contact affects greatly the life of seals. Check these surfaces when you disassemble a valve; minor damage can sometimes be touched up with crocus cloth; noticeable rough surfaces require replacement of the part.
d. Check for dirt and scoring; a valve must move freely and without sticking. Cleanliness and care are a must when working on a steering control valve. Forcing or abusing closely fitted parts of any components will probably damage them enough to require replacement.

4. Assume in the first test we found the hydraulic system was not maintaining enough pressure to give us power for steering, but our second test indicated the pump was working properly. Our third pressure gauge check told us the control valve was also working correctly.

This leaves only the cylinder as the point of trouble, providing no other troubles such as binding or friction were missed in the previous checks. If not, we can conclude that our trouble is in the cylinder and proceed to locate the point of failure.

a. Cylinder trouble is usually leakage--internal due to scored cylinder walls or broken piston rings, or external around a bent, scored or binding piston rod or leaky rod seals.
b. A shuttle valve sticking open will cause a loss of pressure too. If the cylinder has a shuttle valve, be sure to check it.
c. A cylinder functioning improperly cannot apply sufficient power to the steering linkage. Hard steering is the result.

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TRUCK SERVICE MANUAL
TRANSMISSION

TRANSMISSION

FOUR-SPEED, SYNCHRO-MESH

IH MODEL	IH CODE
T-17	13017
T-18	13018

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SPECIFICATIONS

IH MODEL IH CODE	T-17 13017	T-18 13018
TYPE	Synchro-Mesh	Synchro-Mesh
NUMBER OF SPEEDS:		
Forward	4	4
Reverse	1	1
GEAR RATIOS:		
Fourth	1.000 : 1	1.000 : 1
Third	1.662 : 1	1.662 : 1
Second	3.339 : 1	3.339 : 1
First	6.685 : 1	6.685 : 1
Reverse	8.258 : 1	8.258 : 1
MAIN DRIVE GEAR TO SYNCHRONIZER CLEARANCE (In.)	.050 - .070	.050 - .070
MAIN DRIVE GEAR END PLAY (In.)	.007 - .017	.007 - .017
HELICAL GEARS	2, 3 and 4	2, 3 and 4
POWER-TAKE-OFF OPENING	Right Side	Left Side
TORQUE CAPACITY (Lbs. Ft.)	260	260
WEIGHT (Lbs.)	130	130
LUBRICANT CAPACITY (Pints)	7	7

TORQUE CHART (Ft. Lbs.)

IH MODEL IH CODE	T-17 13017	T-18 13018
Main Drive Gear Bearing Retainer to Case	5/16 - 18 25 - 30	
Shift Bar Housing to Case	3/8 - 16 35 - 40	
Mainshaft Rear Bearing Retainer to Case	3/8 - 16 20 - 25	
Countershaft Rear Bearing Retainer to Case	3/8 - 16 35 - 40	
Reverse Idler Shaft Lock Bolt to Case	3/8 - 16 25 - 37	
P.T.O. or P.T.O. Cover to Case	3/8 - 16 20 - 30	
Companion Flange to Mainshaft	1 - 20 350 - 400	

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DESCRIPTION

The transmissions covered in this section are four speed, synchro-mesh units. All forward gears, except first-speed gear, are helical type.

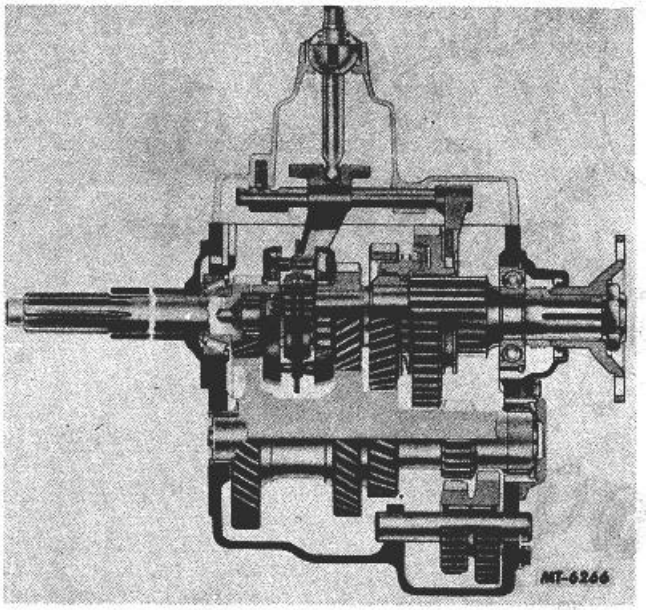


Fig. 1. Transmission Assembly (Cross-Section View)

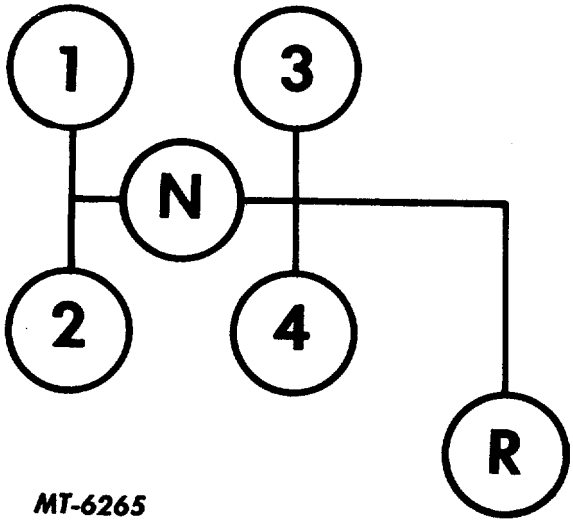


Fig. 2 Transmission Shift Pattern

A tapered roller bearing provides support for the main drive gear. Main drive gear end play is controlled by gaskets between the front bearing retainer and transmission case.

The front end of the mainshaft is supported by a pilot bearing located in the hub of the main drive gear. The rear of the shaft is carried by a ball bearing pressed on the shaft and into the case. The mainshaft and bearing assembly is held in the case by a snap ring and bearing retainer. A spacer located on the rear of the mainshaft, prevents the first reverse-speed sliding gear from contacting the case.

The countershaft is a one-piece shaft and is supported by roller bearings at each end Countershaft end thrust is taken by a thrust washer located on the front of the shaft and a roller type thrust bearing and washer located at the rear.

The reverse idler gear rotates on two sets of roller bearings separated by a thrust washer. A thrust washer and snap ring located at each end of the gear retain the bearings.

OPERATION

The operating characteristics of the transmission covered herein are similar to any conventional four-speed synchromesh unit. Fig. 2 shows the transmission shift pattern. DISASSEMBLY

Place transmission in overhaul stand.

Place gear shift control lever (3, Fig. 4) in neutral position. Remove bolts securing shift bar housing (10, Fig.4) to transmission case (20, Fig. 3) and lift off housing.

Lock transmission in two gears and remove companion flange nut (16, Fig. 3).

Mainshaft

Key numbers used in disassembly and reassembly except for shift bar housing, refer to Fig. 3.

Take out bolts securing mainshaft rear bearing retainer (14) to case (20) and remove retainer. Slide speedometer drive gear (12) off of mainshaft (37).

Remove bolts (1) attaching main drive gear bearing retainer (2) to case (20). Remove retainer and gasket (3).

Rotate main drive gear (23) as required to align notch in main drive gear clutch teeth with countershaft drive gear teeth (42). Remove main drive gear and tapered roller bearing (22) from transmission.

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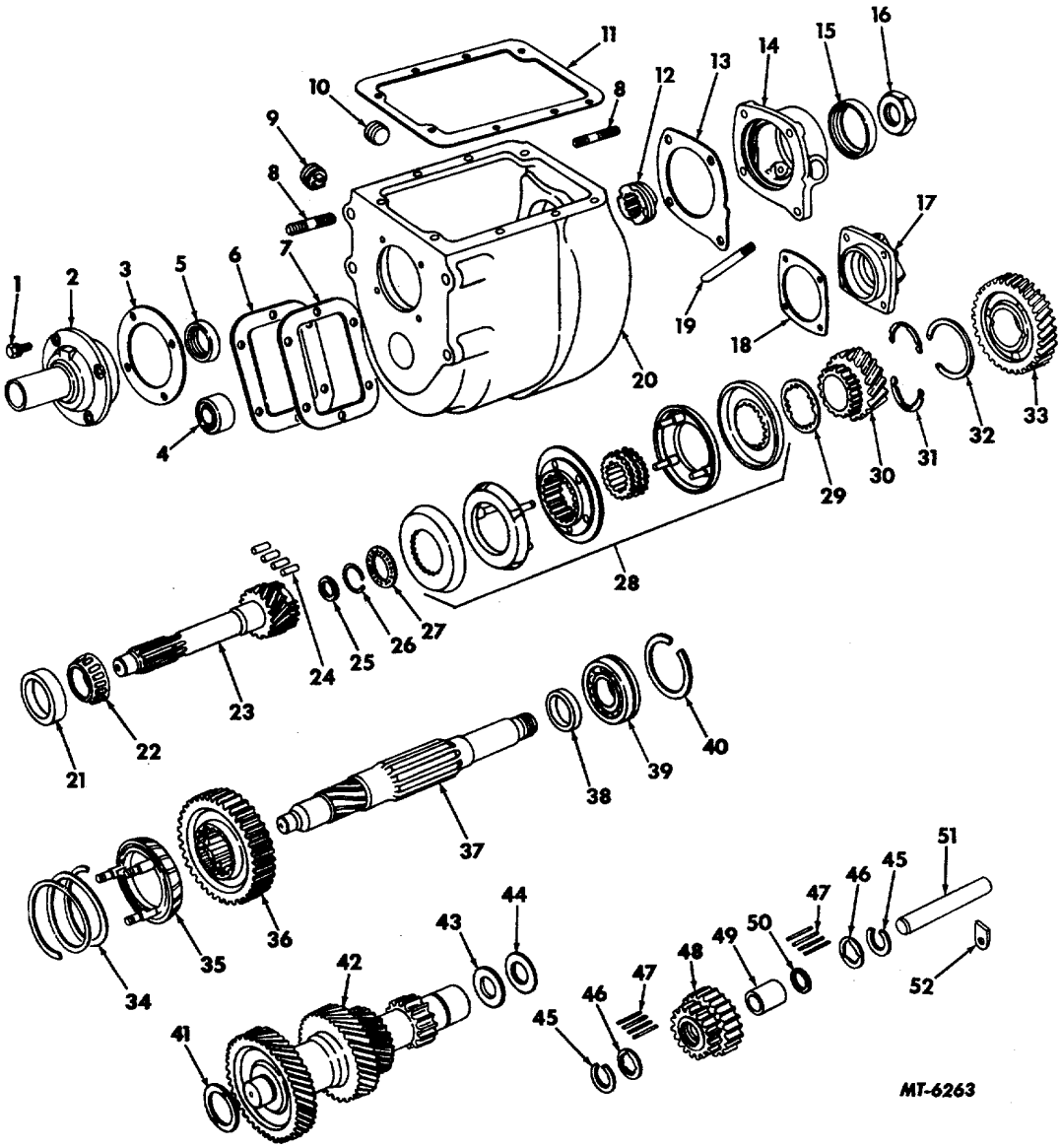


Fig. 3 Transmission Assembly (Exploded View)

Key	Description
1.	BOLT, retainer
2.	RETAINER, main drive gear
3.	GASKET
4.	BEARING, roller, countershaft front
5.	SEAL, main drive gear
6.	COVER, power-take-off
7.	GASKET
8.	STUD
9.	PLUG, drain
10.	PLUG, filler
11.	GASKET
12.	GEAR, speedometer drive
13.	GASKET
14.	RETAINER, mainshaft rear bearing
15.	SEAL, mainshaft rear
16.	NUT, companion flange
17.	RETAINER, countershaft rear bearing
18.	GASKET
19.	TUBE, drain
20.	CASE, transmission
21.	CUP, main drive gear bearing
22.	CONE, main drive gear bearing
23.	GEAR, main drive
24.	BEARING, mainshaft pilot

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25. WASHER, thrust
26. RING, snap
27. BEARING, roller thrust
28. SYNCHRONIZER, assembly 3rd and 4th speed
29. SHIM, synchronizer
30. GEAR, third-speed
31. RING, snap
32. RETAINER, synchronizer
33. GEAR, second-speed
34. SPRING, second-speed synchronizer
35. BRAKE, second-speed synchronizer
36. GEAR, first-speed
37. MAINSHAFT Key Description
38. STOP, first-speed gear
39. BEARING, ball, mainshaft rear
40. RING, snap
41. WASHER, thrust
42. COUNTERSHAFT
43. BEARING, roller thrust
44. WASHER, thrust
45. RING, snap
46. WASHER, thrust
47. BEARING, roller reverse idler
48. GEAR, reverse idler
49. SLEEVE, reverse idler gear
50. WASHER, thrust
51. SHAFT, reverse idler gear
52. PLATE, reverse idler gear shaft lock

Tap mainshaft assembly to rear of transmission to expose rear bearing (39). Attach bearing puller tool and remove bearing from mainshaft. Remove the roller type thrust bearing (27) from front end of mainshaft(37).

Move mainshaft to rear of case. Tilt front of mainshaft up and lift shaft assembly out of case.

Slide third and fourth-speed synchronizer assembly (28) off mainshaft. Remove synchronizer shim (29) and third-speed gear(30) from mainshaft.

Remove snap ring (31) retaining second speed gear (33) to mainshaft (37). Remove second-speed synchronizer retainer (32) and take second-speed gear (33) spring (34) and synchronizer brake (35) off mainshaft. Slide first-speed gear stop (38) and first-speed gear (36) off rear of mainshaft (37).

Counter shaft

Position transmission so that rear of case if facing up. Take out bolts securing countershaft rear bearing retainer (17) to case (20). Tap retainer with a soft hammer to free it from case. Remove retainer (17), thrust washer (44), roller type thrust bearing (43) and gasket (18). Move countershaft (42) to rear of case (20) until shaft is out of front bearing assembly (4). Lift countershaft out of case.

Remove countershaft front bearing assembly (4) from case (20). Bearing can be driven out from the outside of case using a piece of tubing or similar tool having the correct outside diameter.

Reverse Idler Gear

Remove reverse idler gear lock bolt and lock plate (52) from rear of transmission case (20). Support gear (48) to prevent it from dropping and remove idler shaft (51). Lift gear (48) out of case (20).

Remove snap ring (45) from each end of reverse idler gear (48). Remove the two end thrust washers (46), two rows of roller bearings (47), thirty-four bearings in each row, center thrust washer (50) and sleeve (49).

Shift Bar Housing

Key numbers used in disassembly and reassembly of shift bar housing, refer to Fig.4.

Slide boot off of cap (5). Turn cap clockwise and remove gear shift control lever (3) from shift bar housing (10).

Using a No. 2 EZ-Out, remove roll pin (13) from first and second-speed shift fork (28). Remove roll pin (13) from first and second-speed shift block (27) using same procedure.

Push first and second-speed shift bar (26) out through front of shift bar housing (10) to force plug (9) out of housing. Cover poppet ball access hole in housing to prevent ball (17) and spring (18) from being expelled as shift bar (26) clears hole. Remove first and second-speed shift fork (28) and block (27).

Using procedure outlined for first and second-speed shift bar and fork removal, remove third and fourth-speed (24) and reverse shift bars (16). Remove shift forks (25 and 12).

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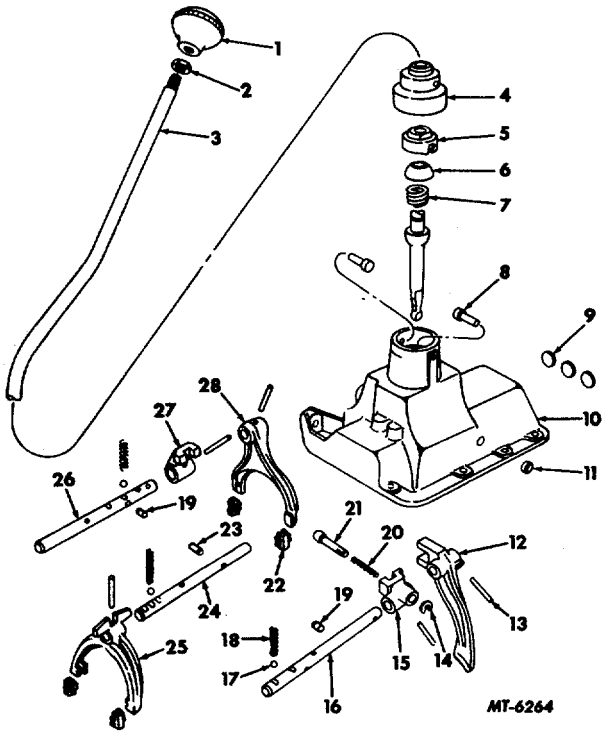


Fig. 4 Shift Bar Housing (Exploded View)

Legend for Fig. 4

Key	Description
1.	KNOB, gear shift lever
2.	NUT, jam
3.	LEVER, gear shift control
4.	BOOT
5.	CAP
6.	SEAT, spring
7.	SPRING
8.	PIN, retainer
9.	PLUG, expansion
10.	HOUSING, shift bar
11.	THIMBLE, shift bar housing
12.	FORK, reverse shift
13.	PIN, roll
14.	CLIP, reverse gear plunger
15.	BLOCK, reverse shift
16.	BAR, reverse shift
17.	BALL, poppet
18.	SPRING, poppet ball
19.	PLUNGER, interlock
20.	SPRING, reverse gear plunger
21.	PLUNGER, reverse gear
22.	SHOE, shift fork
23.	PIN, interlock
24.	BAR, 3rd and 4th speed shift
25.	FORK, 3rd and 4th speed shift
26.	BAR, 1st and 2nd speed shift
27.	BLOCK, 1st and 2nd speed shift
28.	FORK, 1st and 2nd speed shift

Compress reverse gear plunger (21) and remove retaining clip (14). Remove plunger (21) and spring (20) from reverse shift block (15).

Main Drive Gear and Bearing Retainer

Remove snap ring (26), roller bearings (24) and thrust washer (25) from bore of main drive gear (23). Using suitable bearing remover tool, remove tapered roller bearing (22) from main drive gear (23).

Using suitable puller tools, remove tapered roller bearing cup (21) and seal assembly (5) from bore of main drive gear bearing retainer (2).

CLEANING, INSPECTION AND REPAIR

After disassembly, clean all parts thoroughly with a cleaning solvent. The transmission case should be washed before reassembly. Replace all oil seals and gaskets.

Bearings should be washed in a pressure bearing washer. Be certain that all ball bearings are a press fit on the shafts and that the outer race of these bearings fit tightly in their bores. Check all bearings for defects and replace if necessary. Examine teeth on all gears careully. Cracked or chipped teeth, or spots where case hardening is worn through renders gears unfit for further use. Inspect splines on mainshaft and main drive gear for evidence of wear. Check first and reverse gear to see that it slides smoothly on the mainshaft. Inspect mainshaft thrust washers and if worn to permit excessive end play, replace them. Check reverse idler shaft and roller bearings; replace if worn.

All seals and bearings should be dipped in transmission lubricant at assembly to provide initial lubrication.

REASSEMBLY

Main Drive Gear and Bearing Retainer

Using adapters of correct diameter, install oil seal (5) and tapered roller bearing cup (21) in main drive gear bearing retainer (2). NOTE: Seal should be installed with lip pointing towards transmission case (20) when retainer (2) is installed on case.

Place tapered roller bearing (22) on main drive gear (23) and support bearing in an arbor press. Place a block of wood on the main

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drive gear and press shaft into bearing until gear contacts bearing inner race.

Place thrust washer (25) in position in bore of main drive gear (23). Coat bore of main drive gear with a thin film of grease. Install the fourteen roller bearings (24) in the bore, sliding the final roller axially into place. Secure bearings with snap ring (26).

Shift Bar Housing

Assemble spring (19) on reverse gear plunger (20) and hold it in reverse shift block (15). Compress it in block and install retaining clip (14).

Enter reverse shift bar (16) in housing (10) and place poppet ball spring (18) and ball (17) in position. Depress the ball and slide the shift bar over it.

Install block (15) and shift fork (12) on shift bar (16). Install a new roll pin (13) in block and in shift fork.

Apply a film of sealer in plug seat at front of housing (10).

Install a new plug (9) in reverse shift bar bore.

Place reverse shift fork (12) in neutral position.

Install the two interlock plungers (19) in their bores.

Insert interlock pin (23) in third and fourth-speed shift bar (24). Install shift bar (24) in same manner as reverse shift bar (16) mechanism.

Install first and second-speed shift bar (26) in same manner making sure that interlock plunger (19) is in place.

Position gear shift lever (3) in place and retain it with the cap (5). Install the boot (4).

Reverse Idler Gear

Coat bore of reverse idler gear (48) with a thin film of grease. Place sleeve (49) and center thrust washer (50) in bore of gear (48). Install thirty-four roller bearings (47) in each end of gear. Install thrust washer (46) and snap ring (45) in each end of gear (48).

Install reverse idler gear (48) in case (20) with the large gear toward rear of case. Insert reverse idler gear shaft (51) into case. Coat the rear of the shaft with sealer and install lock plate (52). Secure lock plate with lock bolt.

Countershaft

Position countershaft front bearing assembly (4) in case so that lubrication hole in bearing is in alignment with slot in case. Using an adapter of correct diameter, carefully press bearing into case until bearing cage is flush with front of case.

Position transmission with front facing down. Apply a thin film of grease on front thrust washer (41) and position it in front of case. NOTE: Thrust washer is bored off-center; therefore, be certain that the tangs match the slots in the case boss.

Place countershaft (42) in position in case. Place roller type thrust bearing (43) and thrust washer (44) on rear of countershaft in that order.

Install bearing assembly into countershaft rear bearing retainer using proper adapter. Install new gasket (18) and rear bearing retainer (17) on rear of case. Secure with mounting bolts and torque to value shown in "Torque Chart".

Mainshaft

Slide first-speed gear (36) and first-speed gear stop (38) on rear of mainshaft (37) in that order. Install second-speed synchronizer brake (35), spring (34) and second-speed gear (33) on mainshaft (37). Install second-speed synchronizer retainer (32) and second-speed gear snap ring (31). Slide third-speed gear (30) and synchronizer shim (29) on mainshaft. Install third and fourth-speed synchronizer assembly (28) and roller type thrust bearing (27) on mainshaft.

Place main drive gear assembly (23) on mainshaft assembly (37) and position complete assembly in a vise with main drive gear up. Check distance between third and fourth-speed synchronizer (28) and main drive gear (23). If distance exceeds .043" .053", install necessary thickness of shims (29) between the third-speed gear (30) and the third and fourth-speed synchronizer (28). After correct shim thickness has been established, remove main drive gear (23) from mainshaft (37).

Remove mainshaft assembly from vise and install in transmission case by tilting front end up. Place a block of wood against the inside front end of case. Place mainshaft rear bearing assembly (39) on rear of mainshaft(37). Using an adapter of correct diameter to contact the bearing inner race, drive the bearing onto

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the mainshaft while holding the front end of the mainshaft against the wood block. Remove wood block and pull mainshaft forward positioning rear bearing in case.

Position main drive gear (23) in case (20) so that cut-away portion of clutch teeth is facing down. Install main drive gear bearing retainer (2) with no gasket (3) or bolts (1), Hold retainer concentric with mainshaft and measure clearance between retainer and case with feeler gauge. Install a gasket shim pack .010" .015" thicker than measured clearance between retainer (2) and case (20). This should provide the required main drive gear end play (see "Specifications"). Secure main drive gear bearing retainer (2) to case (20) with bolts (1) and torque to value shown in "Torque Chart". After bolts have been torqued, recheck main drive gear end play.

When main drive gear end play is within specifications, recheck synchronizer clearance. See "Specifications" for required clearance. Adjust synchronizer clearance if required.

Using an adapter of correct diameter, install new seal (15) in mainshaft rear bearing retainer (14). NOTE: Seal lip should point towards speedometer drive gear (12) when retainer (14) is installed on case (20).

Slide speedometer drive gear (12) on rear of mainshaft (37) and install mainshaft rear bearing retainer (14). Secure retainer to case with bolts and tighten to value shown in "Torque Chart". Slide companion flange on rear of mainshaft and secure with nut (16). Place transmission gear train into two gears at one time and tighten companion flange nut to value shown in "Torque Chart".

Place transmission gears in neutral position. Position new gasket (11) on transmission case (20) and install snift bar housing (10, Fig. 4). Install attaching bolts and tighten to value shown in "Torque Chart".

LUBRICATION

All roller bearings should be dipped in transmission lubricant before reassembling.

For initial filling, fill transmission with proper lubricant until it runs out filler hole; then replace plug.

Use straight mineral oil SAE-90 for temperatures 0°F and up. Use SAE-80 for temperatures below 0°F. When temperature is consistently below 0°F and parked vehicles are exposed to cold for long periods of time, use SAE-75. Constant temperatures above 90"F require SAE-140.

Inspect every 1, 000 miles or at each chassis lubrication interval. Keep lubricant up to level of filler plug. Drain and flush twice each year (preferably in the spring and fall) or every 10, 000 miles.

See "Specifications" for lubricant capacity.

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TRUCK SERVICE MANUAL
TRANSMISSION

TRANSMISSION

IH Model	IH Code
T-425	13425

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TRUCK SERVICE MANUAL
TRANSMISSION

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TRUCK SERVICE MANUAL
TRANSMISSION

DESCRIPTION

This transmission is synchronized in all four forward speeds and incorporates a sliding helical reverse gear on the rear of the output shaft.

The mainshaft reverse gear slides into the fixed reverse idler gear and is prevented from jumping by a positive torque lock step in the mainshaft splines.

The drive gear (input shaft) is supported by an adjustable tapered roller bearing. The front of the output shaft is supported by a pilot bearing located at the rear of the drive gear. The rear of the output shaft is supported by a tapered roller bearing, while the countershaft is supported by roller bearings.

OPERATION

First Gear

When the transmission is shifted to first gear, the low-speed sliding clutch gear is moved rearward, locking the first-speed gear to the mainshaft. In all other shift positions the first-speed gear is free running. In first gear engine power is applied to the countershaft low-speed gear through the transmission input shaft or drive gear and to the mainshaft low-speed gear through the countershaft low-speed gear. There are no sliding gears in any forward speed

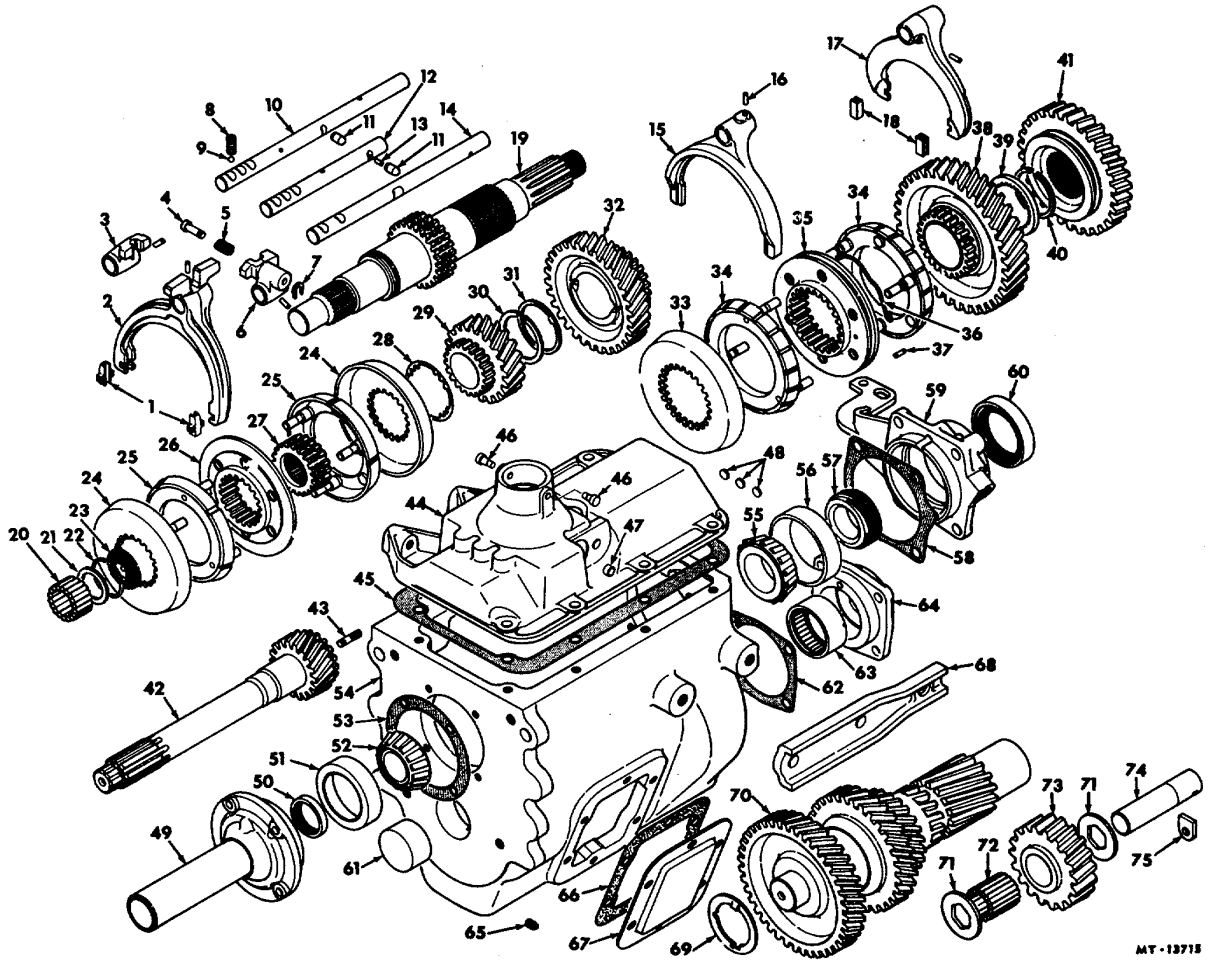


Fig. 1 Exploded View

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Key	Description
1	PLATE, Shift Fork Wear (2)
2.	FORK with PLATES, Third and Direct-Speed Shift
3	BLOCK, Low and Second-Speed Shift
4	PLUNGER, Reverse-Speed Shift Block
5	SPRING, Reverse-Speed Shift Block Plunger
6	BLOCK, Reverse-Speed Shift
7	WASHER, Reverse-peed Plunger
8	SPRING, Shift Bar Poppet Ball (3)
9	BALL, Poppet, 3/8 (3)
10	BAR, Low and Second-Speed Shift
11	PLUNGER, Shift Bar Interlock (2)
12	BAR, Third and Direct-Speed Shift
13	PIN, Shift Bar Interlock
14	BAR, Reverse-Speed Shift
15	FORK, Low and Second-Speed Shift
16	PIN, Shift Fork (5)
17	FORK, Reverse-Speed Shift
18	PLATE, Shift Fork Wear (2)
19	MAINSHAFT
20	BEARING, Mainshaft Roller (14)
21	WASHER, Mainshaft Roller Bearing
22	RING, Mainshaft Snap
23	BEARING, Clutch Gear Thrust
24	RING, Synchronizer Outer (2)
25	RING with PINS, Synchronizer (2)
26	CLUTCH, Sliding
27	GEAR, Synchronizer Clutch
28	SHIM, Synchronizer Adjusting
29	GEAR, Mainshaft Third-Speed
30	RING, Mainshaft Snap
31	WASHER, Mainshaft Thrust
32	GEAR, Mainshaft Second-Speed
33	RING, Synchronizer Outer Stop
34	RING with PINS, Synchronizer (2)
35	CLUTCH with PINS and SPRING, Sliding Rear
36	SPRING, Sliding Clutch (2) 37 PIN, Spring (2)
37	PIN, Spring

Key	Description
38	GEAR with BUSHING, Low-Speed
39	WASHER, Mainshaft Thrust
40	RING, Mainshaft Snap
41	GEAR, Mainshaft Reverse
42	GEAR, Main Drive
43	STUD, Transmission Mounting Front (4)
44	HOUSING, Control Lever
45	GASKET, Control Housing
46	PIN, Control Lever Pivot (2)
47	PLUG, Shift Bar Interlock
48	PLUG, Expansion, 3/4 (3)
49	RETAINER, Main Drive Gear Bearing
50	SEAL, Main Drive Gear Oil
51	BEARING, Main Drive Gear Cup
52	BEARING, Main Drive Gear Cone
53	GASKET, Main Drive Gear Brg. Retainer
54	CASE with MAGNET, Transmission
55	BEARING, Mainshaft Cone
56	BEARING, Mainshaft Cup
57	GEAR, Speedometer Drive
58	GASKET, Mainshaft Rear Brg. Retainer
59	RETAINER with SEAL, Mainshaft Rear Bearing
60	SEAL, Mainshaft Bearing Retainer Oil
61	BEARING, Countershaft Front
62	GASKET, Countershaft Rear Brg. Cover
63	BEARING, Countershaft Rear
64	COVER with BEARING, Countershaft
65	PLUG, Drain and Filler (2)
66	GASKET, PTO Opening Cover (2)
67	COVER, PTO Opening (2)
68	BAR, Brake Anchor
69	WASHER, Countershaft Front Thrust
70	GEAR, Countershaft
71	WASHER, Reverse Idler Thrust (2)
72	BEARING, Reverse Idler Needle (21)
73	GEAR with BEARING and WASHERS, Reverse Idler
74	SHAFT, Reverse Idler
75	LOCK, Reverse Idler Gear Shaft

Second Gear

When the transmission is shifted into second, the low-speed shift fork moves forward and the low-speed sliding clutch gear pushes against the synchronizer and locks the second-speed gear to the mainshaft. Engine power is applied to the countershaft through the drive gear and from the second-speed gear on the countershaft to the mainshaft second-speed gear. The mainshaft second-speed gear is free running in all other shift positions.

Third Gear

When the transmission is shifted to third gear, the shift fork moves the third-fourthspeed sliding clutch gear rearward and locks the third-speed gear to the output shaft. In all other shift positions the third-speed gear is free running. Ir third gear engine power is applied through the drive gear to the countershaft and from the countershaft third-speed gear to the mainshaft third-speed gear.

Fourth Gear

When the transmission is shifted to fourth gear, the third-fourth-speed sliding clutch gear is moved forward, locking the input shaft to the output shaft. Engine power is applied directly from the transmission drive gear to the mainshaft. The drive gear also drives the countershaft, which in turn drives the free-running forward gears on the mainshaft. The transmission output shaft turns at engine speed when the transmission is in fourth gear.

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Reverse

When the shift lever is moved to reverse, the mainshaft sliding reverse gear is moved forward into contact with the reverse idler gear, which is driven by the low-speed gear on the countershaft. The reverse idler is not shifted but remains in constant contact with the countershaft low-speed gear.

DISASSEMBLY

1. Drain lubricant. Place transmission in holding fixture.

2. Shift transmission gears into neutral. Remove gearshift cover attaching bolts. Note that the two bolts opposite the tower are shouldered to properly position cover and are provided with lockwashers. Be sure that the alignment bolts are properly positioned and tightened first during cover installation. Lift cover straight up to remove.

3. Lock transmission in two gears and remove mainshaft nut and yoke.

4. Loosen and remove retainer attaching bolts. Remove mainshaft rear bearing retainer and speedometer drive gear.

Drive Gear (Pinion)

1. Remove attaching bolts from front bearing retainer and pull off bearing retainer and gasket.

2. Rotate drive gear to align gear flat with countershaft drive gear teeth. Remove drive gear and tapered roller bearing from transmission, Fig. 2.

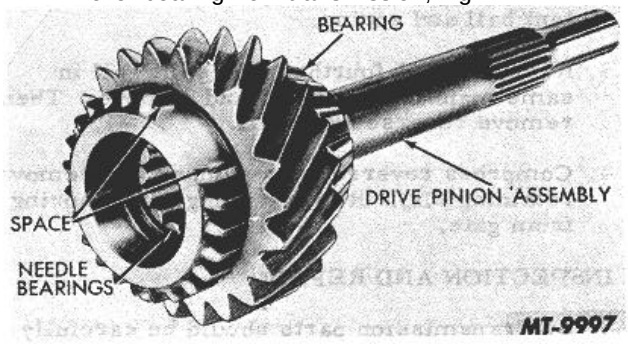


Fig. 2

Mainshaft

1. Remove thrust bearing.
2. Push mainshaft assembly to rear of transmission and tilt front of mainshaft up, Fig. 3.

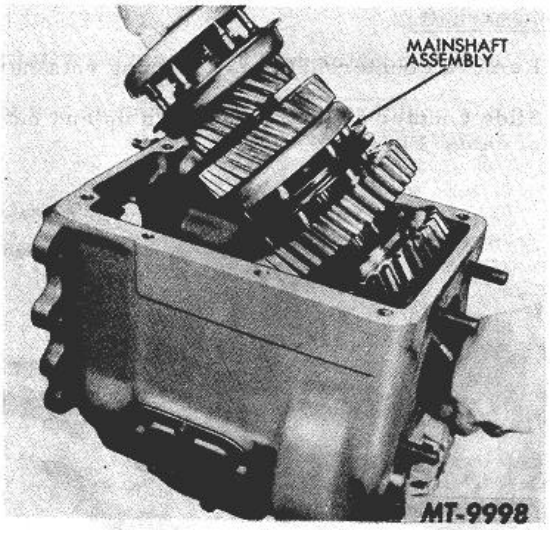


Fig. 3

3. Remove mainshaft assembly from transmission case.

Reverse Idler Gear

1. Remove reverse idler lock screw and lock plate.

2. Using a hammer and brass drift drive out reverse idler shaft through rear of case. NOTE: Do not drive idler shaft forward, as the shaft is shouldered and a broken case will result. See Fig. 4.

3. Lift out reverse idler gear.

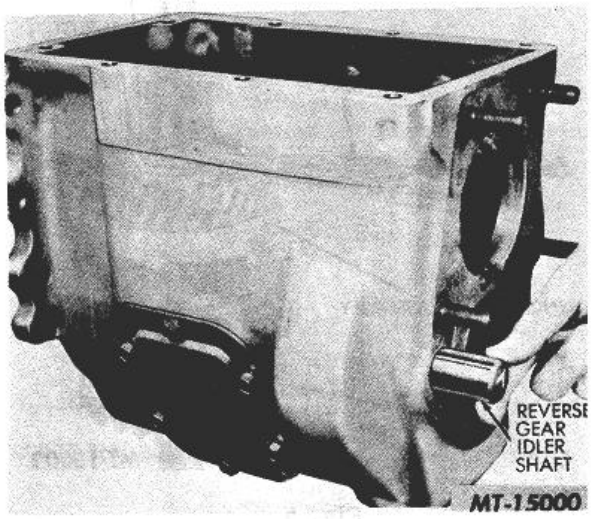


Fig. 4

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Countershaft

1. Remove countershaft rear bearing retainer.

2. Slide countershaft to rear, then up and out of case, Fig. 5.

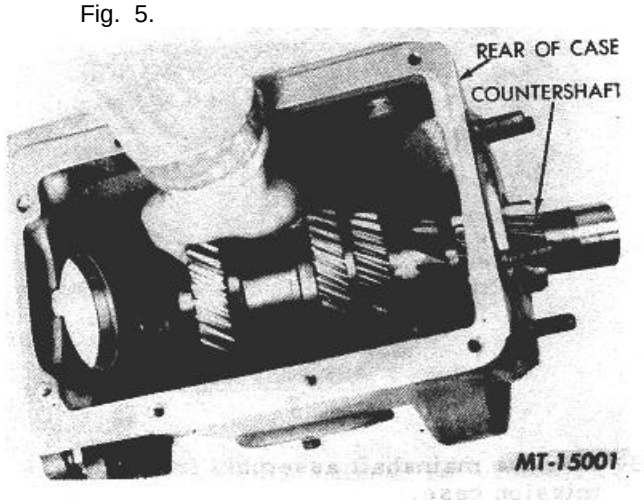


Fig. 5

3. Drive countershaft front bearing assembly forward out of transmission case.

DISASSEMBLY OF SUB-ASSEMBLIES

Mainshaft

1. Place mainshaft vertically in soft-jawed vise with front end up.

2. Lift third-fourth synchronizer and high speed clutch gear off of mainshaft.

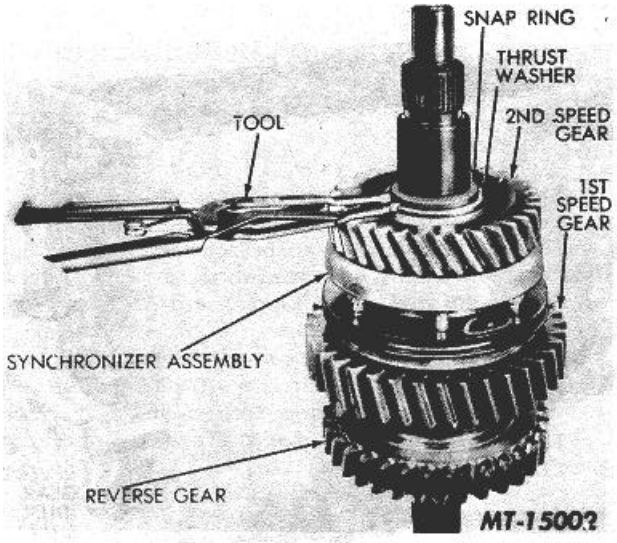


Fig. 6

3. Remove third-speed gear.

4. Remove second-speed gear snap ring with snap ring pliers. Lift off thrust washer. The thrust washer must be positioned with the ground surface toward the second-speed gear when the mainshaft is reassembled, Fig. 6.

5. Remove second-speed gear.
6. Lift off low-speed and second-speed synchronizer.
7. Reverse mainshaft in vise.
8. Install appropriate gear puller and remove tapered bearing from rear of mainshaft.
9. Lift off reverse sliding gear.
10. Remove first-speed gear snap ring and thrust washer.
11. Lift off first-speed gear.

Cover and Shift Fork Assembly

The shift cover should be disassembled only if it is necessary to replace a shift fork, a shaft or the cover itself.

1. Remove the roll pin from the first-second-speed shift fork. Use a square type or spiral-wound "easy-out" mounted in a tap handle. Remove roll pin from shift gate in the same manner.

2. Push first-second-speed shift rail out of the rear of the cover, driving out the expansion plug. Remove rail fork and gate. Be sure to cover detent hole to prevent loss of detent ball and spring.

3. Remove third-fourth-speed shift rail in same manner as steps 1 and 2 above. Then remove reverse shift rail.

4. Compress reverse gear plunger and remove retaining clip. Remove plunger and spring from gate.

INSPECTION AND REPAIR

All transmission parts should be carefully checked and inspected prior to reassembly. All gaskets must be replaced. All worn or damaged parts must be replaced. Maximum service life can only be expected from a reconditioned transmission if inspection procedures are thorough.

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Bearings: Wash all bearings in clean solvent. Check all rollers and races for wear, pitting and spalled areas. Replace bearings that are worn, pitted or spalled.

Gears: Check operating gear teeth for wear or pitting on tooth faces. All gears with worn or pitted teeth must be replaced.

Check all engaging gear teeth. Gears with teeth which have been shortened or tapered from clashing during gear shifts should be replaced. Check axial gear clearance. If excessive clearance is found, check snap rings, washers, spacers and gear hubs for excessive wear. Proper axial clearance must be maintained on all mainshaft gears.

Splines: Check splines on mainshaft for excessive wear. If sliding gears, clutch hubs or flanges have worn into the sides of the splines, the shafts should be replaced.

Reverse Idler Gear and Shaft: Check shaft, gear and rollers for wear.

Grey Iron Parts: Check all grey iron parts for cracks and fractures. Replace or repair all damaged parts. Castings may be welded or brazed as long as cracks do not extend into bearing bores or bolting surfaces.

Shift Bar Housings (Cover): Check forks and gates for wear at pads and lever slot. Replace worn parts. Check all forks for alignment. Check roll pin fit in forks and gates. Replace all worn roll pins. Check neutral notches of shift shafts for wear from interlock balls. Shafts which are indented at points adjacent to neutral notches should be replaced.

Synchronizers: Check synchronizers for burrs and for uneven or excessive wear at contact surfaces.

Check blocker pins for excessive wear or looseness. Check synchronizer contact surfaces on all affected gears for excessive wear.

After all parts have been thoroughly cleaned and carefully inspected, secure replacement for all defective components. Clean the transmission housing thoroughly and wipe out all bores and bearing surfaces.

REASSEMBLY

Prior to beginning reassembly, lubricate all parts with clean transmission lubricant. During reassembly replace all expansion plugs, gaskets, and seals.

REASSEMBLY OF SUB-ASSEMBLIES

Mainshaft

1. Place mainshaft in vertical position in a soft-jawed vise, rear end up. Lubricate with transmission oil.

2. Slide first-speed gear over mainshaft, clutch gear down. Install thrust washer and snap ring,

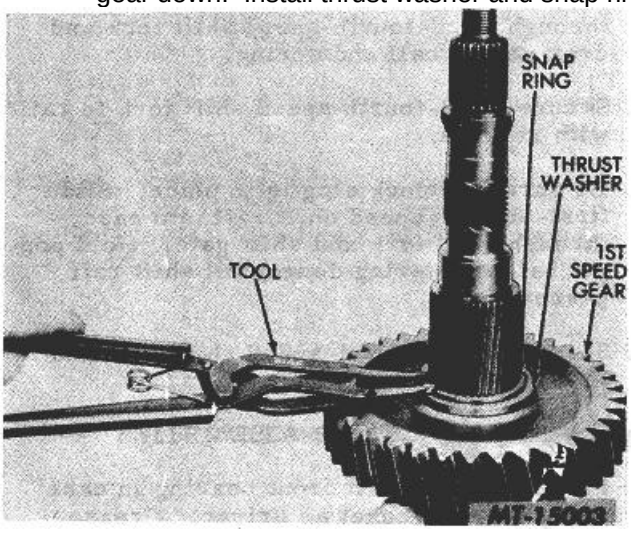


Fig. 7.

3. Slide reverse gear over end of mainshaft, fork groove down.

4. Install mainshaft rear bearing on mainshaft with sleeve of suitable diameter while pressing on bearing inner race.
5. Reverse mainshaft in vise.

6. Install low and second-speed synchronizer.

7. Slide second-speed gear over mainshaft.

8. Install keyed thrust washer over mainshaft, ground side toward second gear. Secure with snap ring.

9. Install third-speed gear and one shim on mainshaft.

10. Install third-fourth synchronizer over mainshaft. Be sure slotted end of clutch gear is positioned toward third-speed gear.

Transmission Cover

1. Grease interlock slugs and slide into openings in shift rail supports.

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2. Insert reverse shift rail from rear of cover and slide into supports.
3. Slide reverse shift rail through reverse shift plate and shift fork.
4. Secure reverse shift plate and shift fork with roll pin. Install interlock pin in third-fourth rail. Secure with grease.
5. Slide third-fourth-speed shift rail into rail supports from rear of cover. Slide rail' through third-fourth-speed shift fork and over poppet ball and spring.
6. Secure third-fourth-speed shift fork to rail with roll pin.
7. Be sure interlock slug is in place. Slide first-second-speed shift rail into case, through shift fork and shift gate. Hold poppet ball and spring down until shift rail passes.
8. Secure first second speed shift fork and shift gate with roll pins.

INSTALLATION OF SUB-ASSEMBLIES

1. Install countershaft front bearing in case using 1-3/8" socket as driver. Grease needle bearing prior to installation. Hold bearings in place in bearing retainer with socket of appropriate diameter while seating retainer. Drive retainer in until flush with front of case.
2. Install tanged thrust washer on countershaft with tangs facing out. Install countershaft in case.
3. Install countershaft rear bearing retainer over countershaft rear bearing. Use new washer and position retainer with curved segment toward bottom of case.
4. Install reverse idler gear with gear chamfer to rear of case. Hold thrust washers and needle bearing in position. 5. Slide reverse idler shaft into case and through idler gear. Be sure shaft lock notch is down and at rear of shaft.
6. Install shaft lock and bolt.
7. Place the mainshaft vertical in a soft-jawed vise, front end up.
8. Mount the drive gear on top of the mainshaft.
9. Measure the clearance between the high speed synchronizer and the drive gear with two feeler gauges. CTS-2584P If the clearance is greater than 1.1 mm to 1.35 mm (0.43 in. to 0.053 in.), install synchronizer shims between the third-speed gear and the synchronizer brake drum of the thickness needed to bring clearance to specifications. After required shim thickness has been determined, remove the drive gear from the mainshaft.
10. Insert assembled mainshaft into case. Place thrust washer over pilot end of mainshaft.
11. Position the drive gear so that the cutaway portion of the gear is facing down. Slide into the front of the case so that the mainshaft pilot enters the pocket in the drive gear.
12. Slip the drive gear front bearing retainer over the shaft with no gasket or capscrews.
13. Install mainshaft rear bearing retainer. Tighten bearing retainer bolts as specified.
14. Hold retainer against front of transmission case and measure clearance with feeler gauge. Remove front bearing retainer.
15. Install a gasket pack on front bearing retainer which is .25 mm to .38 mm (0.010 in. to 0.015 in.) thicker than clearance measured in step 14 above. Install front bearing retainer and torque bolts as specified. This will insure the required .18 mm to .43 mm (0.007 in. to 0.017 in.) drive gear end play.
16. The end play float on the front synchronizer must be checked before installation of the transmission cover assembly. Measure end play float by inserting two feeler gauges diametrically opposite each other between the third-speed gear and the synchronizer stop ring. Accurate measurement can be made only after all mainshaft components are in place and tightened to specifications, Fig. 8.

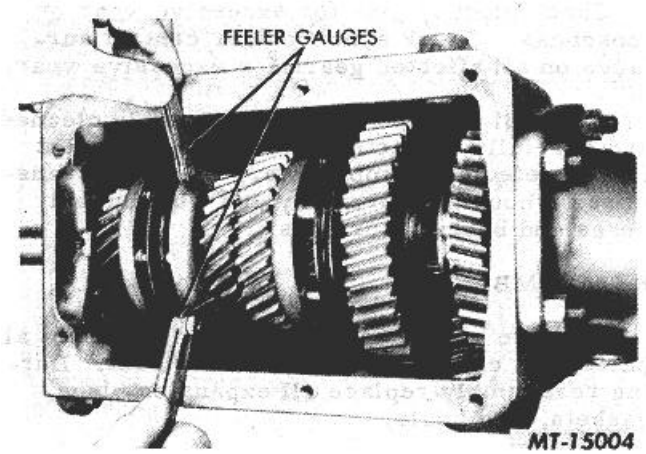


Fig. 8.

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17. If front synchronizer end play float does not fall between 1.3 mm to 1.8 mm (0.050 in. and 0.070 in.) shims should be added or removed as required between the third-speed gear and the synchronizer stop ring.

18. Install yoke and retaining nut on rear of mainshaft. Shift transmission into two gears at once and torque yoke nut to 170 N-m (125 ft. lbs.).

19. Shift transmission into neutral.

20. Install cover gasket.

21. Shift transmission into second gear. Shift cover into second gear also.

22. Carefully lower cover into position. It may be necessary to position reverse gear to permit shift fork to engage groove.

23. Install cover aligning screws and tighten finger tight.

24. Install remaining cover screws. Tighten all cover screws to specifications after cover is seated evenly on gasket.

LUBRICATION

For lubrication intervals, refer to Operator's manual. For types of lubricants recommended, refer to LUBRICATION, Section CTS-2412.

SPECIFICATIONS

IH MODEL IH CODE	T-425 13425
TYPE	Synchro-Mesh
NUMBER OF SPEEDS:	
Forward	4
Reverse	1
MAIN DRIVE GEAR TO SYNCHRONIZER CLEARANCE mm	1.3 mm to 1.8 mm (.050 in. to .070 in.)
MAIN DRIVE GEAR END PLAY mm	.18 mm to .43 mm (.007 in. to .017 in.)
HELICAL GEARS	All
POWER TAKE-OFF OPENING	Both Sides
TORQUE CAPACITY N-m	441 (325 Ft. Lbs.)
WEIGHT KILOGRAMS	70 (155 Lbs.)
LUBRICANT CAPACITY LITERS	3.8 (8 Pints)

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TORQUE CHART

Description	N-m	Ft. Lbs.
Cover Screw	27-54	20-40
Drive Gear Retainer Screw	20-34	15-25
Front Countershaft Retainer Screw	20-34	15-25
Front Countershaft Bearing Washer Screw	16-30	12-22
Flange Nut	170	125
Mainshaft Rear Retainer Screw	20-34	15-25
Rear Countershaft Retainer Screw	20-34	15-25
PTO Cover Screw	11-16	8-12
Filler and Drain Plug	34-61	25-45
Reverse Idler Shaft Lock Screw	27-54	20-40

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TRANSMISSION

FIVE-SPEED SYNCHROMESH

IH Model	Code
T-495	13495
T-496	13496

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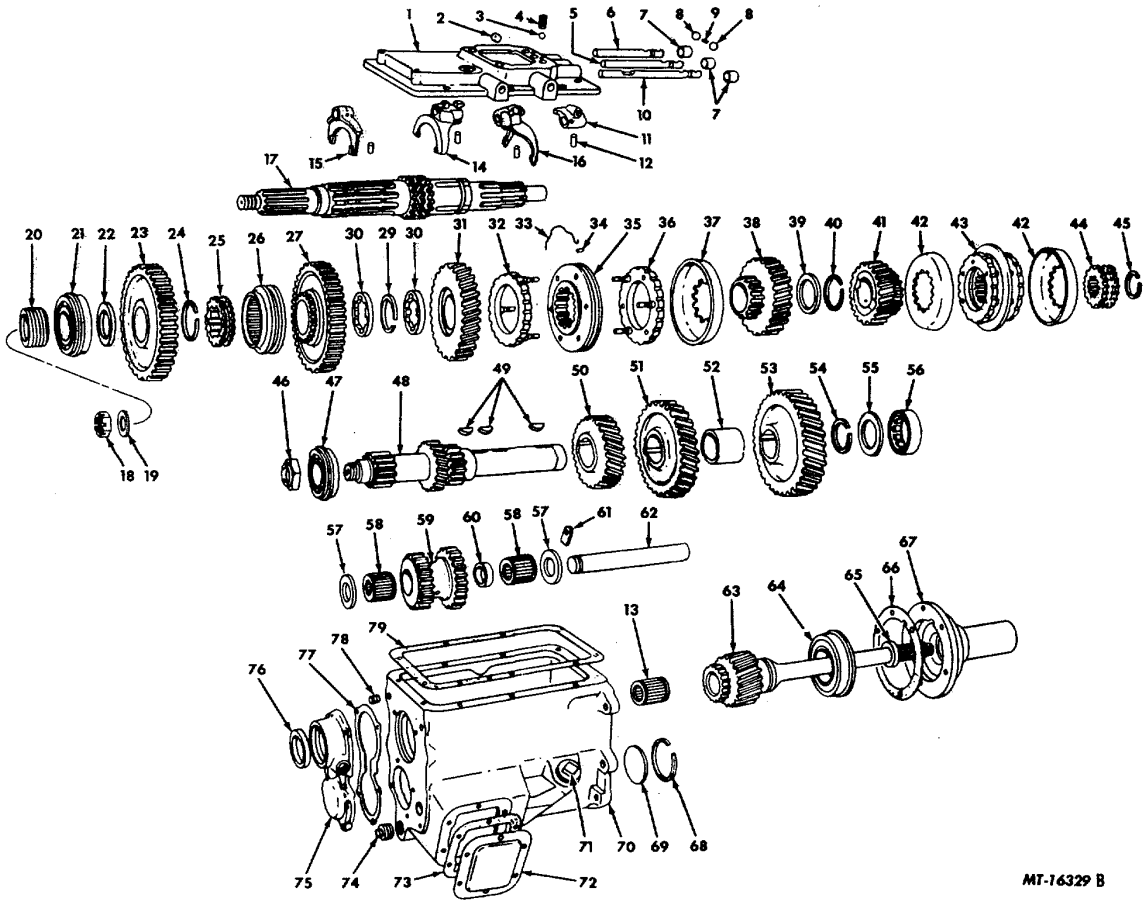


Fig. 1 Synchronized Transmission

Legend for Fig. 1

Key	Description
1	HOUSING, W/First and Reverse Speed Poppet
2	PLUG, Shift Bar Dust
3	BALL, Shift Bar Poppet
4	SPRING, Poppet Ball
5	BAR, Second and Third Speed Shift
6	BAR, Fourth and Drive Speed Shift
7	CUP, Shift Bar Dust
8	BALL, Shift Bar Interlock
9	PIN, Shift Bar Interlock Plunger
10	BAR, First and Reverse Speed Shift
11	BLOCK, W/Plunger and Spring, First and Reverse Shift
12	PIN, Shift Fork Set
13	BEARING, Mainshaft Pilot
14	FORK, Second and Third Speed Shift
15	FORK, First and Reverse Speed Shift
16	FORK, Fourth and Fifth Speed Shift
17	MAINSHAFT
18	NUT, Companion Flange
19	WASHER, Companion Flange Nut
20	GEAR, Speedometer Drive
21	BEARING, Mainshaft Rear
22	WASHER, Mainshaft Bearing
23	GEAR, Mainshaft First Speed
24	RING, Mainshaft First Speed Gear Snap, Select Fit 1.96 mm to 2.00 mm(.077 - .079") Thick 2.03 mm to 2.08 mm(.080 - .082") Thick 2.11 mm to 2.16 mm(.083 - .085") Thick 2.18 mm to 2.24 mm(.086 - .088") Thick 2.26 mm to 2.31 mm(.089 - .091") Thick
25	HUB, Clutch
26	CLUTCH, Sliding
27	GEAR, Mainshaft Reverse
28	SEE ITEM 30

Key	Description
29	RING, Mainshaft Reverse Speed Gear Snap
30	WASHER, Mainshaft Reverse and Second Speed Gear Thrust, Select Fit
	3.89 mm to 3.94 mm (.153 - .155") Thick
	3.96 mm to 4.01 mm (.156 - .158") Thick
	4.04 mm to 4.09 mm (.159 - .161") Thick
	4.12 mm to 4.17 mm (.162 - .164") Thick
31	GEAR, Mainshaft Second Speed, W/Washer
32	RING, W/Pins, Synchronizer Unit Inner Rear
33	SPRING, Sliding Clutch
34	PIN, Spring
35	CLUTCH, W/Pins and Springs, Sliding
36	RING, W/Pins, Synchronizer Unit Inner Forward
37	RING, Synchronizer Unit Outer Stop
38	GEAR, Mainshaft Third Speed
39	WASHER, Thrust, Select Fit
	3.02 mm to 3.09 mm (.119 - .122") Thick
	3.12 mm to 3.18 mm (.123 - .125") Thick
	3.23 mm to 3.30 mm (.127 - .130") Thick
	3.33 mm to 3.41 mm (.131 - .134") Thick
40	RING, External Snap
41	GEAR, Mainshaft Fourth Speed
42	RING, Outer Stop
43	SYNCHRONIZER, Front, Assembly
44	GEAR, Mainshaft Clutch
45	RING, Mainshaft Snap, Select Fit
	2.18 mm to 2.24 mm (.086 - .088") Thick
	2.26 mm to 2.31 mm (.089 - .091") Thick
	2.34 mm to 2.39 mm (.092 - .094") Thick
	2.41 mm to 2.46 mm (.095 - .097") Thick
46	NUT, Countershaft Rear Bearing
47	BEARING, Countershaft Rear
48	COUNTERSHAFT
49	KEY, Woodruff
50	GEAR, Countershaft Third Speed
51	GEAR, Countershaft Overdrive
52	SPACER, Countershaft Gear
53	GEAR, Countershaft Drive
54	RING, Countershaft Gear Snap
55	WASHER, Countershaft Front Bearing
56	BEARING, Countershaft Front
57	WASHER, Thrust
58	BEARING, Reverse Idler Gear
59	GEAR, Reverse Idler
60	NOT USED
61	LOCK, Reverse Idler Gear Shaft
62	SHAFT, Reverse Idler Gear
63	GEAR, Main Drive
64	BEARING, Main Drive Gear
65	SEAL, Bearing Retainer Oil
66	GASKET, Bearing Retainer
67	RETAINER, W/Seal, Main Drive Gear Bearing
68	RING, Expansion Plug Snap
69	PLUG, Countershaft Front Bearing Expansion
70	CASF, Transmission
71	PLUG, Pipe, Sq. Hd. 1-1/4, Filler
72	COVER, PTO Opening
73	GASKET, PTO Opening
74	PLUG, Pipe Countersunk 3/4, Drain
75	RETAINER, W/Seal and Bushing, Mainshaft Rear Bearing
76	SEAL, Mainshaft Oil
77	GASKET, Mainshaft Rear Bearing Retainer
78	PLUG
79	GASKET, Shift Bar Housing Mounting

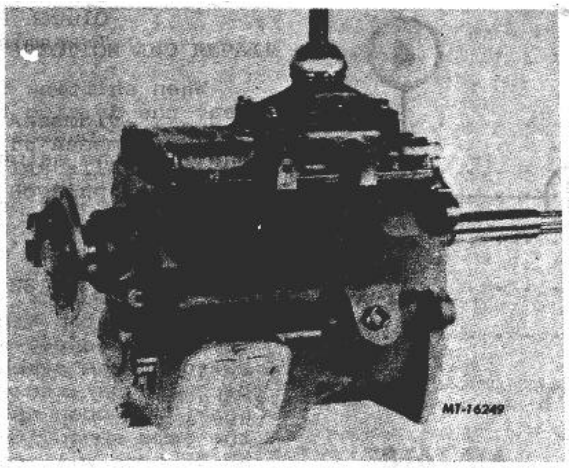


Fig. 2 Transmission Assembly

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DESCRIPTION

The T-495 and T-496 transmissions have five speeds forward and one reverse. The fifth speed is direct. Fig. 3 illustrates the shift diagram.

The T-495 and T-496 are synchromesh transmissions.

OPERATION

The T-495 and T-496 transmissions incorporate synchronizers on the mainshaft to provide a smooth, silent shift. The first and reverse gears are in constant mesh (Key 23 and 27, Fig. 1).

With the transmission control lever in neutral position, the sliding clutch of the front (4th and 5th speed) and rear (2nd and 3rd speed) synchronizers and first and reverse gear sliding clutch is as shown in Fig. 4.

This allows the main drive gear to turn independently of the mainshaft. When shifting into first gear the driving torque from the main drive gear passes through the countershaft to the first gear which is engaged by the sliding clutch (Fig. 5).

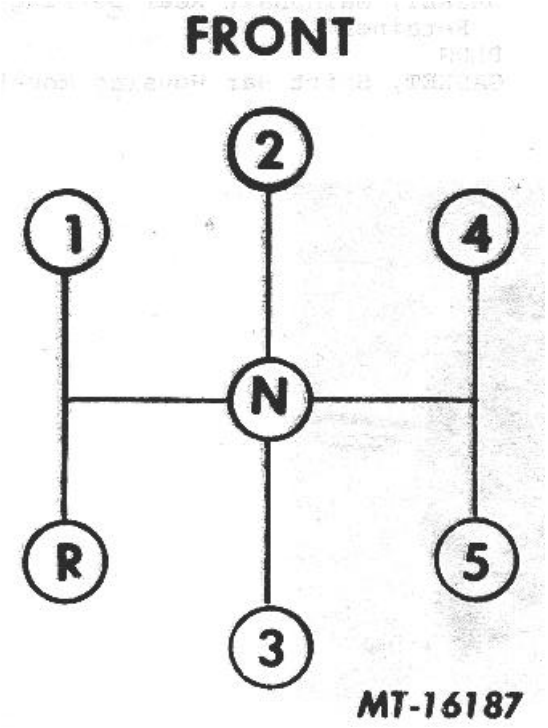


Fig. 3 T-495 and T-496 Shift Diagram

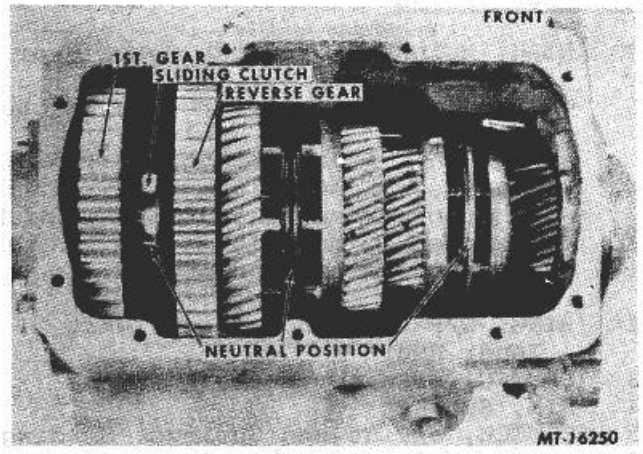


Fig. 4 Synchronizers and Sliding Clutch Positions with Transmission in Neutral

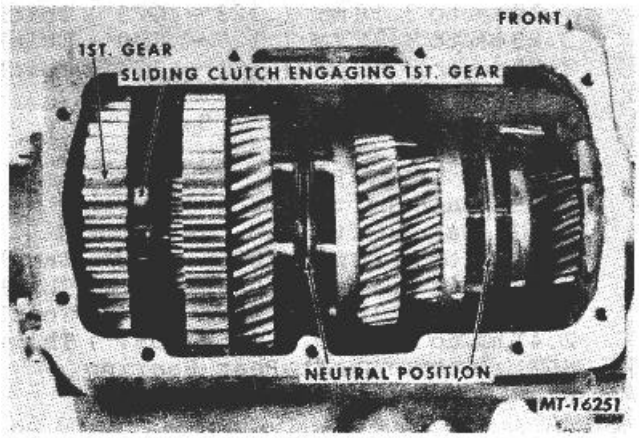


Fig. 5 Synchronizers and Sliding Clutch Positions with Transmission in First

When shifting from first to second gear the driving torque from the main drive gear passes through the countershaft to the mainshaft second speed gear. However, slightly prior to the actual gear change the pressure of the shift fork on the synchronizer sliding clutch moves the clutch against the shoulders of the three pins extending from the inner stop ring. This pressure causes the inner stop ring to press against the second speed gear. The turning speed of the synchronizer assembly will become equalized with the second speed gear. As soon as both units are turning the same speed, the pressure of the shift fork will continue to completely engage the sliding clutch with the second speed gear (Fig. 6). The first

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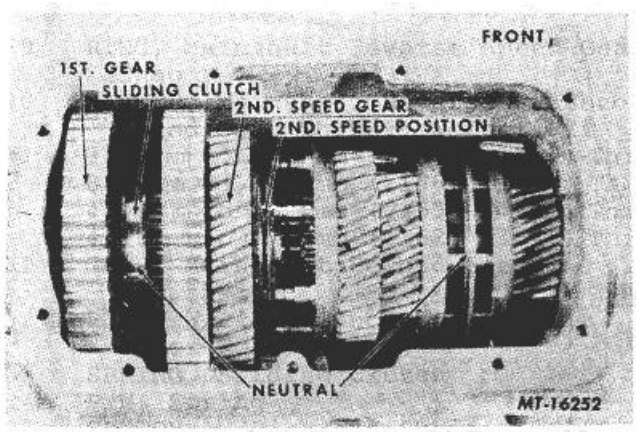


Fig. 6 Synchronizers and Sliding Clutch Positions with Transmission in Second

gear has been relieved by the sliding clutch moving to the neutral position. The driving torque is thereby delivered through the synchronizer sliding clutch and on out the mainshaft (Fig. 6).

The action involved in delivering the torque from the main drive gear to the mainshaft third speed gear is much like the action described previously for the second speed gear except that the sliding clutch is moved forward (Fig. 7) against the three pins extending from the inner stop ring. The inner stop ring is moved against the outer stop ring which is constantly meshed with the third speed gear. As soon as the sliding clutch and the third speed gear are turning the same speed, the shift fork pressure completely engages the sliding clutch with the third speed gear.

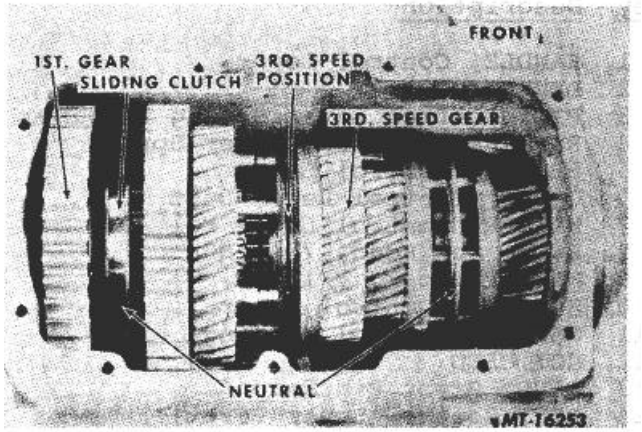


Fig. 7 Synchronizers and Sliding Clutch Positions with Transmission in Third

Torque delivery in the fourth speed forward is similar to the second and third speed except that the rear synchronizer is in a neutral position while the sliding clutch of the front (4th and 5th speed) synchronizer is moved toward the rear of the mainshaft (Fig. 8). The inner stop ring is moved against the outer stop ring, which is constantly meshed with the fourth speed gear. The pressure of the inner stop ring against the outer stop ring corrects the speed of the fourth speed gear with the speed of the sliding clutch. The sliding clutch which is constantly meshed with the mainshaft through the clutch gear is then engaged with the fourth speed gear by the shift fork. The torque is then delivered through the synchronizer and on out the mainshaft.

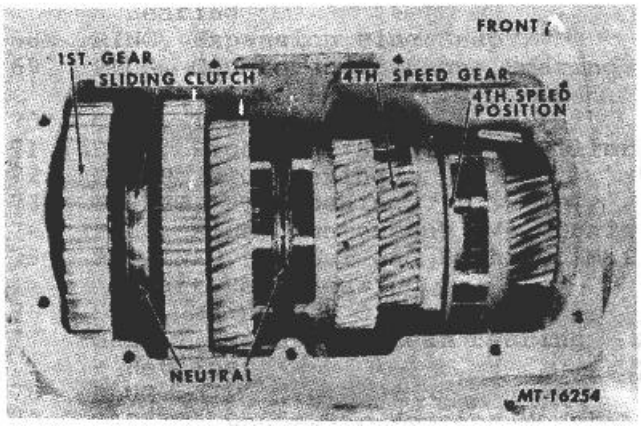


Fig. 8 Synchronizers and Sliding Clutch Positions with Transmission in Fourth

When the control lever is moved from fourth to fifth gear, the shift fork moves the sliding clutch forward and against the three pins of the inner stop ring. The inner stop ring then presses against the outer stop ring and begins to equalize the speed of the main drive gear with that of the sliding clutch. As soon as the speed is equalized, the shift fork completes engagement of the sliding clutch with the main drive gear (Fig. 9). Since the sliding clutch is constantly meshed with the clutch gear which is splined to the mainshaft, the torque is carried by the synchronizer to the mainshaft. The countershaft has no function in delivering torque when the transmission is in gear. It is carried through the transmission by the mainshaft itself; hence the fifth speed forward is direct.

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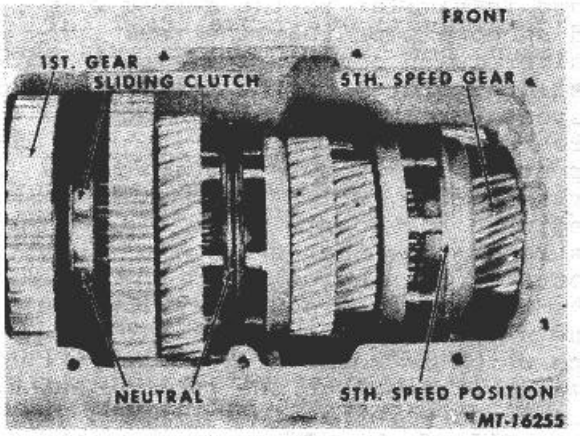


Fig. 9 Synchronizers and Sliding Clutch Positions with Transmission in Direct Drive

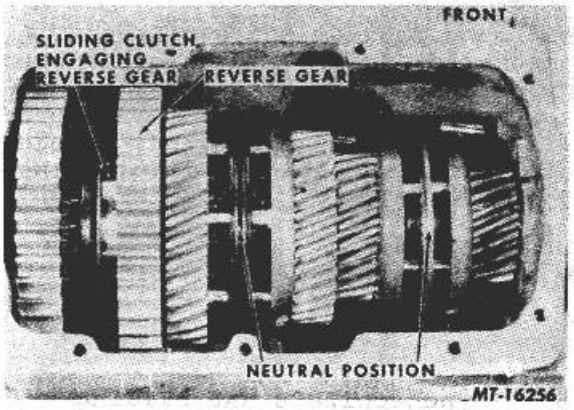


Fig. 10 Synchronizers and Sliding Clutch Positions with Transmission in Reverse

To obtain reverse gear the sliding clutch engages the reverse gear. All forward speed gears are in idle or neutral position at this time (Fig. 10).

DISASSEMBLY

Control Lever and Shift Bar Housing

Place control lever in reverse position. Remove bolts, machined shoulder bolts (2) and lockwashers from shift bar housing and lift housing and gasket from top of transmission case (Fig. 11).

Take out the four bolts securing control housing to shift bar housing and lift off control lever housing (Fig. 12).

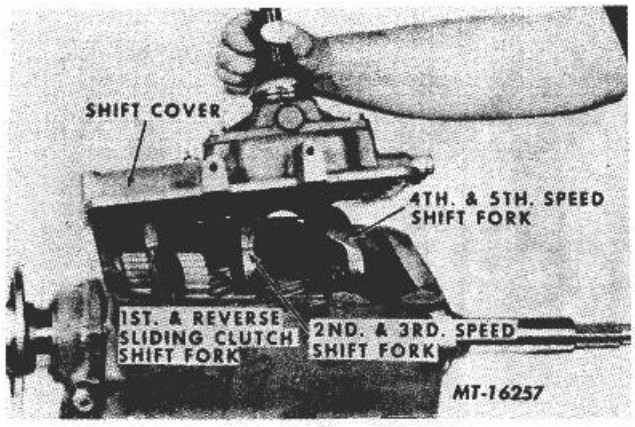


Fig. 11 Shift Bar Housing

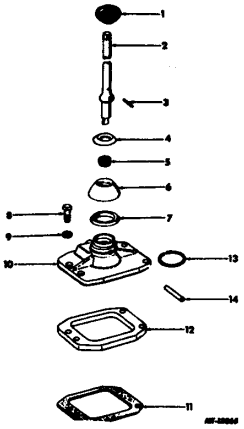


Fig. 12 Control Lever Housing Assembly

Legend for Fig. 12

Key	Description
1	HANDLE, Control Lever
2	LEVFR, Control
3	PIN, Control Lever Spring Retainer
4	RETAINER, Control Lever Spring
5	SPRING, Control Lever
6	COVER, Control Lever Dust
7	WASHER, Control Lever Felt
8	BOLT, Hex Head, 7/16 NC
9	WFASHER, Lock, 7/16
10	HOUSING, Control Lever
11	GASKET, Control Housing
12	NOT USED
13	RING, Pivot Pin Snap
14	PIN, Control Lever Pivot

When disassembling control lever housing, place control lever housing in vise and remove control lever handle

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(Key 1, Fig. 12). Take out control lever spring retainer pin (3). Remove control lever spring retainer (4), spring (5), dust cover and felt washer. Remove pivot pin snap ring (13). Take out pivot pin (14) and control lever (2) from housing (10).

Key Numbers used from this point on refer to Fig. 1. To highlight the instructions, individual close-up illustrations are also provided.

Remove poppet springs (4) and poppet balls (3) from shift bar housing (1). See Fig. 13. Remove lock pins (12) from first and reverse speed shift block (11)

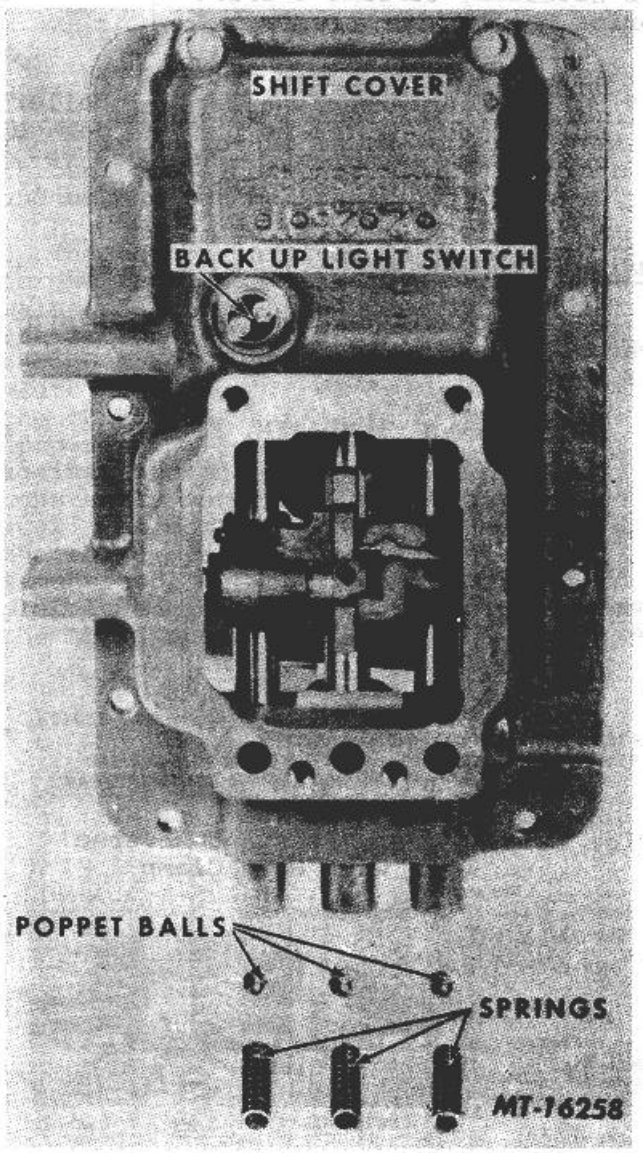


Fig. 13 Poppet Springs and Balls

and shift forks (14, 15 and 16). Drive fourth and fifth speed shift rail out toward the front of the shift bar housing driving our shift rail thimble (7), and remove shift fork (16).

Remove interlock ball and cross pin retainer plug (2) located on the left outside of the housing just below the poppet ball and spring housing, releasing interlock ball (8) and pin (9). Remove first and reverse speed and second and third speed shift forks (14 and 15) and shift rails (5 and 10).

NOTE: In reassembling controls, be certain to replace all parts in their respective positions.

Main Drive Gear and Mainshaft Removal

Lock the transmission by placing it in two gears and remove flange nut, washer and flange. Remove parking brake drum and band.

Remove six bolts and lockwashers from mainshaft rear bearing retainer (75). Lift retainer and gasket (73) from case (70). Slide speedometer drive gear (20) from mainshaft (17). (See Fig. 14)

NOTE: Remove countershaft rear bearing nut (50) while transmission is locked.

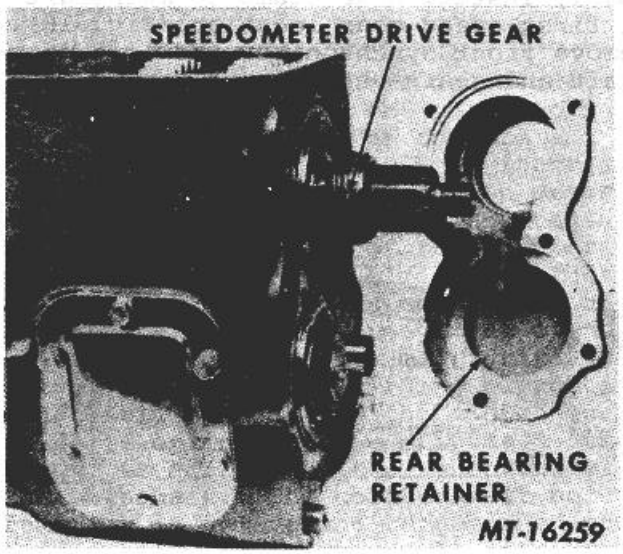


Fig. 14 Mainshaft Rear Bearing Retainer

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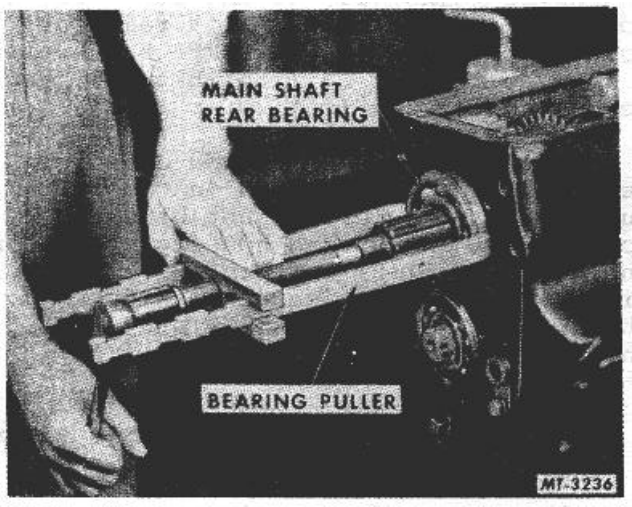


Fig. 15 Mainshaft Rear Bearing

Drive mainshaft assembly toward rear of case sufficiently to expose mainshaft rear bearing (21) and snap ring. Install a suitable bearing puller and pull bearing from mainshaft (17) as shown in Fig. 15.

Remove six bolts from main drive gear bearing retainer (67) and remove retainer and gasket (66) as shown in Fig. 16.

Remove main drive gear (63) and bearing (64), main drive gear bearing specer (60) and mainshaft pilot bearing (13) out through front of case, Fig. 17.

To facilitate mainshaft and gear removal, install hose clamp to mainshaft at first speed gear location (Fig. 18). Remove front synchronizer and lift mainshaft and gears out through top of case

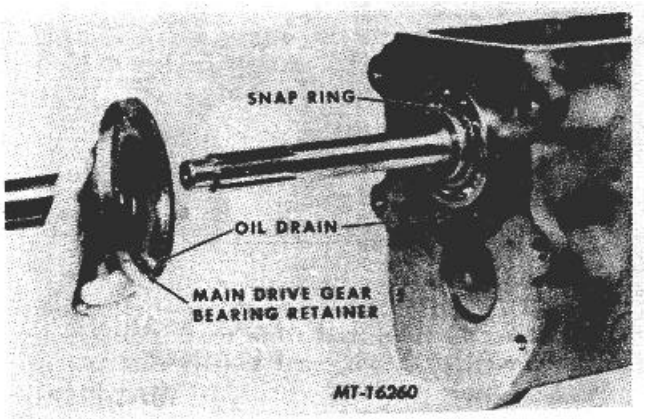


Fig. 16 Main Drive Gear Front Bearing Retainer

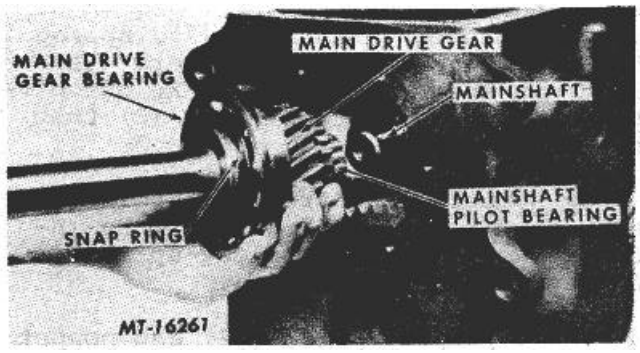


Fig. 17 Main Drive Gear

tilting the front end upward. It will be necessary to remove front synchronizer prior to mainshaft removal.*

* NOTE: Countershaft slinger impeller must be horizontal to prevent damage to slinger impeller blades when removing mainshaft or installing.

Mainshaft Disassembly

Slide front (4th and 5th speed) synchronizer assembly off mainshaft, Fig. 18.

Remove snap ring (-45), Fig. 19.

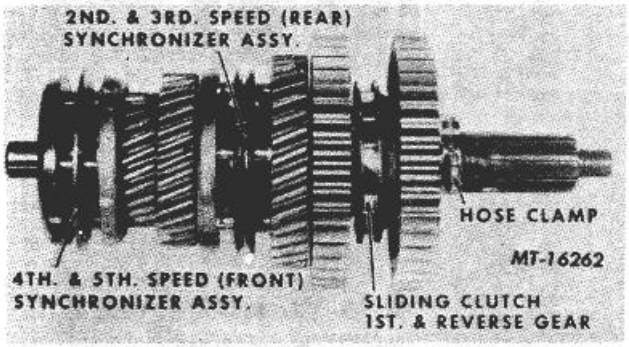


Fig. 18 Retain First and Reverse Gear with Hose Clamp

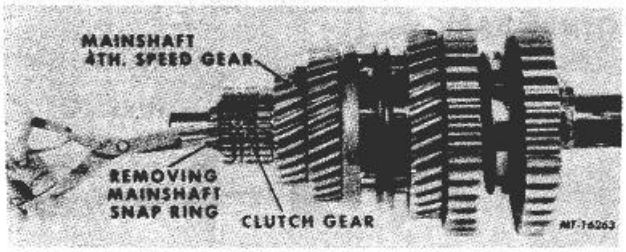


Fig. 19 Mainshaft Snap Ring

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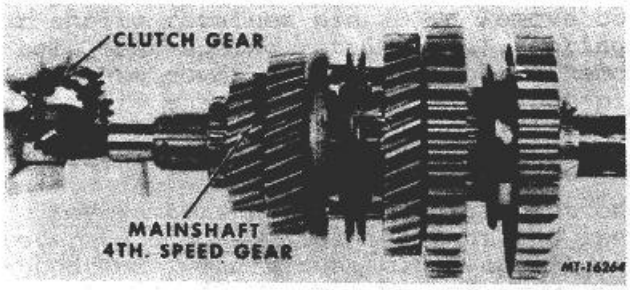


Fig. 20 Clutch Gear

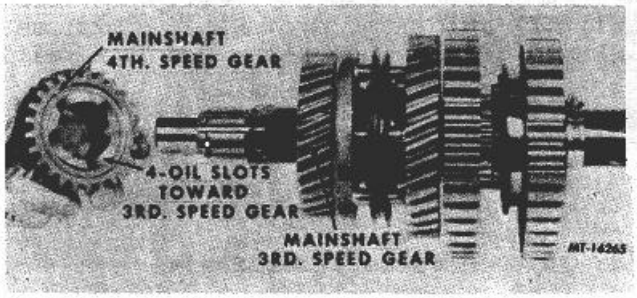


Fig. 21 Mainshaft Fourth Speed Gear

Remove mainshaft clutch gear (44), Fig. 20.

Slide fourth speed gear off mainshaft Fig. 21. When reassembling fourth speed gear, make sure oil slots are positioned as shown.

Remove mainshaft third speed gear snap ring (40) and thrust washer (39), as shown in Fig. 22.

Slide mainshaft third speed gear (38) off mainshaft, Fig. 23.

Remove rear (2nd and 3rd speed) synchronizer assembly, Fig. 24

Remove radiator clamp used to facilitate removal of

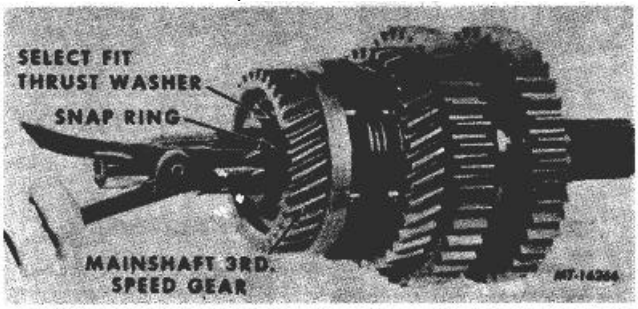


Fig. 22 Mainshaft Third Speed Gear Snap Ring and Thrust Washer

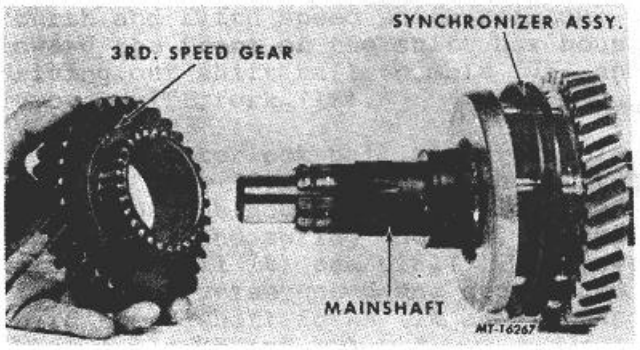


Fig. 23 Mainshaft Third Speed Gear

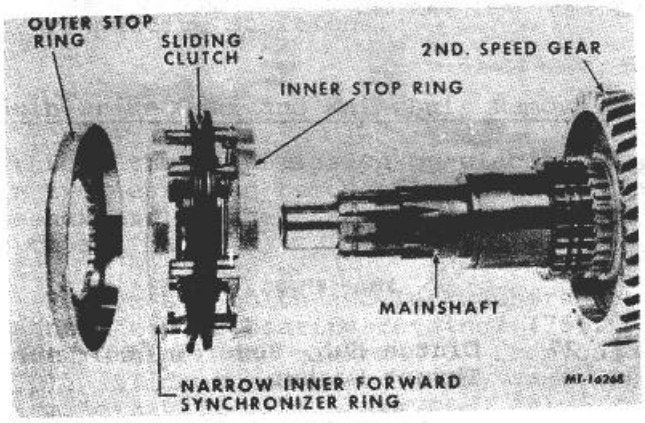


Fig. 24 Rear Synchronizer Assembly

mainshaft assembly.

Remove first speed gear thrust washer (22) and first speed gear (23).

First and reverse gear sliding clutch removal and select fit snap ring location is illustrated in Fig. 25.

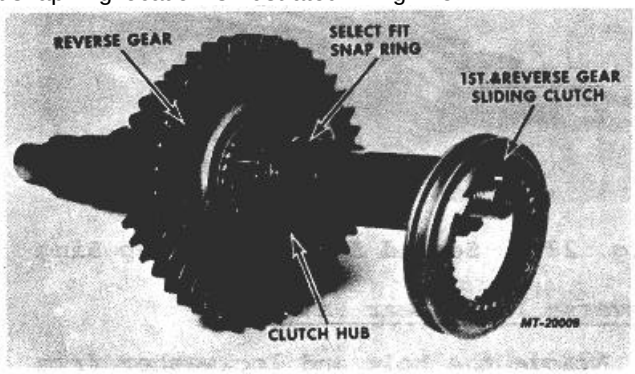


Fig. 25 First and Reverse Gear Sliding Clutch and Select Fit Snap Ring

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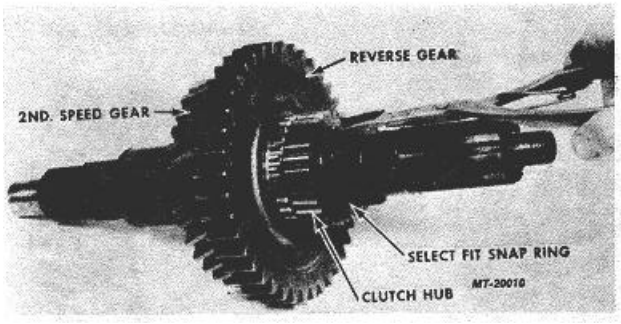


Fig. 26 Select Fit Snap Ring

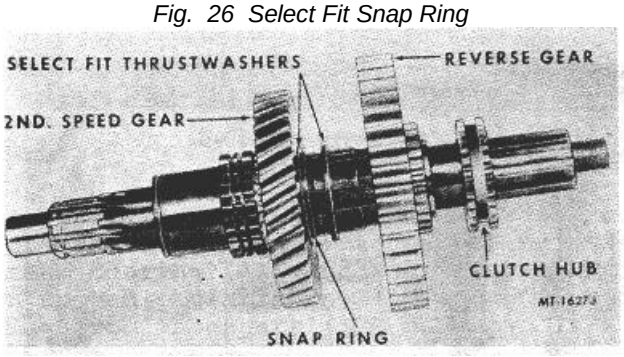


Fig. 27 Clutch Hub, Reverse Gear and Thrust Washer

To remove clutch hub, remove select fit snap ring as illustrated in Fig. 26.

With the select fit snap ring removed, the clutch hub, reverse gear and thrust washer can be removed, Fig. 27.

Second speed gear can be removed by removing snap ring, Fig. 28.

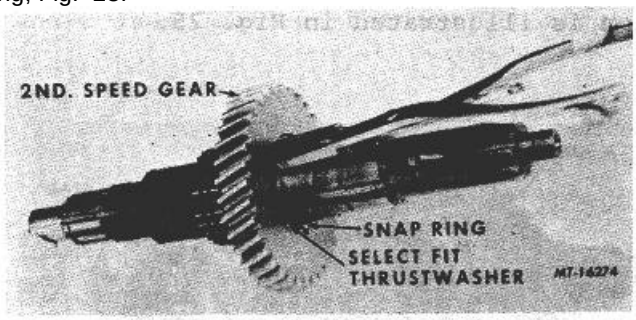


Fig. 28 Second Speed Gear Snap Ring

Reverse Idler Gear Removal

Remove the bolt and lockwasher from the reverse idler shaft lock plate (61) and remove lock plate from slot in reverse idler shaft (62), Fig. 29.

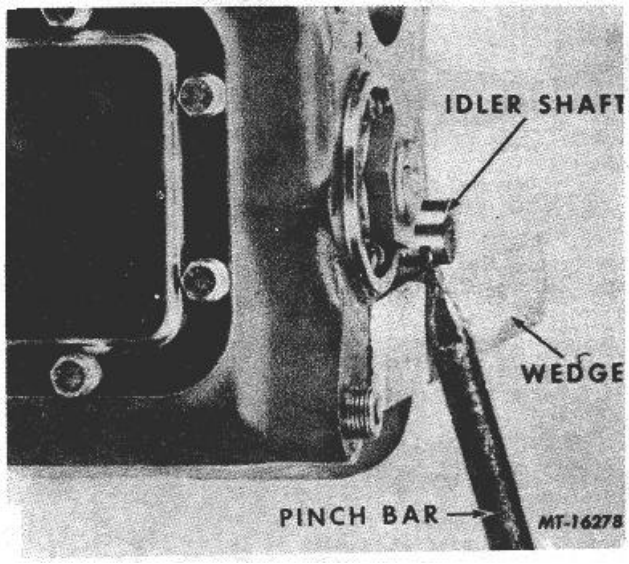


Fig. 29 Reverse Idler Shaft

Use pry bar and wedge to remove idler shaft or use a brass drift and drive shaft out from inside of case.

Lift out reverse idler gear (59), bearings (58), spacer (60) and thrust washers (57). See Fig. 29.

When reassembling reverse idler gears, make sure the 21 tooth gear is facing the rear of the transmission, Fig. 30.

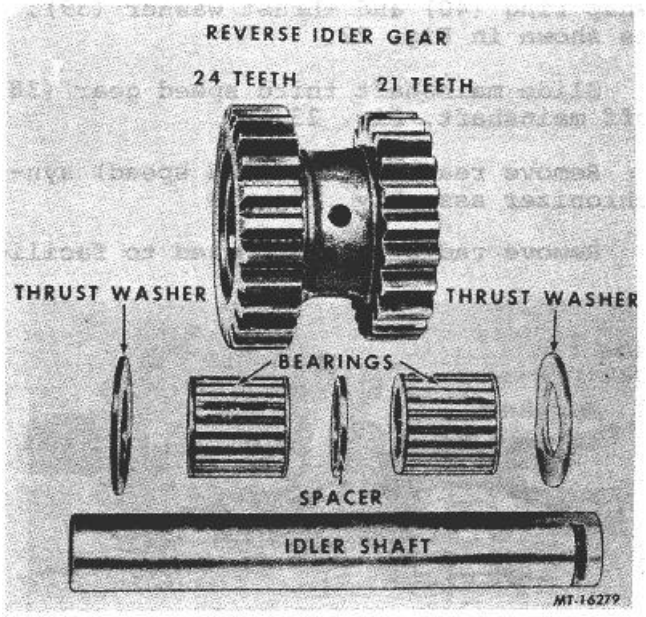


Fig. 30 Reverse Idler Gear, Bearings, Spacer and Thrust Washers

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Countershaft Gear Removal

Remove countershaft rear bearing nut (46). If nut was not removed while transmission was in locked position, use pinch bar to restrict countershaft movement when removing countershaft rear bearing nut, Fig. 31.

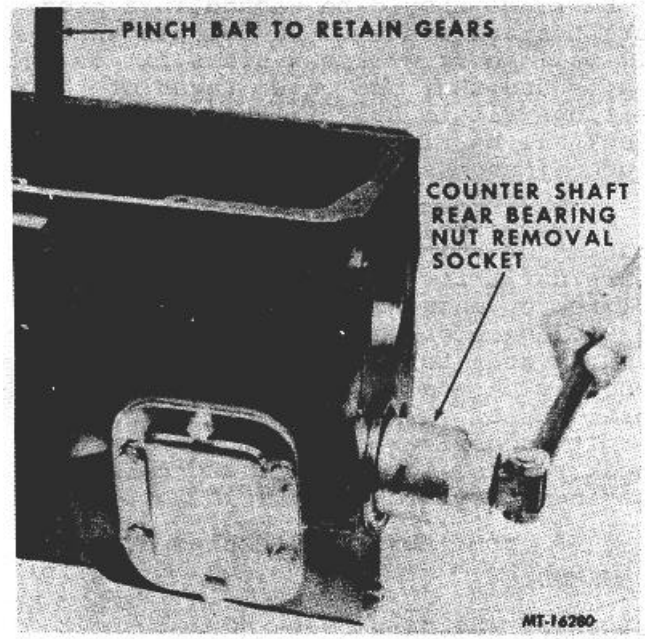


Fig. 31 Removing Countershaft Rear Bearing Nut

Drive countershaft assembly toward rear of case (70) sufficiently to expose rear bearing snap ring. Attach a suitable puller and remove rear bearing (47) from countershaft (48), Fig. 32.

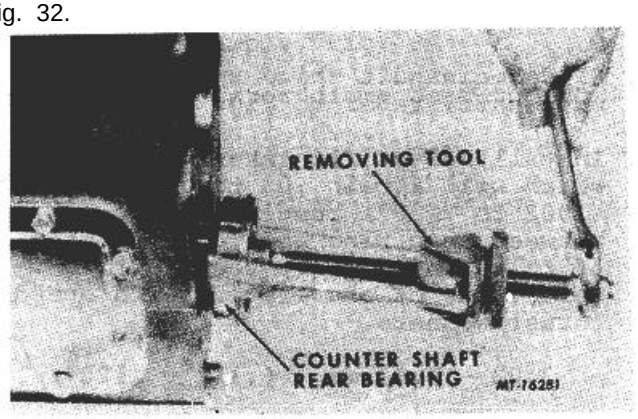


Fig. 32 Removing Countershaft Rear Bearing

Lift countershaft assembly out through top of case, lifting front end upward and tilting the assembly. Also remove front bearing thrust washer (55). See Fig. 33.

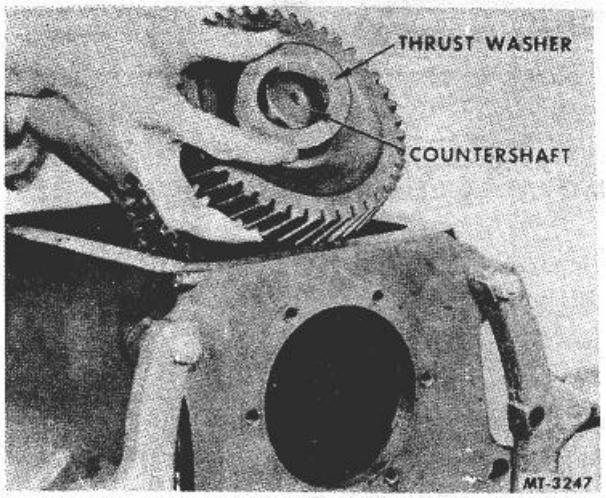


Fig. 33 Removing Countershaft and Thrust Washer

The countershaft front roller bearing (56) is disassembled by removing the countershaft expansion plug snap ring (68) and driving the expansion plug (69) from the case.

Drive countershaft front roller bearing (56) from case (70) with a brass drift.

Countershaft Disassembly

> NOTE: Nylon slinger assembly must be removed prior to countershaft disassembly. Slinger assembly may be removed by drilling through rivet head with a drill 0.8 mm (1/32") smaller than rivet body.

Remove snap ring (54) from countershaft (48). See Fig. 34

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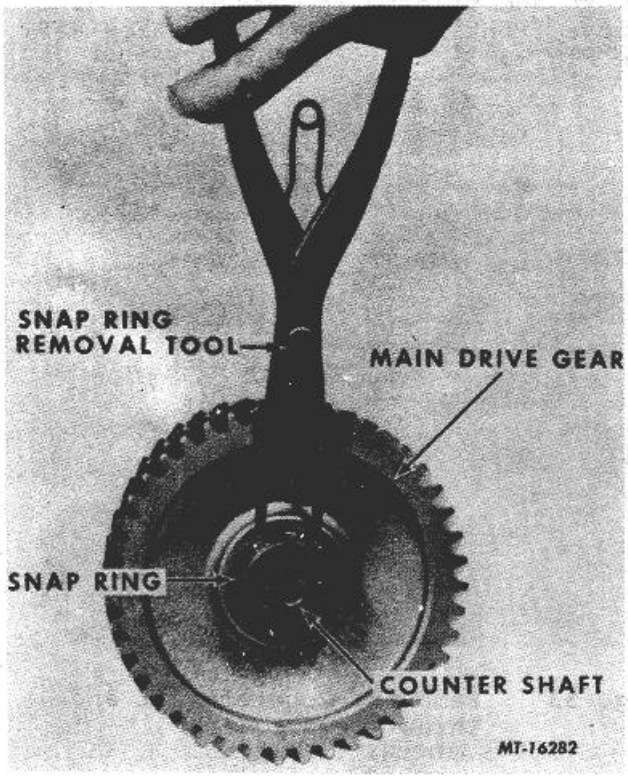


Fig. 34 Removing Countershaft Snap Ring

Using adapter plates press countershaft drive gear (53), spacer (52), fourth speed gear (51) and third speed gear (50) from countershaft (48). Remove woodruff keys (49) from countershaft, Fig. 35.

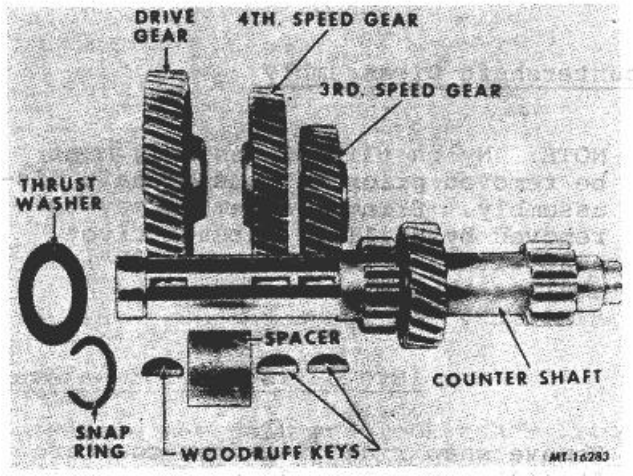


Fig. 35 Exploded View of Countershaft

CLEANING, INSPECTION AND REPAIR

After disassembly clean all parts thoroughly with a cleaning solvent. The transmission case should be washed before reassembly. Replace all oil seals and gaskets.

Bearings should be washed in a pressure bearing washer. Be certain that all ball bearings are a press fit on the shafts and that the outer races of these bearings fit tightly in their bores. Check all bearings for defects and replace if necessary.

Examine teeth on all gears carefully. Cracked or chipped teeth render the gears unfit for further use. Inspect splines on mainshaft and main drive gear for evidence of wear. Check first and reverse gear to see that it slides smoothly on the mainshaft. Inspect mainshaft thrust washers, and if worn to permit excessive end play, replace them. Check reverse idler shaft and roller bearings; replace if worn.

REASSEMBLY

Mainshaft Assembly

1. Prelube all high friction areas such as gear bushings and mainshaft bearing journals prior to assembly with moly lubricant (HEP 135 ± 3% MO 52). Keep parts clean after lubrication.

2. Install rear (2nd and 3rd speed) synchronizer assembly, refer to Fig. 24. Make sure wider stop ring (inner) is reassembled as illustrated to fit in second gear cavity.

3. Slide mainshaft third speed gear on mainshaft, refer to Fig. 23.

4. Install select fit thrust washer which will attain .05 to .15 mm (.002 to .006") running clearance between snap ring and thrust washer of third speed gear, see Fig. 36. Select one of the listed third speed thrust washers.

3.02 - 3.09 mm	(.119 - .122")
3.12 - 3.18 mm	(.123 - .126")
3.23 - 3.30 mm	(.127 - .130")
3.33 - 3.41 mm	(.131 - .134")

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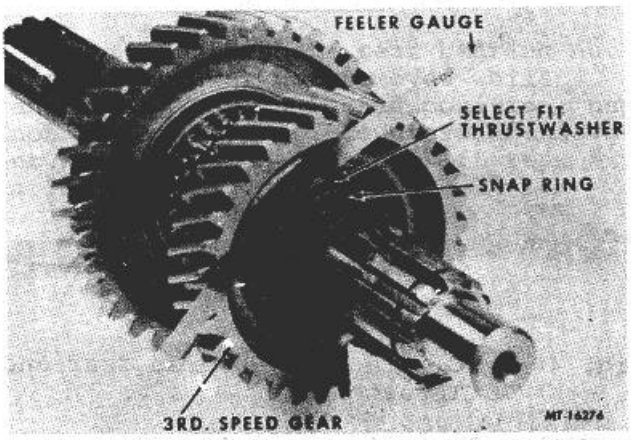


Fig. 36 Select Fit Thrust Washer

5. Install third speed gear snap ring (4), refer to Fig. 22.

6. Install fourth speed mainshaft gear with oil slots toward third speed gear, refer to Fig. 21.

7. Install mainshaft clutch gear (44), placing oil grooves next to fourth speed gear (41) as shown in Fig. 20.

8. Install mainshaft snap ring (45), refer to Fig. 19. Select a snap ring that will provide a tight fit. Make sure 4th speed gear rotates on shaft after selective fit snap ring is installed. Snap rings are available in the following sizes:

2.18 - 2.24 mm	(.086 - .088")
2.26 - 2.31 mm	(.089 - .091")
2.34 - 2.39 mm	(.092 - .094")
2.41 - 2.46 mm	(.095 - .097")

9. Install second speed gear (31) and second speed gear select fit thrust washer (30), Fig. 37.

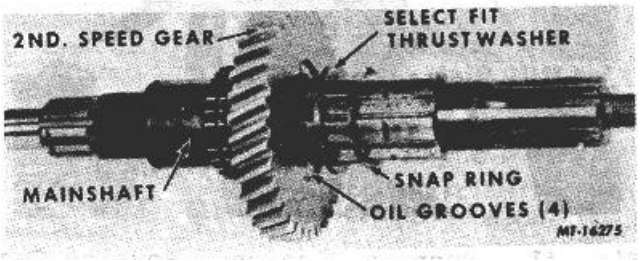


Fig. 37 Second Speed Gear Select Fit Thrust Washer and Snap Ring

10. Install snap ring (29), refer to Fig. 28

11. Check end play (running clearance) of second speed gear (31). Place mainshaft with second speed gear in vise. Fig. 38. Use vise jaw protectors to protect mainshaft splines and journals. Insert feeler gauges between second speed gear and forward part of mainshaft. Holding feeler gauges in place, rotate second speed gear slowly 360 degrees. Find gear high spot. Insert proper select fit thrust washer to obtain .05 to .15mm (.002 to .006") running clearance. Select one of the following thrust washers.

3.89 - 3.94 mm	(.153 - .155")
3.96 - 4.01 mm	(.156 - .158")
4.04 - 4.09 mm	(.159 - .161")
4.12 - 4.17 mm	(.162 - .164")

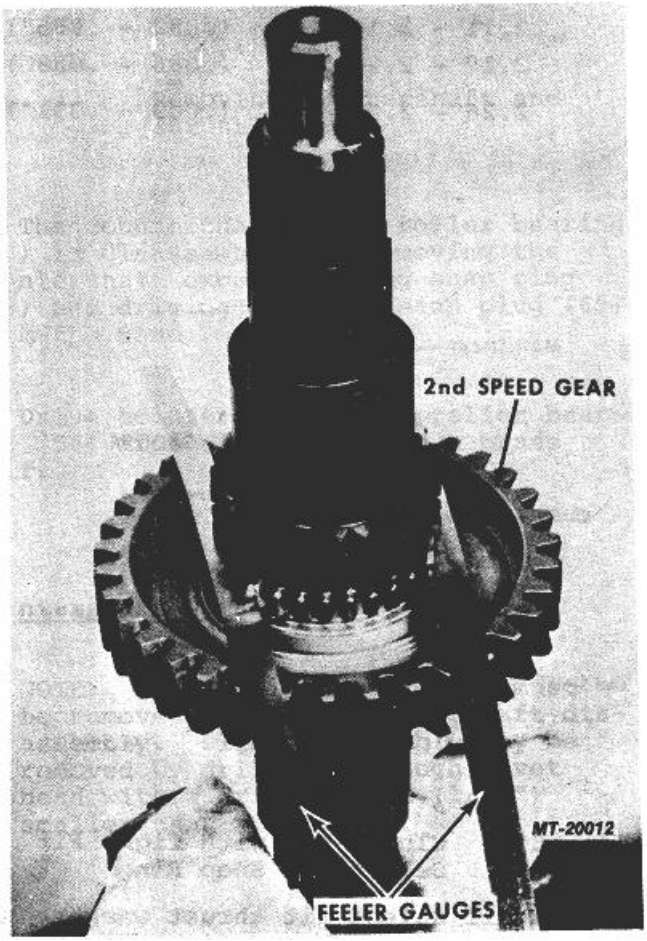


Fig. 38 Running Clearance Second Speed Gears).

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12. To provide a tight fit between the first/reverse clutch hub (25) and select fit snap ring (24), position mainshaft in vise as shown in Fig. 39. Use vise jaw protectors to protect mainshaft splines and journals. Place first/reverse clutch hub (25) on mainshaft. Insert a select fit snap ring (24) in the mainshaft groove. Check snap ring fit in four locations on mainshaft. Select snap ring for tight fit.

    NOTE: Snap ring (24) and first/reverse clutch hub (25) will be installed later, after reverse gear running clearance is established.

    Select snap ring from one of the following:

1.92 - 2.00 mm	(.077 - .079")
2.03 - 2.08 mm	(.080 - .082")
2.11 - 2.16 mm	(.083 - .085")
2.18 - 2.24 mm	(.086 - .088")
2.26 - 2.31 mm	(.089 - .091")

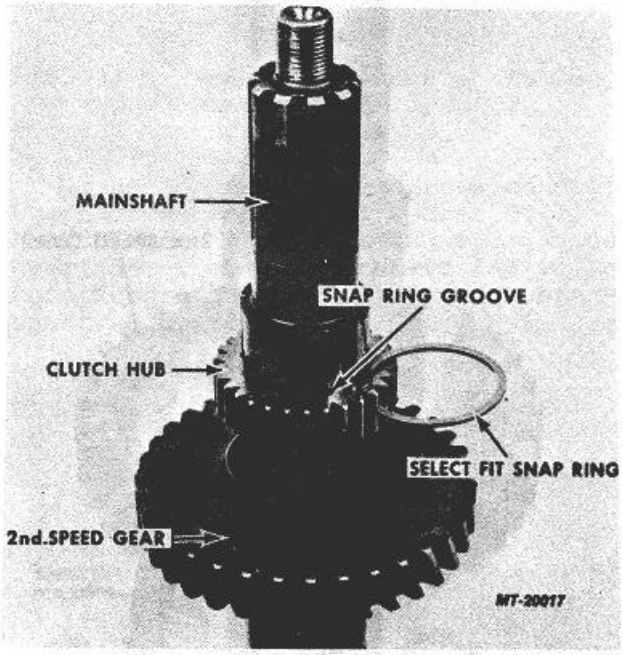


Fig. 39 Clutch Hub with Tight Fit Select Fit Snap Ring

13. Install select fit thrust washer (30) reverse gear (27) and first/reverse clutch hub (25) to mainshaft. Install select fit snap ring (24) selected in previous operation. For installation sequence of the listed components, refer to Fig. 40.

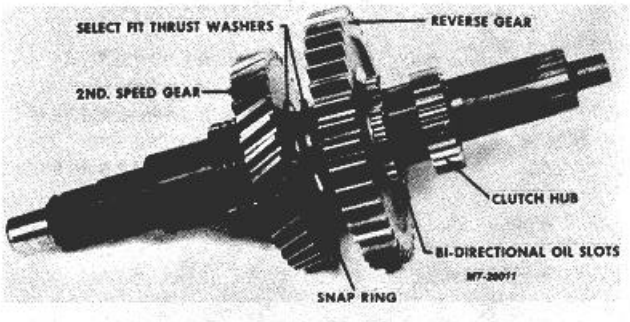


Fig. 40 Clutch Hub, Reverse Gear and Thrust Washer

14. With select fit snap ring (24) installed, insert second speed gear feeler gauges which were used to obtain second speed gear running clearance between second speed gear and forward part of mainshaft, see Fig. 41.

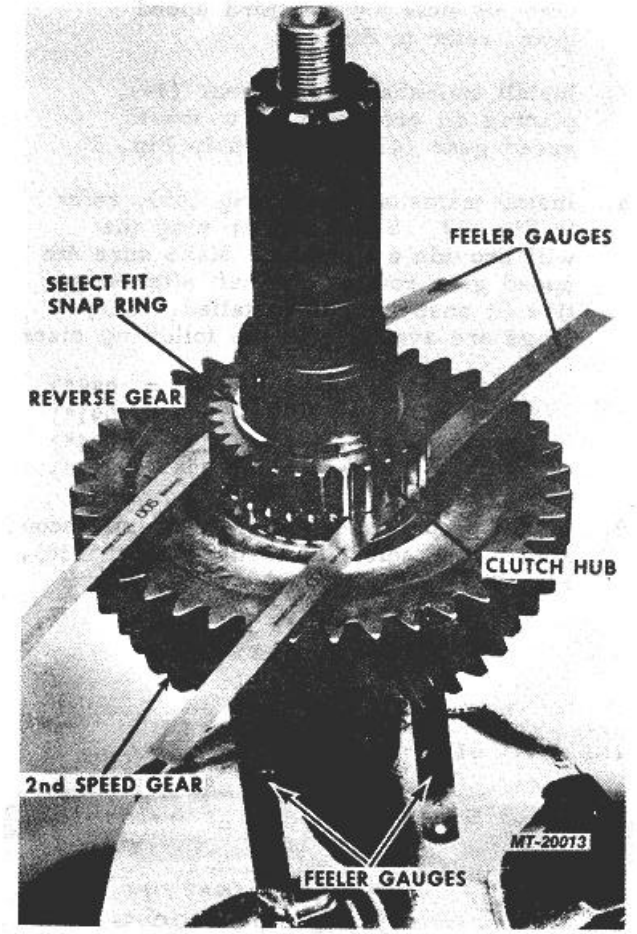


Fig. 41 Running Clearance Reverse Gear

15. Place mainshaft in vise. Use vise jaw protectors to protect mainshaft splines and journals.

16. Insert feeler gauges, both sides of mainshaft between first/reverse clutch hub (25) and reverse gear (27) clutch teeth, Fig. 41. Rotate reverse gear 360 degrees slowly with feeler gauges positioned as illustrated. Running clearance should be between .05 to .15 mm (.002 .007") at the high spot between gear hubs when rotating reverse gear. To obtain proper running clearance select one of the following select fit thrust washers.

3.89 - 3.94 mm	(.153 - .155")
3.96 - 4.01 mm	(.156 - .158")
4.04 - 4.09 mm	(.159 - .161")
4.12 - 4.17 mm	(.162 - .164")

NOTE: Make sure selective fit snap ring (24) is not distorted when final select fit thrust washer is selected before reinstalling snap ring (24). The select fit thrust washers for the second speed gear and reverse speed gear are the same. They are listed for reference purpose only.

17. With reverse gear running clearance established and all feeler gauges left in position, we will now check first speed gear running clearance.

18. Install first speed gear (23).

19. Install first speed gear thrust washer (22).

20. Make an adapter locally to permit simulating a load on the first speed gear thrust washer, see Fig. 42. Insert feeler gauges between first speed gear washer and hub of first speed gear; running clearance should be .05 to .15 mm (.002 to .006").

NOTE: If a minimum of .05 mm (.002") running clearance cannot be obtained, then a new first speed gear should be installed. The dimension between the first speed gear hub gear teeth and hub should be 31.14 mm ± .025 mm (1.222 ± .001"), see Fig. 42.

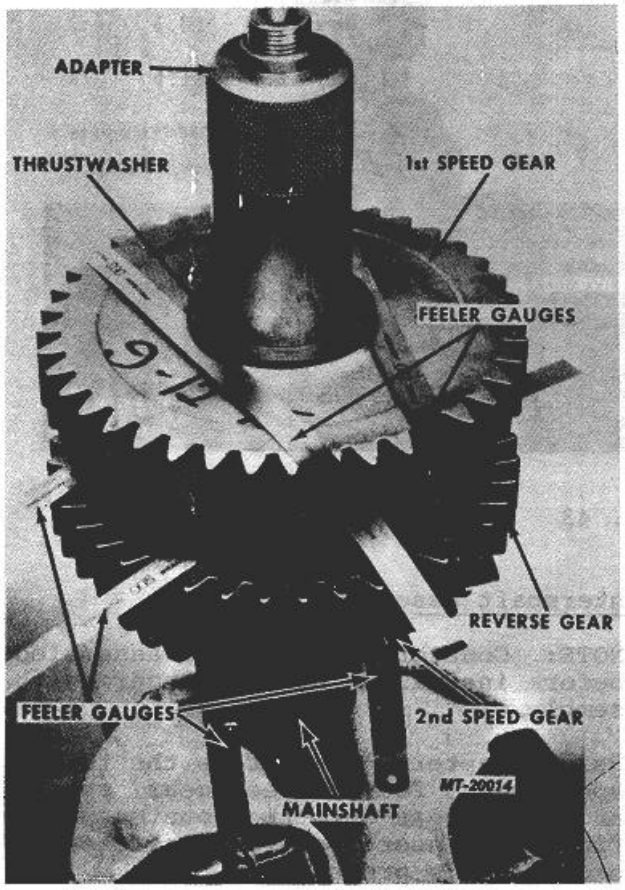


Fig. 42 Running Clearance First Speed Gear

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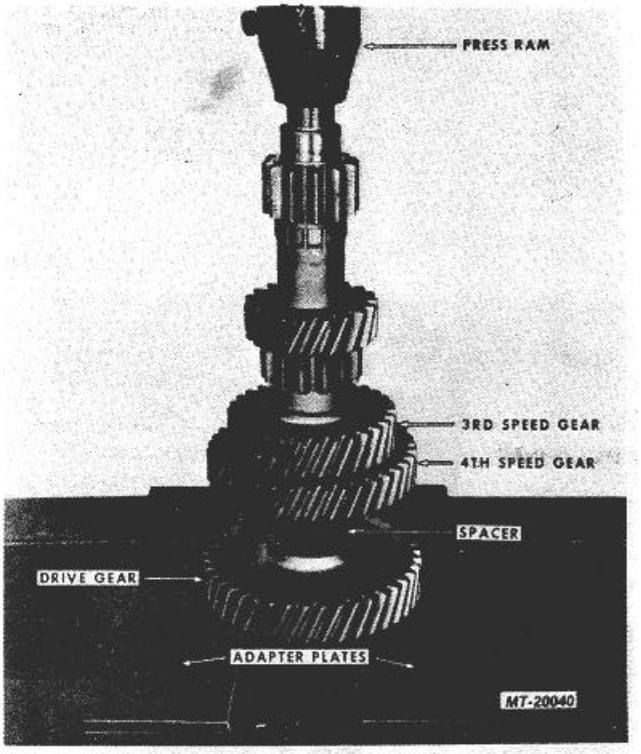


Fig. 43 Countershaft Assembly

Countershaft Assembly

NOTE: Countershaft must be assembled before installing nylon slinger assembly.

1. Using adapter plates press the third speed gear, fourth speed gear, spacer and drive gear onto the countershaft,

2. Install snap ring on end of countershaft, refer to Fig. 34. Thrust washer should be placed on end of countershaft at time of transmission assembly.

3. When installing the nylon slinger, it must be assembled with one raised mounting ear and one flat mounting ear back to back as shown in Fig. 44.

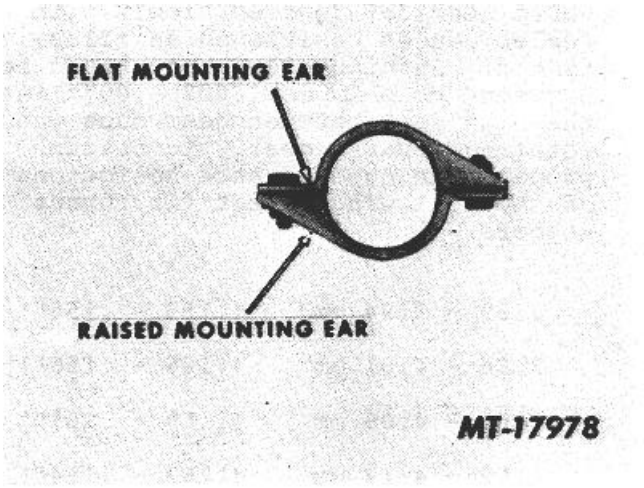


Fig. 44 Nylon Slinger Assembly

4. Place each half of the nylon slinger around the countershaft seating the splines of the slinger halves in the grooves of the countershaft. When assembled properly little or no space will appear between the slinger mounting ears on either side.

5. Install nylon slinger assembly retaining bolts, Fig. 45. Torque nut alternately and evenly to not more than 4 to 4.5 Newton-Meters (35 to 40 in. lbs.).

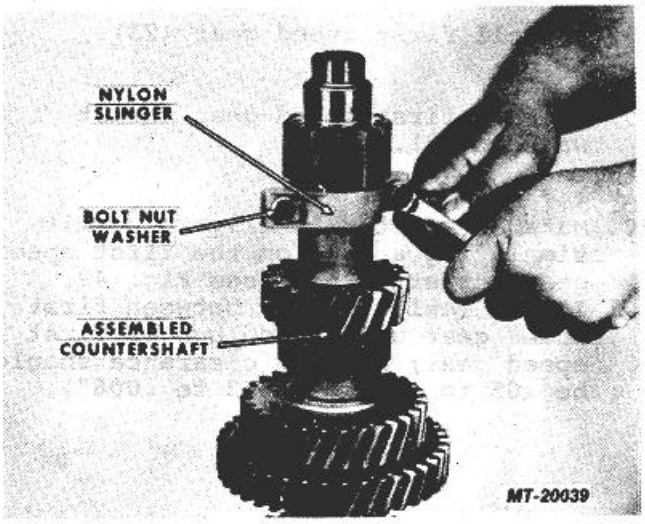


Fig. 45 Nylon Slinger Installation

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Mainshaft Installation

1. With the first speed gear running clearance established, the mainshaft assembly should be prepared for assembly into the transmission case.

   NOTE: Countershaft slinger impeller must be in horizontal position to prevent damage to slinger impeller blades when installing mainshaft.

2. To facilitate mainshaft assembly installation, install hose clamp or similar retainer to rear of first speed gear thrust washer location, see Fig. 46. Remove front synchronizer, lift mainshaft assembly and while tilting the front end upward, install assembly through top of case. Install front synchronizer. Remove hose clamp or similar retainer.

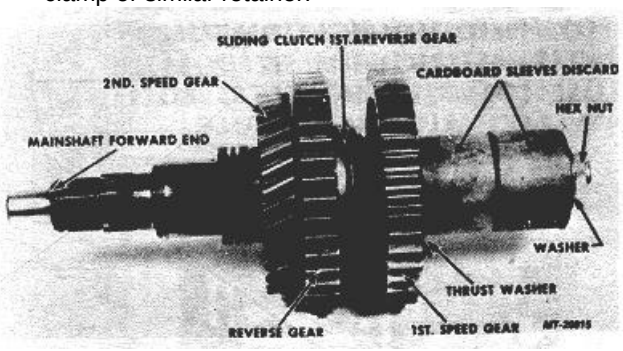


Fig. 46 Mainshaft Assembly

3. Install main drive gear (63) and bearing (64), Refer to Fig. 17.

   Depending on the main drive gear being used will determine if a main drive gear pilot bearing spacer is to be used in the main drive gear pilot bearing cavity.

   Fig. 47 illustrates both the early and latest version main drive gear.

   Use main drive gear spacer with early version drive gear only.

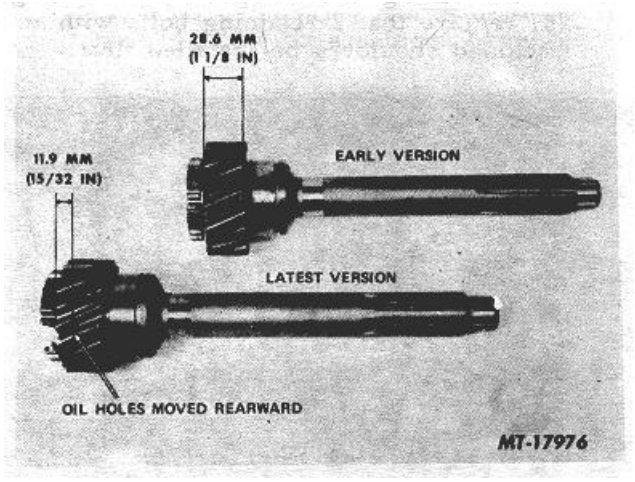


Fig. 47 Main Drive Gear

   Do not use bearing spacer with latest version drive gear which is designed to eliminate the spacer. Use of the spacer with the latest version drive gear will result in assembly problems and failure of the pocket bearing.

4. Install main drive gear bearing retainer (67) with new gasket (66) as shown in Fig. 16.

5. Install mainshaft rear bearing (21) and snap ring to rear of mainshaft and case.

6. Install speedometer drive gear (20) on rear mainshaft. Install new rear bearing retainer gasket (77) and install rear bearing retainer (75).

7. Lock transmission by placing it in two gears. Install companion flange, washer (19) and nut (20). Torque nut to 258-312 Newton-Meters (190-230 ft. lbs), preferably on high side.

Shift Bar Housing Installation

1. Place mainshaft gears in reverse position.

2. Use new shift bar housing gasket (79).

3. Place shift lever in reverse on shift bar housing. Install shift bar housing to transmission case, see Fig. 11.

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4. Covers having dowel alignment holes (Fig. 48) require that 2 retaining bolts with machined shoulders be installed first Fig. 48

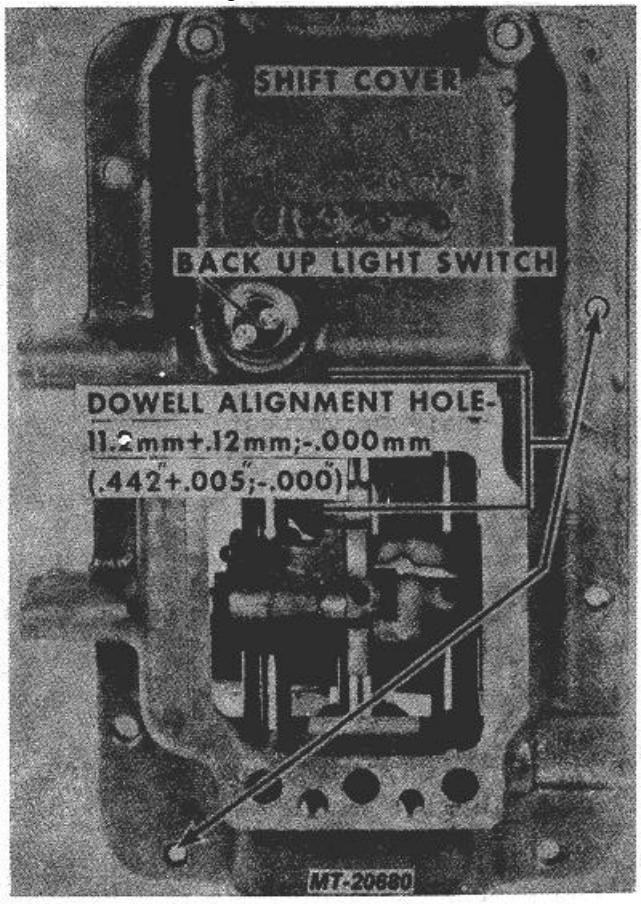


Fig. 48

5. Lift cover up onto shoulder bolts to accomplish cover fit, then seat these bolts down. Insert the rest of the cover-to-case bolts, and torque all bolts 41-57 N.m (30-40 ft. lbs.). TORQUE SHOULDER BOLTS FIRST.

6. Covers not having dowel alignment holes can be identified by the FULL threaded cover retaining bolt and a 25/64" diameter hole in the cover at the locations illustrated in Fig. 49.

Covers not having dowel alignment holes can be modified as follows to incorporate dowel alignment holes. Refer to Fig. 49.

With cover removed from the transmission, retain cover in a tool fixture or clamp to the drill press table for drilling alignment holes with stationary drill press. Use a 7/16" drill in a drill press and open up the two holes, front right and left side rear in cover from 25/64". The holes to be drilled must be clean and dry. Drilling must be done with a dry drill; use no fluid. After drilling out the two holes, clean area around holes. Set the cover on the case and start the two shoulder bolts (part no. 483503-C1) by hand. Lift cover up onto shoulder bolts to accomplish cover fit, then seat these bolts down. Insert the rest of the cover-to-case bolts, and torque all bolts 41-57 N.m (30-40 ft. lbs.). Torque shoulder bolts first.

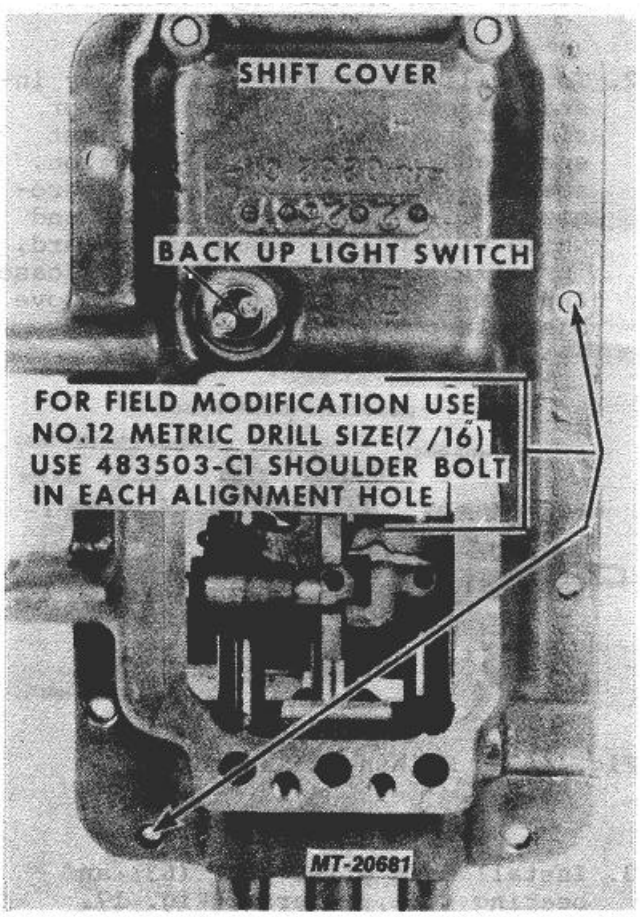


Fig. 49

LUBRICATION

For lubrication intervals, refer to Operator's Manual.

For types of lubricants recommended, refer to LUBRICATION Section CTS-2412.

Lubricant Capacity

6.6 Liters (14 pints).

SPECIFICATIONS

IH Model IH Code	T-495 13495	T-496 13496
Type	Direct in 5th	Direct in 5th
Number of Speeds:		
Forward	5	5
Reverse	1	1
P.T.O. Openings	2	2
Location	Both Sides	Both Sides
Weight, Kilograms	87.0 (192 Lbs.)	87.0 (192 Lbs.)
Lubricant Capacity	6.6 (14 Pints)	6.6 (14 Pints)
Serial No. Location	*	*

* Stamped above drain plug.

DRIVE GEAR RUNNING CLEARANCES

3rd Speed Gear	.05 - .15 mm	.002 - .006"
* 2nd Speed Gear	.05 - .15 mm	.002 - .006"
Reverse Gear	.05 - .18 mm	.002 - .007"

* Establish second speed gear running clearance prior to establishing reverse gear running clearance.

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TORQUE CHART

DESCRIPTION	N.m	(Ft. Lbs.)
Drive Gear Bearing Retainer to Case	21-30	16-22
Control Lever Housing to Shift Cover	41-57	30-42
Cover to Case	34-52	25-38
Mainshaft Rear Bearing Retainer to Case	41-52	30-38
Countershaft Lock Bolt to Case	33-51	25-38
P.T.O. or P.T.O. Cover to Case	29-37	21-27
Companion Flange to Mainshaft	258-312	190-230
Countershaft Rear Bearing Nut	271-423	200-250
Parking Brake Bracket	142-169	105-125

For determining the correct torque, be certain that screw threads are cleaned and lubricated before taking torque wrench readings.

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AUXILLIARY TRANSMISSION

AT-522 AND AT-523

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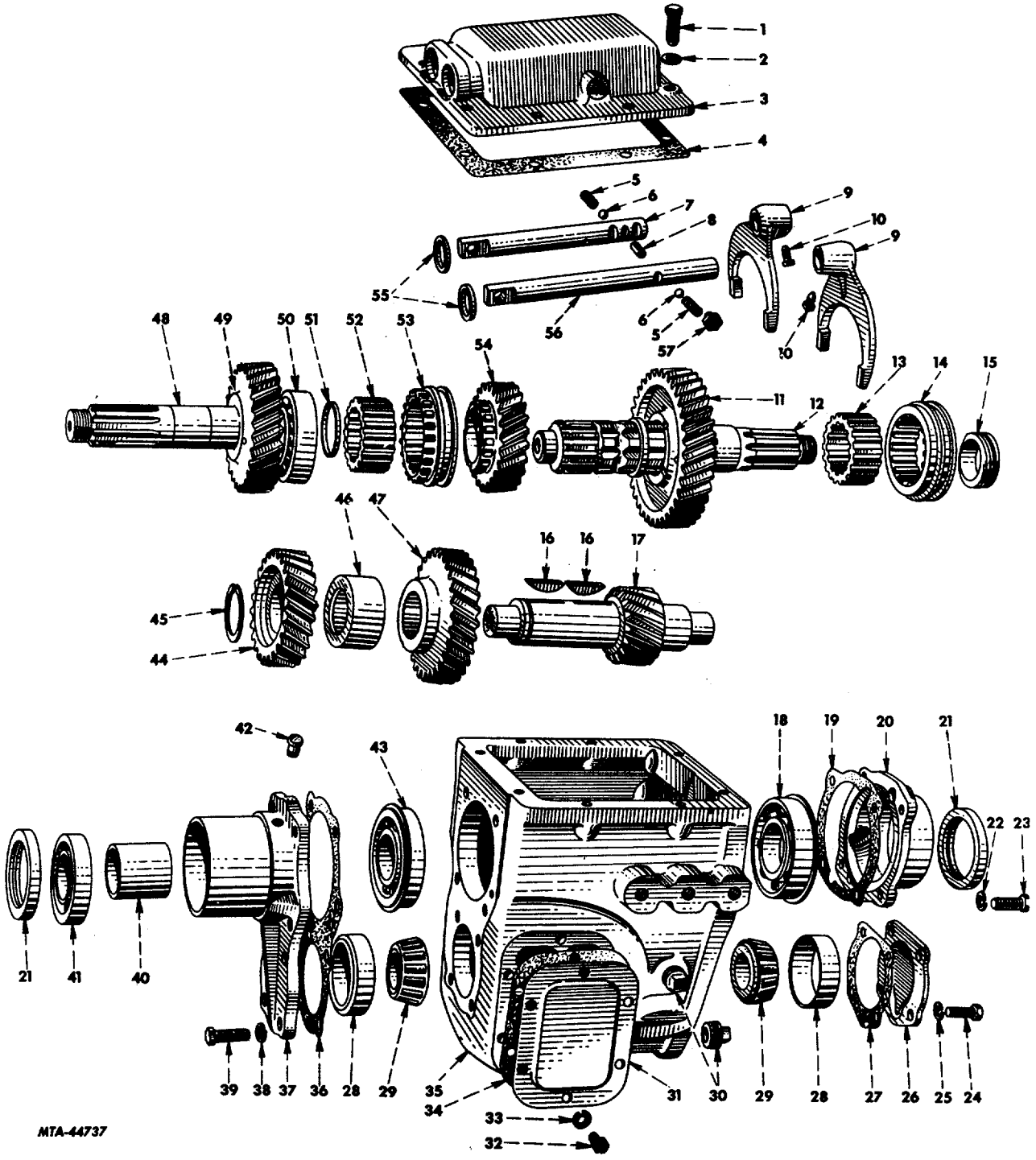


Fig. 1 AT-522 Auxiliary Transmission (Exploded View)

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Legend for Fig. 1

Key	Description
1	BOLT, hex-hd.
2	WASHER, lk., 3/8", med.
3	HOUSING, shift bar aux. trans.
4	GASKET, hsg., shift bar
5	SPRING, shift bar poppet
6	BALL, shift bar poppet
7	BAR, overdrive shift
8	LOCK, inter-shift bar
9	FORK, shift
10	SCREW, lk., shift fork
11	GEAR, mainshaft underdrive
12	SHAFT, main
13	CLUTCH, mainshaft
14	COLLAR, underdrive clutch gear
15	SPEEDOMETER, drive gear
16	KEY, woodruff, ct shft. gear
17	SHAFT, aux. trans. counter
18	BEARING, mainshaft, rear
19	GASKET, mainshaft bearing cap
20	RETAINER, mainshaft bearing retainer asm., rear
21	SEAL, mainshaft bearing, rear
22	WASHER, lk., 1/2", med.
23	BOLT, hex. hd.
24	BOLT, hex-hd., 7/16NC x 1-3/8"
25	WASHER, lk., 7/8", med.
26	COVER, counter shaft rear brg.
27	SHIM, counter shaft rear brg. cap
28	BEARING, cup, counter shaft, front and rear
29	BEARING, cone, counter shaft, front and rear
30	PLUG, oil filler and drain
31	COVER, PTO opening
32	BOLT, hex-hd., 3/8NC x 3/4"
33	WASHER, lk., 3/8" med.
34	GASKET, PTO opening cover
35	CASE, aux. trans.
36	GASKET, main dr. gear brg. ret.
37	RETAINER, main dr. gear brg.
38	WASHER, lk.
39	BOLT, hex-hd.
40	SPACER, main dr. gear brg.
41	BEARING, ball, main dr. gear, otr.
42	BREATHER, asm.
	HEAD, breather
	GASKET, breather
	PIN, cotter, 3/32 x 1-1/8"
43	BEARING, ball, main dr. gear, inner
44	GEAR, counter shaft drive
45	RING, snap, counter shaft dr. gear
46	SPACER, counter shaft gear
47	GEAR, counter shaft overdrive
48	GEAR, main dr.
49	RING, snap, main shaft, front
50	BEARING, roller, main dr. gear pilot
51	RING, snap, mainshaft, rear
52	GEAR, direct and overdrive
53	COLLAR, mainshaft overdrive gear
54	GEAR, mainshaft overdrive
55	SEAL, oil, shift bar
56	BAR, shift, underdrive
57	RETAINER, poppet spring

The Model AT-522 auxiliary transmission has three forward speeds, namely, Underdrive, Direct drive and Overdrive. As an auxiliary it may be used with either four or five speed transmissions.

Disassembly of this transmission is outlined below with all reference numbers referring to Fig. 1 unless otherwise stated.

DISASSEMBLY

1. Clean loose dirt and grease from outside the transmission case (35).

2. Drain lubricant from transmission by removing drain plug (30).

3. Remove hex head bolts (1) and lockwashers (2) from shift housing (3).

4. Lift off shift housing (3) and remove housing gasket (4).

5. Shift the transmission into direct drive by sliding the overdrive clutch collar (53) against the main drive gear (48). Then, slide the underdrive clutch collar (14) into mesh with the underdrive gear (11). This will lock the main shaft (12) and main drive gear (48) to permit removal of the front flange nut and flange.

6. Remove bolts (32) and lockwashers (33) from left hand power-take-off cover (31) and remove cover and gasket (34).

7. Follow same procedure for right hand power take off cover. Also remove speedometer drive gear (15).

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8. Remove four bolts (24), lockwashers (25) from countershaft rear bearing retainer (26).

9. Remove bearing retainer and shims (27). Keep shim pack and retainer together as removed from case.

10. Remove bolts (39), lockwashers (38) from main drive gear bearing retainer (37).

11. Lift off main drive gear bearing retainer and gasket (36). Note: The main drive gear shaft outer bearing (41) is located in the retainer (37) and is removed with the retainer.

12. Place the front bearing retainer in a vise, Fig. 2, and press out the main drive gear outer bearing (41), main drive gear bearing spacer (40) and oil seal (21).

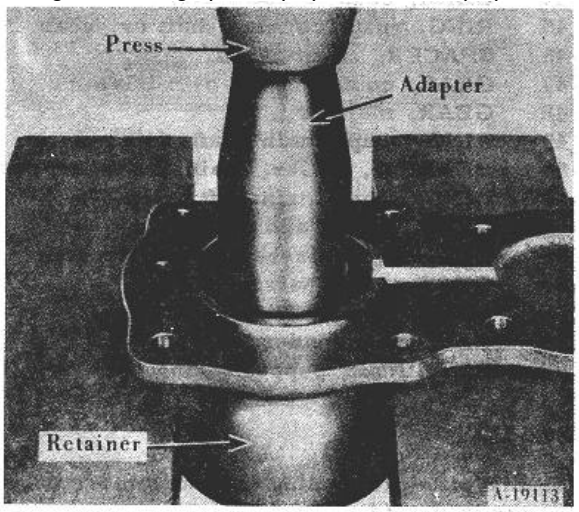


Fig. 2 Removing Main Drive Gear Outer Bearing

13. Remove the four bolts (23), lockwashers(22) from main shaft rear bearing retainer (20).

14. Lift off bearing retainer with seal (21) and remove gasket (19).

15. Using a soft hammer (brass or lead), Fig. 3, drive against the underdrive gear to start the main shaft rear bearing (18) out of the case toward the rear. Strike the gear carefully until further movement is blocked by the gears on the countershaft (17). The countershaft must now be moved a short distance to the rear and dropped down in the case to permit further disassembly at the main shaft. Proceed as follows:

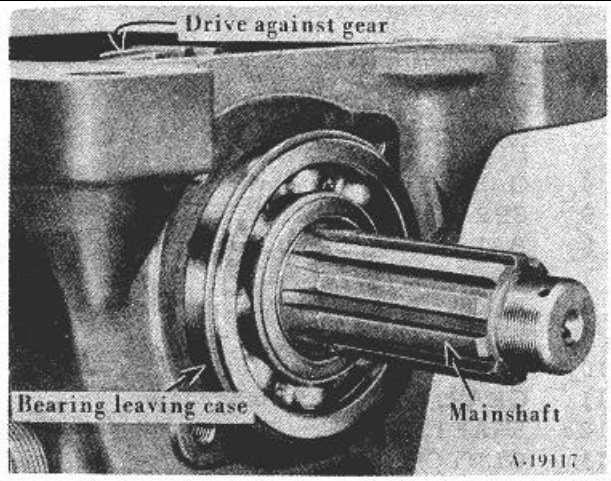


Fig. 3 Removing Mainshaft Rear Bearing

16. Using a brass drift, drive on the front end of the countershaft (17), forcing the rear countershaft bearing cup (28) out of the case. Allow the countershaft to drop to the bottom of the case.

17. With the countershaft resting on the bottom of the case, the main shaft rear bearing (18) can now be driven free of the case. Remove the main shaft rear bearing, using puller equipment, Fig. 4.

18. Remove the underdrive mainshaft drive gear collar (14) through the bearing bore -in case.

19. Slides the in, mainshaft clutch gear (13) off the mainshaft (12).

20. Tilt the mainshaft and gear assembly and remove from case. Remove the underdrive clutch collar. Upon reassembly, the main shaft and gears are placed in position in the same manner. Note that the countershaft remains resting at the bottom of the case.

21. Place gear assembly in vise and remove the underdrive gear (11) from the main shaft (12).

22. Remove mainshaft overdrive gear (54) from mainshaft.

23. Remove the mainshaft overdrive clutch collar (53) off mainshaft.

24. Remove mainshaft gear (52) and main shaft snap ring (51) from mainshaft.

25. Remove main drive gear roller bearing (50).

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26. Press the main drive gear inner bearing (43) off the main drive gear (48).

27. Lift countershaft assembly from the transmission case. Note that the countershaft drive gear (44) is installed toward the front of the case.

28. Using a suitable puller remove the countershaft front and rear bearings (29) from countershaft (17).

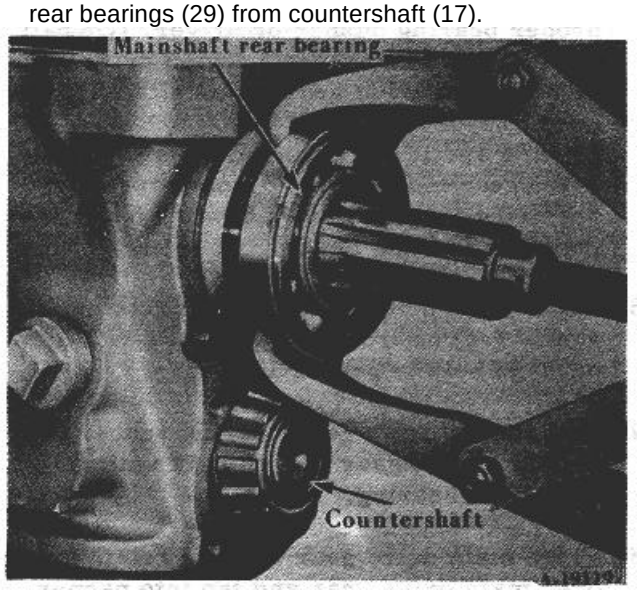


Fig. 4 Removing Mainshaft Rear Bearing

29. Remove countershaft drive gear snap ring (45).

30. Support countershaft drive gear in press, and press out countershaft drive gear (44). Countershaft gear spacer (46) and countershaft overdrive gear (47). Note: Do not lose woodruff keys (16).

SHIFT HOUSING

Disassemble shift housing as follows:

1. Remove poppet spring retainer (57) from housing (3).

2. Remove shift bar poppet spring (5) and ball (6).

3. Cut lock wires from shift fork screws (10) and remove screws.

4. Pull the direct and overdrive shift bar (7) (short bar) out of fork (9) and housing.

5. Remove the underdrive shift bar (56)(long bar) in the same manner. NOTE: With the removal of this last bar, the remaining poppet ball, poppet spring and interlock pin (8) will slip from the bore in housing.

6. Remove and replace shift bar oil seals (55) if necessary.

CLEANING AND INSPECTION

1. Wash bearings in a pressure bearing washer and examine for defects. Bearings which are worn excessively will cause noisy operation and possible serious damage to the transmission. See General Section for care and handling of bearings.

2. To prevent scoring and provide initial lubrication, coat the bearings and gears with gear oil before assembly.

3. Examine teeth on all gears carefully. Cracked or chipped teeth, or spots where casehardening is worn through, renders gears unfit for further use.

4. Gears on counter shaft must be tight. Replace parts if countershaft keyway is found to be worn. Use a new key in the countershaft when reassembling.

5. The case should be drained and washed clean before new parts are installed.

6. Use new gaskets and oil seals. Be sure all bolts are tightened securely.

7. DO NOT fail to refill transmission to the prescribed level with a good grade of lubricant. (See lubrication.)

ADJUSTMENTS

The countershaft bearings are adjusted by means of shims at the rear bearing retainer. Add or remove shims to obtain a free-turning countershaft, with no perceptible bind or end-play.

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REASSEMBLY

Assembly of countershaft.

1. Place woodruff keys (16) in countershaft (17).

2. Press on countershaft overdrive gear (47), spacer (46) and counter shaft drive gear (44) on countershaft with gear toward front end of countershaft.

3. Place countershaft drive gear snap ring (45) on front end of countershaft and make sure it is seated in groove in countershaft.

4. Press tapered roller bearing cones (29) on front and rear ends of countershaft.

Assembly of countershaft in main case.

1. Place countershaft assembly in main case by lowering rear end of countershaft in main case first and then front end.

2. Slide countershaft assembly forward into position.

3. Place tapered roller bearing cups (28) in position in each end of main case countershaft bearing bore.

4. Place gasket (36) and maindrive gear bearing retainer in position on front of main case to locate front tapered roller bearing cup.

5. Place countershaft rear bearing retainer (26) and shims (27) in position (with oil passages in proper location) on rear of transmission.

6. Add or remove shims so countershaft rolls free and has from .001 to .003 end play.

7. After countershaft tapered roller bearings have been adjusted remove main drive gear bearing retainer (37).

Assembly of main drive gear and main drive gear bearing retainer.

1. Press in outer bearing (41) in front of main drive gear bearing retainer.

2. Press in oil seal (21) with wiping lip toward rear of bearing retainer.

3. Coat drive gear pocket bearing position with cup grease.

4. Place main drive gear (47) in front mainshaft bearing bore of case from inside of main case.

5. Place main drive gear inner bearing (43) over front end of main drive gear with snap ring (49) on O. D. of ball bearing toward front of transmission. And tap ball bearing on main drive gear and in bore of case with proper bearing pusher or driver. (Or ball bearing can be pressed on main drive gear before main drive gear is installed in main case by removing snap ring on O. D. of bearing and it can be installed with main drive gear from inside of main case and snap ring installed after bearing has been installed in main case.)

6. Place main drive gear bearing retainer gasket (36) on front of main case with oil passage hole in proper location.

7. Place main drive gear bearing spacer (40) on main drive gear and slide it against inner ball bearing.

8. Place main drive gear bearing retainer on over main drive gear and tap into proper position against main case.

9. Secure main drive gear bearing retainer to main case-with cap screws and lock washers.

10. Screw in breather (42) in top of bearing retainer.

Assembly of mainshaft and gears.

1. Place mainshaft overdrive gear (54) on front end of mainshaft (12) with clutching teeth on gear toward front of mainshaft.

2. Place mainshaft overdrive and direct clutch (13) on front of mainshaft with face of clutch that has "X" stamped on it toward the front end of mainshaft.

3. Place snap ring (51) on mainshaft next to clutch making sure snap ring is not over expanded when assembling and fits tight in bottom of groove of mainshaft.

4. Place mainshaft direct and overdrive clutch collar (53) on mainshaft clutch gear (13)

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with clutching teeth on O. D. of clutch collar toward front end of the mainshaft.

5. Place mainshaft low or underdrive gear (11) on rear of mainshaft with clutching teeth toward rear end of mainshaft.

6. Place mainshaft with the two gears, and direct and overdrive clutch(l13) and collar (14) in main case by lowering rear end of mainshaft into rear bearing bore of main case first and then lower front end of mainshaft and slide forward so pilot end of mainshaft enters pocket bearing rollers in main drive gear.

7. Slide low or underdrive clutch gear on rear of mainshaft with face of clutch gear that has "X" stamped on it toward the rear end of mainshaft and slide clutch gear through rear bearing bore and against mainshaft low or underdrive gear.

8. Place low or underdrive clutch collar on rear of mainshaft with long hub of clutch collar toward front or toward mainshaft underdrive gear and slide through rear bearing bore of main case and over underdrive clutch gear.

9. Place mainshaft rear bearing over rear of mainshaft with snap ring on O.D. of bearing toward rear and tap on mainshaft and into rear bore of main case with proper bearing pusher or driver.

10. Place speedometer drive gear on rear of mainshaft and slide up against mainshaft rear bearing.

11. Place rear mainshaft bearing retainer gasket on rear of main case making sure oil passage holes are properly lined up.

12. Press oil seal (21) in mainshaft rear, bearing retainer (20).

13. Make sure small bushing for speedometer driven gear is in mainshaft rear bearing retainer.

14. Place speedometer driven gear in position in mainshaft rear bearing retainer and secure in place outer sleeve.

15. Place mainshaft rear bearing retainer on rear of main case making sure oil passage holes are lined up in proper location and secure with cap screws and lockwashers.

16. Place power take-off gasket (34) and P.T.O. covers (21) on P.T.O. openings on each side of main case and secure in place with cap screws and lock washers.

17. Make sure drain and filler oil plugs (30) are tight.

Assembly of shifter housing and shift forks.

1. Set shifter housing in vise with poppet cross hole opening up.

2. Slide poppet spring through poppet cross hole until it is seated in bottom of hole.

3. Place poppet spring ball on spring.

4. Slide low or underdrive shift rod (longest rod) through front opening of shifter housing and hold down poppet ball and push shift rod through center support and place low or underdrive shift fork on shift rod with longest hub of shift fork toward front of shifter housing.

5. Line up set screw hole in shift fork in proper location on shift rod and secure in place with pointed set screw and lock wire head of set screw. Shift to neutral position.

6. Place interlock in cross hole and slide through to low speed shift rod.

7. Slide direct and overdrive shift rod (short rod) through front opening of shifter housing and place direct and overdrive shift fork (longest hub toward rear) on shift rod and slide shift rod through center support.

8. Line up set screw hole in shift fork in proper location on shift rod and secure in place with pointed set screw and lock wire head of set screw.

9. Place poppet ball and poppet spring in cross hole and screw in poppet spring retaining plug.

10. Place the two oil seals over front end of shift rods and press into shifter housing making sure not to damage oil seals when sliding them over front end of shift rods.

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Assembly of shifter housing and shift fork on main case.

1. Place shifter housing and main case gasket on top of main case.

2. Shift transmission and shifter housing assembly into neutral position.

3. Place shifter housing assembly on main case with shift rods toward front of transmission making sure shift forks go into proper location in shift collar.

4. Secure shift cover to main case with cap screws and lockwashers.

TROUBLESHOOTING

CAUSE	REMEDY
NOISY TRANSMISSION	
Gears worn and pitted due to lugging engine with transmission in too high a gear range.	Replace gears.
Bearing worn due to lugging engine with transmission in too high a gear range, or to chips and dirt in oil.	Replace worn and rough bearings.
Transmission not lined up properly in chassis.	Line up transmission with main transmission and rear axle so as to correct angles of universal joints.
JUMPING OUT OF GEAR	
Shift rail poppet springs broken.	Replace poppet springs.
Shift rail poppet notch worn.	Replace shift rail.
Shift forks sprung or loose on shift rail.	Replace sprung fork or tighten set screw in shift fork.
Linkage and rods between shift lever and auxiliary transmission not properly adjusted.	Check and adjust linkage and rods to make sure transmission is shifting full into gear.
Clutch gear teeth worn tapered.	Replace worn parts.
Bearings worn.	Replace bearings.
Transmission mounting in chassis puts strain on case.	Line up front mounting bracket so it does not cause strain on front mainshaft bearing retainer.
OIL LEAKAGE	
Transmission overfilled.	Drain to proper level.
Breather stopped up.	Clean breather assembly.
Use of transmission oil that foams and expands when hot.	Drain and refill with high grade, properly refined, straight run mineral oil.
Drain back holes between bearing retainers and main case stopped up.	Check drain holes and gaskets to make sure openings are clean.
Broken gaskets.	Replace gaskets and use gasket cement.

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LUBRICATION

For types of lubricant recommended, refer to LUBRICATION, CTS-2412. For lubrication intervals, refer to Operator's Manual.

SPECIFICATIONS

IH Model	AT-522	AT-523
IH Code	13522	13523
Number of Speeds	3	
Power-Take-Off Opening	Both Sides	
Type Bearings	Roller	
Countershaft End Play (Shims)	.025 - .076 mm (.001 - .003")	
Lubricant Capacity	3.8 Liters (8 Pints)	
Unit Serial Number Location	Plate on Left Side of Case	

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TRANSMISSION

AUXILIARY TRANSMISSION AND POWER-TAKE-OFF

MODEL	CODE
AT-521	13521
AT-524	13524

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SPECIFICATIONS
AT-524 AUXILIARY

RATIOS:	
First (Underdrive)	2.14 to 1.00
Second (Underdrive)	1.24 to 1.00
Third (Direct)	1.00 to 1.00
Fourth (Overdrive)	86 to 1.00
Number of Speeds	4
Type Bearings	Roller and Ball
Lubricant Capacity	8 Pints
Rear Bearing Retainer Adj. (shims)	.001 to .003

AT-521 POWER-TAKE-OFF

No. of Speeds	2
RATIOS:	
Forward	1.06 to 1.00
Reverse	1.65 to 1.00

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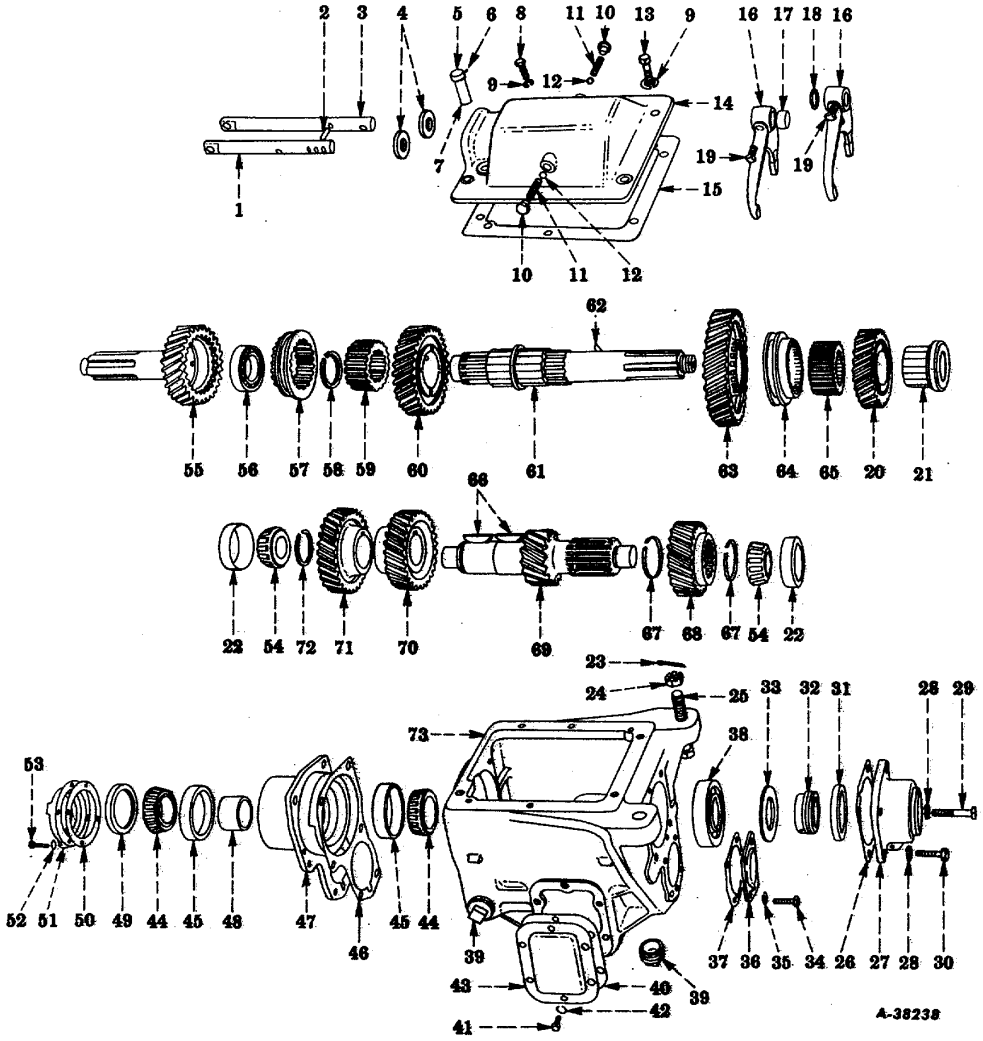


Fig. 1 AT-524 Auxiliary Transmission (Exploded View)

Key	Description	Key	Description
1	BAR, shift, underdrive	14	HOUSING, shift bar
2	LOCK, shift bars	15	GASKET, shift bar hsg.
3	BAR, shift, overdrive	16	FORK, shift
4	SEAL, oil shift bar	17	SPACER, overdrive shift bar
5	COVER, breather	18	SPACER, underdrive shift bar
6	PIN, cotter, 3/32 x 1-1/4"	19	SCREW, set, shift forks
7	BREATHER, asm.	20	GEAR, mainshaft second speed underdrive
8	BOLT, hex-hd., 3/8NC x 1-1/8"	21	SLEEVE, mainshaft second speed gear
9	WASHER, lk., 3/8", med.	22	BEARING, cup, countershaft
10	PLUG, retainer, shift bar poppet ball spring	23	PIN, cotter, 1/8 x 1-1/2"
11	SPRING, shift bar poppet ball	24	NUT, hex., slt., 3/4NF
12	BALL, poppet, 7/16"	25	BOLT, transmission mounting
13	BOLT, hex-hd., 1/2NC x 1-1/8"	26	GASKET, mainshaft rear bearing retainer

Key	Description
27	RETAINER, mainshaft, rear bearing
28	WASHER, lk., 1/2", med.
29	BOLT, hex-hd., 1/2NC x 2-1/2"
30	BOLT, hex-hd., 1/2NC x 1-5/8"
31	SEAL, oil, asm. (mainshaft, rear)
32	GEAR, speedometer drive
33	SPACER, speedometer drive gear
34	BOLT, hex-hd., 7/16NC x 1-3/8"
35	WASHER, lk., 7/16", med.
36	RETAINER, countershaft rear bearing
37	SHIM, countershaft rear bearing retainer
38	BEARING, ball, mainshaft, rear
39	PLUG, pipe, sq-hd., 1-1/4"
40	GASKET, PTO opening cover
41	BOLT, hex-hd.,3/8NC x 3/4"
42	WASHER, lk., 3/8", med.
43	COVER, PTO opening
44	BEARING, cone, main drive gear
45	BEARING, cup, main drive gear
46	GASKET, main drive gear bearing retainer
47	RETAINER, main drive gear bearing
48	SPACER, main drive gear
49	SEAL, oil, asm. (mainshaft front)
50	GASKET, mainshaft oil seal retainer
51	RETAINER, mainshaft oil seal
52	WASHER, lk., med.
53	BOLT, hex-hd.
54	BEARING, cone, countershaft
55	GEAR, main drive
56	BEARING, ball, mainshaft, pilot
57	COLLAR, direct and overdrive clutch
58	RING, snap, direct and overdrive gear
59	GEAR, direct and overdrive clutch
60	GEAR, mainshaft overdrive
61	SHAFT, main
62	KEY, Woodruff, 1/8 x 5/8"
63	GEAR, mainshaft first speed underdrive
64	COLLAR, first and second speed clutch
65	GEAR, first and second speed underdrive clutch
66	KEY, Woodruff, 3/8 x 2-1/8"
67	RING, snap, countershaft PTO gear
68	GEAR, countershaft, second speed underdrive
69	SHAFT, counter
70	GEAR, countershaft overdrive
71	GEAR, countershaft drive
72	RING, snap, countershaft drive gear
73	CASE, auxiliary transmission, w/PLUGS, asm

The Model AT-524 Auxiliary Transmission used in conjunction with the regular transmission has four speeds forward and no reverse.

Disassembly of this transmission is outlined below with all reference numbers referring to Fig. 1

DISASSEMBLY

1. Clean loose dirt and grease from outside transmission case (73).

2. Drain lubricant from transmission by removing drain plugs (39).

3. Remove hex head bolts (8) and (13) and lockwashers (9).

4. Lift off shift bar housing (14) and remove housing gasket (15).

5. Remove hex head bolts (41), lockwashers (42) and remove power take off cover (43) and gasket (40).

6. Follow same procedure for left side power take off cover.

7. Remove hex head bolts (53) and lockwashers (52) from main drive gear bearing retainer (47) and remove mainshaft oil seal retainer (51) and gasket (50).

8. Remove main drive gear bearing retainer (47), bearings (44), bearing cups (45) and main drive gear as a unit.

9. Remove main drive gear bearing retainer gasket (46).

10. Press main drive gear (55) from bearing retainer.

11. Remove main drive gear cone bearing (44), main drive gear cup bearing (45), main drive gear bearing spacer (48), mainshaft front oil seal (49) from retainer.

12. Remove main drive gear cone bearing (44) and main drive gear cup bearing (45) from main drive gear (55).

13. Remove hex head bolts (34), lockwashers (35) from countershaft rear bearing retainer (36) and shims (37).

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14. Remove hex head bolts (29) and (30), lockwashers (28) from mainshaft rear bearing retainer (27).

15. Remove mainshaft rear bearing retainer (27) and gasket (26).

16. Remove speedometer drive gear (32) and speedometer drive gear spacer (33).

17. Press out mainshaft rear oil seal (31).

18. Using a suitable puller remove mainshaft rear bearing (38).

19. Remove mainshaft (61) with gears assembly from transmission.

20. Place assembly in vise and using a suitable puller remove mainshaft pilot bearing (56).

21. Remove these remaining parts from mainshaft. Direct and overdrive clutch collar (57), direct and overdrive gear snap ring (58), direct and overdrive clutch gear (59), mainshaft overdrive gear (60), mainshaft first speed underdrive gear (63), first and second speed clutch collar (64), first and second speed underdrive clutch gear (65), mainshaft second speed underdrive gear (20), and mainshaft second speed gear sleeve (21). NOTE: When removing these parts, do not lose woodruff keys (62).

22. Remove countershaft with gear and bearing assembly from transmission.

23. Place countershaft in a vise and using a suitable puller remove countershaft cone bearings (54) and countershaft cup bearing (22).

24. Remove countershaft gear snap ring (72), countershaft power take off gear snap ring (67), countershaft second speed underdrive gear (68) and second countershaft power take off gear snap ring (67).

25. Press countershaft (69) from countershaft overdrive gear (70) and counter shaft drive gear (71). NOTE: Do not lose woodruff keys (66).

SHIFT HOUSING

Disassemble shift housing as follows:

1. Remove poppet ball retainer plug (10) from housing (14).

2. Remove shift bar poppet spring (11) and ball (12).

3. Cut lock wires from shift fork screws (19) and remove screws.

4. Remove shift bar lock (2).

5. Pull underdrive shift bar (1) and overdrive shift bar (3) from housing.

6. Inspect shift bar oil seals (4) and replace if necessary.

7. Remove shift fork (16), overdrive shift bar spacer (17) and underdrive shift bar spacer (18).

8. Remove and inspect breather assembly (7).

CLEANING AND INSPECTION

1. Wash bearings in a pressure bearing washer and examine for defects. Bearings which are worn excessively will cause noisy operation and possible serious damage to the transmission. See General Section for care and handling of bearings.

2. To prevent scoring and provide initial lubrication, coat the bearings and gears with gear oil before assembly.

3. Examine teeth on all gears carefully. Cracked or chipped teeth, or spots where casehardening is worn through, renders gears unfit for further use.

4. Gears on countershaft must be tight. Replace parts if countershaft key way is found to be worn. Use a new key in the countershaft when reassembling.

5. The case should be drained and washed clean before new parts are installed.

6. Use new gaskets and oil seals. Be sure all the bolts are tightened securely.

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7. DO NOT fail to refill transmission to the prescribed level with a good grade of lubricant.

ADJUSTMENTS

The countershaft bearings are adjusted by means of shims at the rear bearing retainer. Add or remove shims to obtain a free-turning countershaft, with no perceptible bind or end-play.

REASSEMBLY

Assembly of Maindrive Gear and Maindrive Gear Bearing Retainer

1. Press in the two tapered roller bearing cups (45) in main drive gear bearing retainer (47).

2. Press one tapered roller bearing cone on main drive gear and make sure it is seated against hub of gear.

3. Set main drive gear up on gear end and place main drive gear bearing retainer over main drive gear.

4. Place bearing spacer sleeve over front end of main drive gear and slide into place against bearing cone race.

5. Place front tapered roller bearing cone in place over main drive gear.

6. Place main drive gear and bearing retainer on bed of arbor press with gear resting on bed of arbor press.

7. Place suitable tube over front end of main drive gear and press against drive gear with approximately 20,000 pounds pressure to check bearing adjustment on main drive gear tapered roller bearings so they will have .001 to .003 end movement. If bearing adjustment is too loose, remove bearing spacer sleeve and install a shorter bearing spacer sleeve. If adjustment is too tight, install a longer bearing spacer sleeve.

8. Press oil seal in front bearing oil seal retainer.

9. Coat oil seal retainer gasket with gasket cement and place gasket on main drive gear bearing retainer.

10. Place oil seal and retainer in place on front of bearing retainer and secure in place with bolts and lockwashers.

11. Press in mainshaft and main drive gear pocket ball bearing in main drive gear.

Assembly of Mainshaft Rear Bearing Retainer

1. Press oil seal in position in mainshaft rear bearing retainer.

2,. Install speedometer driven gear.

Assembly of Shift Cover and Shift Forks

1. Place shift cover in vise or on bench upside down and. by standing at front end of shift cover proceed as follows.

2. Place low and second speed shift rod (longest rod) through front right hand opening and slide through into position.

3. Place narrow spacer on shift rod.

4. Place low and second speed shift fork on shift rod with set screw hole in shift fork toward left hand side.

5. Line up set screw hole in shift fork in its proper location on shift rod and secure shift fork rod with pointed set screw.

6. Lockwire head of set screw around shift fork.

7. Install shift rod interlock in left hand side cross hole in shift cover and slide through to low and second speed shift rod.

8. Place third and fourth speed shift rod (short rod) through front left hand opening and slide through part way. Place third and fourth shift fork on shift rod with set screw hole in shift fork toward left hand side and slide rod through fork. Place spacer on shift rod and slide shift rod through into proper location and line up set screw hole in shift fork in its proper location on shift rod and secure shift fork to shift rod with pointed set screw.

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9. Lock wire head of set screw around shift fork.

10. Place two oil seals over shift rods in front of shift cover and press into position.

11. Place shift rod poppet ball, poppet ball spring and spring retaining plug in cross hole on each side of shift cover.

12. Screw in breather assembly in top of shift cover housing.

Assembly of Countershaft in Main Case

1. Place countershaft assembly into main case by lowering rear end of countershaft in case first and then lower front end and slide countershaft assembly forward into position.

2. Slide countershaft second speed gear to rear of countershaft so it is against rear snap ring on countershaft.

3. Slide the snap ring that had been assembled ahead of countershaft second speed gear back against countershaft second speed gear and in groove provided in countershaft.

4. Press tapered roller bearing cones on each end of countershaft.

5. Press tapered roller bearing cups in each end of countershaft bearing bores in main case. (Countershaft bearing adjustment is made after front main shaft bearing retainer has been assembled on main case.)

Assembly of Mainshaft in Main Case

1. Place mainshaft first speed gear inposition in main case with clutch teeth toward rear of transmission.

2. Place mainshaft first and second speed clutch gear and clutch collar in position next to mainshaft first speed gear with hub of clutch collar toward rear of transmission. Slide clutch collar over clutch teeth of mainshaft low speed gear to hold it in position.

3. Place mainshaft second speed gear in position with clutch teeth toward front of transmission.

4. Place the mainshaft with overdrive gear, clutch gear and clutch collar on it in front main drive gear bearing bore of main case. Slide mainshaft through mainshaft low speed gear, first and second speed clutch gear and mainshaft second speed gear and through mainshaft rear bearing bore of main case.

5. Place mainshaft second speed gear sleeve on rear of mainshaft with hub toward rear, line up key way in sleeve with key in mainshaft and press sleeve on mainshaft and through mainshaft second speed gear.

6. Place mainshaft rear ball bearing over rear end of mainshaft and press in main case and on mainshaft.

7. Place speedometer drive gear (or spacer sleeve) on mainshaft.

8. Coat main drive gear bearing retainer gasket with gasket cement and place in proper location on front of main case.

9. Place main drive gear and bearing retainer assembly in place in front mainshaft bearing bore and secure in place with bolts and lockwashers.

10. Assemble countershaft rear bearing retainer and shims in place and remove or add shims under bearing retainer to get proper bearing adjustment of .001 to .003 end movement with dial indicator and countershaft rotating freely.

11. Coat mainshaft rear bearing retainer gasket with gasket cement and place in proper location on rear of main case, making sure oil passage holes are in proper location.

12. Place mainshaft rear bearing retainer on rear of main case and secure with bolts and lockwashers.

13. Coat shift cover gasket with gasket cement and place on top of main case.

14. Shift transmission and shift cover in neutral position.

15. Place shift cover assembly on transmission making sure shift forks go down in proper location in shift collar in transmission.

16. Secure shift cover assembly to main case with bolts and lockwashers.

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TROUBLE SHOOTING

CAUSE	REMEDY
NOISY TRANSMISSION	
Gears worn and pitted due to lugging engine with transmission in too high a gear range.	Replace gears.
Bearing worn due to lugging engine with transmission in too high a gear range, or to chips and dirt in oil.	Replace worn and rough bearings.
Transmission not lined up properly in chassis.	Line up transmission with main transmission and rear axle so as to correct angles of universal joints.
JUMPING OUT OF GEAR	
Shift rail poppet springs broken.	Replace poppet springs.
Shift rail poppet notch worn.	Replace shift rail.
Shift forks sprung or loose on shift rail.	Replace sprung fork or tighten set screw in shift fork.
Linkage and rods between shift lever and auxiliary transmission not properly adjusted.	Check and adjust linkage and rods to make sure transmission is shifting full into gear.
Clutch gear teeth worn tapered.	Replace worn parts.
Bearings worn.	Replace bearings.
Transmission mounting in chassis puts strain on case.	Line up front mounting bracket so it does not cause strain on front mainshaft bearing retainer.
OIL LEAKAGE	
Transmission overfilled.	Drain to proper level.
Breather stopped up.	Clean breather assembly.
Use of transmission oil that foams and expands when hot.	Drain and refill with high grade, properly refined, straight run mineral oil.
Drain back holes between bearing retainers and main case stopped up.	Check drain holes and gaskets to make sure openings are clean.
Broken gaskets.	Replace gaskets and use gasket cement.

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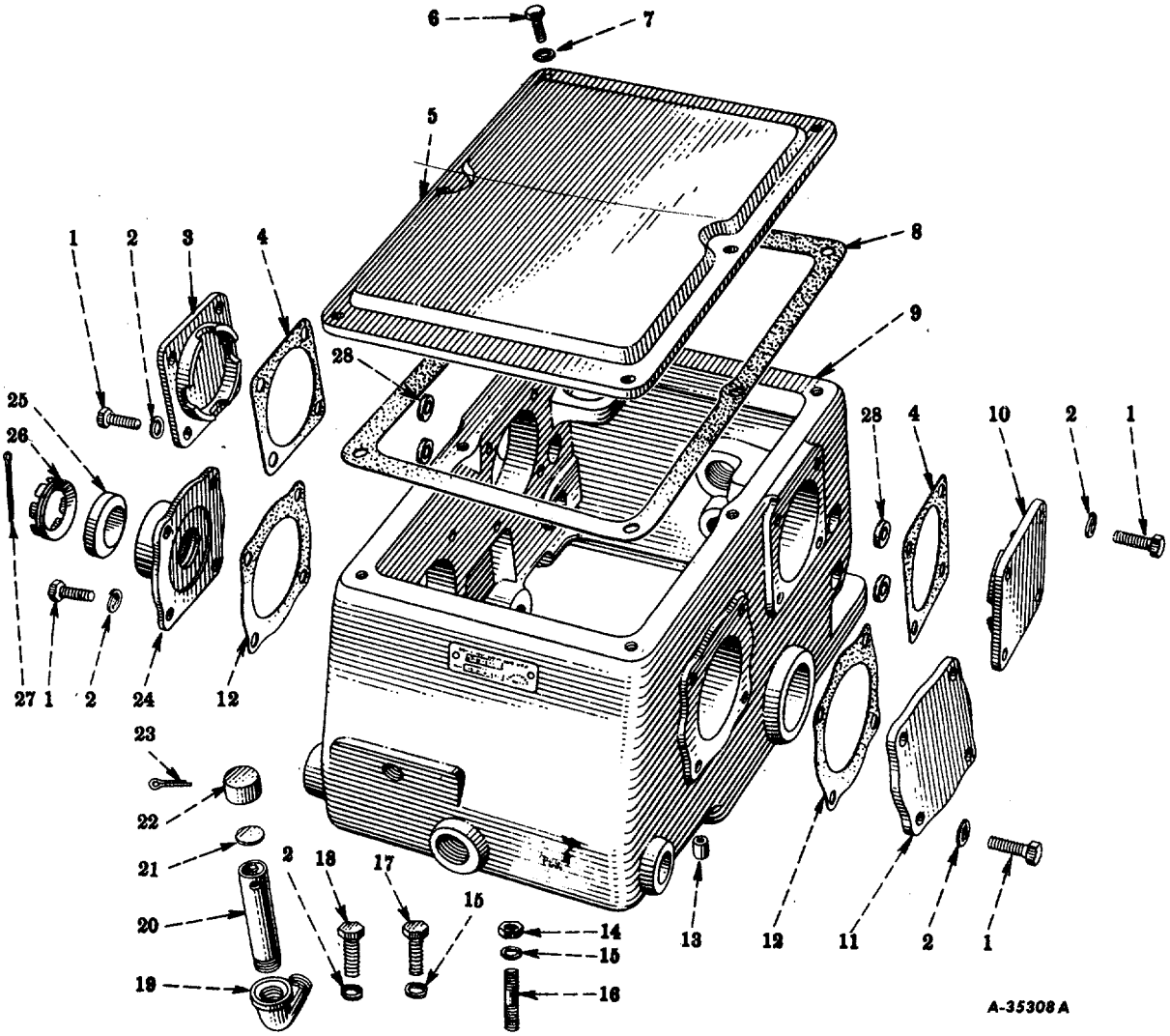


Fig. 2 AT-521 Power-Take-Off Case

Key	Description
1.	BOLT, hex-hd., 3/8NC x 1"
2.	WASHER, lk., 3/8", med.
3.	COVER, reverse gear, bearing, rear
4.	GASKET, reverse gear bearing cover
5.	COVER, case
6.	BOLT, hex-hd.,5/16NC x 7/8"
7.	WASHER, lk., 5/16", med.
8.	GASKET, case cover
9.	CASE, PTO
10.	COVER, reverse gear bearing, front
11.	COVER, mainshaft bearing, front
12.	GASKET, mainshaft bearing cover
13.	PIN, dowel, case
14.	NUT, hex., 1/2NF (PTO mounting stud)
15.	WASHER, lk., 1/2", med.
16.	STUD, PTO mtg.
17.	BOLT, hex-hd., 1/2NC x 1-1/8" (PTO mounting)
18.	BOLT, hex-hd., 3/8NC x 1-1/8" (PTO mounting)
19.	ELBOW, 3/8", 90 deg. (at breather)
20.	PIPE, breather BREATHER, w/COVER, asm.
21.	GASKET, breather cover
22.	COVER, breather
23.	PIN, cotter, 3/32 x 1-1/4"
24.	COVER, mainshaft bearing, rear
25.	PACKING, mainshaft, front
26.	GLAND, mainshaft packing
27.	PIN, cotter, 1/8 x 1-1/4"

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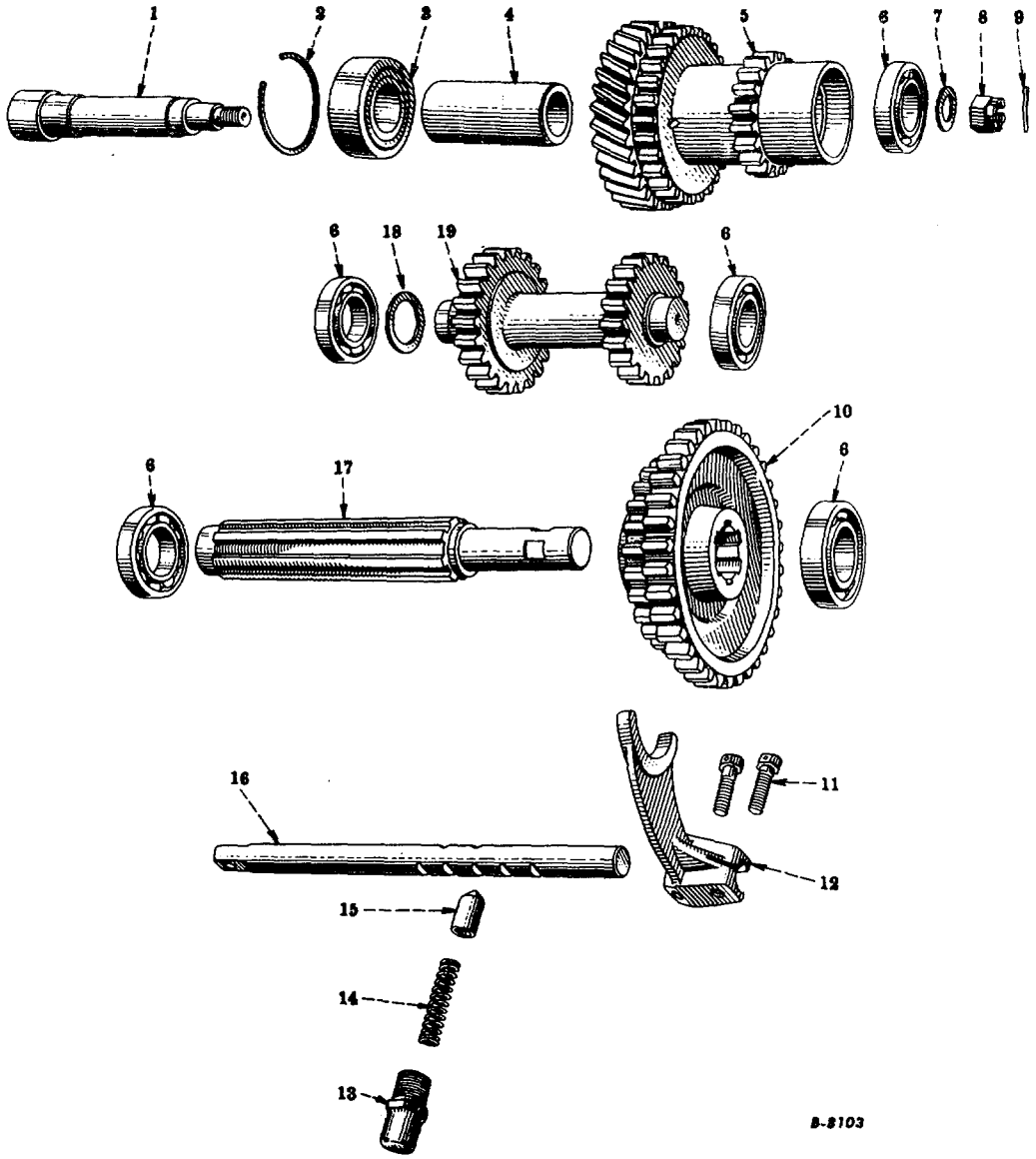


Fig. 3 AT-521 Power-Take-off Gears

Key	Description
1	SHAFT, intermediate gear
2	RING, snap, intermediate gear bearing
3	BEARING, intermediate gear, front
4	SPACER, intermediate gear bearing
5	GEAR, intermediate and direct
6	BEARING, ball, intermediate gear, rear mainshaft and reverse gear
7	WASHER, intermediate gear shaft nut
8	NUT, hex., slt., 3/4NF (intermediate; gear shaft)
9	PIN, cotter, 1/8 x 1-1/4" (intermediate gear shaft nut)

Key	Description
10	GEAR, mainshaft
11	BOLT, hex-hd.,drilled 7/16NC x 1-1/2"
12	FORK, shift, drive gear
13	RETAINER, shift bar interlock cup spring
14	SPRING, shift bar interlock cup
15	CUP, shift bar interlock
16	BAR, shift
17	SHAFT, main
18	WASHER, reverse gear
19	GEAR, reverse

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AT-521 POWER TAKE OFF

DISASSEMBLY

Reference numbers in the following disassembly instructions refer to Figure 2.

1. Clean dirt and grease from power-takeoff case (9).
2. Remove bolts (6) and lockwashers (7) from power-take-off cover (5).
3. Remove gasket (8) from case.
4. Remove hex head bolts (1), lockwashers (2) from reverse gear rear bearing cover (3) and remove cover.
5. Remove bearing cover gasket (4).
6. Remove reverse gear front bearing cover (10) in same manner.
7. Remove hex bolts (1) and lockwashers (2) from mainshaft front bearing cover (11) and remove cover.
8. Remove cover gasket (12).
9. Remove breather (20) from power-takeoff case.
10. Dismantle breather assembly in this order, remove cotter key (23) breather cover (22), breather cover gasket (21) and breather elbow (19).
11. Remove hex bolts (1) and lockwashers (2) from mainshaft rear bearing cover (24) and remove cover.
12. Remove cover gasket (12).
13. Remove cotter key (27), mainshaft packing gland (26) and mainshaft front packing (25) from cover.

Reference numbers in the following disassembly instructions refer to Figure 3.

1. Remove shift bar retainer (13) from case, releasing shift bar spring (14) and shift bar cup (15).
2. Remove cotter key (9) and hex nut (8) and intermediate gear shaft nut (7) from intermediate gear shaft (1).
3. Remove intermediate gear snap ring (2).
4. Drive intermediate gear shaft toward rear of case until shaft is free from bearing (6).
5. Remove shaft from case, placing shaft (1) in press, press .shaft from intermediate and drive gear (5), intermediate gear bearing spacer (4), intermediate gear front bearing (3).
6. Using a suitable puller remove reverse gear bearings (6) and reverse gear washer (18) from reverse gear (19).
7. Remove mainshaft bearing (6) and mainshaft gear (10) from mainshaft (17).
8. Remove shift bar hex bolts (11) from shift fork (12) and remove shift bar (16) from case.

REASSEMBLY

Reassemble power-take-off gears and case parts in reverse manner of disassembly.

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TRANSFER CASE

IH MODEL	IH CODE
TC-155	13155
TC-156	13156

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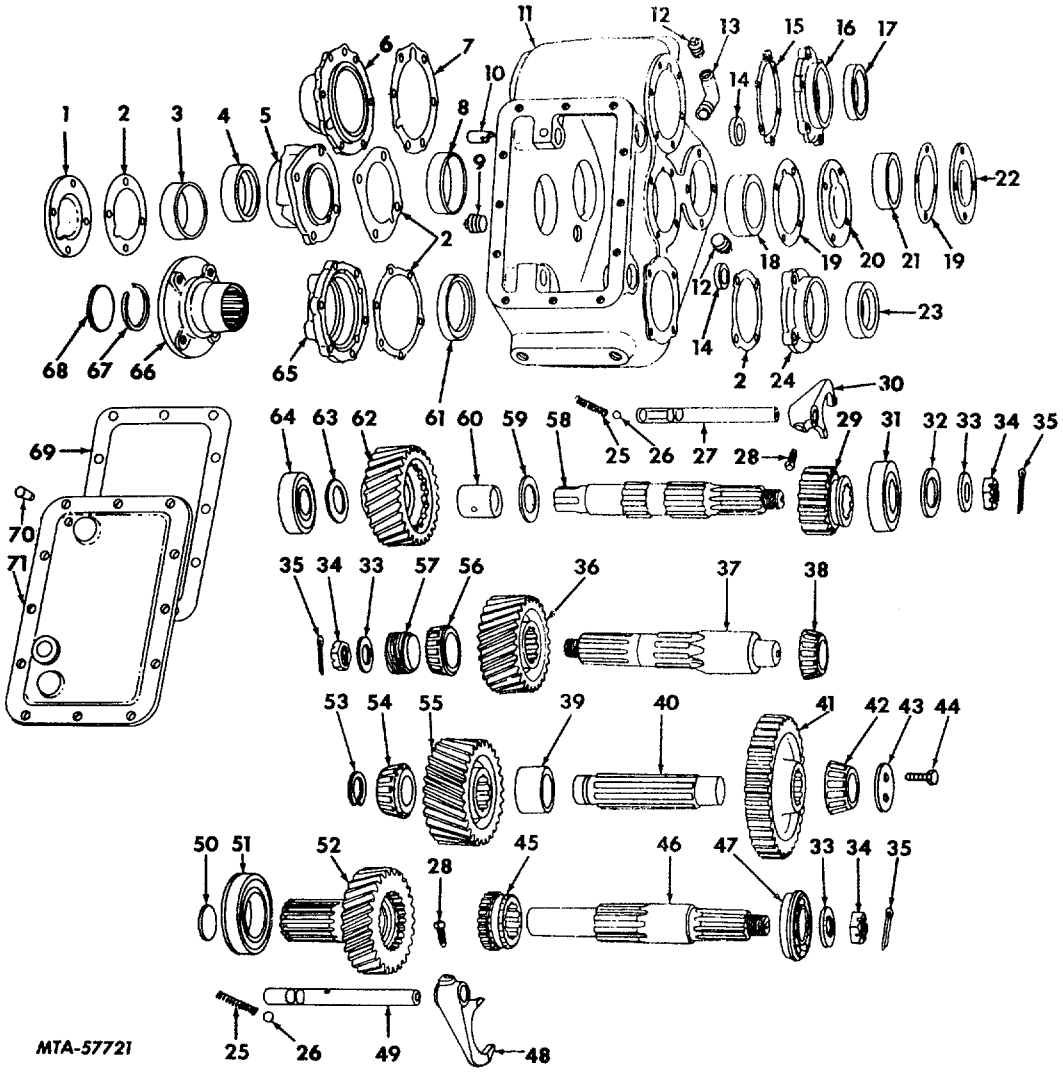


Fig. 1

Legend for Figure 1

Key	Description	Key	Description
1	CAP, Idler Shaft Rear Bearing	15	SHIMS, .08 mm (.003") Thick
2	GASKET		.13 mm (.005") Thick
3	CUP, Idler Shaft Rear Bearing		.25 mm (.010") Thick
4	SEAL, Rear Output Shaft Oil	16	CAP, Input Shaft Front Bearing
5	CAP, Rear Output Shaft Rear Bearing	17	SEAL, Oil
6	CAGE, Input Shaft Rear Bearing	18	CUP, Idler Shaft Front Bearing
7	GASKET	19	SHIMS, .08 mm (.003") Thick
8	CUP, Rear Output Shaft Rear Bearing		.13 mm (.005") Thick
9	PLUG, Pipe		.25 mm (.010") Thick
10	TUBE, Input Shaft Rear Bearing Oil Catch	20	CAP, Idler Shaft Front Bearing
11	HOUSING, Transfer Case	21	CUP, Rear Output Shaft Front Bearing
12	PLUG, Pipe, Filler/Drain	22	CAP, Rear Output Shaft Front Bearing
13	ELBOW, 45 Degree	23	SEAL, Oil
14	SEAL, Shift Shaft Oil	24	CAP, Front Output Shaft Front Bearing

Key	Description
25	SPRING, Detent
26	BALL, Detent
27	SHAFT, Range Shift
28	SCREW, Shift Fork Set
29	GEAR, Low Speed Sliding
30	FORK, Range Shift
31	BEARING, Input Shaft Front
32	SHIM, Bearing Adjusting
33	WASHER, Companion Flange
34	NUT, Companion Flange
35	PIN, Cotter
36	GEAR, Rear Output Shaft
37	SHAFT, Rear Output
38	BEARING, Rear Output Shaft Front
39	SPACER, Idler Gear
40	SHAFT, Idler
41	GEAR, Idler Shaft Low Speed
42	BEARING, Idler Shaft Front
43	PLATE, Bearing Retainer
44	BOLT, Bearing Retainer
45	CLUTCH, Output Shaft Sliding
46	SHAFT, Front Output
47	BEARING, Front Output Shaft Front
48	FORK. Shift. Front Axle Declutch
49	SHAFT, Declutch Shift
50	PLUG, Expansion
51	BEARING, Front Output Shaft Rear
52	GEAR, Front Output Shaft
53	RING, Idler Shaft Snap
54	BEARING, Idler Shaft Rear
55	GEAR, Idler Shaft High Speed
56	BEARING, Rear Output Shaft Rear
57	GEAR, Speedometer Drive
58	Shaft, Input
59	WASHER, Direct Drive Gear Spacing
60	BUSHING, Direct Drive Gear
61	SEAL, Oil
62	GEAR, Direct Drive
63	SPACER, Input Shaft Rear Bearing
64	BEARING, Input Shaft Rear
65	CAP, Front Output Shaft Rear Bearing
66	HUB, Brake
67	NOT USED
68	NOT USED
69	GASKET
70	BREATHER, Oil
71	COVER, Transfer Case Housing

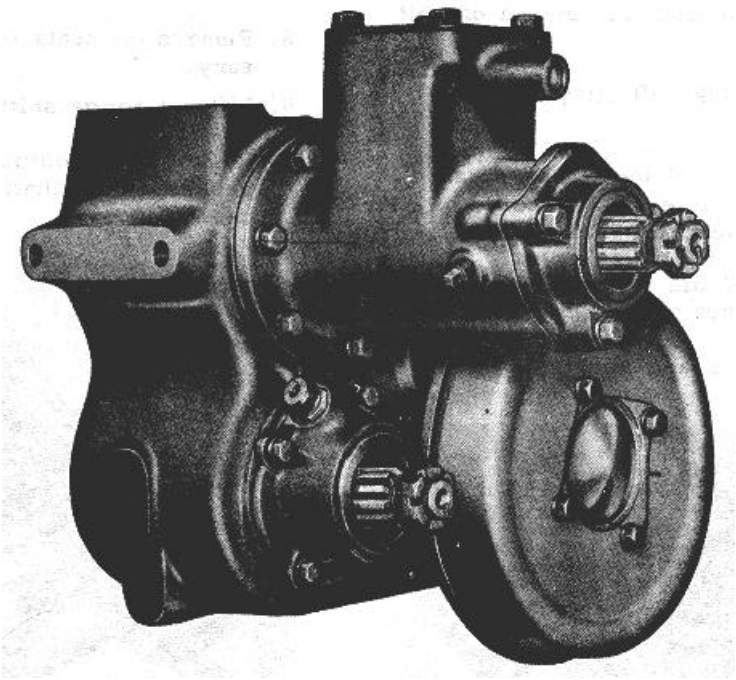


Fig. 2

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DESCRIPTION

A transfer case is a gear box located between the main transmission and rear axle. Its purpose is to transfer power from the transmission to the front driving axle as well as the rear driving axle.

The transfer case incorporates a front axle declutch which is used to drive the front axle whenever the vehicle is used on off-road operations or operated on steep grades.

The transfer case also provides an extra gear reduction (Lo) in the vehicle power train. The TC-155 and TC-156 transfer cases are four shaft clover-leaf type, two-speed units. The case contains constant mesh helical and spur gears with the shafts supported by roller and ball bearings.

DISASSEMBLY

Disassembly of Transfer Case

After removing the unit, thoroughly clean the exterior portion before proceeding with the disassembly.

1. Remove drain plug from the bottom of unit and drain oil.
2. Remove nuts and take off all yokes or flanges.
3. Remove capscrews and lockwashers, and pull off the power-take-off assembly, or rear cover if PTO is not used (Fig. 3).
4. Remove capscrews and lockwashers and lift off cover and gasket (Fig. 4).
5. Remove detent balls and springs.

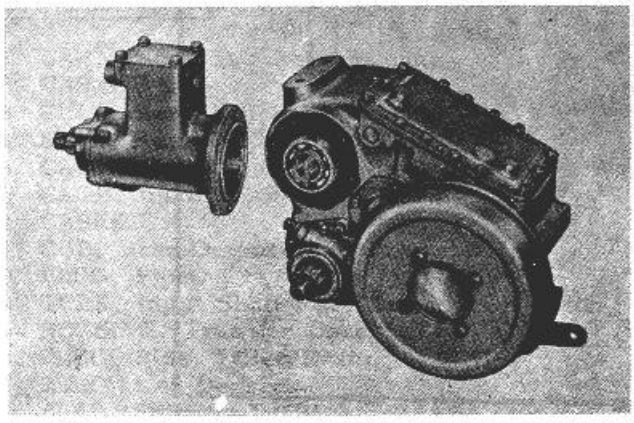


Fig. 3

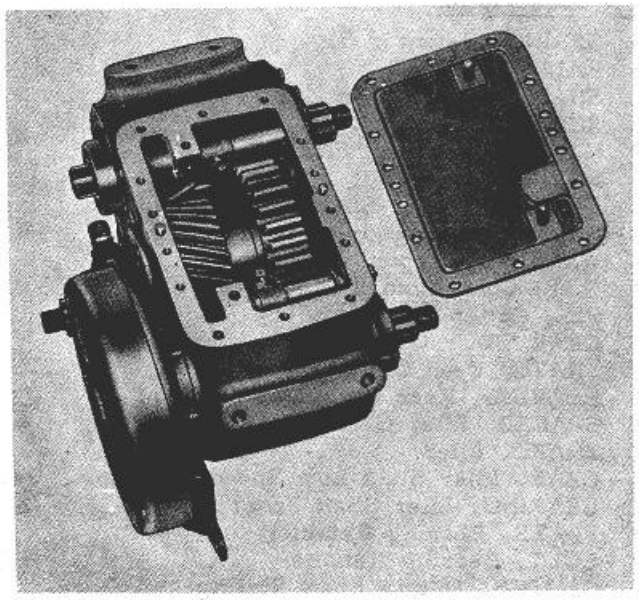


Fig. 4

6. Cut lock wire and loosen shift fork set screws.
7. Pull both shift shafts out through front of case, if possible (Fig. 5). Otherwise, use a soft metal drift and drive shafts and expansion plugs out through rear of case.
8. Remove oil seals from front of case, if necessary.
9. Lift out range shift fork and declutch fork.
10. Remove front output shaft bearing cap and gasket. Pull shaft and declutch collar from case (Fig. 6).

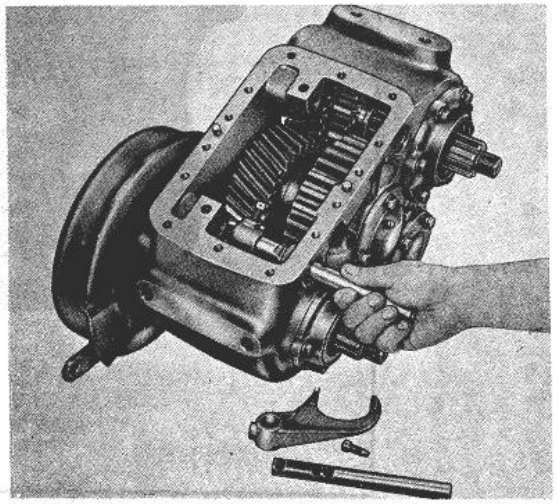


Fig. 5

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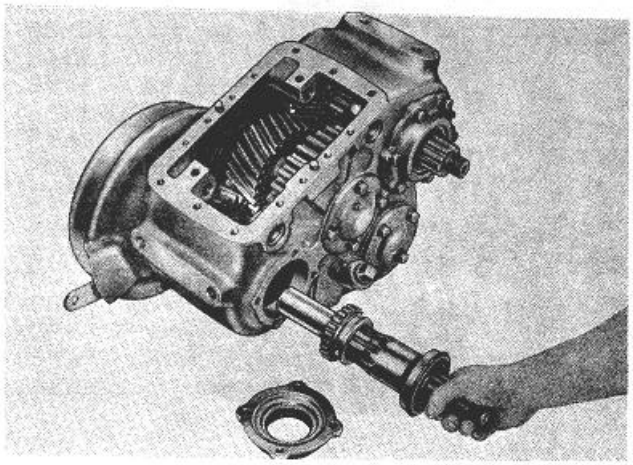


Fig. 6

11. Slide a bar through front output shaft gear and tap out small and large expansion plugs located in brake section (Fig. 7).

12. Cut lock wire and remove capscrews from brake drum. Take off drum.

13. Remove brake hub retaining ring (Fig. 8).

14. Remove hub with a suitable puller (Fig. 9).

15. Unhook brake shoe return springs; remove brake shoes and lever (Fig. 10).

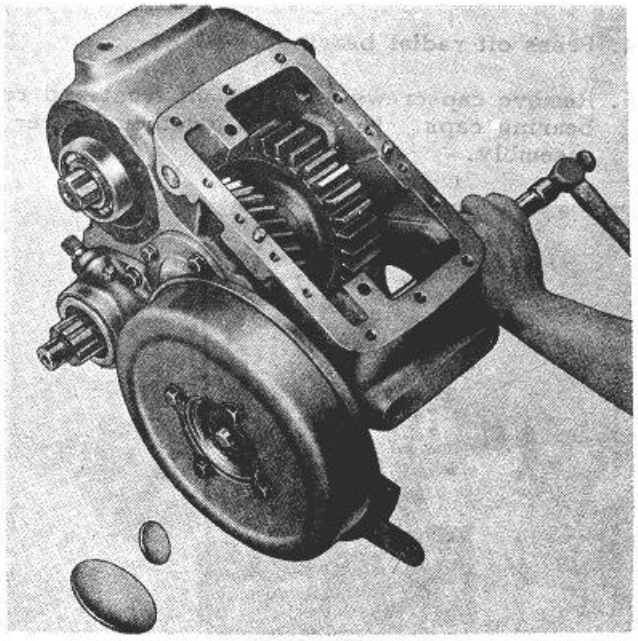


Fig. 7

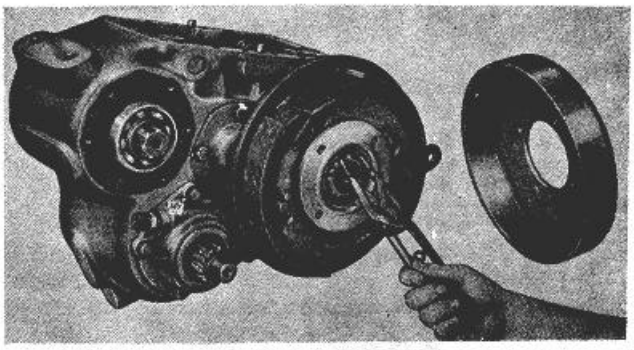


Fig. 8

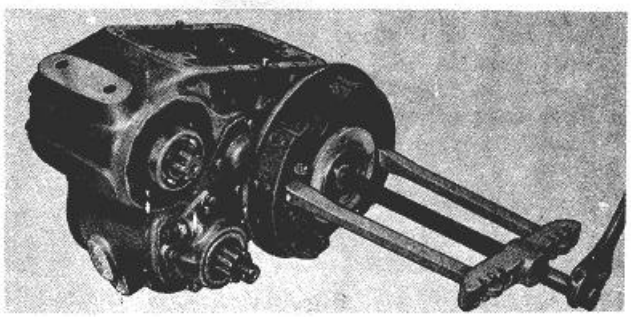


Fig. 9

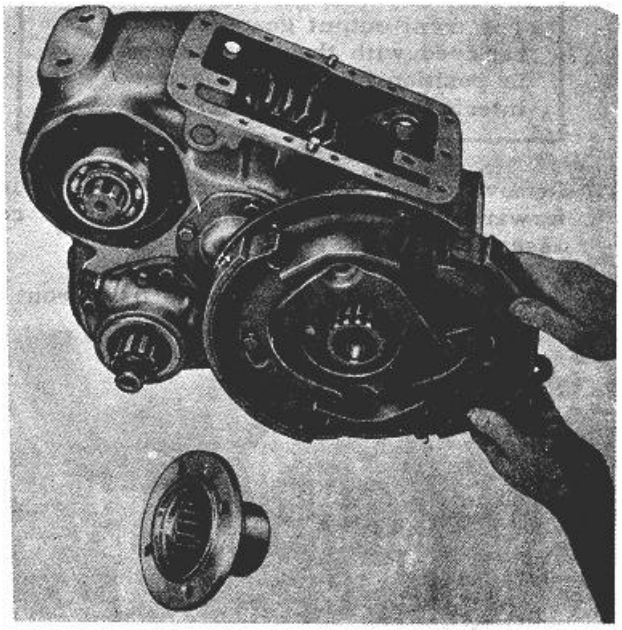


Fig. 10

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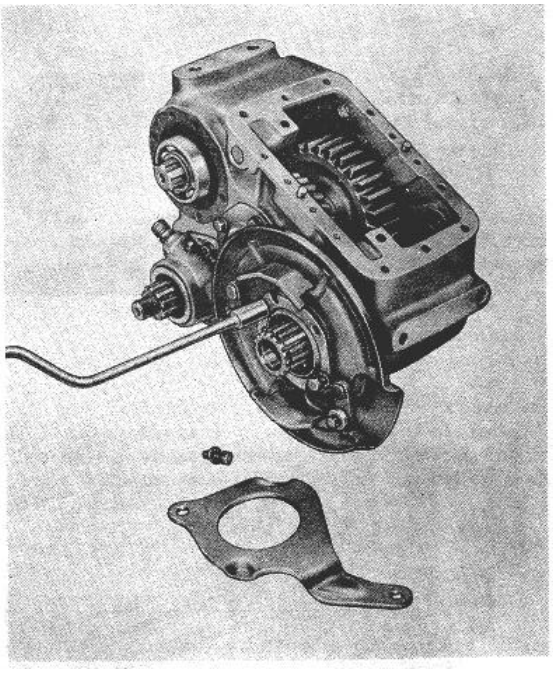


Fig. 11

16. Remove mounting bolts and take off backing plate assembly with washer, deflector and gasket (Fig. 11).

IMPORTANT

The front output gear cannot be removed with the idler assembly in position because the gears interfere with each other.

17. Remove front and rear bearing caps. Wire forward bearing cap shims together for reassembly.

18. Remove bearing retainer plate from front end of idler shaft; then press shaft out through rear of case (Fig. 12).

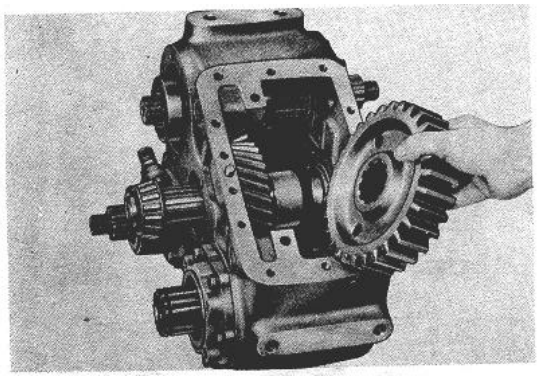


Fig. 12

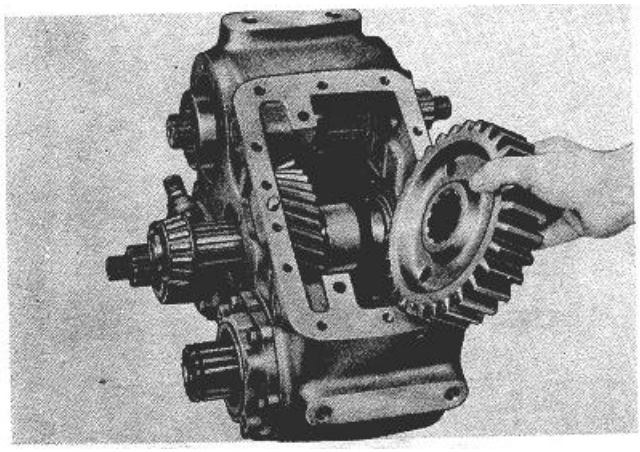


Fig. 13

19. Lift out the Lo gear, gear spacer and front bearing (Fig. 13).

20. Remove Hi gear. Tap front bearing cup from case (Fig. 14).

21. Remove snap ring and press rear bearing from idler shaft.

22. With idler assembly removed, the front output gear and bearing can be removed. Remove rear bearing cap and gasket.

23. Take off bearing snap ring and tap gear into case; reach through cover opening and lift out gear and bearing (Fig. 15).

24. Press off radial bearing.

25. Remove capscrews and take off front and rear bearing caps. Wire shims together for reassembly.

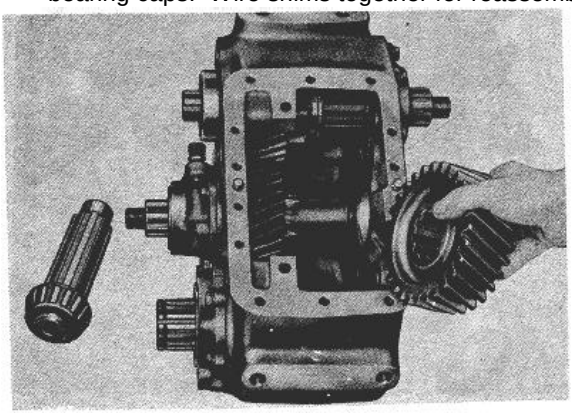


Fig. 14

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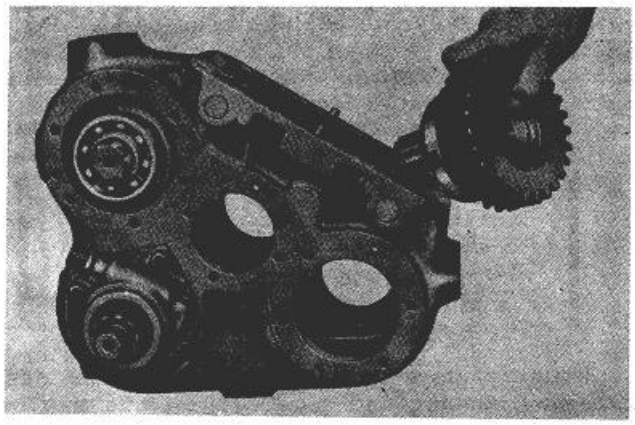


Fig. 15

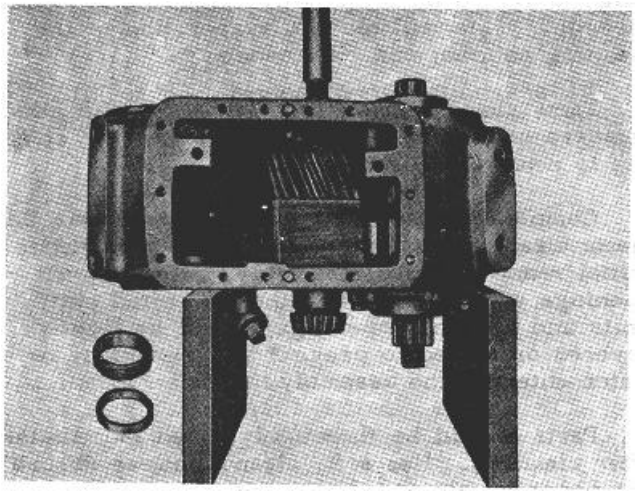


Fig. 16

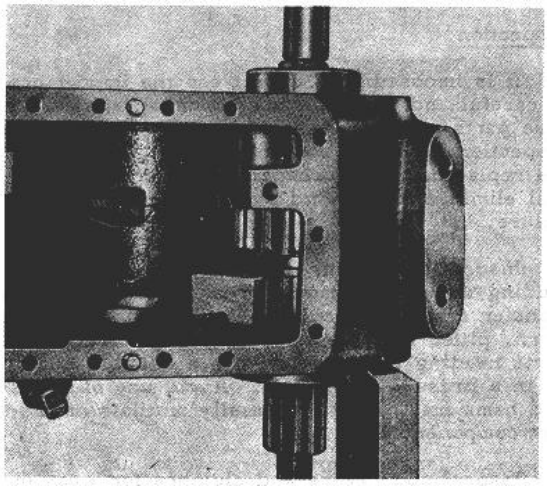


Fig. 17

26. Remove speedometer drive gear and spacer.

27. Block gear with a piece of wood and press rear output shaft and front bearing out of the case as shown (Fig. 16). The gear and rear bearing can be lifted out through cover hole.

28. Remove input shaft front bearing cover. Wire shim pack together for reassembly.

29. Using a block of wood between sliding gear and case, press out input shaft and front bearing (Fig. 17). Do not pound on shaft if gear becomes bound.

30. Lift out sliding gear, drive gear and spacer (Fig. 18). Remove front bearing from shaft.

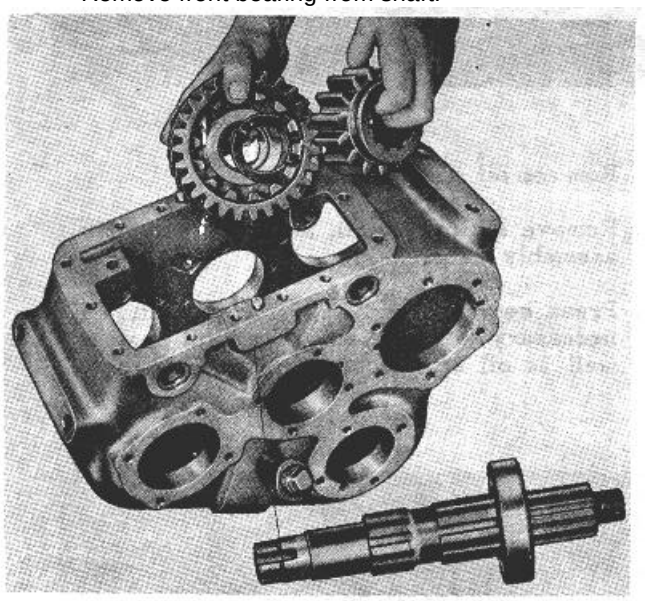


Fig. 18

Disassembly of Power-Take-Off

1. Remove capscrews and lockwashers; lift off cover and gasket

2. Take out detent spring and ball.

3. Cut wire and loosen shift fork set screw.

4. Tap shift shaft out through rear of housing (expansion plug will fall out).

5. Remove shift shaft and shift fork (Fig. 19).

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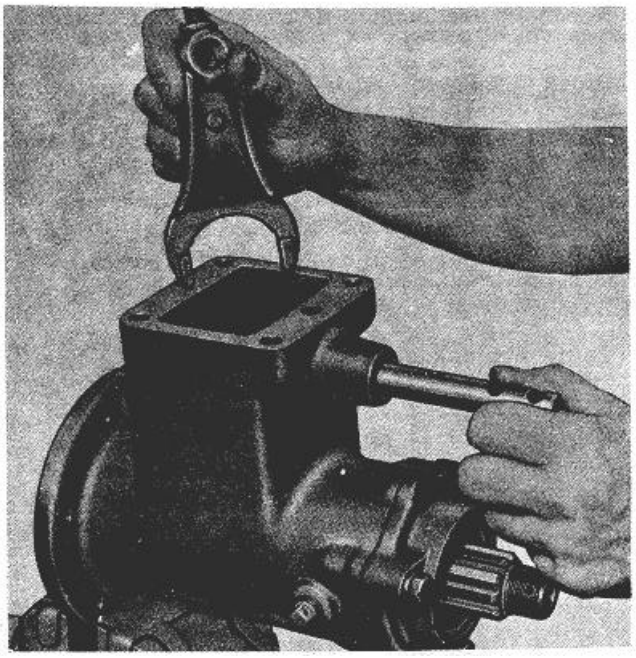


Fig. 19

6. Remove oil seal cage.

7. Remove sliding clutch and pull out shaft assembly (Fig. 20).

8. Press bearings and wiper from shaft. If necessary, remove shift shaft oil seal as well as oil seal located inside housing.

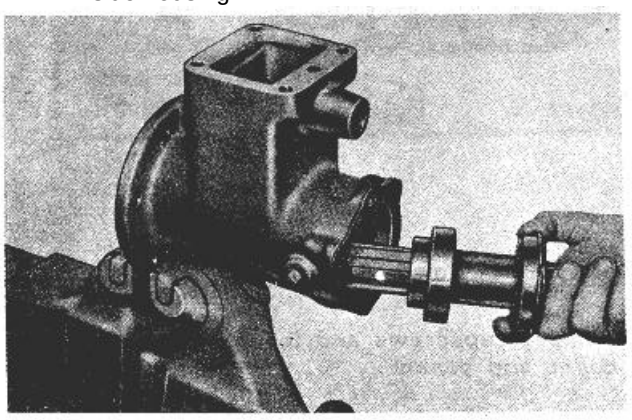


Fig. 20

CLEANING, INSPECTION AND REPAIR

Cleaning Clean parts having ground and polished surfaces, such as gears, bearings and shafts, with solvent type cleaners such as emulsion cleaners or petroleum solvents excluding gasoline. Do not clean these parts in a hot solution tank or with water and alkaline solutions such as sodium hydroxide, orthosilicates or phosphates.

CAUTION

Exercise care to avoid skin rashes, fire hazards and inhalation of vapors when using solvent type cleaners.

Rough parts such as transfer case housings, accessory housing and some brake parts may be cleaned in hot solution tanks with mild alkali solutions providing these parts are not ground or polished. Parts should remain in the tank long enough to be thoroughly cleaned and heated through. This will aid the evaporation of the cleaning solution and rinse water.

Parts cleaned in solution tanks or with alkali cleaners should be thoroughly rinsed after cleaning to remove all traces o alkali.

Completely assembled transfer cases may be steam cleaned, on the outside only, to facilitate initial removal and disassembly, providing all openings are closed. Breathers, vented shift units and all other openings should be tightly covered or closed to prevent the possibility of water entering the assembly.

Parts should be thoroughly dried immediately after cleaning. Use soft, clean, lintless absorbent paper towels or wiping rags free of abrasive material such as lapping compound, metal filings or contaminated oil. Bearings should never be dried by spinning with compressed air.

Inspection

It is impossible to overstress the importance of careful and thorough inspection of transfer case parts prior to reassembly. Thorough visual inspection for indications of wear or stress and the replacement of such parts as are necessary will eliminate costly and avoidable drive unit failure.

Inspect all bearings, cups and cones, including those not removed from parts of the transfer case, and replace if rollers or cups are worn, pitted or damaged in any way. Remove parts needing replacement with a suitable puller or in a press with sleeves. Avoid use of drifts and hammers. They may easily mutilate or distort component parts.

Inspect spur gears and clutches for wear or damage. Gears which are scored, pitted, ridged or worn should be replaced.

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Parts that have been cleaned, dried, inspected and are to be immediately reassembled should be coated with light oil to prevent corrosion. If these parts are to be stored for any length of time, they should be treated with a good rust preventive and wrapped in special paper or other material designed to prevent corrosion.

Repair

Replace all worn or damaged parts. Hex nuts with rounded corners, all lockwashers, oil seals and gaskets should be replaced at the time of overhaul. Use only genuine International replacement parts for satisfactory service. For example, using gaskets of foreign material generally leads to mechanical trouble due to variations in thickness and the inability of certain materials to withstand compression, oil, etc. Remove nicks, mars and burrs from machined or ground surfaces. Threads must be clean and free to obtain accurate adjustment and correct torque. A fine mill file or India stone is suitable for this purpose. Studs must be tight prior to reassembling the parts.

When assembling component parts use a press where possible.

Tighten all nuts to correct torque. (See torque limits following service instructions.) Use soft iron locking wire to prevent possibility of wire breakage.

The burrs, caused by lockwashers, at the spot face of stud holes of cages and covers should be removed to assure easy reassembly of these parts.

ASSEMBLY

Assembly of Power-Take-Off

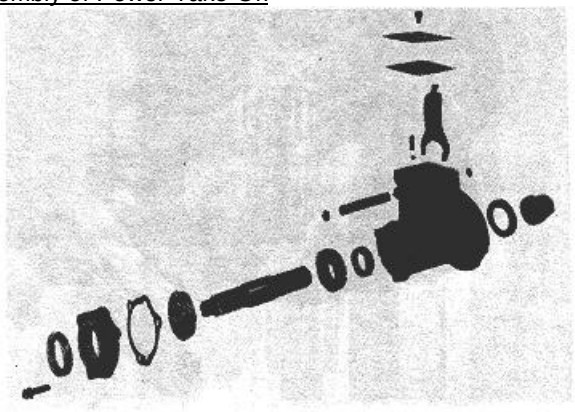


Fig. 21

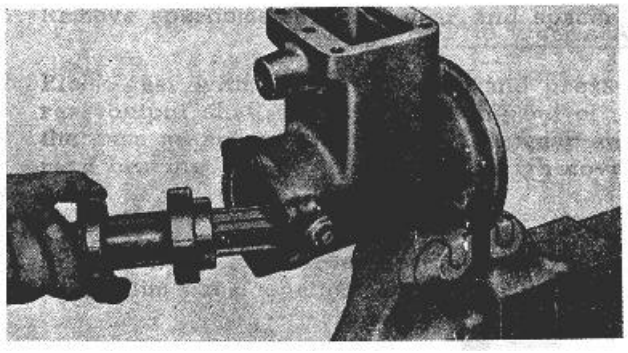


Fig. 22

1. Install ball bearings on power-take-off shaft.
2. Position wiper against inner bearing. Install snap ring in groove of outer bearing,
3. Slide shaft assembly into housing and install sliding clutch on inner end (Fig. 22).
4. Position a new gasket and install oil seal cage assembly. Secure with capscrews and lockwashers.
5. Place shift fork in groove of sliding clutch. Slide shift shaft into bore of fork (Fig. 23).
6. Line up recess in shaft with set screw and tighten screw. Lock wire the set screw to fork.
7. Install expansion plug in shift shaft hole. If necessary, replace shift shaft oil seal located in front of housing.

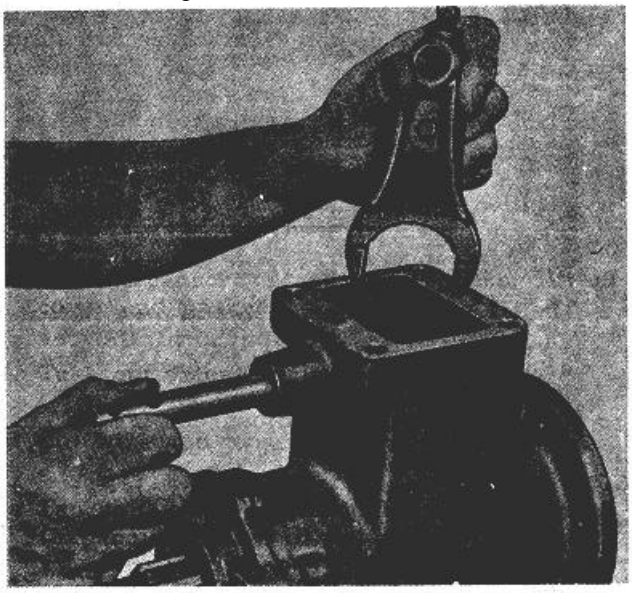


Fig. 23

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Assembly of Transfer Case

1. Install front bearing on input shaft with shielded side against shoulder (Fig. 24).

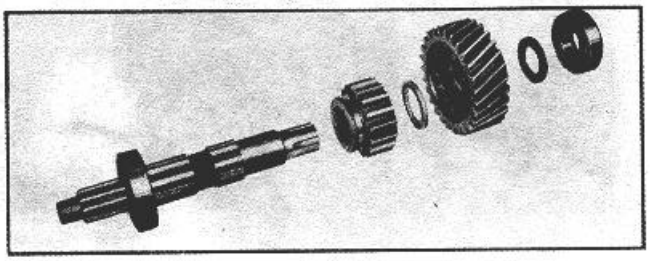


Fig. 24

2. Start input shaft into case. Mount sliding gear, spacer and drive gear (with bushing) on shaft (Fig. 25).

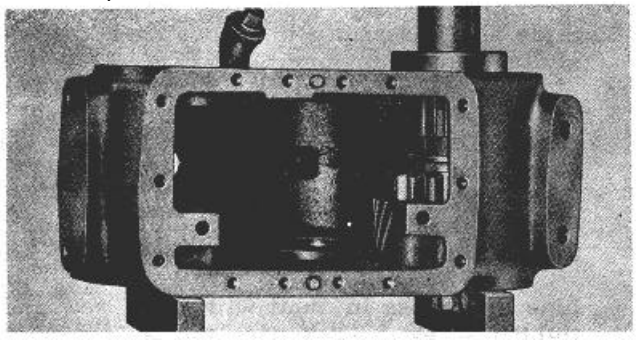


Fig. 25

3. Tap input shaft into position using a suitable sleeve against the inner race of front bearing.

4. Position original shim pack plus .254 mm (.010") more to make sure there is end play in assembly. Install front cover and tighten capscrews.

5. Place thrust washer on shaft and install rear bearing with shielded side toward the inside.

6. Position a new gasket and attach power-takeoff (or cover, if used) to rear of case. Tighten capscrews.

7. Mount a dial indicator on the unit. Set stem against front end of input shaft and check the amount of end play in the assembly (Fig. 26). Remove enough shims from under bearing cap to arrive at an adjustment of .076 mm .127 mm (.003" .005") end play.

8. Reposition bearing cap, insert capscrews and tighten to specified torque. Remove power take-off for convenience in handling transfer case.

9. Press front bearing onto rear output shaft with suitable sleeve.

10.

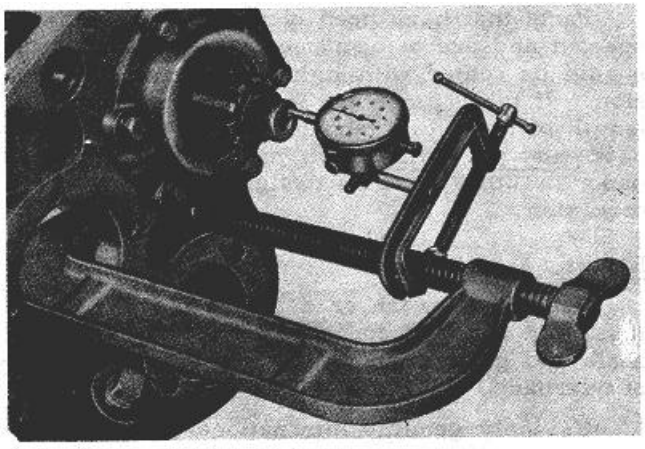


Fig. 26

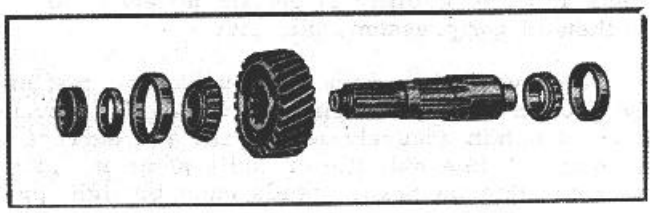


Fig. 27

10. Hold rear output gear in position inside case and slide shaft through it (Fig. 28).

11. Install front bearing cup and original shim pack plus .254 mm (.010"). Install bearing cover, lockwasher and tighten capscrews.

12. Press rear bearing on shaft with a suitable sleeve (Fig. 29); then Lap bearing cup into position.

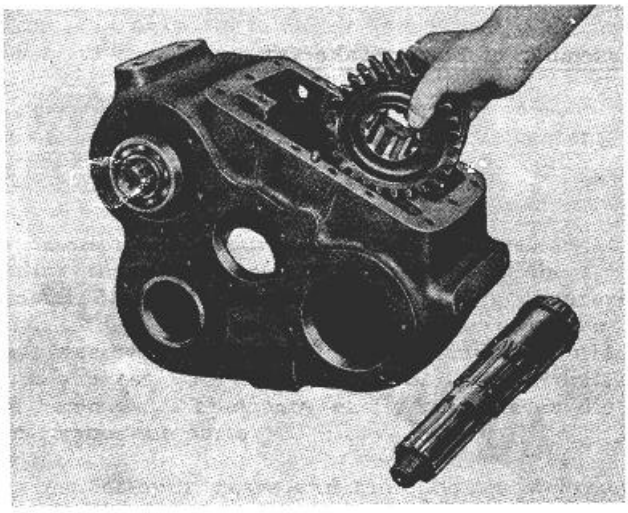


Fig. 28

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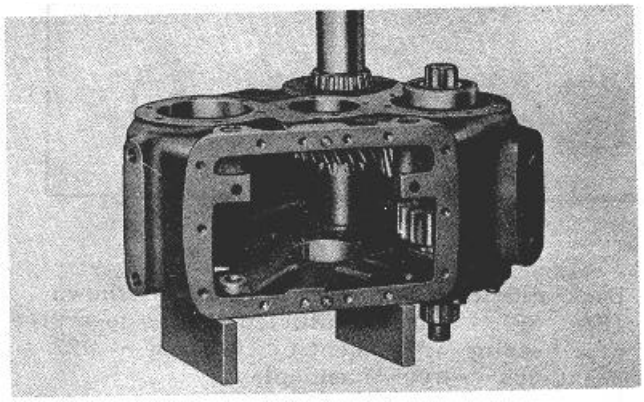


Fig. 29

13. Install spacer and speedometer drive gear over shaft.

14. Position new gasket, bearing cap (and oil seal) over shaft. Install lockwashers and capscrews and tighten to specified torque.

15. Rotate shaft to seat beatings. Mount a dial indicator against rear end of shaft to check amount of end play in assembly (Fig. 30). Remove sufficient shims from under front bearing cap to arrive at an adjustment of zero end play and zero preload.

IMPORTANT

The front output gear must be installed in case before idler assembly is installed.

16. Install ball bearing on hub of gear. Position gear and bearing in case and install snap ring on bearing (Fig. 31).

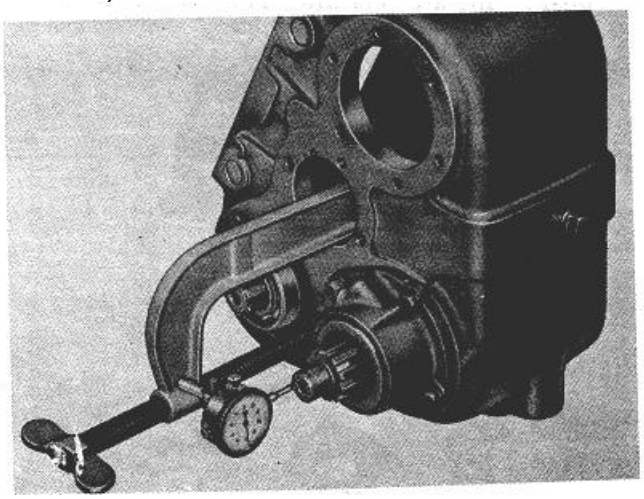


Fig. 30

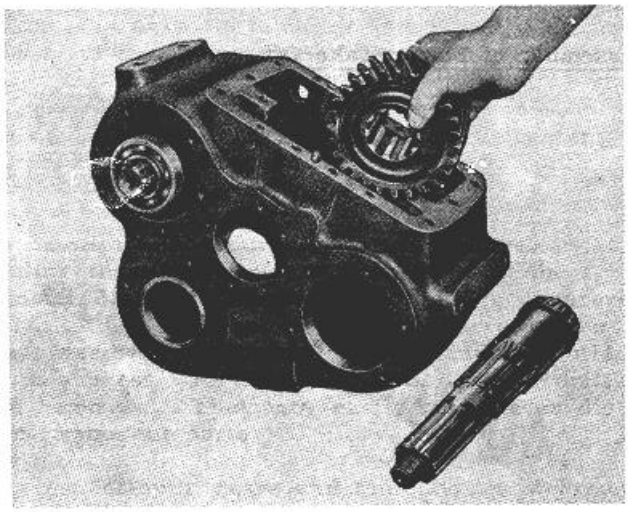


Fig. 31

17. Install rear bearing cap over a new gasket. Insert capscrews and lockwashers and tighten to specified torque.

18. Press rear bearing on idler shaft. Install snap ring.

19. Hold Hi gear in position inside case and tap idler shaft through it with soft hammer. The short hub side of gear goes to the outside, rear (Fig. 33).

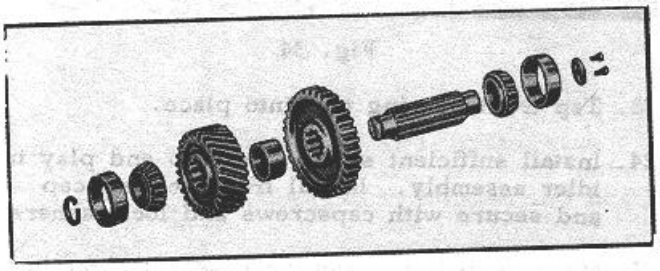


Fig. 32

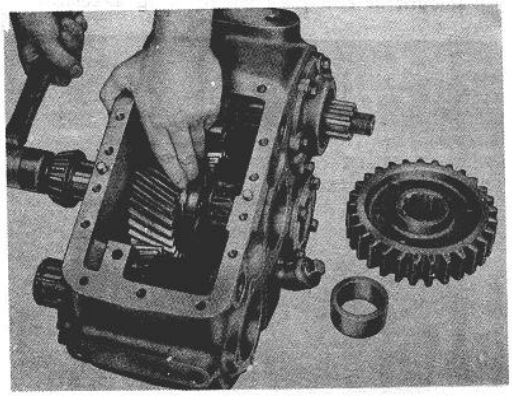


Fig. 33

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20. Install gear spacer on shaft and then install Lo gear with long hub toward outside (front) of case.

21. With shaft in position, install rear bearing cup in case. Use a new gasket and install rear bearing cap, lockwashers and capscrew. Tighten capscrews to specified torque.

22. Drive front bearing onto idler shaft. Hold shaft rigid to avoid damaging rear bearing and cup (Fig. 34). Install bearing retainer plate and capscrews. Lock wire.

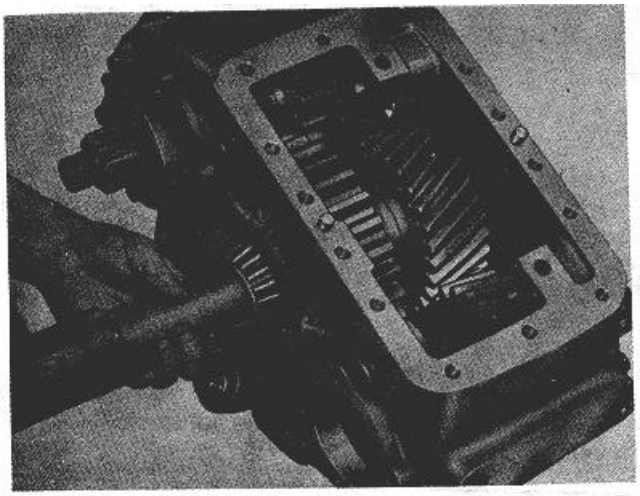


Fig. 34

23. Tap front bearing cup into place.

24. Install sufficient shims to set up end play in idler assembly. Install front bearing cap and secure with capscrews and lockwashers.

25. Mount a dial indicator on case with stem set against inside face of Lo gear. Check the amount of end play by working assembly back and forth with two prybars as shown (Fig. 35). Remove sufficient shims to arrive at a bearing adjustment of .076 mm .127 mm (.003" .005") end play.

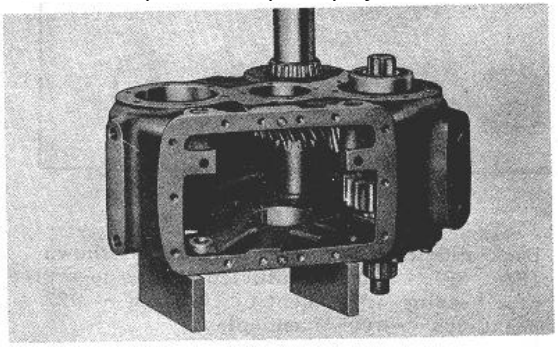


Fig. 35

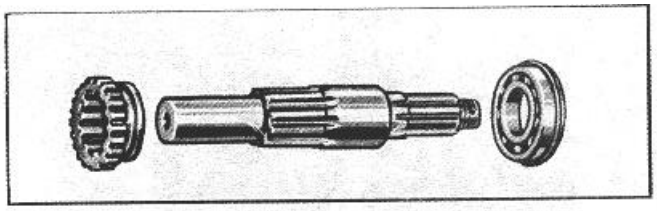


Fig. 36

26. Install ball bearing on front output shaft with bearing snap ring toward outside.

27. Install sliding collar on shaft. Slide shaft into case (Fig. 37).

28. With shaft in position, install a new gasket, bearing cap and oil seal, lockwashers and capscrews. Tighten capscrews to specified torque.

29. Position a new gasket and then mount backing plate, deflector and stamped washer. Insert capscrews and star washers and tighten to specified torque (Fig. 38).

30. Position brake lever on backing plate.

31. Position brake shoes on backing plate with actuating pawl in web slot (Fig. 39).

32. Hook up brake shoe return springs.

33. Slide brake hub over splines of front output gear. Install retaining ring (Fig. 40).

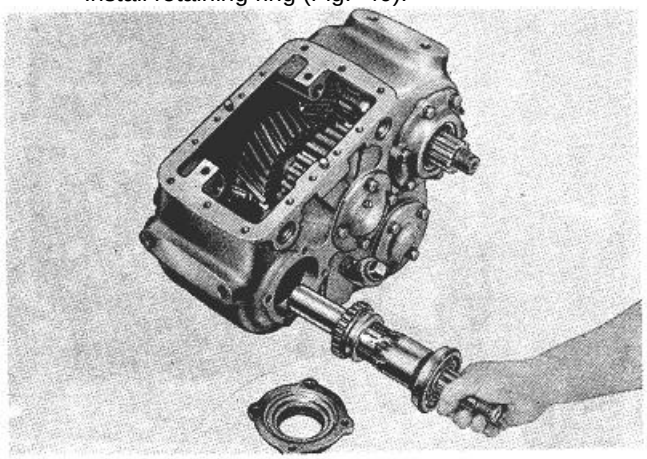


Fig. 37

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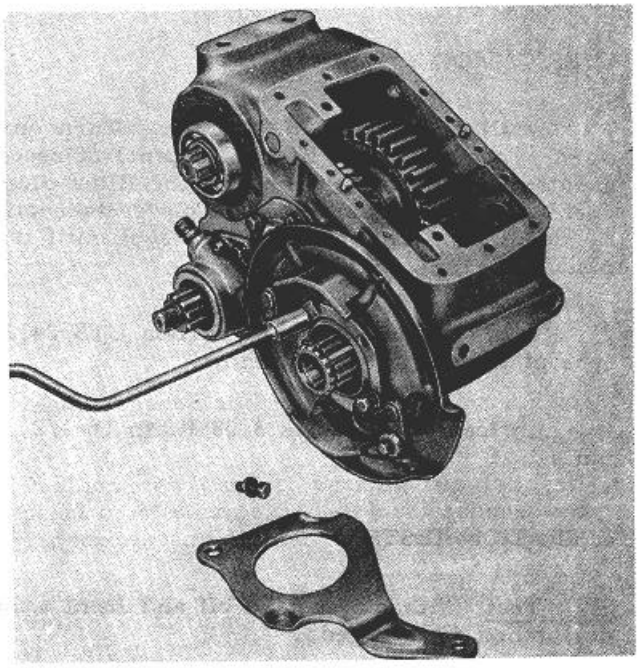


Fig. 38

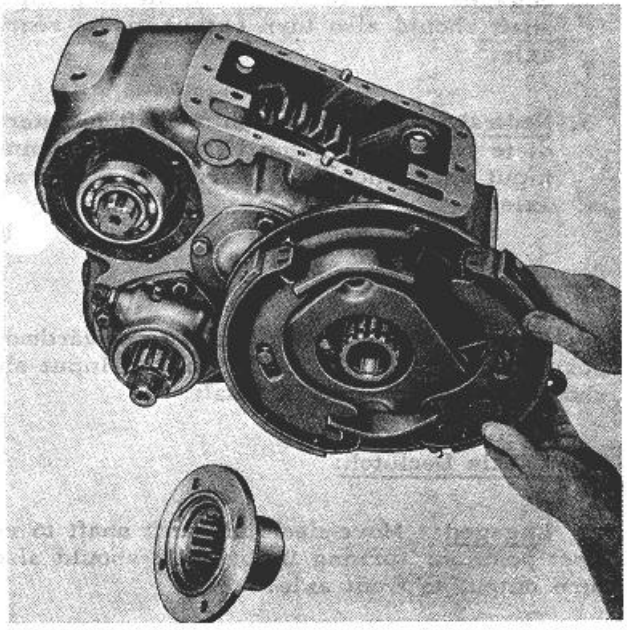


Fig. 39

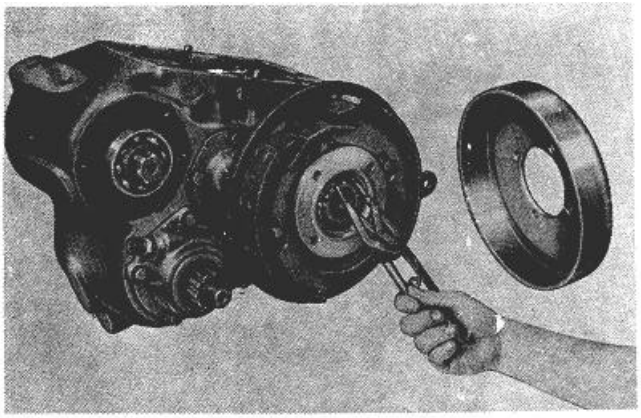


Fig. 40

34. Install brake drum and lockwashers and capscrews. Tighten capscrews to specified torque and insert lock wire.

35. Install expansion plugs. The smaller goes in the bore of front output gear and the larger in brake hub.

36. Install new shift shaft oil seals in case.

37. Position declutch fork in collar.

38. Grease declutch shift shaft and slide it into case and through fork (Fig. 41).

39. With shift shaft in position, insert set screw. Tighten screw and lock wire to fork.

40. Position range shift fork in sliding gear.

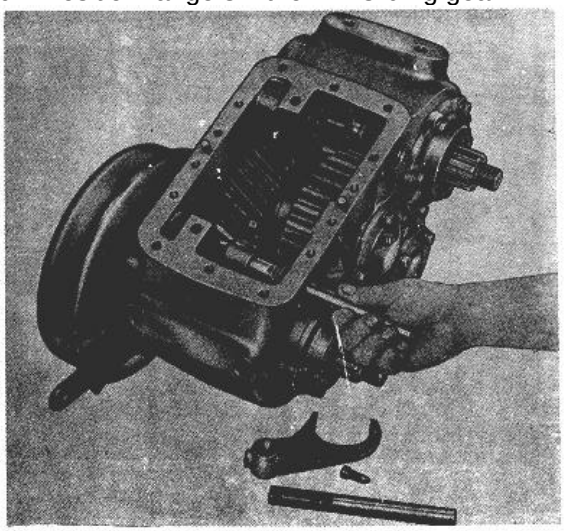


Fig. 43

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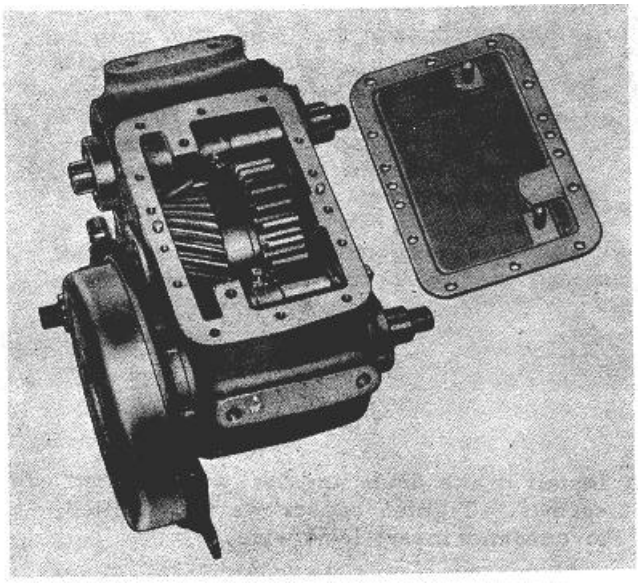


Fig. 42

41. Slide range shift shaft through fork. Install set screw, tighten and lock wire to shift fork (Fig. 42).

42. Install expansion plugs at rear of case and flatten to expand.

43. Place detent balls and springs in position in case.

44. Install cover with a new gasket and tighten capscrews to specified torque.

45. Install power-take-off assembly over a new gasket (Fig. 43). Secure with capscrews and lockwashers. 46. Install yokes or flanges and nuts and tighten to specified torque.

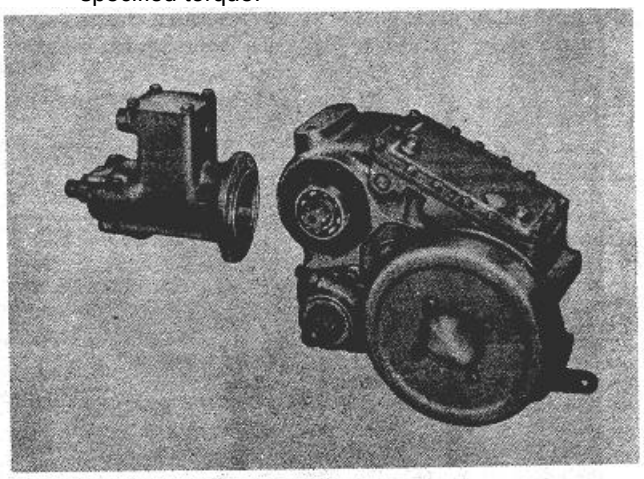


Fig. 43

LUBRICATION

Install drain plug and tighten. Turn unit upright and pour .47 liter (1/2 pint) of recommended gear lubricant through the filter plug opening. Add some oil to the power-take-off. Do not fill the unit to specified level until it is installed under the vehicle.

Refer to LUBRICATION, Section CTS-2412 for type of lubricants recommended.

Lubricant capacity is 3.08 liters (6-1/2 pints).

OPERATION TESTS

Shift Test (With power-take-off and front axle declutched disengaged).

1. High Range: Move range shift shaft to the rearmost position (so the sliding gear engages direct drive gear); turning input shaft should also turn output to the rear axle.

2. Low Range: Move range shift shaft to forwardmost position (so the sliding gear disengages direct drive gear); turning input shaft should also turn output to the rear axle.

3. Neutral: Move range shift shaft to intermediate position between Hi and Lo; turning input shaft should not turn output to rear axle.

Power-Take-Off

Engaged: Move shift shaft to forwardmost position to engage the PTO: turning input shaft should also turn the PTO shaft.

Front Axle Declutch:

Engaged: Move declutch shift shaft to rearmost position; turning input shaft should also turn output to front axle.

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TORQUE CHART

CAPSCREWS		
Location on Unit	Torque, N.m (Lb Ft)	
	Minimum	Maximum
Top Cover	52 (38)	66 (49)
Bearing Caps (All)	52 (38)	66 (49)
Brake Drum	81 (60)	104 (77)
Brake Mounting	81 (60)	104 (77)
PTO to Case	52 (38)	66 (49)
PTO Bearing Cap-to-Housing	52 (38)	66 (49)
PTO Top Cover	52 (38)	(49)
YOKE OR FLANGE NUTS		
Input Shaft	407 (300)	543 (400)
Front Output Shaft	407 (300)	543 (400)
Rear Output Shaft	407 (300)	543 (400)
PTO Shaft	407 (300)	543 (400)

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SPECIFICATIONS

IH MODEL	TC-155, TC-156
IH CODE	13155, 13156
TYPE	Constant Mesh
INPUT SHAFT:	
Bearings	Ball
Shaft End Play	.381 mm (.015") Max.
Shaft Adjustment Method	Shims
Shims Available	.076 mm (.003") .127 mm (.005") .254 mm (.010")
Drive Gear Thrust Washer Thickness	4.55 mm - 4.59 mm (.179" - .181")
Rear Bearing Thrust Washer Thickness	4.09 mm - 4.22 mm (.161" - .166")
IDLER SHAFT:	
Bearings	Tapered Roller
Bearing Adjustment	Zero End Play - No Preload
Bearing Adjustment Method	Shims
Shims Available	.076 mm (.003") .127 mm (.005") .254 mm (.010")
SHIFT BAR POPPET BALL SPRING:	
Free Length	37.70 mm (1-31/64")
Newtons (Pounds Pressure) at 25.4 mm (1")	227 - 267 N (50 - 60 Lbs)
LUBRICANT CAPACITY	3.08 Liters (6-1/2 Pints)
UNIT SERIAL NUMBER LOCATION	Top of Case

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WHEELS, RIMS, TIRES

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CHAPTER I

WHEELS

GENERAL

The information presented herein covers factory installed wheels and hubs for medium and heavy duty vehicles. Many types of wheels are available and they vary in size, types (disc or cast) and materials (steel or aluminum). Fundamentally, they are the same in that all wheels (or hubs for disc wheels) are mounted to the axles on tapered roller bearings.

SAFETY PRECAUTIONS

Always deflate tires completely before removing locks or side rings.

Always inspect and clean all parts before assembly.

Always inflate tires in safety cage.

Always use a "clip-on" air chuck with remote valve to inflate tires.

Never mix parts of different types or size.

Never use cracked, bent or badly rusted parts.

Never reinflate flat tire on vehicle--use the spare.

Never add air until certain each side or lock ring is fully seated.

WHEEL BEARING ADJUSTMENT

Satisfactory wheel operation and long bearing life depends on correct wheel bearing installation, lubrication and adjustment. The following will help you perform these required services for wheels and hubs.

FRONT WHEEL BEARINGS

Wheels or hubs, bearing cups, nuts, locks, hub caps, shafts and spindles are to be free from any foreign matter. Bearing cones must be properly packed with specified lubricant if wheels are grease packed (see LUBRICATION, Section CTS-2412).

If wheel bearings are oil lubricated dip bearing cones in lubricant to provide proper starting lubrication. Outer surface of bearing cone and matching surface of cup may be coated with lubricant to promote cone-to-cup adhesion and facilitate assembly.

After wheel (or hub) and bearings are assembled in place on the spindle, tighten the wheel bearing adjusting nut to 69 N.m (50 ft lbs) while rotating the wheel. Then back off the nut 1/4 turn. If the lock or cotter key can be installed at this position, do so; if not, tighten to the nearest locking position and insert new key or lock. Bent type lockwasher is to have one tab bent over the adjusting nut. For axles that have double nut type lock, tighten jam nut to 136 203 N.m (100-150 ft lbs) and bend one tab of the lockwasher over the jam nut (Fig. 1). These procedures are intended to result in zero to .25mm (.010") end play with no preload.

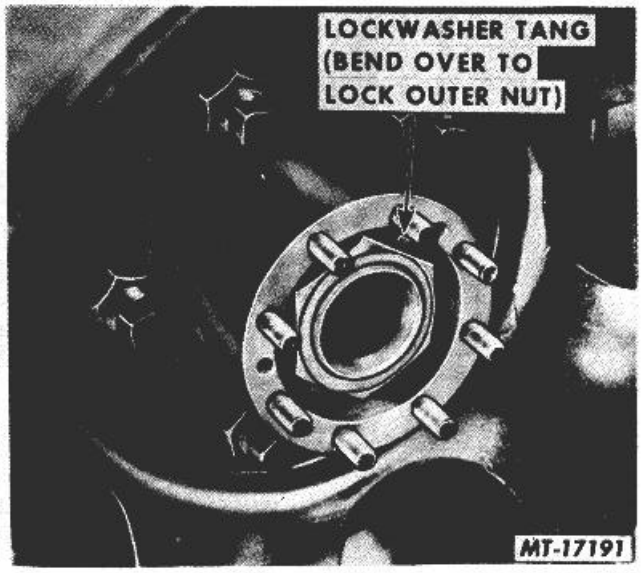


Fig. 1

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NOTE:

The cotter key should be inserted with the long tang toward the end of the spindle. Bend long tang of cotter key over end of spindle. Clip remaining tang leaving just enough stock to bend down against side of nut. A correctly installed cotter key should have the appearance as shown in Figure 2.

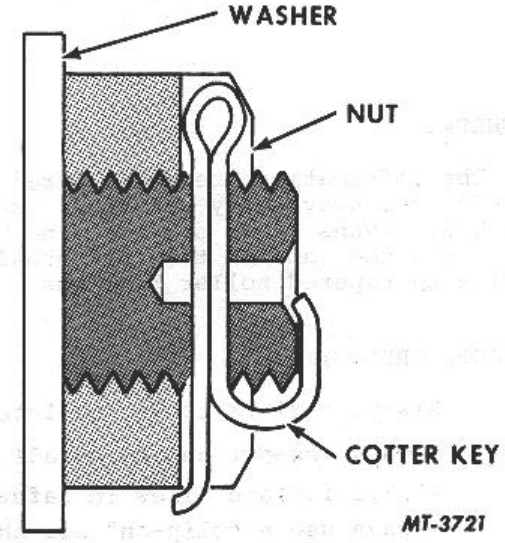


Fig. 2

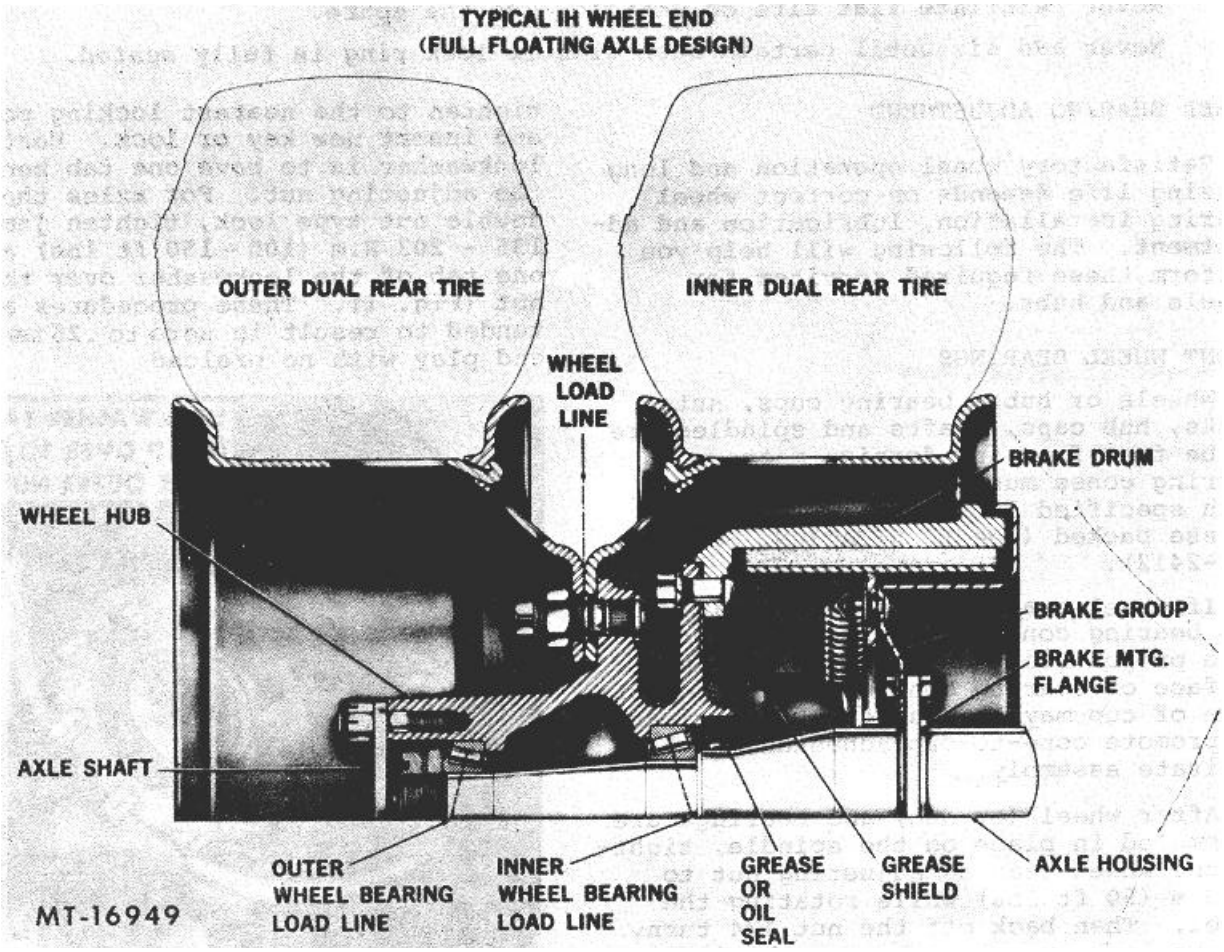


Fig. 3 Heavy Duty

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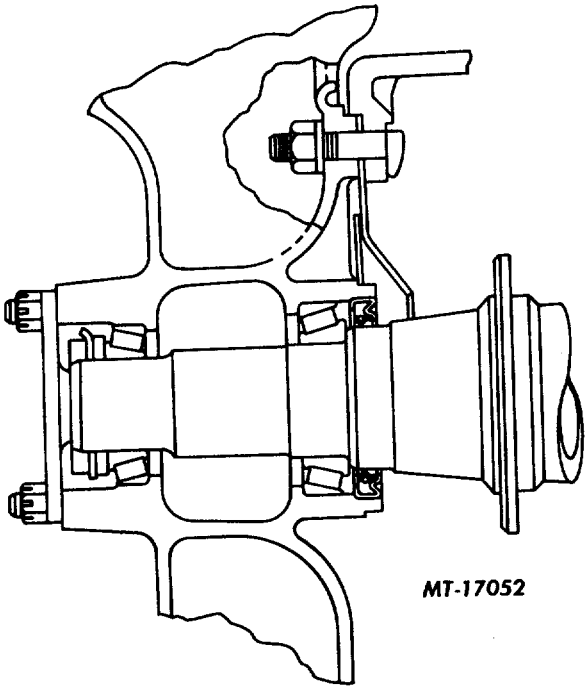


Fig. 4 Medium Duty

REAR WHEEL BEARINGS

Full Floating axle wheel bearings (Fig. 3 and Fig. 4) are adjusted by an adjusting (inner) nut on end of axle. Install adjusting nut and rotate wheel while tightening to be sure bearings are properly seated.

NOTE:
68.0 N.m (50 ft lbs) torque on adjusting nut is considered sufficient to seat bearings.

Back off adjusting nut 1/4 turn and install lockwasher and jam nut. Tighten jam nut to 203 N.m (150 ft lbs) torque and bend over lockwasher tang to secure nut. Assemblies which use doweled adjusting nut and pierced wheel bearing nut lock require 271 407 N.m (200 300 ft lbs) torque on outer lock nut.

OIL SEALS (OIL LUBRICATED WHEEL BEARINGS)

Various precautions are necessary when oil seals are installed in wheels and also when wheels with oil seals are installed on axles. To insure satisfactory performance from oil seals, the following information has been prepared to guide and assist in proper installation.

Due to the various types of front and rear axle hub seal installations, check axle ring and hub seal position at time of disassembly to assure proper reassembly of new seal and axle ring (wiper).

OIL SEALS WITH AXLE RING (WIPER)

Axle Ring (Wiper) Installation

1. Thoroughly clean all parts: axle tube or spindle, bearings, nuts and inside of wheel hub.

2. Remove burrs from axle tube or spindle shoulder. Shoulder must be smooth.

3. Apply a thin coat of Permatex No. 2 to inside perimeter of axle ring.

4. Place axle ring on axle tube or spindle using an installing tool (Fig. 5).

NOTE:
A suitable installing tool can be made locally by obtaining a piece of standard 8.9 cm (3-1/2") inside diameter tubing approximately 25.4 cm (10") long.

Weld a used close fitting bearing cone or large washer to one end and similarly close opposite end with a plate. This will enable tool to pilot squarely onto axle tube and permit driving force to be centered over the complete ring. The same type of tool can be used for both front and rear axles.

The care with which the axle ring is installed cannot be over-emphasized. Damage to this ring will result in shortened seal life.

5. Tap on end of axle tool driving axle ring firmly on shoulder until axle tool contacts shoulder. Remove excess Permatex.

6. Check position of axle ring to make sure edge of ring is parallel with shoulder.

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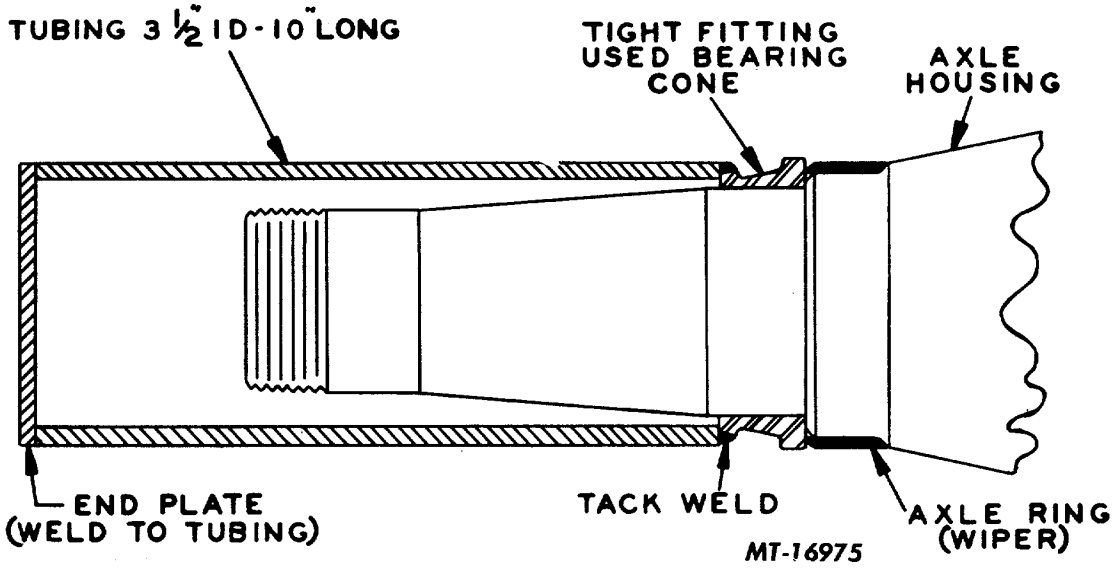


Fig. 5

OIL SEAL INSTALLATION
(OIL SEAL WITH AXLE RING)

1. Remove burrs from inside back edge of hub. Hub must be smooth and free from burrs that will scratch the hub seal.

2. Apply a thin coat of Permatex No. 2 around the outside perimeter of hub seal. Permatex coating must be very light yet cover press fit area. Remember that Permatex is abrasive and should never be allowed to contact lip of leather seal nor contaminate oil.

3. Lay wheel flat with brake drum up. Place inner wheel bearing into bearing cup and place hub seal into starting position on hub.

4. Install hub seal using SE-1904 Installer Set (Fig. 6). Select the size disc which will apply force to outer edge of hub seal and prevent seal from becoming distorted or damaged.

5. Drive hub seal into hub until it bottoms in hub bore. Do not continue to drive after seal is once seated as this will distort or damage the seal. After removal of seal installer tool, clean off excess Permatex (for proper installation, note Fig. 7).

UNITIZED OIL SEAL
(AXLE RING NOT REQUIRED)

Unitized oil seals do not require axle rings (wipers) and minimize wear on the axle spindle as follows. The outer shell of the seal being pressure fit in the wheel hub rotates with the wheel around the sealing element which is pressure fit on the axle spindle. With the unitized seal when replacement is made, the worn surface created by the sealing lip is also replaced.

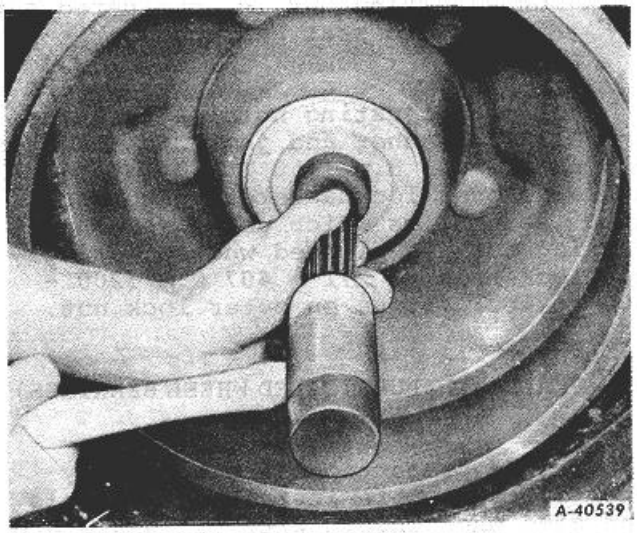


Fig. 6

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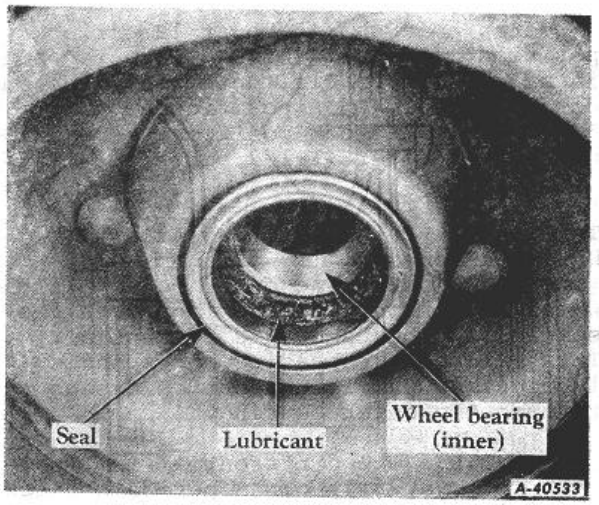


Fig. 7

Unitized Seal Installation

1. If wheel is being changed to a unitized seal from another type of seal, remove wear sleeve backing plates or axle rings as they are no longer required. Note the order of parts at disassembly to assure proper reassembly.

2. Thoroughly clean all parts and remove all burrs from spindle and hub bore. Inspect and replace all parts as warranted.

3. To install unitized seal in wheel, seat outer face of seal in the recess of tool adapter SE-2524 (Fig. 8). Insert centering plug of tool in bore of inner hearing cone (Fig. 9). Using the centering plug prevents cocking of the seal in wheel bore. Bore-tite coating on seal fills in minor imperfections in the wheel bore.

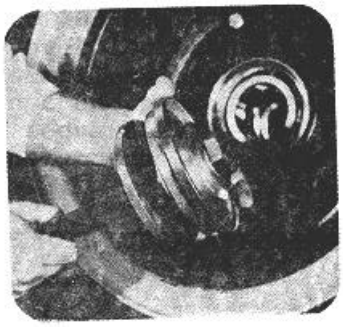


Fig. 8

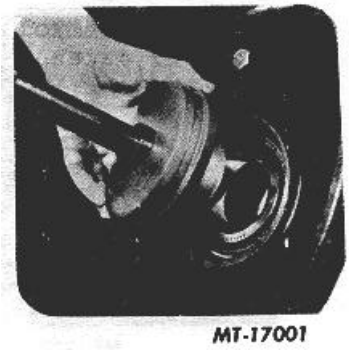


Fig. 9

4. Hold tool handle firmly and strike until sound of impact changes when seal is seated (Fig. 10).

NOTE:
Seal must be reseated any time wheel is removed.

A good check of proper seal installation is to move the synthetic sealing member with your fingers after installation in wheel hub. There should be a slight in and out movement possible.



Fig. 10

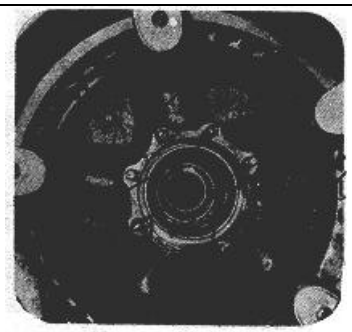
MOUNTING WHEEL ON SPINDLE INSTRUCTIONS
(With Oil Lubricated Bearings)

1. To insure good starting lubrication fill wheel cavity between the bearings with lubricant.

   Front Axle: Fill wheel cavity with engine oil or rear axle lubricant (see LUBRICATION, Section CTS-2412).

   Rear Axle: Fill with same gear lubricant as used in the axle differential.

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Fig. 11

2. Using a wheel dolly place wheel on spindle; care must be taken not to damage the seal, especially on the leading edge of the spindle or axle (Fig. 11).

INITIAL LUBRICATION OF WHEEL BEARINGS

Transparent Hub Cap (Front Axle)

Add oil through filler plug hole in hub cap allowing time for oil to seep through the bearings and seek a level on initial fill. When properly filled oil should be on or 9.5 mm (3/8") above the oil level mark on the hub cap window. Use engine oil or gear oil for front wheels (see LUBRICATION, Section CTS2412).

Hub Cap Without Window (Front Axle)

Add .71 liter (1-½ pints) of matching differential lubricant or enough lubricant to touch the bottom surface of the wheel spindle outside diameter of each front wheel. For initial fill, pipe tap hole should be at 12 o'clock position. Add oil through pipe tap hole in axle shafts. Fill until oil runs out of filler hole when positioned at 4 to 5 or 7 to 8 o'clock positions [approximately .71 liter (1-1/2 pints)].

TRACTOR DRIVE WHEELS (Rear Axle)
Dip bearing cones in lubricant.

Before installing outer cone fill the wheel cavity between bearings with the same oil to be used in differential. This will assure bearing and spindle lubrication until lubrication creeps through the outer bearing.

NOTE:

The differential must not be over-filled. A periodic check is to be made for proper lubricant level.

On tractor drive wheels, apply Loctite gasket eliminator (sealant) material No. 504 to back of axle flange and install axle (Fig. 12).



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Fig. 12

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CHAPTER II

BRAKE DRUMS

INSPECTION

The friction surface of brake drums must be smooth, true and concentric whether for air or hydraulic brakes. Make certain with a visual check that drums are not barrel shaped, bellmouthed, scored or eccentric. A barrel shaped drum (Fig. 1) results from overheating. If this barrel shaped condition is not corrected, the braking surface is reduced and uneven lining wear results.

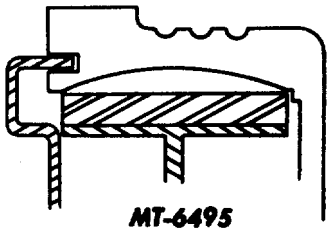


Fig. 1

Extreme pressure which over a period of time will create a bellmouthed drum is shown in Fig. 2. Brake linings on a bellmouthed brake drum will make contact only on the inner surface of the drum. In addition to cutting the braking surface to a minimum, it will also cause uneven and rapid wear.

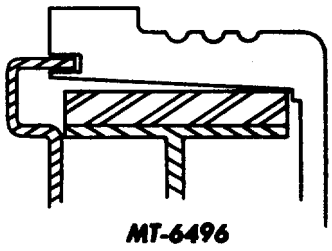


Fig. 2

Scored drums are the result of worn linings to the point where the drum-to-shoe contact is made or an accumulation of small steel particles imbed themselves in the brake lining (Fig. 3). The steel particles form a tough scale which is sometimes harder than the drum. As a result deep grooves are formed in friction surface of drum.

Brake drum scoring never improves but continually gests worse until both lining and brake drum are useless. Attempting to reline brakes without turning scored

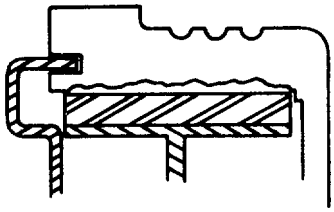


Fig. 3

brake drum surface will quickly destroy new lining and make effective braking impossible.

Brake lining in an eccentric or out-of-round drum cannot make full contact with the drum resulting in rapid or uneven lining wear and could even cause brakes to seize or chatter. Maximum allowable out-of-round or eccentricity should be .10 mm (.004").

If inspection shows that any of the preceding conditions exist, brake drum should be either turned or replaced. To assure a balanced braking system, always install turned or new brake drums in pairs on each axle.

Any time a new brake drum is to be installed on a vehicle, the runout should be checked as follows. Place the new brake drum with hub and wheel assembled in lathe making certain drum is centered. Mount Dial Indicator SE-1848 on lathe and check runout about 12.7mm (.5") in from end of drum as shown in Fig. 4. Runout must not exceed .38 mm (.015").

NOTE:

Before assembling drum, hub and wheel, all parts must be clean and free of foreign matter.

If runout exceeds .38 mm (.015") remove drum from hub, rotate drum 1800 and reinstall on hub. Check runout again; if runout still exceeds .38mm (.015"), remove drum from hub and rotate drum 1/4 turn. Reinstall drum on hub and recheck runout.

REFINISHING BRAKE DRUM

On brake drums manufactured after January 1, 1971, the maximum diameter to which drum can be worn is stamped or cast into drum. Drum should be discarded if worn beyond this limit. Minor scores on brake drum can be removed with fine emery cloth or steel wool, but always clean

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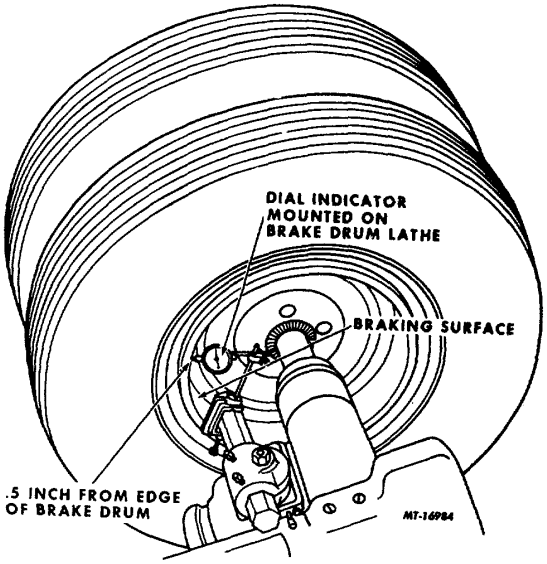


Fig. 4

emery or steel wool particles from drum after this operation. More heavily damaged or out-of-round drums should be ground or turned on brake drum lathe.

If depth of scoring, bellmouth or barrel shaping exceeds .13mm (.005"), measured with micrometer across part or all of brake surface, drum should be refinished. Reboring limits (seedrum) must not be exceeded and no heat checks, cracks or bluing is evident.

Use a micrometer also to check for an out-of-round drum. Make check by measuring drum brake surface diameter at various points, 450 apart around circumference. Eccentricity (out-of-round) should not exceed .38 mm (.015") on diameter.

For older brake drums which do not show a maximum diameter the drum must be discarded when diameter is 3.05mm (.120") over original diameter.

Remember that each time brake drums are turned, less metal remains to absorb the heat developed by braking action. Brake drums containing less metal will operate at a higher temperature. As a result, brake fade, slow recovery and erratic wear will be more noticeable. Also extremely high temperatures shorten lining life and cause heat checks and cracks (Fig. 5) form on inner surface of drums. These conditions will become progressively worse until finally drums fail.

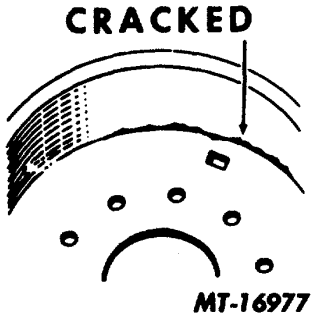


Fig. 5

To recondition a brake drum in a lathe (Fig. 6), the drum must be mounted so that it is centered. Use proper size cone to provide accurate centering. Turn drum, taking only light cuts and remove just enough material to clean up drum. Then grind the finished surface if grinder is available or use emery cloth on a straight piece of wood and polish the drum friction surface.

NOTE:

Brake drums that are otherwise in good condition can be turned in a lathe. However, it must be remembered that recommended rebore limit for brake drums over 35.6 cm (14") in diameter must not be increased more than 2.03 mm (.080") diameter (total cut) and discarded at 3.05 mm (.120") over normal diameter.

Brake drums should be cleaned thoroughly with a steam cleaner or hot water. Do not use a solvent which leaves an oily residue. If inspection shows the drums may be used without remachining, rub friction surface with fine emery cloth or sandpaper to remove any foreign deposits. If drum has been reconditioned, clean friction surface with fine emery cloth or sandpaper and wash. Next examine very carefully to see that no metal chips remain in drum.

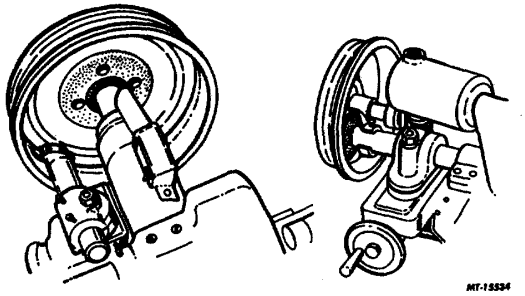


Fig. 6

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CHAPTER III

RIMS AND TIRES

GENERAL

Since there are many different kinds of rims and tires for trucks, the methods of servicing them also vary. Most types, however, have been in use for many years, and for that reason the instructions covered here will pertain chiefly to the newest or tubeless types. Some of the most common types of rim and tire combinations are given in the following illustrations (Figs. 1 through 4).

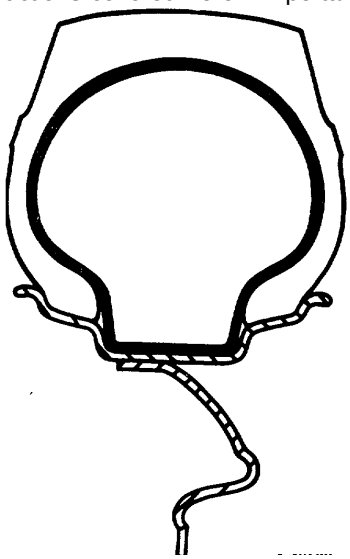


Fig. 1 Drop Center Type Disc Wheel (with Tube)

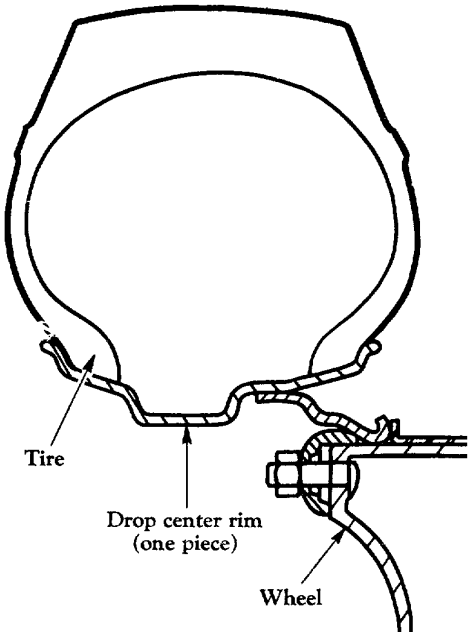


Fig. 2 Drop Center Type Disc Wheel (Tubeless)

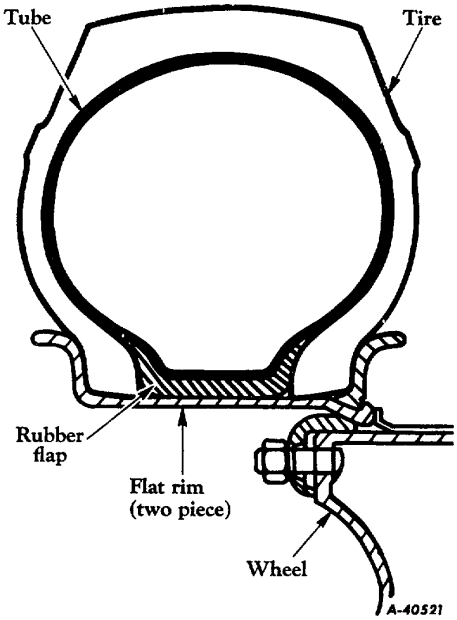


Fig. 3. Dual Cast Wheel and Two Piece Rim (with Tube)

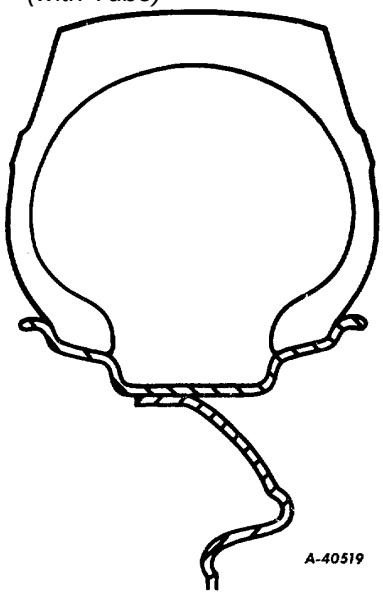


Fig. 4 Dual Cast Wheel and One Piece Rim (Tubeless)

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Multiple Piece Rims

On multiple piece rims if it is determined during periodic inspection or during tire changes, that a part is defective it must be replaced.

Caution must be observed when selecting the proper replacement part, an incorrect fit is dangerous. (See Incorrect Assembly Fig. 5). The side ring, locking ring and base must all fit correctly as illustrated in Figure 5 under Correct Assembly.

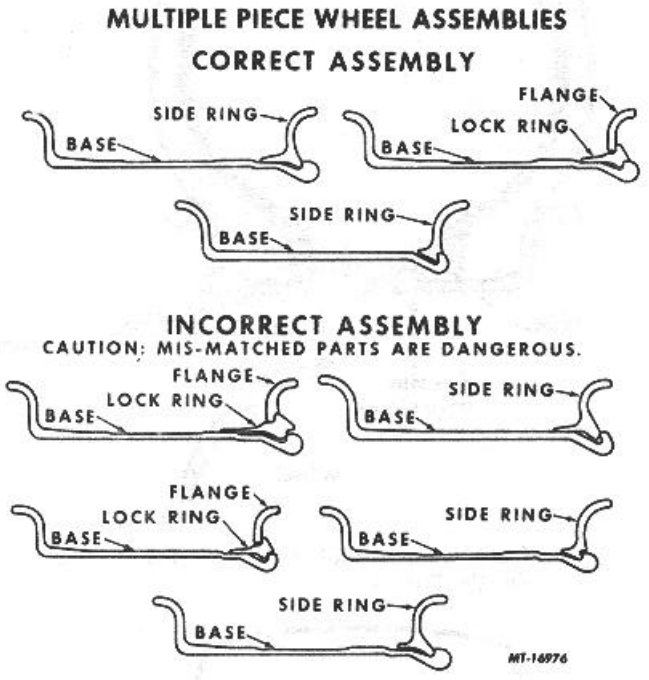


Fig. 5

ALUMINUM WHEELS

Care and Maintenance

Aluminum wheels should be periodically inspected both on the vehicle and during tire changes for cracks, loose wheel studs, worn mounting holes or being bent.

When checking cap nuts on dual disc wheels, back off outer nut before attempting to tighten inner nut.

Whenever a tire is removed, clean off all grease and road dirt. Use a wire brush or steel wool to remove the rubber from the bead seat.

Projections on the side wall of the gutter may cause uneven seating of the side ring and lead to chipping of the gutter. Remove these and other projections in the mounting area to assure the best possible fits.

Nicks and gouges in the vicinity of the fixed flange may lead to rim fracture.

NOTE:
Do not heat or weld wheels in an attempt to straighten or repair severe road damage. The special alloy used in these wheels is heat-treated, and uncontrolled heating from welding torch affects the properties of the material.

To avoid possible corrosive affects to aluminum wheels, use only a slight amount of water and neutral soap (similar to Ivory Snow, Dreft, etc. no detergents) when mounting tires. Do not use commercial rubber lubricants.

Wheel Installation

When installing aluminum wheels, lubricate stud threads using a petroleum base grease containing colloidal graphite. Be certain end of wheel wrench is smooth as it will tear grooves in the wheel around the stud nuts it if is rough.

NOTE:
Do not allow dirt to enter the mounting area during installation. See "TORQUE CHART" for correct torque values.

Wheel Studs and Mounting Nuts

Maintaining wheel stud and mounting nut tightness does much to insure safe and satisfactory wheel operation. Loose wheel mounting can cause vibration, shimmy, tire wear, stud breakage, worn studs, mounting nuts (Fig. 6) and worn or elongated stud holes (Fig. 7). Parts with these characteristics must be replaced. Always keep wheel stud nuts tightened to specified torque.

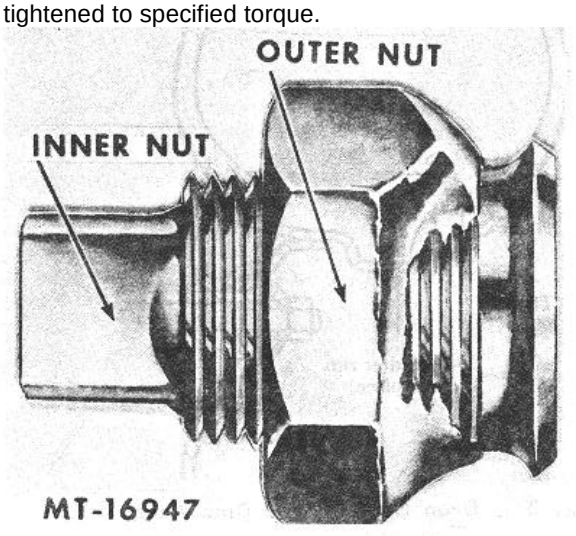


Fig. 6

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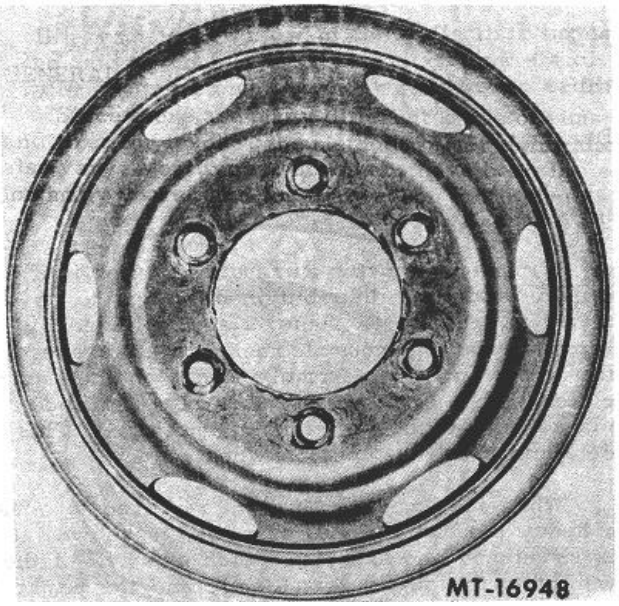


Fig. 7

NOTE:

Rust streaks (Fig. 8) from stud holes is a good indication that mounting nuts are not tightened to the specified torque.

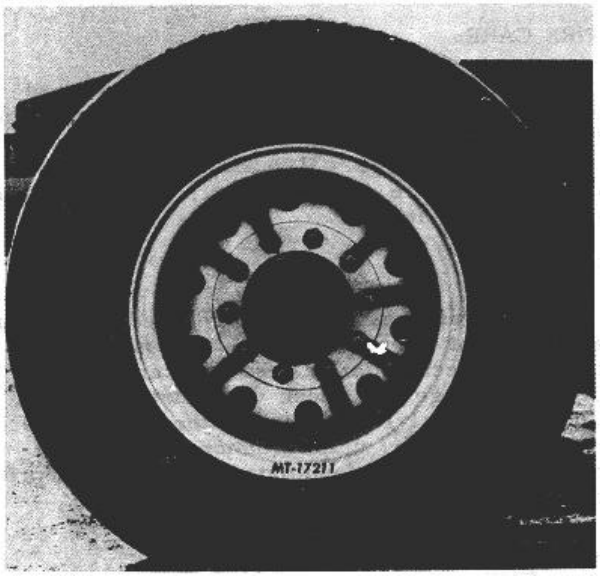


Fig. 8

DISC WHEELS

On disc wheels, which have rims integral with the wheel itself, the important thing to note is that the wheel stud nuts must be kept tight. This means they should be inspected and tightened at regular intervals. When checking the mounting studs and nuts on dual disc wheels, (Fig. 9) the outer nut should be backed off before attempting to tighten the inner nut. Try all cap nuts after the first trip or any wheel change. Properly installed they should remain tight indefinitely. On cast wheels which have rims that are demountable with the tire, the rim clamp nuts should also be kept tight. Rim and tire to wheel alignment should be checked frequently to make sure the tire is running true. Left-hand thread nuts can be identified by the small groove machined around the flats. Lefthand studs can be identified by the letter "L" stamped on the head. Use left-hand nuts on the left side of the truck.

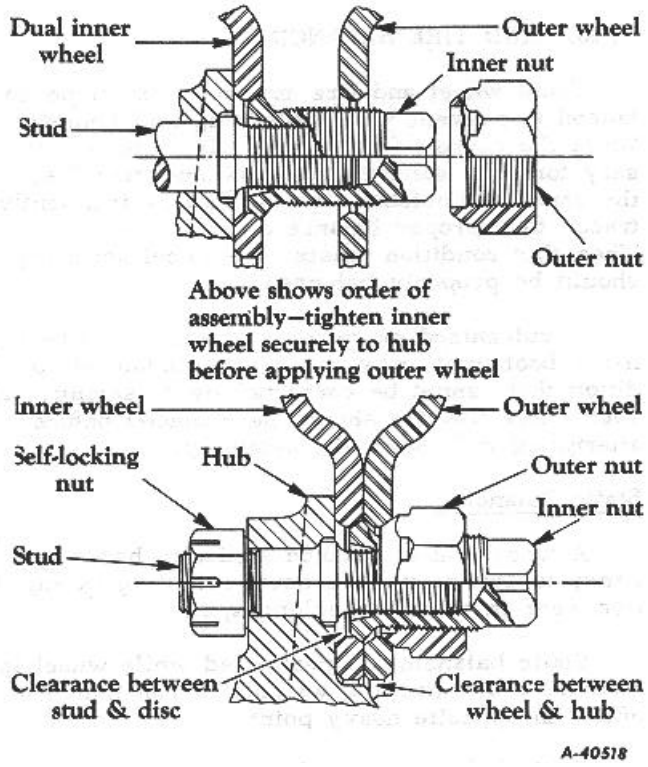


Fig. 9

NOTE:

Before mounting wheel assemblies or vehicle make sure all parts are clean and free from foreign matter. Excess paint on wheel stud hole perimeters can permit wheel mounting nuts to loosen with use.

RIM TIGHTENING AND ALIGNMENT

When installing demountable rims, be certain stud threads are clean to permit correct torquing of nuts. NOTE: Do not use any type of lubrication on threads except when installing aluminum wheels.

With rims in position (valve stem 180 degrees apart) successively tighten opposite nuts to assure drawing wheel (or wheels) in evenly. This procedure will also minimize wheel misalignment.

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See "TORQUE CHART" for correct torque values.

After rim has been properly torqued, it should be checked for alignment. This can be accomplished by rotating wheel with a piece of chalk attached to a steady, firm surface and placed to just barely clear outside surface of tire bead seat. This procedure will point out the "high spot". Keep in mind, however, that a "high spot" does not necessarily mean that lug nuts have been unevenly tightened. This condition or misalignment can also result from a bent wheel.

WHEEL AND TIRE BALANCING

Front wheel and tire assemblies must be balanced to prevent wheel vibrating and bounce. While the correct front wheel alignment is necessary for easy steering and maximum tire life, the cause of unstable steering can be frequently traced to improper balance of front wheels. When this condition exists, the wheel assembly should be properly balanced.

A vulcanized or retreaded tire, or a tire that has a boot in it, may cause an unbalanced condition that cannot be corrected by balancing. In such cases the tire should be replaced before attempting to balance the assembly.

Static Balancing

A wheel out of balance statically has a tendency to bounce up and down resulting in rapid tire wear in round or oblong spots.

Static balancing is performed while wheel is stationary by attaching weights to rim flange to offset an opposite heavy point.

Static balancing may be sufficient in some instances where vehicle is operated only at slow speeds, however, dynamic balancing (in motion) balances the wheel and tire assembly statically as well as dynamically, thereby eliminating vibrations and wheel bounce at both low and high speeds.

NOTE:

A wheel may be perfectly balanced statically (not in motion) but may still vibrate and bounce at high speed rotation because of its being out of balance dynamically.

Dynamic Balancing

Dynamic balancing is complete wheel balancing of which static balancing is only a part.

Dynamic balancing (in motion) takes into consideration the distribution of weight to be added to the wheel. This is accomplished by rapidly rotating (normal truck operating speed) the wheel and tire assembly either on the vehicle or with the wheel assembly removed and placed on a dynamic balancing machine. This determines heavy point on wheel.

When the amount of weight required to offset a heavy part in a wheel assembly is known, it is sometimes necessary to attach one-half of the weight to the outside rim flange and the remaining half to the inside rim flange.

With the weight properly distributed on the wheel assembly, the wheel should be in balance both statically and dynamically and should rotate free of vibration and bounce at normal truck operating speeds.

TIRE CARE

Proper tire inflation, tire loads, and road speeds are important determining factors governing tire mileage, and also affect steering ease and maneuverability. How much these three factors affect tire wear is illustrated in the paragraphs which follow.

INFLATION

Tire pressures should be checked at regular and frequent intervals and the pressures maintained to specifications. Use an accurate tire pressure gauge and check when tires are cool. The chart (Fig. 10) illustrates the loss in tire mileage caused by underinflation. It will be noted that a tire underinflated only 20% will produce only 70% normal mileage.

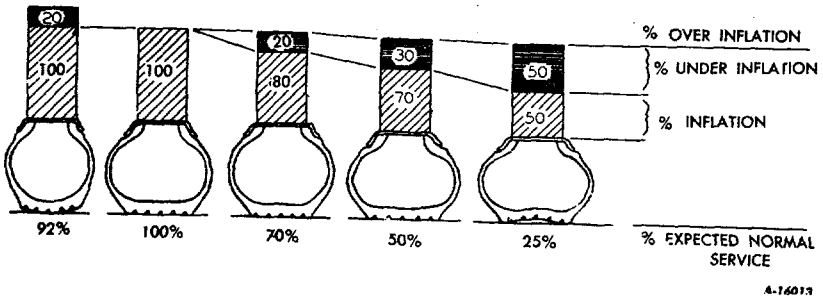


Fig. 10 Inflation vs. Mileage

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Overinflation is also costly because a tire which is 20% overinflated will produce only 92% normal tire mileage.

"Bleeding" of air from hot tires should never be practiced. The pressure will be reduced but an increase in temperature will result as soon as driving continues.

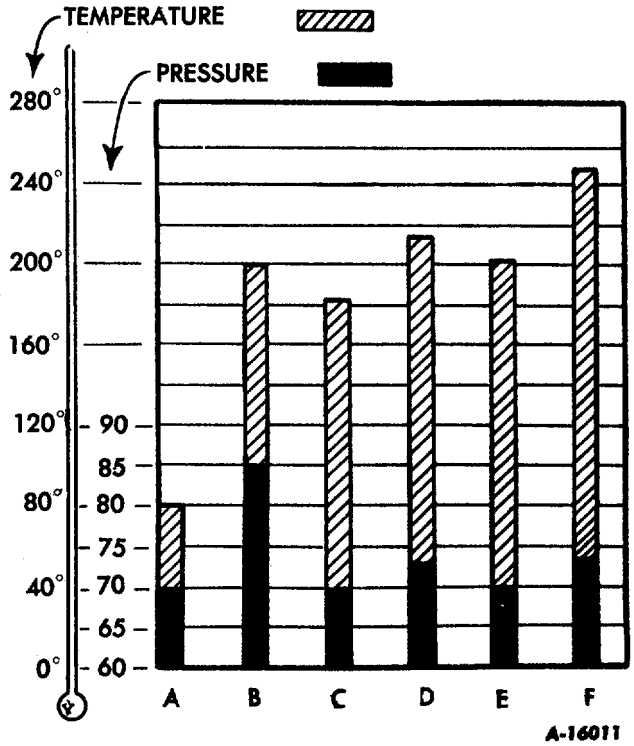


Fig. 11 Chart Showing Effects of Bleeding

The chart (Fig. 11) illustrates a condition where a tire was started cool with a pressure of 70 pounds and at a temperature of 26.7 degrees C (80 degrees F).

A - Initial conditions.

B - After 225 km (140 miles) of driving the pressure had increased to 85 pounds and temperature 93.3 degrees C (200 degrees F).

C - The pressure was then "bled" to 70 pounds and an additional drive made of 225 km (140 miles). Note the temperature.

D - The pressure had increased to 73 pounds while the temperature increased to approximately 104.4 degrees C (220 degrees F).

E - Again "bleeding" was resorted to Note the temperature.

F - After 322 km (200 miles), the tire failed from a temperature of over 121.1 degrees C (250 degrees F).

LOADS

Loading tires beyond their rated capacity is expensive because tire mileages are rapidly decreased with overloads. The following chart (Fig. 12) illustrates how an overload of only 20% will result in tire mileage being only 70% of normal.

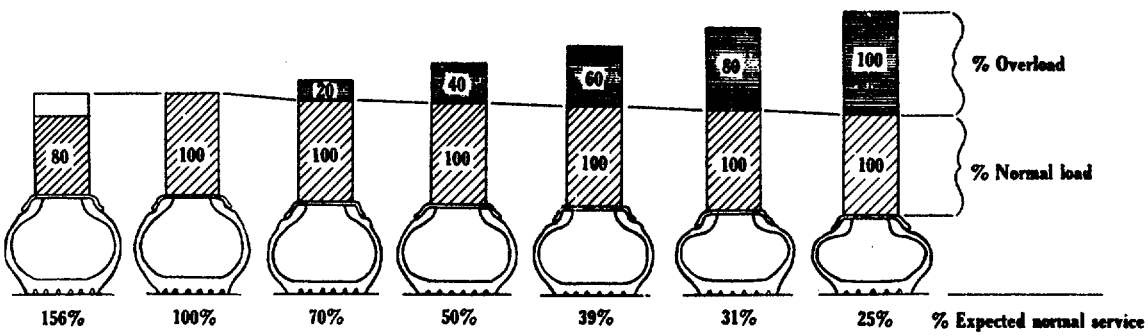


Fig. 12 Overload vs. Mileage

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SPEEDS

Excessive speed is definitely one of the most important factors in loss of tire mileage. The chart (Fig. 13) illustrates how an increase in speed from 40 to 50 mph results in 18% loss in mileage. An increase of speed from 40 to 60 mph results in a 33% mileage loss.

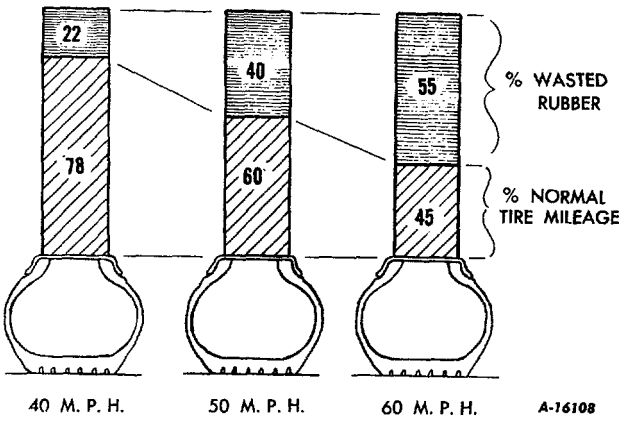


Fig. 13 Speed vs. Mileage

TIRE MATCHING (Dual Tires)

Use care in matching dual tires. Tires which differ more than ¼" in diameter or ¾" in circumference should not be mounted on the same dual wheel. Should it become necessary to mount two tires of unequal size on the same dual wheel, place the larger or less worn tire on the outside.

TIRE MATCHING (Tandem Drive Axles)

When mounting tires on tendem drive axles, follow the same instructions as specified for dual tires. However, never install the four largest tires on one driving axle and the four smallest on the other. This method of tire mounting will cause high lubricant temperatures which may lead to premature axle failures.

TIRE REPAIR

Methods for repairing tires will vary slightly with each manufacturer and it is recommended that the tire manufacturers' procedures be followed if possible. However, the procedure outlined here applies in general to most tires whether they are light duty or heavy duty. Patching will usually be satisfactory for all injuries up to 3/16" diameter. Larger injuries should be handled by spot or section repair methods. The first four steps given here apply to both the hot and cold patch methods.

NOTE:

Some tire repair methods for simple punctures do not require the dismounting of tire from rim. These methods should be regarded as temporary fixes since there is a good chance of ply separation and ultimate tire failure can result when puncture plug is installed from the outside.

1. Remove tire and wheel assembly and inflate the tire to the recommended pressure. Locate the leak and mark with a crayon. It may be necessary to immerse the tire in water or apply a coat of soapsuds to the tire to locate the leak. Demount the tire. Probe the injury with an awl (Fig. 14) to remove the puncturing object and foreign material.

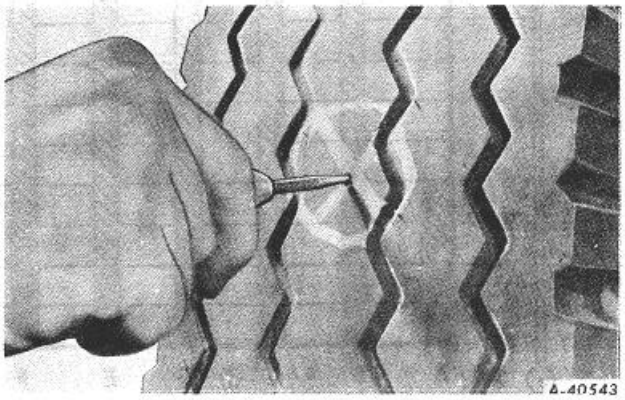


Fig. 14

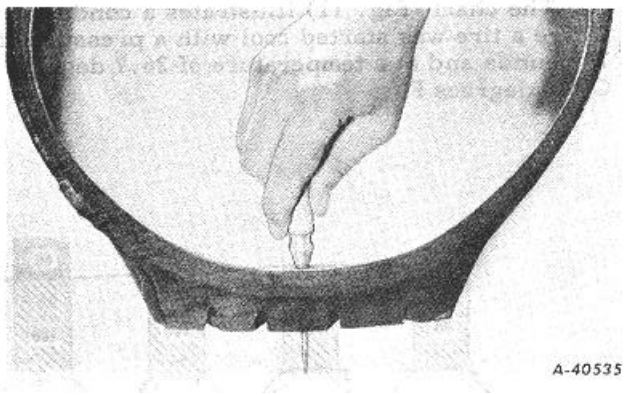


Fig. 15

2. Thoroughly clean the inside of the tire around the injury with rubber solvent and allow to dry. As a safety precaution, solvent vapors should be blown out of the tire with compressed air. Solvent is not needed

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to clean an injury if a power buffer equipped with a fine wire brush is used. Care must be taken not to buff through the inner liner. Clean the awl needle and dip in self-vulcanizing fluid and from the inside of the tire, force the needle through the puncture until the point extends beyond the tread (Fig. 15).

3. Remove the detachable handle from the needle. Cut a 3.175 mm (1/8") strip of filler rubber and place it into the hole of the needle with the end of the rubber strip extending beyond the needle. Pull needle through the tire with a pliers (Fig. 16). Filler rubber will remain in puncture. Using an awl, pack excess rubber flush with inside of tire.

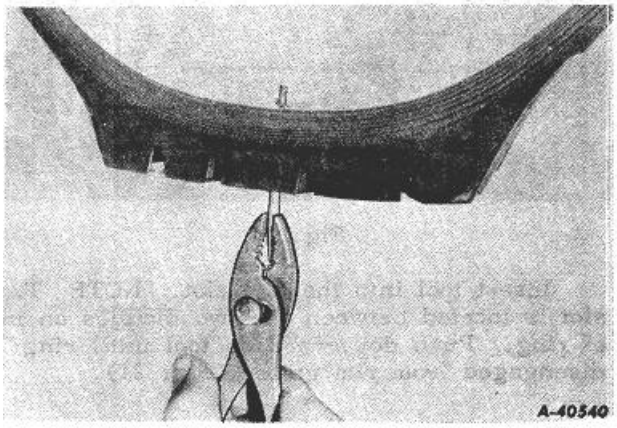


Fig. 16

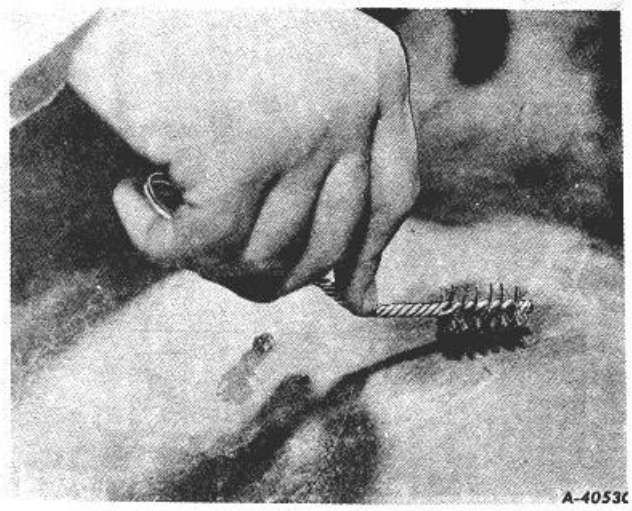


Fig. 17

4. With a wire brush (Fig. 17) or a power buffer, thoroughly roughen an area about the injury slightly larger than patch and within previously cleaned surface area. Remove all traces of lubricant, foreign material, etc. Do not use more solvent after buffing.

The next three steps apply only to the hot patch method.

5. Remove backing from patch and carefully center it over injury. Place a clamp over patch and tighten clamp only finger tight (Fig. 18).

6. Ignite patch and allow it to cool for at least 15 minutes or until cool to the touch. Carefully remove metal pan and ashes remaining in tire.

7. Remount tire. Inflate to recommended operating pressure. Then check to make sure injury is sealed.

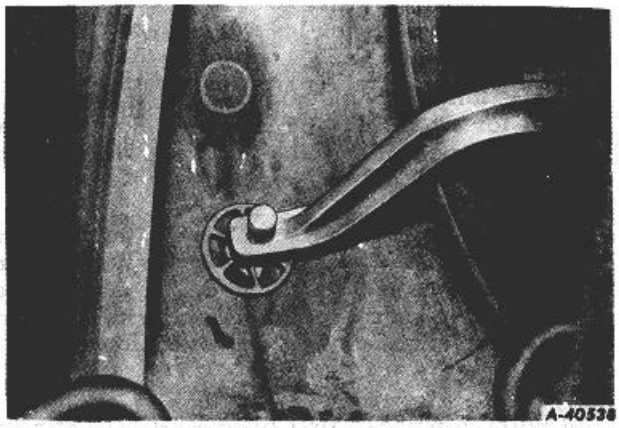


Fig. 18

The next three steps apply only to the cold patch method.

8. Apply self-vulcanizing cement over buffed area and allow it to dry for a minimum of five minutes. This time factor is important.

9. Remove backing from patch base and place patch over injury. Press down firmly, especially at the edges, for good adhesion (and easy removal of paper cover) (Fig. 19).

10. Remount tire. Inflate to the recommended operating pressure. Then check to make sure injury is sealed.

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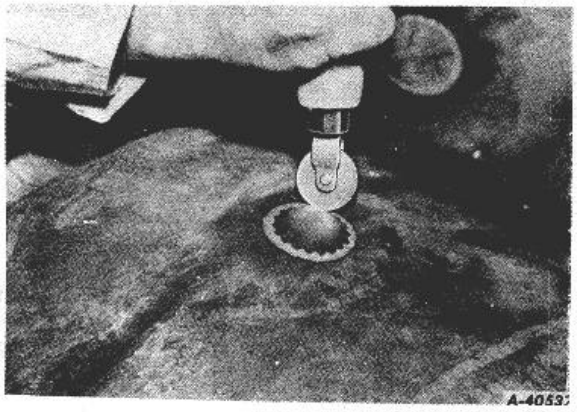


Fig. 19

MOUNTING AND DISMOUNTING TIRES

General

The following instructions were prepared as an aid for mounting and dismounting tires on different types of wheels. All standard safety precautions should be observed.

CAUTION: Before mounting radial tires make certain that heavy duty rims or approved rims for these tires are being used. It may be-necessary to contact your wheel and rim distributor to determine if rims are approved for radial tires.

TWO-PIECE WHEEL AND SIDE RING (Continuous Base, Continuous Side-Ring)

The following instructions are given as an aid in servicing the two-piece wheel and side ring.

Dismounting Tire

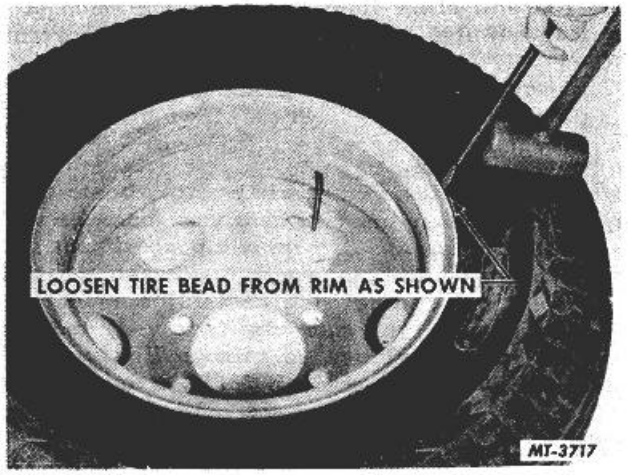


Fig. 20

Completely deflate tire by removing valve core. Loosen tire bead from ring by driving the curved end of tool between ring and bead (Fig. 20).

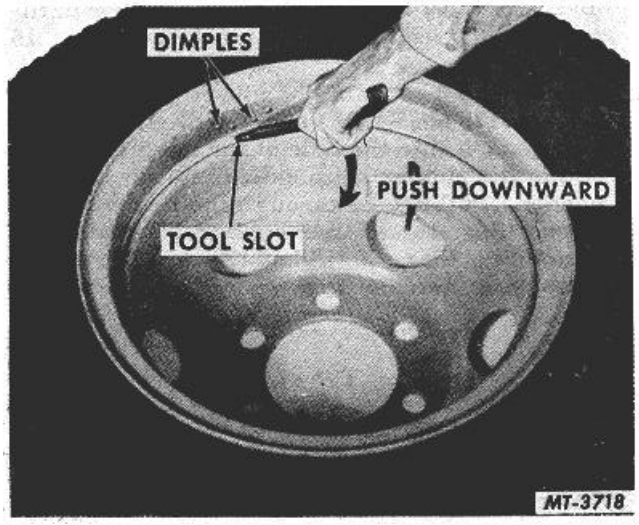


Fig. 21

Insert tool into the tool slot. NOTE: Tool slot is located between the two dimples on inside of ring. Push downward on tool until ring is disengaged from rim gutter (Fig. 21).

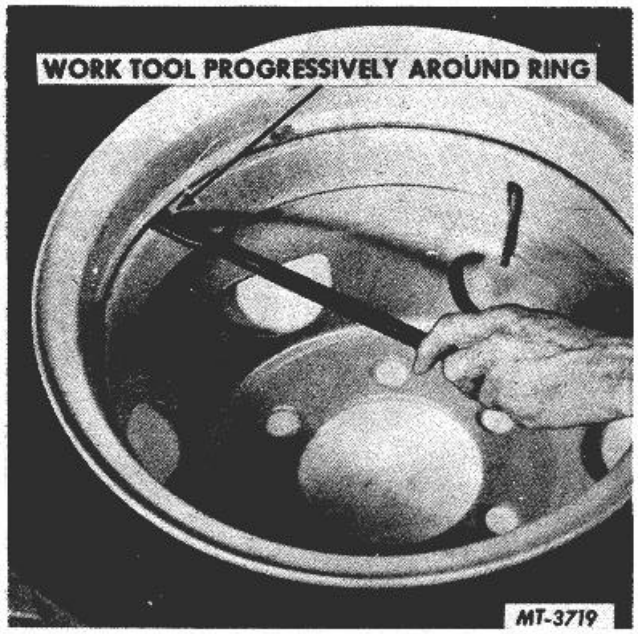


Fig. 22

Work progressively around ring until ring can be removed. Turn tire over and loosen opposite tire bead (Fig. 22).

Remove wheel from tire as shown in Fig. 23.



Fig. 23

Mounting Tire

Remove all dirt or foreign matter from wheel. Position tube in tire and inflate until tube is nearly rounded out. Lubricate tire beads, rim sides of tube, and tire flap sides. Position flap in tire. Lay disc portion of wheel on floor (Fig. 24).

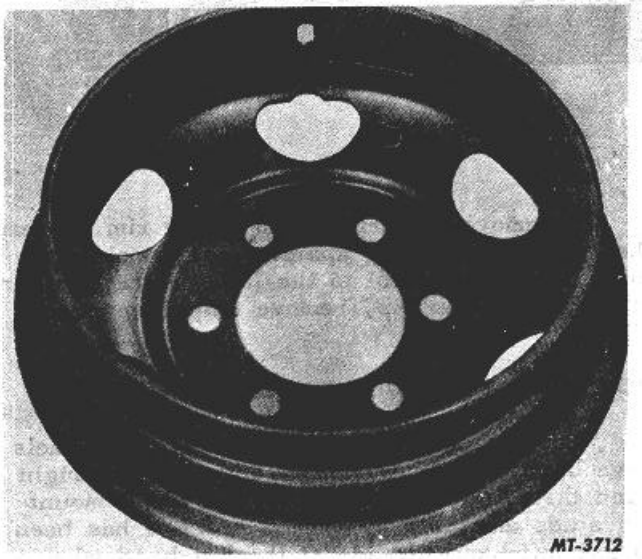


Fig. 24

NOTE: Do not use commercial rubber lubricants for mounting tires to aluminum wheels.

Install tire and lube assembly being sure valve stem is pointing in position shown in Fig. 25.

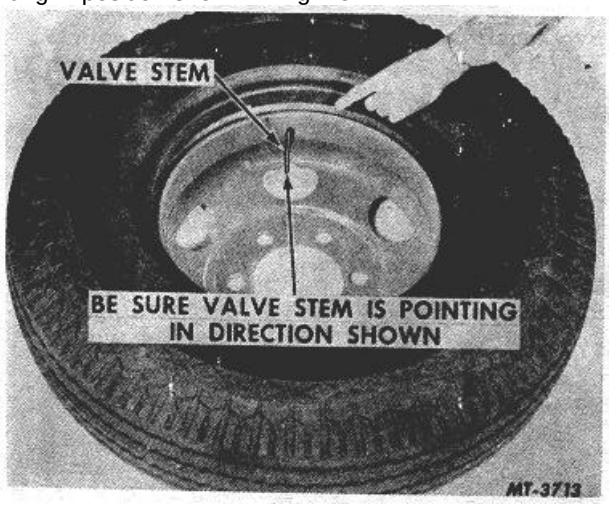


Fig. 25

Position side ring to wheel so that tool slot "A" is away from the valve stem (Fig. 26). This will prevent tool from contacting valve stem.

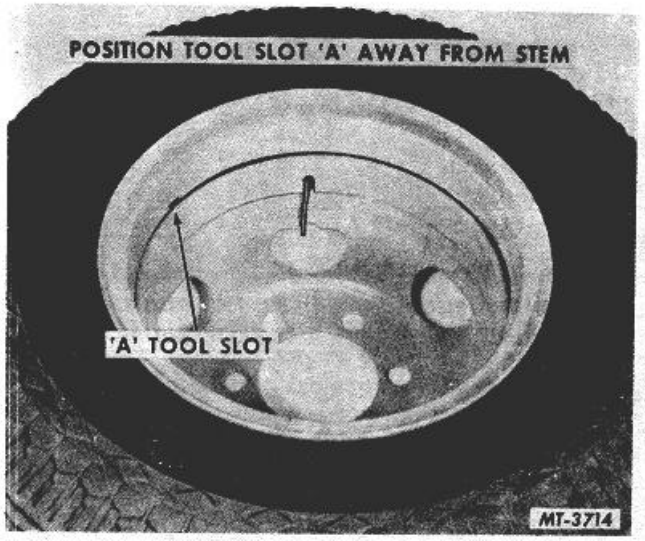


Fig. 26

Step on the ring to force tire down, until cut-away "AA" on ring slip over the edge and hook on rim. Then insert tool into tool slot and push outward (Fig. 26). Hold onto tool and hammer the ring between slot and nearest cutaway.

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This action will hook ring and rim together.

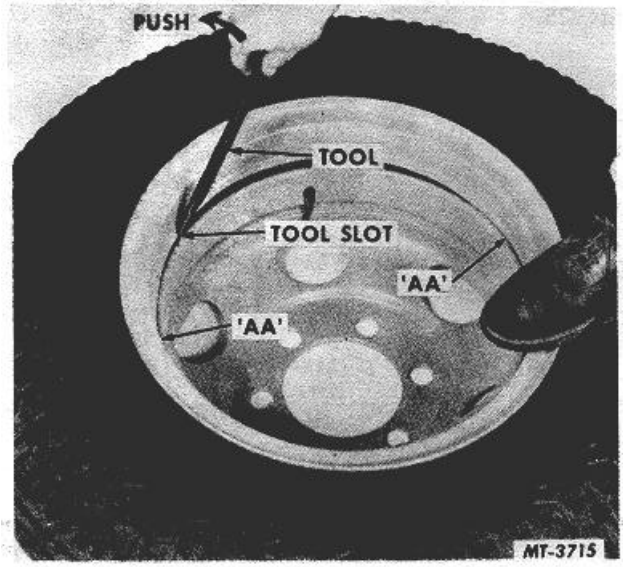


Fig. 27

Using a rubber hammer tap around wheel (side) ring to be certain it is properly seated (Fig. 28).

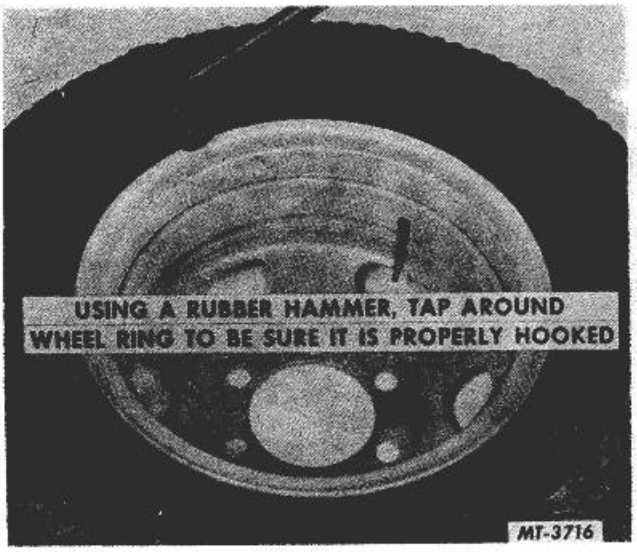


Fig. 28

When side ring is properly installed on rim, it is loose. If side ring cannot be moved, the ring is binding.

CAUTION !

TO PREVENT POSSIBLE BODILY INJURY caused by the wheel side ring being blown off with extreme violence during inflation, DO NOT stand unprotected in front of side ring when inflating tire. If no protection device is available, stand wheel and tire close to a solid wall with side ring facing the wall. Inflate tire from side opposite ring. If no solid wall is available place tire and wheel on floor with side ring next to floor (down) and inflate from above keeping body AWAY from directly in front of or above tire at all times. See Precautions, Chapter 1.

Inflate tire until tire beads are firmly seated against rim flanges. CAUTION: Never inflate above 40 psi to seat beads. Completely deflate tire by removing valve core; then reinflate tire to recommended pressure.

Refer to "Operator's Manual" for recommended inflation pressures.

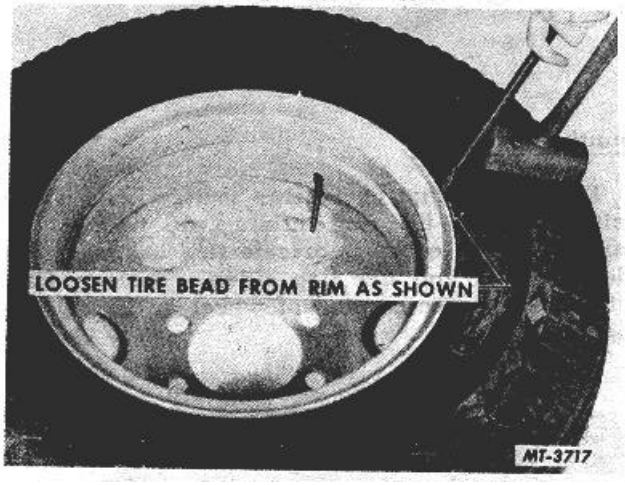


Fig. 29

To remove side ring from a new rim, spread the rim and side ring apart. Insert tool in the tool slot and pull tool to the left. After side ring starts to lift over lip, remove ring from rim (Fig. 29).

MOUNTING NUTS (Disc Wheels)

Where standard automotive type disc wheels have been used in the past, both left and right hand threads will be found at the wheel mounting studs and nuts. Common practice has been to use left-hand threads at the left-hand wheels and right-hand threads at the right side of the vehicle. This was done to assure keeping wheel mounting nuts tight.

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With the improvement in design of both wheel bolt holes and mounting bolts or nuts the left-hand threaded parts are no longer used and right-hand threaded parts are used at all wheels. To prevent loosening of wheel bolts or nuts, cup-shaped depressions are formed in wheel disc at the bolt holes so that when mating cup-shaped nut or bolt is tightened, elastic pressure against the nut or bolt together with thread friction prevents loosening in service. For this reason wheel mounting bolts, nuts and wheel bolt hole surface must not be lubricated.

It is good practice to tighten wheel nuts daily during the first 500 miles of service on new vehicles and anytime wheels have been removed. Regular inspection periods should be established to assure keeping nuts tightened.

ONE PIECE DROP CENTER HEAVY DUTY TUBELESS TIRES (7.00-20 and Up)

The mounting or demounting of heavy duty tubeless truck tires is accomplished in much the same manner as light duty or passenger-car type tubeless tires. Consequently, same precautions for protecting the sealing edges of the tire beads and rims should be observed. Rims used are all of the one-piece drop-center type whether they are integral with wheel (disc type) or demountable (cast type). Because heavier tires are less flexible, it is suggested that the special tubeless truck tire tools, which are available, be obtained.



Fig. 30

Dismounting Instructions

1. Remove the valve core to completely deflate tire. With tire lying flat on the floor, loosen beads from rim seats by walking around on tire with heels at points close to rim. With wide side of rim down, lubricate top bead thoroughly. Insert spoon ends of both tire irons between rim and tire bead at points about 10" apart. While standing on tire, pull end of tire iron to the opposite side of rim so as to pry tire bead up and out of rim (Fig. 30).

2. Hold tool in position with one foot and pull second tool toward center of rim (Fig. 31). Progressively work bead off rim in this manner, taking additional bites as necessary. Fig. 31

3. Stand assembly in a vertical position and lubricate second bead. At top of assembly, insert straight end of tool between bead and back flange of rim at about 45 degree angle (Fig. 32).



Fig. 32

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4. Turn tool so it is perpendicular to rim and pry off second bead (Fig. 33).



Fig. 33

Mounting Instructions

1. Inspect the rim to insure that bead seats are clean and smooth. Then place rim on the floor with wide side down and lubricate first bead of tire and upper bead seat of rim (Fig. 34).



Fig. 34

2. Push the first bead into well of rim and onto rim as far as possible. Using straight end of tool (with stop resting on rim flange), take small bites to work remaining section of first bead onto rim (Fig. 35).



Fig. 35

3. Hold the second bead in the well by standing on tire. When necessary, push a section of the bead into rim well and anchor with a vise-grip pliers by pinching the plier onto the rim flange (snub side toward tire). Using spoon end of the tire iron with stop toward rim, work progressively around the bead, using small bites until bead slips over flange onto the rim base. If necessary, insert a second tire iron and lubricate the last 15. 3 cm (6") of bead before completing mounting (Fig. 36).



Fig. 36

4. Check valve to be certain that hex nut at the base is tight; also check valve core to make sure that no air loss can occur. Stand tire in a vertical position and inflate to recommended air pressure.

TWO-PIECE FLAT BASE (Continuous Base, Split Side-Ring)

Dismounting:

1. Deflate tire or both tires if working on duals completely by removing the valve core, before removing tire and rim assembly from truck. Remove tire from truck and place on floor with the side-ring up. Pry bead loose from side-ring by inserting curved end of rim tool and hooked-end of rim tool between side-ring and side-wall of tire. Then apply downward pressure on rim tools. Continue to pry around tire until bead is completely free from side-ring (Fig. 37).

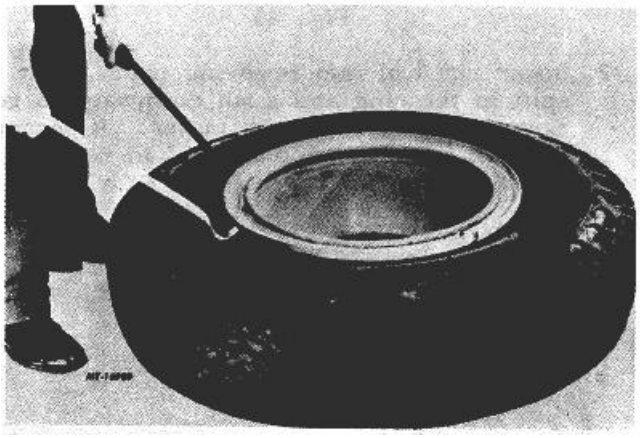


Fig. 37

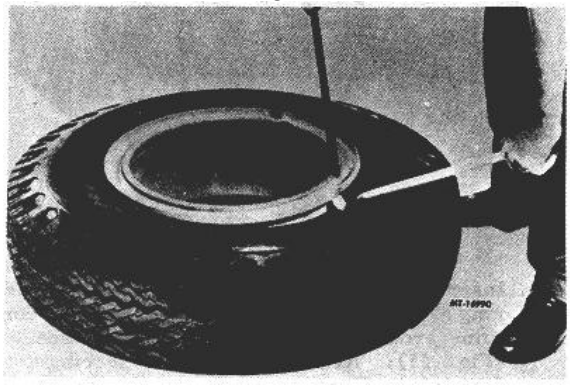


Fig. 38

2. Insert tapered end of tool into notch on sidering, pry ring upward and outward to remove side-ring from its groove in rim. Place hooked-end of tool between the ring and tire. Pry upward on ring and downward on tire to free ring from tire bead (Fig. 38).

3. Continue prying around tire until ring is free (Fig. 39). Turn tire and rim assembly over on floor. Unseat second bead from rim. Lift the rim from tire. Remove tube and flap, if used, from tire.

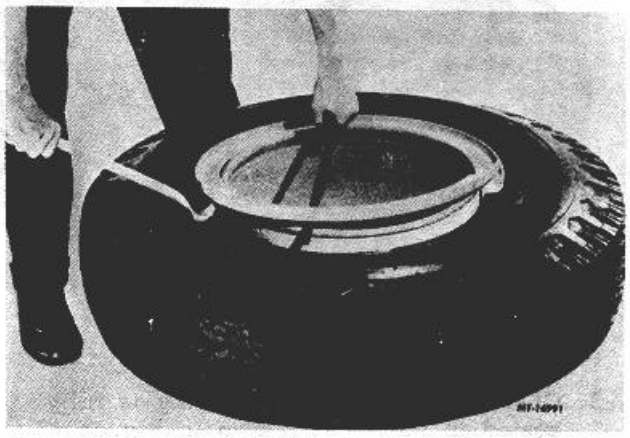


Fig. 39

Mounting:

1. Place tube and flap into tire and partially inflate to round out tube. Apply approved rubber lubrication to inside and outside surfaces of both beads and also to the portion of tube and flap that appears between beads. With valve slot up place rim flat on floor. Align valve with rim valve slot, place tire on rim and insert valve through valve slot. Place side-ring on rim base with ring split opposite the valve stem. Install leading end of ring into gutter of rim (Fig. 40).

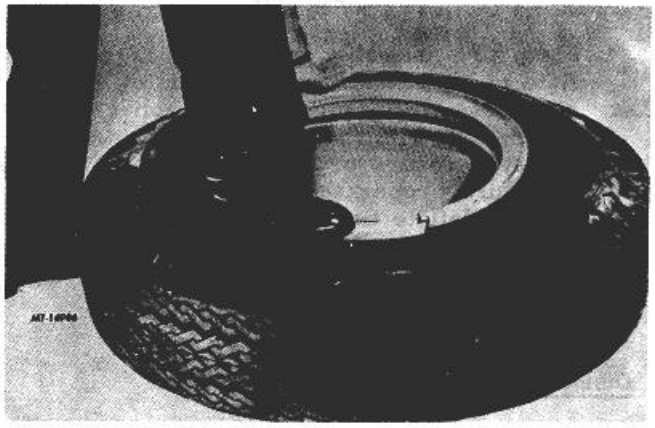


Fig. 40

2. Continue "Walking" side-ring into place (Fig. 41).

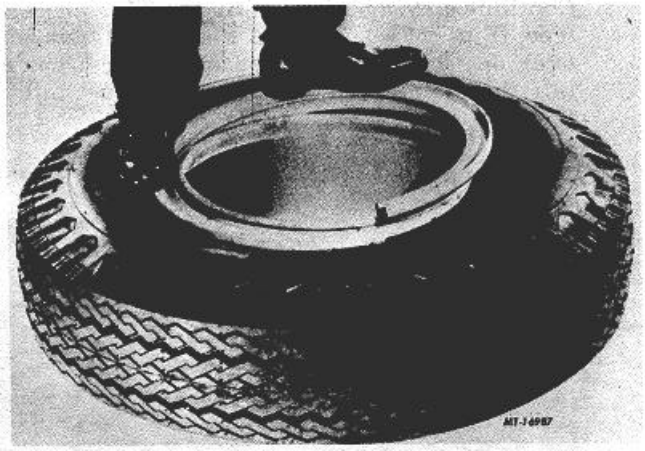


Fig. 41

3. Check to insure that side-ring is fully seated in gutter as shown in Figure 42.

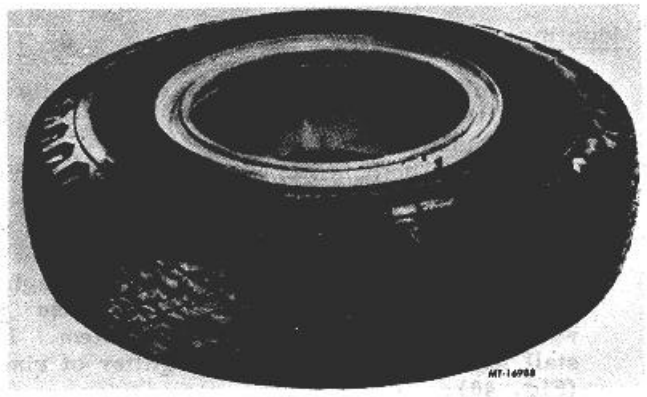


Fig. 42

4. Place tire assembly into safety cage and inflate to a maximum of 10 psi using an extension hose with gauge and clip-on chuck. Check side-ring by lightly tapping with mallet to insure proper engagement. Inspect to insure proper seating of beads. Completely deflate tire to prevent tube from buckling. Reinflate to recommended pressure.

THREE-PIECE FLAT BASE

Dismounting:

1. Remove valve core and completely deflate the tire or both tires if working on duals before removing the tire and rim assembly from the truck. Remove tire assembly from truck and place on floor with the side-ring up. Insert tapered end of rim tool into depression in lock ring, or between rings, and press down on side ring to free bead. Continue around tire until the bead is completely freed from the bead seat (Fig. 43).

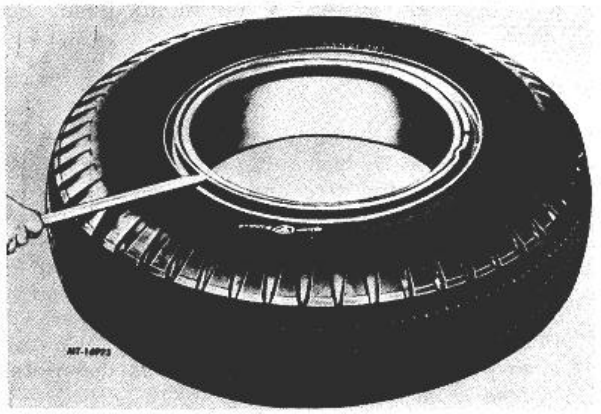


Fig. 43

2. Insert rim tool into removing notch, near split in the ring and push downward to remove lock-ring from rim gutter. A second rim tool may be helpful to aid in removal (Fig. 44).

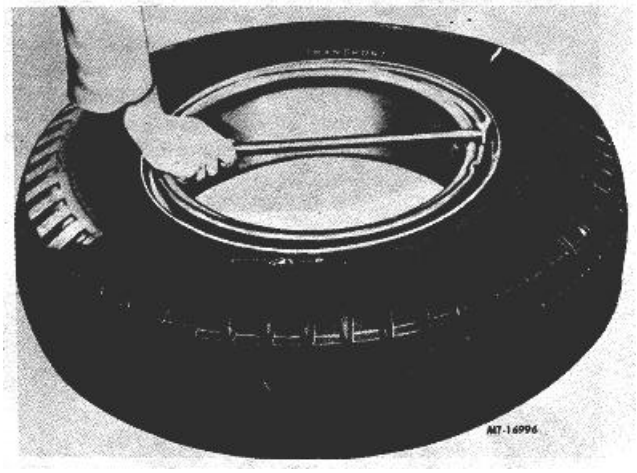


Fig. 44

3. Insert rim tool between lock-ring and sidering. Press down to pry ring up and continue around rim until lock-ring is free (Fig. 45). Remove lock and side-rings from rim. Turn assembly over, unseat second tire bead, stand tire up and remove rim base.

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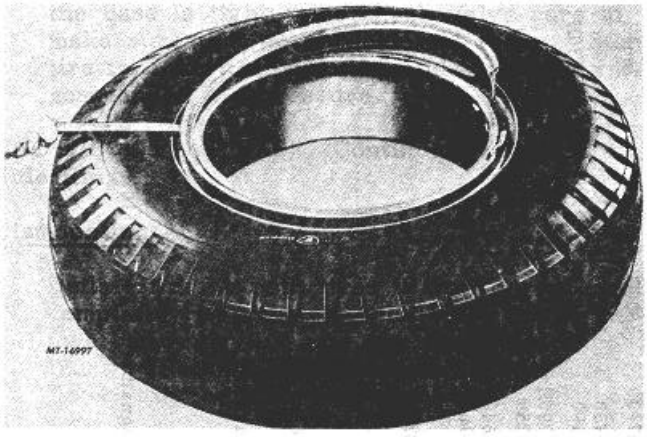


Fig. 45

Mounting:

1. Insert tube and flap into tire and partially inflate to round out tube. Apply approved rubber lubricant to inside and outside surfaces of both beads and also to the portion of tube and flap that appears between beads. Lay rim flat on floor with valve slot up. Align valve with rim valve, place tire on rim and insert valve through valve slot.

2. Place side-ring on bead of tire. Insert tapered end of lock-ring between side-ring and rim base (Fig. 46).

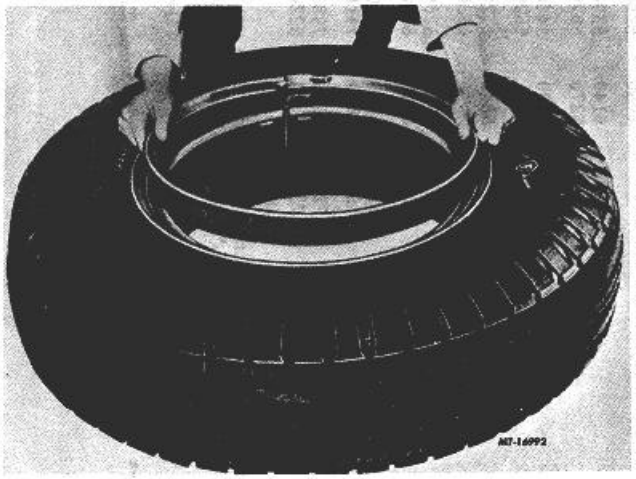


Fig. 46

3. Fasten lock-ring by holding at one end of split with foot and hammering end of ring into place with rim mallet (Fig. 47).

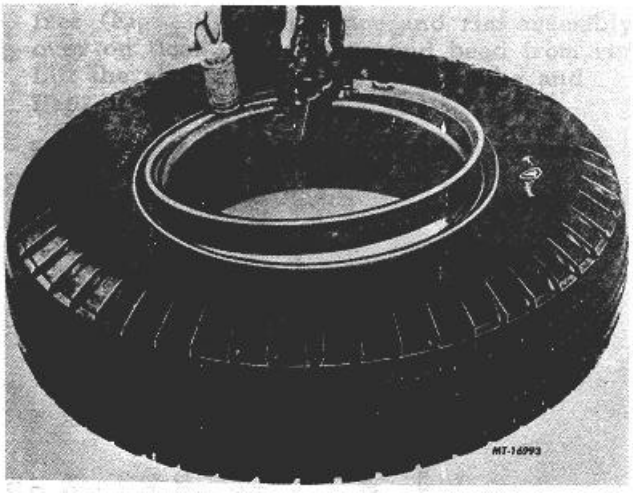


Fig. 47

4. Continue hammering around rim while holding ring with foot until entire ring is seated (Fig. 48).

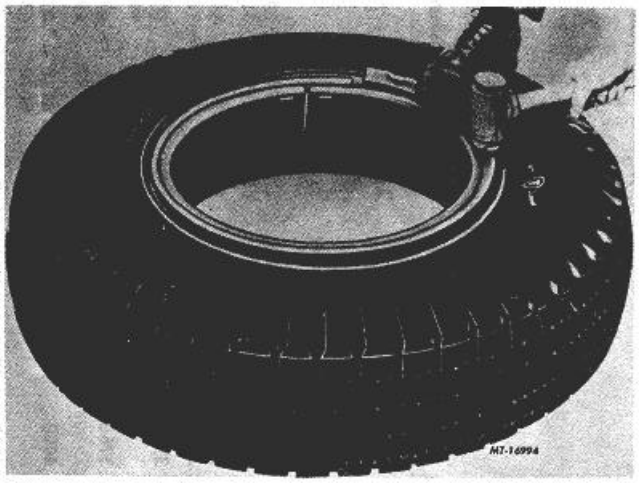


Fig. 48

5. Place tire assembly into safety cage and inflate to a maximum of 10 psi using extension hose with gauge and clip-on chuck. Inspect beads, side-ring and lock-ring for proper seating. Completely deflate tire to prevent tube from buckling. Reinflate to recommended pressure.

TIRE LOAD AND INFLATION CHART

(For Trucks, Buses and Trailers in Normal Highway Service)

Tire Size Designations			Tire Load Limits at Various Cold Inflation Pressures														
		*	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115
Tube Type	Tubeless	**	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120
7.50x20	8-22.5	D	2070	2220	2350	2490	2620	2750D	2870	2990	3100E	3210	3320	3430F	3540	3640G		
		S			2360	2530	2680	2840	2990	3140D	3270	3410	3530E	3660	3780	3910	4040	4150G
8.25x20	9-22.5	D	2460	2640	2800	2960	3120	3270	3410	3550E	3690	3820	3950F	4070	4200	4320G		
		S			2800	3010	3190	3370	3560	3730	3890	4050E	4210	4350	4500F	4640	4790	4920G
9.00x20	10-22.5	D		3120	3310	3510	3690	3870	4040E	4200	4360	4520F	4670	4820	4970G			
		S				3560	3770	4000	4210	4410	4610E	4790	4970	5150F	5320	5490	5670G	
10.00x20	11-22.5	D			3760	3970	4180	4380	4580	4760F	4950	5120	5300G	5470	5630	5800H		
		S					4290	4530	4770	4990	5220	5430F	5640	5840	6040G	6240	6430	6610H
10.00x22	11-24.5	D			4000	4230	4450	4660	4870	5070F	5260	5450	5640G	5820	6000	6170H		
		S					4560	4820	5070	5310	5550	5780F	6000	6210	6430G	6630	6840	7030H
11.00x20	12-24.5	D			4100	4330	4560	4780	4990	5190F	5390	5590	5780G	5960	6150	6320H		
		S					4670	4940	5200	5450	5690	5020F	6140	6370	6570G	6790	7010	7200H
11.00x22	12-24.5	D			4350	4600	4840	5080	5300	5520F	5730	5940	6140G	6330	6530	6720H		
		S					4960	5240	5520	5790	6040	6290F	6530	6770	7000G	7220	7440	7660H
11.00x24		D			4620	4890	5140	5390	5630	5860F	6090	6310	6520G	6730	6930	7130H		
		S					5270	5570	5860	6140	6420	6680F	6940	7190	7430G	7670	7900	8130H
12.00x20		D				4930	5190	5440	5680	5910	6140G	6360	6580	6790H	7000	7200J		
		S						5620	5920	6200	6480	6740	7000G	7250	7500	7740H	7980	8210J
12.00x24		D				5550	5840	6120	6390	6650	6910G	7160	7410	7640H	7870	8100J		
		S						6330	6660	6980	7280	7580	7880G	8160	8450	8710H	8970	9230J
	15-22.5	D		5000E	5320	5620	5910F	6200	6480	6740G	7000	7250	7500H					
		S				5680E	6040	6390	6720F	7040	7360	7660G	7950	8240	8520H			
	16.5-22.5	D		5800	6170	6520	6860	7190	7520	7820	8120H							
		S				6590	7010	7410	7790	8170	8540	8890	9230H					
	18-22.5	D		6430	6850	7230	7610G	7980	8330	8680H	9010	9340	9650J					
		S				7310	7780	8220	8650G	9070	9470	9860H	10240	10610	10970J			

For applicable load limits for other than normal highway service, for other size designations and for size designations with suffixes such as "ML" consult the tire manufacturer.

* Cold Inflation Pressure for Bias Tires.

** Cold Inflation Pressure for Radial Tires. Radial Tires have an "R" in the Size Designation; examples 10.00R20.

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TIRE AND RIM COMBINATIONS

Tube Type		Tubeless	
Tire Size	Rim Width	Tire Size	Rim Width
7.50x20	6.00,6.50	8-22.5	6.75
8.25x20	6.50,7.00	9-22.5	6.75
9.00x20	7.00,7.50	10-22.5	6.75,7.50
10.00x20	7.50,8.00	11-22.5	7.50,8.25
10.00x22	7.50,8.00	11-24.5	7.50,8.25
11.00x20	7.50,8.00	12-22.5	8.25
11.00x22	7.50,8.00	12-24.5	8.25
11.00x24	7.50,8.00	15-22.5	12.25
		16.5-22.5	12.25
		18-22.5	14.00

CAUTION: Always use approved tire and rim combinations for diameters and contours. After mounting dual tires, insure tires do not contact each other under a loaded condition.

CONVERSION OF PLY RATING TO
LOAD RANGE DESIGNATION

Load Range	Replaces Ply Rating
A	2
B	4
C	6
D	8
E	10
F	12
G	14
H	16
J	18
L	20
M	22
N	24

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CHAPTER IV

TORQUE CHART

DISC WHEELS

Size		Torque N•m	Torque Ft Lbs
11/16"	Flange Nut Mounting	475-543	350-400
¾"	Standard Square Cap Nut Mounting:		
	13/16" Across Flats	610- 678	450-500
	1-½" Across Flats	610-678	450-500
1-1/8"	Standard Hex Cap Nut Mounting:		
	1-½" Across Flats	610-678	450-500
	Heavy Duty Hex Cap Nut Mounting:		
	1-¾" Across Flats	882-949	650-700
15/16"	Heavy Duty Square Cap Nut Mounting:		
	1-5/16" Across Flats	1017-1221	750-900
1-5/16"	Heavy Duty Cap Nut Mounting:		
	1-¾" Across Flats	1017-1221	750-900
	CAST WHEELS		
½"	Rim Clamp	109-122	80-90
9/16"	Rim Clamp	217-237	160-175
5/8"	Rim Clamp	217-237	160-175
¾"	Rim Clamp	237-271	175-200

DRY THREADS-NO LUBRICATION

Where excessive corrosion exists, a light coat of lubricant on first three threads of stud on bolt is permitted. Keep lubricant away from cap nut ball faces or ball seats of disc wheels and rim clamps of cast wheels.

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FAILURE ANALYSIS

This failure analysis section has been prepared to assist servicemen in diagnosing the cause of failed tire and wheel components. The section contains various corrective measures for preventing the reoccurrence of the same type failure.

This publication has been compiled from actual case histories in an effort to record information that will be of assistance in analyzing tire, wheel, rim, or stud failures.

Proper wheel and tire maintenance is more than simple parts replacement. It also includes the application of mechanical skills and knowledge for reassembly, lubrication and periodic inspection.

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CHAPTER 1-WHEELS, RIMS

Road failures are generally caused by either overloading or oversight in the maintenance program. To save hours of downtime a simple visual check of the following components should periodically be made.

Cracked Rims

Cracked rims or flanges are a result of metal fatigue or overloading, thus periodic inspections should be made to assure safe operations, Fig. 1.

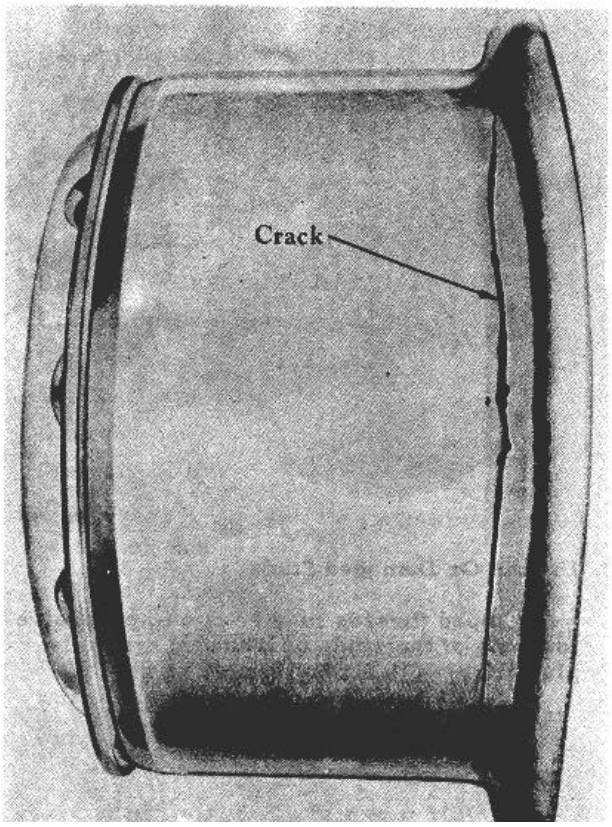


Fig. 1

Rim Corrosion

Corrosion is occasionally found on both tubed and tubeless type rims, Fig. 2. If the corrosion is minor a wire brushing or buffing will clean satisfactorily. The tire mounting surfaces of the rim can then be painted with a good quality frame enamel or coated with a non-water suspended lubricant. If corrosion is excessive, fatigue cracks may have developed in the rim base or the ring may not be seating in the gutter. The wheel in this case should be replaced.

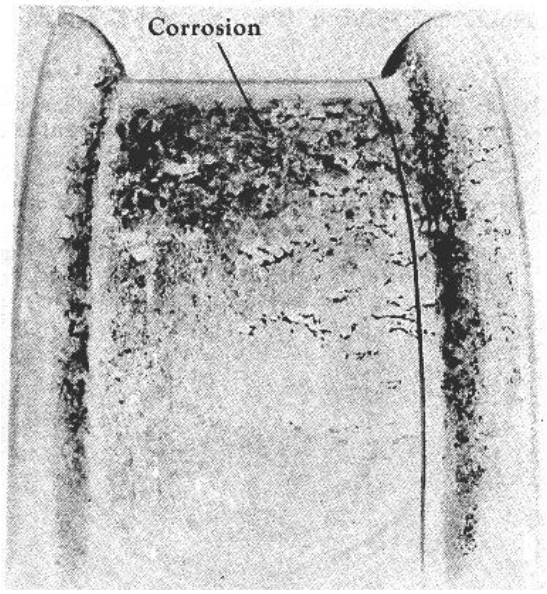


Fig. 2

Damaged Or Cracked Rings

Broken or cracked rings are generally caused by rough use of tire tools or improper initial seating in the rim gutter. Bent or sprung rings are caused by rough or improper removal, and cannot be properly reformed to seat accurately in the rim gutter. They should be replaced, Fig. 3. When removing the rings they should be worked off in small steps, starting at one point and gradually working in one direction around the entire circumference.

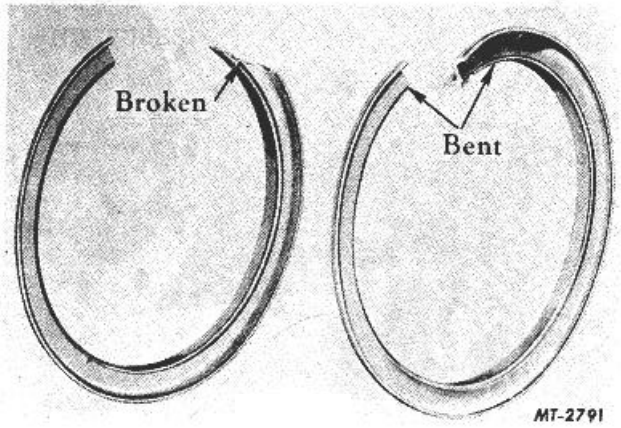


Fig. 3

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Worn Wheel Stud Holes

This condition will usually be accompanied by evidence of a bright worn surface on the wheel face, indicating that loose wheels are working against each other. The wheels should be replaced, Fig. 4.

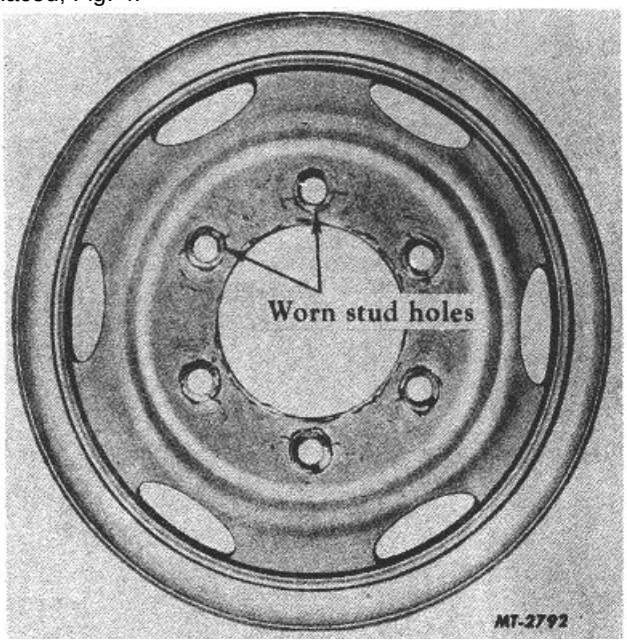


Fig. 4

Worn Hub Face

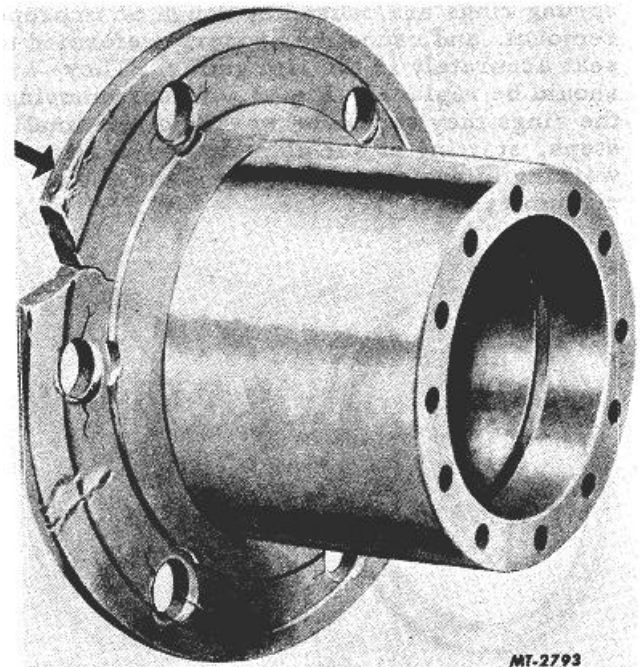


Fig. 5

A worn hub face is always caused by running wheel assemblies in a loose condition. If the wear is not too excessive the hub face can be machined to a flat surface with the studs removed, otherwise a new hub should be installed, Fig. 5.

Broken Or Cracked Hub

If the hub barrel or flange is broken or cracked the unit must be replaced, Fig. 6.

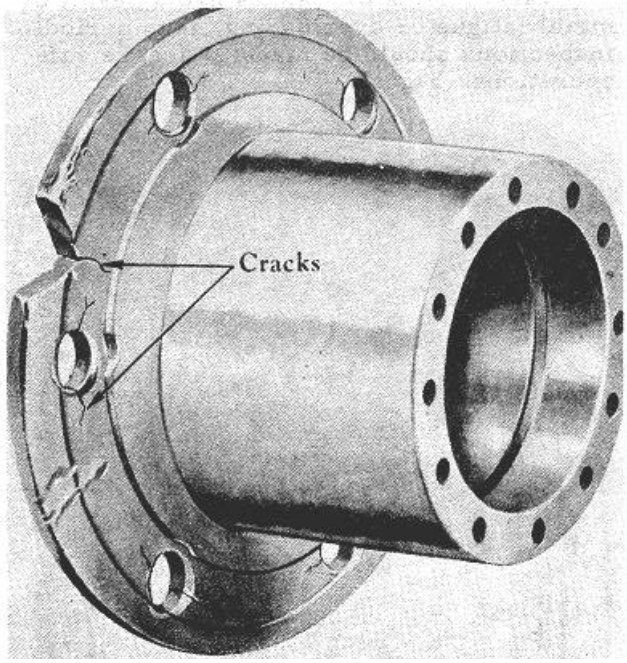


Fig. 6

Broken Or Damaged Studs

Stripped threads may be due to excessive torquing of the studs or when the wheel is placed over the studs, Fig. 7.

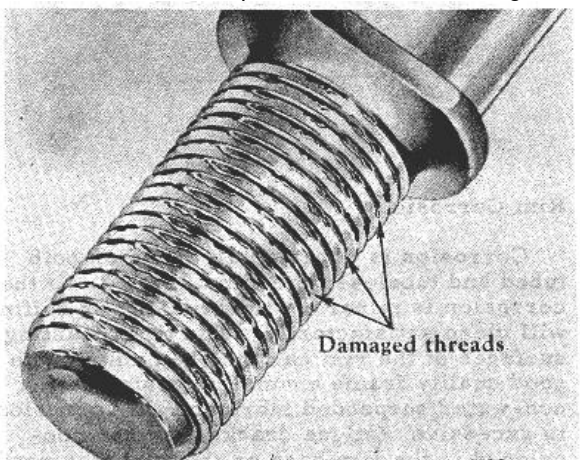


Fig. 7

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Stud Corrosion

While this problem is not too common, it can occur and make it difficult to obtain accurate torque checks. When corroded studs are encountered thorough wire brushing is necessary. If corrosion is excessive, stud replacement is recommended. If corrosion is persistent and a definite problem is encountered with the cap nut freezing, the lubrication of the first three threads of the stud with a graphite base lubricant will solve this problem. Care must be taken to assure that no lubricant gets in the ball seats of the stud holes or in the ball faces of the cap nuts. Clean, dry cap nut faces and nut seats at the wheels is necessary to maintain tight nuts to specified torque. DO NOT OIL nut or stud threads except as stated above.

Worn Stud Grooves

This is a result of improper initial assembly of the stud, or from insufficiently tightened cap nuts. Either of these conditions allow the shoulder of the stud to work in the groove and eventually wear the groove until the stud will not hold, Fig. 8.

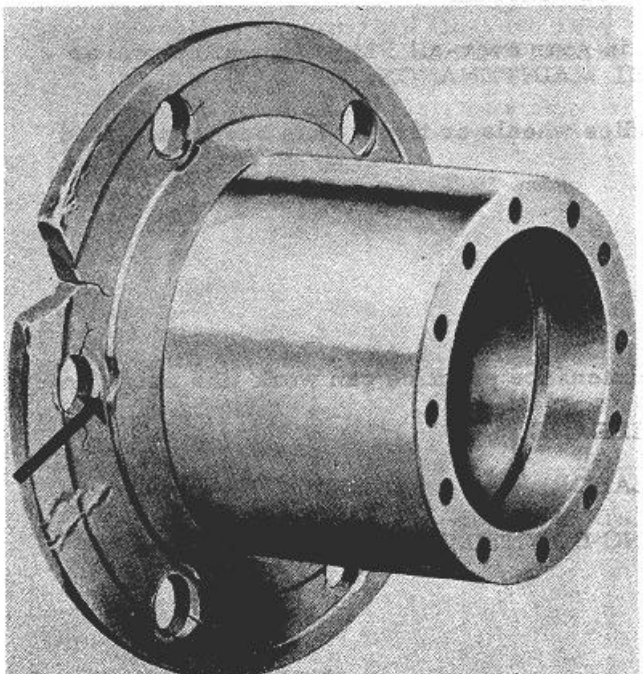


Fig. 8

Use Of Correct Studs

When it is necessary to replace studs in a hub, it is very important that the correct stud is used. Fig. 9 and 10 illustrate the correct stud application.

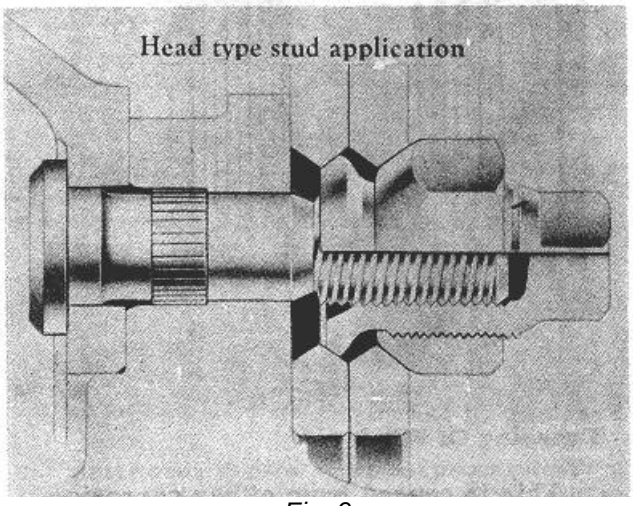


Fig. 9

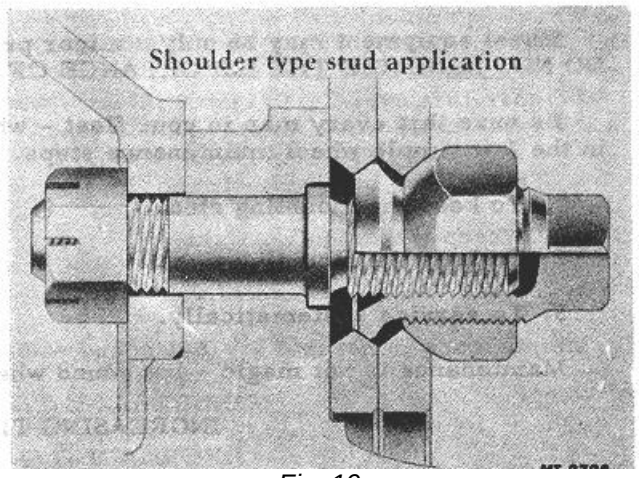


Fig. 10

CAP NUTS

Worn Ball Faces

This is a result of operating on a loose wheel assembly, Fig. 11.

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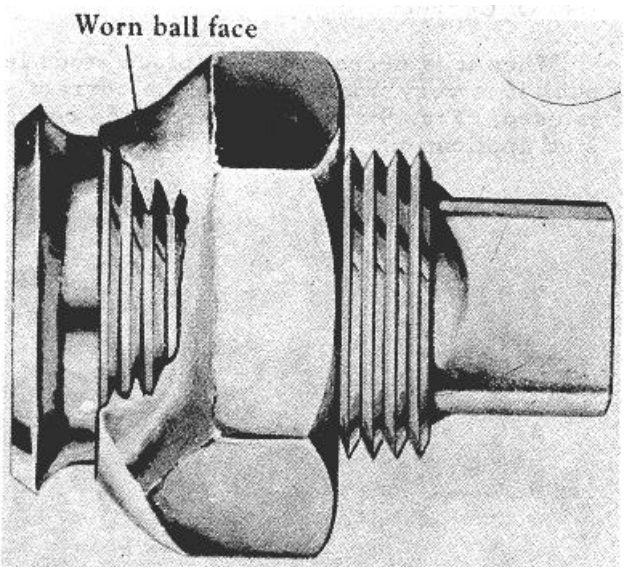


Fig. 11

Freezing Of Nut

This is caused from either corrosion, galling or improper tightening of the inner cap nuts.

TO THE FLEET OPERATOR

Wheel equipment may be only a minor problem in your over-all PM program. However-DO NOT MINIMIZE THE IMPORTANCE OF WHEEL MAINTENANCE.

Be sure that every man in your fleet-who handles wheels or tires-has been instructed in the few simple wheel maintenance steps.

1. To keep the mounting clean.
2. To keep the mounting tight.
3. To service systematically.

Maintenance is not magic-but sound wheel maintenance practice can work like magic in:

INCREASING TIRE MILEAGE

DECREASING SHOP LABOR

REDUCING OPERATING DOWNTIME

CHAPTER 2-TIRES AND TUBES

GENERAL

Proper maintenance and careful driving will result in maximum tire life. When a tire is properly inflated it will provide maximum traction, resist damage from road shock, tires will run cooler and "squirm" less than at a lower pressure. A tire properly inflated can be injured when a chuck hole, curb or other object is struck with sufficient force. When driving on a rough surface road slow down. Tread wear can be shortened by driving habits such as, sudden stops, excessive use of brakes, driving at excessive speeds, and riding on edge of pavement.

Air pressure is what enables tires to support a load and proper inflation is essential for maximum tire life. Refer to the vehicles operator manual or tire manufacturer's inflation chart for proper air pressure. Remember that the recommended pressures are cool tire pressure. Check air pressure before driving or after tires have a chance to cool.

"Bleeding" air from hot tires should never be practiced. The pressure will be reduced, but an increase in temperature and pressure will result as soon as driving continues.

TREAD WEAR PATTERNS

Underinflation:

The abnormal wear of the treads as shown in Fig. 12 is due to underinflation. Increase air pressure to the recommended level. Never exceed maximum tire pressure.

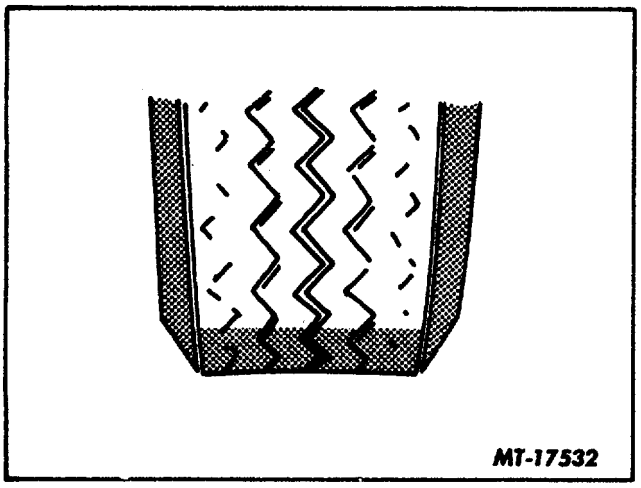


Fig. 12 Underinflation Causes Excessive Side Tread Wear

Overinflation:

Excessive wear in the center of the tread is due to overinflation, Fig. 13. Never "bleed" air from hot tires. The pressure will be reduced but an increase in temperature will result as soon as driving continues.

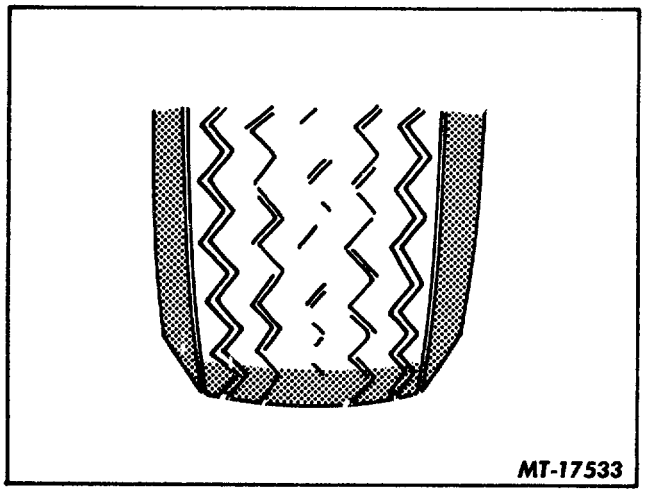


Fig. 13 Overinflation, Excessive Wear in Center of Tread

Fast Cornering:

Fast cornering causes tires to wear more on the shoulders of the tread as shown in Fig. 14. Slow down before negotiating curves or corners.

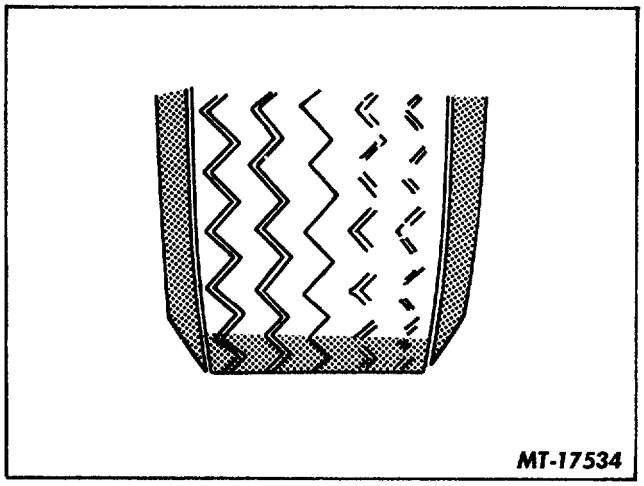


Fig. 14 Fast Cornering Results in Excessive Wear on Shoulders of Tread

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Camber:

Excessive even tread wear on one or the other side of a tire indicates too much wheel camber, Fig. 15. Unequal camber can cause one tire to wear uneven and pull vehicle to one side. Readjust camber to specifications of vehicle, see proper service manual.

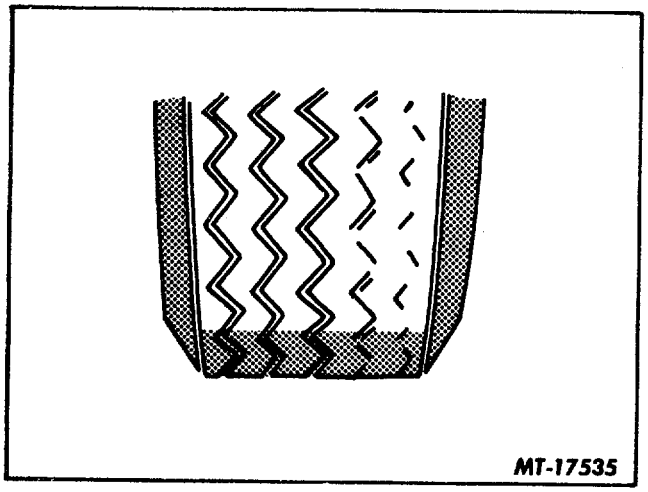


Fig. 15 Excessive Even Tread Wear on One Side Caused by Too Much Camber

Mechanical Problems:

Mechanical problems or underinflation can cause irregular tread wear as shown in Fig. 16. A single spot or a series of cuppings around the circumference of a tire is usually caused by a combination of worn wheel bearings, worn shock absorbers, loose tie rods, out of balance wheel and tire assemblies, or brakes that grab. Inspect and service parts as required.

Caster is the backward tilt of the axle or inclination of the king pin at the top. Too little caster causes wheel wander or weave resulting in irregular tread wear. Too much caster may cause wheel "shimmy". Unequal caster will cause wheel pull to one side, resulting in excessive irregular tread wear.

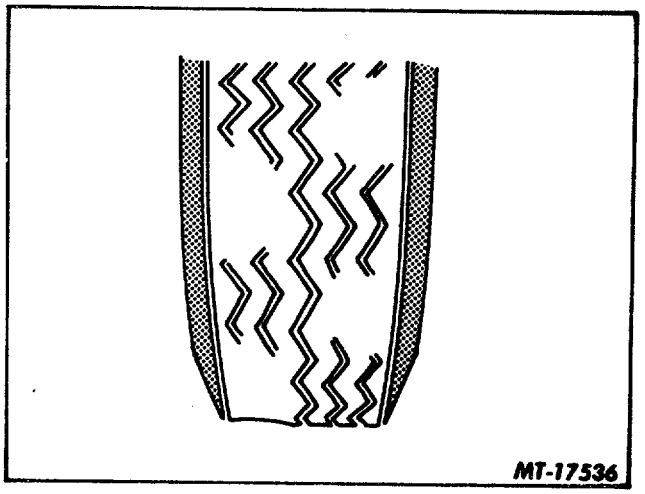


Fig. 16 Irregular Tread Wear May be a Sign of Mechanical Problems

Misalignment:

Misalignment causes a tire to be dragged sideways over the road. Excessive toe-in produces a feathered edge on the inside of the tread design. Toe-out causes a feathered edge on the out-side of the tread design. Align to specifications of vehicle.

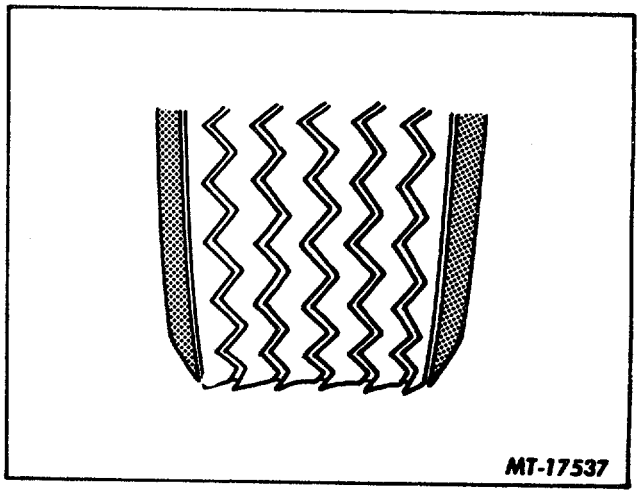


Fig. 17 Feathered Edge is Result of Misalignment

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TIRE INJURIES

Ply or Tread Separation:

Ply or tread separation as shown in Fig. 18 can result from underinflation, overloading. or high speed.

Driving a tire that is flat or seriously underinflated can cause unrepairable cord breakage, ply, and even tread separation. The amount of damage is directly proportional to the amount of underinflation and distance driven in this con dition.

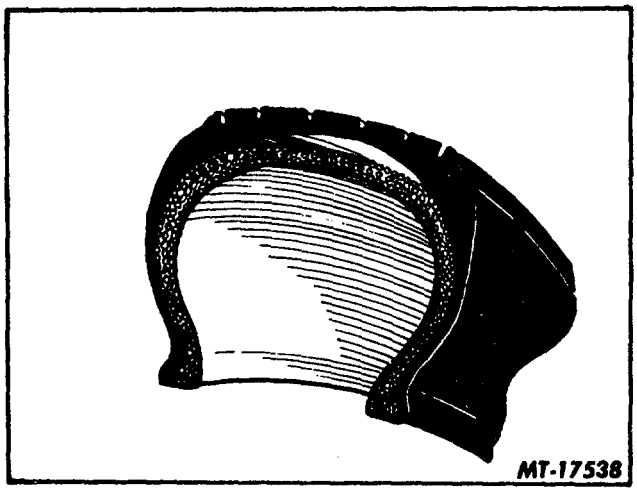


Fig. 18 Tread Separation Result of Underinflation, Overloading, or High Speed

Cord Breakage:

The proper deflection of tire sidewalls is inhibited by the increased tension caused by overinflation. Overinflation increases strain on the cords in the tread area and the tire loses its ability to absorb ordinary road shocks. Under this overinflated condition an impact can cause either an X-break or a diagonal break. Four pounds extra pressure for high speed driving is not considered overinflation, providing the maximum inflation of the tire is not exceeded. Reduce cool air pressure to recommended level. Never "bleed" air from a hot tire.

Even with properly inflated tires, cords can be broken when a tire is crushed between an object like a concrete curb and steel rim of the wheel. The position and breakage of cords is determined by the angle and force of impact.

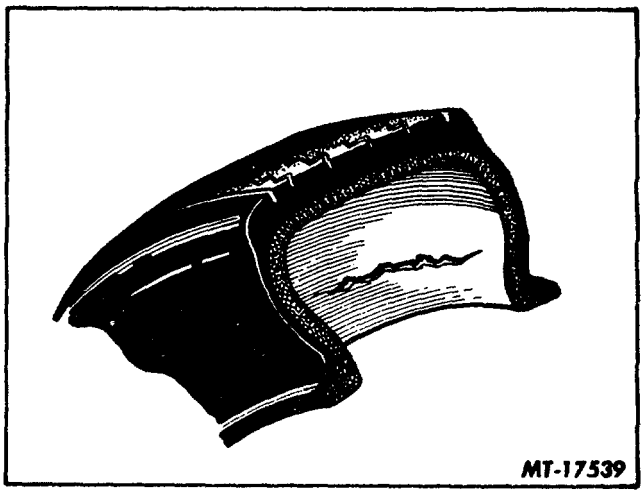


Fig. 19 Broken Cords Caused by Severe Blow

INNERTUBE INJURIES

Chafed Innertube:

Innertubes that are chafed by the tire can be prevented by proper mounting techniques. First inflate innertube to 10 psi, deflate and reinflate inner tube to recommended pressure. This procedure will prevent chafing.

Damage to both the innertube and inside of tire can be caused by not cleaning foreign matter from tire, innertube, or wheel at time of assembly. Thoroughly clean tire, innertube, and wheel removing all foreign matter, dirt, rust, and labels from all surfaces.

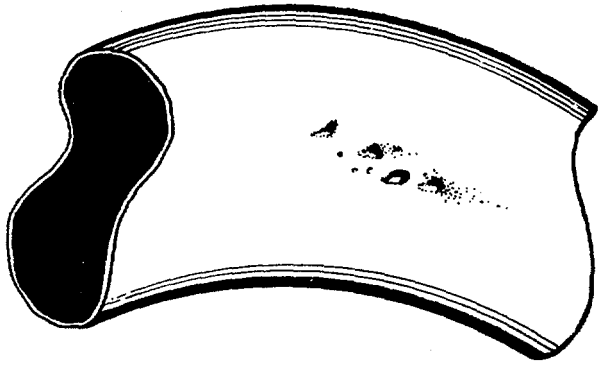


Fig. 20 Damage Caused by Dirt In Tire

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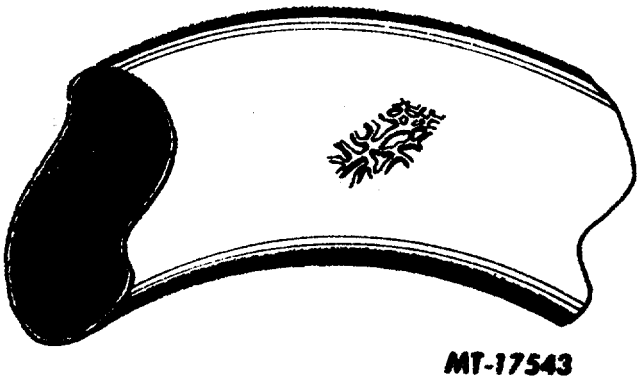


Fig. 21 Damage Caused by Not Removing Label

Crease or Fold:

Be certain the innertube being used is the proper size for the tire. A crease or fold can result from innertube being too large for the tire, Fig. 22.

Underinflation:

Driving on severly underinflated tires can result in a broken valve stem. To prevent damage inflate innertube to recommended cool air pressure.

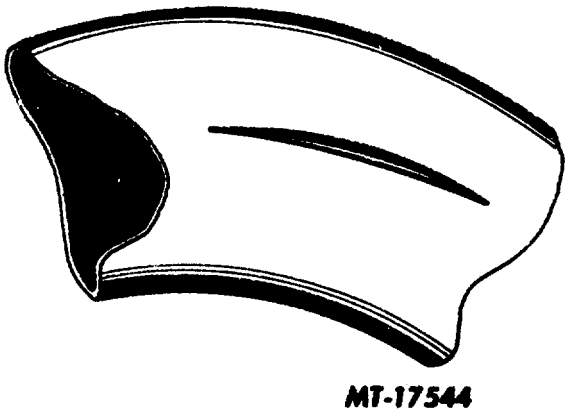


Fig. 22 Crease or Fold Result of Innertube Being Too Large for Tire

Pinched Innertube:

Proper mounting techniques increase the life of innertubes. Be careful not to pinch innertube with tire iron when mounting tire on rim.

Proper assembly, maintenance and good driving habits will result in maximum wheel, tire and innertube life.

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General, United States Army
Chief of Staff

Official:

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The Adjutant General

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THE METRIC SYSTEM AND EQUIVALENTS

Linear Measure

1 centimeter = 10 millimeters = .39 inch
1 decimeter = 10 centimeters = 3.94 inches
1 meter = 10 decimeters = 39.37 inches
1 dekameter = 10 meters = 32.8 feet
1 hectometer = 10 dekameters = 328.08 feet
1 kilometer = 10 hectometers = 3.2808.8 feet

Weights

1 centigram = 10 milligrams = .15 grain
1 decigram = 10 centigrams = 1.54 grains
1 gram = 10 decigram = .035 ounce
1 dekagram = 10 grams = .35 ounce
1 hectogram = 10 dekagrams = 3.52 ounces
1 kilogram = 10 hectograms = 2.2 pounds
1 quintal = 100 kilograms = 220.46 pounds
1 metric ton = 10 quintals = 1.1 short tons

Cubic Measure

1 cu. centimeter = 1000 cu. millimeters = .06 cu. inch
1 cu. decimeter = 1000 cu. centimeters = 61.02 cu in.
1 cu. meter = 1000 cu. decimeters = 35.31 cu. feet

Square measure

1 sq. centimeter = 100 sq. millimeters = .155 sq. in.
1 sq. decimeter = 100 sq. centimeters = 15.5 inches
1 sq. meter (centare) = 100 sq. decimeters = 10.76 feet
1 sq. dekameter (are) = 100 sq. meters = 1.076.4 sq. ft.
1 sq. hectometer (hectare) = 100 sq. dekameters = 2.47 acres
1 sq. kilometer = 100 hectometers = .386 sq. miles

Liquid Measure

1 dekaliter = 10 liters = 2.64 gallons
1 hectoliter = 10 dekaliters = 26.42 gallons
1 kiloliter = 10 hectoliters = 264.18 gallons
1 liter = 10 deciliters = 33.81 fl. ounces
1 centiliter = 10 milliliters = .34 fl. ounce
1 deciliter = 10 centiliters = 3 38 fl. ounces
1 metric ton = 10 quintals = 1.1 short tons

Approximate Conversion Factors

To change	To	Multiply by
inches	centimeters	2.540
feet	meters	.305
yards	meters	.914
miles	kilometers	1.609
sq. inches	sq. centimeters	6.451
sq. feet	sq. meters	.093
sq. yards	sq. meters	.836
sq. miles	sq. kilometers	2.590
acres	sq. hectometers	.405
cubic feet	cubic meters	.028
cubic yards	cubic meters	.765
fluid ounces	milliliters	29.573
pints	liters	.472
quarts	liters	.946
gallons	liters	3.785
ounces	grams	28.349
pounds	kilograms	.454
short tons	metric tons	.907
pound inches	newton-meters	.11296

To change	To	Multiply by
ounce inches	newton-meters	.0070062
centimeters	inches	.394
meters	feet	3.280
meters	yards	1.094
kilometers	miles	.621
sq. centimeters	sq. inches	.155
sq. meters	sq. yards	10.764
sq. kilometers	sq. miles	1.196
sq. hectometers	acres	2.471
cubic meters	cubic feet	35.315
milliliters	fluid ounces	.034
liters	pints	2.113
liters	quarts	1.057
grams	ounces	.035
kilograms	pounds	2.205
metric tons	short tons	1.102
pound-feet	newton-meters	1.356

Temperature (Exact)

°F Fahrenheit temperature — 5/9 (after subtracting 32) — Celsius Temperature °C

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