TECHNICAL MANUAL

OPERATOR'S, ORGANIZATIONAL, DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE MANUAL (INCLUDING REPAIR PARTS INFORMATION AND SUPPLEMENTAL MAINTENANCE AND REPAIR PARTS INSTRUCTIONS) FOR

COMPACTOR, HIGH SPEED, TAMPING SELF-PROPELLED (CCE) BOMAG MODEL K300 NSN 3895-01-024-4064

This copy is a reprint which includes current pages from Changes 1 through 2.

H E A D Q U A R T E R S , D E P A R T M E N T O F T H E A R M Y

APRIL 1980

CHANGE

NO. 2

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington D.C., *30 September 1991*

OPERATOR'S, ORGANIZATIONAL, DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE MANUAL (INCLUDING REPAIR PARTS INFORMATION AND SUPPLEMENTAL MAINTENANCE AND REPAIR PARTS INSTRUCTIONS)

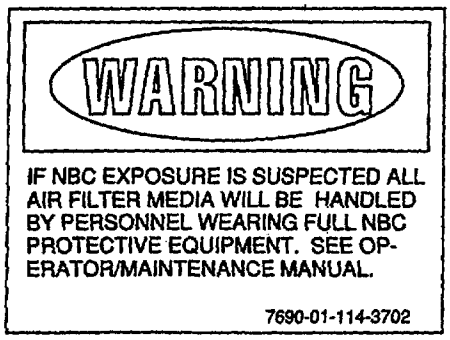
FOR
COMPACTOR, HIGH SPEED
TAMPING SELF-PROPELLED (CCE)
BOMAG MODEL K300
NSN 3895-01-024-4064

TM 5-3895-349-14&P, 25 April 1980, is changed as follows:

The tile and cover are changed to read as shown above.

OPERATION GUIDE, 3208 INDUSTRIAL ENGINE, page 2, the following paragraph is added after, **"ENGINE OPERATION, GENERAL"**

A decal has been developed that warns of NBC exposure is to be positioned in a noticeable place on or near the air cleaner or air filter housing. You may order the decal using part number 12296626, CAGEC 19207. Refer to TB 43-0219 for further information. Add the decal to the air cleaner (AIR CLEANER ASSEMBLY, page 40-1.2, service bulletin, page 40-1.3 and page 40-1.4, and OPERATION, page 200-3.1)



Add the following WARNING to the following locations;

PARTS, page 4-1.2, after, "AIR CLEANER ASSEMBLY

ENGINE PARTS CATALOG, page 91, position inside of illustration for AIR CLEANER ADAPTER;

ENGINE PARTS CATALOG, *page 92*, position inside of illustration for AIR CLEANER CAP GROUP and AIR CLEANER GROUP;

MAINTENANCE AND LUBRICATION, ENGINE*, page 20-1.2*, preceding, "CLEAN AIR FILTER" and preceding, "CHANGE AIR FILTER ELEMENT";

MAINTENANCE AND LUBRICATION, ENGINE, *page 20-2.1*, after, "ENGINE CRANKS OVER BUT FAILS TO START" and "ENGINE RUNS ROUGH";

MAINTENANCE AND LUBRICATION, ENGINE*, page 40-1.1*, after, "AIR CLEANER";

MAINTENANCE AND LUBRICATION, ENGINE*, page 40-1.2*, SERVICE BULLETIN, after, "Service Instructions for Cyclopac Series Air Cleaners", *page 40-1.3*, after "FW Series Cyclopac Air Cleaners*", page 40-1.4*, after "Service Procedure" and *page 40-1.5*, after "Element Cleaning Methods";

OPERATION GUIDE, *page 8*, after, "EVERY 150 SERVICE METER UNITS OR 3 WEEKS", preceding, "Change air cleaner elements";

OPERATION GUIDE, *page 9*, preceding note: 3;

OPERATION GUIDE, *page 12*, after, "AIR INDUCTION AND EXHAUST SYSTEM"

SYSTEMS OPERATION TESTING AND ADJUSTING, **3208, INDUSTRIAL & MARINE ENGINES**, *page 15*, after, "AIR INLET AND EXHAUST SYSTEM'

3208, INDUSTRIAL & MARINE ENGINES, *page 39*, preceding problem 19, "TOO MUCH WHITE OR GRAY SMOKE";

DISASSEMBLY AND ASSEMBLY **3208 INDUSTRIAL & MARINE ENGINES**, *page 6*, after "AIR CLEANER FUEL INJECTION LINES;

DISASSEMBLY AND ASSEMBLY **3208 INDUSTRIAL & MARINE ENGINES,** *page 7*, after "AIR INLET MANFOLD";

DISASSEMBLY AND ASSEMBLY **3208 INDUSTRIAL & MARINE ENGINES**, *page 8*, after "AIR CLEANER";

DISASSEMBLY AND ASSEMBLY **3208 INDUSTRIAL & MARINE ENGINES,** *page 9*, preceding, “REMOVE A INLET MANIFOLD (INDUSTRIAL ENGINE)";

DISASSEMBLY AND ASSEMBLY **3208 INDUSTRIAL & MARINE ENGINES**, *page 11*, after, "FUEL INJECTION PUMP HOUSING AND GOVERNOR";

DISASSEMBLY AND ASSEMBLY **3208 INDUSTRIAL & MARINE ENGINES**, *page 14*, after, "FUEL INJECTION PUMP HOUSING AND GOVERNOR";

OPERATION MANUAL, *page 200-1.1*, after, **1.2.3. SAFETY PRECAUTIONS;**

MAINTENANCE, *page 400-4.2*, after, "CHECK AIR CLEANER RESTRICION INDICATOR'

MAINTENANCE, *page 400-5.1*, after, **"ENGINE CRANKS OVER BUT FAILS TO START"**, preceding item 4;

VENDOR LITERATURE OPERATION GUIDE, *page 8*, after, "EVERY 150 SERVICE METER UNITS OR 3 WEEKS”;

VENDOR LITERATURE OPERATION GUIDE, *page 12*, after, **"AIR INDUCTION AND EXHAUST SYSTEM"**;

VENDOR LITERATURE OPERATION GUIDE, *page 25*, **Service bulletin**, after, "Proper service improves performance-cuts operating costs";

APPENDIX C, *page 15*, preceding, "0304 Air Cleaner";

ORGANIZATIONAL PREVENTIVE MAINTENANCE CHECKS AND SERVICES, *page 42*, preceding, "AIR CLEANER":

WARNING

If NBC exposure is suspected, all air filter media should be handled by personnel wearing protective equipment. Consult your unit NBC Officer or NBC NCO for appropriate handling or disposal instructions.

SPECIFICATIONS FOR 3208 INDUSTRAL & MARINE ENGINES, *page 50-2.1*, add the following after the first sentence in the paragraph on, **MAINTENANCE**:

CAUTION

Do not attempt this check with cold oil. Failure to follow this procedure may result in damage to equipment."

To bring the oil temperature to this specification, it is necessary to either work the machine or "stall out the converter. Where the former means is impractical, the later means should be employed as follows: engage shift levers in forward and high speed and apply brakes. Accelerate engine half to 3/4 throttle. Hold stall until desired converter outlet temperature is reached.

CAUTION

Full throttle stall speeds for excessive length of time will overheat the converter.

By Order of the Secretary of the Army:

GORDON R. SULLIVAN
General, United states Amy
Chief of Staff

Official:

PATRICIA P. HICKERSON
Brigadier General United States Army
The Adjutant General

Distribution:
To be distributed in accordance with DA Form 12-25-E (Block 0322) Operator, Unit, Direct and General Support maintenance requirements for TM5-3895-349-14&P.

TM 5-389349-14&P
C1

Change No. 1

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C. 7 July 1982

OPERATOR'S, ORGANIZATIONAL, DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE MANUAL (INCLUDING REPAIR PARTS INFORMATION AND SUPPLEMENTAL MAINTENANCE AND REPAIR PARTS INSTRUCTIONS)

COMPACTOR, HIGH SPEED, TAMPING SELFPROPELLED (CCE) BOMAG MODEL K300 NSN 3895-01-024-4064

TM 5-3895-349-14&P 25 April 1980 is changed as follows:

Page i, below the title. REPORTING OF ERRORS is superseded as follows:

REPORTING OF ERRORS AND RECOMMENDING IMPROVEMENTS

You can help improve this manual. If you find any mistakes 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 publication direct to: US Amy Tank-Automotive Command, ATTN: DRSTA-MB, Warren, MI 48090. A reply will be furnished to you.

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3815	Seal Kit, Pump	6-3
3816	Plug, Port	6-3
3819	Reducer	5-2
3830	Seal Kit, Dozer Valve	6-2
3832	Plate, Cover	3-1
3833	Radiator Assembly	4-3
3834	Tank Assembly, Bottom	4-3
3835	Bracket, Steering	3-1
3838	Cover, Bulkhead	2-1
3840	Plate, Front Floor	2-3
3842	Hose, Hydraulic Tank to Pump	6-1
3843	Hose, Pump to Valve	6-1
3845	Valve, Check	6-4
3846	Valve, Check	6-1
3848	Grommet, Rubber	7-6
3849	Nut, Center Joint	3-2
3881	Relief Assembly, Main	6-2
3882	Relief Assembly, Cylinder Port	6-2
3883	Bonnet, Float Positioner	6-2
3884	Bolt, Hex Head	6-9
3885	Seal, Ball Guide	6-2
3886	Washer, Screw Seal	6-2
3887	Seal, No. 16 Plug	6-2
3888	Seal, No. 20 Plug	6-2
3889	Seal, Outer Spool	6-2
3890	Seal, Port Relief, Body	6-2
3891	Seal, Port Relief, Seat	6-2
3910	Pump Assembly, Steering	6-4 6-6
3911	Body, Steering Pump	6-6
3912	Pin, Dowel	6-6
3913	Cover, Front	6-6
3914	Seal	6-6
3916	Gear, Driven	6-6
3917	Gear and Shaft, Drive	6-6
3918	Plate, Wear	6-6

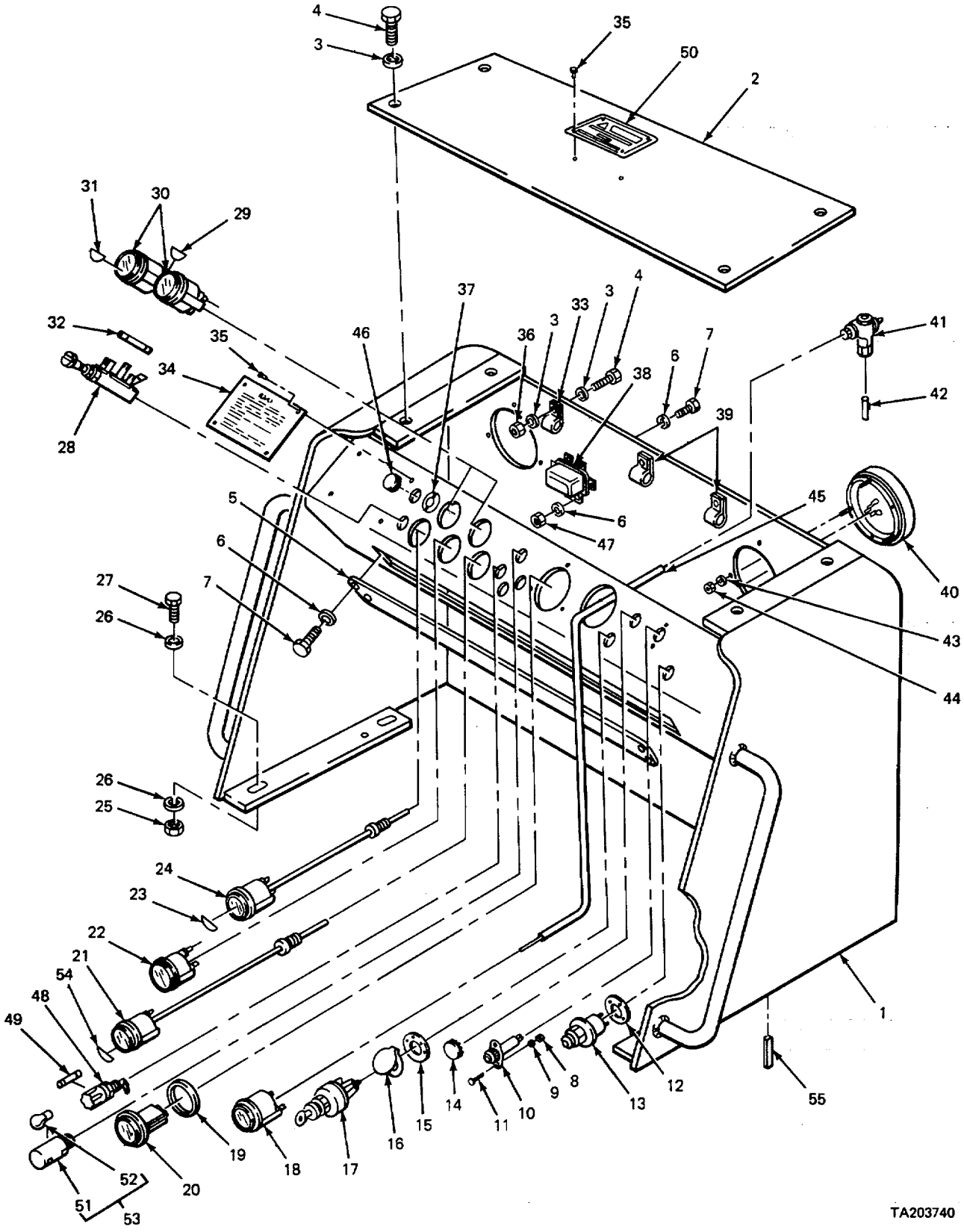
PART NO.	DESCRIPTION	PAGE NO.
3919	Seal Kit, Steering Pump	6-6
3920	Seal	6-6
3921	Seal	6-6
3922	Seal	6-6
3925	Bushing, Bracket	3-2
3927	Bracket, Bottom Hose	3-2
3928	Bracket, Top Hose	3-2
3930	Pump Assembly	6-6
		6-4
3931	Cover, Shaft End	6-6
3932	Plug, Port	6-6
3933	Bearing, Roller	6-6
3934	Plate, Thrust	6-6
3935	Housing, Gear	6-6
3936	Cover, Port End	6-6
3937	Gear and Shaft Set	6-6
3938	Washer	6-6
3939	Screw, Mounting	6-6
3940	Seal, Kit	6-6
3941	Seal, Shaft Lip	6-6
3942	Seal, Ring	6-6
3943	Seal, Strip	6-6
3944	Seal, Gasket	6-6
3954	Fan (6 Blade)	4-6
3955	Cooler	4-3
3980	Button, Starter	2-6
3983	Plate, Starter	2-6
3985	Shroud, Assembly	4-3
3986	Guard, Fan R.H.	4-3
3987	Guard, Fan L.H	4-3
4104	Cover, Front Floor Plate	2-3
4106	Plate Assembly, Rear Floor	2-3
4118	Seal Kit	6-8
4122	Cylinder, Steering	6-4
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4202	Valve, Steering Relief	6-4
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4203	Valve, Steering	6-4
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4204	Hose, Steering Pump to Relief	6-4
4205	Hose, Relief to Steering	6-4
4206	Nipple, Pipe	6-4
4207	Hose, Relief to Hydraulic Tank	6-4
4208	Hose, Steering to Cylinder	6-4
4209	Hose, Steering to Cylinder	6-4
4210	Hose, Cylinders Cross Over	6-4
4211	Hose, Tank to Steering Pump	6-4
4215	Column, Steering	7-4
4216	Wheel, Steering	7-4
4217	Button Kit, Horn	7-4
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4218	Nut, Steering Wheel	7-4
4223	Gasket, Steering Pump	6-4
4224	Hose, Steering to Relief	6-4
4232	Shaft Assembly, Center	5-1
4233	Shaft Assembly, Rear	5-1
4234	Shaft Assembly, Front	5-1
4235	Yoke,	5-1
4236	Cap & Bolt Assembly	5-1
4237	Bolt, Self-Locking	5-1
4238	Cap, Bearing Race	5-1
4239	Bolt	5-1
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4245	Axle, Rear	5-4
4246	Hose Assembly, Cooler	5-2
4247	Hose Assembly, Cooler to Cooler	5-2
4250	Axle, Front	5-4
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4256	Ring, Snap	5-1
4257	Journal Cross & Bearing Ass'y	5-1
4258	Repair Kit	5-1
4259	Journal Cross & Bearing Ass'y	5-1
4260	Cover Kit	5-1
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4277	Rod, Piston	6-8
4278	Locknut	6-8
4279	Piston	6-8
4280	Head	6-8
4281	Tube, Stop	6-8
4282	Drive, Steering Valve	6-5
4283	Plate, Steering Valve	6-5
4284	Gerotor Set	6-5
4285	Spacer	6-5
4286	Spacer	6-5
4287	Spline	6-5

PART NO.	DESCRIPTION	PAGE NO.
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4289	Cap, End	6-5
4290	Screw, Cap	6-5
4291	Screw, Cap	6-5
4292	Seal Kit	6-5
4293	Plate, Mounting	6-5
4294	Bushing, Locator	6-5
4295	Bearing Kit	6-5
4296	Locator, Bearing	6-5
4297	Race, Bearing	6-5
4298	Bearing	6-5
4299	Control Assembly	6-5
4300	Plug, Seal	6-5
4301	Seat, Check	6-5
4302	Ball, Steel	6-5
4303	Spring, Compression	6-5
4304	Pin, Centering	6-5
4307	Cap, Dust	5-1
4308	Washer, Steel	5-1
4309	Washer, Cork	5-1
4311	Cap	6-7
4313	Body	6-7
4314	Kit, Valve Rebuilding	6-7
4315	Kit, Seal	6-7
4316	Spring, Pilot	6-7
4317	Kit, Piston and Cylinder	6-7
4318	Spring, Piston	6-7
4319	Poppet	6-7
4320	Screw, Adjusting	6-7
4349	Cable, Horn Button	7-4
4351	Hose Assembly, Bottom Cooler	5-2
4352	Hose Assembly, Tee to Brake	5-2
4360	Seal, Oil	6-5
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4362	Seal, 0 Ring	6-5
4363	Seal, 0 Ring	6-5
4374	0 Ring, Body	6-7
4375	0 Ring, Relief Body	6-2
4376	Washer, Back Up	6-7
4379	0 Ring, Relief Body	6-2 6-7
4380	Washer, Back Up	6-2 6-7
4381	Housing, Relief Valve	6-7
4382	Gasket, Cap	6-7
4383	Cylinder	6-7
4384	Piston	6-7
4385	Ring, Retaining	6-7
4386	Pin, Wire	6-7
4387	Plate, Striker	7-4
4388	Retainer, Spring	7-4
4389	Contact, Horn	7-4
4390	Button, Horn	7-4
4391	Cover, Horn Button	7-4
4392	Spring, Contact	7-4
4393	Spacer Contact	7-4
4394	Screw, Horn Button	7-4
4414	Hose Assembly, Cooler	5-2
4415	Hose Assembly, Cooler	5-2
1012-4-5	Adapter	7-1 3-2
1012-4-6	Adapter	4-5
1012-6-6	Adapter	4-5
1012-12-10	Adapter	6-4
1012-12-12	Adapter	5-2
1012-12-16	Adapter	5-2
1012-16-16	Adapter	6-1
1012-20-20	Adapter	6-1
1015-4-6	Adapter	7-1
1015-12-12	Adapter	5-2
1018-5-5	Adapter	7-1
1021-2-5	Adapter	3-2
1021-8-10	Adapter	4-5
1025-16-16	Elbow, Adapter	6-1 6-4
1025-20-20	Elbow, Adapter	6-1
1032-12-10	Tee, Adapter	6-4
1037-16-16	Elbow	6-1
1040-8-10	Adapter	6-4
1040-10-10	Adapter	6-4
1040-12-12	Adapter	5-2
1040-12-16	Adapter	6-4
1040-16-16	Adapter	6-1
1040-20-20	Adapter	6-1
1042-6-8	Adapter	4-5
1042-12-12	Adapter	5-2
1048-16-16	Elbow, Adapter	6-1
1093-4-2	Reducer	4-6
1093-12-4	Reducer	5-2
1093-12-6	Reducer	5-2
1093-12-8	Reducer	5-2

PART NO.	DESCRIPTION	PAGE NO.
1093-20-16	Reducer	6-4
1248-219	Seal, 0 Ring	6-1
1248-222	Seal, 0 Ring	6-1
1249-6	Seal, 0 Ring	7-1
1249-8	Seal, 0 Ring	6-4
1249-10	Seal, 0 Ring	6-4
1249-12	Seal, 0 Ring	6-4
1249-16	Seal, Ring	6-1
1249-20	Seal, 0 Ring	6-1
2550-16	Flange, Split	6-1
2560-20	Flange, Split	6-1
2628-19	Clamp, Cable	2-3
		5-2
		7-5
2628-24	Clamp, Cable	2-6
2628-35	Clamp, Cable	2-3
2628-40	Clamp, Cable	2-3
		2-6
2628-48	Clamp, Cable	5-2
15850-12	Cross, Adapter	5-2
15858-12-12	Swivel, Adapter	5-2
15862-12-12	Tee, Adapter	5-2
16913-12-12	Tee, Adapter	5-2
103522	Nut, Wheel	5-4
120218	Stud, Wheel	5-4
121062	Nut, Wheel Stud	5-4
145027	Relay, Starter Switch	5-2
		8-1
173094	Mount, Engine Rubber	4-4
173773	Angle, Mounting	4-4
211433	Cap, Filler-Breather	5-2
236395	Switch, Neutral	8-1
1N8207	Pulley, Alternator Idler	4-6
1N9398	Pulley, Fan	4-6
2N2361	Fan	4-6
2N2777	Pulley	4-6
2N995	Dipstick, Engine Oil	4-6
2P4230	Belt, Alternator	4-6
4B2544	Belt Set, Fan	4-6
4N3355	Switch, Oil Pressure	4-6
		8-1
4N4316	Fuel Solenoid	8-1
4N6663	Pulley, Crankshaft	4-6
4N8253	Motor, Starter	4-6
4N8580	Belt Set, Water Pump	4-6
6N12	Diode Harness	8-1
6N8355	Body, Panel Light	2-6
7M9957	Bulb, Panel Light	2-6
9M1974	Washer, Fan Mounting	4-6
9L6298	Alternator	4-6
		8-1
9L7311	Pulley, Alternator	4-6
9L7626	Pulley, Camshaft	4-6
9L8439	Cap, Oil Filler	4-6
216F-316M	Swivel, Adapter	6-1
S-114-B	Bolt, Engine Mount	4-4
S-1618	Bolt, Fan Mounting	4-6
VP25K	Resistor, Diode	8-1

Page 2-6.1 and 2-6.2. Illustration and legend for control console assembly is superseded as follows.

CONTROL CONSOLE ASSEMBLY



CONTROL CONSOLE ASSEMBLY

REF. NO.	DESCRIPTION	QTY.	PART NO.
1	Control Console Subassembly (incl. items 2-7)	1	1269
2	Panel, Top	1	1278
3	Washer, Hardened Flat 3/8 Diameter	12	--
4	Bolt, Hex 3/8-16 UNC x 1 Long	8	--
5	Panel, Bottom	1	2456
6	Washer, Hardened Flat 1/4 Diameter	6	--
7	Bolt, Hex 1/4-20 UNC x 3/4 Long	6	--
8	Nut, Hex No. 6-32 UNC	2	--
9	Lockwasher, External Tooth No. 6 Diameter	2	--
10	Socket	1	2504
11	Screw, No. 6-32 UNC x 3/4 Long	2	--
12	Plate, Starter (Ser. Nos. 9050-ON only)	1	3983
13	Button, Starter (Ser. Nos. 9050-ON only	1	3980
14	Plug, Chrome Button 3/4 Diameter	1	--
15a	Plate, Ignition Key (Ser. Nos. 9050-ON)	1	3982
15b	Plate, Ignition Key (Ser. Nos 9001-9049)	1	2894
16	Protector, Key Switch (Ser. Nos. 9001-9049 only)	1	3285
17a	Switch, Key Start (Ser. Nos. 9050-ON)	1	3979
17b	Switch, Key Start (Ser. Nos. 9001-9049)	1	2445
18	Tachometer	1	1979
19	Mount, Rubber	1	2580
20	Hourmeter	1	1250
21	Gauge, Water Temperature	1	2340
22	Ammeter	1	1977
23	Decal "Trans Oil Temp	1	3190
24	Gauge, Oil Temperature	1	2339
25	Locknut, Hex 5/8-11 UNC	4	--
26	Washer, Hardened Flat 5/8 Diameter	8	--
27	Bolt, Hex 5/8-11 UNC x 1-3/4 Long	4	--
28	Switch, Light (includes item 32)	1	1566
29	Decal "Engine Oil Pres"	1	3189
30	Gauge, Oil Pressure	2	1252
31	Decal "Converter Oil Pres"	1	3192
32	Fuse, Switch	1	3461
33	Clamp, Cable	2	2628-24
34	Plate, Instructions	1	2362
35	Screw, Metallic Drive No. 4 x 5/16 Long	8	--
36	Locknut, Hex 3/8-16 UNC	6	--
37	Light, Ammeter Warning	1	3286
38	Relay, Warning Light	1	3418
39	Clamp, Cable	4	2628-40
40	Headlight	2	1567
41	Adapter, Tachometer Cable (includes item 42)	1	3775
42	Tip, Tachometer Adapter Drive	1	3092
43	Lockwasher, External Tooth No. 10 Diameter	6	--
44	Nut, Hex No. 10-24 UNC	6	--

CONTROL CONSOLE ASSEMBLY

REF. NO.	DESCRIPTION	QTY.	PART NO.
45	Cable, Tachometer	1	3608
46	Plug, Chrome Button 11/16 Diameter	1	--
47	Locknut, Hex 1/4-20 UNC	2	--
48	Fuse Holder	3	3443
49	Fuse ...	3	3461
50	Plate, Ear Protection	1	3647
51	Body, Panel Light	1	6N8355
52	Bulb, Panel Light	1	7M9957
53	Light, Panel (includes item 51 and 52)	1	1569
54	Decal "Water Eng Temp"	1	3191
55	Pin, Roll 3/8 Diameter x Long	2	--

Page 2-7.1 Legend for decals and nameplates is superseded as follows:

DECALS AND NAMEPLATES

PART NO.	DESCRIPTION	QTY.
2360	Plate, Transmission "F-N-R"	1
2361	Plate, Dozer Control	1
2362	Plate, Instructions	1
2517	Plate, K300 Identification	1
2590	Plate, "Parking Brake"	1
2591	Plate, "Apply"	1
2592	Plate, "Release"	1
2894	Plate, Ignition Key (Ser. Nos. 9001-9049)	1
2934	Decal, "K-Koehring Bomag"	1
2939	Decal, "K-Koehring"	2
3093	Decal, "Caution-Transmission Fluid Only"	1
3094	Decal, "Diesel Fuel Only	1
3096	Decal, "Hydraulic Oil Only"	1
3189	Decal, "Engine Oil Pres"	1
3190	Decal, "Trans Oil Temp"	1
3191	Decal, "Water Engine Temp"	1
3192	Decal, "Converter Oil Pres"	1
3245	Plate, "Warning-No Space"	2
3283	Plate, Operator's Caution	1
3647	Plate, "Warning-Ear Protection"	1
3690	Decal, "K300" (White)	1
3691	Decal, "Bomag" (White)	2
3764	Plate, Lifting	1
.3765	Plate, Tiedown Procedure	1
3774	Plate, Transmission Speed	1
3785	Plate, Lubrication	1
3817	Plate, Towing Instructions	1
3982	Plate, Ignition Key (Ser. Nos. 9050-ON)	1
3983	Plate, Starter (Ser. Nos. 9050-ON)	1

Page 4-3.2. Legend for cooling assembly is superseded as follows.

COOLING ASSEMBLY

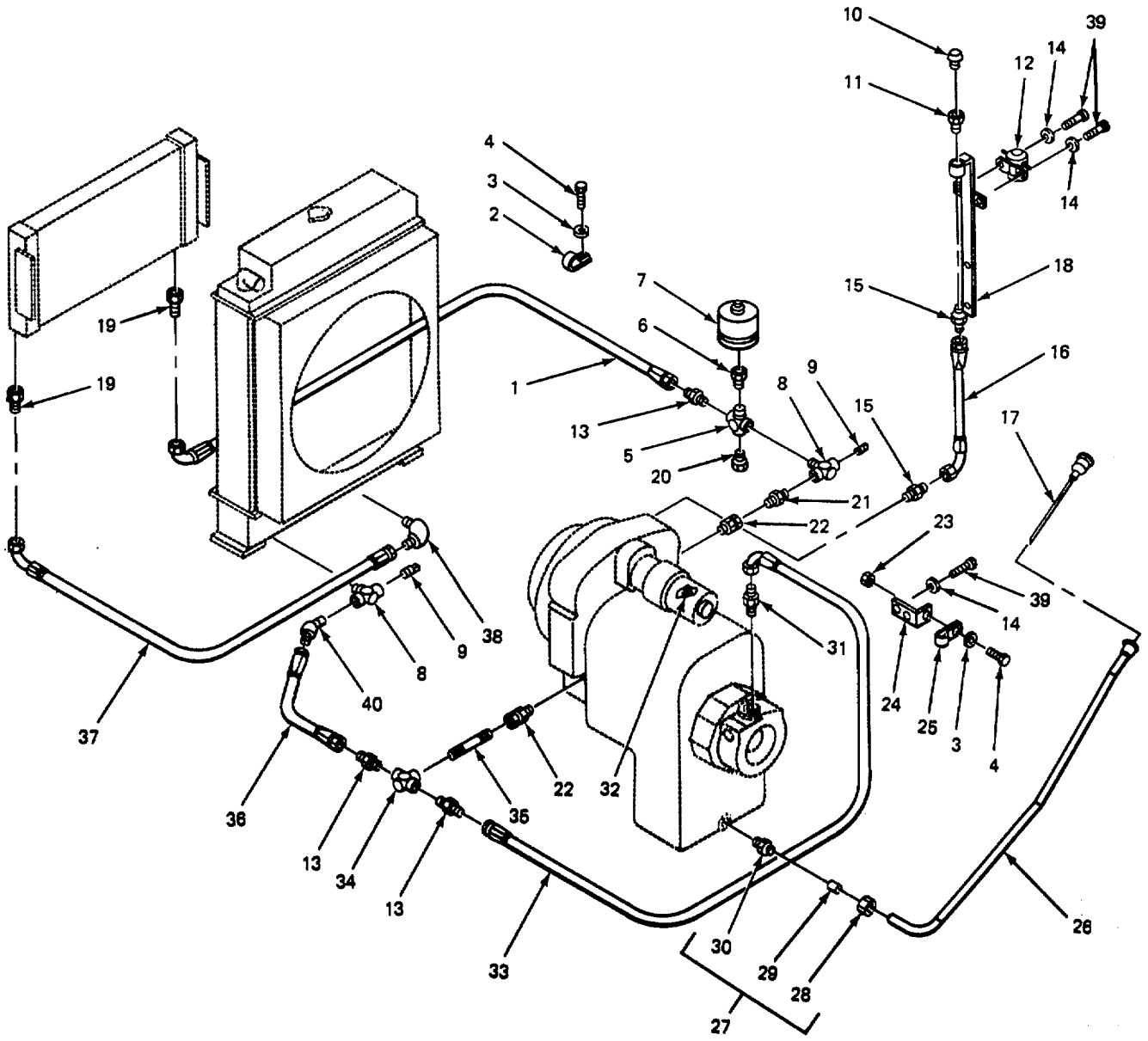
REF. NO.	DESCRIPTION	QTY.	PART NO.
1a	Radiator Assembly incl. items 2-22a, 23-29) (Ser. Nos. 9076-ON).	1	3833
1b	Radiator Assembly (incl. items 2-21, 22b-29) (Ser. Nos. 9001-9075)	1	3683
2	Tank Assembly, Top	1	3684
3	Cap, Radiator	1	2382
4	Hose, ..1	3169	
5	Clip, Overflow Hose	3	3170
6	Gasket,	2	3167
7	Bolt, Hex 1/2 - 13 UNC x 3-3/4 Long	2	-
8	Washer, Hardened Flat 1/2	8	-
9	Locknut, Hex 1/2 - 13 UNC	2	-
10	Air-Oil Cooler Assembly	1	3752
11	Plug, 1/4 NPT	2	-
12	Washer, Hardened Flat 3/4 Diameter	4	-
13	Locknut, Hex 3/4 - 10 UNC	2	-
14	Bolt, Hex 3/4 - 10 UNC x 4 Long	2	-
15	Support Arm, Right	1	3746
16	Support Arm, Left	1	3758
17	Lock, Washer, 1/2 Diameter	2	-
18	Bolt, Shoulder 5/8 x 1/2 Long x 1/2 - 13 U NC	2	-
19	Bolt, Hex 5/16 - 18 UNC x 1 Long	64	-
20	Bolt, Hex 5/16 - 18 UNC x 1-1/4 Long	24	-
21	Frame and Header Bar Assembly	1	3795
22a	Tank Assembly, Bottom (incl. Cooler P.N 3955) (Ser. Nos. 9076-ON)	1	3834
22b	Tank Assembly, Bottom (without Cooler) (Ser Nos. 9001-9075)	1	3685
23	Lockwasher, 5/16 Diameter	88	-
24	Nut, Hex 5/16 - 18 UNC	72	-
25	Shroud Assembly	1	3538
26	Core and Header Assembly	1	3794
27	Lockwasher, 1/4 Diameter	8	-
28	Bolt, Hex 1/4 - 20 UNC x 3/8 Long	2	3168
30	Bolt, Hex 1/2 - 13 UNC x 2-1/4 Long	2	-
31	Mount, Top Rubber	2	3472
32	Plate, Top Bolt	2	2615
33	Cock, Drain	1	2827
34	Bolt, Hex 5/8 - 11 UNC x 2-1/2 Long	2	-
35	Washer, Hardened Flat 5/8 Diameter	2	-
36	Plate, Bottom Bolt	2	2613
37	Mount, Bottom Rubber	2	2612
38	Clamp, Hose	4	1687
39	Hose, Bottom	1	3687
40a	Guard, Fan R.H. (Ser. Nos. 9076-ON)	1	3986

COOLING ASSEMBLY

REF. NO.	DESCRIPTION	QTY.	PART NO.
40b	Guard, Fan R.H. (Ser. Nos. 9001-9075).	1	3607
41a	Guard, Fan L.H. (Ser. Nos. 9076-ON	1	3987
41b	Guard, Fan L.H. (Ser. Nos. 9001-9075)	1	3606
42	Washer, Hardened Flat 3/8 Diameter	24	-
43	Bolt, Hex 3/8 - 16 UNC.x 1 Long	12	-
44	Locknut, Hex 3/8 - 16 UNC	12	-
45	Hose ...	1	3689
47	Hose, Top	1	3686
48	Plug, 3/8 NPT	1	-

Page 5-2.1 and 5-2.2. Illustration and legend for transmission oil system is superseded as follows.

TRANSMISSION OIL SYSTEM
K300: 9076-ON



TRANSMISSION OIL SYSTEM

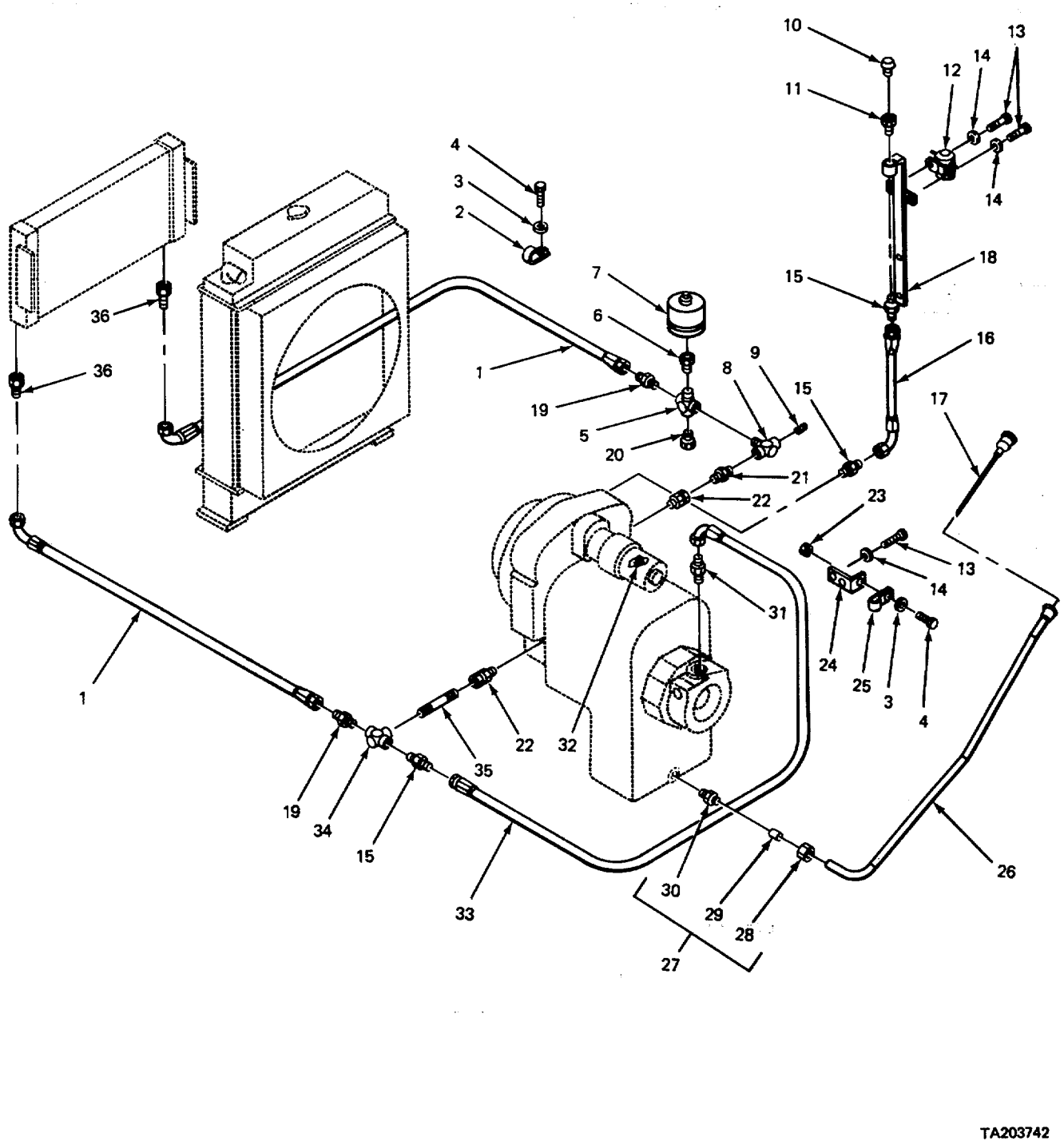
K300: 9076-ON

REF. NO.	DESCRIPTION	QTY.	PART NO.
1	Hose Assembly, Cooler In	1	4246
2	Clamp .	2	2628-48
3	Washer, Hardened Flat 3/8 Dia	6	-
4	Bolt, Hex 3/8-16 UNC x 1 Lg	3	-
5	Cross, Adapter	1	15850-12
6	Reducer	1	3819
7	Sender, Transmission Oil Pressure	1	1253
8	Tee, Adapter	1	16913-12-12
9	Plug, 3/4 NPT	1	-
10	Cap, Filler-	1	211433
11	Reducer	1	1093-12-6
12	Relay, Starter Switch	1	145027
13	Adapter	3	1012-12-16
14	Washer, Hardened Flat	4	-
15	Adapter	2	1012-12-12
16	Hose Assembly, Filler-Breather	1	2700
17	Dipstick, Transmission Oil	1	2707
18	Bracket, Filler-Breather	1	3288
19	Adapter	2	1015-12-16
20	Reducer	1	1093-12-8
21	Adapter	1	1042-12-12
22	Swivel,	2	15858-12-12
23	Locknut, Hex 3/8-16 UNC	3	-
24	Bracket, Dipstick	1	3194
25	Clamp .	1	2628-19
26	Tube, Dipstick	1	3193
27	Fitting Assembly (incl. items 28-30)	1	2709
28	Nut, Dipstick Tube	1	3112
29	Sleeve, Dipstick Tube	1	3111
30	Adapter, Dipstick Tube	1	3110
31	Adapter	1	1040-12-16
32	Element, Trans Oil Filter	1	3605
33	Hose Assembly, Tee to Brake	1	4352
34	Tee, Adapter	1	15862-12-12
35	Nipple, Pipe	1	3109
36	Hose Assembly, Bottom Cooler	1	4415
37	Hose Assembly, Cooler to Cooler	1	4414
38	Elbow, Adapter	1	1025-12-16
39	Bolt, Hex 1/4-20 UNC x 3/4 Lg	4	-
40	Elbow, Adapter 45°	1	1021-12-16

NOTE

Pages 18 and 19 are added illustration and legend for 9076-ON transmission oil system.

K300: 9001-9075



TRANSMISSION OIL SYSTEM

K300: 9001-9075

REF. NO.	DESCRIPTION	QTY.	PART NO.
1	Hose Assembly, Cooler	2	4244
2	Clamp .	2	2628-48
3	Washer, Hardened Flat 3/8 Diameter	6	-
4	Bolt, Hex 3/8 - 16 UNC x 1 Long	3	-
5	Cross, Adapter	1	15850-12
6	Reducer	1	3819
7	Sender, Transmission Oil Pressure	1	1253
8	Tee, Adapter	1	16913-12-12
9	Plug, 3/4 NPT Pipe	1	-
10	Cap, Filler-Breather	1	211433
11	Reducer	1	1093-12-6
12	Relay, Starter Switch	1	145027
13	Bolt, Hex 1/4 - 20 UNC x 3/4 Long	4	-
14	Washer, Hardened Flat 1/4 Diameter	4	-
15	Adapter	5	1012-12-12
16	Hose Assembly, Filler-Breather	1	2700
17	Dipstick, Transmission Oil	1	2707
18	Bracket, Filler-Breather	1	3288
19	Adapter	2	1015-12-12
20	Reducer	1	1093-12-8
21	Adapter	1	1042-12-12
22	Swivel, Adapter	2	15858-12-12
23	Locknut, Hex 3/8 - 16 UNC	3	-
24	Bracket, Dipstick	1	3194
25	Clamp .	1	2628-19
26	Tube, Dipstick	1	3193
27	Fitting Assembly (includes items 28 to 30)	1	2709
28	Nut, Dipstick Tube	1	3112
29	Sleeve, Dipstick Tube	1	3111
30	Adapter, Dipstick Tube	1	3110
31	Adapter	1	1040-12-12
32	Element, Transmission Oil Filter.	1	3605
33	Hose Assembly, Tee to Brake	1	3107
34	Tee, Adapter	1	15862-12-12
35	Nipple, Pipe	1	3109

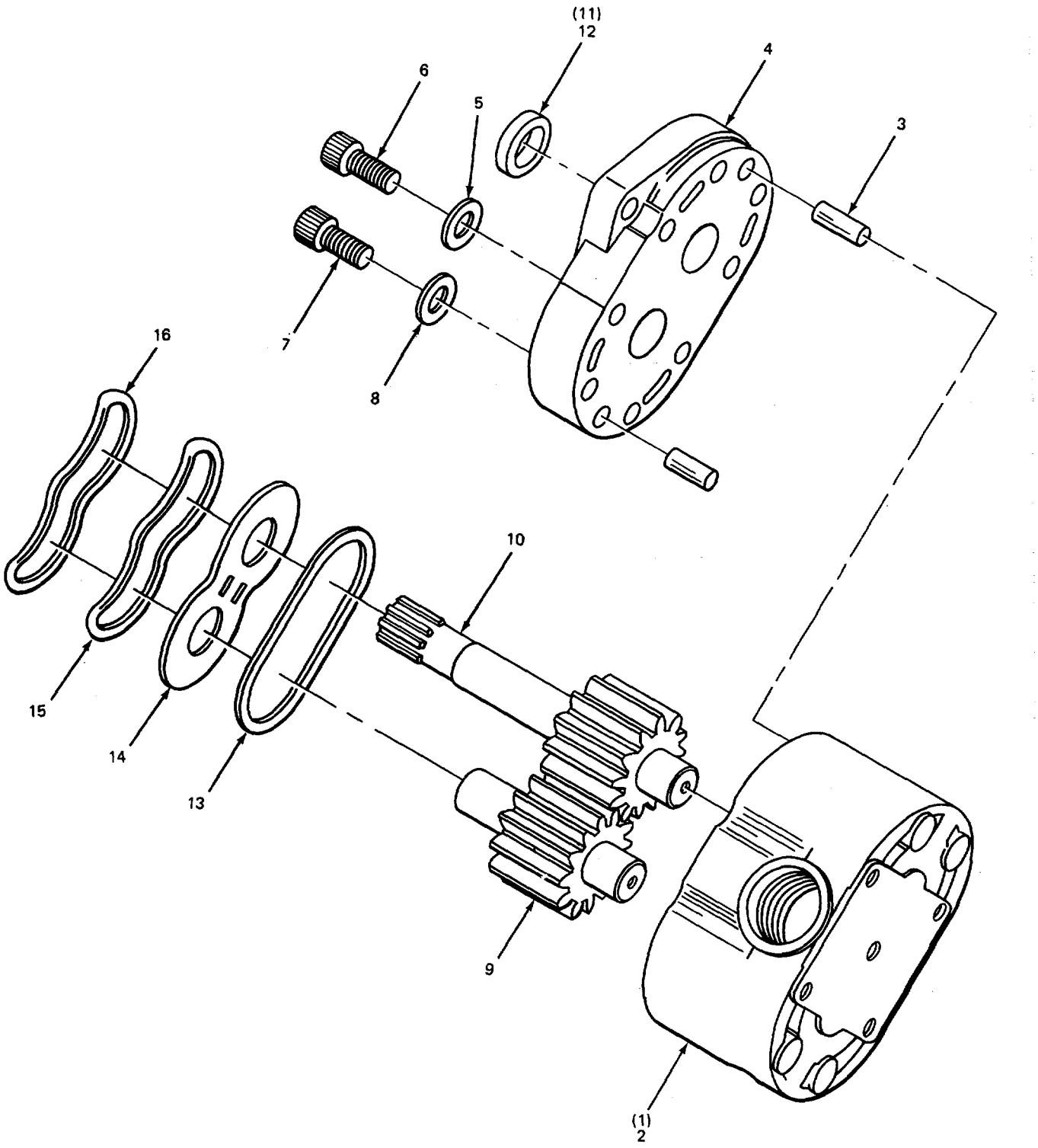
Page 6-4.2. Legend for steering hydraulic system is superseded as follows:

STEERING HYDRAULIC SYSTEM

1	Valve Assembly, Steering (See Page 6-5 for details)	1	4203
2	Hose Assembly, Valve to Cylinder	1	4208
3	Tee, Adapter	3	1033-12-10
4	Hose Assembly, Cylinder Cross Over	2	4210
5	Adapter	3	1012-12-10
6	Cylinder Assembly, Steering (See Page 6-8 for details)	2	4122
7	Bolt, Hex 7/16 - 14 UNC x 1-3/4 Long	2	-
8	Washer, Hardened Flat 7/16 Diameter	2	-
9	Bracket, Relief Valve Mounting	1	3791
10	Washer, Hardened Flat 3/8 Diameter	8	-
11	Locknut, Hex 3/8 - 16 UNC	3	-
12	Valve, Chick	1	3845
13	Hose Assembly, Relief to Tank	1	4207
14	Elbow, Pipe 1-1/4 NPT x 90°	1	-
15	Nipple, Pipe 1-1/4 NPT x 6 Long	1	4206
16	Tee, Pipe 1-1/4 NPT	1	-
17	Reducer	1	1093-20-16
18	Elbow, Adapter	1	1025-16-16
19	Hose Assembly, Tank to Pump	1	4211
20	Adapter (includes item 35)	1	1040-12-16
21	Gasket, Steering Pump	1	4223
22a	Pump Assembly, Steering (See Page 6-6) (Ser. Nos. 9076-ON)	1	3930
22b	Pump Assembly, Steering See Page 6-6) . (Sera Nos. 9001-9075)	1	3910
23	Adapter (includes item 36)	1	1040-10-10
24	Bolt, Hex 3/8 - 16 UNC x 1-1/4 Long	2	-
25	Hose Assembly, Pump to Relief	1	4204
26	Plug, Pipe 3/4 NPT	1	-
27	Valve Assembly, Steering Relief (See Page 6-7 for details)	1	4202
28	Tee, Adapter	1	1032-12-10
29	Bolt, Hex 3/8 - 16 UNC x 2-1/4 Long	3	-
30	Hose Assembly, Relief to Valve	1	4224
31	Hose Assembly, Valve to Relief	1	4205
32	Adapter (includes item 33)	4	1040-8-10
33	Seal, 0 Ring	4	1249-8
34	Hose Assembly, Valve to Cylinder	1	4209
35	Seal 0 Ring	1	1249-12
36	Seal 0 Ring	1	1249-10

Page 6-6.1 and-6.2. Illustration and legend for steering pump are superseded as follows:

STEERING PUMP
K300: 9076-04



STEERING PUMP

K300: 9076-ON

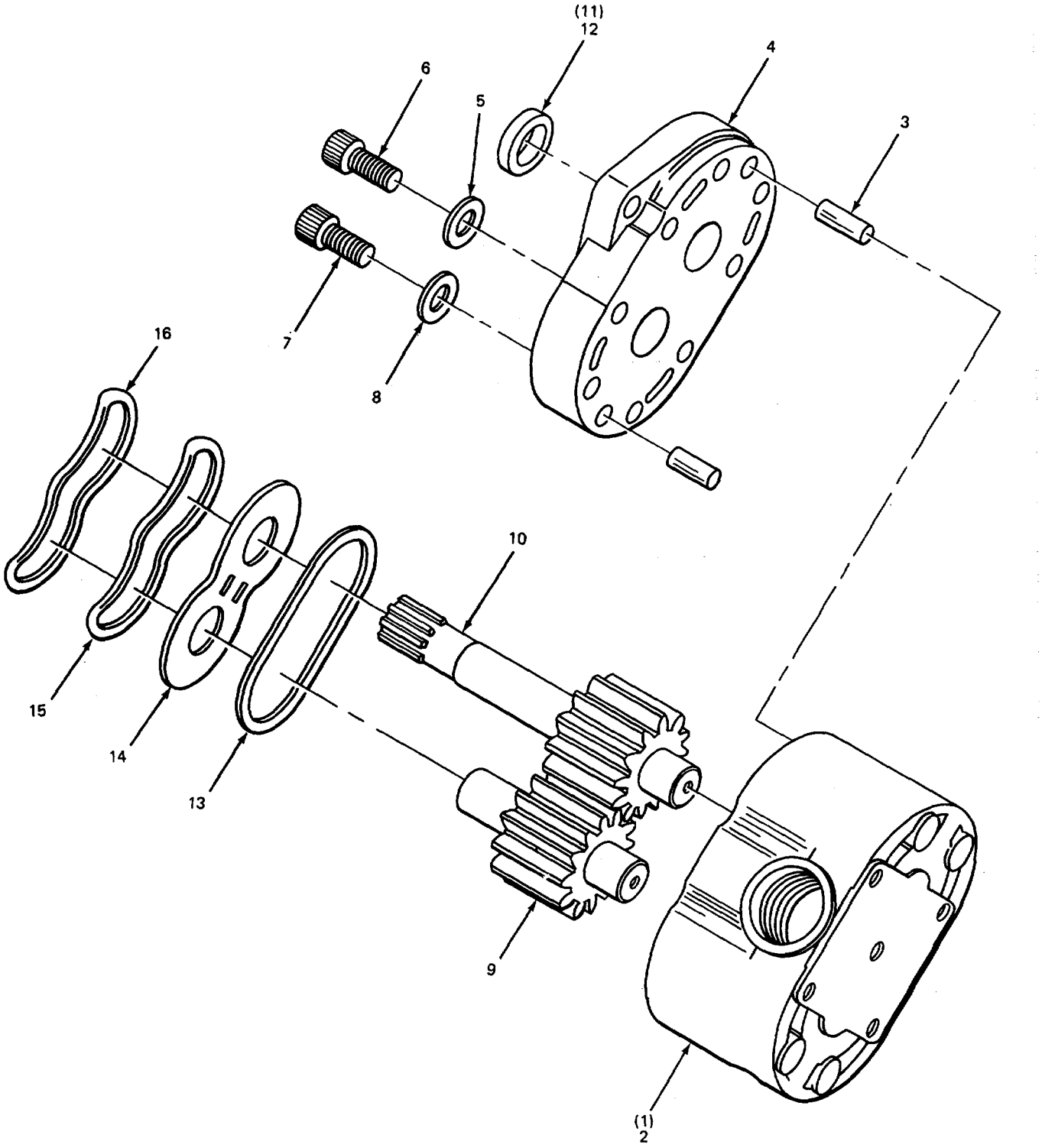
REF. NO.	DESCRIPTION	QTY.	PART NO.
1	Pump Assembly, Steering Hydraulic (incl. items 2-15)	1	3930
2	Cover, Shaft End	1	3931
3	Plug, Port	1	3932
4	Bearing, Roller	4	3933
5	Plate, Thrust .	2	3934
6	Housing, Gear	1	3935
7	Cover, Port End	1	3936
8	Gear and Shaft Set	1	3937
9	Washer	4	3938
10	Screw, Mounting	4	3939
11	Seal Kit, Pump (incl. items 11-15)	1	3940
12	Seal, Shaft Lip	1	3941
13	Seal, Ring	4	3942
14	Seal Strip, Pocket (consists of 12 Pocket Seals)	1	3943
15	Seal, Gasket	2	3944

NOTE

Pages 23 and 24 are added illustration and legend for 9001-9075 steering pump.

STEERING PUMP

K300: 9001-9075



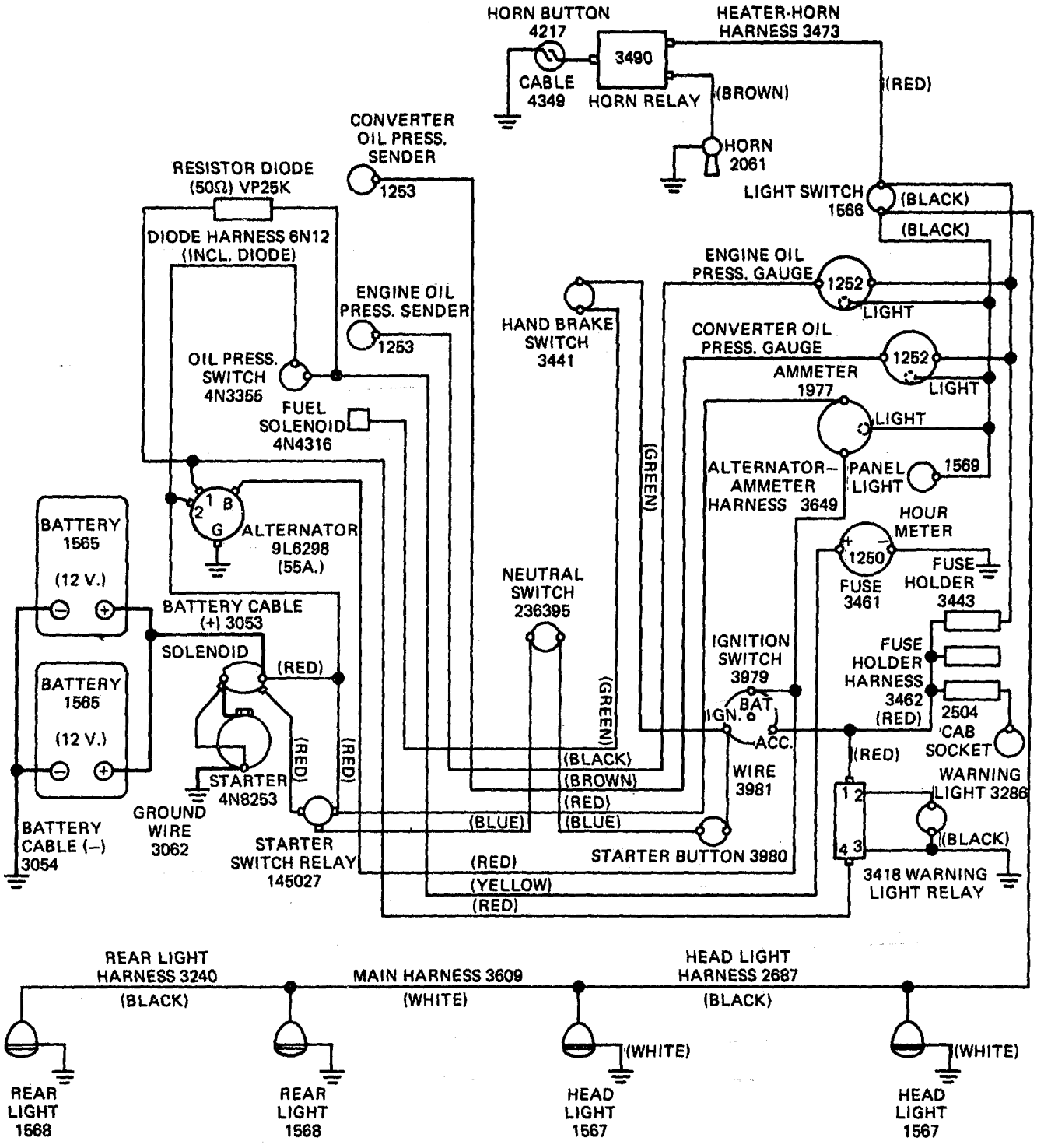
STEERING PUMP

K300: 9001-9075

REF. NO.	DESCRIPTION	QTY.	PART NO.
1	Pump Assembly, Steering (includes items 2 to 16)	1	3910
2	Body, Steering Pump	1	3911
3	Pin, Dowel	2	3912
4	Cover, Front	1	3913
5	Washer, 3/8 Diameter	4	3914
6	Screw, Socket Head 3/8 - 16 UNC x 1 1/2 Long	4	-
7	Screw, Socket Head 5/16 - 18 UNC x 1 1/4 Long	4	-
8	Washer, 5/16 Diameter	4	3915
9	Gear, Driven	1	3916
10	Gear and Shaft, Drive	1	3917
11	Seal Kit (includes items 12 to 16)	1	3919
12	Seal, Shaft	1	3921
13	Seal, Body	1	3920
14	Plate, Wear	1	3923
15	Seal, Wear Plate	1	3918
16	Seal, Rubber	1	3922

Page 8-1.1. **Wiring diagram is superseded as follows:**

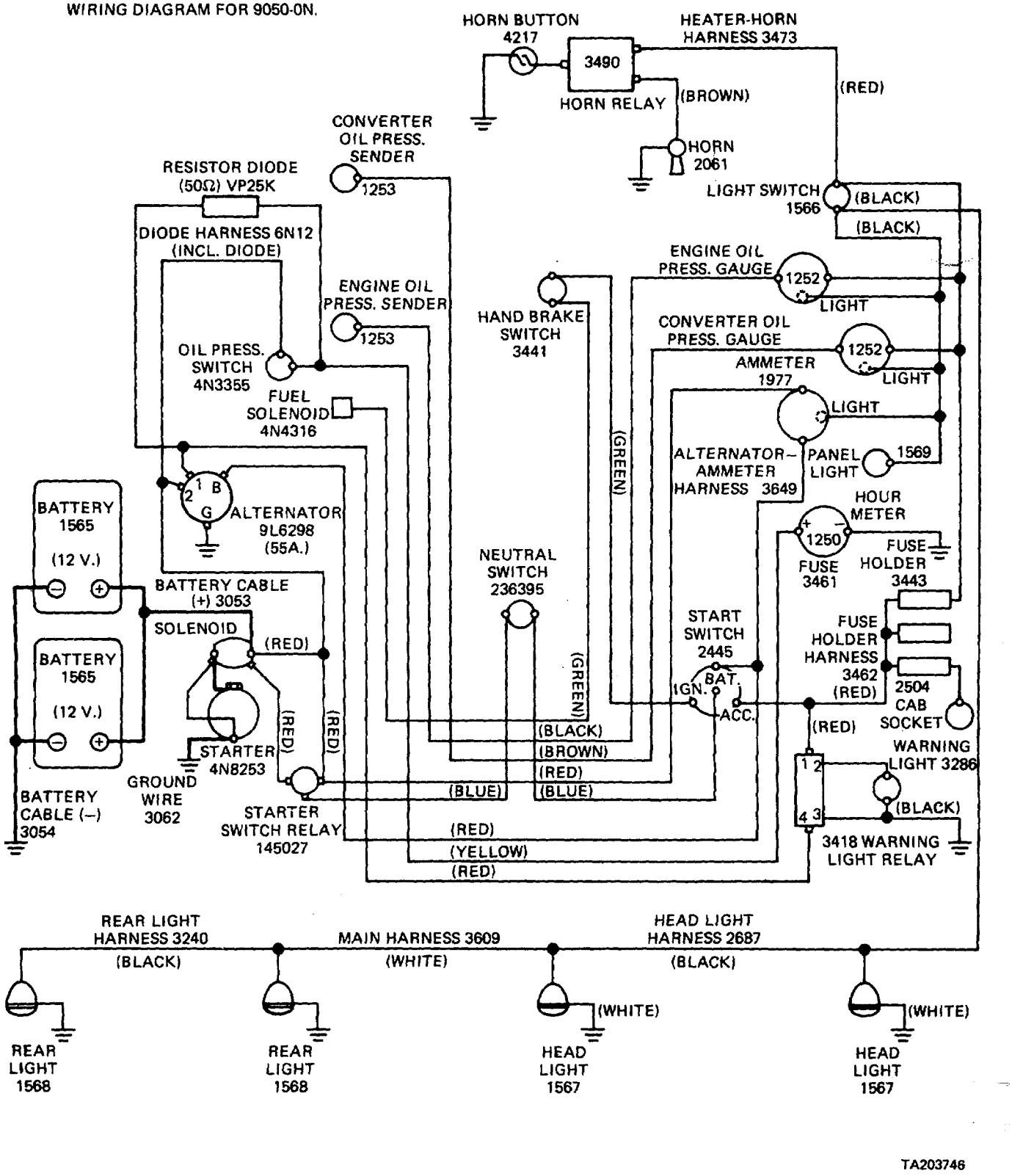
WIRING DIAGRAM
K300: 9050-ON



TA203745

NOTE:
PAGE 26 IS THE ADDED
WIRING DIAGRAM FOR 9050-0N.

WIRING DIAGRAM
K300: 9050-0N



TA203746

Section IV, page 4, paragraph 2-7a. In second line, "TB 740-97-2" is changed to "TB 740-94-2".

Section IV, page 27, appendix F. In fourth line from bottom, "2910-00-138-1782" is changed to "2940-00-832-8728".

By Order of the Secretary of the Army:

E. C. MEYER
General, United States Army
Chief of Staff

Official:

ROBERT M. JOYCE
Brigadier General, United States Amy
The Adjutant General

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Technical Manual

No. 5-389-349-14&P

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, DC, *25 April 1980*

OPERATOR'S, ORGANIZATIONAL, DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE MANUAL (INCLUDING REPAIR PARTS INFORMATION AND SUPPLEMENTAL MAINTENANCE AND REPAIR PARTS INSTRUCIONS)

COMPACTOR, HIGH SPEED, TAMPING SELF-PROPELLED (CCE) BOMAG MODEL K300 NSN 3895-01-024-4064

REPORTING OF ERRORS

You can improve this manual by recommending improvement using DA Form 2028 (Recommended Changes to Publications and Blank Forms) or DA Form 2022 located in the back of the manual Mail your form to Commander, US Army Tank-Automotive Materiel Readiness Command, ATTN: DRSTA-MBS, Warren, MI, 48090. A reply will be furnished dire to you.

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SECTION II	MAINTENANCE INSTRUCTIONS
SECTION III	OPERATING INSTRUCTIONS
SECTION IV	SUPPLEMENTAL OPERATING, MAINTENANCE AND REPAIR PARTS INSTRUCTIONS

AUTHENTICATION STATEMENT

This technical manual is an authentication of the manufacturers' commercial literature and does not conform with the format and content specified in AR 310-3, Military Publications. This technical manual does, however, contain available information that is essential to the operation and maintenance of the equipment.

PARTS MANUAL

This manual contains complete information on components used in the manufacture of machine model K300, serial number range 9001-9075.

MODEL IDENTIFICATION

The machine model and serial number appear on a metal plate attached to the left hand side of the rear frame, located directly below the operator station.

MACHINE MODEL No. **K 300**	*MACHINE SERIAL No.* SPARE COPY
ENGINE MODEL CATERPILLAR 3208	*ENGINE SERIAL No* -
BOOK PART No. 3680	*BOOK No.* A 098

LOCATION OF SERIAL NUMBERS

MACHINE: As described above and also stamped on the left rear frame structure, forward of the operator position, outlined in red.

ENGINE: Right rear (lower) corner of engine.

TRANSMISSION: Right front (lower) corner of transmission.

AXLE: Centre of differential housing.

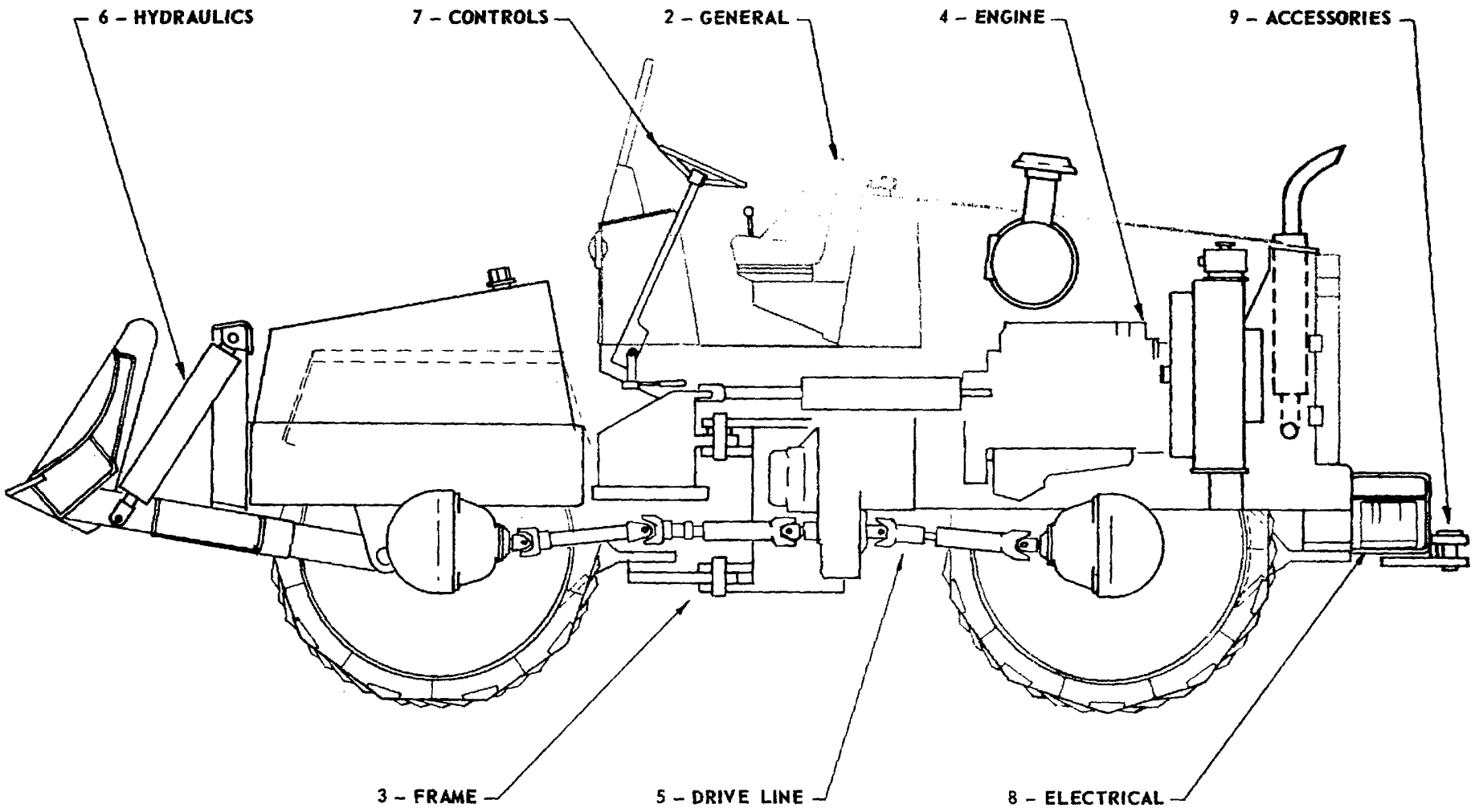
PARTS ORDERING PROCEDURE

1. The terms 'right hand' and 'left hand' when referring to a machine component are determined by sitting in the operator's seat and facing toward front of machine.
2. Order parts from the BOMAG distributor in your territory.
3. Always provide the model and serial numbers of the machine and for assembly.
4. Provide part number and complete description.
5. Provide complete address of destination and specify clearly preferred shipping method.
6. Confirm all telephone, telex or cable orders in writing.
7. Engine parts should be ordered from the engine manufacturers' authorized service dealers.
8. Credit will *not* be allowed on parts unless they are returned to the BOMAG distributor from whom they were purchased. Distributors please refer to BOMAG 'Parts Return Policy'.
9. Claims for shortages or errors will not be considered unless such claim is immediately reported on receipt of goods.
10. In the case of damaged items, a complete description of the damage is to be made by the carrier agent on the Bill of Lading whereupon full damage can be collected from the transport company.
11. We do not accept liability for delay or damage to merchandise while in transit. Liability ceases once the shipment is accepted by the transportation company from whom receipt is received, acknowledging the good condition of the shipment when received by them.

KOEHRING

Koehring Canada Limited
BOMAG Division

PICTORIAL INDEX-K300



Rev. 5-76

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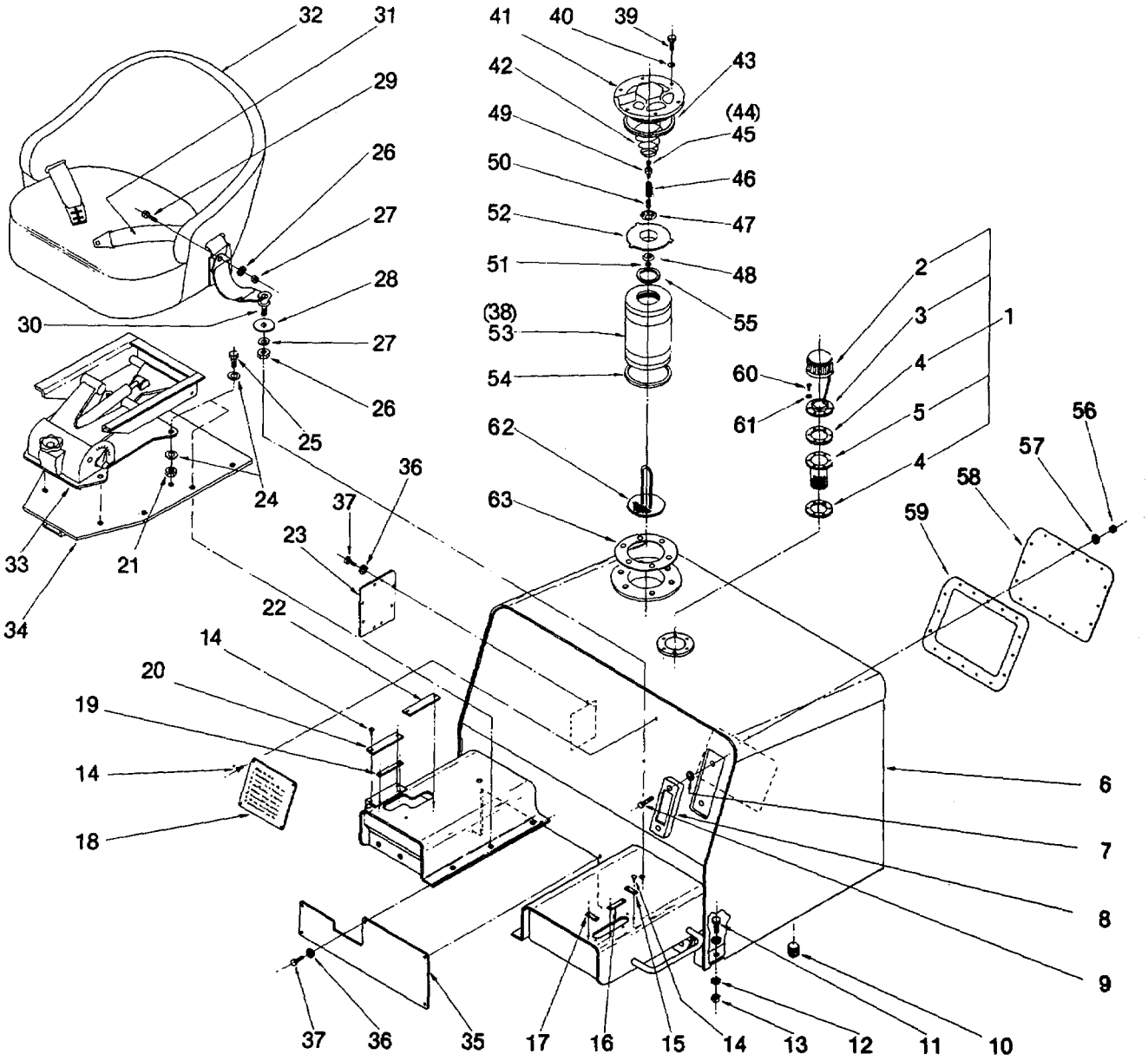
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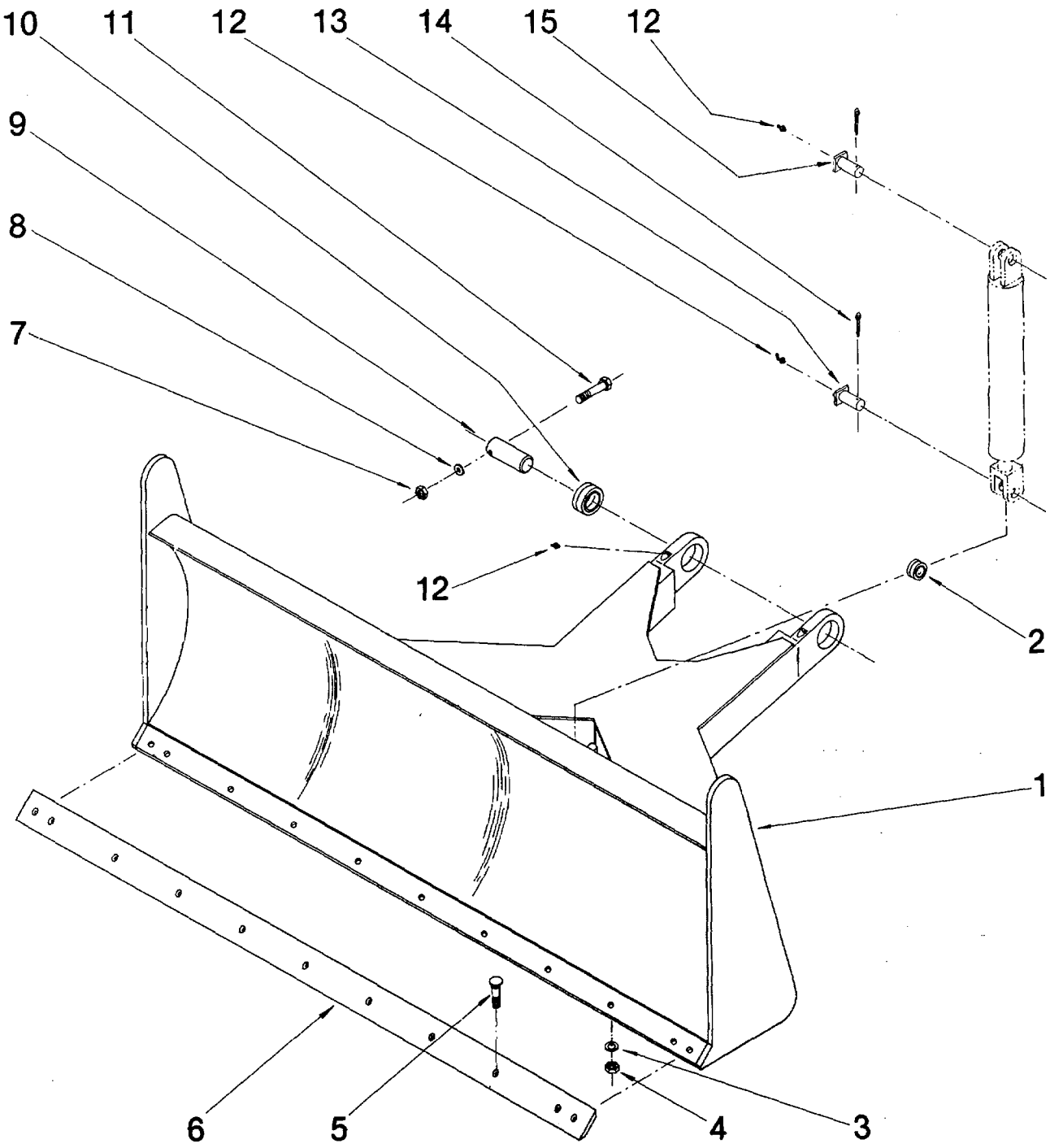
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HYDRAULIC TANK ASSEMBLY



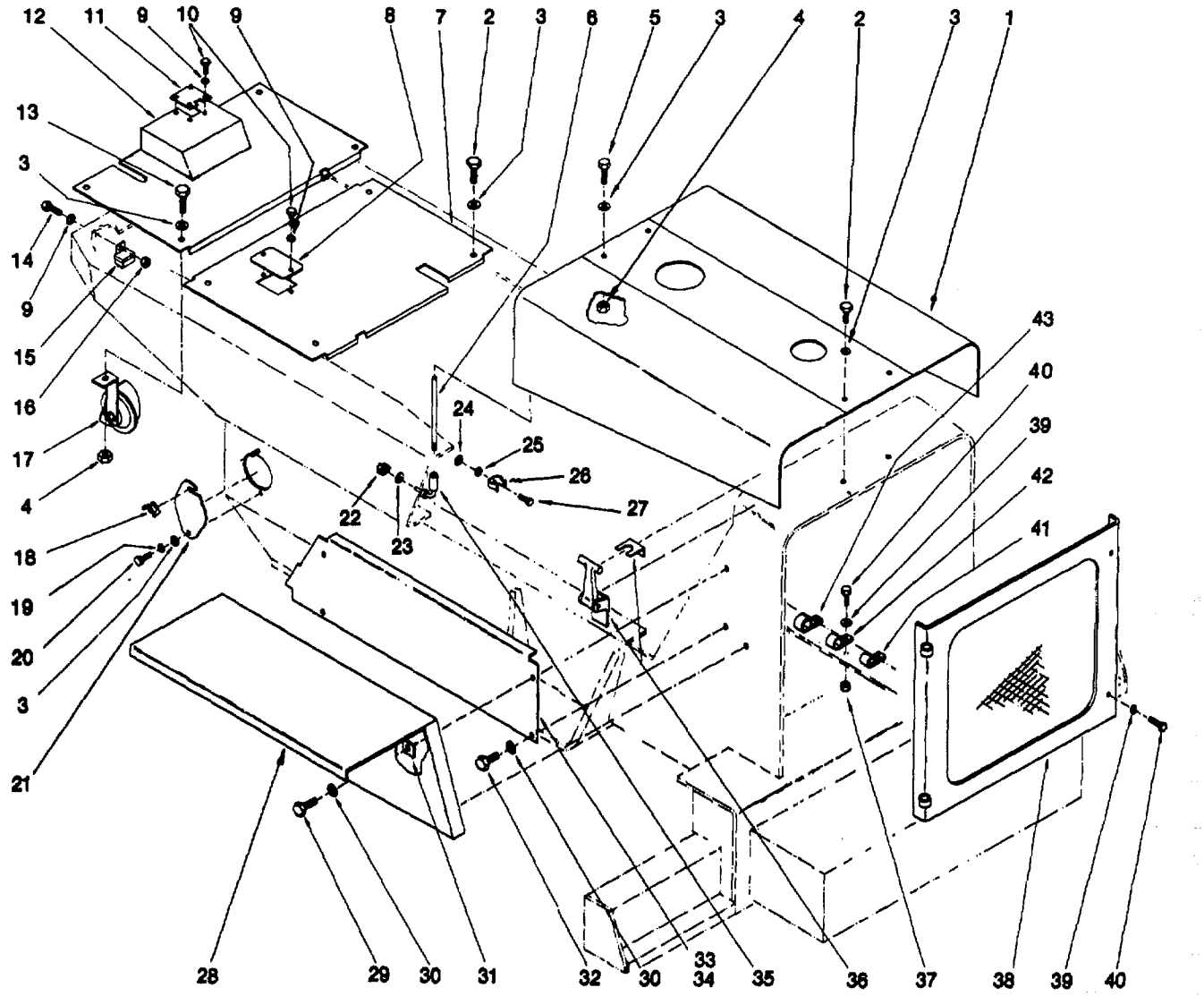
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33	**Mechanism,** Seat Suspension	1	2044
34	**Base**, Seat Mounting	1	3531
35	**Cover,** Bulkhead	1	3838
36	**Washer,** Hardened Flat 1/4 Diameter	13	-
37	**Bolt,** Hex 1/4 - 20 UNC x 3/4 Long	13	-
38	**Filter Assembly** (includes items 39 to 55)	1	1563
39	**Bolt,** Hex 5/16 - 18 UNC x 3/4 Long	6	-
40	**Lockwasher,** 5/16 Diameter	6	-
41	**Head,** Filter	1	3013
42	**Spring,** Conical	1	3012
43	**Seal,** Filter Head	1	2695
44	**Valve Assembly** By-Pass (includes items 45 to 51)	1	3011
45	**Screw,** By-Pass Valve	1	3700
46	**Spring,** By-Pass	1	3696
47	**Guide,** Valve	1	3697
48	**Guide,** Valve	1	3698
49	**Cap,** Stem	1	3699
50	**Spacer**	1	3695
51	**Nut**	1	3701
52	**Retainer**	1	3702
53	**Element,** Filter	1	1946
54	**Gasket,** Element	1	2696
55	**Seal,** Rubber	1	2697
56	**Locknut,** Hex 1/2 - 13 UNC	16	-
57	**Washer**, Hardened Flat 1/2 Diameter	16	-
58	**Cover,** Inspection	1	3118
59	**Gasket,** Inspection Cover	1	3129
60	**Screw,** No 10 - 24 UNC x 1/2 Long	6	-
61	**Lockwasher,** External Tooth No 10	6	-
62	**Strainer,** Filter	1	3185
63	**Gasket,** Filter Head	1	3114


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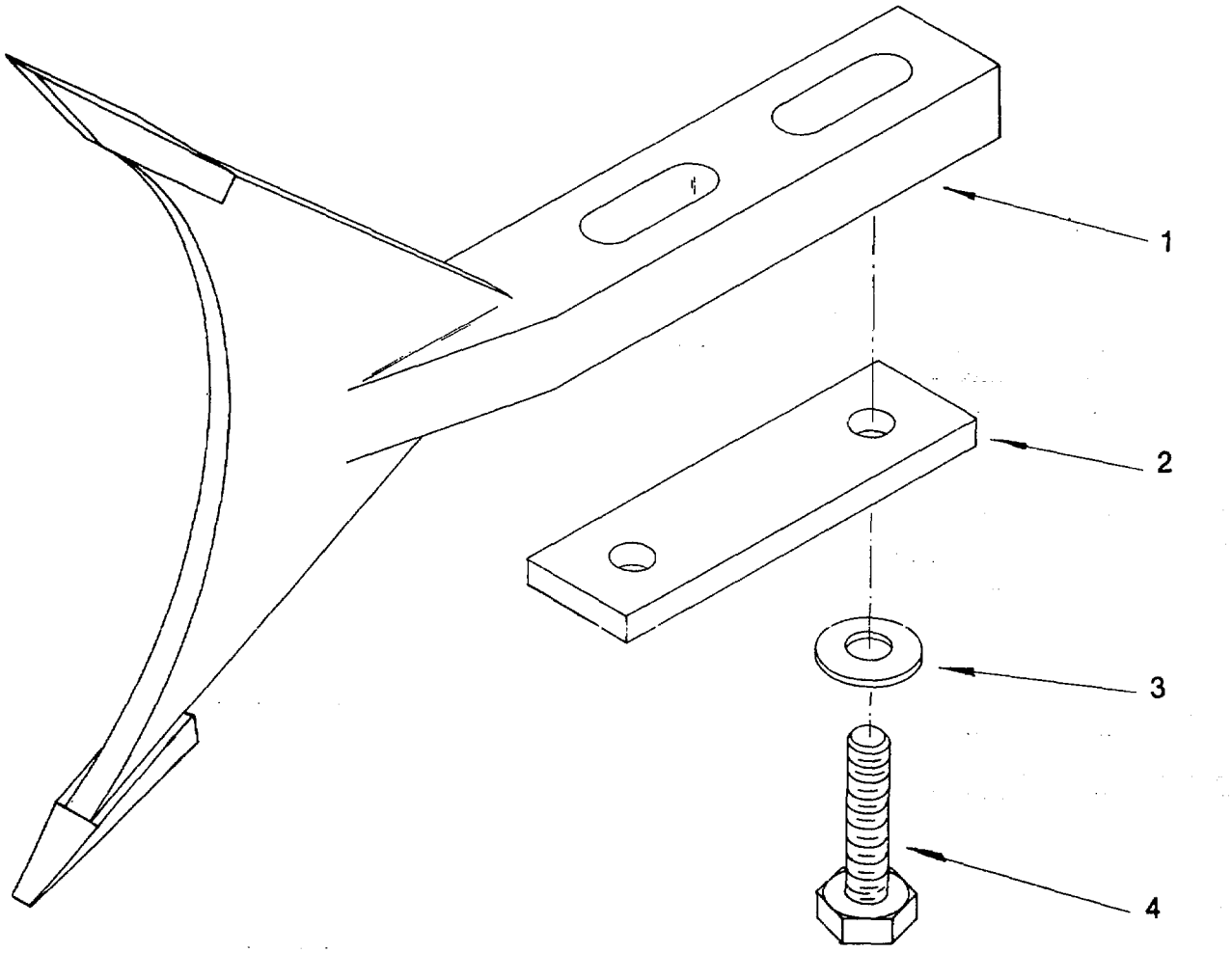
DOZER ASSEMBLY

REF. NO.	DESCRIPTION	QTY.	PART NO.
1	**Dozer Weldment**	1	2184
2	**Bushing**, Cylinder Clevis	2	1077
3	**Washer**, Hardened Flat 5/8 Diameter	11	-
4	**Locknut,** Hex 5/8-11 UNC	11	-
5	**Bolt,** Dozer Edge	11	2235
6	**Edge,** Dozer	1	3267
7	**Locknut,** Hex 3/4 - 10 UNC	2	-
8	**Washer,** Hardened Flat 3/4 Diameter	2	-
9	**Pin**, Dozer Clevis	2	2896
10	**Bushing,** Dozer Pin	2	2031
11	**Bolt,** Hex 3/4 - 10 UNC x 51/2 Long	2	-
12	**Fitting,** Grease 1/4 NPT 671/2 a	4	-
13	**Pin,** Bottom Cylinder Clevis	1	3425
14	**Pin,** Cotter 3/16 x 21/2 Long	2	-
15	**Pin,** Top Cylinder Clevis	1	1071


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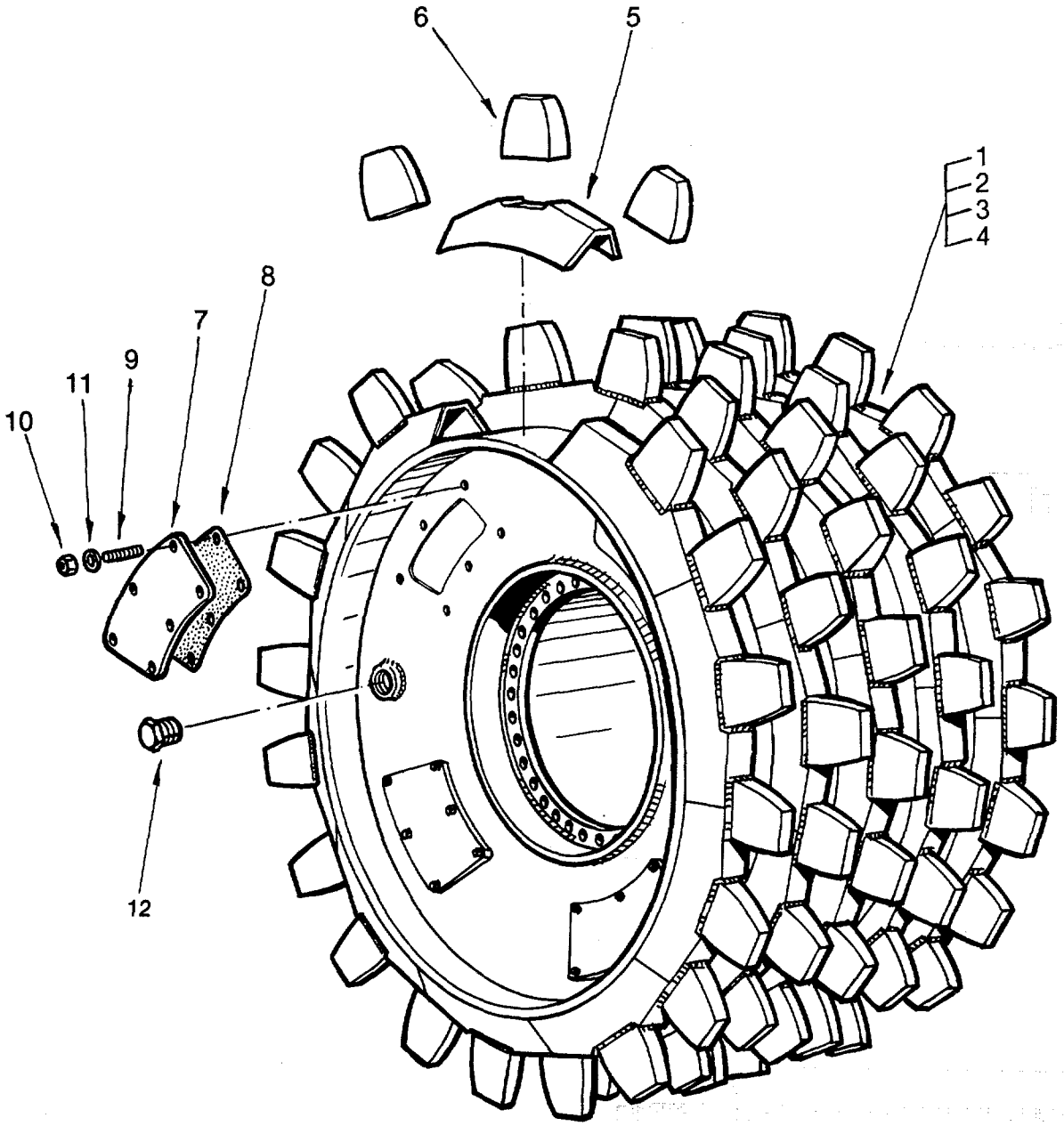
REF. NO.	DESCRIPTION	QTY.	PART NO.
1	**Hood Assembly**	1	3422
2	**Bolt**, Hex 1/2-13 UNC x 1 Long	9	-
3	**Washer,** Hardened Flat 1/2 Diameter	16	
4	**Locknut,** Hex 1/2-13 UNC	3	
5	**Bolt,** Hex 1/2 -13 UNC x 1-1/4 Long	2	
6	**Arm**, Hood Holder	2	3047
7	**Plate**, Rear Floor (includes items 8 to 10)	1	4106
8	**Cover**, Rear Floor Plate	1	2991
9	**Lockwasher,** 1/4 Diameter	7	-
10	**Bolt,** Hex 1/4-20 UNC x 3/4 Long	6	-
11	**Cover**, Front Floor Plate	1	4104
12	**Plate**, Front Floor (includes items 9 to 11)	1	3840
13	**Bolt,** Hex 1/2-13 UNC x 11/2 Long	1	-
14	**Bolt,** Hex 1/4-20 UNC x 1/4 Long	1	-
15	**Relay**, Horn	1	3490
16	**Locknut,** Hex 1/4-20 UNC	1	-
17	**Horn ..**	1	2061
18	**Wingnut,** Dipstick Cover	1	2712
19	**Washer,** Spring 3/8 Diameter	1	-
20	**Screw**, Shoulder	1	2713
21	**Cover,** Dipstick	1	2949
22	**Nut,** Hex 5/16-24 UNF	2	-
23	**Washer**, Hardened Flat 5/16 Diameter	2	-
24	**Nut,** Hex No. 6-32 UNC	4	-
25	**Lockwasher**, No., 6 Dia meter	4	-
26	**Clip,** Spring	2	3459
27	**Screw,** No. 8-32 UNC x 1/2 Long	4	-
28	**Fender**	4	1192
29	**Bolt,** Hex 5/8-11 UNC x 11/2 Long	16	-
30	**Washer,** Hardened Flat 5/8 Dlaieter	20	-
31	**Washer,** Fender	18	2395
32	**Bolt,** Hex 5/8-11 UNC x 11/4 Long	4	-
33	**Pane**l, Engine Side L.H.	1	1425
34	**Panel,** Engine Side R. H.	1	1191
35	**Joint,** Ball	2	3045
36	**Clamp**, Rubber (Includes brackets)	4	1815
37	**Locknut**, Hex 3/8-16 UNC	12	-
38	**Guard,** Radiator	1	3098
39	**Washer,** Hardened Flat 3/8 Diameter	26	-
40	**Bolt,** Hex 3/8-16 UNC x 1 Long	14	-
41	**Clamp,** Small	8	2628-19
42	**Clamp**, Medium	2	2628-35
43	**Clamp**, Large	2	2628-40

CLEANER TOOTH ASSEMBLY



CLEANER TOOTH ASSEMBLY

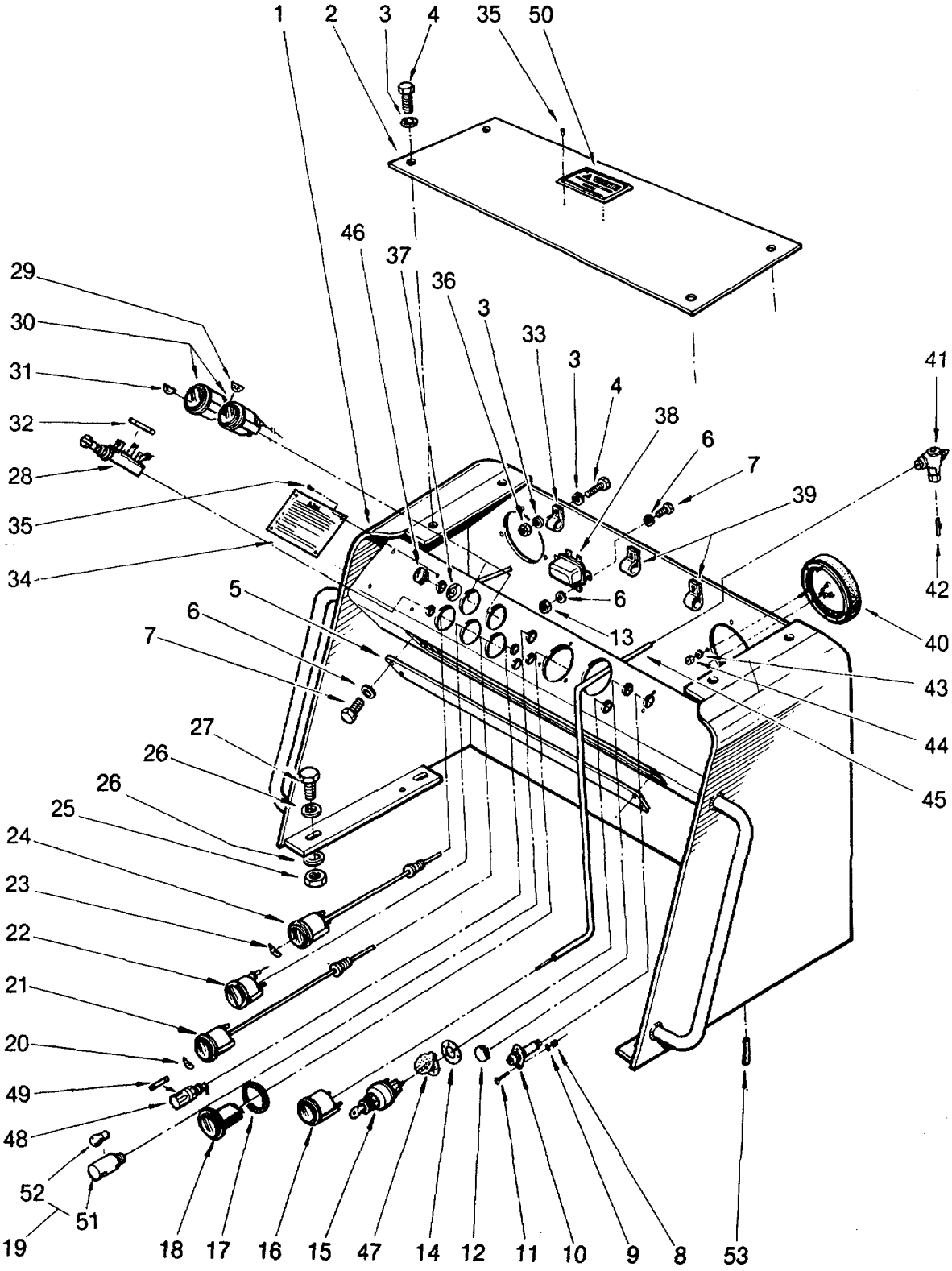
REF. NO.	DESCRIPTION	QTY.	PART NO.
1	**Tooth,** Cleaner	14	2204
2	**Plate,** Bolt	14	207
3	**Washer,** Hardened Flat 3/4 Diameter	28	-
4	**Bolt,** Hex 3/4 - 10 UNC x 4 Long	28	-


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WHEEL ASSEMBLY

REF. NO.	DESCRIPTION	QTY.	PART NO.
1	**Wheel Assembly**, Right Front (includes items 5 to 12)	1	1040
2	**Wheel Assembly,** Left Front (includes items 5 to 12)	1	1041
3	**Wheel Assembly**, Right Rear (includes items 5 to 12)	1	1042
4	**Wheel Assembly,** Left Rear (includes items 5 to 12)	1	1043
5a	**Shoe,** Front Wheel	50	1060
5b	**Shoe**, Rear Wheel	40	1060
6a	**Cap**, Front Wheel	00	1046
6b	**Cap,** Rear Wheel	80	1046
7	**Plate**, Inspection Cover	4	1045
8	**Gasket,** Cover Plate	4	1048
9	**Stud,** Cover Plate	24	1047
10	**Nut,** Hex 1/2- 13 UNC	24	-
11	**Lockwasher,** 1/2 Diameter	24	-
12	**Plug,** 2 NPT Pipe	1	-

CONTROL CONSOLE ASSEMBLY

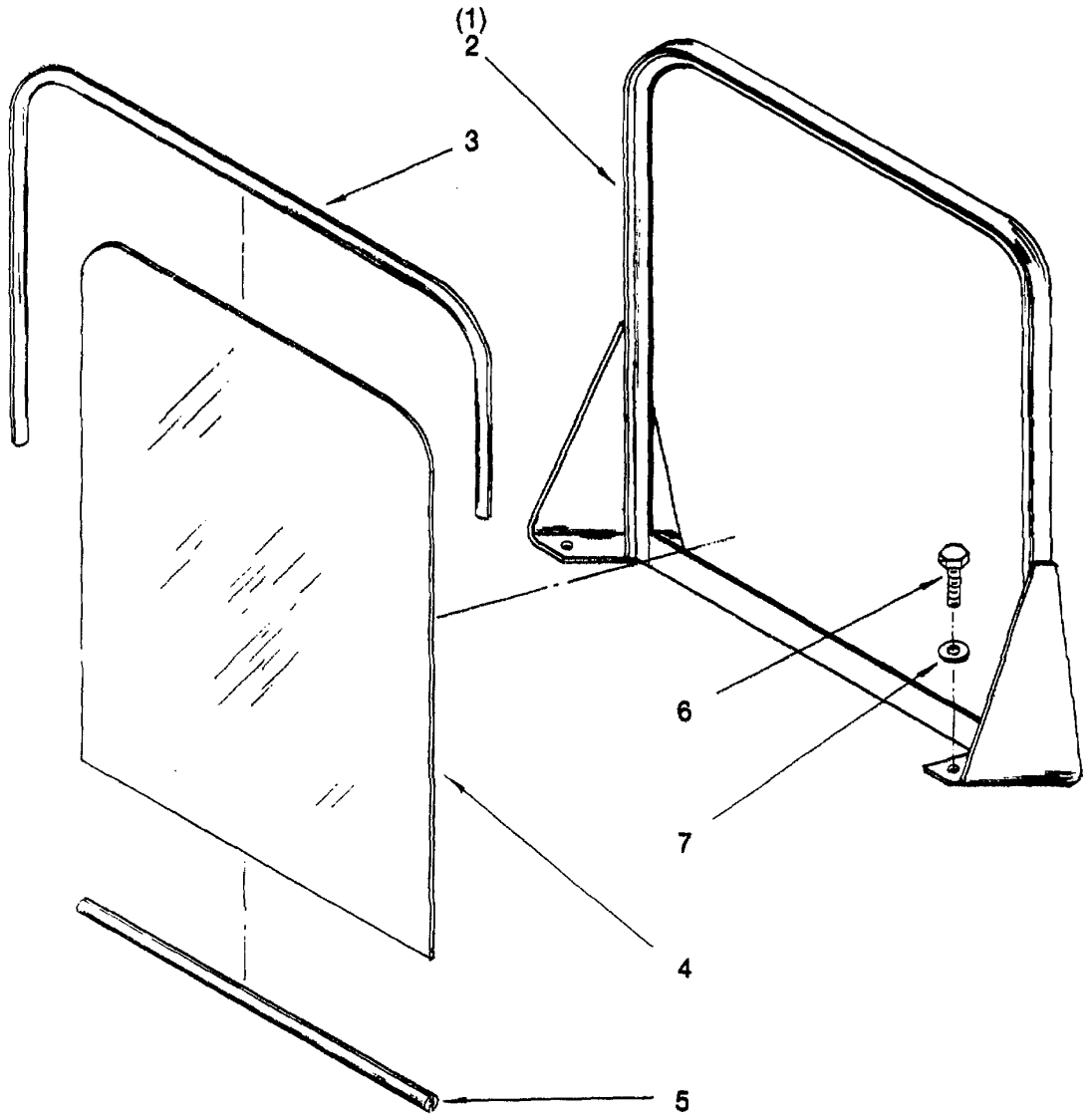


CONTROL CONSOLE ASSEMBLY

REF. NO.	DESCRIPTION	OTY.	PART NO.
1	**Control Console Subassembly**, (includes items 2 to 7)	1	1269
2	**Panel,** Top	1	1278
3	**Washer**, Hardened Flat 3/8 Diameter	12	-
4	**Bolt**, Hex 3/8 - 16 UNC x 1 Long	8	-
5	**Panel**, Bottom	1	2456
6	**Washer**, Hardened Flat 1/4 Diameter	6	-
7	**Bolt**, Hex 1J4 - 20 UNC x 3/4 Long	6	-
8	**Nut,** Hex No. 6-32UNC	2	-
9	**Lockwasher**, External Tooth No. 6 Diameter	2	-
10	**Socket**	1	2504
11	**Screw**, No. 6-32 UNC x 3/4 Long	2	-
12	**Plug**, Chrome Button 3/4 Diameter	1	-
13	**Locknut**, Hex 1/4 - 20	2	-
14	**Plate**, Ignition Key	1	2894
15	**Switch**, Key Start	1	2445
16	**Tachometer**	1	1979
17	**Mount**, Rubber	1	2580
18	**Hourmeter**	1	1250
19	**Light,** Panel (includes items 51 and 52).	1	1569
20	**Decal** "Water Eng Temp"	1	3191
21	**Gauge**, Water Temperature	1	2340
22	**Ammeter**	1	1977
23	**Decal** "Trans Oil Temp"	1	3190
24	**Gauge**, Oil Temperature	1	2339
25	**Locknut**, Hex 5/8 - 11 UNC	4	-
26	**Washer**, Hardened Flat 5/8 Diameter	8	-
27	**Bolt,** Hex 5/8- 11 UNC x 1-3/4 Long	4	-
28	**Switch**, Light (includes item 32)	1	1566
29	**Decal** "Engine Oil Pres"	1	3189
30	**Gauge**, Oil Pressure	2	1252
31	**Decal** "Converter Oil Pres"	1	3192
32	**Fuse**, Switch 1	1	3461
33	**Clamp**, Cable	2	2628-24
34	**Plate,** Instructions	1	2362
35	**Screw**, Metallic Drive No. 4 x 5/16 Long	8	-
36	**Locknut**, Hex3/8- 16 UNC	6	-
37	**Light**, Ammeter Warning	1	3286
38	**Relay**, Warning Light	1	3418
39	**Clamp**, Cable	4	2628-40
40	**Headlight**	2	1567
41	**Adapter**, Tachometer Cable (includes item 42)	1	3775
42	**Tip**, Tachometer Adapter Drive	1	3092
43	**Lockwasher**, External Tooth No. 10 Diameter	6	-
44	**Nut**, Hex No. 10 - 24 UNC	6	-
45	**Cable**, Tachometer	1	3608
46	**Plug**, Chrome Button 11/16 Diameter	1	-
47	**Protector**, Key Switch	1	3285
48	**Fuse Holder**	3	3443
49	**Fuse .**	3	3461
50	**Plate**, Ear Protection	1	3647
51	**Body**, Panel Light	1	6N8355
52	**Bulb**, Panel Light	1	7M9957
53	**Pin**, Roll 3/8 Diameter x 1 Long	2	-

DECALS AND NAMEPLATES

PART NO.	DESCRIPTION	QTY
2360	**Pate**, Transmission "F-N-R"	1
2361	**Plate**, Dozer Control	1
2362	**Plate,** Instructions	1
2517	**Plate,** K300 Identification	1
2590	**Plate**, "Parking Brake"	1
2591	**Plate,** "Apply"	1
2592	**Plate,** "Release".	1
2894	**Plate,** Ignition Key	1
2934	**Decal,** "K - Koehring Bomag"	1
2939	**Decal,** "K Koehring"	2
3093	**Decal**, "Caution - Transmission Fluid Only"	1
3094	**Decal**, "Diesel Fuel Only".	1
3096	**Decal,** "Hydraulic Oil Only"	1
3189	**Decal,** "Engine Oil Pres	1
3190	**Decal,** "Trans Oil Temp"	1
3191	**Decal,** "Water Engine Temp"	1
3192	**Decal,** "Converter Oil Pres"	1
3245	**Plate,** "Warning - No Space"	1
3647	**Plate,** "Warning - Ear Protection".	1
3690	**Decal** "K300" (White).	1
3691	**Decal,** "Bomag" (White)	2
3764	**Plate**, Lifting Procedure	1
3765	**Plate**, Tiedown Procedure	1
3774	**Plate,** Transmission Speed	1
3785	**Plate,** Lubrication.	1
3817	**Plate,** Towing Instructions	1



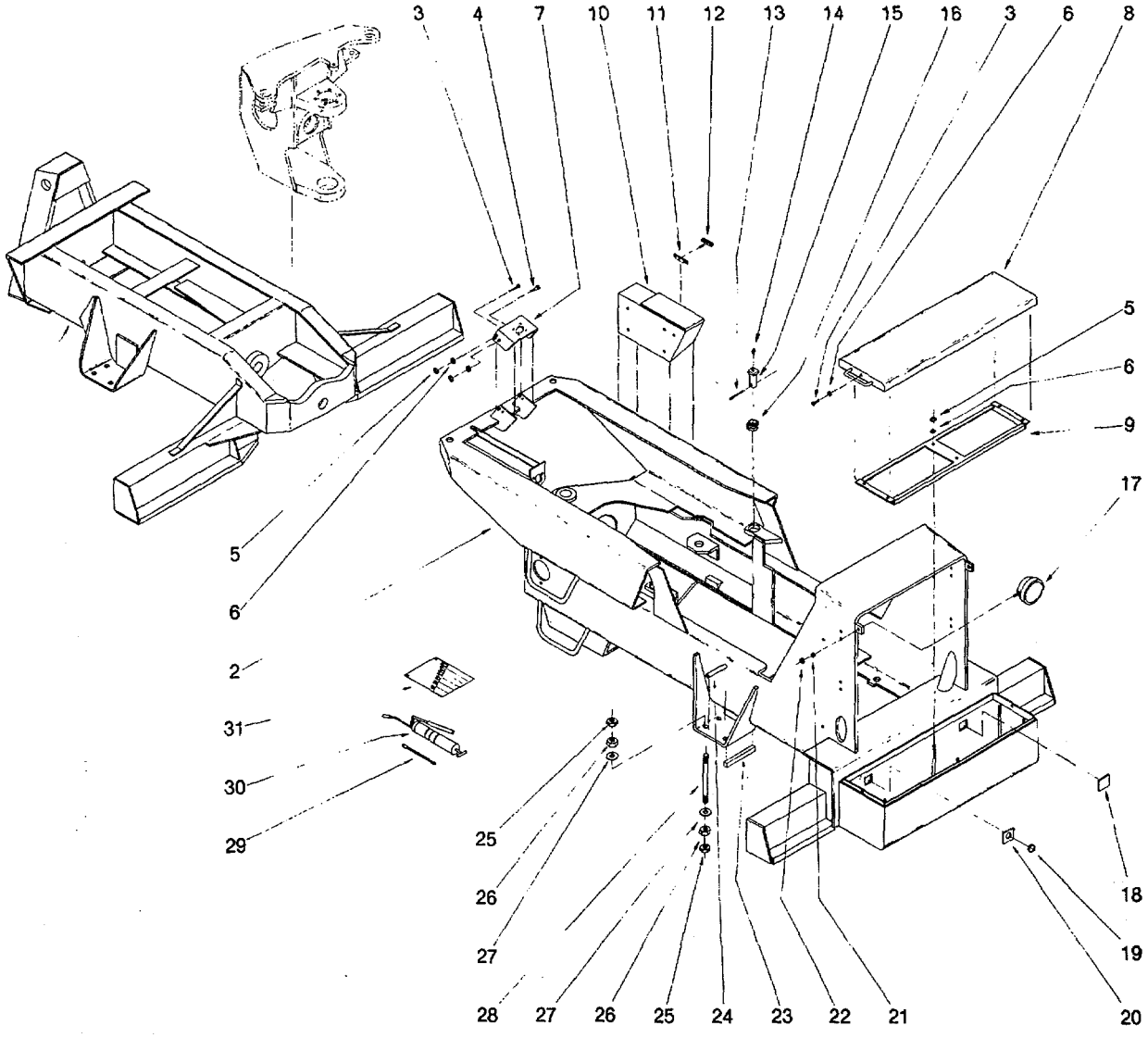
REF. NO.	DESCRIPTION	OTY.	PART NO.
1	**Windshield Assembly** (includes items 2 to 5	1	1582
2	**Frame**, Windshield	1	1583
3	**Strip**, Seal	1	1589
4	**Glass**, Windshield	1	1588
5	**Strip**, Bottom Seal	1	159
6	**Bolt**, Hex 3/8 - 16 UNC x 1 Long	4	-
7	**Washer**, Hardened Flat 3/8 Diameter	4	-

FRAME SECTION

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Frame Assembly 3-1
Center Joint Assembly.....3-2

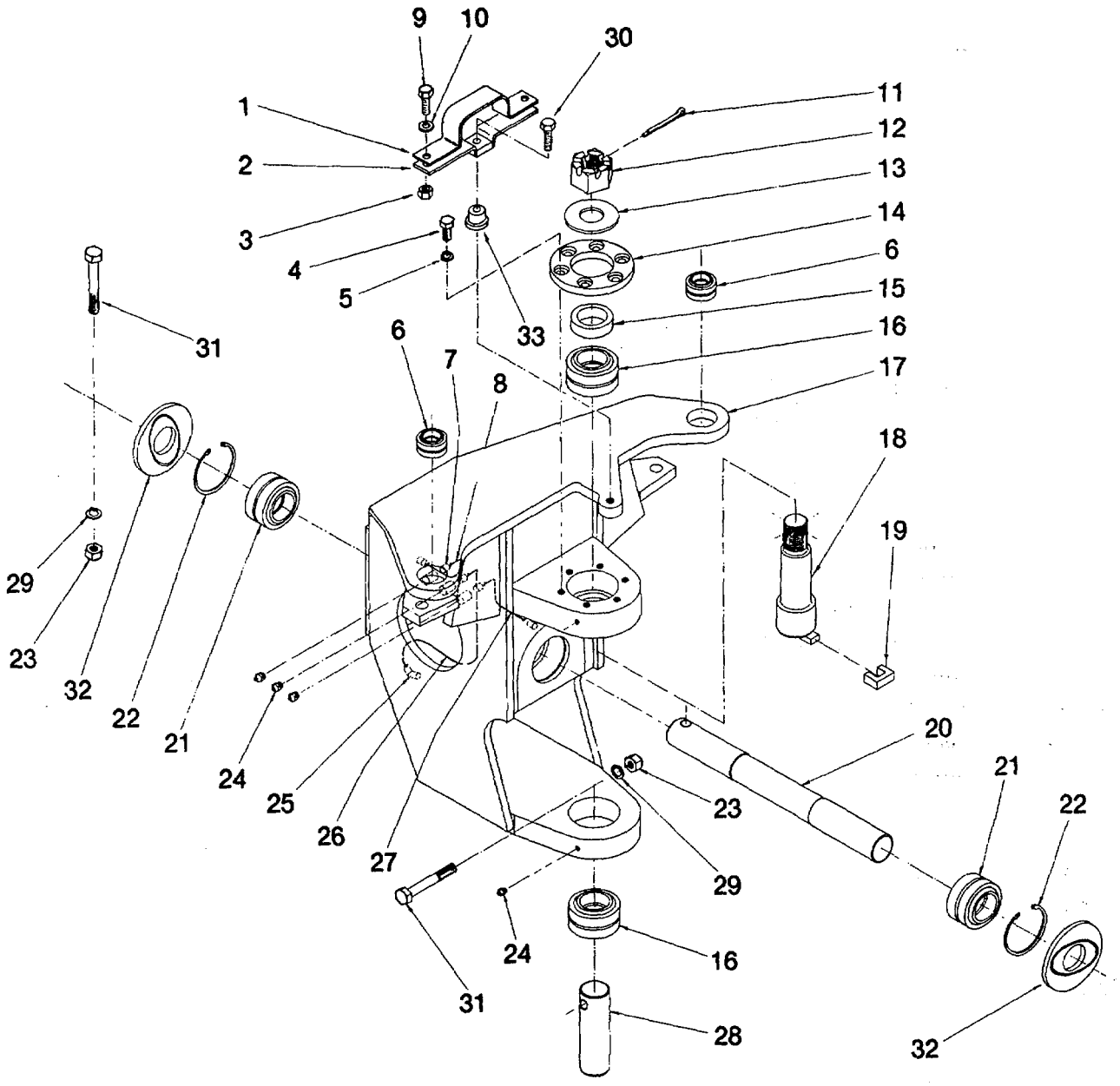
FRAME ASSEMBLY



FRAME ASSEMBLY

REF. NO.	DESCRIPTION	OTY.	PART NO.
1	**Frame Weldment,** Front	1	2871
2	**Frame Weldment,** Rear (includes items 3 to 9)	1	3800
3	**Bolt,** Hex 3/8 - 16 UNC x 1-1/4 Long	4	-
4	**Screw,** Shoulder 1/2 Diameter x 1/2 Long	2	-
5	**Locknut,** Hex 3/8 - 16 UNC	10	-
6	**Lockwasher,** 3/8 Diameter	10	-
7	**Bracket,** Steering	1	3835
8	**Cover,** Battery Box	1	3043
9	**Clamp**, Battery Hold Down	1	3042
10	**Tool Box**	1	2054
11	**Lock,** Tool Box	1	2086
12	**Key**, Tool Box .	1	2087
13	**Pin**, Cotter 3/16 x 2-1/2 Long	4	-
14	**Nipple,** Grease 1/4 NPT 671/2°	4	-
15	**Pin,** Steering Cylinder Clevis	4	1071
16	**Bearing,** Spherical Thrust	2	1077
17	**Light,** Rear	2	1568
18	**Plate,** Cover	1	3832
19	**Grommet,** No. 41	1	3656
20	**Support,** Battery Cable	1	3052
21	**Washer,** Hardened Flat 1/2 Diameter	2	-
22	**Locknut,** Hex 1/2- 13 UNC	2	-
23	**Bar,** Stop	8	3115
24	**Pipe,** Stop	8	3209
25	**Nut**, Hex Jam 1" - 8 UNC	32	-
26	**Nut,** Hex 1" -8 UNC	32	-
27	**Lockwasher**, 1" Diameter	16	3481
29	**Extension,** Grease Gun	1	2089
30	**Gun**, Grease	1	2055
31	**Tool Set**	1	2500

CENTER JOINT ASSEMBLY



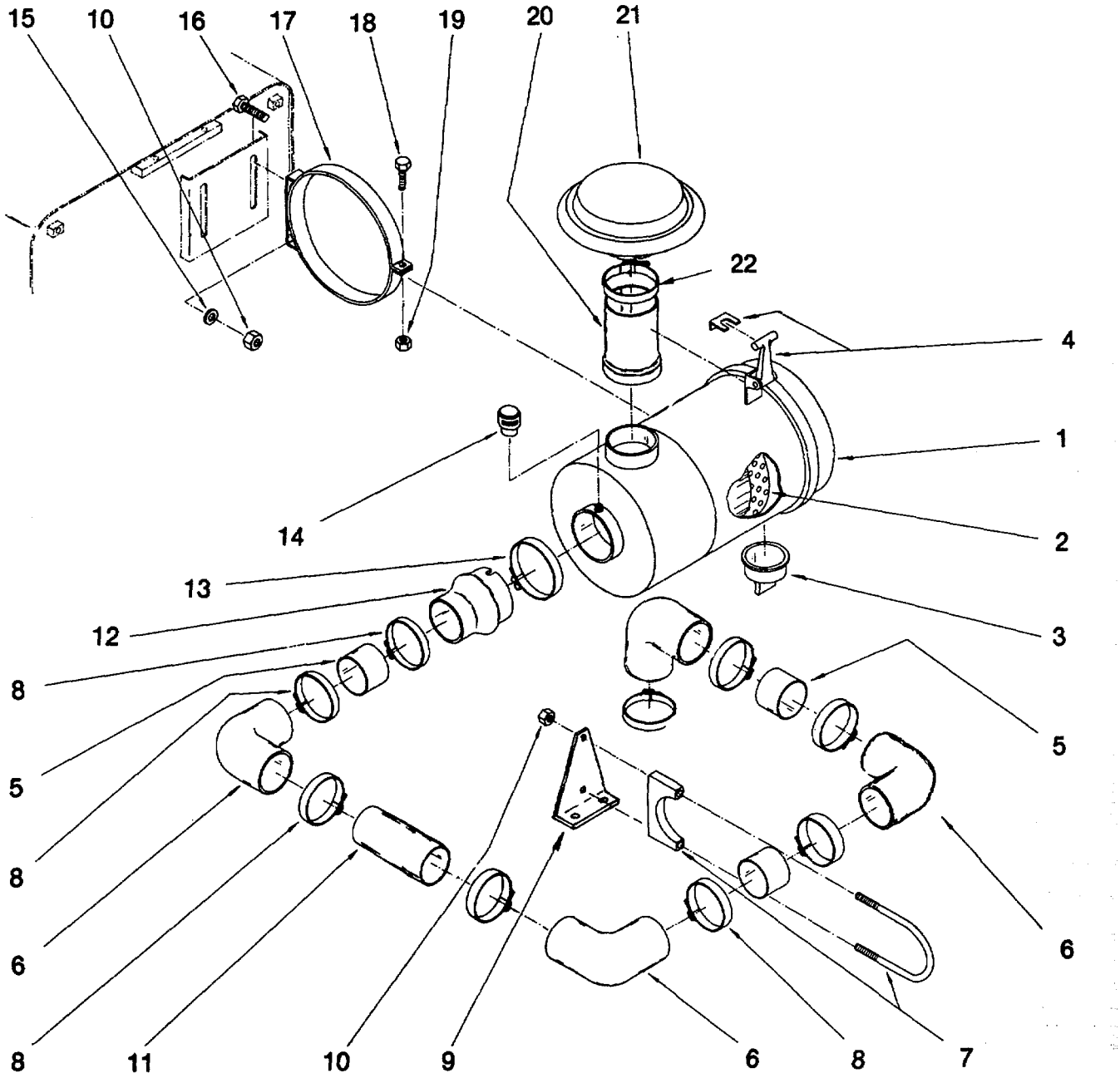
CENTER JOINT ASSEMBLY

REF NO.	DESCRIPTION	QTY.	PART NO.
1	**Bracket,** Top Hose Support	1	3928
2	**Bracket,** Bottom Hose Support	1	3927
3	**Locknut,** Hex 3/8 - 16 UNC	2	-
4	**Bolt,** Hex 5/8 - 18 UNF x 1-1/4 Long	6	-
5	**Lockwasher,** 5/8 Diameter	6	-
6	**Bearing,** Spherical Thrust	2	1077
7	**Adapter**	5	1012-4-5
8	**Hose Assembly**	1	3026
9	**Bolt,** Hex 3/8- 16 UNC x " Long	2	-
10	**Washer**, Hardened Flat 3/8 Diameter	2	-
11	**Pin**, Cotter 3/8 x 4 Long	1	-
12	**Nut**, Slotted Hex 2 - 12 UNF	1	3849
13	**Washer**, Top Bearing	1	2901
14	Flange, Top Bearing Retainer	1	2900
15	**Collar,** Bearing Mounting	1	2902
16	**Bearing**, Spherical Thrust	2	2757
17	**Center Joint Weldment**	1	2847
18	**Pin Assembly,** Top Pivot	1	2899
19	**Stop U**, Pivot	1	2903
20	Pin, Horizontal Pivot	1	2859
21	**Bearing,** Spherical Thrust	2	2758
22	**Circlip,** Horizontal Pin	2	2944
23	**Locknut,** Hex 3/4 - 10 UNC	2	-
24	**Nipple,** Grease 1/4 NPT 671/2	5	-
25	**Adapter**	1	1021-2-5
26	**Hose Assembly**	1	3028
27	**Hose Assembly**	1	3027
28	**Pin,** Lower Pivot	1	2895
29	**Lockwasher,** 3/4 Diameter	2	-
30	**Bolt,** Hex 3/4 - 10 UNC x 1-3/4 Long	1	-
31	**Bolt,** Hex 3/4 - 10 UNC x 5-1/2 Long	2	-
32	**Washer**, Thrust	2	2861
33	**Bushing,** Bracket	1	3925

ENGINE SECTION

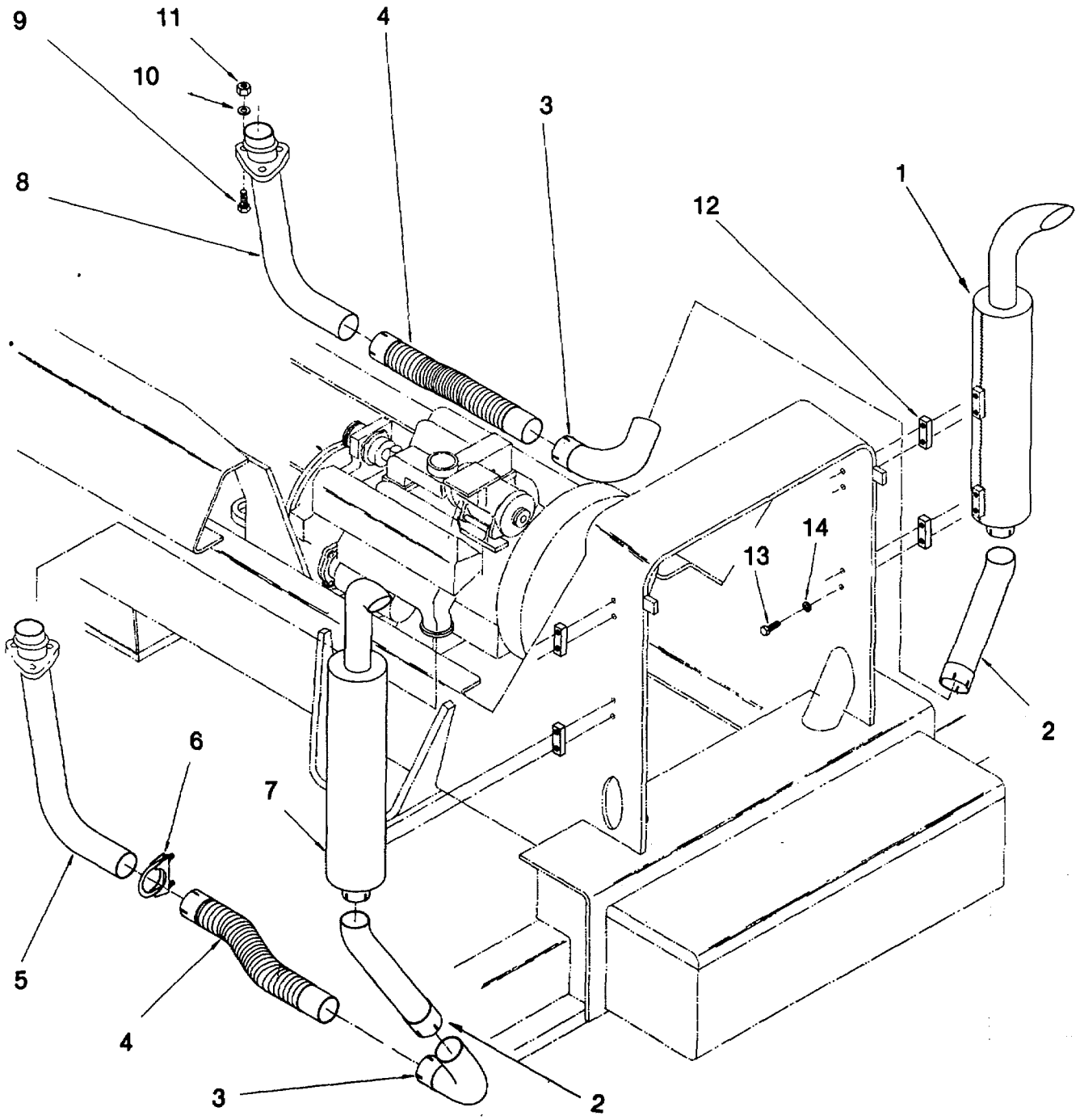
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AIR CLEANER ASSEMBLY

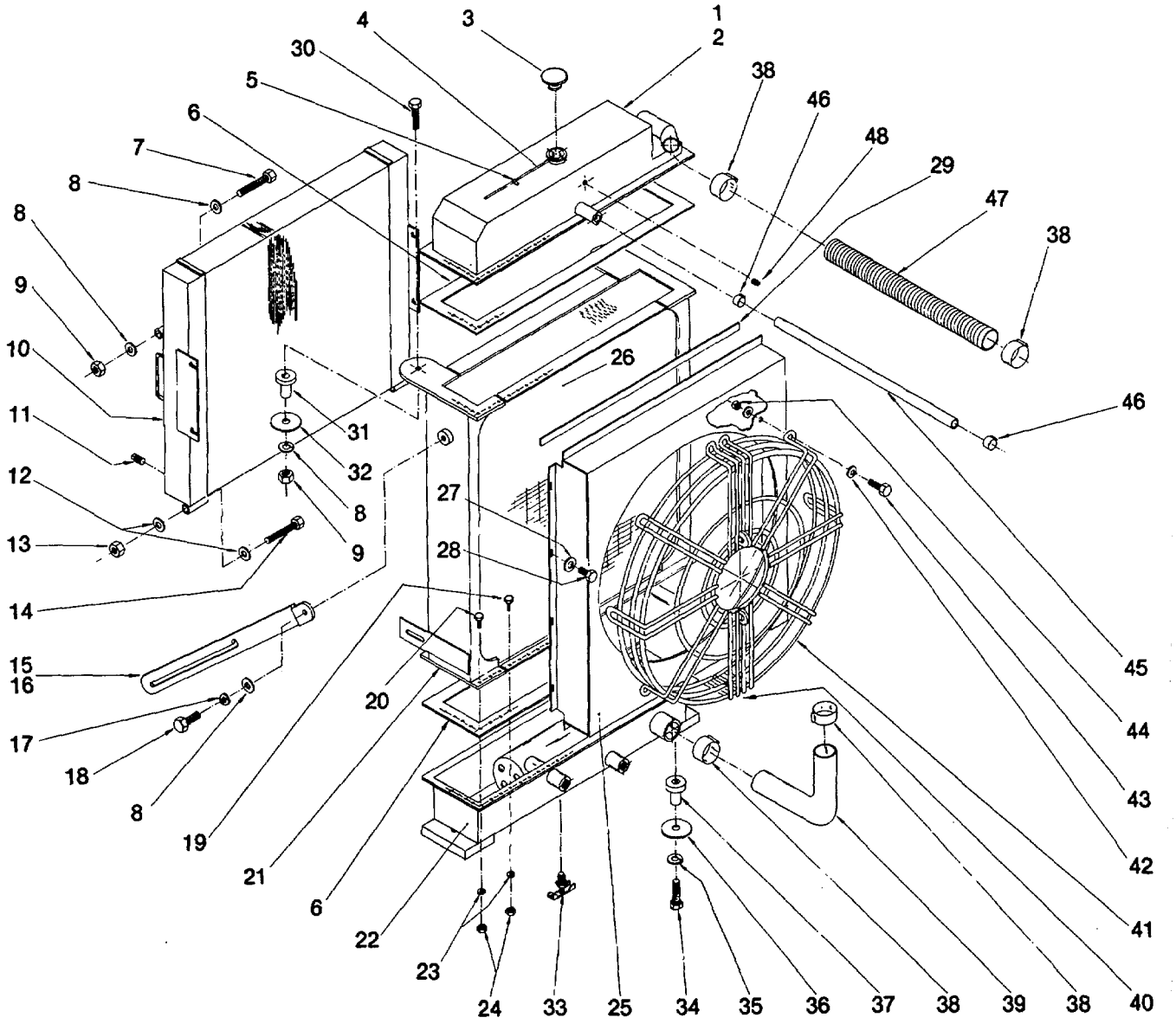
REF. NO.	DESCRIPTION	QTY	PART NO.
1	**Cleaner,** Air (includes items 2 and 3)	1	1571
2	**Element**, Filter	1	2045
3	**Valve,** Vacuator	1	3645
4	**Clamp**, Rubber (includes brackets)	1	1815
5	**Tubing,** Air inlet	3	1971
6	**Elbow**, Air Inlet Rubber	4	1574
7	**Clamp**, "U" (includes item 10)	1	2350
8	**Clamp**, Hose	9	2228
9	**Bracket**, Mounting	1	3536
10	**Locknut**, Hex 3/8 - 16 UNC	6	-
11	**Tubing,** Air Inlet	1	3294
12	**Reducer**, Air Inlet	1	1575
13	**Clamp**, Hose	1	1576
14	**Indicator**, Restriction	1	3278
15	**Washer**,-,Hardened Flat 3/8 Diameter	8	-
16	**Bolt,** Hex 3/8 - 16 UNC x 1 Long	4	-
17	**Band**, Mounting (includes items 18 and 19)	2	1573
18	**Bolt**, Hex 5/16 -18 UNC x 1-1/2 Long	2	-
19	**Nut,** Hex 5/16 - 18 UNC	2	-
20	**Extension**, Air Inlet.	1	2523
21	**Hood,** Air Inlet (includes item 22)	1	1572
22	**Clamp**, Air Inlet Hood	1	3583


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EXHAUST SYSTEM

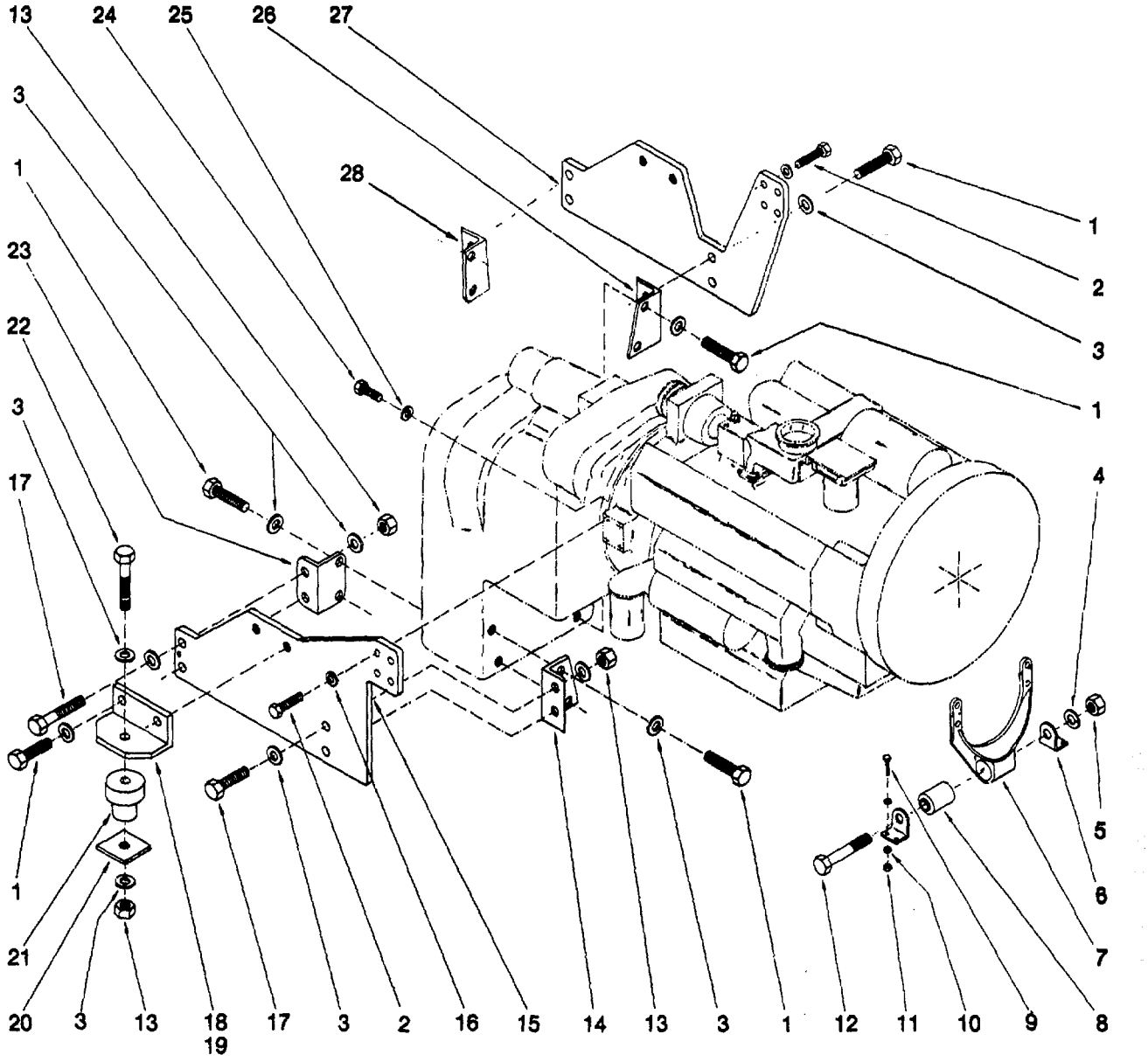
REF. NO	DESCRIPTION	QTY.	PART NO.
I	**Muffler,** R H	1	2490
2	**Tubing,** Exhaust	2	2485
3	**Elbow**, Exhaust	2	2488
4	**Tubing,** Flexible Exhaust	2	2488
5	**Elbow**, Manifold L.H	1	3297
6	**Clamp**, Muffler	8	1963
7	**Muffler,** L.H	1	2489
8	**Elbow,** Manifold R.H	1	3298
9	**Bolt, Hex** 3/8 - 16 UNC x 1-1/2 Long	10	-
10	**Washer,** Hardened Flat 3/8 Diameter	6	-
11	**Locknut**, 3/8 - 16 UNC	6	-
12	**Block**, Muffler Mounting	4	2016
13	**Bolt,** Hex 1/2 - 13 UNC x 1-1/4 Long	8	-
14	**Washer,** Hardened Flat 1/2 Diameter	8	-

COOLING ASSEMBLY



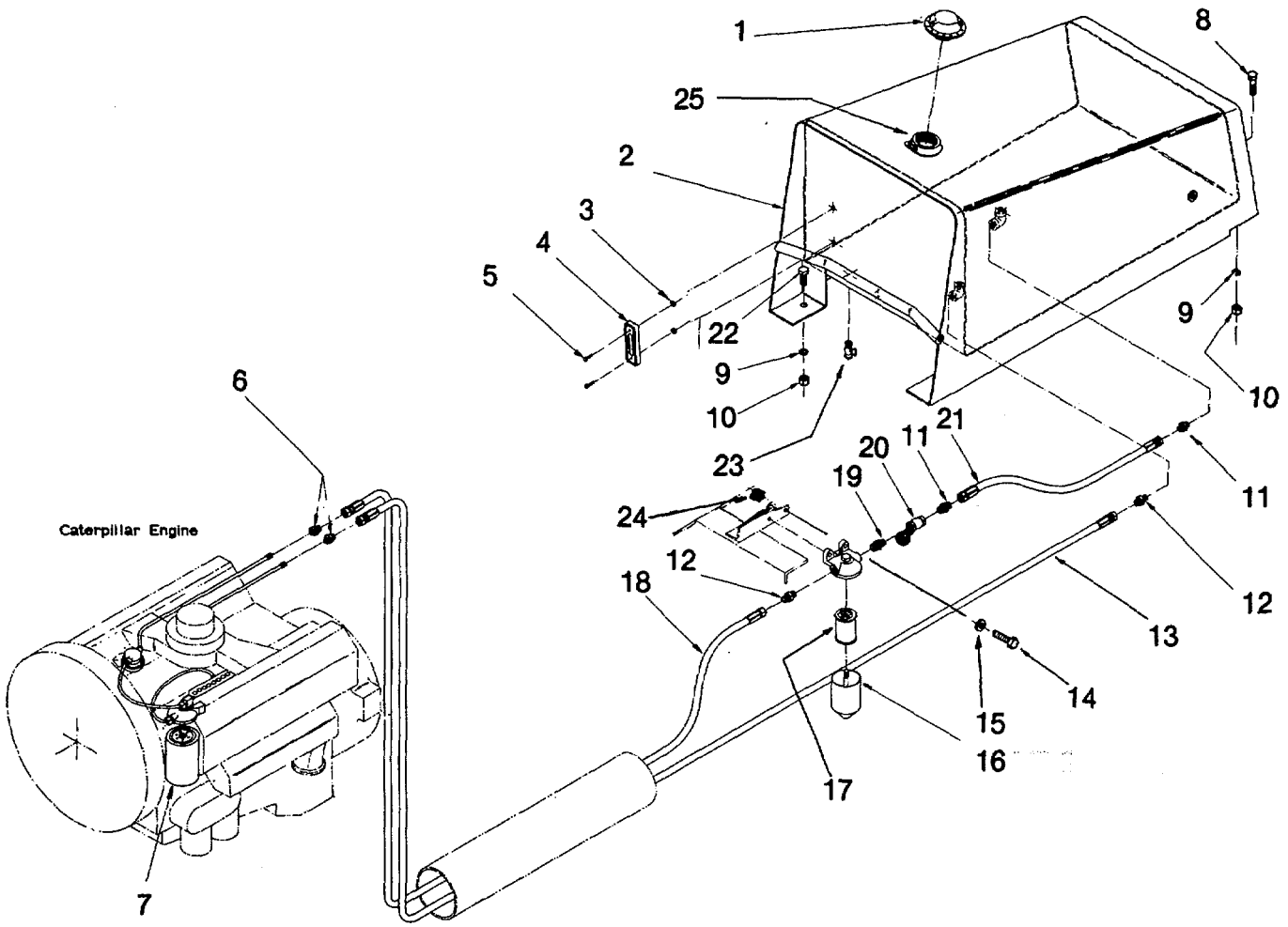
COOLING ASSEMBLY

REV. NO.	DESCRIPTION	QTY.	PART NO.
1	**Radiator Assembly** (includes items 2 to 29)	1	3683
2	**Tank** Assembly, Top	1	3684
3	**Cap**, Radiator	1	2382
4	**Hose**, Overflow	1	3169
5	**Clip**, Overflow Hose	3	3170
6	**Gasket**, Tank	2	3167
7	**Bolt,** Hex 1/2 - 13 UNC x 3-3/4 Long	2	-
8	**Washer**, Hardened Flat 1/2 Diameter	8	-
9	**Locknut**, Hex 1/2- 13 UNC	2	-
10	**Air-Oil Cooler Assembly**	1	3752
11	**Plug**, 1/4 NPT	2	-
12	**Washer**, Hardened Flat 3/4 Diameter	4	-
13	**Locknut**, Hex 3/4 - 10 UNC	2	-
14	**Bolt,** Hex 3/4 - 10 UNC x 4 Long	2	-
15	**Support Arm**, Right	1	3746
16	**Support Arm**, Left	1	3758
17	**Lockwasher**, 1/2 Diameter	2	-
18	**Bolt**, Shoulder 5/8 x 1/2 Long x 1/2- 13 UNC	2	-
19	**Bolt**, Hex 5/16 - 18 UNC x 1 Long	64	-
20	**Bolt**, Hex 5/16 - 18 UNC x 1-1/4 Long	24	-
21	**Frame and Header Bar Assembly**	1	3795
22	**Bottom Tank Assembly**	1	3685
23	**Lockwasher**, 5/16 Diameter	88	-
24	**Nut,** Hex 5/16 - 18 UNC	72	-
25	**Shroud Assembly**	1	3538
26	**Core and Header Assembly**	1	3794
27	**Lockwasher**, 1/4 Diameter	8	-
28	**Bolt,** Hex 1/4 - 20 UNC x 3/8 Long	8	-
29	**Gasket**, Permastick	2	3168
30	**Bolt**, Hex 1/2 - 13 UNC x 2-1/4 Long	2	-
31	**Mount,** Top Rubber	2	3472
32	**Plate**, Top Bolt	2	2615
33	**Cock**, Drain	1	2827
34	**Bolt,** Hex 5/8 - 11 UNC x 2-1/2 Long	2	-
35	**Washer.,** Hardened Flat 5/8 Diameter	2	-
36	**Plate,** Bottom Bolt	2	2613
37	**Mount**, Bottom Rubber	2	2612
38	**Clamp,** Hose	4	1687
39	**Hose**, Bottom	1	3687
40	**Guard,** Fan R.H	1	3607
41	**Guard,** Fan L.H	1	3606
42	**Washer**, Hardened Flat 3/8 Diameter	24	-
43	**Bolt,** Hex 3/8 - 16 UNC x 1 Long	12	-
44	**Locknut,** Hex 3/8 - 16 UNC	12	-
45	**Hose**	1	3689
46	**Clamp**, Hose	2	2013
47	**Hose,** Top	1	3686
48	**Plug**, 3/8	1	-


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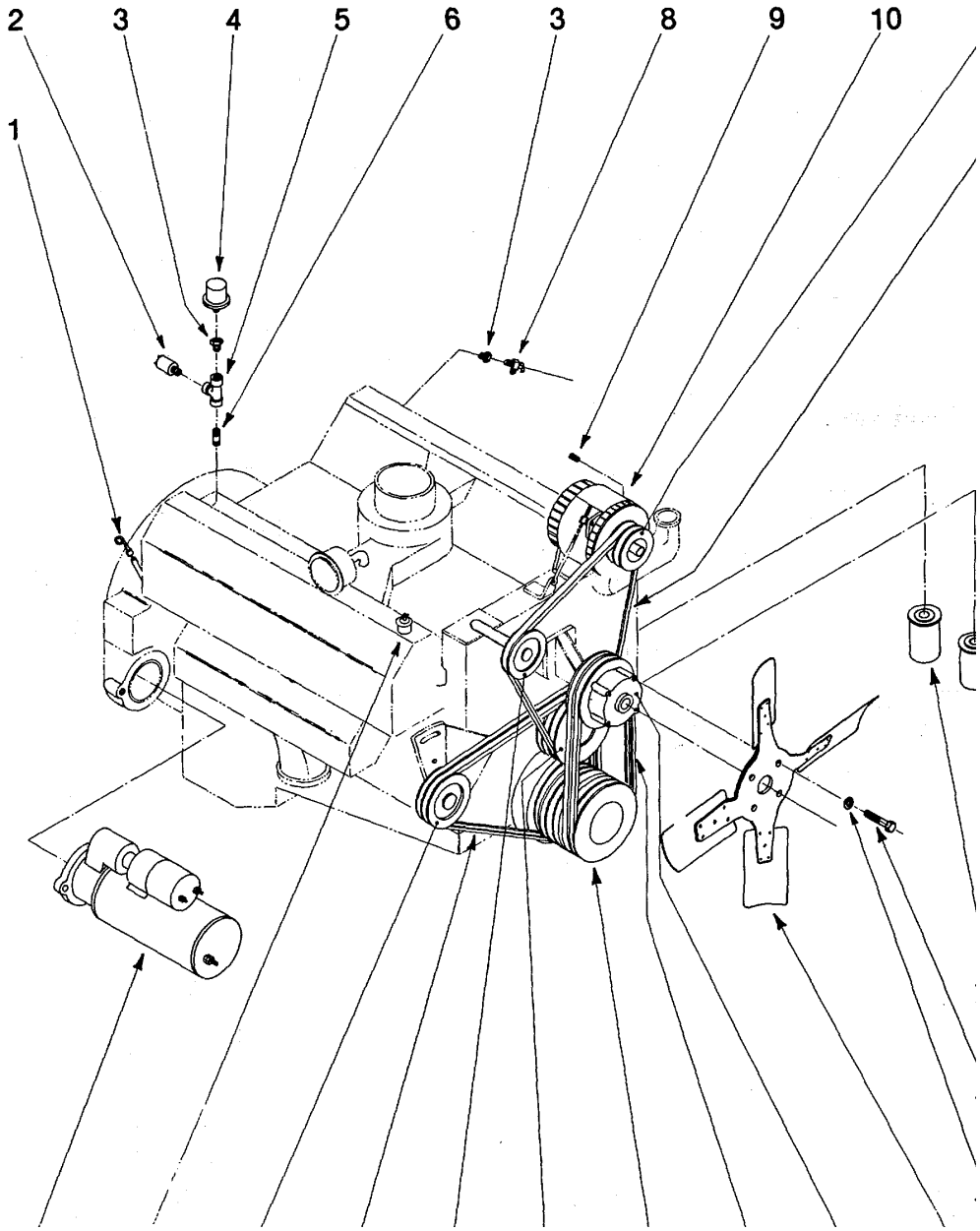
ENGINE & TRANSMISSION MOUNTING

REF. NO.	DESCRIPTION	QTY.	PART NO.
1	**Bolt**, Hex 3/4 - 10 UNC x 1-3/4 Long	14	-
2	**Bolt**, Hex 1/2 - 13 UNC x 2 Long	8	-
3	**Washer**, Hardened Flat 3/4 Diameter	30	-
4	**Lockwasher**, 3/4 Diameter	1	-
5	**Nut**, Hex 3/4 - 16 UNF	1	-
6	**Angle,** Mounting	2	173773
7	**Bracket,** Engine Mounting	1	3540
8	**Mount**, Engine Bracket Rubber	1	173094
9	**Bolt**, Hex 7/16 - 14 UNC x 1-3/4 Long	4	-
10	**Washer**, Hardened Flat 7/16 Diameter	8	-
11	**Locknut**, Hex 7/16 - 14 UNC	4	-
12	**Bolt,** Engine Mount	1	S-114-B
13	**Locknut**, Hex 3/4 - 10 UNC	8	-
14	**Bracket**, Transmission Rear L.H	1	2029
15	**Plate**, Engine-Transmission L.H	1	3290
16	**Washer**, Hardened Flat 1/2 Diameter	8	-
17	**Bolt**, Hex 3/4 - 10 UNC x 2-1/2 Long	6	-
18	**Angle**, Mounting L.H	1	2026
19	**Angle**, Mounting R.H	1	1807
20	**Washer**, Snubbing	2	2356
21	**Mount, Rubber**	2	1808
22	**Bolt,** Hex 3/4 - 10 UNC x 4-1/2 Long	2	-
23	**Bracket**, Transmission Front L.H	1	2027
24	**Bolt,** Hex 3/8 - 16 UNC x 1-1/2 Long	12	-
25	**Washer**, Hardened Flat 3/8 Diameter	12	-
26	**Bracket**, Transmission Rear R.H	1	2122
27	**Plate**, Engine-Transmission on R.H	1	3289
28	**Bracket**, Transmission Front R.H	1	1809


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Caterpillar Engine
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FUEL SYSTEM

REF. NO	DESCRIPTION	QTY.	PART NO.
I	**Cap,** Fuel Filler	1	1406
2	**Tank,** Fuel	1	1181
3	**Seal**, O Ring	4	3009
4	**Gauge**, Level (includes items 3 and 5)	1	2565
5	**Bolt**, Hollow Mounting	2	3010
6	**Adapter**	2	1012-4-6
7	**Cartridge, Fuel Filter**	1	3603
8	**Bolt,** Hex 5/8- 11 UNC x 2-1/2 Long.	2	-
9	**Washer,** Hardened Flat 518 Diameter	5	-
10	**Locknut,** Hex 518 - 11 UNC	5	-
11	**Adapter**	2	1021-8-10
12	**Adapter**	3	1012-6-6
13	**Hose Assembly**, Fuel Return	1	3539
14	**Bolt**, Hex 3/8 - 16 UNC x 1-1/2 Long	2	-
15	**Washer**, Hardened Flat 3/8 Diameter	2	-
16	**Filter Assembly**, Primary Fuel	1	2051
17	**Element,** Fuel Filter	1	2052
18	**Hose Assembly**, Filter to Engine	1	1982
19	**Adapter**	1	1042-6-8
20	**Valve**, Shut Off	1	3545
21	**Hose Assembly**, Tank to Filter	1	3024
22	**Bolt**, Hex 518 - 11 UNC x 1-3/4 Long	3	-
23	**Cock,** Drain	1	2827
24	**Locknut,** Hex 3/8 - 16 UNC	2	-
25	**Slug,** Cap Locking	1	2909


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ENGINE ACCESSORIES

REF. NO.	DESCRIPTION	QTY.	PART NO.
1	**Dipstick,** Engine Oil	1	2N995
2	**Switch**, Oil Pressure	1	4N3355
3	**Reducer**	2	1093-4-2
4	**Sender**, Oil Pressure	1	1253
5	**Tee**, Pipe 1/4	1	-
6	**Nipple,** Pipe 1/4 NPT x 2 Long	1	3679
7	**Motor,** Starter	1	4N8253
8	**Cock**, Drain	1	2827
9	**Plug,** 1/4 NPT	I	-
10	**Alternator**	1	9L6298
11	**Pulley**, Alternator	1	9L7311
12	**Belt,** Alternator	1	2P4230
13	**Cap**, Oil Filler	1	9L8439
14	**Element**, Oil Filter	2	3604
15	**Bolt**, Fan Mounting	4	S1618
16	**Washer,** Fan Mounting	4	9M1974
17	**Fan**	1	2N2361
18	**Pulley**, Fan	1	1N9398
19	**Belt Set**, Fan	1 4	B2544
20	**Pulley**, Crankshaft	1	N6663
21	**Pulle**y, Camshaft	1	9L7626
22	**Pulley**, Alternator Idler	1	1N8207
23	**Belt Set**, Water Pump	1	4N8580
24	**Pulley**, Water Pump Idler	1	2N2777

ENGINE

ENGINE PARTS CATALOG

REF. NO.	DESCRIPTION	QTY.	PART NO.
1	Engine Assembly	1	3601

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ORDERING PARTS_____ 2
QUICK REFERENCE CHART INSIDE FRONT COVER
USING THE PARTS BOOK_____2

PARTS BOOK

3208
INDUSTRIAL ENGINE

SERIAL NUMBER
90N 6121-UP

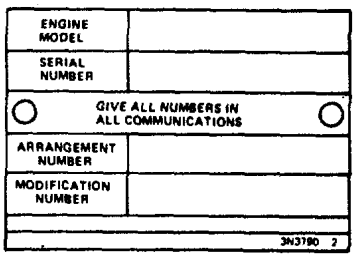
PUBLISHED DECEMBER 1974
CATERPILLAR TRACTOR CO.
PUBLICATIONS DIV.—SERVICE G.O.
PEORIA, ILL. U.S.A.
COMPILED BY BETTY J. SCHMIDGALL

QUICK REFERENCE GUIDE TO MAJOR SECTIONS

BASIC ENGINE
LUBRICATION SYSTEM
COOLING SYSTEM
INTAKE & EXHAUST SYSTEM
FUEL SYSTEM & GOVERNOR
STARTING & ELECTRICAL SYSTEM
ATTACHMENTS & SERVICE EQUIPMENT

ORDERING PARTS Quality Caterpillar Replacement parts are available from Caterpillar dealers throughout the world. Their parts stocks are up to date and include all parts normally required to protect your investment in Caterpillar machines. When ordering parts, always use the Parts Book covering the serial number of your machine.

Your order should specify the quantity, part number, part name and show the machine serial number for which the parts are needed. If in doubt about the part number, please provide your dealer with a complete description of the needed item.



See Specifications for Location of Serial Number Plate.

HOW TO USE THE PARTS BOOK Caterpillar Parts Books include illustrations of the groups or assemblies which make up the machine. These illustrations show the standard components of the machine plus many of the attachments available for the machine.

The alphabetical index located in the front part of the book should be used to determine the page number on which specific illustrations are shown. Reference to those pages will identify each of the individual serviceable parts.

Captions

The caption under each illustration identifies the part number and name of the group or assembly shown. If more than one illustration is included for any group, the caption identifies the specific machine serial numbers to which each illustration applies. In some cases it is not possible to determine the specific machine serial numbers to which different illustrations are applicable, In those cases the caption id*enti*fies the illustration as

"First Type", "Second Type", etc, Reference to the actual group or assembly is necessary in those cases to determine which illustration should be used,

Captions provide additional information such as page numbers where illustrations of sub assemblies are shown, information re. guarding quantities used and other information intended to assist the use in determining parts needs.
Indented Part Names

Within each illustration is a parts list identifying each serviceable part in the illustration. When a part name is indented in this list, it means that serviceable item is a pert of the serviceable item under which it *is* indented.

Abbreviations and Symbols

!	Used to call attention to additional information shown elsewhere with in the illustration.	
R.H.	Right Hand	Refer to the side of the
L.H.	Left Hand	machine as viewed from the operator's compartment.
C	Indicates changes from the previous illustration of the same group or assmbly.	
O. D.	Outside Diameter	
I. D.	Inside Diameter	
N/S	Not Serviceable	
Assem.	Assembly	
in.	Inch	
ft	Foot	
cm	Centimeter	
dm	Decimeter	

Note:
Continuing improvement and advancement- of product design may cause changes to your machine which may not be included in this publication. Each pub*lic*ation *s revie*wed and revised, as required, to update and include these changes In later editions

Whenever a question aris*es* regarding your Caterpillar product, or this publication, please consult your Caterpillar dealer for the latest available information.

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CANCELLATIONS TO 6N2892 BASIC ENGINE ARRANGEMENT
0IL LEVEL GAUGE GROUP
OIL LINES GROUP

6N3005 ENGINE PROCUREMENT ARRANGEMENT
Provides 210 BHP without fan at 2800 R.P.M. full load
NOTE: WHEN ORDERING PARTS GIVE ARRANGEMENT NUMBER AND SERIAL NUMBER

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CANCELLATIONS TO 6N2892 BASIC ENGINE ARRANGEMENT
OIL LEVEL GAUGE GROUP
OIL PAN GROUP
OIL LINES GROUP

6N3006 ENGINE PROCUREMENT ARRANGEMENT
Provides 210 BHP without fan at 2800 R.P.M. full load
NOTE: WHEN ORDERING PARTS GIVE ARRANGEMENT NUMBER AND SERIAL NUMBER

	CONSISTS OF:		PAGE
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1	9N529	FLYWHEEL HOUSING GROUP	65
1	9L7861	FLYWHEEL HOUSING COVER GROUP	66

CANCELLATIONS TO 6N2892 BASIC ENGINE ARRANGEMENT
FLYWHEEL HOUSING GROUP
FLYWHEEL HOUSING COVER GROUP

6N3007 ENGINE, PROCUREMENT ARRANGEMENT
Provides 210 BHP without fan at 2800 R.P.M. full load
NOTE: WHEN ORDERING PARTS GIVE ARRANGEMENT NUMBER AND SERIAL NUMBER

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CANCELLATIONS TO 6N2892 BASIC ENGINE ARRANGEMENT
FLYWHEEL HOUSING GROUP
FLYWHEEL HOUSING COVER GROUP
OIL LEVEL GAUGE GROUP
OIL LINES GROUP

6N3008 ENGINE PROCUREMENT ARRANGEMENT
Provides 210 BHP without fan at 2800 R.P.M. full load
NOTE: WHEN ORDERING PARTS GIVE ARRANGEMENT NUMBER AND SERIAL NUMBER

		CONSISTS OF:	PAGE
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1	4N8855	OIL LEVEL GAUGE GROUP	69
1	4N8853	OIL PAN GROUP	67
1	4N8854	OIL LINES GROUP	72

CANCELLATIONS TO 6N2892 BASIC ENGINE ARRANGEMENT
FLYWHEEL HOUSING GROUP
FLYWHEEL HOUSING COVER GROUP
OIL LEVEL GAUGE GROUP
OIL PAN GROUP
OIL LINES GROUP

6N3009 ENGINE PROCUREMENT ARRANGEMENT
Provides 210 BHP without fan at 2800 R.P.M. full load
NOTE: WHEN ORDERING PARTS GIVE ARRANGEMENT NUMBER AND SERIAL NUMBER

		CONSISTS OF:	PAGE
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CANCELLATIONS TO 6N2892 BASIC ENGINE ARRANGEMENT
CRANKSHAFT GROUP
GOVERNOR AND FUEL INJECTION PUMP GROUP

6N3010 ENGINE PROCUREMENT ARRANGEMENT
Provides 175 BHP without fan at 2800 R.P.M. full load
NOTE: WHEN ORDERING PARTS GIVE ARRANGEMENT NUMBER AND SERIAL NUMBER

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CANCELLATIONS TO 6N2892 BASIC ENGINE ARRANGEMENT
CRANKSHAFT GROUP
OIL LEVEL GAUGE GROUP
OIL LINES GROUP
GOVERNOR AND FUEL INJECTION PUMP GROUP

6N3011 ENGINE PROCUREMENT ARRANGEMENT
Provides 175 BHP without fan-2800 R.P.M. full load
NOTE: WHEN ORDERING PARTS GIVE ARRANGEMENT NUMBER AND SERIAL NUMBER

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1	9N1352	GOVERNOR AND FUEL INJECTION PUMP GROUP	96

CANCELLATIONS TO 6N2892 BASIC ENGINE ARRANGEMENT
CRANKSHAFT GROUP
OIL LEVEL GAUGE GROUP
OIL PAN GROUP
OIL LINES GROUP
GOVERNOR AND FUEL INJECTION PUMP GROUP

6N3012 ENGINE PROCUREMENT ARRANGEMENT
Provides 175 BHP without fan a 2800 R.P.M. full load
NOTE: WHEN ORDERING PARTS GIVE ARRANGEMENT NUMBER AND SERIAL NUMBER

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CANCELLATIONS TO 6N2892 BASIC ENGINE ARRANGEMENT
CRANKSHAFT GROUP
FLYWHEEL HOUSING GROUP
FLYWHEEL HOUSING COVER GROUP
GOVERNOR AND FUEL INJECTION PUMP GROUP

6N3013 ENGINE PROCUREMENT ARRANGEMENT
Provides 175 BHP without fan 2800 R.P.M. full bad
NOTE: WHEN ORDERING PARTS GIVE ARRANGEMENT NUMBER AND SERIAL NUMBER

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CANCELLATIONS TO 6N2892 BASIC ENGINE ARRANGEMENT
CRANKSHAFT GROUP
FLYWHEEL HOUSING GROUP
FLYWHEEL HOUSING COVER GROUP
OIL LEVEL GAUGE GROUP
OIL LINES GROUP
GOVERNOR AND FUEL INJECTION PUMP GROUP

6N3014 ENGINE PROCUREMENT ARRANGEMENT
Provides 175 BHP without fan at 2800 R.P.M. full load
NOTE: WHEN ORDERING PARTS GIVE ARRANGEMENT NUMBER AND SERIAL NUMBER

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1	4N8853	OIL PAN GROUP	67
1	418854	OIL LINES GROUP	72
1	9N1352	GOVERNOR AND FUEL INJECTION PUMP GROUP	96

CANCELLATIONS TO 6N2892 BASIC ENGINE ARRANGEMENT
CRANKSHAFT GROUP
FLYWHEEL HOUSING GROUP
FLYWHEEL HOUSING COVER GROUP
OIL LEVEL GAUGE GROUP
OIL PAN GROUP
OIL LINES GROUP
GOVERNOR AND FUEL INJECTION PUMP GROUP

6N3015 ENGINE PROCUREMENT ARRANGEMENT
Provides 175 BHP without fan 2800 R.P.M. full load
NOTE. WHEN ORDERING PARTS GIVE ARRANGEMENT NUMBER AND SERIAL NUMBER

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1	9N730	VALVE MECHANISM COVER GROUP	56
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1	9N191	LIFTING GROUP--R.H. SIDE	58
1	9N210	LIFTING GROUP--L.H. SIDE	58
1	9N487	VALVE MECHANISM GROUP	56
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6N2892 BASIC ENGINE ARRANGEMENT-Part 1 of 2
Provides for 210 BHP at 2800 R.P.M. a full load. Also part of 6N3005, 6N3006, 6N3007, 6N3008, 6N3009, 6N3010, 6N3011, 6N3012, 6N3013, 6N3014 and 6N305 Engine Procurement Arrangements listed on Pages 11 through 17
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FUEL SYSTEM AND GOVERNOR

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1	4N3287	FUEL PRIMING PUMP GROUP	117
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NOTE: SERIAL NUMBER PLATE IS LOCATED ON R.H. SIDE OF CYLINDER BLOCK

N2892 BASIC ENGINE ARRANGEMENT-Part 2 of 2
Provides for 210 BHP at 2800 R.P.M. at full load. Also part of 6N3005, 6N3006, 6N3007, 6N3008, 6N3009, 6N3010, 6N3011, 6N3012, 6N013, 6N3014 and 6N3015 Engine Procurement Arrangement listed on Pages 11 through 17. NOTE: WHEN ORDERING PARTS GIVE ARRANGEMENT NUMBER AND SERIAL NUMBER

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1	9N315	CRANKSHAFT GROUP	50
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1	9N730	VALVE MECHANISM COVER GROUP	56
1	9NI105	CYLINDER HEAD GROUP	55
1	9N191	LIFTING GROUP--R.H. SIDE	58
1	9N210	LIFTING GROUP--L.H, SIDE.	58
1	9N487	VALVE MECHANISM GROUP	56
		FRONT STRUCTURE	
1	9N560	FRONT HOUSING COVER GROUP	60
1	9N787	PULLEY AND DAMPER GROUP	53
1	9N1080	FRONT HOUSING GROUP	59
I	4N5487	SUPPORT GROUP	60
		REAR STRUCTURE	
1	9L7861	FLYWHEEL HOUSING COVER GROUP	66
1	9N529	FLYWHEEL HOUSING GROUP	65
1	4N8850	FLYWHEEL GROUP	62
		LOWER STRUCTURE	
1	4N8930	OIL LEVEL GAUGE GROUP	68
1	9N565	OIL PAN GROUP	67
		LUBRICATION SYSTEM	
2	9L9200	OIL FILTER ASSEMBLY	70
1	9N533	OIL LINES GROUP	71
1	9N541	OIL PUMP GROUP	70

6N2893 ENGINE ARRANGEMENT Part 1 of 2
Provides 125 BHP without fan at 2400 R.P.M. full load
NOTE: WHEN ORDERING PARTS GIVE ARRANGEMENT NUMBER AND SERIAL NUMBER

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1	9N733	WATER LINES GROUP	74
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INTAKE AND EXHAUST SYSTEM			
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1	9L6258	EXHAUST MANIFOLD GROUP	87
1	9N555	INLET MANIFOLD GROUP	89
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FUEL SYSTEM AND GOVERNOR			
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1	4N5868	FUEL FILTER GROUP	117
1	9N435	FUEL FILTER-LINES GROUP	116
1	9N119	FUEL INJECTION LINES GROUP	115
1	4N3287	FUEL PRIMING PUMP GROUP	117
1	6N3567	GOVERNOR AND FUEL INJECTION PUMP GROUP	95
ELECTRICAL SYSTEM			
1	6N467	ALTERNATOR GROUP	128
MISCELLANEOUS			
1	6N471	NAME PLATES AND TRANSFERS	156
2	9L7132	CONNECTOR ASSEMBLY	
1	1N9787	SPACER	
1	2N5880	HARNESS ASSEMBLY	
1	2N7278	REGULATOR ASSEMBLY	
1	2N8985	BRACKET ASSEMBLY	

NOTE: SERIAL NUMBER PLATE IS LOCATED ON R.H. SIDE OF CYLINDER BLOCK

6N2893 ENGINE ARRANGEMENT--Part 2 of 2
Provides 125 BHP without fan at 2400 R.P.M. full load
NOTE: WHEN ORDERING PARTS GIVE ARRANGEMENT NUMBER AND SERIAL NUMBER

CONSISTS OF: PAGE

CENTRAL STRUCTURE

1	9N130	CYLINDER BLOCK GROUP	46
1	9N728	CAMSHAFT GROUP	54
1	9L6065	CYLINDER BLOCK COVER GROUP	47
1	9N310	CRANKSHAFT GROUP	49
8	9N150	CONNECTING ROD AND PISTON GROUP	54
1	9N542	CRANKSHAFT SEAL GROUP	51

UPPER STRUCTURE

1	9N730	VALVE MECHANISM COVER GROUP	56
1	9NO1105	CYLINDER HEAD GROUP	55
1	9N191	LIFTING GROUP--R.H. SIDE	58
1	9N210	LIFTING GROUP--L.H. SIDE	58
1	9N487	VALVE MECHANISM GROUP	56

FRONT STRUCTURE

1	9N560	FRONT HOUSING COVER GROUP	60
1	9N787	PULLEY AND DAMPER GROUP	53
1	9N1080	FRONT HOUSING GROUP	59
1	4N5487	SUPPORT GROUP	60

REAR STRUCTURE

1	4N5866	FLYWHEEL HOUSING COVER GROUP	66
1	4N5870	FLYWHEEL HOUSING GROUP	64
1	4N8852	FLYWHEEL GROUP	62

LOWER STRUCTURE

1	9N142	OIL LEVEL GAUGE GROUP	68
1	9N565	OIL PAN GROUP	67

LUBRICATION SYSTEM

2	9L9200	OIL FILTER ASSEMBLY	70
1	9N550	OIL LINES GROUP	71
1	9N541	OIL PUMP GROUP	70

6N2894 ENGINE ARRANGEMENT-Part 1 of 2
Provides 203 BHP without fan at 2700 R.P.M. full load
NOTE: WHEN ORDERING PARTS GIVE ARRANGEMENT NUMBER AND SERIAL NUMBER

CONSISTS OF:			PAGE
COOLING SYSTEM			
1	9N521	OIL COOLER GROUP	73
1	6N466	WATER LINES GROUP	75
1	9N140	WATER PUMP GROUP	78
INTAKE AND EXHAUST SYSTEM			
1	3N2915	AIR CLEANER ADAPTER GROUP	91
1	9N535	EXHAUST MANIFOLD GROUP	88
I	9N555	INLET MANIFOLD GROUP	89
1	9N735	POSITIVE CRANKCASE VENTILATION VALVE GROUP	93
FUEL SYSTEM AND GOVERNOR			
1	9L6743	GOVERNOR CONTROL GROUP	113
1	9N740	GOVERNOR AND FUEL PUMP DRIVE GROUP	94
1	9L6925	FUEL SYSTEM FASTENER GROUP	118
1	4N5868	FUEL FILTER GROUP	117
1	9N435	FUEL FILTER LINES GROUP	116
1	9N119	FUEL INJECTION LINES GROUP	115
1	4N3287	FUEL PRIMING PUMP GROUP	117
1	4N9233	GOVERNOR AND FUEL INJECTION PUMP GROUP	95
MISCELLANEOUS			
1	6N468	NAME PLATES AND TRANSFERS	156
1	4H7869	GASKET	
1	2N4989	STRAP	
1	4N6776	SUPPORT	

NOTE: SERIAL NUMBER PLATE IS LOCATED ON R.H. SIDE OF CYLINDER BLOCK

6N2894 ENGINE ARRANGEMENT-Part 2 of 2
Provides 203 BHP without fan at 2700 R.P.M. full load
NOTE: WHEN ORDERING PARTS GIVE ARRANGEMENT NUMBER AND SERIAL NUMBER

CONSISTS OF: PAGE

CENTRAL STRUCTURE

1	9N130	CYLINDER BLOCK GROUP	46
1	9N728	CAMSHAFT GROUP	54
1	9L6065	CYLINDER BLOCK COVER GROUP	47
1	9N310	CRANKSHAFT GROUP	49
8	9N150	CONNECTING ROD AND PISTON GROUP	54
1	9N542	CRANKSHAFT SEAL GROUP	51

UPPER STRUCTURE

1	9N730	VALVE MECHANISM COVER GROUP	56
1	9Nl105	CYLINDER HEAD GROUP	55
1	1gl91	LIFTING GROUP--R.H. SIDE	58
1	9N210	LIFTING GROUP--L.H. SIDE	58
1	9N487	VALVE MECHANISM GROUP	56

FRONT STRUCTURE

1	9N560	FRONT HOUSING COVER GROUP	60
1	9N787	PULLEY AND DAMPER GROUP	53
1	9N1080	FRONT HOUSING GROUP	59
1	4N5487	SUPPORT GROUP	60

REAR STRUCTURE

1	9L7861	FLYWHEEL HOUSING COVER GROUP	66
1	9N529	FLYWHEEL HOUSING GROUP	65
1	4N8850	FLYWHEEL GROUP	62

LOWER STRUCTURE

1	9N142	OIL LEVEL GAUGE GROUP	68
1	9N565	OIL PAN GROUP	67

LUBRICATION SYSTEM

2	9L9200	OIL FILTER ASSEMBLY	70
1	9N550	OIL LINES GROUP	71
1	9N541	OIL PUMP GROUP	70

6N2895 ENGINE ARRANGEMENT-Part 1 of 2
Provides 210 BHP without fan at 2800 R.P.M. full load
NOTE WHEN ORDERING PARTS GIVE ARRANGEMENT NUMBER
AND SERIAL NUMBER

CONSISTS OF: PAGE

COOLING SYSTEM

1	9N521	OIL COOLER GROUP	73
1	6N466	WATER LINES GROUP	75
1	9N140	WATER PUMP GROUP	78

INTAKE AND EXHAUST SYSTEM

1	3N2915	AIR CLEANER ADAPTER GROUP	91
1	4N5867	EXHAUST ELBOW GROUP	90
1	4N5875	EXHAUST MANIFOLD GROUP	87
1	9N555	INLET MANIFOLD GROUP	89
1	9N735	POSITIVE CRANKCASE VENTILATION VALVE GROUP	93

FUEL SYSTEM AND GOVERNOR

1	9L6743	GOVERNOR CONTROL GROUP	113
1	9N740	GOVERNOR AND FUEL PUMP DRIVE GROUP	94
1	9L6925	FUEL SYSTEM FASTENER GROUP	118
1	4N5868	FUEL FILTER GROUP	117
1	9N435	FUEL FILTER LINES GROUP	116
1	9N119	FUEL INJECTION LINES GROUP	115
1	4N3287	FUEL PRIMING PUMP GROUP	117
1	9N1351	GOVERNOR AND FUEL INJECTION PUMP GROUP	94

ELECTRICAL SYSTEM

1	2N3538	ELECTRIC STARTING MOTOR GROUP	119

MISCELLANEOUS

1	4N9614	FAN BELT DRIVE GROUP	81
1	4N9613	NAME PLATES AND TRANSFERS	157
1	9L895	VEE BELT SET--FAN DRIVE	
1	2N4989	STRAP--ALTERNATOR ADJUSTING	
1	3N2444	FAN SPIDER ASSEMBLY	
1	4N6776	SUPPORT--ALTERNATOR	

NOTE: SERIAL NUMBER PLATE IS LOCATED ON R.H. SIDE OF CYLINDER BLOCK

6N2895 ENGINE ARRANGEMENT-Part 2 of 2
Provides 210 BHP without fan at 2800 R.P.M. full load
NOTE: WHEN ORDERING PARTS GIVE ARRANGEMENT NUMBER AND SERIAL NUMBER

CONSISTS OF:			PAGE
CENTRAL STRUCTURE			
1	9N130	CYLINDER BLOCK GROUP	46
1	9N728	CAMSHAFT GROUP	54
1	9L6065	CYLINDER BLOCK COVER GROUP	47
1	9N315	CRANKSHAFT GROUP	50
8	9N150	CONNECTING ROD AND PISTON GROUP	54
1	9N542	CRANKSHAFT SEAL GROUP	51
UPPER STRUCTURE			
1	9N730	VALVE MECHANISM COVER GROUP	56
1	9N1105	CYLINDER HEAD GROUP	55
2	9N191	LIFTING GROUP	58
1	9N487	VALVE MECHANISM GROUP	56
FRONT STRUCTURE			
1	9N560	FRONT HOUSING COVER GROUP	60
1	9N787	PULLEY AND DAMPER GROUP	53
1	9N1080	FRONT HOUSING GROUP	59
1	4N5487	SUPPORT GROUP	60
REAR STRUCTURE			
1	9L7861	FLYWHEEL HOUSING COVER GROUP	66
1	9N529	FLYWHEEL HOUSING GROUP	65
1	4N8850	FLYWHEEL GROUP	62
LOWER STRUCTURE			
1	9N142	OIL LEVEL GAUGE GROUP	68
1	9N565	OIL PAN GROUP	67
LUBRICATION SYSTEM			
2	9L9200	OIL FILTER ASSEMBLY	70
1	9N550	OIL LINES GROUP	71
1	9N541	OIL PUMP GROUP	70

6N2896 ENGINE ARRANGEMENT-Part 1 of 2
Provides 144 BHP without fan at 2330 R.P.M. full load
NOTE: WHEN ORDERING PARTS GIVE ARRANGEMENT NUMBER AND SERIAL NUMBER

CONSISTS OF:			PAGE
COOLING SYSTEM			
1	9N521	OIL COOLER GROUP	73
1	6N466	WATER LINES GROUP	75
1	9N140	WATER PUMP GROUP	78
INTAKE AND EXHAUST SYSTEM			
1	3N2915	AIR CLEANER ADAPTER GROUP	91
1	4N5867	EXHAUST ELBOW GROUP	90
1	4N5875	EXHAUST MANIFOLD GROUP	87
1	9N555	INLET MANIFOLD GROUP	89
1	9N735	POSITIVE CRANKCASE VENTILATION VALVE GROUP	93
FUEL SYSTEM AND GOVERNOR			
1	9L6743	GOVERNOR CONTROL GROUP	113
1	9N740	GOVERNOR AND FUEL PUMP DRIVE GROUP	94
1	9L6925	FUEL SYSTEM FASTENER GROUP	118
1	4N5868	FUEL FILTER GROUP	117
1	9N435	FUEL FILTER LINES GROUP	116
1	9NI119	FUEL INJECTION LINES GROUP	115
1	4N3287	FUEL PRIMING PUMP GROUP	117
1	6N1865	GOVERNOR AND FUEL INJECTION PUMP GROUP	96
ELECTRICAL SYSTEM			
1	2N3538	ELECTRIC STARTING MOTOR GROUP	119
MISCELLANEOUS			
1	6N471	NAME PLATES AND TRANSFERS	156
1	3N2445	SUCTION FAN GROUP	83

NOTE: SERIAL NUMBER PLATE IS LOCATED ON R.H. SIDE OF CYLINDER BLOCK

6N2896 ENGINE ARRANGEMENT-Part 2 of 2
Provides 144 HP without fan at 2330 R.P.M. full load
NOTE: WHEN ORDERING PARTS GIVE ARRANGEMENT NUMBER AND SERIAL NUMBER

CONSISTS OF: PAGE

CENTRAL STRUCTURE

1	9N130	CYLINDER BLOCK GROUP	46
1	9N728	CAMSHAFT GROUP	54
1	9L6065	CYLINDER BLOCK COVER GROUP	47
1	9N315	CRANKSHAFT GROUP	50
8	9N150	CONNECTING ROOD AND PISTON GROUP	54
1	9N542	CRANKSHAFT SEAL GROUP	51

UPPER STRUCTURE

1	9N730	VALVE MECHANISM COVER GROUP	56
1	9N1105	CYLINDER HEAD GROUP	55
1	9N191	LIFTING GROUP--R.H. SIDE	58
1	9N210	LIFTING GROUP--L.H. SIDE	58
1	9N487	VALVE MECHANISM GROUP	56

FRONT STRUCTURE

1	9N560	FRONT HOUSING COVER GROUP	60
1	gN787	PULLEY AND DAMPER GROUP	53
1	9N1080	FRONT HOUSING GROUP	59
1	6N464	SUPPORT GROUP 61	61

REAR STRUCTURE

1	9L7861	FLYWHEEL HOUSING COVER GROUP	66
1	9N529	FLYWHEEL HOUSING GROUP	65
1	4N4854	FLYWHEEL GROUP	63

LOWER STRUCTURE

1	9N142	OIL LEVEL GAUGE GROUP	68
1	9N565	OIL PAN GROUP	67

LUBRICATION SYSTEM

2	9L9200	OIL FILTER ASSEMBLY	70
1	9N550	OIL LINES GROUP	71
1	9N541	OIL PUMP GROUP	70

6N2898 ENGINE ARRANGEMENT--Part 1 of 2.
Provides 175 BHP without fan at 2800 R.P.M. full load
NOTE: WHEN ORDERING PARTS GIVE ARRANGEMENT NUMBER AND SERIAL NUMBER

		CONSISTS OF:	PAGE
COOLING SYSTEM			
1	9N521	OIL COOLER GROUP	73
1	6N465	WATER LINES GROUP	76
1	9N140	WATER PUMP GROUP	78
INTAKE AND EXHAUST SYSTEM			
1	9N535	EXHAUST MANIFOLD GROUP	88
1	9N555	INLET MANIFOLD GROUP	89
1	9N735	POSITIVE CRANKCASE VENTILATION VALVE GROUP	93
1	3N2915	AIR CLEANER ADAPTER GROUP	91
FUEL SYSTEM AND GOVERNOR			
1	9L6743	GOVERNOR CONTROL GROUP	113
1	9N740	GOVERNOR AND FUEL PUMP DRIVE GROUP	94
1	91L6925	FUEL SYSTEM FASTENER GROUP	118
1	4N5868	FUEL FILTER GROUP	117
1	9N435	FUEL FILTER LINES GROUP	116
1	9N119	FUEL INJECTION LINES GROUP	115
1	4N3287	FUEL PRIMING PUMP GROUP	117
1	9N1352	GOVERNOR AND FUEL INJECTION PUMP GROUP	96
MISCELLANEOUS			
1	6N1203	NAME PLATES AND TRANSFERS	157
1	2N2458	SUCTION FAN GROUP	85

NOTE: SERIAL NUMBER PLATE IS LOCATED ON R.H. SIDE OF CYLINDER BLOCK

6N2898 ENGINE ARRANGEMENT-Part 2 of 2
Provides 175 BHP without fan at 2800 R.P.M. full load
NOTE: WHEN ORDERING PARTS GIVE ARRANGEMENT NUMBER AND SERIAL NUMBER

CONSISTS OF: PAGE

CENTRAL STRUCTURE

1	9N130	CYLINDER BLOCK GROUP	46
1	9N728	CAMSHAFT GROUP	54
1	9L6065	CYLINDER BLOCK COVER GROUP	47
1	9N315	CRANKSHAFT GROUP	50
8	9N150	CONNECTING ROD AND PISTON GROUP	54
1	9N542	CRANKSHAFT SEAL GROUP	51

UPPER STRUCTURE

1	9N730	VALVE MECHANISM COVER GROUP	56
1	9N1105	CYLINDER HEAD GROUP	55
1	9N191	LIFTING GROUP--R.H. SIDE	58
1	9N210	LIFTING GROUP--L.H. SIDE	58
1	9N487	VALVE MECHANISM GROUP	56

FRONT STRUCTURE

1	9N560	FRONT HOUSING COVER GROUP	60
1	9N787	PULLEY AND DAMPER GROUP	53
1	9N1080	FRONT HOUSING GROUP	59
1	4N5487	SUPPORT GROUP	60

REAR STRUCTURE

1	4N5866	FLYWHEEL HOUSING COVER GROUP	66
1	4N5870	FLYWHEEL HOUSING GROUP	64
1	4N8852	FLYWHEEL GROUP	62

LOWER STRUCTURE

1	4N8855	OIL LEVEL GAUGE GROUP	69
1	418853	OIL PAN GROUP	67

LUBRICATION SYSTEM

2	9L9200	OIL FILTER ASSEMBLY	70
1	41N8854	OIL LINES GROUP	72
1	9N541	OIL PUMP GROUP	70

6N2899 ENGINE ARRANGEMENT-Part 1 of 2
Provides 185 BHP without fan at 2800 R.P.M. full load
NOTE: WHEN ORDERING PARTS GIVE ARRANGEMENT NUMBER AND SERIAL NUMBER

CONSISTS OF: PAGE

COOLING SYSTEM

1	9N521	OIL COOLER GROUP	73
1	4N8856	WATER LINES GROUP	77
1	9N140	WATER PUMP GROUP.	78

INTAKE AND EXHAUST SYSTEM

1	3N2915	AIR CLEANER ADAPTER GROUP	91
1	9N535	EXHAUST MAN I FOLD GROUP	88
1	9N555	INLET MANIFOLD GROUP	89
1	9N735	POSITIVE CRANKCASE VENTILATION VALVE GROUP	93

FUEL SYSTEM AND GOVERNOR

1	9L6743	GOVERNOR CONTROL GROUP	113
1	9N740	GOVERNOR AND FUEL PUMP DRIVE GROUP	94
1	9L6925	FUEL SYSTEM FASTENER GROUP	118
1	4N5868	FUEL FILTER GROUP	117
1	9N435	FUEL FILTER LINES GROUP	116
1	9N119	FUEL INJECTION LINES GROUP	115
1	4N3287	FUEL PRIMING PUMP GROUP	117
1	6N3563	GOVERNOR AND FUEL INJECTION PUMP GROUP	98

MISCELLANEOUS

1	4N8943	NAME PLATES AND TRANSFERS	158

NOTE: SERIAL NUMBER PLATE IS LOCATED ON R.H. SIDE OF CYLINDER BLOCK

6N2899 ENGINE ARRANGEMENT-Part 2 of 2
Prove 185 BHP without fan 2800 R.P.M. full load
NOTE: WHEN ORDERING PART GIVE ARRANGEMENT NUMBER AND SE *RI*AL NUMBER

CONSISTS OF: PAGE

CENTRAL STRUCTURE
1 9N130 CYLINDER BLOCK GROUP 46
1 9N728 CAMSHAFT GROUP 54
1 9L6065 CYLINDER BLOCK COVER GROUP 47
1 9N310 CRANKSHAFT GROUP 49
8 9N150 CONNECTING ROD AND PISTON GROUP 54
1 9N542 CRANKSHAFT SEAL GROUP..... 51

UPPER STRUCTURE
1 9N730 VALVE MECHANISM COVER GROUP 56
1 9N1105 CYLINDER HEAD GROUP 55
1 9N191 LIFTING GROUP--R.H. SIDE 58
1 9N210 LIFTING GROUP--L.H. SIDE 58
1 9N487 VALVE MECHANISM GROUP 56

FRONT STRUCTURE
1 9N560 FRONT HOUSING COVER GROUP..... 60
1 9N787 PULLEY AND DAMPER GROUP 53
1 9N1080 FRONT HOUSING GROUP 59
1 4N5487 SUPPORT GROUP 60

REAR STRUCTURE
1 4N5866 FLYWHEEL HOUSING COVER GROUP 66
1 4N5870 FLYWHEEL HOUSING GROUP 64
1 4N8852 FLYWHEEL GROUP 62

LOWER STRUCTURE
1 4N8855 OIL LEVEL GAUGE GROUP 69
1 4N8853 OIL PAN GROUP..... 67

LUBRICATION SYSTEM
2 9L9200 OIL FILTER ASSEMBLY 70
1 4N8854 OIL LINES GROUP 72
1 9N541 OIL PUMP GROUP 70

6N2900 ENGINE ARRANGEMENT-Part 1 of 2
Provides 210 BHP without fan at 2800 R.P.M. full load
NOTE WHEN ORDERING PARTS GIVE ARRANGEMENT NUMBER AND SERIAL NUMBER

CONSISTS OF:			PAGE
COOLING SYSTEM			
1	9N521	OIL COOLER GROUP	73
1	4N8856	WATER LINES GROUP	77
1	9N140	WATER PUMP GROUP	78
INTAKE AND EXHAUST SYSTEM			
1	3N2915	AIR CLEANER ADAPTER GROUP	91
1	9N535	EXHAUST MANIFOLD GROUP	88
1	9N555	INLET MANIFOLD GROUP	89
1	9N735	POSITIVE CRANKCASE VENTILATION VALVE GROUP	93
FUEL SYSTEM AND GOVERNOR			
1	9L6743	GOVERNOR CONTROL GROUP	113
1	9N740	GOVERNOR AND FUEL PUMP DRIVE GROUP	94
1	9L6925	FUEL SYSTEM FASTENER GROUP	118
1	4N5868	FUEL FILTER GROUP	117
1	9N435	FUEL FILTER LINES GROUP	116
1	9N119	FUEL INJECTION LINES GROUP	115
1	4N3287	FUEL PRIMING PUMP GROUP	117
1	9N1351	GOVERNOR AND FUEL INJECTION PUMP GROUP	94
MISCELLANEOUS			
1	4N8943	NAME PLATES AND TRANSFERS	158

NOTE: SERIAL NUMBER PLATE IS LOCATED ON R.H. SIDE OF CYLINDER BLOCK

N2900 ENGINE ARRANGEMENT--Part 2 of 2
Provides 210 BHP without fan 2800 R.P.M. full load
NOTE: WHEN ORDERING PARTS GIVE ARRANGEMENT NUMBER AND SERIAL NUMBER

CONSISTS OF: PAGE

CENTRAL STRUCTURE

1	9N130	CYLINDER BLOCK GROUP	46
1	9N728	CAMSHAFT GROUP	54
1	9L6065	CYLINDER BLOCK COVER GROUP	47
1	9N315	CRANKSHAFT GROUP	50
8	9N150	CONNECTING ROD AND PISTON GROUP	54
1	9N542	CRANKSHAFT SEAL GROUP	51

UPPER STRUCTURE

1	9N730	VALVE MECHANISM COVER GROUP	56
1	9N1105	CYLINDER HEAD GROUP	55
1	9N191	LIFTING GROUP--R.H. SIDE	58
1	9N210	LIFTING GROUP--L, H. SIDE	58
1	9N487	VALVE MECHANISM GROUP	56

FRONT STRUCTURE

1	9N560	FRONT HOUSING COVER GROUP	60
1	9N787	PULLEY AND DAMPER GROUP	53
1	9N1080	FRONT HOUSING GROUP	59
1	4N5487	SUPPORT GROUP	60

REAR STRUCTURE

1	9L7861	FLYWHEEL HOUSING COVER GROUP	66
1	9N529	FLYWHEEL HOUSING GROUP	65
1	9L6920	FLYWHEEL GROUP	63

LOWER STRUCTURE

1	4N8855	OIL LEVEL GAUGE GROUP	69
1	4N8853	OIL PAN GROUP	67

LUBRICATION SYSTEM

2	9L9200	OIL FILTER ASSEMBLY	70
1	4N8854	OIL LINES GROUP	72
1	9N541	OIL PUMP GROUP	70

6N2801 ENGINE ARRANGEMENT-Part 1 of 2
Provides 185 BHP without fan at 2800 R.P.M. full load
NOTE: WHEN ORDERING PARTS GIVE ARRANGEMENT NUMBER AND SERIAL NUMBER

CONSISTS OF: PAGE

COOLING SYSTEM

1	9N521	OIL COOLER GROUP	73
1	6N466	WATER LINES GROUP	75
1	9N140	WATER PUMP GROUP	78

INTAKE AND EXHAUST SYSTEM

1	3N2915	AIR CLEANER ADAPTER GROUP	91
1	4N5875	EXHAUST MANIFOLD GROUP	87
1	9N555	INLET MANIFOLD GROUP	89
1	9N735	POSITIVE CRANKCASE VENTILATION VALVE GROUP	93

FUEL SYSTEM AND GOVERNOR

1	9L6743	GOVERNOR CONTROL GROUP	113
1	9N740	GOVERNOR AND FUEL PUMP DRIVE GROUP	94
1	9L6925	FUEL SYSTEM FASTENER GROUP	118
1	4N5868	FUEL FILTER GROUP	117
1	9N435	FUEL FILTER LINES GROUP	116
1	9N119	FUEL INJECTION LINES GROUP	115
1	4N3287	FUEL PRIMING PUMP GROUP	17
1	4N9231	GOVERNOR AND FUEL INJECTION PUMP GROUP	97

ELECTRICAL SYSTEM

1	N3538	ELECTRIC STARTING MOTOR GROUP	119

MISCELLANEOUS

1	6N471	NAME PLATES AND TRANSFERS	156
1	4N7979	PULLEY ASSEMBLY	81
1	584274	BOLT	
2	9M6878	GASKET	
1	1N9400	PLATE	
1	2N2363	FAN SPIDER ASSEMBLY	
2	4N6661	PLATE	

NOTE: SERIAL NUMBER PLATE IS LOCATED ON R.H. SIDE OF CYLINDER BLOCK

6N2901 ENGINE ARRANGEMENT-Part 2 of 2
Provides 185 HP without fan 2800 R.P.M. full load
NOTE: WHEN ORDERING PART GIVE ARRANGEMENT NUMBER AND SERIAL NUMBER

CONSISTS OF:			PAGE
CENTRAL STRUCTURE			
1	9N130	CYLINDER BLOCK GROUP	46
1	9N728	CAMSHAFT GROUP	54
1	9L6065	CYLINDER BLOCK COVER GROUP	47
1	9N310	CRANKSHAFT GROUP	49
8	9N150	CONNECTING ROD AND PISTON GROUP	54
1	9N542	CRANKSHAFT SEAL GROUP	51
UPPER STRUCTURE			
1	9N730	VALVE MECHANISM COVER GROUP	56
1	9N1105	CYLINDER HEAD GROUP	55
1	9N191	LIFTING GROUP--R.H. SIDE	58
1	9N210	LIFTING GROUP--L.H. SIDE	58
1	9N487	VALVE MECHANISM GROUP	56
FRONT STRUCTURE			
1	9N560	FRONT HOUSING COVER GROUP	60
1	9N787	PULLEY AND DAMPER GROUP	53
1	9N1080	FRONT HOUSING GROUP	59
1	4N5487	SUPPORT GROUP	60
REAR STRUCTURE			
1	9L7861	FLYWHEEL HOUSING COVER GROUP	66
1	9N529	FLYWHEEL HOUSING GROUP	65
1	9L6920	FLYWHEEL GROUP	63
LOWER STRUCTURE			
1	AN8855	OIL LEVEL GAUGE GROUP	69
1	4N8853	OIL PAN GROUP	67
LUBRICATION SYSTEM			
2	9L9200	OIL FILTER ASSEMBLY	70
1	4N8854	OIL LINES GROUP	72
1	9N541	OIL PUMP GROUP	70

5N2902 ENGINE ARRANGEMENT-Part 1 of 2
Provides 210 BHP without fan at 2800 R.P.M. full load
NOTE: WHEN ORDERING PARTS GIVE ARRANGEMENT NUMBER AND SERIAL NUMBER

	CONSISTS OF:		PAGE
COOLING SYSTEM			
1	9N521	OIL COOLER GROUP	73
1	6N466	WATER LINES GROUP	75
1	9N140	WATER PUMP GROUP	78
INTAKE AND EXHAUST SYSTEM			
1	3N2915	AIR CLEANER ADAPTER GROUP	91
1	4N5875	EXHAUST MAN[FOLD GROUP	87
1	9N555	INLET MANIFOLD GROUP	89
1	9N735	POSITIVE CRANKCASE VENTILATION VALVE GROUP	93
FUEL SYSTEM AND GOVERNOR			
1	9L6743	GOVERNOR CONTROL GROUP	113
1	9N740	GOVERNOR AND FUEL PUMP DRIVE GROUP	94
1	9L6925	FUEL SYSTEM FASTENER GROUP	118
1	4N5868	FUEL FILTER GROUP	117
1	9N435	FUEL FILTER LINES GROUP	116
1	9N119	FUEL INJECTION **LI**NES GROUP	115
1	4N3287	FUEL PRIMING PUMP GROUP	117
1	9N1351	GOVERNOR AND FUEL INJECTION PUMP GROUP	94
ELECTRICAL SYSTEM			
1	2N3538	ELECTRIC STARTING MOTOR GROUP	119
MISCELLANEOUS			
1	6N471	NAME PLATES AND TRANSFERS	156
1	4N7979	PULLEY ASSEMBLY	81
1	5B4274	BOLT	
2	9M6878	GASKET	
1	N9400	PLATE	
1	2N2363	FAN SPIDER ASSEMBLY	
2	4N6661	PLATE	

NOTE: SERIAL NUMBER PLATE IS LOCATED
ON R.H. SIDE OF CYLINDER BLOCK

6N2902 ENGNE ARRANGEMENT-Part 2 of 2
Provides 210 BHP without fan 2800 R.P.M. full load
NOTE: WHEN ORDERING PARTS GIVE ARRANGEMENT NUMBER AND SERIAL NUMBER

CONSISTS OF:			PAGE
CENTRAL STRUCTURE			
1	9N130	CYLINDER BLOCK GROUP	46
1	9N728	CAMSHAFT GROUP	54
1	9L6065	CYLINDER BLOCK COVER GROUP	47
1	9N315	CRANKSHAFT GROUP	50
9	9N150	CONNECTING ROD AND PISTON GROUP,	54
1	9N542	CRANKSHAFT SEAL GROUP	51
1	9L6560	CYLINDER BLOCK PANEL GROUP	48
UPPER STRUCTURE			
1	9L6978	VALVE MECHANISM COVER GROUP	57
1	9N1105	CYLINDER HEAD GROUP	55
2	9N191	LIFTING GROUP	58
1	9N487	VALVE MECHANISM GROUP	56
FRONT STRUCTURE			
1	9N560	FRONT HOUSING COVER GROUP	60
1	9N787	PULLEY AND DAMPER GROUP	53
1	9N1080	FRONT HOUSING GROUP	59
1	4N5487	SUPPORT GROUP	60
REAR STRUCTURE			
1	4N5866	FLYWHEEL HOUSING COVER GROUP	66
1	4N5870	FLYWHEEL HOUSING GROUP	64
1	9N399	CRANKSHAFT COVER GROUP	51
LOWER STRUCTURE			
1	4N7720	0IL LEVEL GAUGE GROUP	69
1	9N565	OIL PAN GROUP	67
LUBRICATION SYSTEM			
2	9L9200	OIL FILTER ASSEMBLY	70
1	9N550	OIL LINES GROUP	71
1	9N541	OIL PUMP GROUP	70

6N2903 ENGINE ARRANGEMENT-Part 1 of 2
Provides 37 BHP without fan at 2800 R.P.M. full load
NOTE: WHEN ORDERNG PARTS GIVE ARRANGEMENT NUMBER AND SERAL NUMBER

	CONSISTS OF:		PAGE
COOLING SYSTEM			
1	9N729	OIL COOLER GROUP	73
1	9N733	WATER LINES GROUP	74
1	9N140	WATER PUMP GROUP	78
INTAKE AND EXHAUST SYSTEM			
1	3N2915	AIR CLEANER ADAPTER GROUP	91
1	4N5867	EXHAUST ELBOW GROUP	90
1	4N5875	EXHAUST MANIFOLD GROUP	87
1	9N555	INLET MANIFOLD GROUP	89
1	9N735	POSITIVE CRANKCASE VENTILATION VALVE GROUP	93
FUEL SYSTEM AND GOVERNOR			
1	9L6743	GOVERNOR CONTROL GROUP	113
1	9N740	GOVERNOR AND FUEL PUMP DRIVE GROUP	94
1	9L6925	FUEL SYSTEM FASTENER GROUP	118
1	4N15868	FUEL FILTER GROUP	117
1	9N435	FUEL FILTER LINES GROUP	116
1	9N119	FUEL INJECTION LINES GROUP	115
1	4N3287	FUEL PRIMING PUMP GROUP	117
1	4N9227	GOVERNOR AND FUEL INJECTION PUMP GROUP	97
ELECTRICAL SYSTEM			
1	2N9305	ELECTRIC STARTING MOTOR GROUP	119
MISCELLANEOUS			
1	6N471	NAME PLATES AND TRANSFERS	156

NOTE: SERIAL NUMBER PLATE IS LOCATED ON R.H. SIDE OF CYLINDER BLOCK

6N2903 ENGINE ARRANGEMENT-Part 2 of 2
Provides 137 BHP without fan at 2800 R.P.M. full load
NOTE: WHEN ORDERING PARTS GIVE ARRANGEMENT NUMBER AND SERIAL NUMBER

	CONSISTS OF:		PAGE
CENTRAL STRUCTURE			
1	9N130	CYLINDER BLOCK GROUP	46
1	9N728	CAMSHAFT GROUP	54
1	9L6065	CYLINDER BLOCK COVER GROUP	47
1	9N315	CRANKSHAFT GROUP	50
8	9N150	CONNECTING ROD AND PISTON GROUP	54
1	9N542	CRANKSHAFT SEAL GROUP	51
1	9L6560	CYLINDER BLOCK PANEL GROUP	48
UPPER STRUCTURE			
1	9L6978	VALVE MECHANISM COVER GROUP	57
1	9N1105	CYLINDER HEAD GROUP	55
2	9N191	LIFTING GROUP	58
1	9N487	VALVE MECHANISM GROUP	56
FRONT STRUCTURE			
1	9N560	FRONT HOUSING COVER GROUP	60
1	9N768	PULLEY AND DAMPER GROUP	53
1	9N1080	FRONT HOUSING GROUP	59
1	4N5487	SUPPORT GROUP	60
REAR STRUCTURE			
1	9N399	CRANKSHAFT COVER GROUP	51
1	4N7889	FLYWHEEL HOUSING GROUP	65
LOWER STRUCTURE			
1	4N7720	OIL LEVEL GAUGE GROUP	69
1	9N565	OIL PAN GROUP	67
LUBRICATION SYSTEM			
2	9L9200	OIL FILTER ASSEMBLY	70
1	9N550	OIL LINES GROUP	71
1	9N541	OIL PUMP GROUP	70

6N2904 ENGINE ARRANGEMENT-Pat of 2
Provides 165 BHP without fan at 2400 R.P.M. full load
NOTE: WHEN ORDERING PARTS GIVE ARRANGEMENT NUMBER AND SERIAL NUMBER

	CONSISTS OF:		PAGE
COOLING SYSTEM			
1	9N729	OIL COOLER GROUP	73
1	9N733	WATER LINES GROUP	74
1	9N140	WATER PUMP GROUP	78
INTAKE AND EXHAUST SYSTEM			
1	3N2915	AIR CLEANER ADAPTER GROUP	91
1	4N5875	EXHAUST MANIFOLD GROUP	87
1	9N555	INLET MANIFOLD GROUP	89
1	9N735	POSITIVE CRANKCASE VENTILATION VALVE GROUP	93
FUEL SYSTEM AND GOVERNOR			
1	9L6743	GOVERNOR CONTROL GROUP	113
1	9N740	GOVERNOR AND FUEL PUMP DRIVE GROUP	94
1	9L6925	FUEL SYSTEM FASTENER GROUP	118
1	4N5868	FUEL FILTER GROUP	117
1	9N435	FUEL FILTER LINES GROUP	116
1	9N119	FUEL INJECTION LINES GROUP	115
1	4N3287	FUEL PRIMING PUMP GROUP	117
1	4N9229	GOVERNOR AND FUEL INJECTION PUMP GROUP	98
ELECTRICAL SYSTEM			
1	2N9305	ELECTRIC STARTING MOTOR GROUP	119
MISCELLANEOUS			
1	6N471	NAME PLATES AND TRANSFERS	156

NOTE: SERIAL NUMBER PLATE IS LOCATED
ON R.H. SIDE OF CYLINDER BLOCK

6N2904 ENGINE ARANGEMENT--Par 2 of 2
Provides 16 BHP without fan at **2400 RP.M. full load**
NOTE: WHEN ORDERING PARTS GIVE ARRANGEMENT NUMBER AND SERIAL NUMBER

	CONSISTS OF:		PAGE
CENTRAL STRUCTURE			
1	9N130	CYLINDER BLOCK GROUP	46
1	9N728	CAMSHAFT GROUP	54
1	9L6065	CYLINDER BLOCK COVER GROUP	47
1	9N310	CRANKSHAFT GROUP	49
8	9N150	CONNECTING ROD AND PISTON GROUP	54
1	9N542	CRANKSHAFT SEAL GROUP	51
UPPER STRUCTURE			
1	9N730	VALVE MECHANISM COVER GROUP	56
1	9N1105	CYLINDER HEAD GROUP	55
1	9N191	LIFTING GROUP--R.H. SIDE	58
1	9N210	LIFTING GROUP--L.H. SIDE	58
1	9N487	VALVE MECHANISM GROUP	56
FRONT STRUCTURE			
1	9N560	FRONT HOUSING COVER GROUP	60
1	9N787	PULLEY AND DAMPER GROUP	53
1	N1080	FRONT HOUSING GROUP	59
1	6N464	SUPPORT GROUP	61
REAR STRUCTURE			
1	9L7861	FLYWHEEL HOUSING COVER GROUP	56
1	9N529	FLYWHEEL HOUSING GROUP	65
1	41N4854	FLYWHEEL GROUP	63
LOWER STRUCTURE			
1	9N142	OIL LEVEL GAUGE GROUP	68
1	N9565	OIL PAN GROUP	67
LUBRICATION SYSTEM			
2	9L9200	OIL FILTER ASSEMBLY	70
1	9N550	01L LINES GROUP	71
1	9N541	OIL PUMP GROUP	70

6N3631 ENGINE ARRANGMENT-Part 1 of 2
Provides 210 BHP at 2800 R.P.M. full load
NOTE: WHEN ORDERING PARTS GIVE ARRANGEMENT NUMBER AND SERIAL NUMBER

	CONSISTS OF:		PAGE
COOLING SYSTEM			
1	9N521	OIL COOLER GROUP	73
1	6N465	WATER LINES GROUP	76
1	9N140	WATER PUMP GROUP	78
INTAKE AND EXHAUST SYSTEM			
1	9N535	EXHAUST MANIFOLD GROUP	88
1	9N555	INLET MANIFOLD GROUP	89
1	9N735	POSITIVE CRANKCASE VENTILATION VALVE GROUP	93
1	3N2915	AIR CLEANER ADAPTER GROUP	91
FUEL SYSTEM AND GOVERNOR			
I	9L6743	GOVERNOR CONTROL GROUP	113
1	9N740	GOVERNOR AND FUEL PUMP DRIVE GROUP	94
1	9L6925	FUEL SYSTEM FASTENER GROUP	11
1	4N5868	FUEL FILTER GROUP	117
1	9N435	FUEL FILTER LINES GROUP	116
1	9N119	FUEL INJECTION LINES GROUP	115
1	4N3287	FUEL PRIMING PUMP GROUP	117
1	9N1351	GOVERNOR AND FUEL INJECTION PUMP GROUP	94
MISCELLANEOUS			
1	6N1203	NAME PLATES AND TRANSFERS	157
1	3N2445	SUCTION FAN GROUP	83

NOTE: SERIAL NUMBER PLATE IS LOCATED
ON R,H. SIDE OF CYLINDER BLOCK

6N3631 ENGINE ARRANGEMENT-Part 2 of 2
Provides 210 BHP at 2800 RP.M. full load
NOTE: WHEN ORDERING PARTS GIVE ARRANGEMENT NUMBER AND SERIAL NUMBER

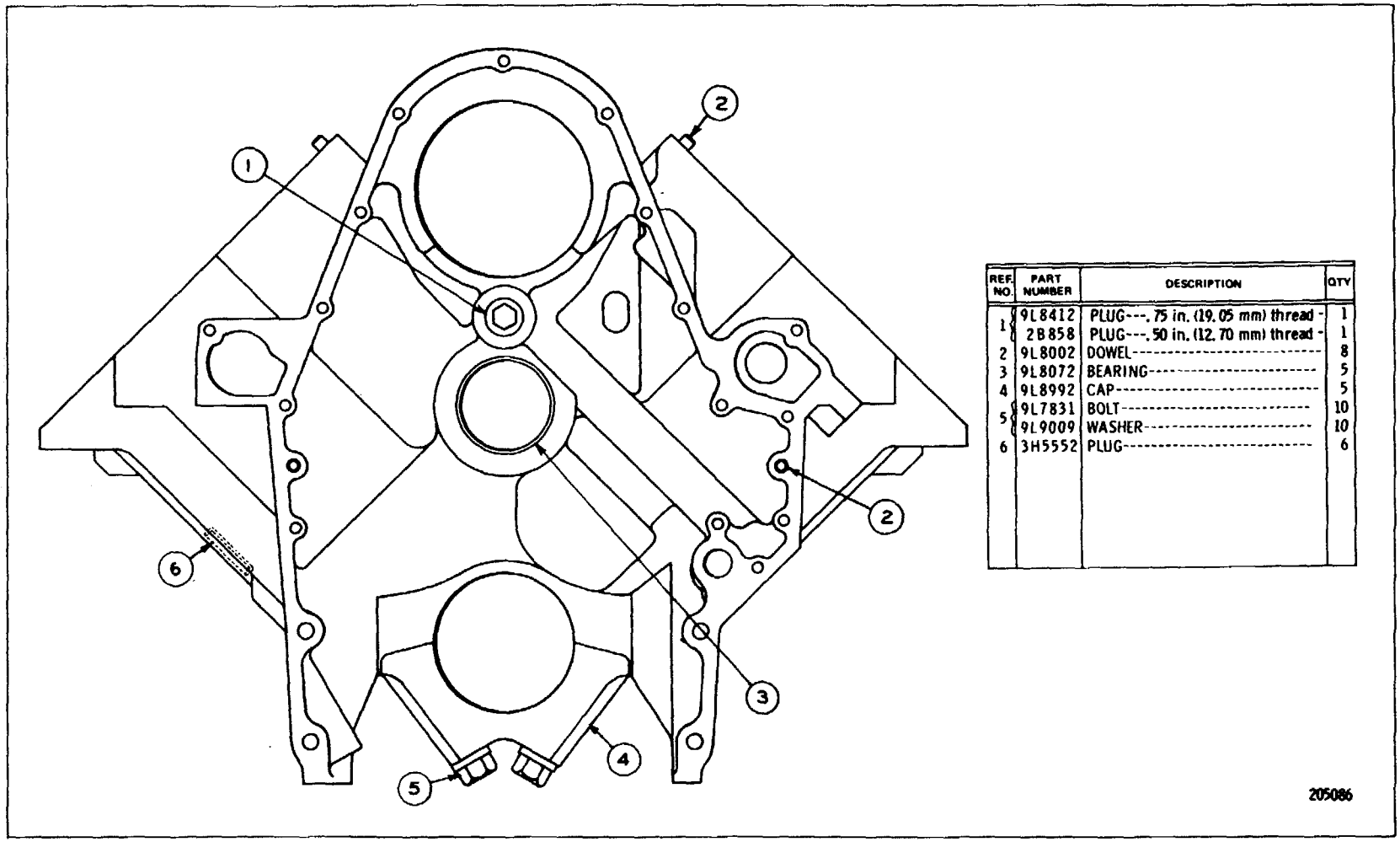
	CONSISTS OF:		PAGE
CENTRAL STRUCTURE			
1	9N130	CYLINDER BLOCK GROUP	46
1	9N728	CAMSHAFT GROUP	54
1	9L6065	CYLINDER BLOCK COVER GROUP	47
1	9N315	CRANKSHAFT GROUP	50
8	9N150	CONNECTING ROD AND PISTON GROUP	54
1	9N542	CRANKSHAFT SEAL GROUP	51
UPPER STRUCTURE			
1	9N730	VALVE MECHANISM COVER GROUP	56
1	9N1105	CYLINDER HEAD GROUP	55
1	9N191	LIFTING GROUP--R.H. SIDE	58
1	9N210	LIFTING GROUP--L.H. SIDE	58
1	9N487	VALVE MECHANISM GROUP	56
FRONT STRUCTURE			
1	9N560	FRONT HOUSING COVER GROUP.	60
1	9N787	PULLEY AND DAMPER GROUP	53
1	9N1080	FRONT HOUSING GROUP	59
1	4N5487	SUPPORT GROUP	60
1	91L7461	CRANKSHAFT PULLEY GROUP	52
REAR STRUCTURE			
1	9L7861	FLYWHEEL HOUSING COVER GROUP	66
1	9N529	FLYWHEEL HOUSING GROUP	65
1	4N8850	FLYWHEEL GROUP	62
LOWER STRUCTURE			
1	4N8930	OIL LEVEL GAUGE GROUP	68
1	9N565	OIL PAN GROUP	67
LUBRICATION SYSTEM			
2	9L9200	OIL FILTER ASSEMBLY	70
1	9N533	OIL LINES GROUP	71
1	9N541	OIL PUMP GROUP	70

6N3740 ENGINE ARRANGEMENT-Part 1 of 2.
Provides 144 BHP without fan at 2330 R.P.M. full load
NOTE: WHEN ORDERING PARTS GIVE ARRANGEMENT NUMBER AND SERIAL NUMBER

	CONSISTS OF:		PAGE
COOLING SYSTEM			
1	9N521	OIL COOLER GROUP	73
1	6N466	WATER LINES GROUP	75
1	9N140	WATER PUMP GROUP	78
INTAKE AND EXHAUST SYSTEM			
1	3N2915	AIR CLEANER ADAPTER GROUP	91
1	4N5875	EXHAUST MANIFOLD GROUP	87
1	9N555	INLET MANIFOLD GROUP	89
1	9N735	POSITIVE CRANKCASE VENTILATION VALVE GROUP	93
1	4N5867	EXHAUST ELBOW GROUP	90
FUEL SYSTEM AND GOVERNOR			
1	9L6743	GOVERNOR CONTROL GROUP	113
1	9N740	GOVERNOR AND FUEL PUMP DRIVE GROUP	94
1	9L6925	FUEL SYSTEM FASTENER GROUP	118
1	4N5868	FUEL FILTER GROUP	117
1	9N435	FUEL FILTER LINES GROUP	116
1	9N119	FUEL INJECTION LINES GROUP	115
1	4N3287	FUEL PRIMING PUMP GROUP	117
1	6N1865	GOVERNOR AND FUEL INJECTION PUMP GROUP	6
ELECTRICAL SYSTEM			
1	6N467	ALTERNATOR GROUP	128
1	2N3538	ELECTRIC STARTING MOTOR GROUP	119
MISCELLANEOUS			
1	6N3741	NAME PLATES AND TRANSFERS	158
1	2N7278	REGULATOR ASSEMBLY--12 VOLT	
1	2N5880	HARNESS ASSEMBLY--REGULATOR	
1	2N8985	BRACKET ASSEMBLY--REGULATOR	
1	2N3909	TACHOMETER DRIVE ADAPTER	

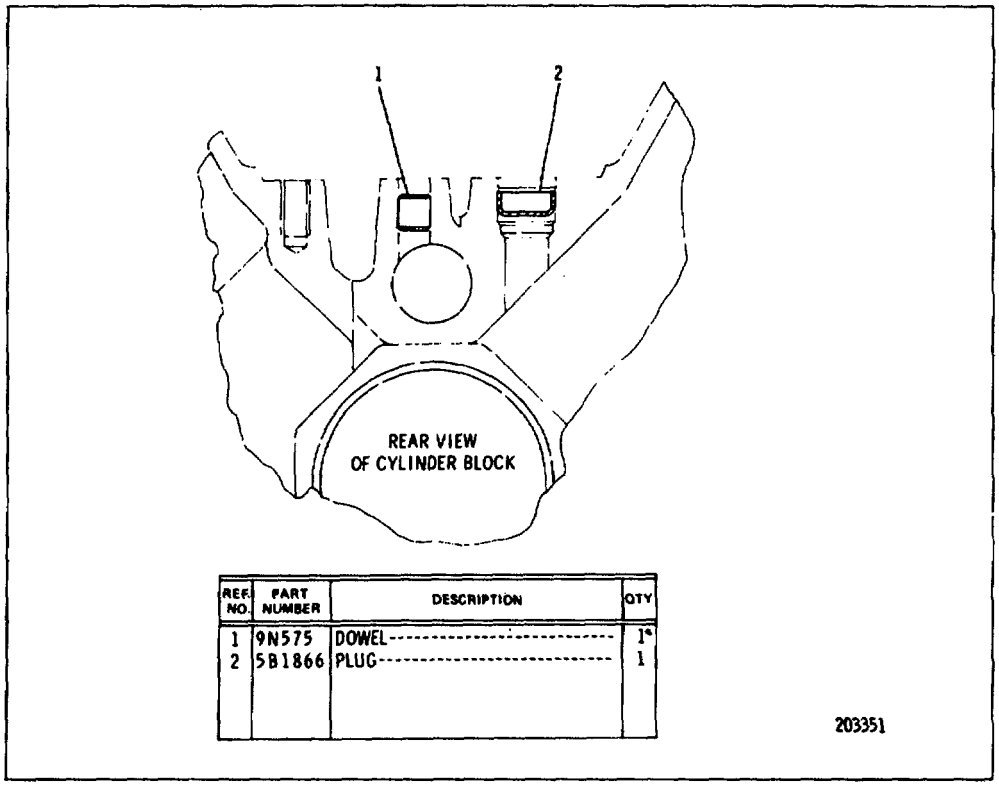
NOTE: SERIAL NUMBER PLATE IS LOCATED
ON R.H. SIDE OF CYLINDER BLOCK

6N3740 ENGNE ARRANGEMENT-Part 2 o 2
Provides 144 HP without f at 2330 R.P.M. full load
NOTE: WHEN ORDERING PARTS GIVE ARRANGEMENT NUMBER AND SERIAL NUMBER



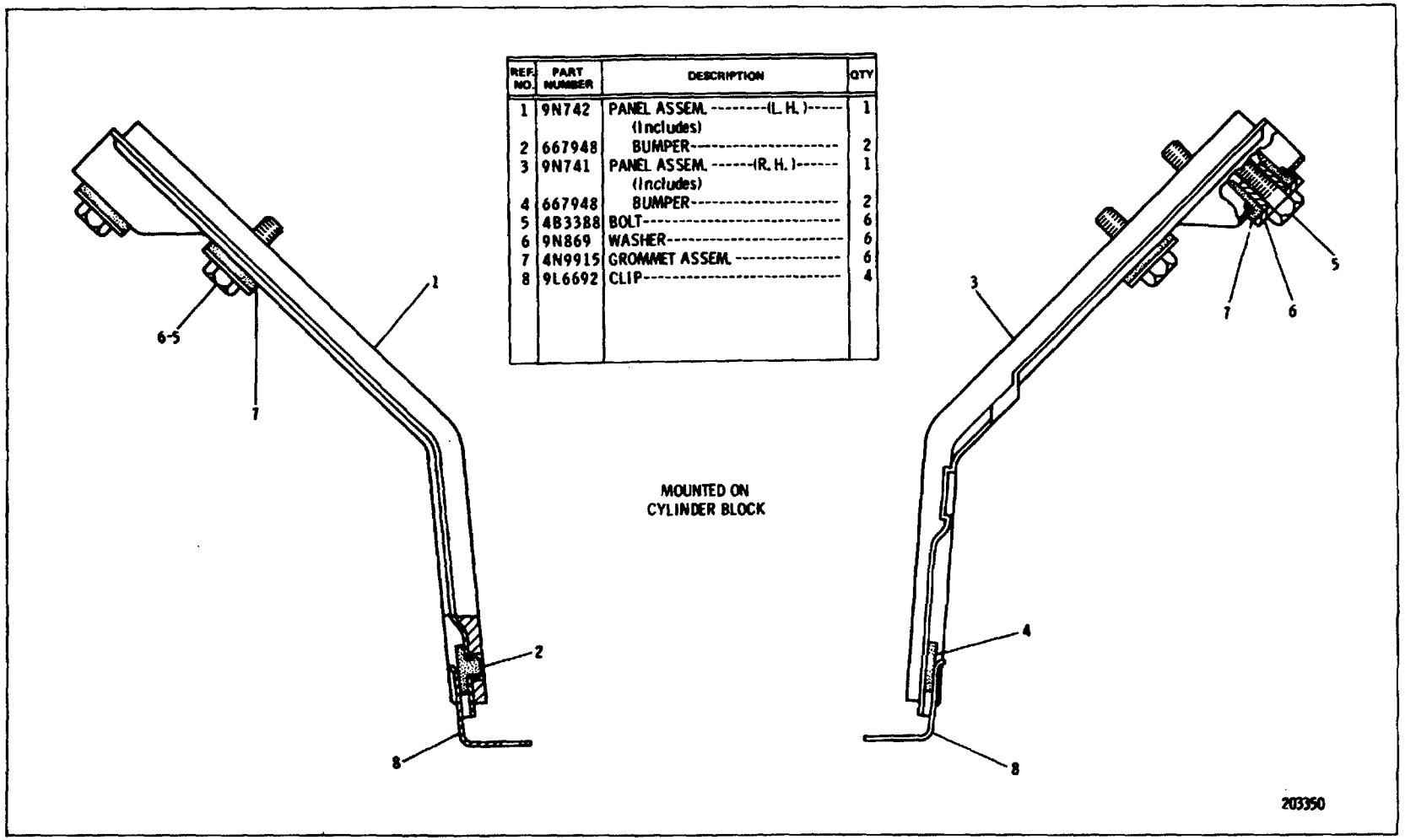
REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	9L8412	PLUG---.75 in. (19.05 mm) thread -	1
	2B858	PLUG---.50 in. (12.70 mm) thread -	1
2	9L8002	DOWEL----------	8
3	9L8072	BEARING----------	5
4	9L8992	CAP----------	5
5	9L7831	BOLT----------	10
	9L9009	WASHER----------	10
6	3H5552	PLUG----------	6

9N130 CYLNDER BLOCK GROUP



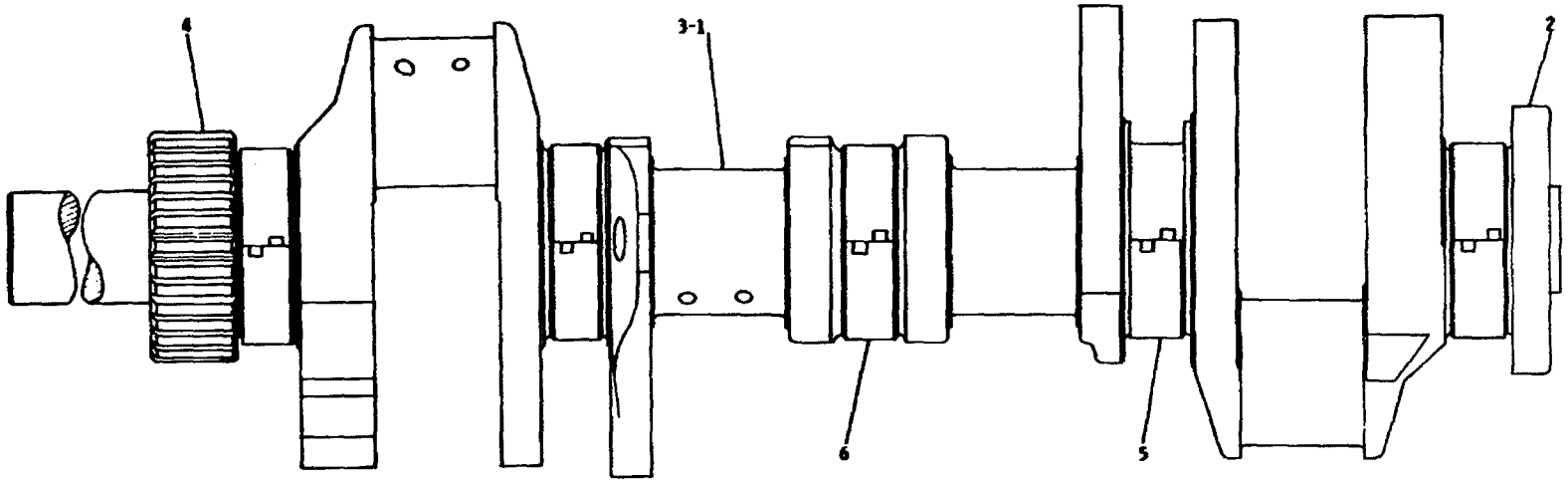
REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	9N575	DOWEL	1*
2	5B1866	PLUG	1

CYLINDER BLOCK COVER (9L6065 N/S)



REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	9N742	PANEL ASSEM. --------(L. H.)----- (Includes)	1
2	667948	BUMPER----------	2
3	9N741	PANEL ASSEM. ------(R. H.)------ (Includes)	1
4	667948	BUMPER----------	2
5	4B3388	BOLT----------	6
6	9N869	WASHER----------	6
7	4N9915	GROMMET ASSEM. ----------	6
8	9L6692	CLIP----------	4

CYUNDER BLOCK PANEL (9L6560 N/S) ALSO AN ATACHMENT



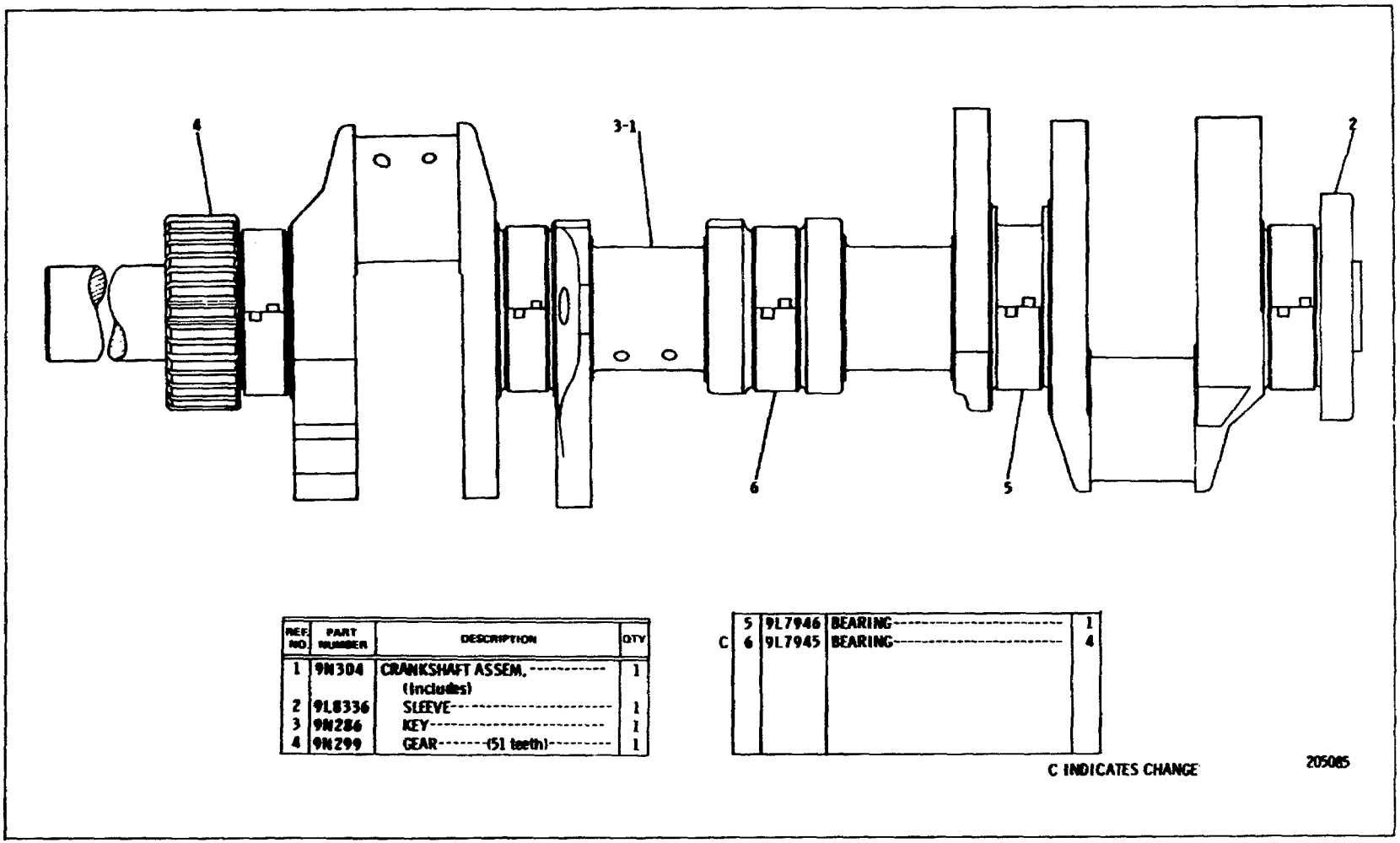
REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	9N304	CRANKSHAFT ASSEM. ---------- (Includes)	1
2	9L8336	SLEEVE----------	1
3	9N286	KEY----------	1
4	9N299	GEAR-------(51 teeth)---------	1

	5	9L7946	BEARING----------	1
C	6	9L7945	BEARING----------	4

C INDICATES CHANGE

205085

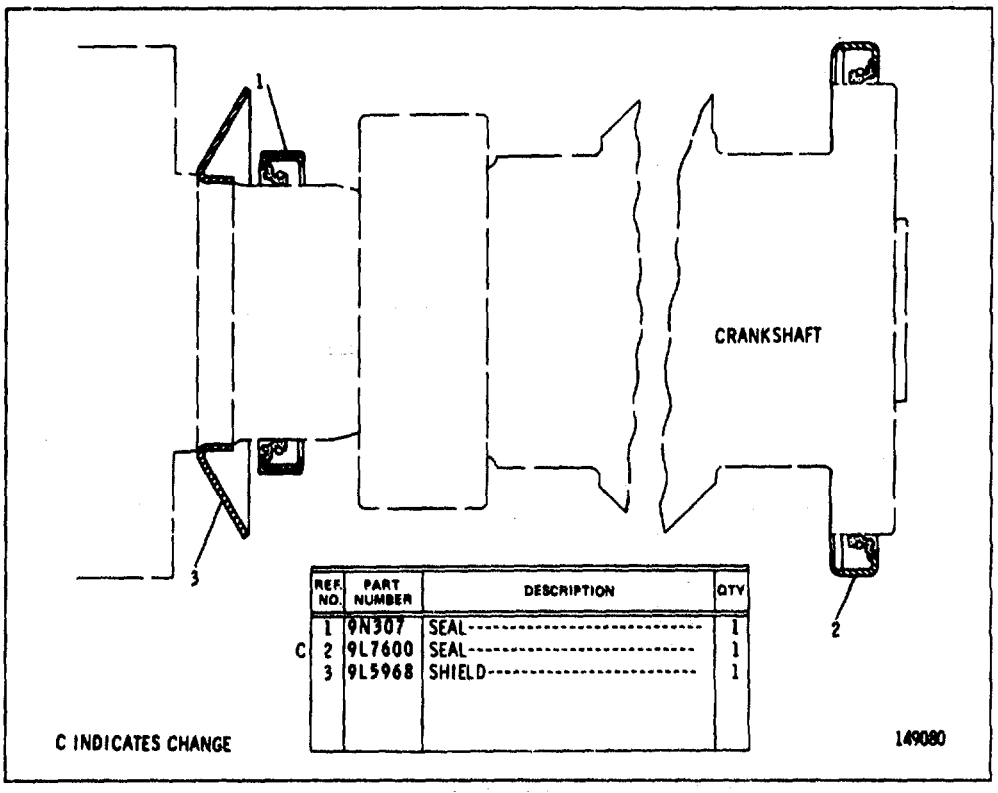
CRANKSHAFT (9N310 N/S)



REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	9N304	CRANKSHAFT ASSEM. (Includes)	1
2	9L8336	SLEEVE	1
3	9N286	KEY	1
4	9N299	GEAR (51 teeth)	1
C 5	9L7946	BEARING	1
C 6	9L7945	BEARING	4

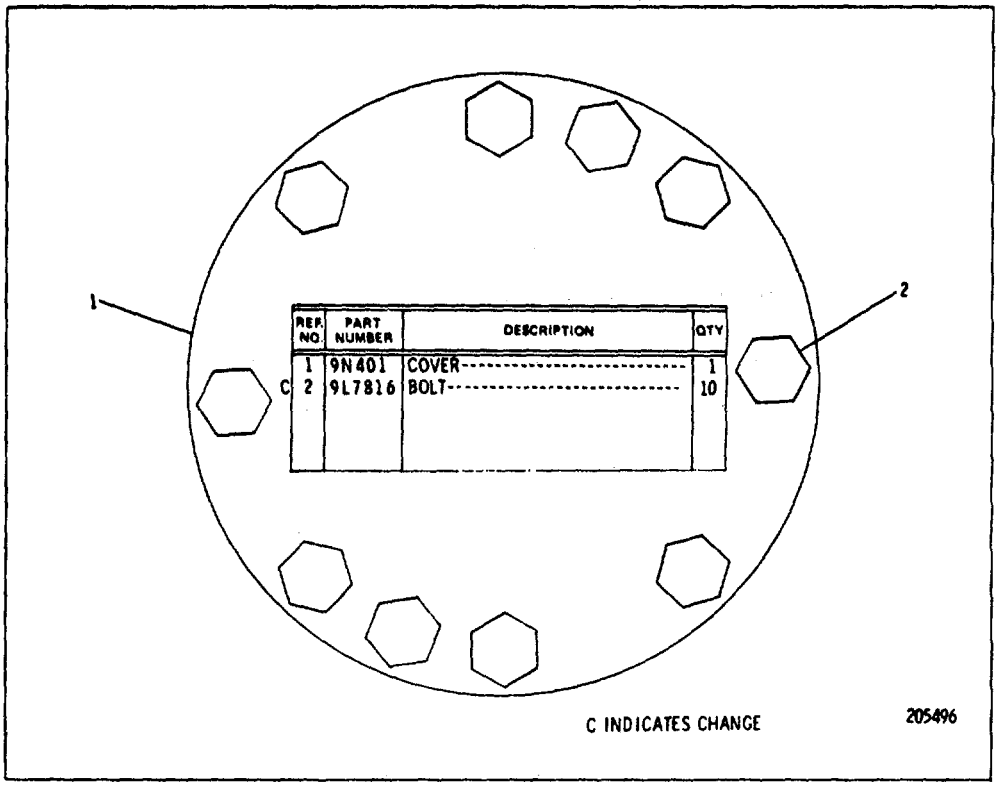
C INDICATES CHANGE

CRANKSHAFT (9N315 N/S)
For Field Replacement of 9N304 Crankshaft Assembly order 1-9N305 Crankshaft Assembly and 2-9L7816 Bolts



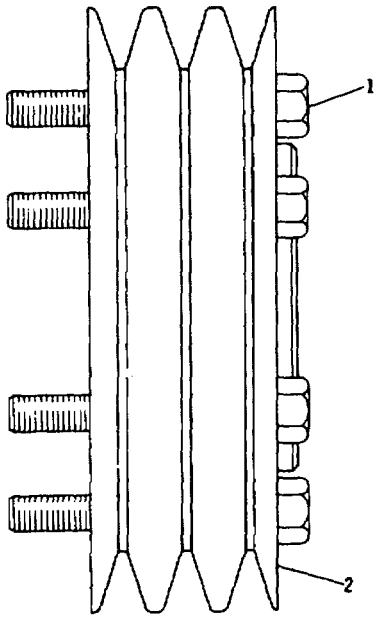
	REF. NO.	PART NUMBER	DESCRIPTION	QTY
	1	9N307	SEAL	1
C	2	9L7600	SEAL	1
	3	9L5968	SHIELD	1

CRANKSHAFT SEAL (9N542 N/S)



	REF. NO.	PART NUMBER	DESCRIPTION	QTY
	1	9N401	COVER	1
C	2	9L7816	BOLT	10

CRANKSHAFT COVER (9N399 N/S)



	REF. NO.	PART NUMBER	DESCRIPTION	QTY
C	1	T573	BOLT----------	6
C	2	9L7245	PULLEY----------	1

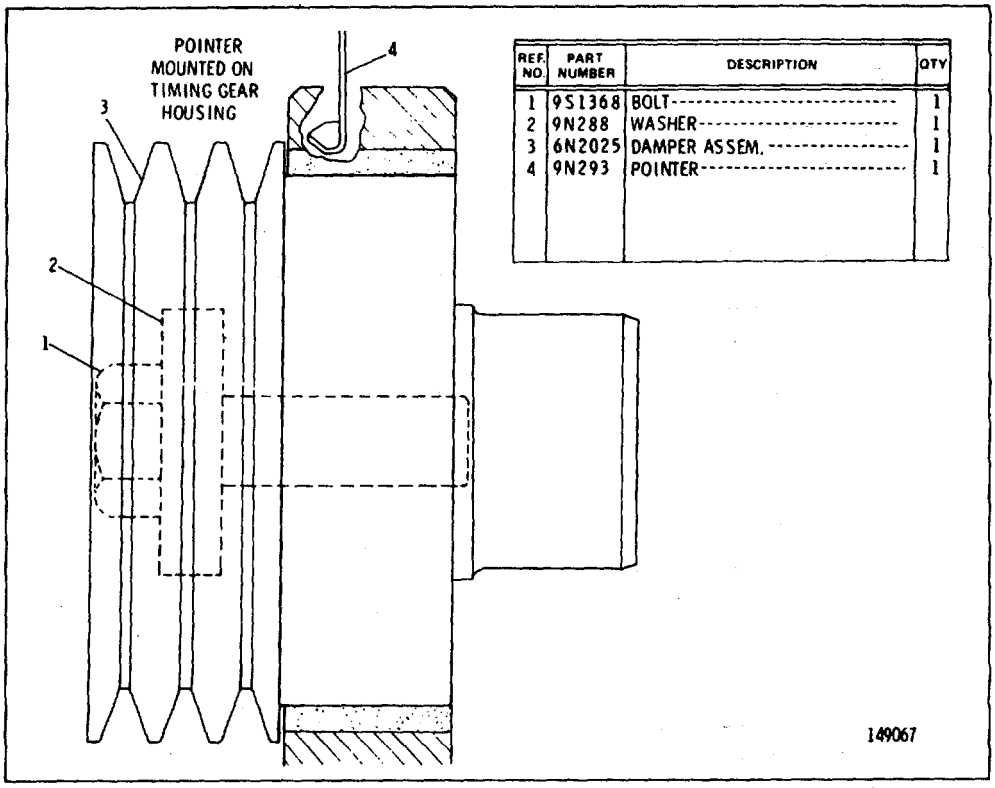
C INDICATES CHANGE

201764

9L7461 CRANKSHAFT PULLEY GROUP
AN ATTACHMENT
NOT FOR USE WITH 4N7393 RADIATOR GROUP SHOWN ON PAGE 86

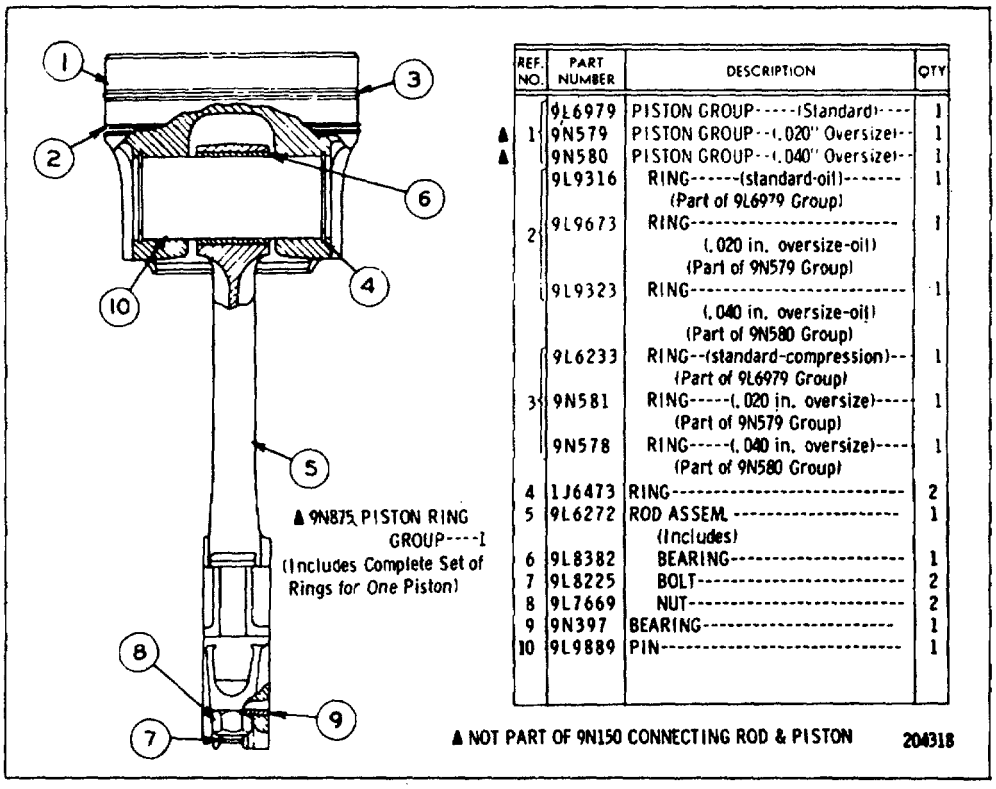
4	9L7948	BEARING--MAIN (.010 OVERSIZE)
4	9L7950	BEARING--MAIN (.010 UNDERSIZE)
4	9L7952	BEARING--MAIN (.020 UNDERSIZE)
1	9N8014	BEARING--MAIN THRUST (.010 OVERSIZE)
1	9L7951	BEARING--THRUST (.010 UNDERSIZE)
1	9L7953	BEARING--THRUST (.020 UNDERSIZE)

CRANKSHAFT BEARNG REPLACEMENTS



REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	9S1368	BOLT	1
2	9N288	WASHER	1
3	6N2025	DAMPER ASSEM.	1
4	9N293	POINTER	1

PULLEY & DAMPER (9N787 N/S)

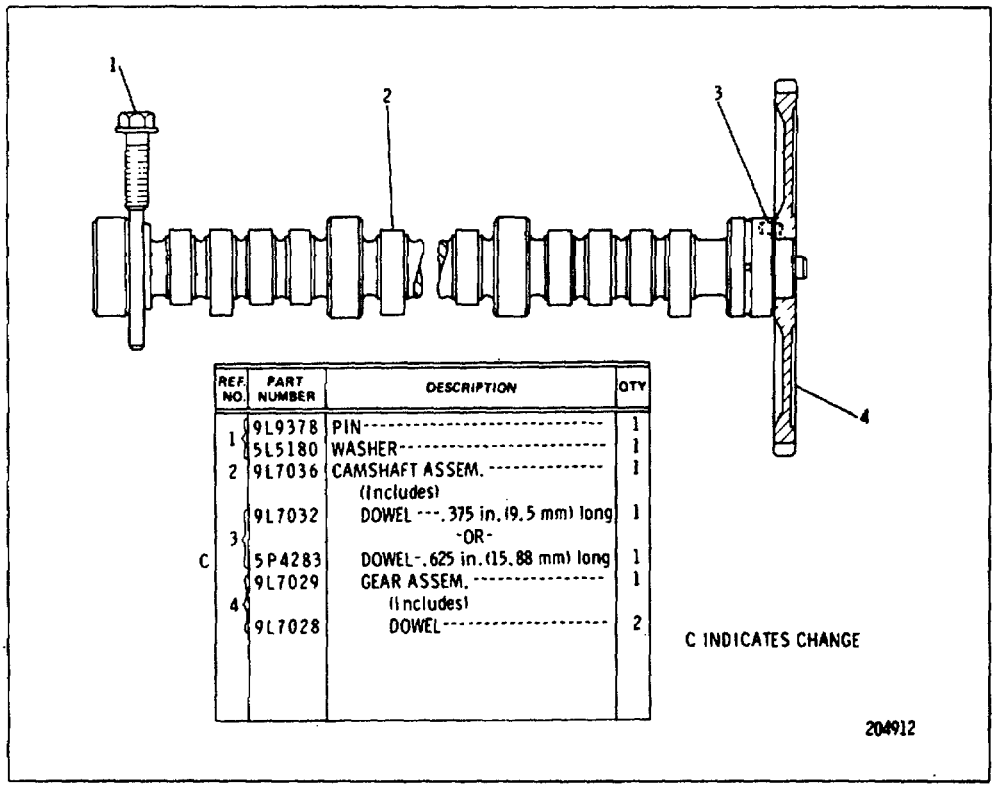


REF. NO.	PART NUMBER	DESCRIPTION	QTY
	9L6979	PISTON GROUP-----(Standard)----	1
▲ 1	9N579	PISTON GROUP--(.020" Oversize)--	1
▲	9N580	PISTON GROUP--(.040" Oversize)--	1
	9L9316	RING------(standard-oil)------- (Part of 9L6979 Group)	1
2	9L9673	RING---------- (.020 in. oversize-oil) (Part of 9N579 Group)	1
	9L9323	RING---------- (.040 in. oversize-oil) (Part of 9N580 Group)	1
	9L6233	RING--(standard-compression)-- (Part of 9L6979 Group)	1
3	9N581	RING-----(.020 in. oversize)----- (Part of 9N579 Group)	1
	9N578	RING-----(.040 in. oversize)----- (Part of 9N580 Group)	1
4	1J6473	RING----------	2
5	9L6272	ROD ASSEM. ---------- (Includes)	1
6	9L8382	BEARING----------	1
7	9L8225	BOLT----------	2
8	9L7669	NUT----------	2
9	9N397	BEARING----------	1
10	9L9889	PIN----------	1

▲ NOT PART OF 9N150 CONNECTING ROD & PISTON

204318

CONNECTING ROD & PISTON (9N150 N/S)--8 Required

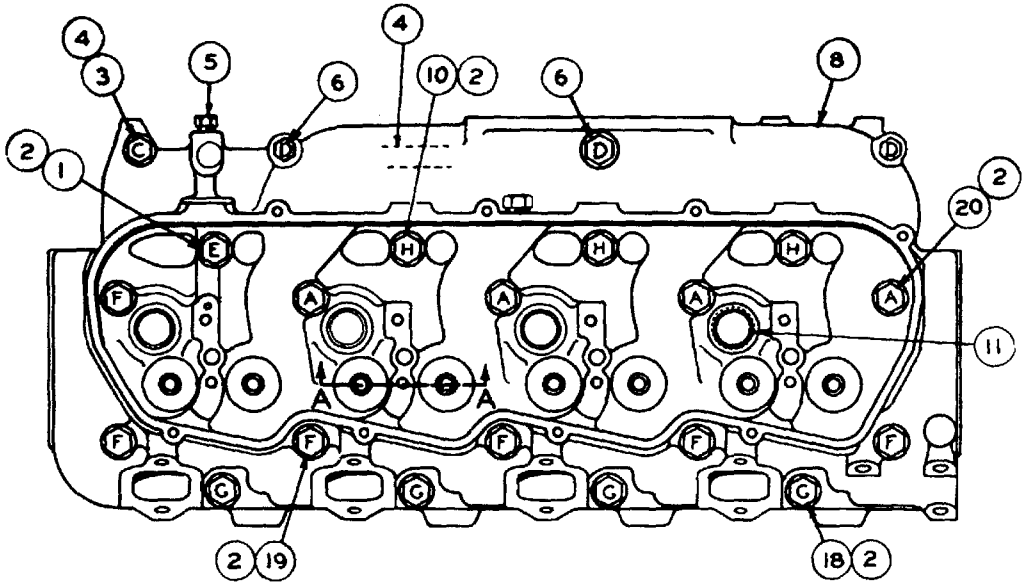


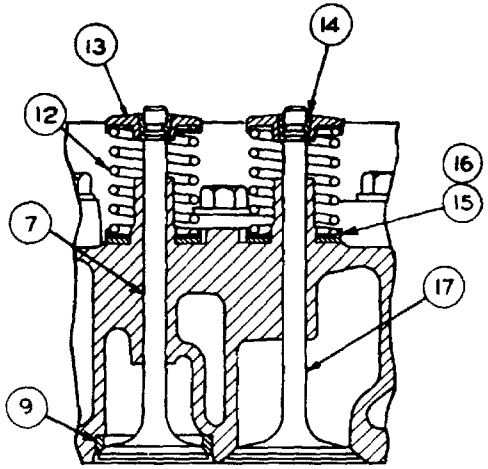
REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	9L9378	PIN----------	1
	5L5180	WASHER----------	1
2	9L7036	CAMSHAFT ASSEM. ---------- (Includes)	1
3	9L7032	DOWEL ---.375 in. (9.5 mm) long	1
		-OR-	
C	5P4283	DOWEL-.625 in. (15.88 mm) long	1
4	9L7029	GEAR ASSEM. ---------- (Includes)	1
	9L7028	DOWEL----------	2

C INDICATES CHANGE

204912

CAMSHAFT (9N728 N/S)



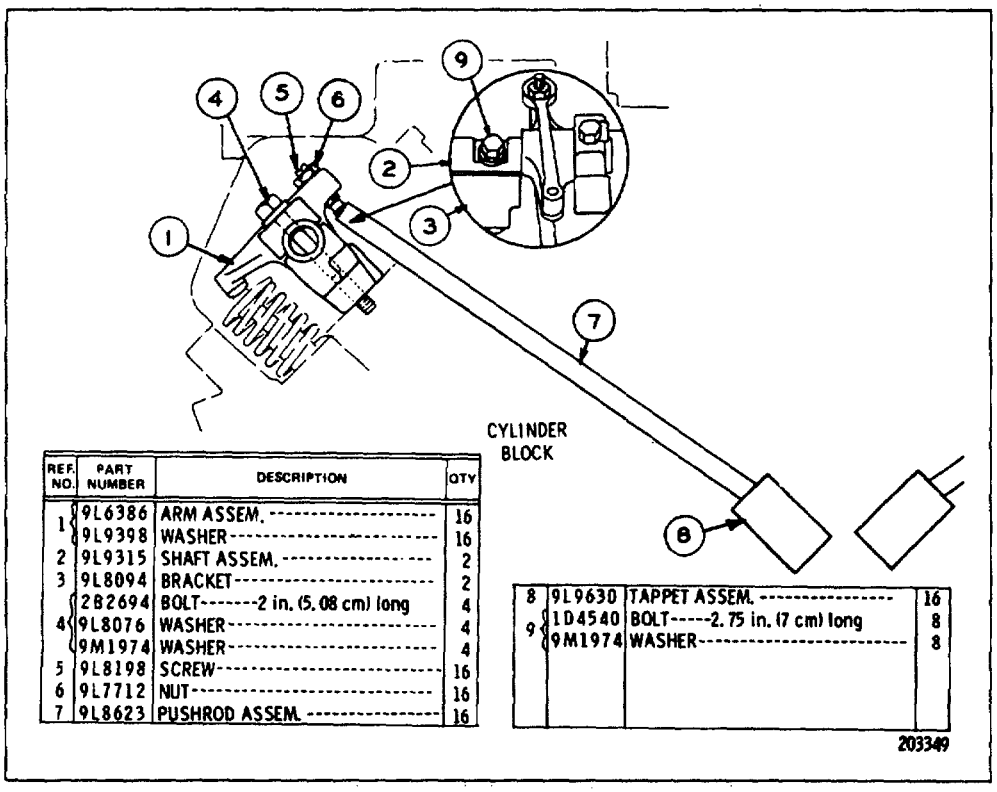


VIEW A-A

REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	L1329	BOLT---------- 3 in. (7.62 cm) long-Location "E"	2
2	3H7654	WASHER----------	36
3	S1571	BOLT-------1.75 in. (4.44 cm) long Location "C" - Left Head	1
	9L9166	STUDBOLT---------- 3.6 in. (9.14 cm) long-Right Head	1
4	9N872	GASKET----------	2
5	5M6213	PLUG----------	4
6	5B9603	BOLT---------- 5 in. (12.7 cm) long-Location "D"	6
7	9L7683	VALVE---------(exhaust)----------	8
8	9L7627	HEAD ASSEM.---------- (Each Includes)	2
	9L7657	PLUG----------	1
9	9L7622	INSERT-------(exhaust)-------	4
10	L1329	BOLT---------- 3 in. (7.62 cm) long-Location "H"	3
11	8M5860	PLUG----------	4
12	9L9190	SPRING----------	16
13	9L9425	RETAINER----------	16
14	2A4429	LOCK----------	32
15	9L8889	WASHER----------	16
16	9N906	SPACER----------	16
▲ 17	9L7862	VALVE---------(intake)----------	8
	2N8943	INSERT--------(intake)----------	8
18	2B947	BOLT---------- 2.25 in. (5.71 cm)long-Location "G"	8
19	2B2006	BOLT---------- 4.75 in. (12 cm) long-Location "F"	12
20	6F5282	BOLT---------- 5.25 in. (13.3 cm) long-Location "A"	8

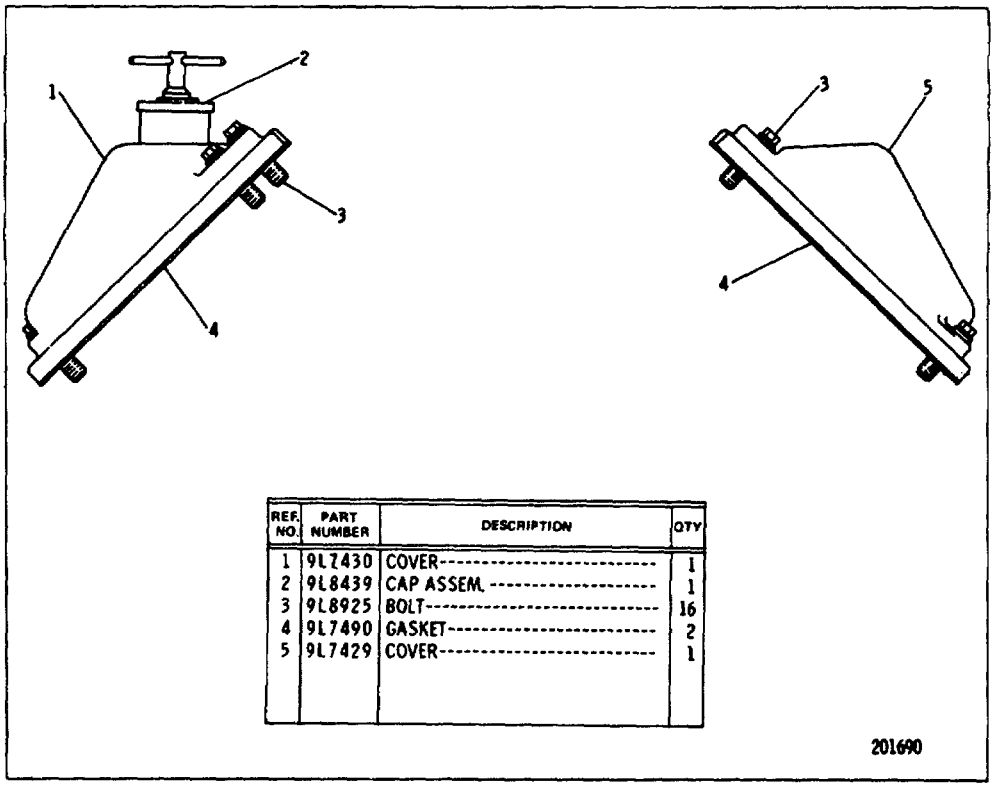
▲ NOT PART OF CYLINDER HEAD GROUP 204323

CYLINDER HEAD (9N1105 N/S)



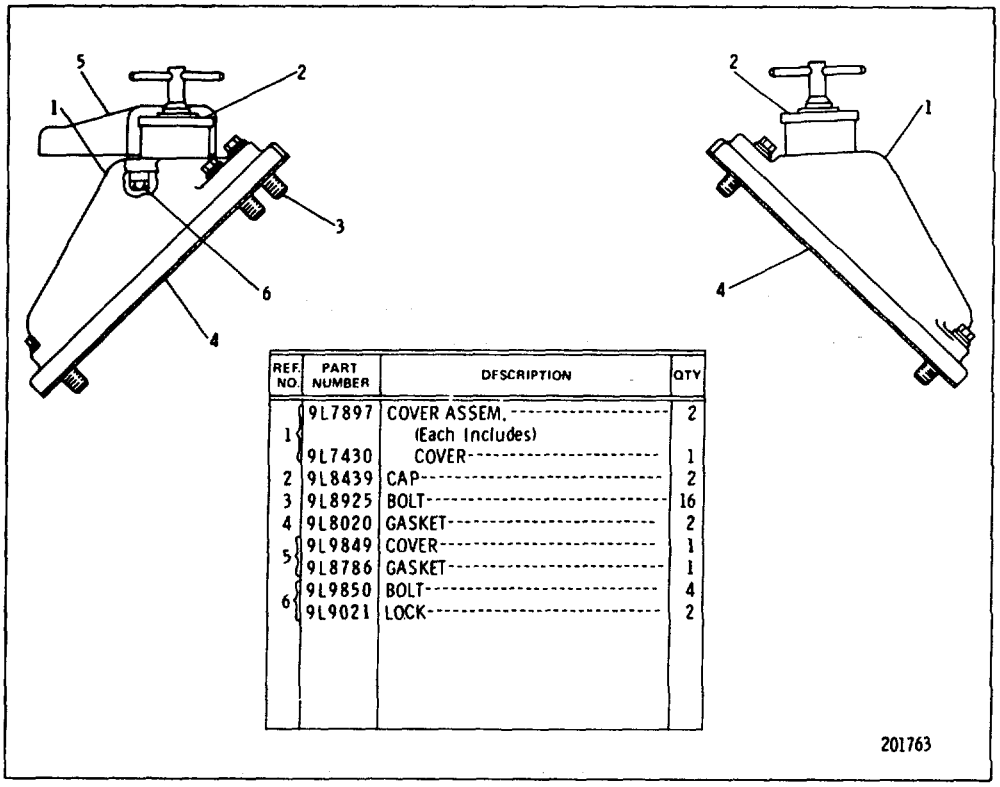
REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	9L6386	ARM ASSEM.	16
	9L9398	WASHER	16
2	9L9315	SHAFT ASSEM.	2
3	9L8094	BRACKET	2
4	2B2694	BOLT-------2 in. (5.08 cm) long	4
	9L8076	WASHER	4
	9M1974	WASHER	4
5	9L8198	SCREW	16
6	9L7712	NUT	16
7	9L8623	PUSHROD ASSEM.	16
8	9L9630	TAPPET ASSEM.	16
9	1D4540	BOLT-----2.75 in. (7 cm) long	8
	9M1974	WASHER	8

VALVE MECHANISM (9N487N/S)



REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	9L7430	COVER	1
2	9L8439	CAP ASSEM.	1
3	9L8925	BOLT	16
4	9L7490	GASKET	2
5	9L7429	COVER	1

VALVE MECHANISM COVER (9N730 N/S)



REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	9L7897	COVER ASSEM.	2
		(Each Includes)	
	9L7430	COVER	1
2	9L8439	CAP	2
3	9L8925	BOLT	16
4	9L8020	GASKET	2
5	9L9849	COVER	1
	9L8786	GASKET	1
6	9L9850	BOLT	4
	9L9021	LOCK	2

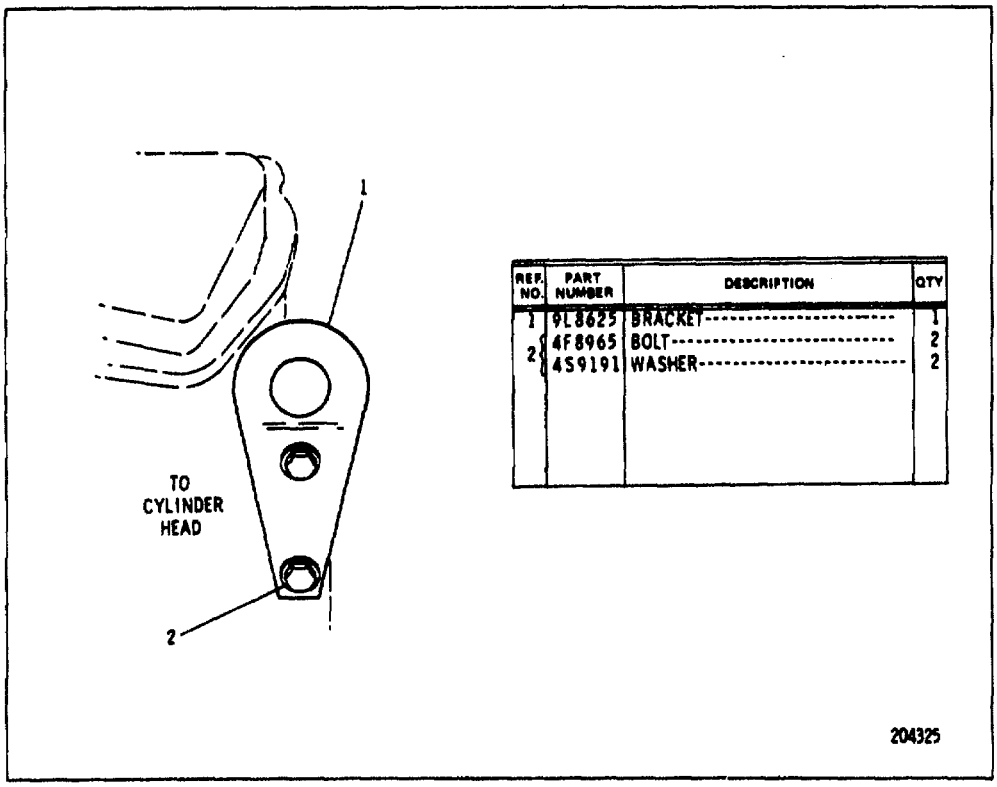
VALVE MECHANISM COVER (9L6978 N/S)

CONSISTS OF:

1 9L7897 COVER ASSEMBLY--ROCKER ARM R.H.

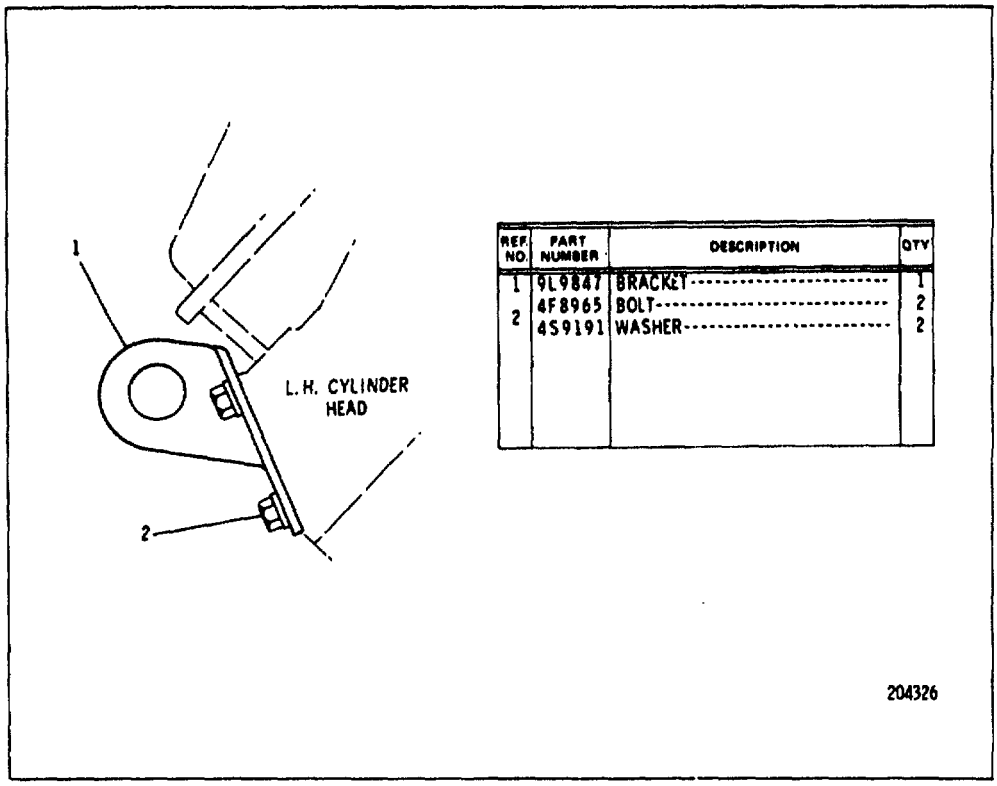
1 9L7898 COVER ASSEMBLY--ROCKER ARM L.H.

9N8009. VALE MECHANISM COVER GROUP
FOR USE WITH FRONT SUMP OIL PAN
AN ATTACHMENT



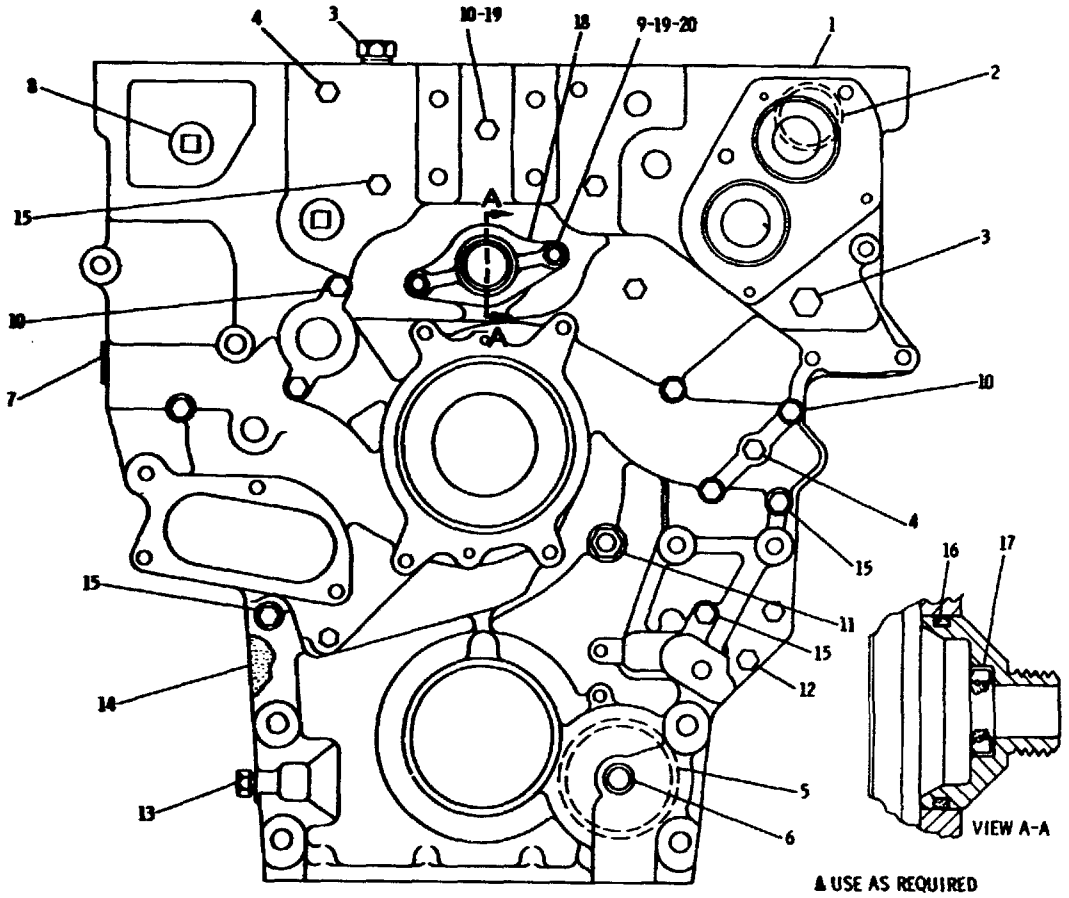
REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	9L8625	BRACKET	1
2	4F8965	BOLT	2
	4S9191	WASHER	2

LIFTING (9N191 N/S)-R.H. Side



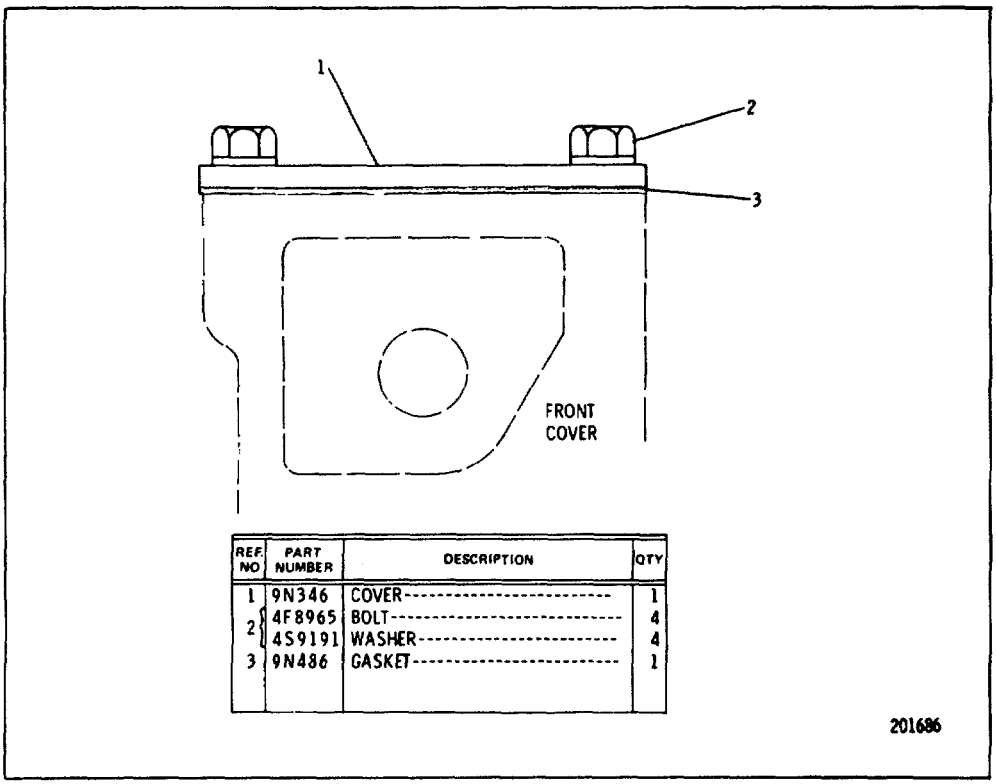
REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	9L9847	BRACKET	1
2	4F8965	BOLT	2
	4S9191	WASHER	2

LIFTING (9N210 N/S)-L.H. Side



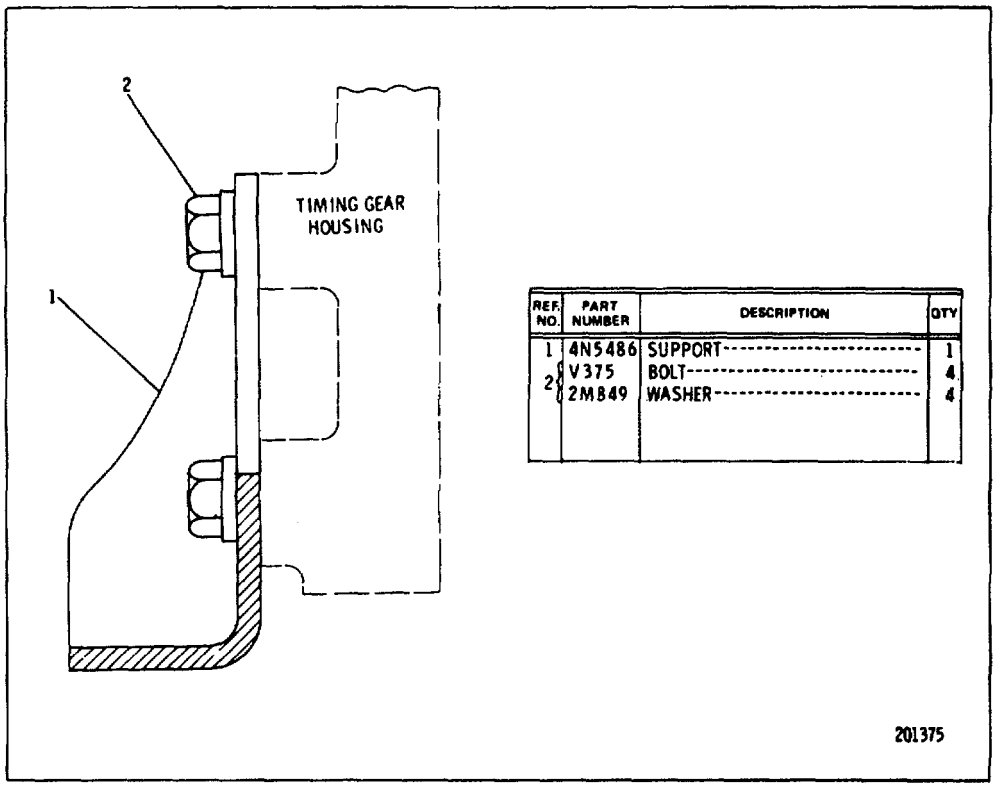
REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	9N357	HOUSING ASSEM. (Includes)	1
2	3H5552	PLUG	1
3	3J5389	PLUG	2
4	5M6214	PLUG	3
5	9N242	BEARING	1
6	9N243	SHAFT	1
7	3B551	PLUG	1
8	1B5174	PLUG	3
9	1A7462	STUD	2
A 10	4B3903	BOLT---4 in. (10.16 cm) long	6
11	9L9412	FITTING	1
	9L9389	CAP	1
12	4B3388	BOLT---1.125 in. (2.85 cm) long	2
13	3J5390	PLUG	1
14	9N258	GASKET	1
15	1D4541	BOLT---3 in. (7.62 cm) long	7
16	8M5661	SEAL	1
17	5P547	SEAL	1
18	9L7842	ADAPTER	1
19	1D4716	NUT	3
20	4P4277	WASHER	2

FRONT HOUSING (9N1080 N/S)



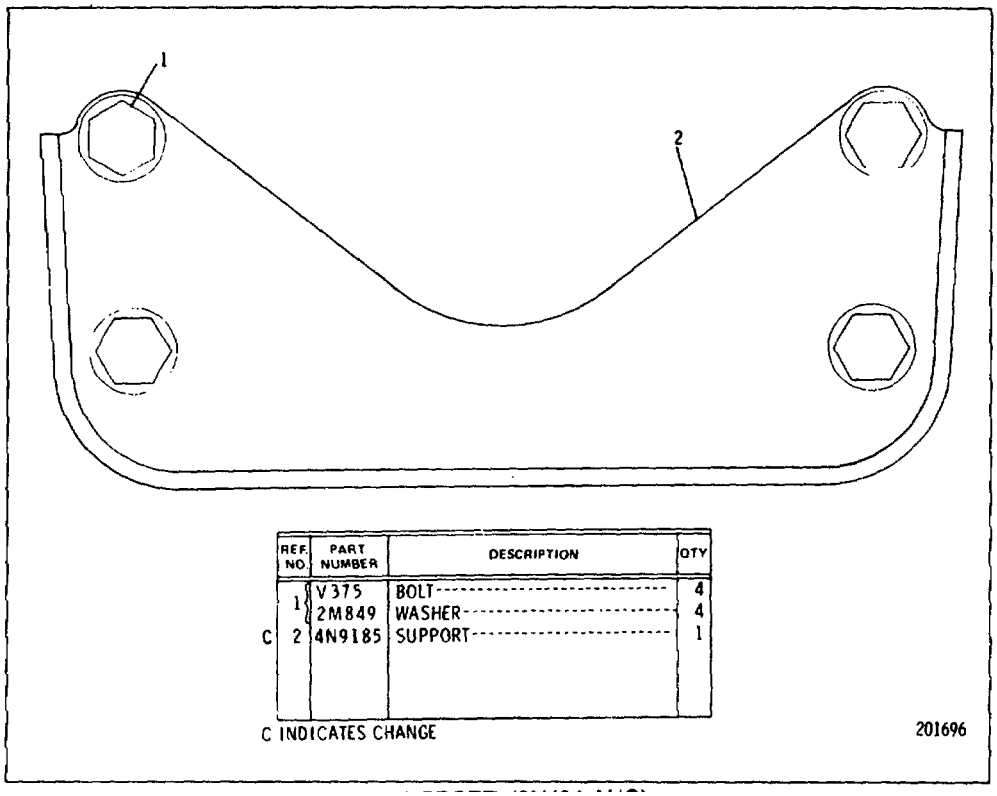
REF. NO	PART NUMBER	DESCRIPTION	QTY
1	9N346	COVER	1
2	4F8965	BOLT	4
	4S9191	WASHER	4
3	9N486	GASKET	1

FRONT HOUSING COVER (9N560 N/S)
Note: 2N3909 Tachometer Drive Adapter is available



REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	4N5486	SUPPORT	1
2	V375	BOLT	4
	2M849	WASHER	4

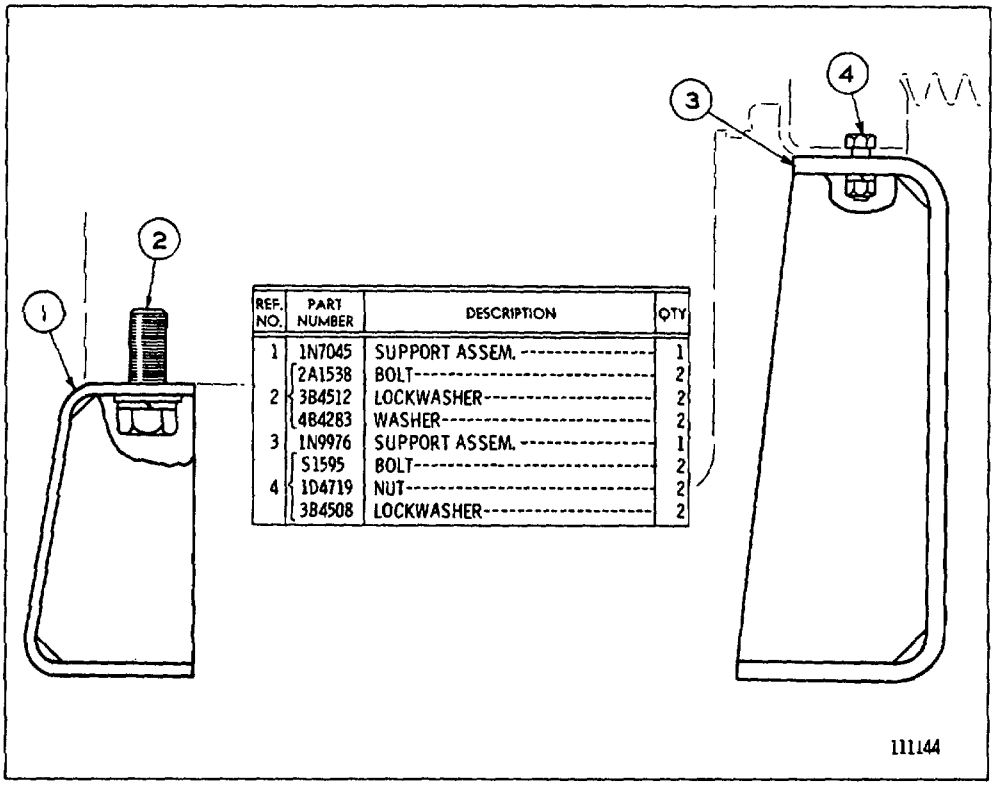
SUPPORT (4N5487 N/S)



	REF. NO.	PART NUMBER	DESCRIPTION	QTY
	1	V375	BOLT	4
		2M849	WASHER	4
C	2	4N9185	SUPPORT	1

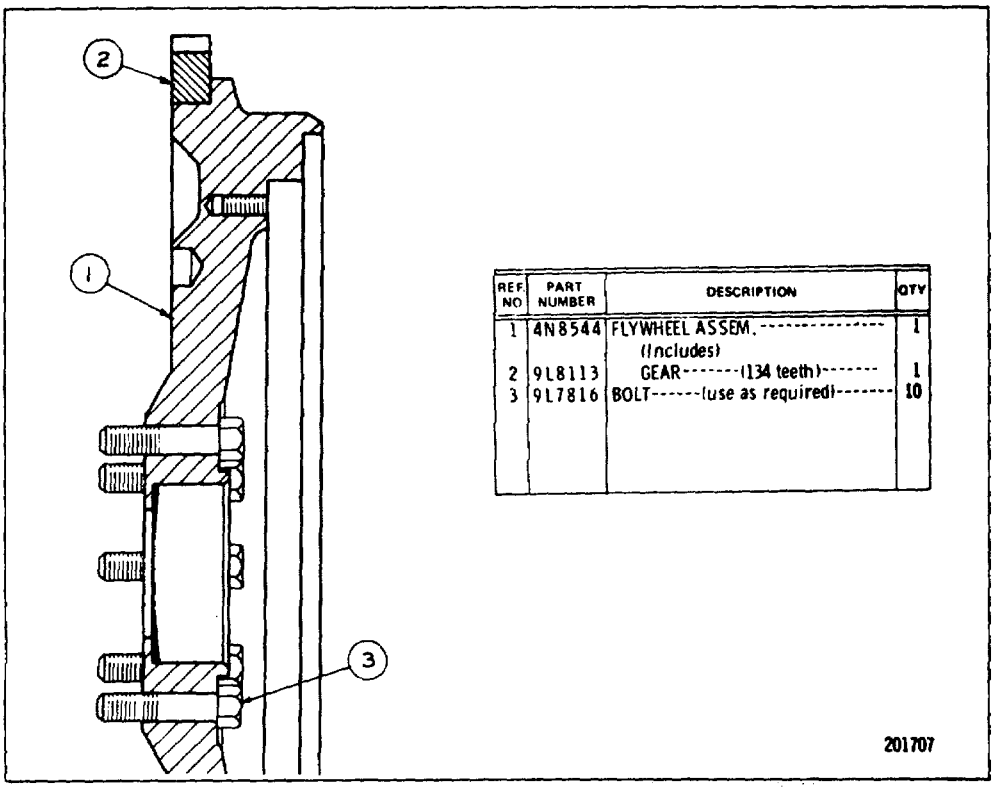
C INDICATES CHANGE

SUPPORT (6N464 N/S)



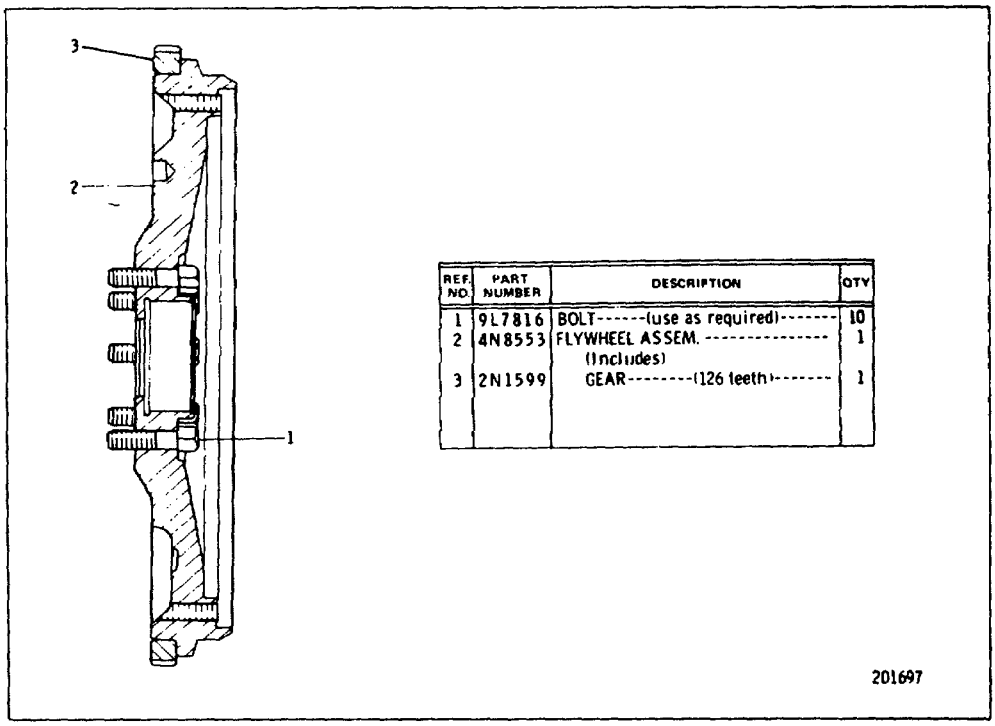
REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	1N7045	SUPPORT ASSEM.	1
2	2A1538	BOLT	2
	3B4512	LOCKWASHER	2
	4B4283	WASHER	2
3	1N9976	SUPPORT ASSEM.	1
4	S1595	BOLT	2
	1D4719	NUT	2
	3B4508	LOCKWASHER	2

SUPPORT(1N9939 N/S)



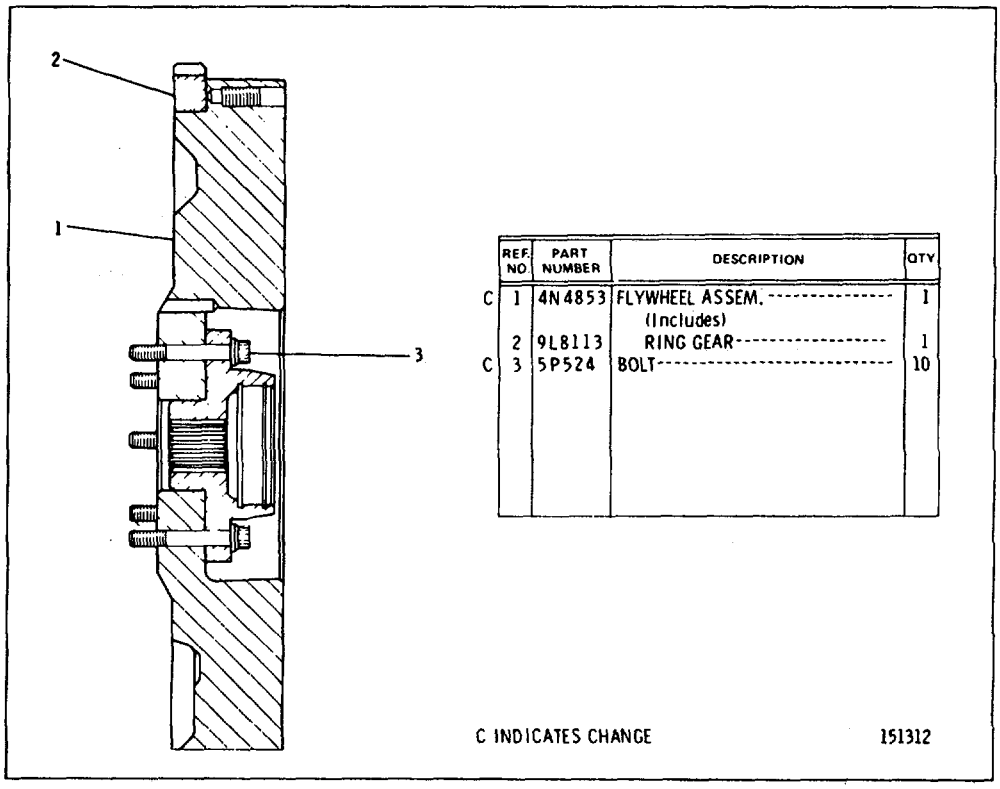
REF. NO	PART NUMBER	DESCRIPTION	QTY
1	4N8544	FLYWHEEL ASSEM. (Includes)	1
2	9L8113	GEAR--------(134 teeth)--------	1
3	9L7816	BOLT------(use as required)--------	10

4N8850 FLYWHEEL GROUP
FOR USE WITH S.A.E. #2 FLYWHEEL HOUSING
ALSO AN ATTACHMENT



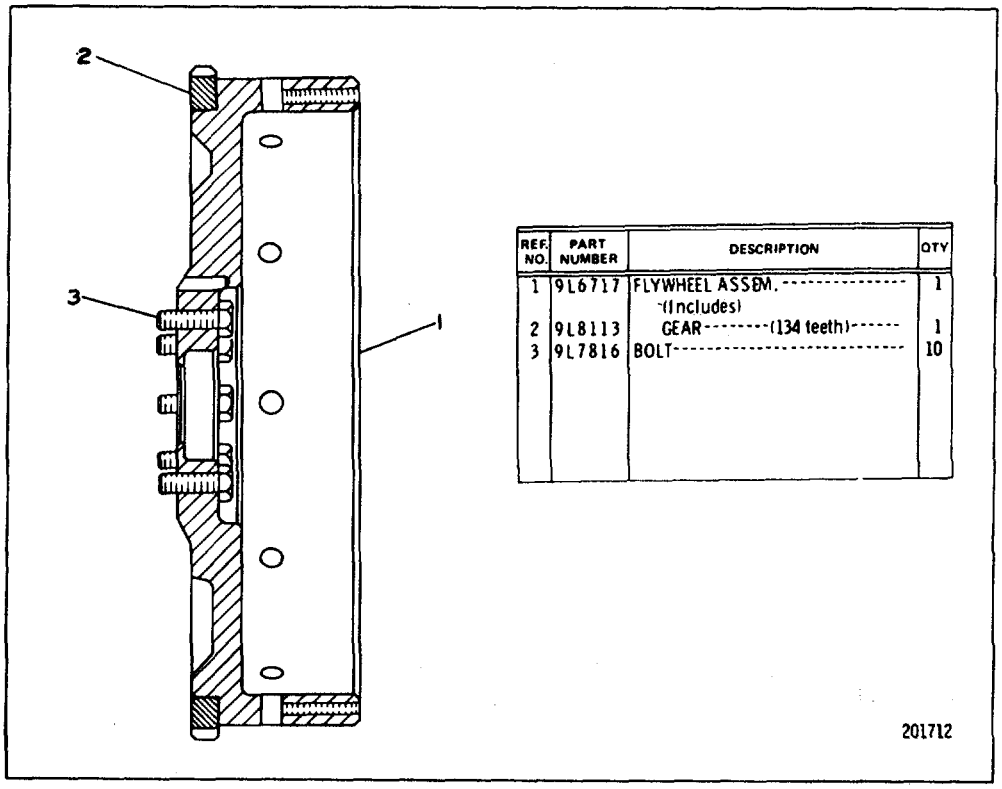
REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	9L7816	BOLT------(use as required)-------	10
2	4N8553	FLYWHEEL ASSEM. (Includes)	1
3	2N1599	GEAR--------(126 teeth)-------	1

FLYWHEEL GROUP (4N8852 N/S)
FOR USE WITH S.A.E. #3 FLYWHEEL HOUSING
ALSO AN ATTACHMENT



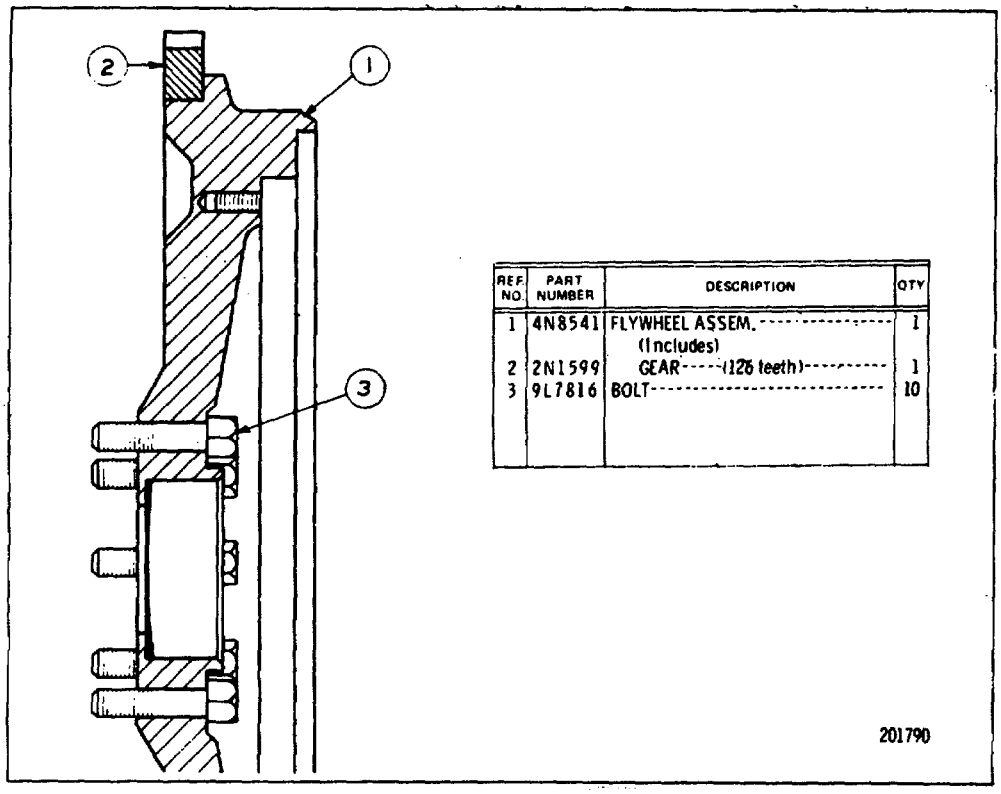
	REF. NO.	PART NUMBER	DESCRIPTION	QTY
C	1	4N4853	FLYWHEEL ASSEM. (Includes)	1
	2	9L8113	RING GEAR	1
C	3	5P524	BOLT	10

FLYWHEEL (4N4854 N/S)
FOR USE WITH S.A.E. #2 FLYWHEEL HOUSING



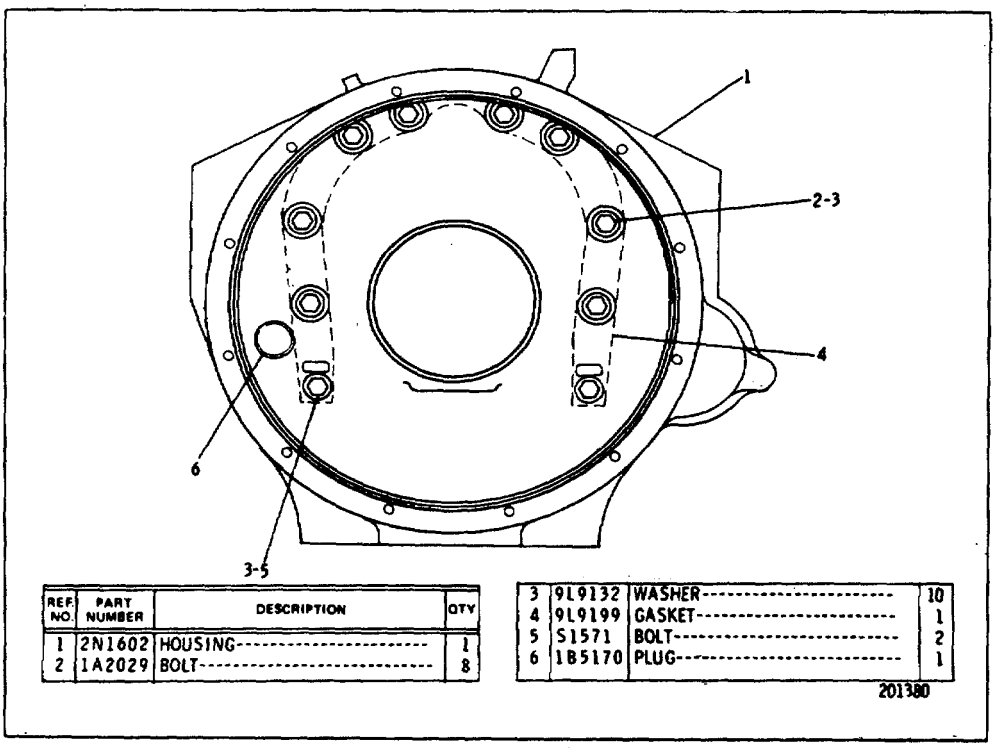
REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	9L6717	FLYWHEEL ASSEM. (Includes)	1
2	9L8113	GEAR (134 teeth)	1
3	9L7816	BOLT	10

9L6920 FLYWHEEL GROUP



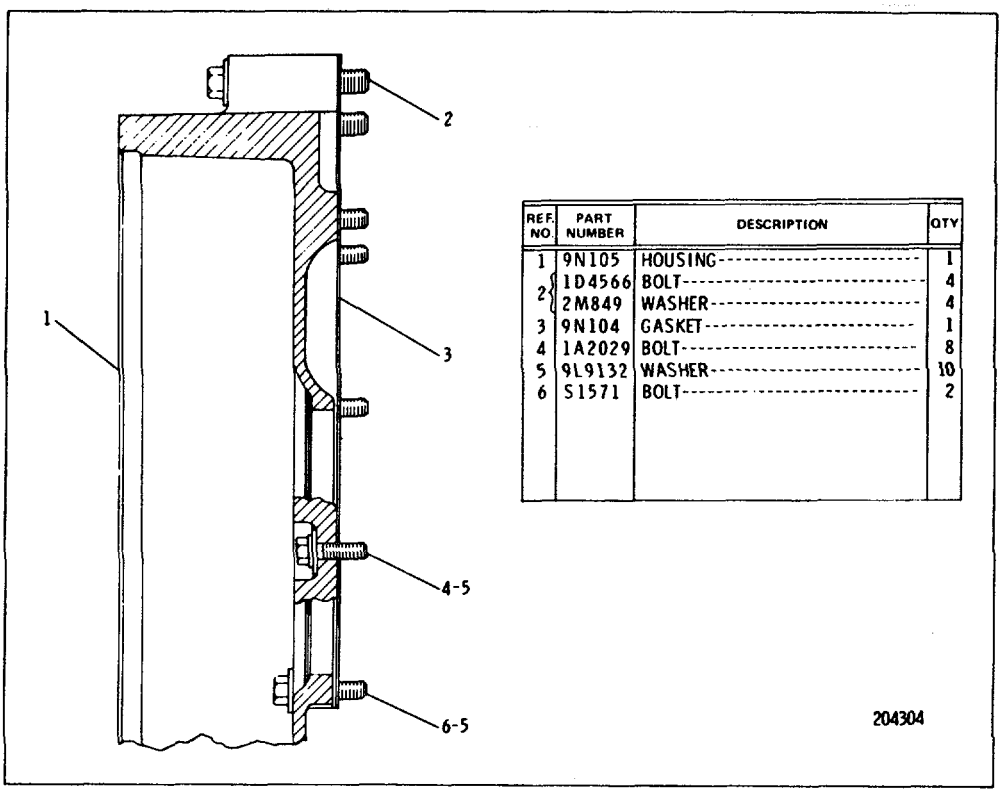
REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	4N8541	FLYWHEEL ASSEM. (Includes)	1
2	2N1599	GEAR (126 teeth)	1
3	9L7816	BOLT	10

4N8851 FLYWHEEL GROUP
AN ATTACHMENT



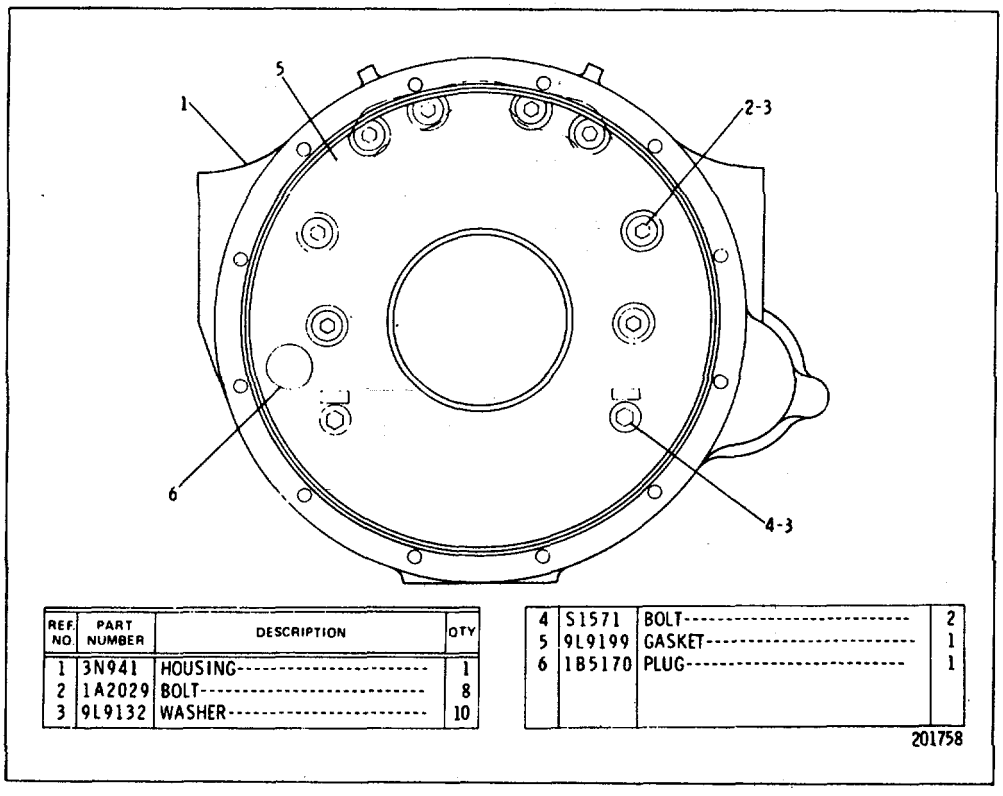
REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	2N1602	HOUSING	1
2	1A2029	BOLT	8
3	9L9132	WASHER	10
4	9L9199	GASKET	1
5	S1571	BOLT	2
6	1B5170	PLUG	1

FLYWHEEL HOUSING (4N5870 N/S)



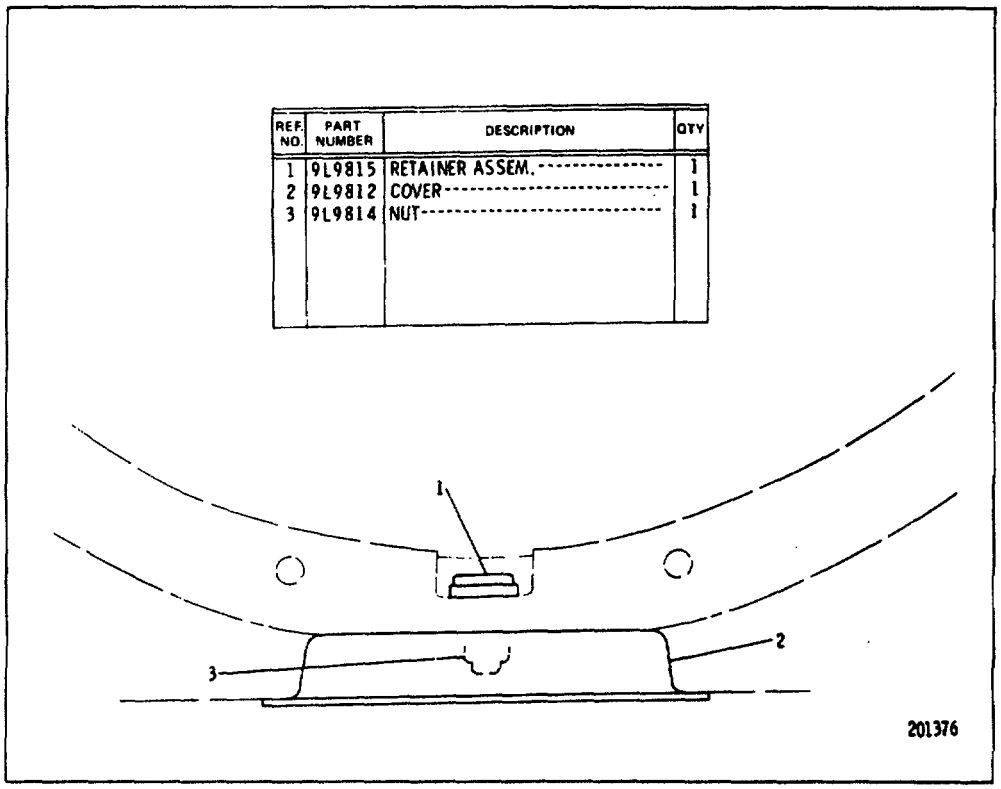
REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	9N105	HOUSING	1
2	1D4566	BOLT	4
	2M849	WASHER	4
3	9N104	GASKET	1
4	1A2029	BOLT	8
5	9L9132	WASHER	10
6	S1571	BOLT	2

FLYWHEEL HOUSING (9N529 N/5)



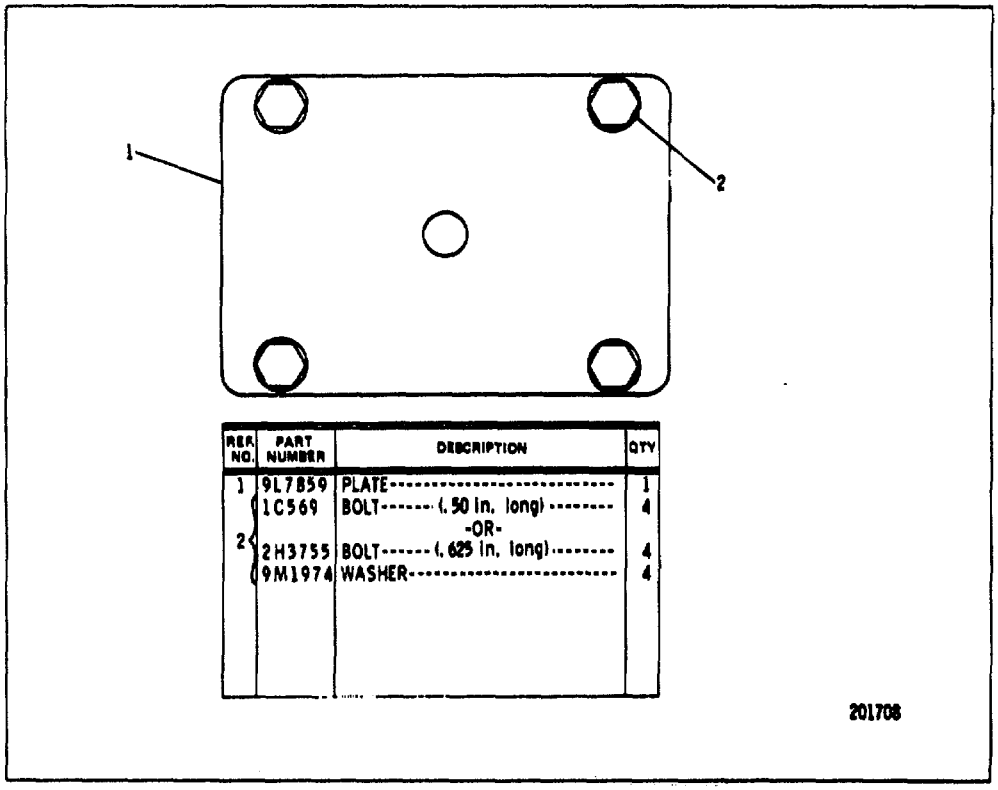
REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	3N941	HOUSING	1
2	1A2029	BOLT	8
3	9L9132	WASHER	10
4	S1571	BOLT	2
5	9L9199	GASKET	1
6	1B5170	PLUG	1

FLYWHEEL HOUSING (4N7889 N/S)



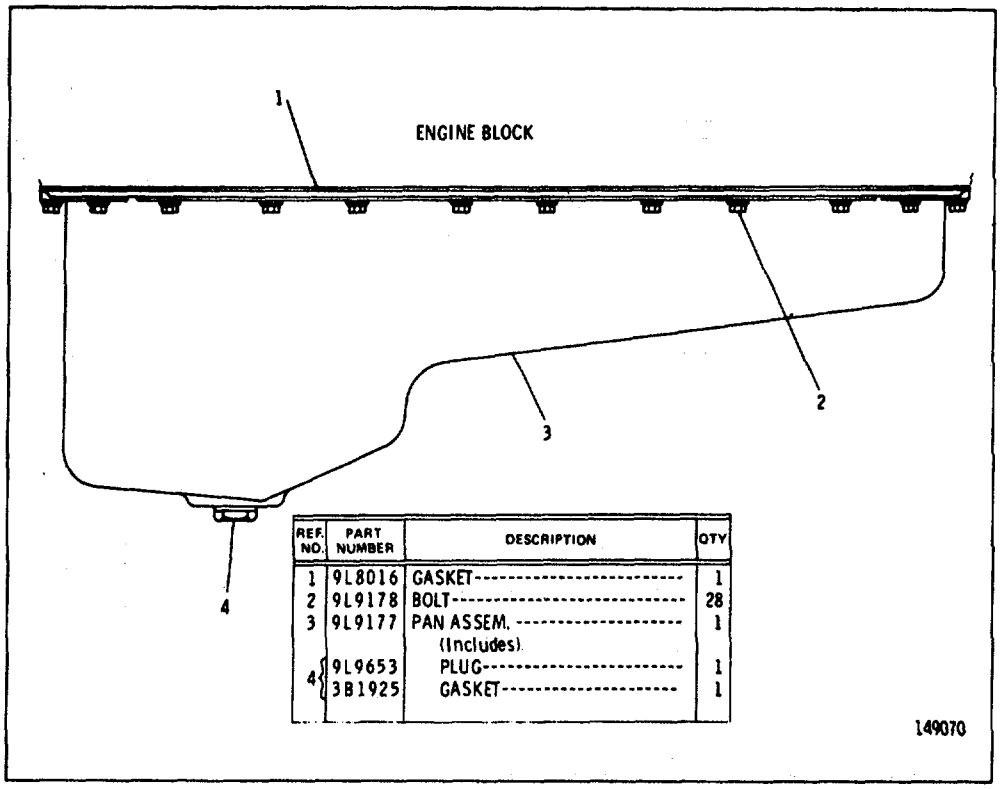
REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	9L9815	RETAINER ASSEM.	1
2	9L9812	COVER	1
3	9L9814	NUT	1

FLYWHEEL HOUSING COVER (4N5866 N/S)



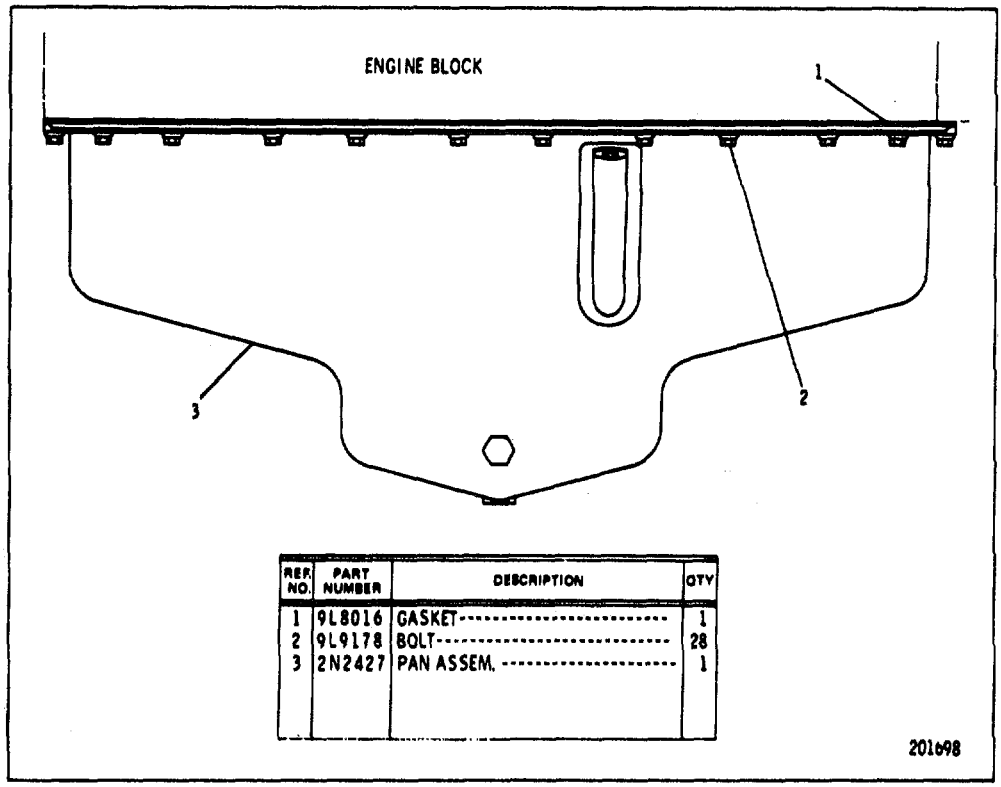
REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	9L7859	PLATE	1
2	1C569	BOLT (.50 in. long)	4
		-OR-	
	2H3755	BOLT (.625 in. long)	4
	9M1974	WASHER	4

9L7861 FLYWHEEL HOUSNG COVER



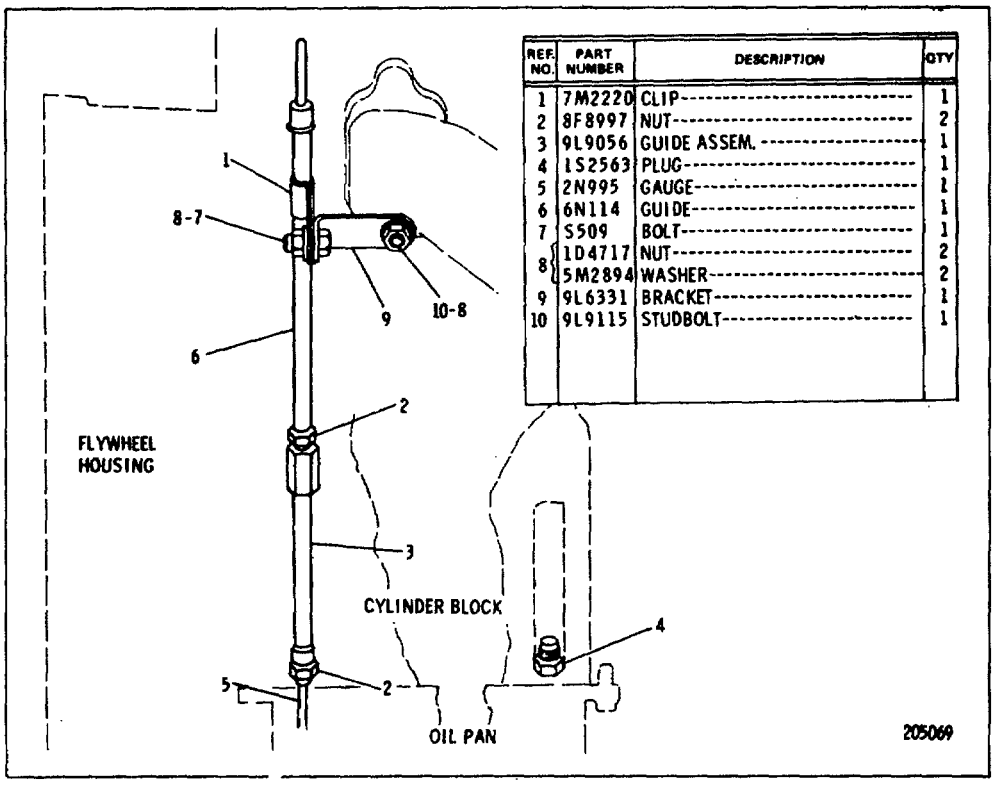
REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	9L8016	GASKET	1
2	9L9178	BOLT	28
3	9L9177	PAN ASSEM. (Includes)	1
4	9L9653	PLUG	1
	3B1925	GASKET	1

OIL PAN (9N565N/S)



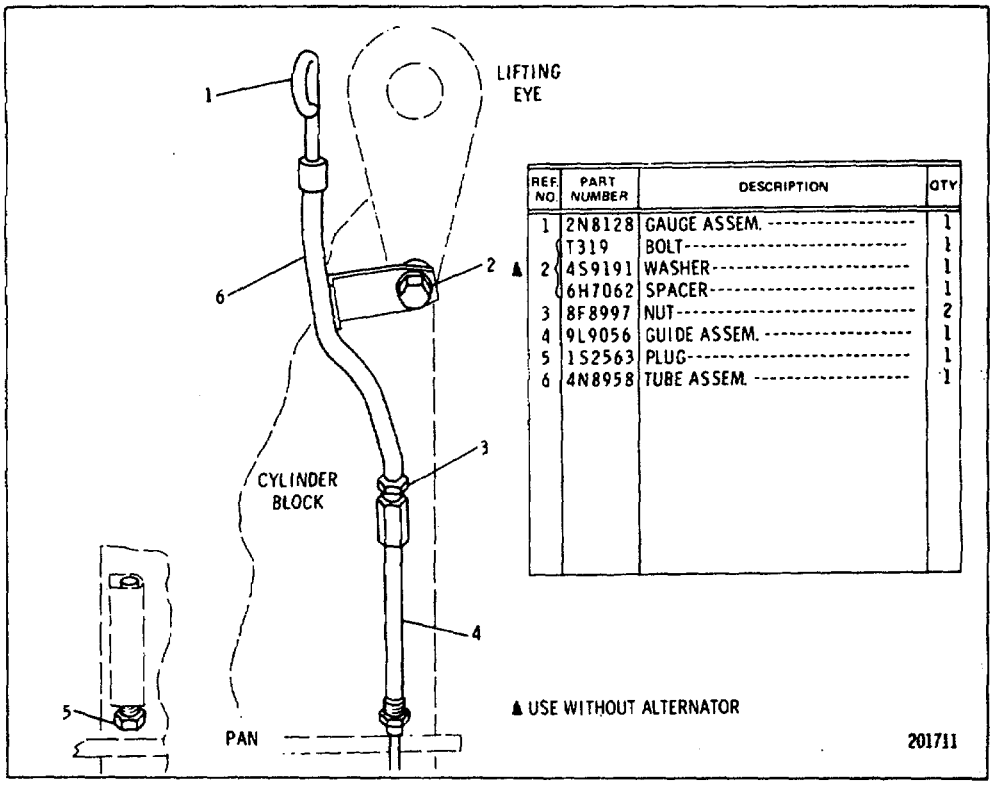
REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	9L8016	GASKET	1
2	9L9178	BOLT	28
3	2N2427	PAN ASSEM.	1

OIL PAN (4N8853 N/S) - Center Sump



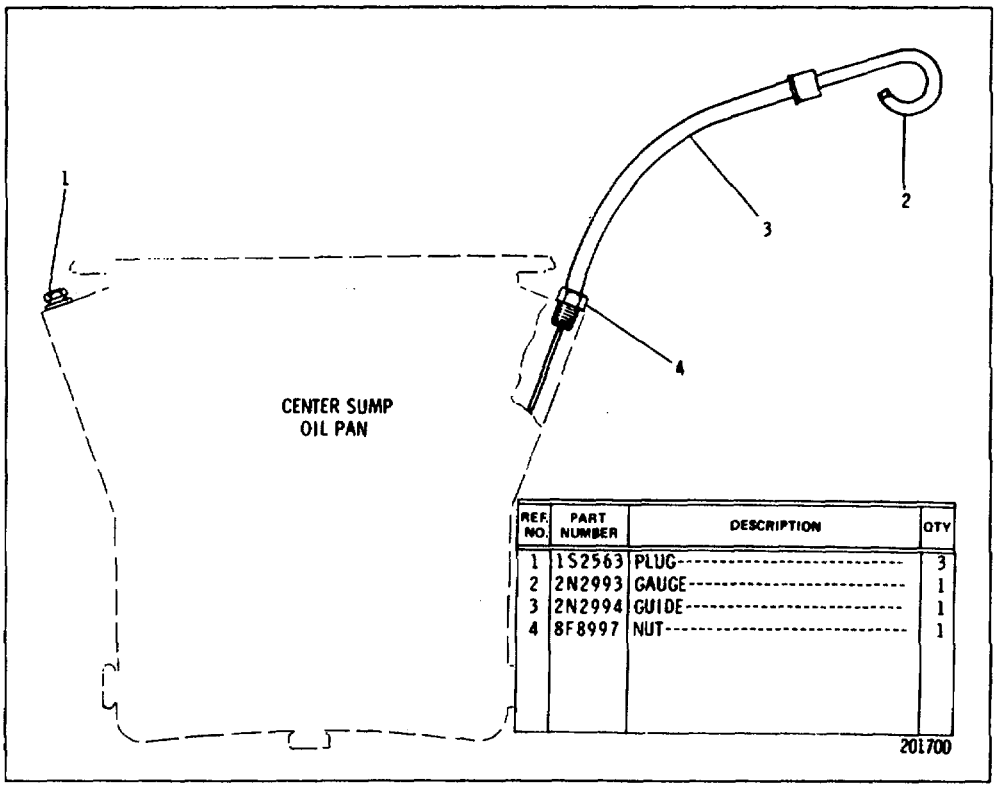
REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	7M2220	CLIP	1
2	8F8997	NUT	2
3	9L9056	GUIDE ASSEM.	1
4	1S2563	PLUG	1
5	2N995	GAUGE	1
6	6N114	GUIDE	1
7	S509	BOLT	1
8	1D4717	NUT	2
	5M2894	WASHER	2
9	9L6331	BRACKET	1
10	9L9115	STUDBOLT	1

OIL LEVEL GAUGE (9N142 N/S)



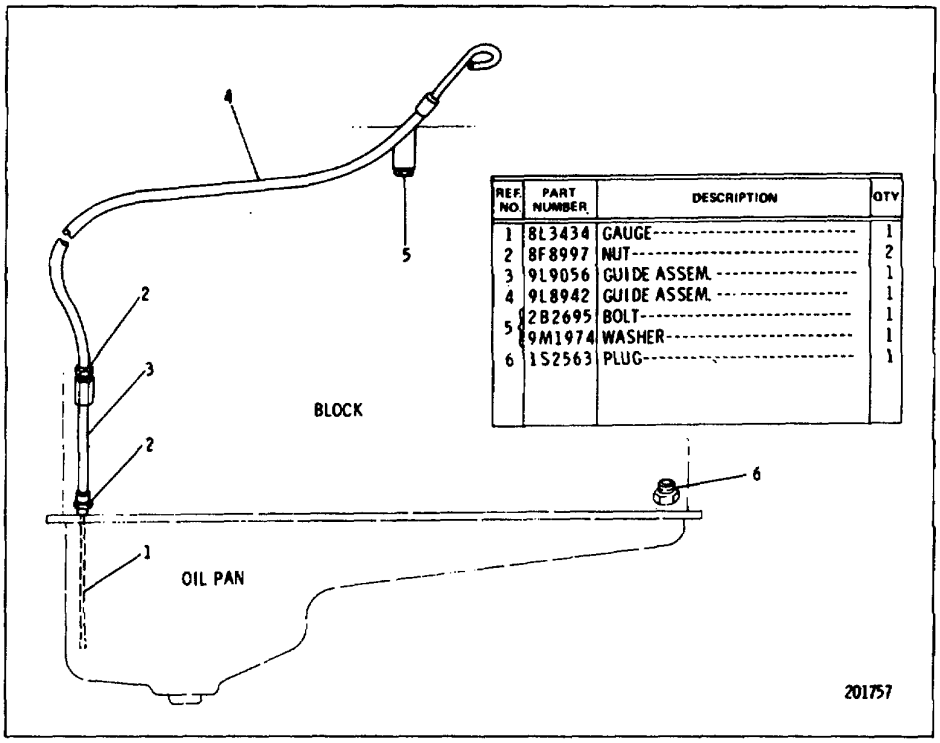
REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	2N8128	GAUGE ASSEM.	1
2 ▲	T319	BOLT	1
	4S9191	WASHER	1
	6H7062	SPACER	1
3	8F8997	NUT	2
4	9L9056	GUIDE ASSEM.	1
5	1S2563	PLUG	1
6	4N8958	TUBE ASSEM.	1

OIL LEVEL GAUGE (4N8930N/S)



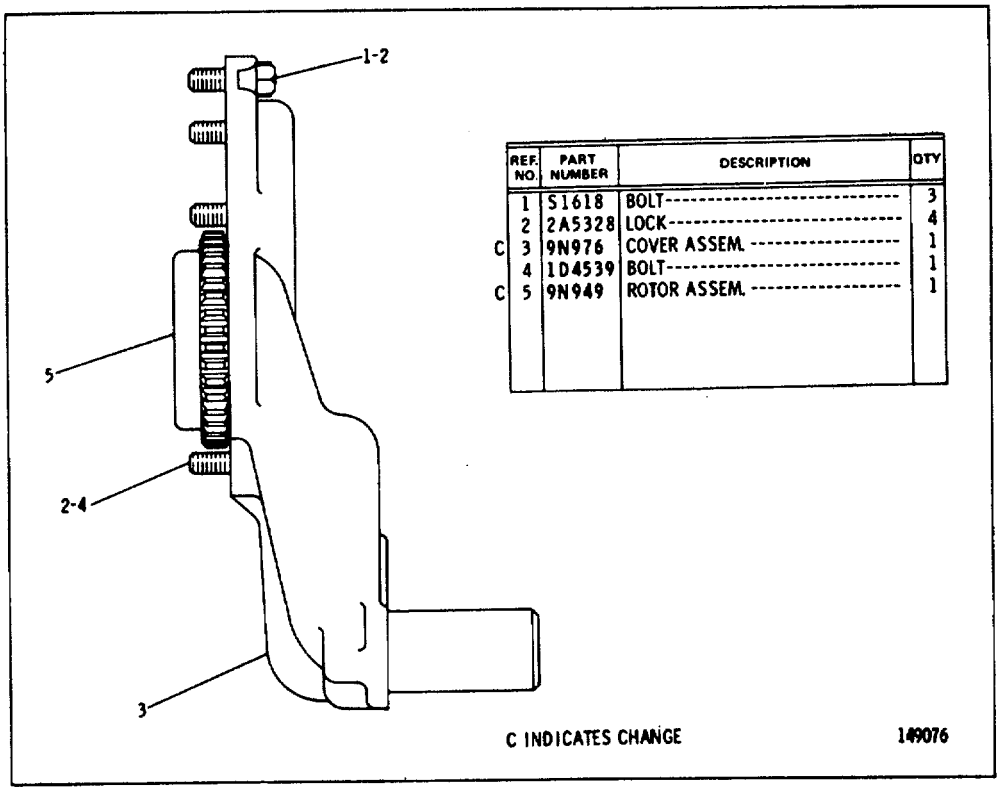
REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	1S2563	PLUG	3
2	2N2993	GAUGE	1
3	2N2994	GUIDE	1
4	8F8997	NUT	1

OIL LEVEL GAUGE (4N8855N/S)



REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	8L3434	GAUGE	1
2	8F8997	NUT	2
3	9L9056	GUIDE ASSEM.	1
4	9L8942	GUIDE ASSEM.	1
5	2B2695	BOLT	1
	9M1974	WASHER	1
6	1S2563	PLUG	1

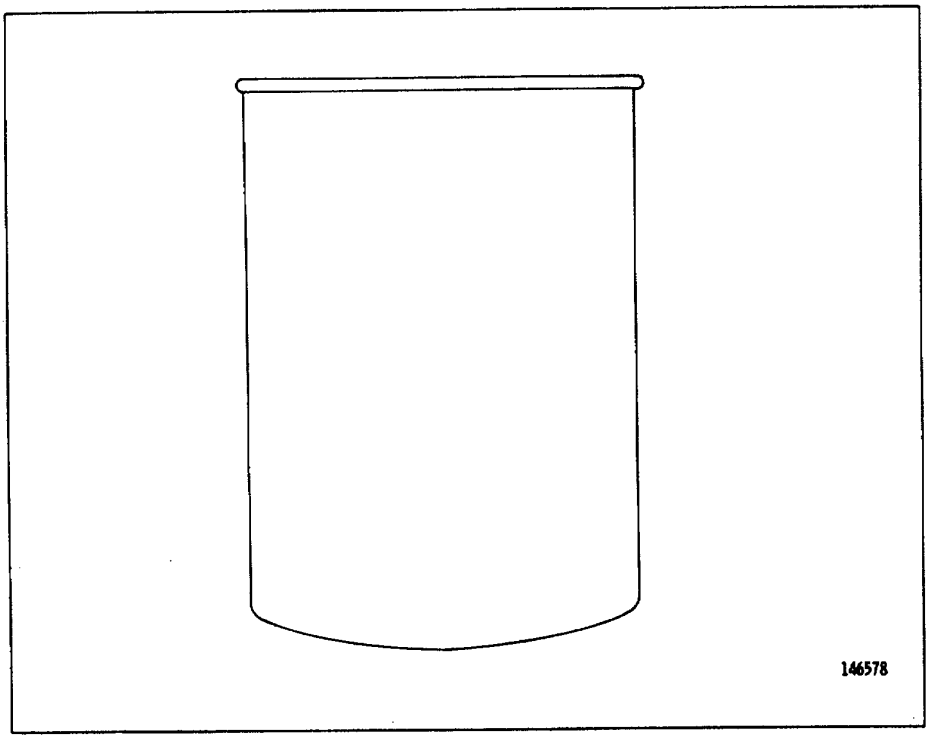
OIL LEVEL GAUGE (4N7720N/S)



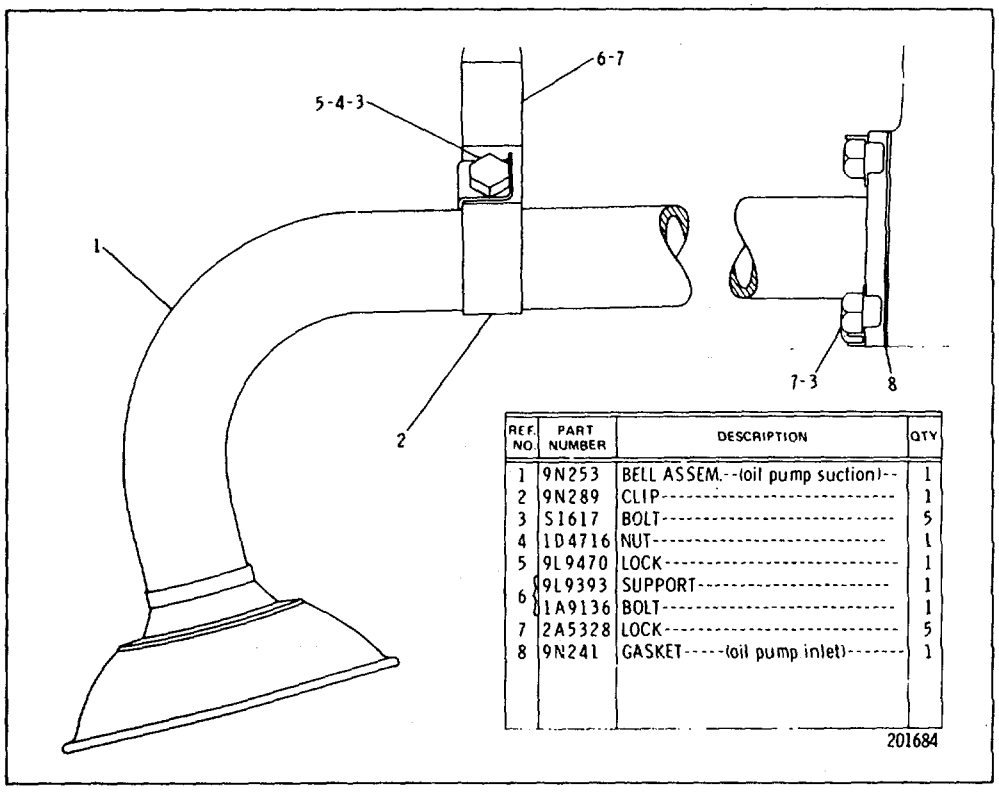
	REF. NO.	PART NUMBER	DESCRIPTION	QTY
	1	S1618	BOLT	3
	2	2A5328	LOCK	4
C	3	9N976	COVER ASSEM.	1
	4	1D4539	BOLT	1
C	5	9N949	ROTOR ASSEM.	1

C INDICATES CHANGE

OIL PUMP (9N541 N/S)



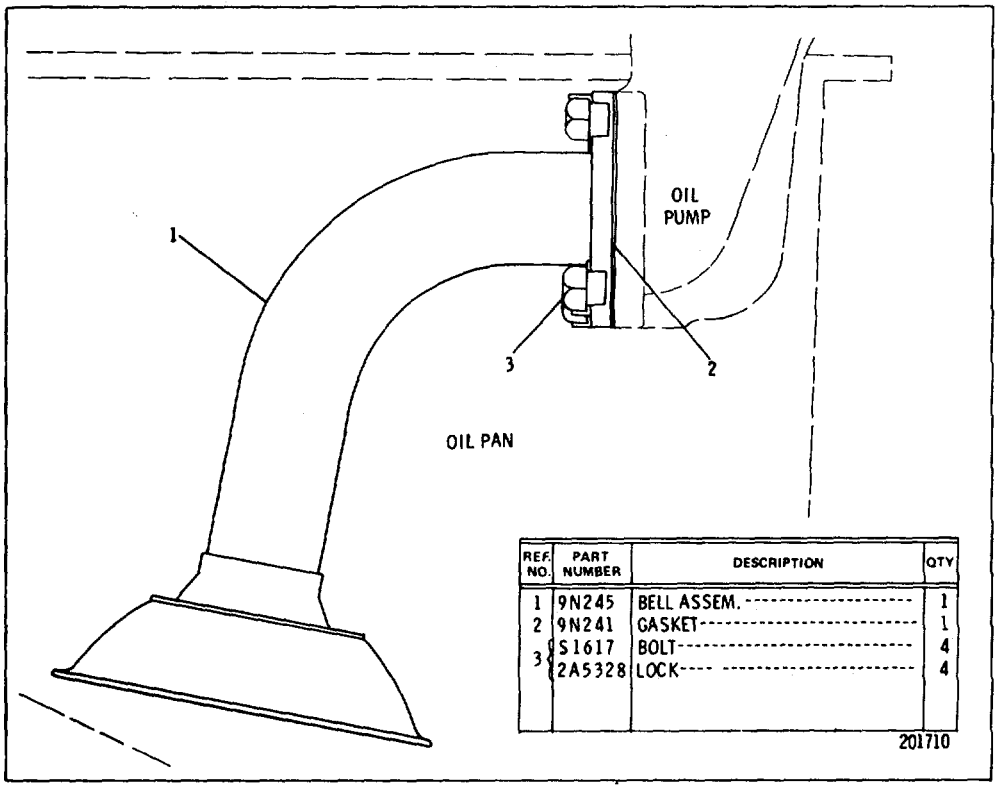
9L9200 OIL FILTER ASSEMBLY



REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	9N253	BELL ASSEM.--(oil pump suction)--	1
2	9N289	CLIP----------	1
3	S1617	BOLT----------	5
4	1D4716	NUT----------	1
5	9L9470	LOCK----------	1
6	9L9393	SUPPORT----------	1
	1A9136	BOLT----------	1
7	2A5328	LOCK----------	5
8	9N241	GASKET-----(oil pump inlet)-------	1

201684

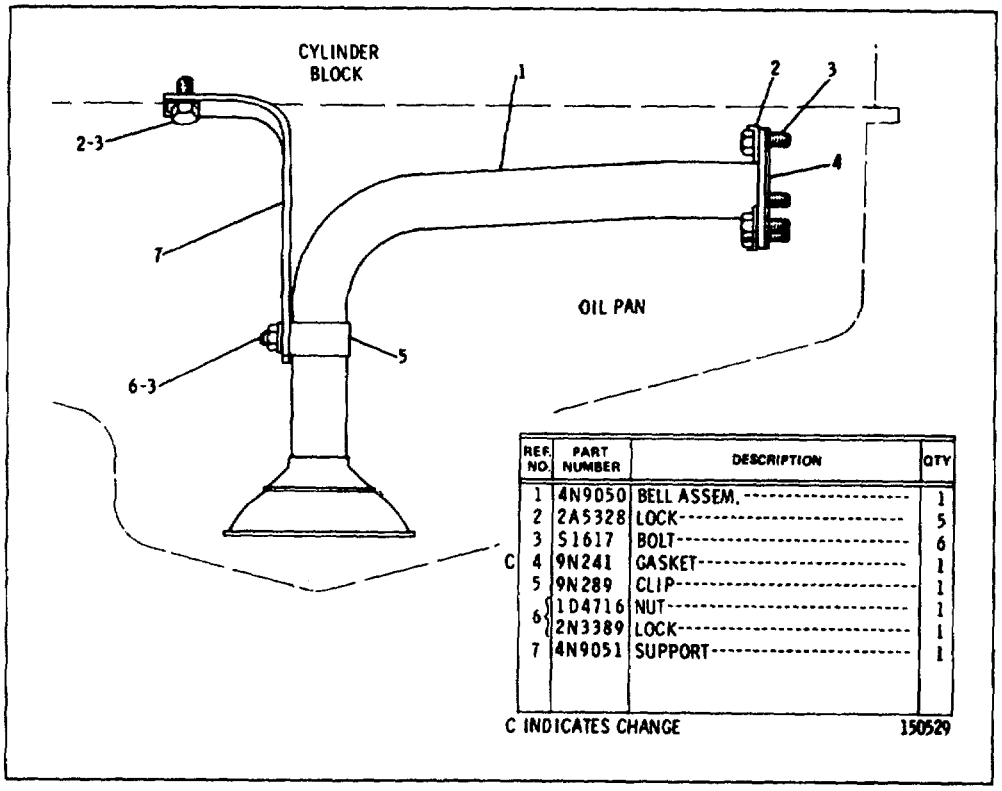
OIL LINES (9N550 N/S) - Rear Sump



REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	9N245	BELL ASSEM. ----------	1
2	9N241	GASKET----------	1
3	S1617	BOLT----------	4
	2A5328	LOCK---- ----------	4

201710

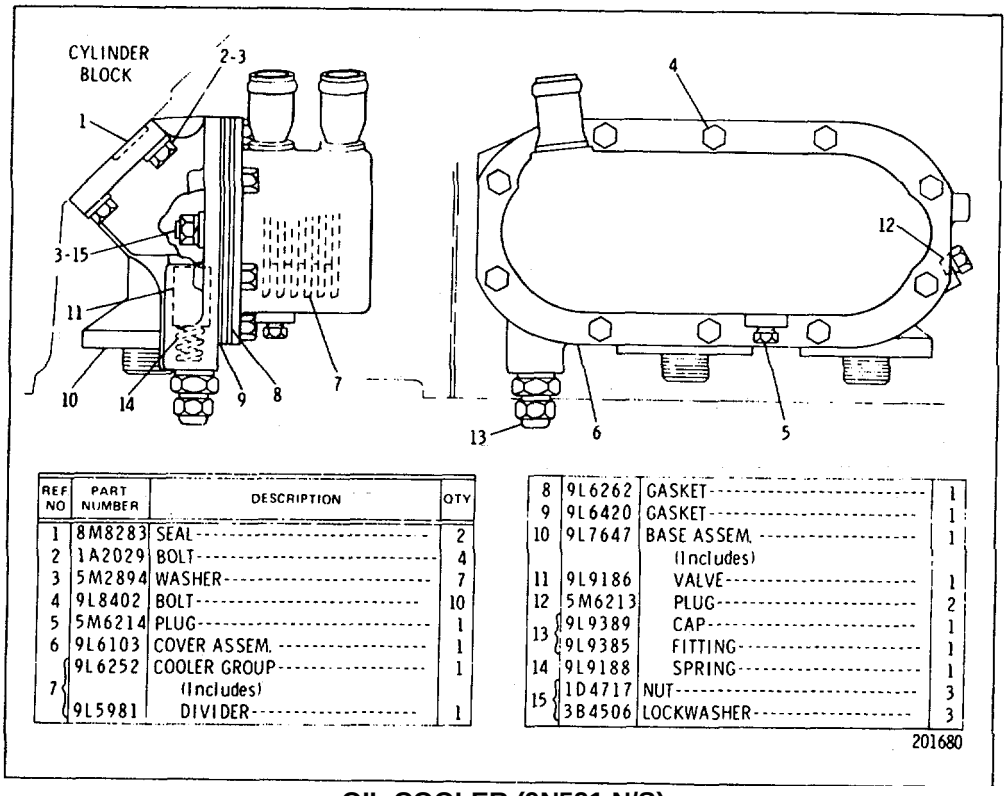
OIL LINES (9N533 N/A) - Front Sump



	REF. NO.	PART NUMBER	DESCRIPTION	QTY
	1	4N9050	BELL ASSEM.	1
	2	2A5328	LOCK	5
	3	S1617	BOLT	6
C	4	9N241	GASKET	1
	5	9N289	CLIP	1
	6	1D4716	NUT	1
		2N3389	LOCK	1
	7	4N9051	SUPPORT	1

C INDICATES CHANGE 150529

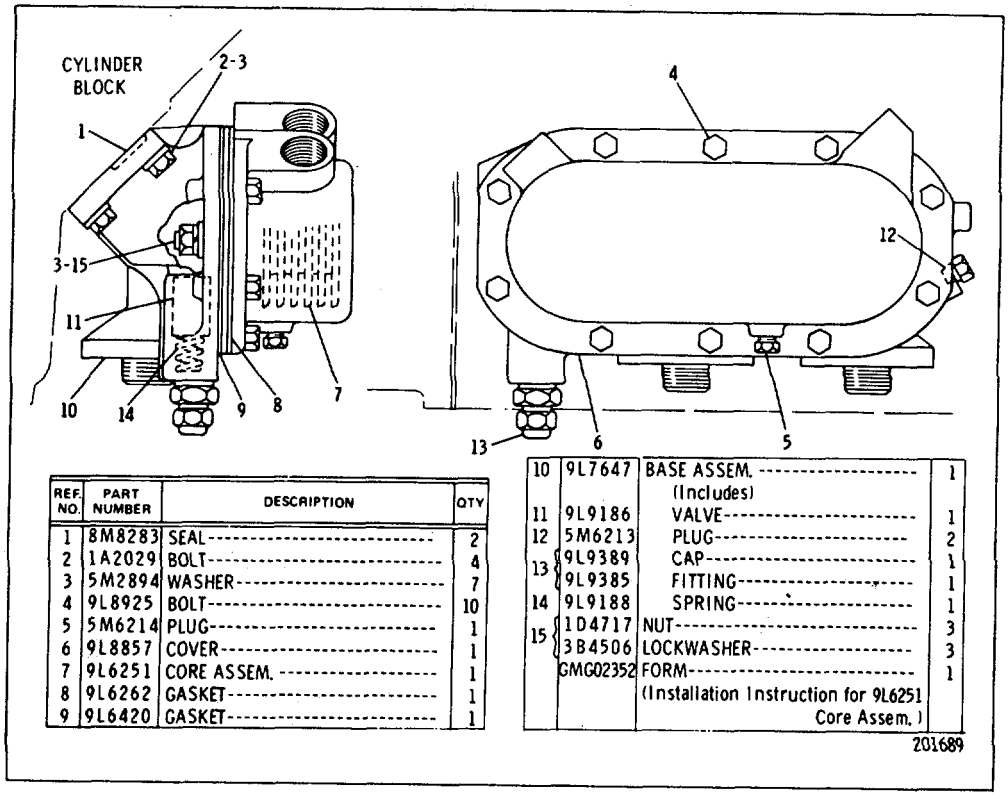
OIL LINES (4N8854 N/S) - Center Sump



REF NO	PART NUMBER	DESCRIPTION	QTY
1	8M8283	SEAL	2
2	1A2029	BOLT	4
3	5M2894	WASHER	7
4	9L8402	BOLT	10
5	5M6214	PLUG	1
6	9L6103	COVER ASSEM.	1
7	9L6252	COOLER GROUP (Includes)	1
	9L5981	DIVIDER	1
8	9L6262	GASKET	1
9	9L6420	GASKET	1
10	9L7647	BASE ASSEM. (Includes)	1
11	9L9186	VALVE	1
12	5M6213	PLUG	2
13	9L9389	CAP	1
	9L9385	FITTING	1
14	9L9188	SPRING	1
15	1D4717	NUT	3
	3B4506	LOCKWASHER	3

201680

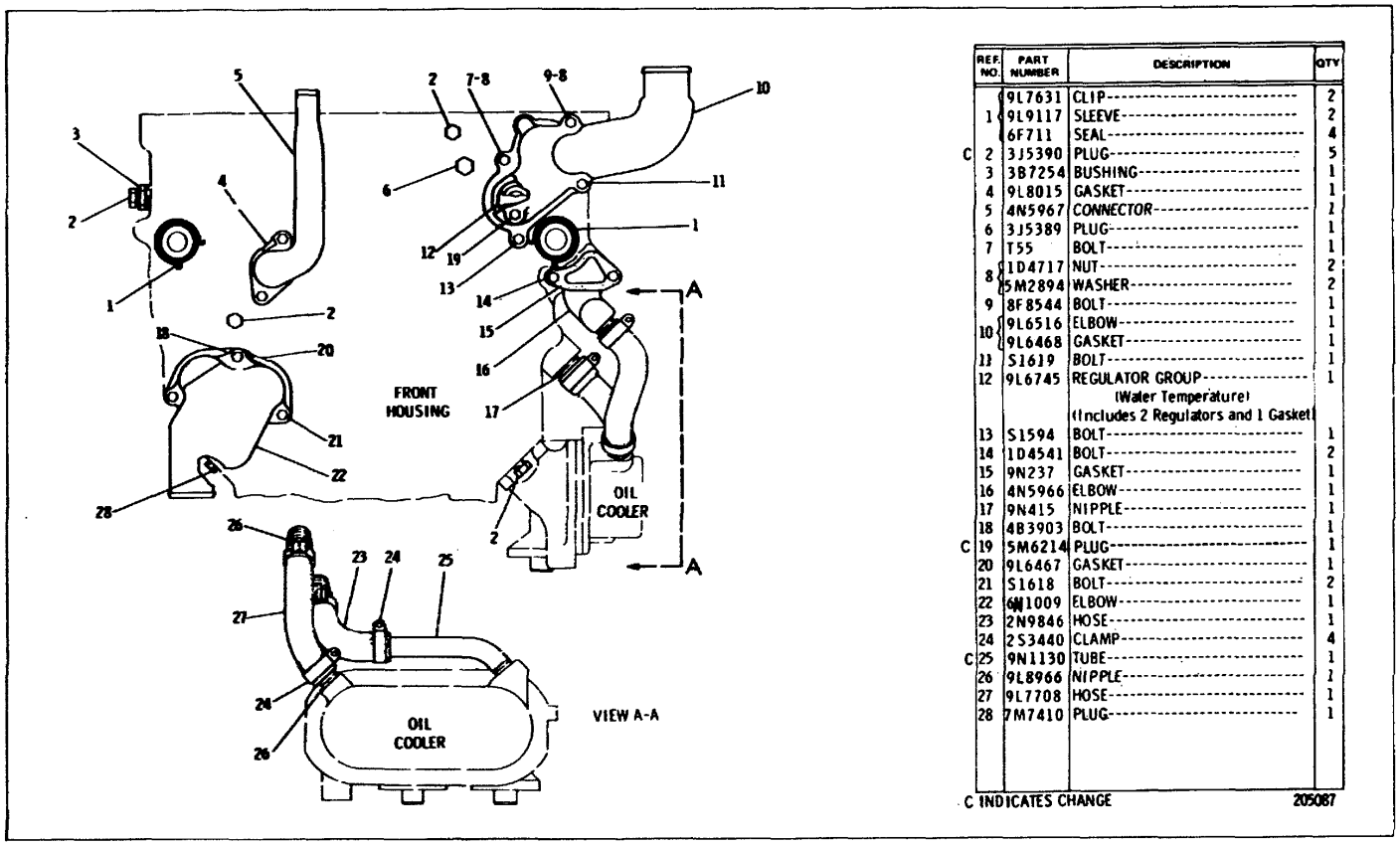
OIL COOLER (9N521 N/S)



REF NO.	PART NUMBER	DESCRIPTION	QTY
1	8M8283	SEAL	2
2	1A2029	BOLT	4
3	5M2894	WASHER	7
4	9L8925	BOLT	10
5	5M6214	PLUG	1
6	9L8857	COVER	1
7	9L6251	CORE ASSEM.	1
8	9L6262	GASKET	1
9	9L6420	GASKET	1
10	9L7647	BASE ASSEM. (Includes)	1
11	9L9186	VALVE	1
12	5M6213	PLUG	2
13	9L9389	CAP	1
	9L9385	FITTING	1
14	9L9188	SPRING	1
15	1D4717	NUT	3
	3B4506	LOCKWASHER	3
	GMG02352	FORM (Installation Instruction for 9L6251 Core Assem.)	1

201689

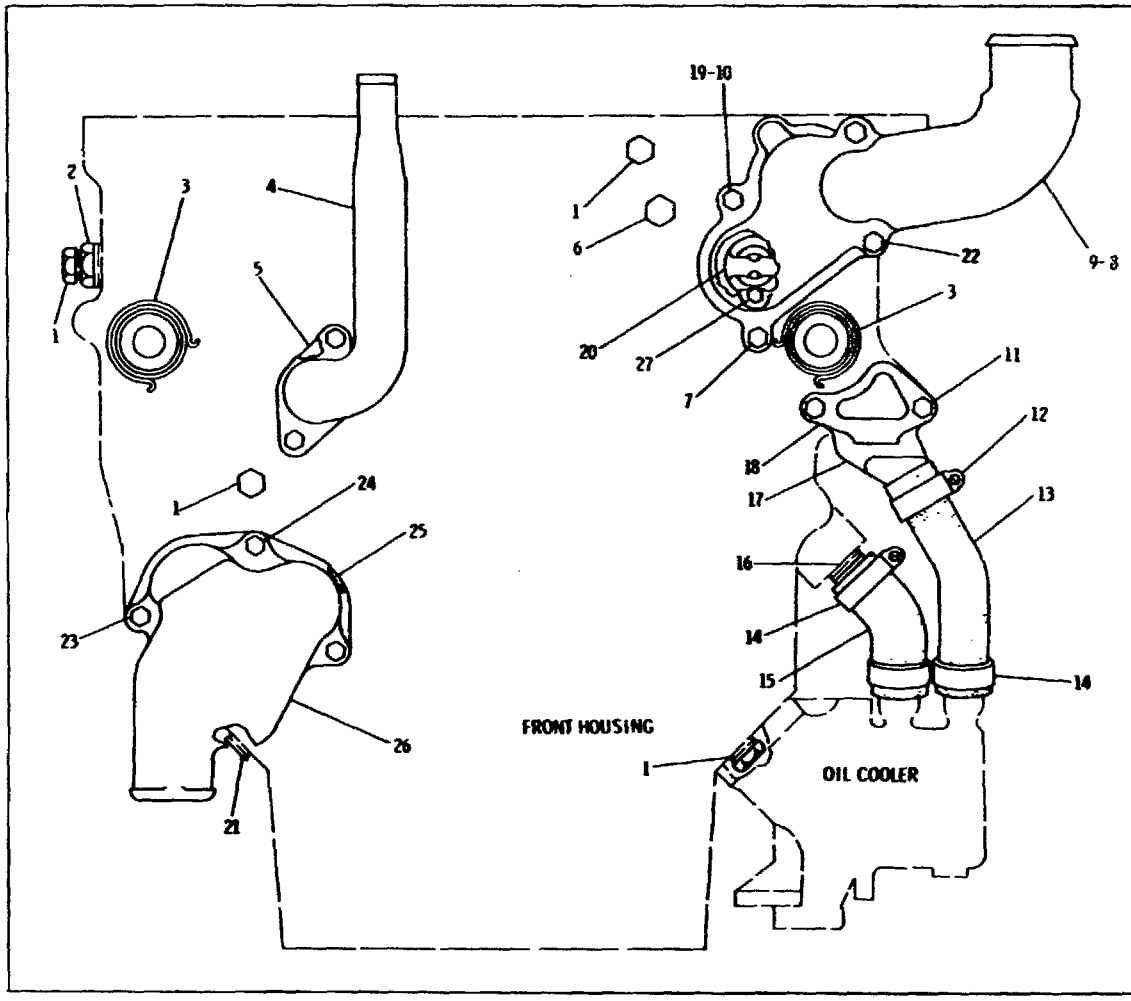
OIL COOLER (9N729 N/S)



REF. NO.	PART NUMBER	DESCRIPTION	QTY
	9L7631	CLIP	2
1	9L9117	SLEEVE	2
	6F711	SEAL	4
C 2	3J5390	PLUG	5
3	3B7254	BUSHING	1
4	9L8015	GASKET	1
5	4N5967	CONNECTOR	1
6	3J5389	PLUG	1
7	T55	BOLT	1
8	1D4717	NUT	2
	5M2894	WASHER	2
9	8F8544	BOLT	1
10	9L6516	ELBOW	1
	9L6468	GASKET	1
11	S1619	BOLT	1
12	9L6745	REGULATOR GROUP (Water Temperature) (Includes 2 Regulators and 1 Gasket)	1
13	S1594	BOLT	1
14	1D4541	BOLT	2
15	9N237	GASKET	1
16	4N5966	ELBOW	1
17	9N415	NIPPLE	1
18	4B3903	BOLT	1
C 19	5M6214	PLUG	1
20	9L6467	GASKET	1
21	S1618	BOLT	2
22	6N1009	ELBOW	1
23	2N9846	HOSE	1
24	2S3440	CLAMP	4
C 25	9N1130	TUBE	1
26	9L8966	NIPPLE	1
27	9L7708	HOSE	1
28	7M7410	PLUG	1

C INDICATES CHANGE 205087

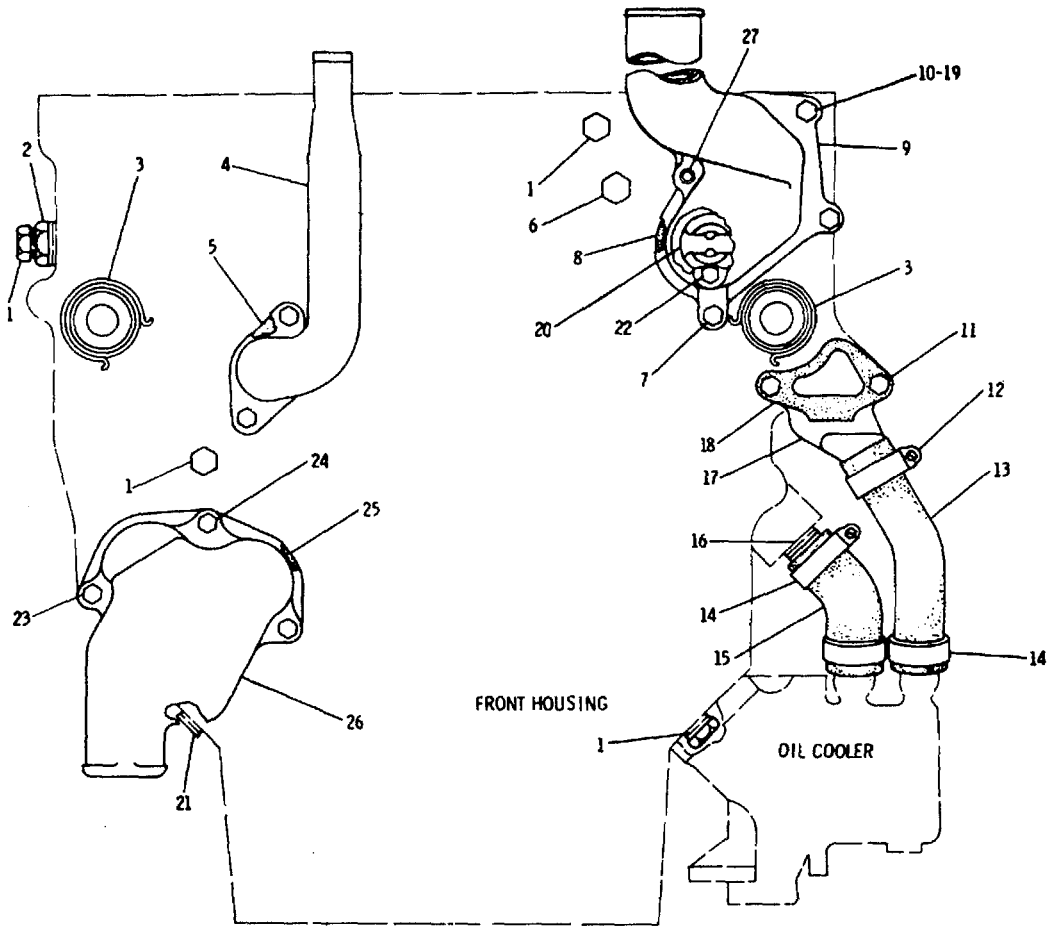
9N733 WATER LINES GROUP



C	REF. NO.	PART NUMBER	DESCRIPTION	QTY
	1	3J5390	PLUG	4
	2	3B7254	BUSHING	1
		9L7631	CLIP	2
	3	9N416	SLEEVE	2
		6F711	SEAL	4
	4	4N5967	CONNECTOR	1
	5	9L8015	GASKET	1
	6	3J5389	PLUG	1
	7	S1594	BOLT---1.00 in. (2.54 cm) long	1
	8	9L6468	GASKET	1
	9	9L6516	ELBOW	1
C		T55	BOLT---4.5 in. (1.14 dm) long	1
C	10	8F8544	BOLT---6.25 in. (1.59 dm) long	1
		1D4717	NUT	2
	11	1D4541	BOLT	2
	12	9M7958	CLAMP	1
	13	9N483	HOSE	1
	14	2S3440	CLAMP	3
	15	9N482	HOSE	1
	16	9N415	NIPPLE	1
	17	9N235	ELBOW	1
	18	9N237	GASKET	1
C	19	5M2894	WASHER	2
	20	9L6745	REGULATOR GROUP (Water Temperature) (Includes 2 Regulators and 1 Gasket)	1
	21	7M7410	PLUG	1
	22	S1619	BOLT	1
	23	S1618	BOLT	2
	24	4B3903	BOLT	1
	25	9L6467	GASKET	1
	26	6N1009	ELBOW	1
	27	5M6214	PLUG	1

C INDICATES CHANGE 205088

WATER LINES (6N466 N/S)

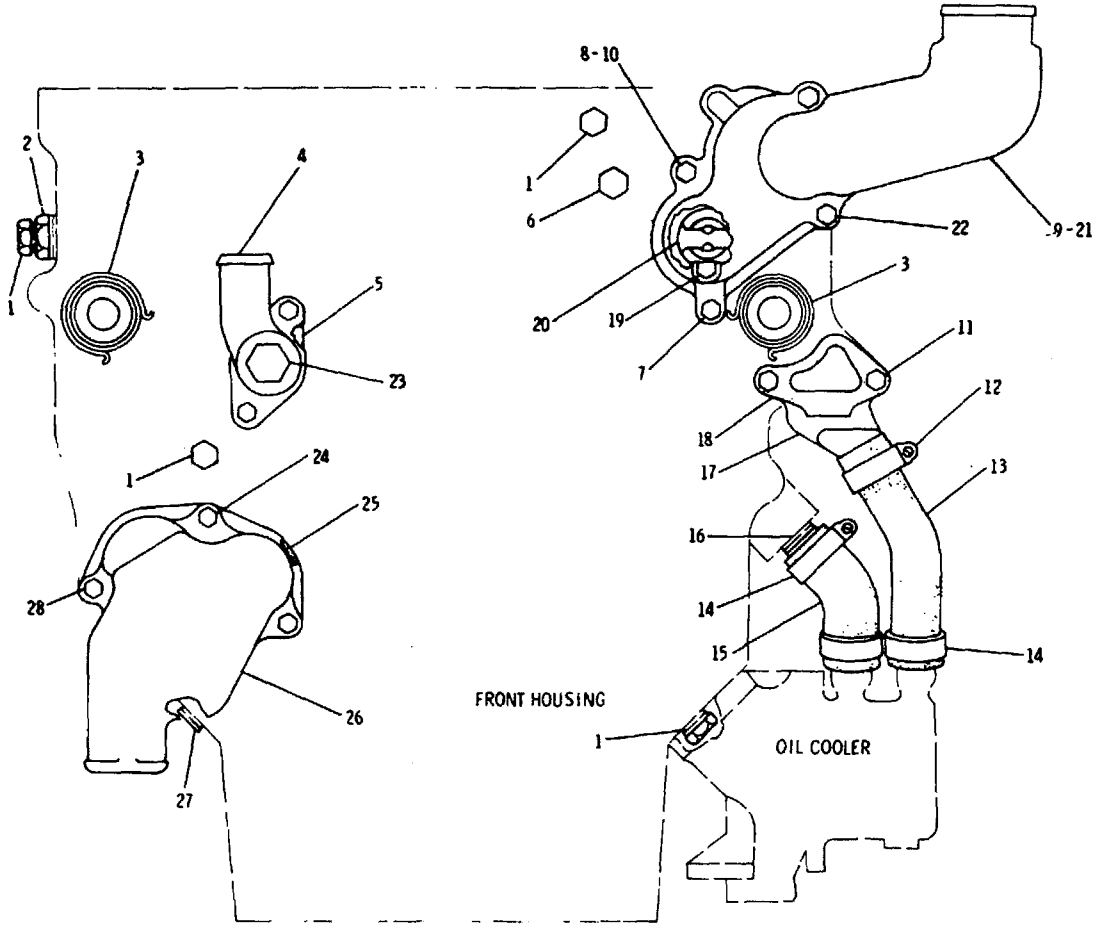


	REF. NO.	PART NUMBER	DESCRIPTION	QTY
	1	3J5390	PLUG	4
	2	9B7254	BUSHING	1
		9L7631	CLIP	2
	3	9N416	SLEEVE	2
		6F711	SEAL	4
	4	4N5967	CONNECTOR	1
	5	9L8015	GASKET	1
	6	3J5389	PLUG	1
	7	S1594	BOLT---1 in. (2.5 cm) long	2
	8	9L6468	GASKET	1
C	9	3N8822	ELBOW	1
C	10	5B2638	BOLT---5.25 in. (13.3 cm) long	1
		1D4717	NUT	1
	11	1D4541	BOLT	2
	12	9M7958	CLAMP	1
	13	9N483	HOSE	1
	14	2S3440	CLAMP	3
	15	9N482	HOSE	1
	16	9N415	NIPPLE	1
	17	9N235	ELBOW	1
	18	9N237	GASKET	1
	19	5M2894	WASHER	1
	20	9L6745	REGULATOR GROUP (Water Temperature) (Includes 2 Regulators and 1 Gasket)	1
	21	7M7410	PLUG	1
	22	5M6214	PLUG	1
	23	S1618	BOLT	2
	24	4B3903	BOLT	1
	25	9L6467	GASKET	1
	26	6N1009	ELBOW	1
C	27	T65	BOLT---3.5 in. (8.9 cm) long	1

C INDICATES CHANGE

152007

WATER LINES (6N465 N/S)

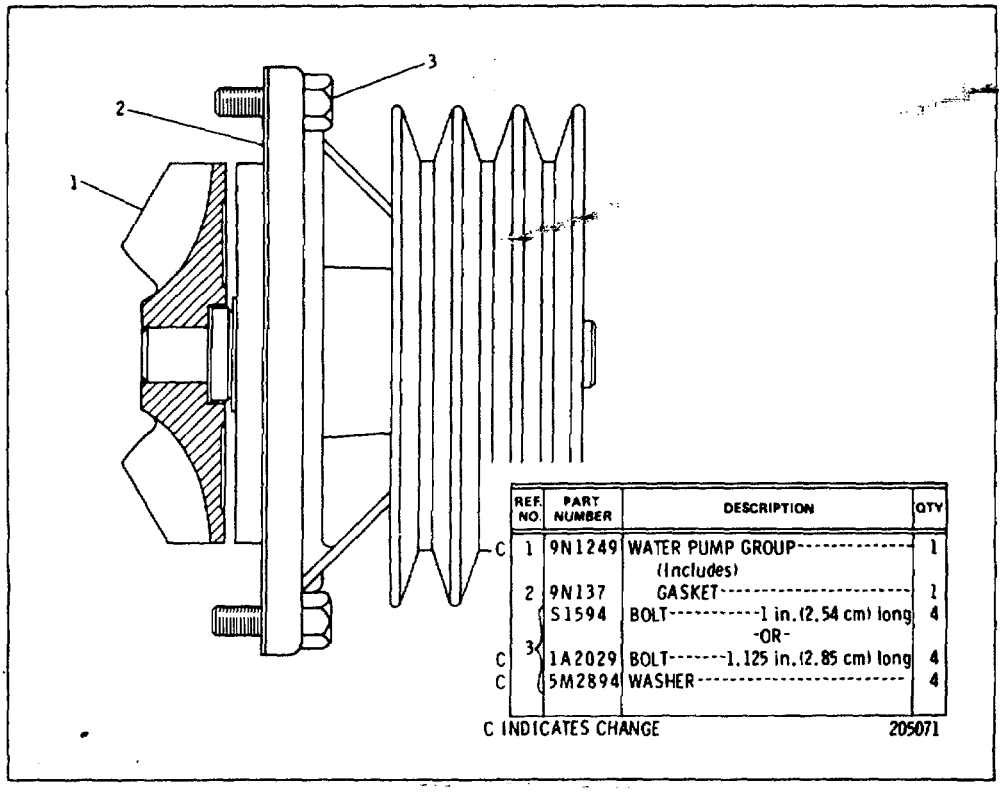


	REF. NO.	PART NUMBER	DESCRIPTION	QTY
	1	3J5390	PLUG	4
	2	3B7254	BUSHING	1
		9L7631	CLIP	2
	3	9N416	SLEEVE	2
		6F711	SEAL	4
	4	2N4675	ELBOW	1
	5	9L8015	GASKET	1
	6	3J5389	PLUG	1
C	7	S1594	BOLT---1 in. (2.54 cm) long	1
	8	5M2894	WASHER	2
C	9	9L6516	ELBOW	1
C		T55	BOLT---4.25 in. (1.08 cm) long	1
C	10	8F8544	BOLT---6.25 in. (15.9 cm) long	1
		1D4717	NUT	2
	11	1D4541	BOLT	2
	12	9M7958	CLAMP	1
	13	9N483	HOSE	1
	14	2S3440	CLAMP	3
	15	9N482	HOSE	1
	16	9N415	NIPPLE	1
	17	9N235	ELBOW	1
	18	9N237	GASKET	1
	19	5M6214	PLUG	1
	20	9L6745	REGULATOR GROUP (Water Temperature) (Includes 2 Regulators and 1 Gasket)	1
	21	9L6468	GASKET	1
	22	S1619	BOLT---3 in. (7.62 cm) long	1
	23	3M7045	PLUG	1
	24	4B3903	BOLT	1
	25	9L6467	GASKET	1
	26	6N1009	ELBOW	1
	27	7M7410	PLUG	1
	28	S1618	BOLT	2

C INDICATES CHANGE

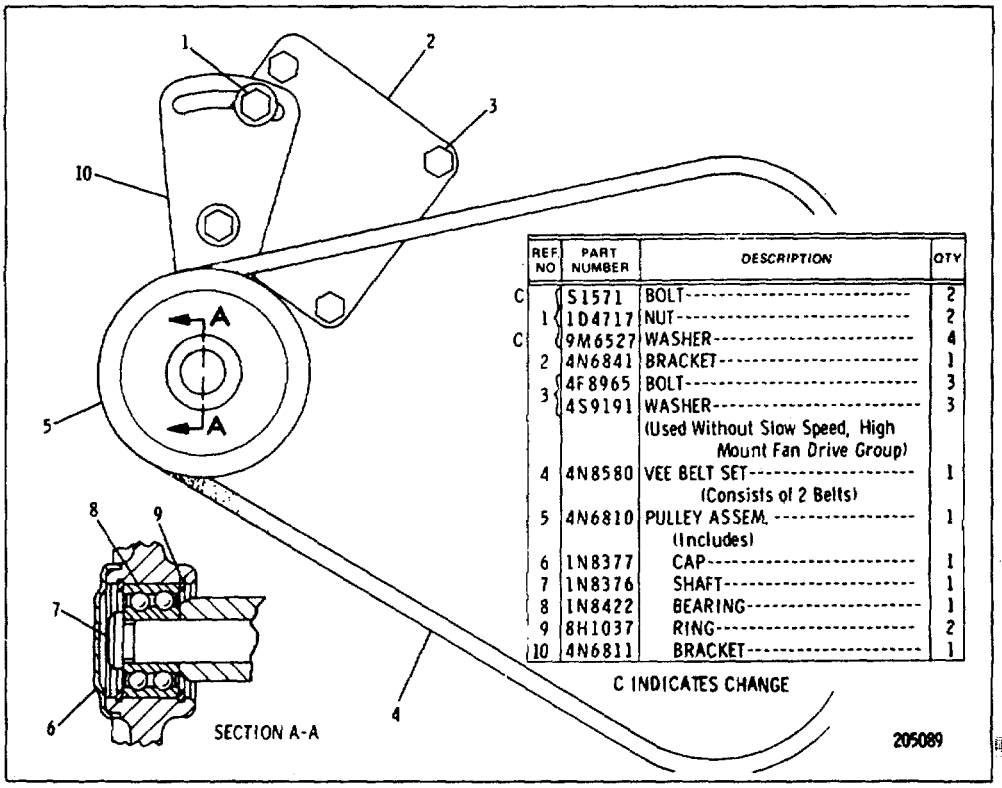
152008

WATER LINES (4N8856 N/S)



REF. NO.	PART NUMBER	DESCRIPTION	QTY
C 1	9N1249	WATER PUMP GROUP (Includes)	1
2	9N137	GASKET	1
3	S1594	BOLT-1 in. (2.54 cm) long -OR-	4
C 3	1A2029	BOLT-1.125 in. (2.85 cm) long	4
C	5M2894	WASHER	4

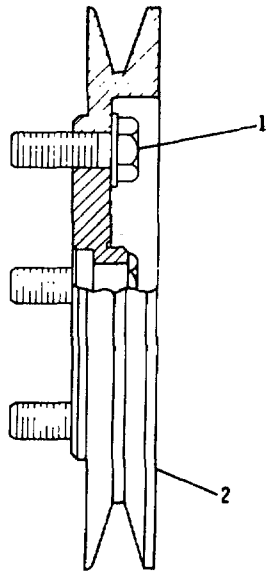
9N140 WATER PUMP GROUP



REF NO	PART NUMBER	DESCRIPTION	QTY
C	S1571	BOLT	2
1	1D4717	NUT	2
C	9M6527	WASHER	4
2	4N6841	BRACKET	1
3	4F8965	BOLT	3
	4S9191	WASHER (Used Without Slow Speed, High Mount Fan Drive Group)	3
4	4N8580	VEE BELT SET (Consists of 2 Belts)	1
5	4N6810	PULLEY ASSEM. (Includes)	1
6	1N8377	CAP	1
7	1N8376	SHAFT	1
8	1N8422	BEARING	1
9	8H1037	RING	2
10	4N6811	BRACKET	1

C INDICATES CHANGE

4N7390 WATER PUMP DRIVE GROUP
NOT FOR USE WITH 4N6981 ALTERNATOR AND 4N7200 ACCESSORY DRIVE SHOWN OF PAGES 131 AND 147. AN ATTACHMENT

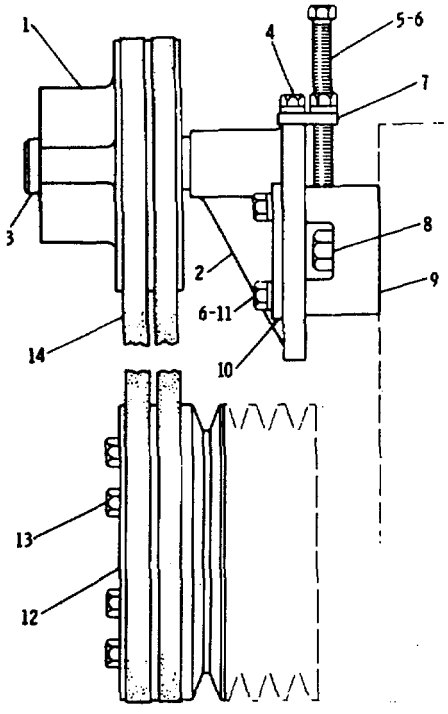


	REF. NO.	PART NUMBER	DESCRIPTION	QTY
C	1	S1618	BOLT	4
		9M1974	WASHER	4
	2	9L7626	PULLEY	1

C INDICATES CHANGE

201765

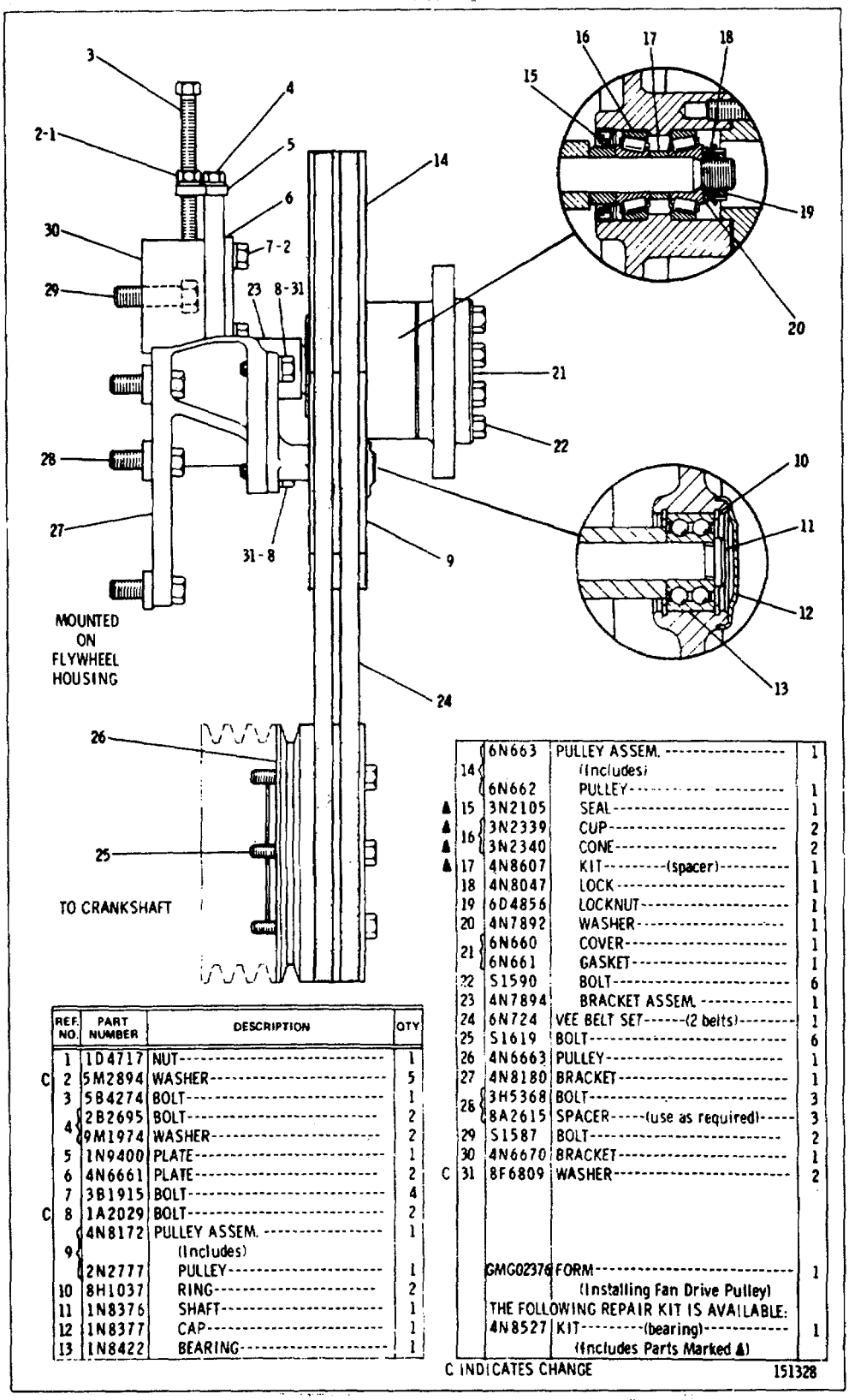
9L7462 WATER PUMP PULLEY GROUP



REF. NO	PART NUMBER	DESCRIPTION	QTY
1	3N1929	PULLEY ASSEM. (Includes)	1
2	1N9397	BRACKET	1
3	3N1930	SHAFT AND BEARING ASSEM.	1
4	2B2695	BOLT	2
	9M1974	WASHER	2
5	5B4274	BOLT	1
	1D4717	NUT	1
6	5M2894	WASHER	5
7	1N9400	PLATE	1
8	S1587	BOLT	2
9	4N6670	BRACKET	1
10	4N6661	PLATE	2
11	3B1915	BOLT	4
12	4N6663	PULLEY	1
13	S1619	BOLT	6
14	9L895	VEE BELT SET (Consists of 2 Belts)	1

201911

4N7438 FAN DRIVE GROUP
NOT FOR USE WITH TURBOCHARGER ENGINE

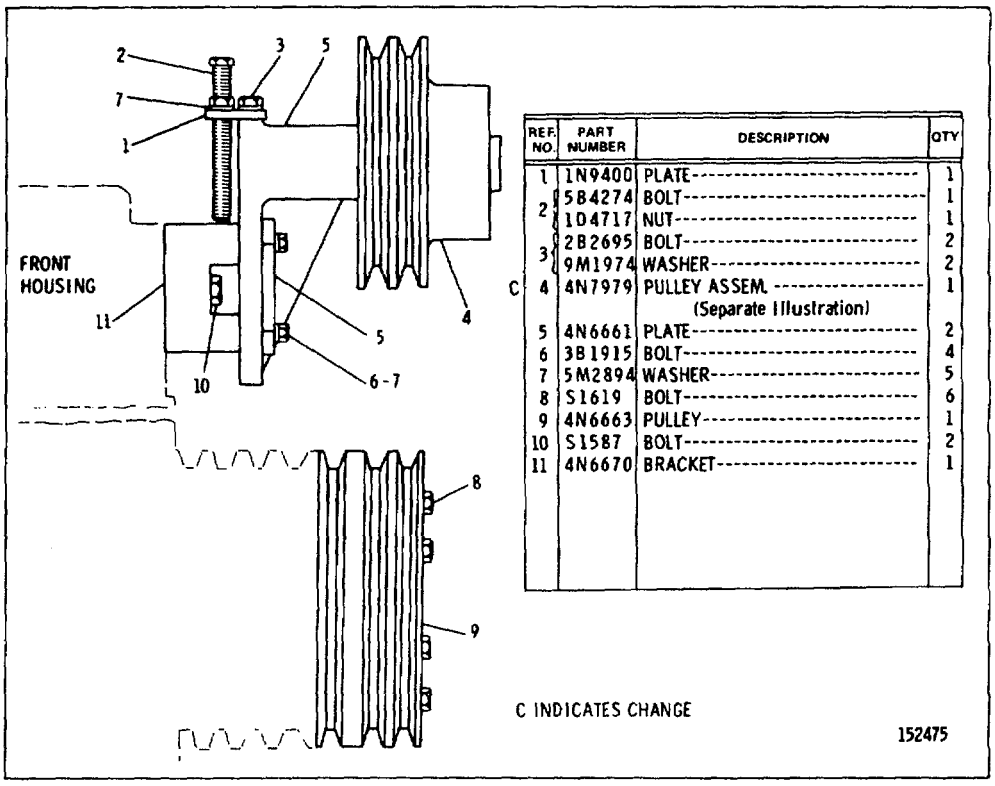


REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	1D4717	NUT	1
C 2	5M2894	WASHER	5
3	5B4274	BOLT	1
4	2B2695	BOLT	2
	9M1974	WASHER	2
5	1N9400	PLATE	1
6	4N6661	PLATE	2
7	3B1915	BOLT	4
C 8	1A2029	BOLT	2
9	4N8172	PULLEY ASSEM. (Includes)	1
	2N2777	PULLEY	1
10	8H1037	RING	2
11	1N8376	SHAFT	1
12	1N8377	CAP	1
13	1N8422	BEARING	1

14	6N663	PULLEY ASSEM. (Includes)	1
	6N662	PULLEY	1
▲ 15	3N2105	SEAL	1
▲ 16	3N2339	CUP	2
▲	3N2340	CONE	2
▲ 17	4N8607	KIT (spacer)	1
18	4N8047	LOCK	1
19	6D4856	LOCKNUT	1
20	4N7892	WASHER	1
21	6N660	COVER	1
	6N661	GASKET	1
22	S1590	BOLT	6
23	4N7894	BRACKET ASSEM.	1
24	6N724	VEE BELT SET (2 belts)	1
25	S1619	BOLT	6
26	4N6663	PULLEY	1
27	4N8180	BRACKET	1
28	3H5368	BOLT	3
	8A2615	SPACER (use as required)	3
29	S1587	BOLT	2
30	4N6670	BRACKET	1
C 31	8F6809	WASHER	2
	GMG02376	FORM (Installing Fan Drive Pulley)	1
	THE FOLLOWING REPAIR KIT IS AVAILABLE:		
	4N8527	KIT (bearing) (Includes Parts Marked ▲)	1

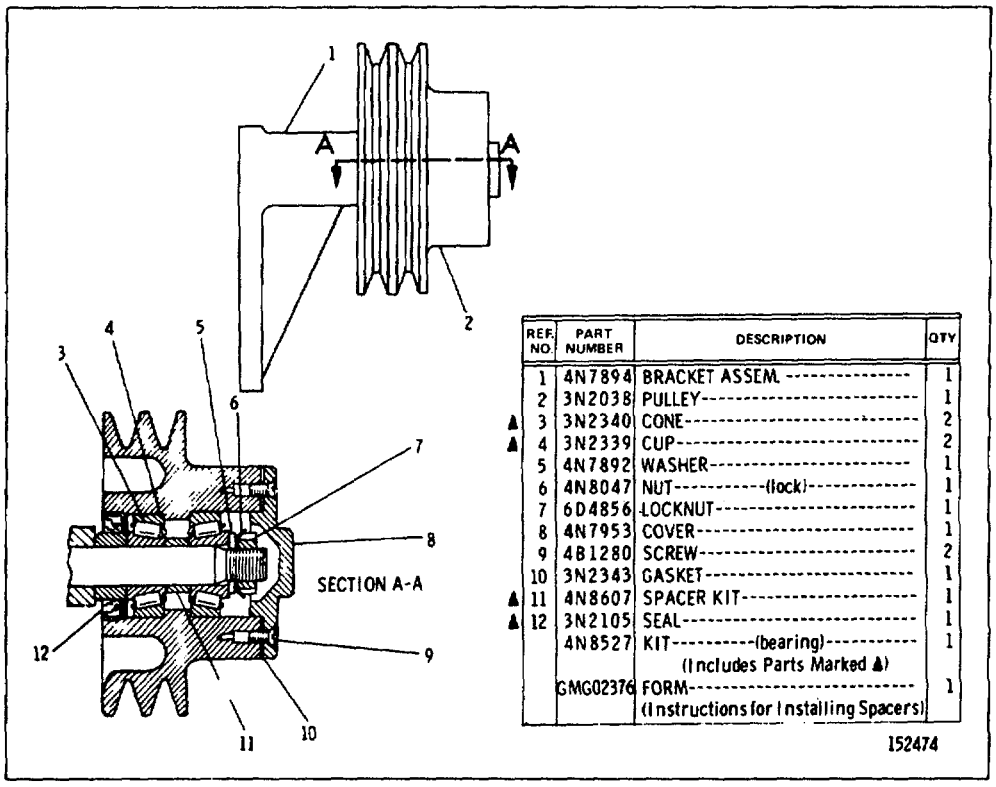
C INDICATES CHANGE 151328

6N353 FAN DRIVE GROUP



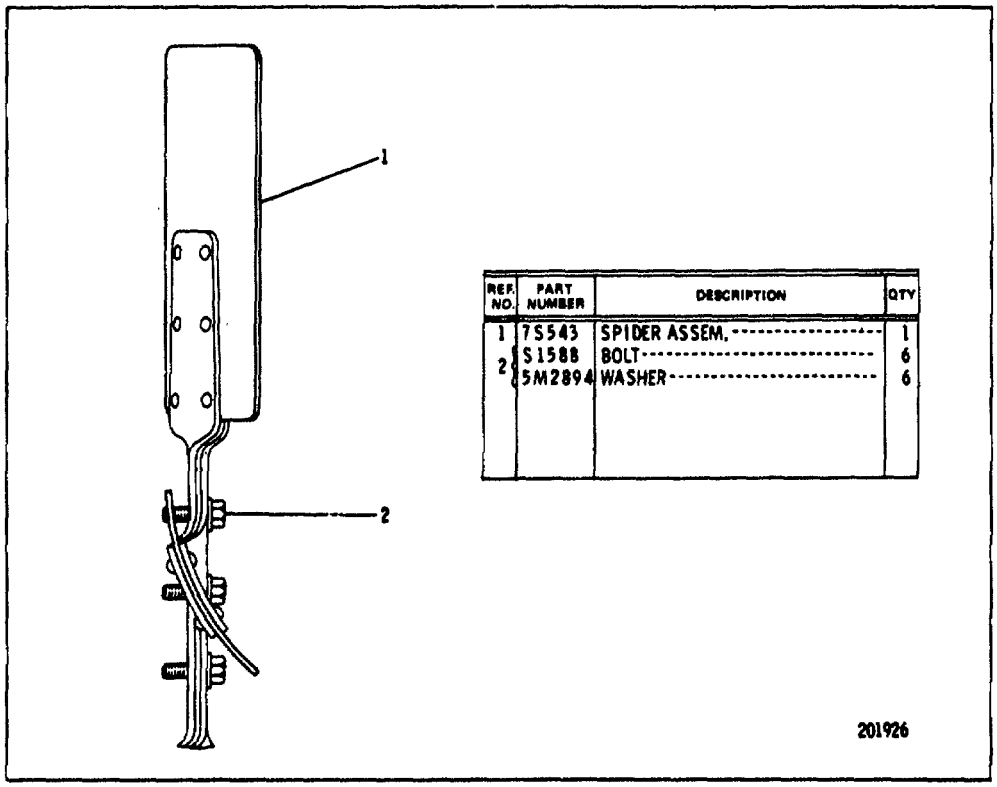
REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	1N9400	PLATE	1
2	5B4274	BOLT	1
	1D4717	NUT	1
3	2B2695	BOLT	2
	9M1974	WASHER	2
C 4	4N7979	PULLEY ASSEM. (Separate Illustration)	1
5	4N6661	PLATE	2
6	3B1915	BOLT	4
7	5M2894	WASHER	5
8	S1619	BOLT	6
9	4N6663	PULLEY	1
10	S1587	BOLT	2
11	4N6670	BRACKET	1

FAN BELT DRIVE (4N9614 N/S)



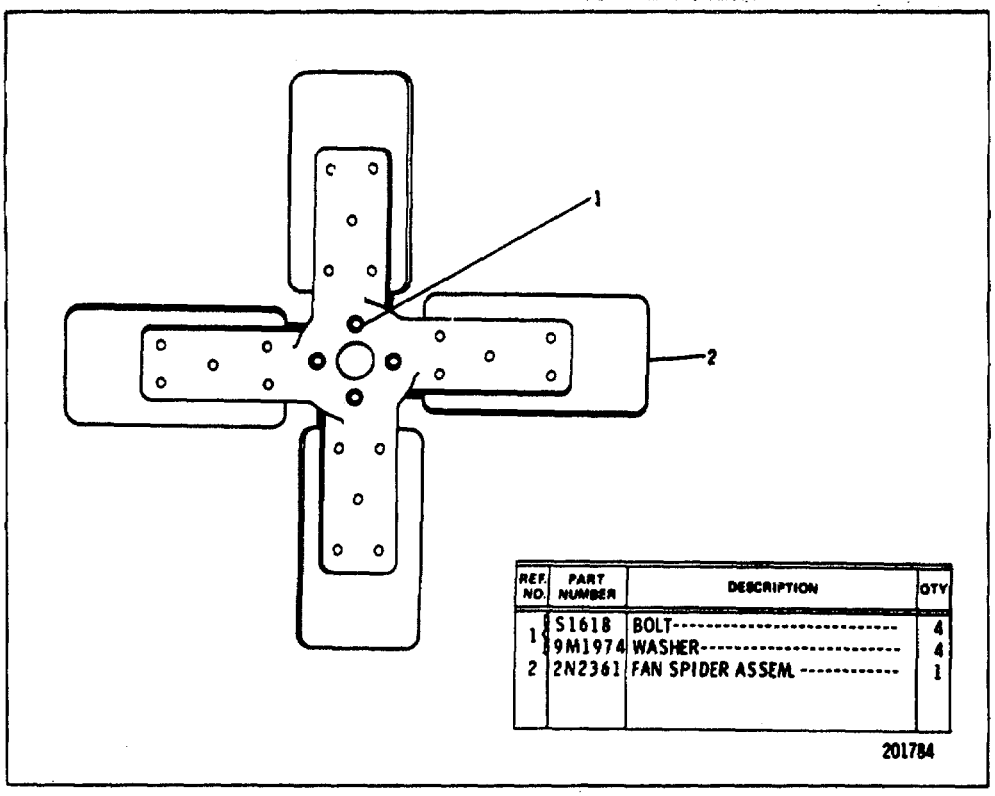
REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	4N7894	BRACKET ASSEM.	1
2	3N2038	PULLEY	1
▲ 3	3N2340	CONE	2
▲ 4	3N2339	CUP	2
5	4N7892	WASHER	1
6	4N8047	NUT-(lock)	1
7	6D4856	LOCKNUT	1
8	4N7953	COVER	1
9	4B1280	SCREW	2
10	3N2343	GASKET	1
▲ 11	4N8607	SPACER KIT	1
▲ 12	3N2105	SEAL	1
	4N8527	KIT-(bearing) (Includes Parts Marked ▲)	1
	GMG02376	FORM-(Instructions for Installing Spacers)	1

4N7979 PULLEY ASSEMBLY
Part of Fan Belt Drive



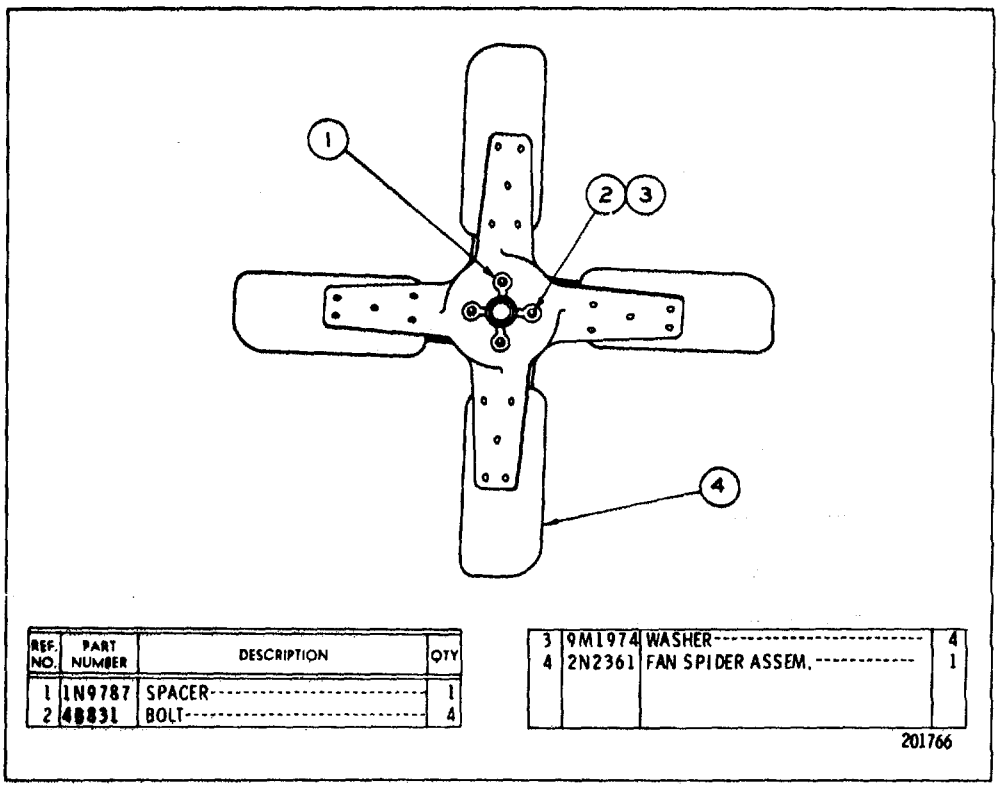
REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	7S543	SPIDER ASSEM.	1
2	S1588	BOLT	6
	5M2894	WASHER	6

6N352 BLOWER FAN GROUP
AN ATTACHMENT



REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	S1618	BOLT	4
	9M1974	WASHER	4
2	2N2361	FAN SPIDER ASSEM.	1

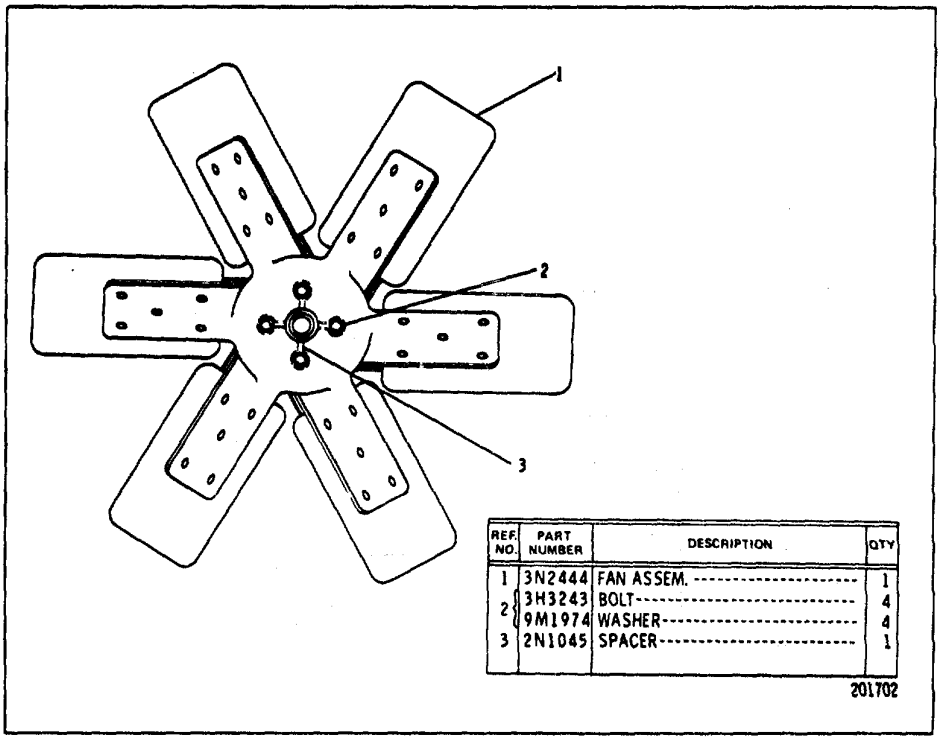
4N8673 BLOWER FAN GROUP
NOT FOR USE WITH TURBOCHARGED ENGINE
AN ATTACHMENT



REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	1N9787	SPACER	1
2	4B831	BOLT	4
3	9M1974	WASHER	4
4	2N2361	FAN SPIDER ASSEM.	1

201766

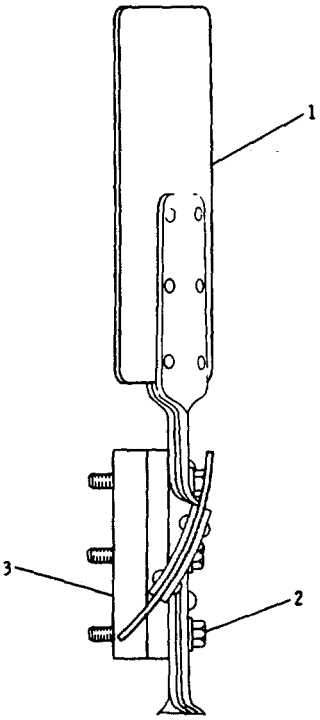
2N2858 BLOWER FAN GROUP-22" Diameter
NOT FOR USE WITH TURBOCHARGED ENGINE
AN ATTACHMENT



REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	3N2444	FAN ASSEM.	1
2	3H3243	BOLT	4
	9M1974	WASHER	4
3	2N1045	SPACER	1

201702

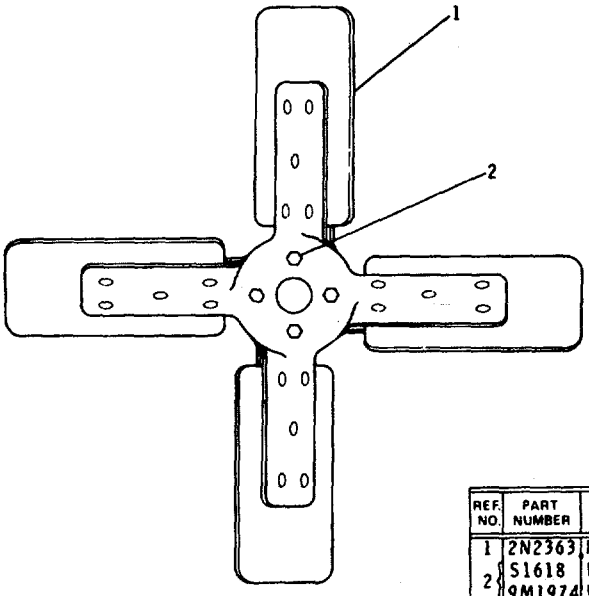
3N2445 SUCTION FAN GROUP - 22" Diameter
NOT FOR SALE WITH TURBOCHARGED ENGINE
ALSO AN ATTACHMENT



REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	7S544	SPIDER ASSEM.	1
2	T573	BOLT	6
	5M2894	WASHER	6
3	6N659	SPACER	1

201927

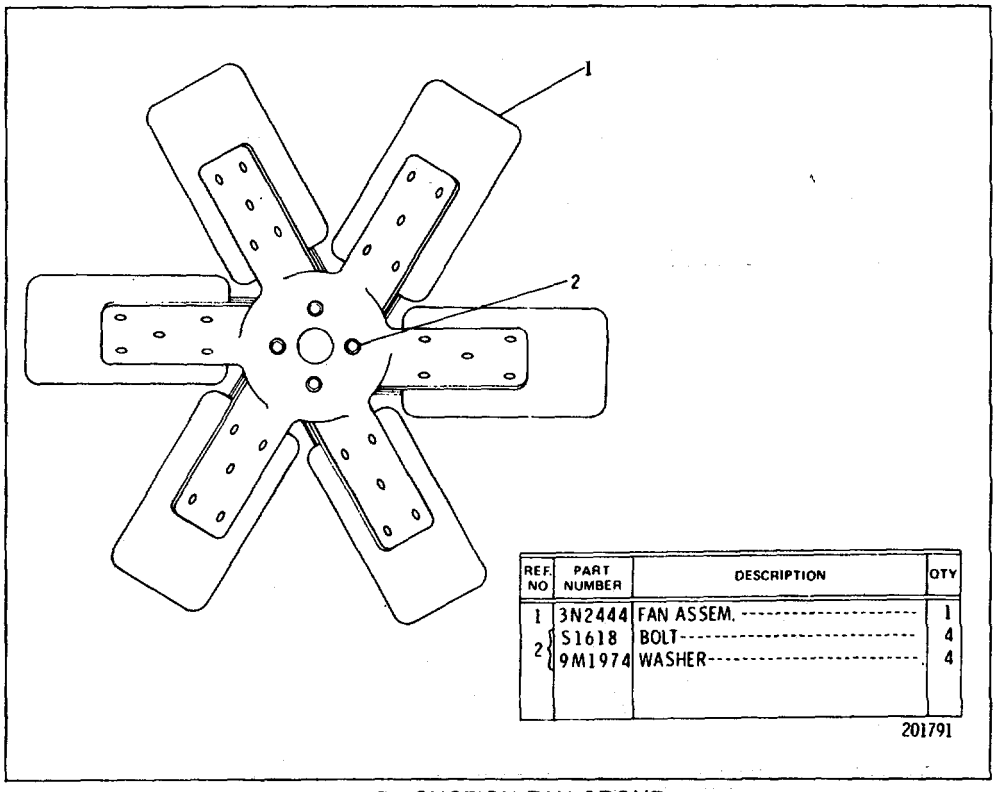
6N351 SUCTION FAN GROUP
AN ATTACHMENT



REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	2N2363	FAN ASSEM.	1
2	S1618	BOLT	4
	9M1974	WASHER	4

201792

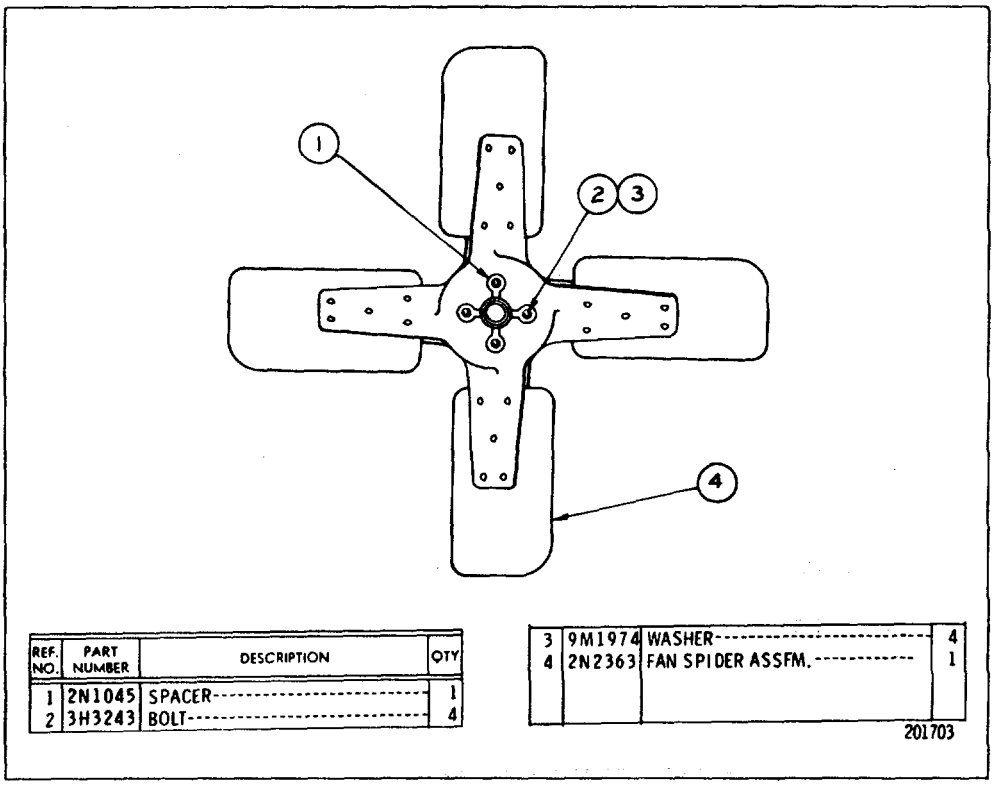
4N8672 SUCTION FAN GROUP
NOT FOR SALE WITH TURBOCHARGED ENGINE
AT ATTACHMENT



REF. NO	PART NUMBER	DESCRIPTION	QTY
1	3N2444	FAN ASSEM.	1
2	S1618	BOLT	4
	9M1974	WASHER	4

201791

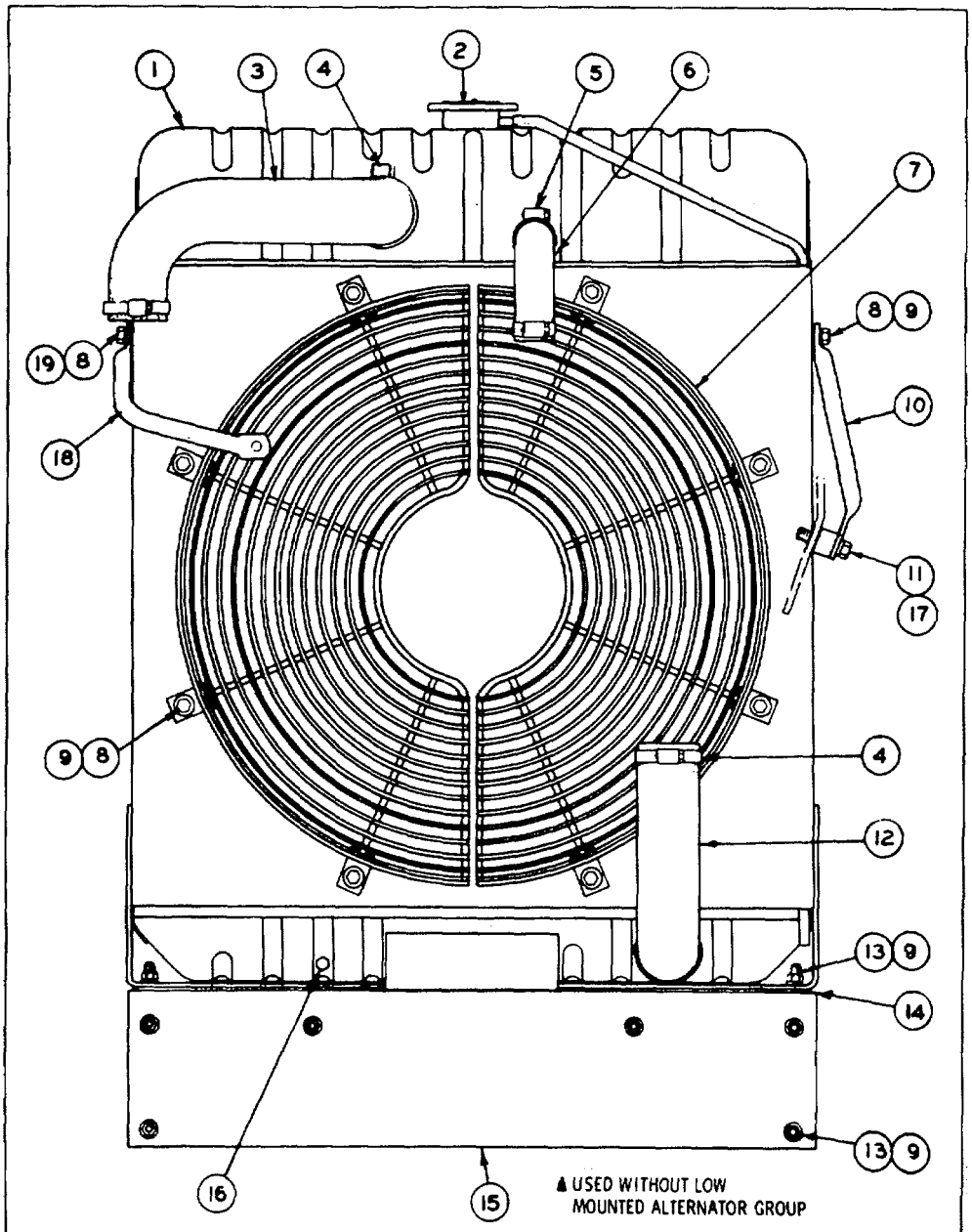
4N8671 SUCTION FAN GROUP
NOT FOR USE WITH TURBOCHARGED ENGINE
AN ATTACHMENT



REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	2N1045	SPACER	1
2	3H3243	BOLT	4
3	9M1974	WASHER	4
4	2N2363	FAN SPIDER ASSFM.	1

201703

2N2458 SUCTION FAN GROUP[
ALSO AN ATTACHMENT

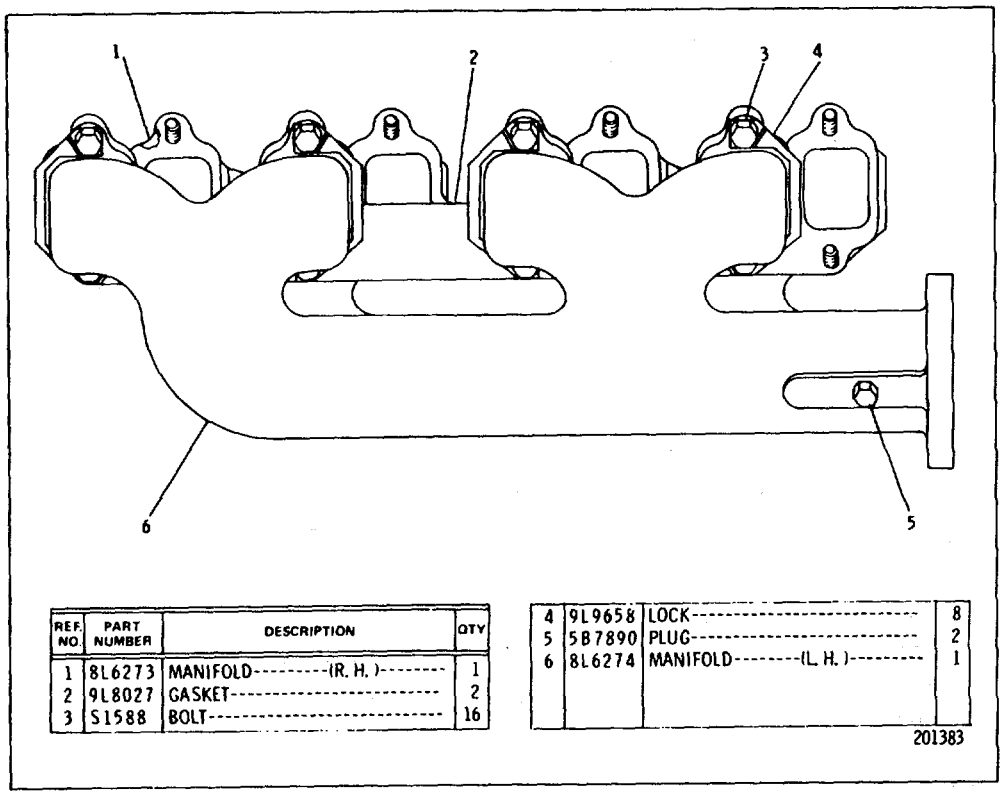


	REF. NO.	PART NUMBER	DESCRIPTION	QTY
	1	3N2913	RADIATOR ASSEM. (Includes)	1
	2	6L8617	CAP	1
	3	4N8146	HOSE	1
C	4	5P597	CLAMP	4
	5	9M7958	CLAMP	2
	6	4N6742	HOSE	1
	7	1N9358	GUARD	2
	8	S509	BOLT	10
C	9	5M2894	WASHER	26
	10	2N199	BRACE	1
C ▲	11	T319	BOLT	1
		6H7062	SPACER	1
	12	2N193	HOSE	1
	13	S1588	BOLT	8
		1D4717	NUT	8
	14	2N1322	DAMPER	2
	15	2N170	SUPPORT ASSEM.	1
	16	5B7890	PLUG	1
C	17	4S9191	WASHER	1
	18	4N6910	BRACE	1
	19	4B4278	WASHER	2

C INDICATES CHANGE

205093

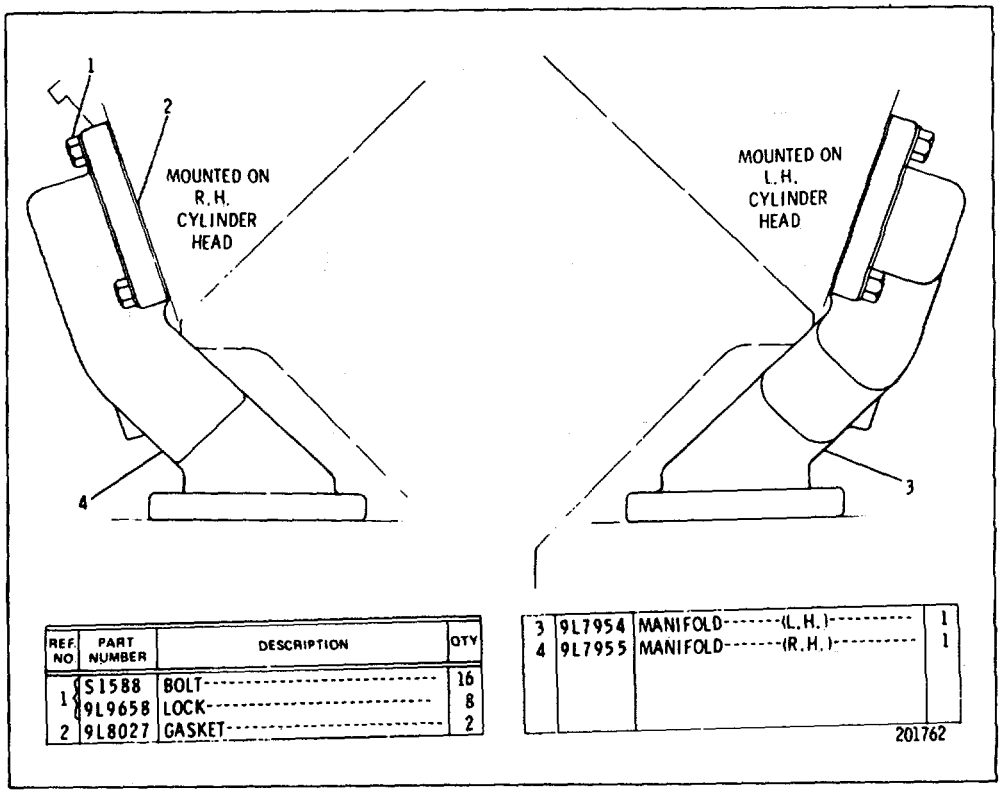
4N7393 RADIATOR GROUP
NOT FOR USE WITH TURBOCHARGED ENGINE
AN ATTACHMENT



REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	8L6273	MANIFOLD---------(R. H.)--------	1
2	9L8027	GASKET----------	2
3	S1588	BOLT----------	16
4	9L9658	LOCK----------	8
5	5B7890	PLUG----------	2
6	8L6274	MANIFOLD--------(L. H.)---------	1

201383

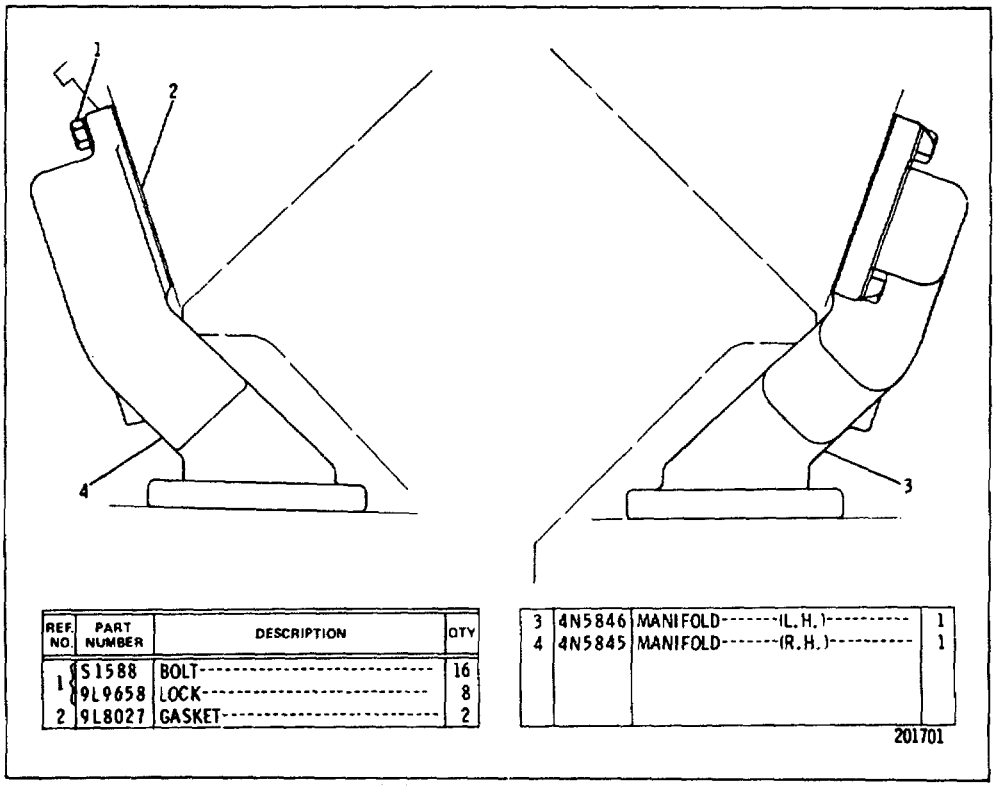
EXHAUST MANIFOLD (4N5875 N/S)



REF. NO	PART NUMBER	DESCRIPTION	QTY
1	S1588	BOLT----------	16
	9L9658	LOCK----------	8
2	9L8027	GASKET----------	2
3	9L7954	MANIFOLD-------(L.H.)----------	1
4	9L7955	MANIFOLD-------(R.H.)----------	1

201762

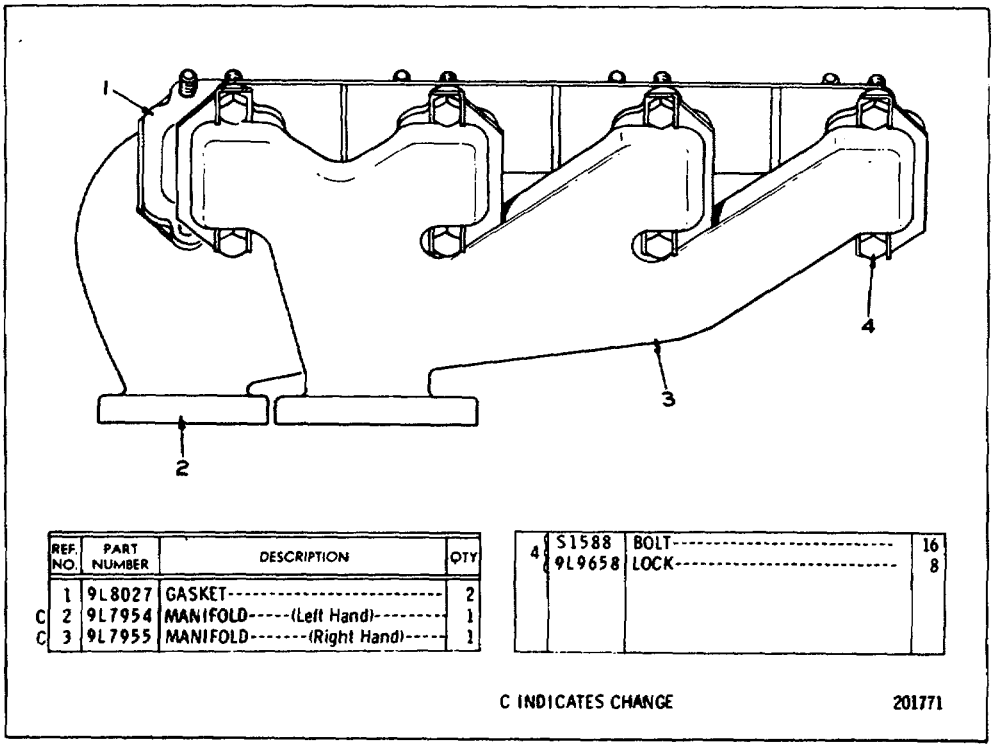
EXHAUST MANIFOLD (9L6258 N/S)



REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	S1588	BOLT----------	16
	9L9658	LOCK----------	8
2	9L8027	GASKET----------	2
3	4N5846	MANIFOLD-------(L.H.)----------	1
4	4N5845	MANIFOLD-------(R.H.)----------	1

201701

EXHAUST MANIFOLD (9N535 N/S)

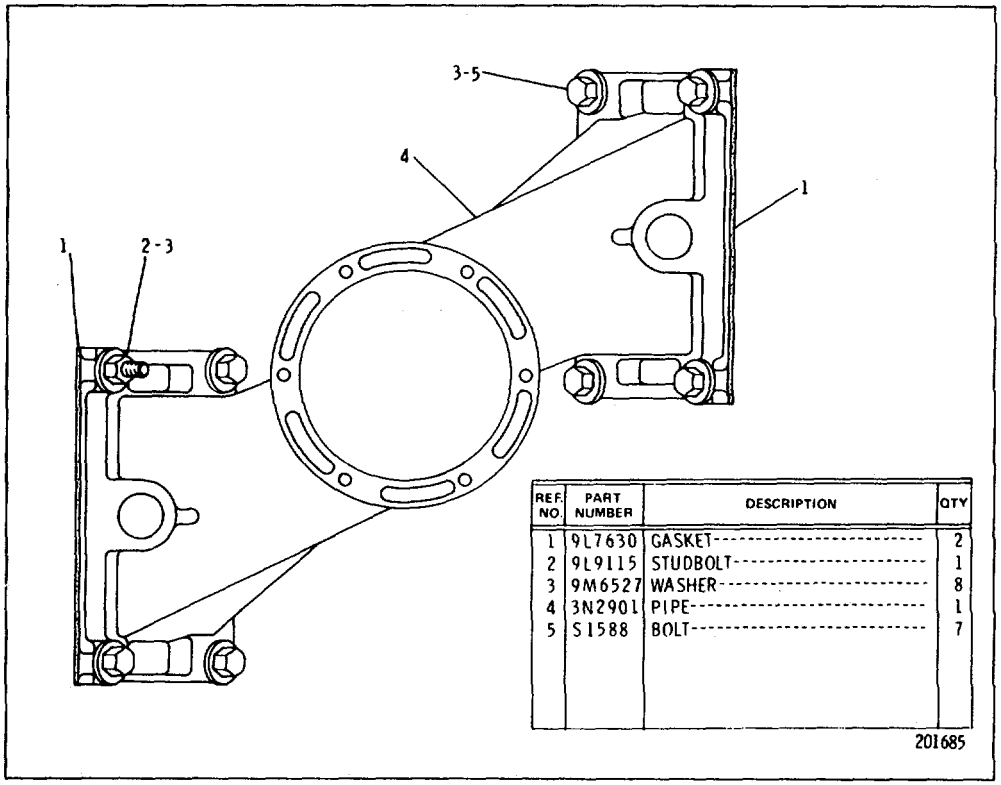


	REF. NO.	PART NUMBER	DESCRIPTION	QTY
	1	9L8027	GASKET----------	2
C	2	9L7954	MANIFOLD-----(Left Hand)----------	1
C	3	9L7955	MANIFOLD-------(Right Hand)-----	1
	4	S1588	BOLT----------	16
		9L9658	LOCK----------	8

C INDICATES CHANGE

201771

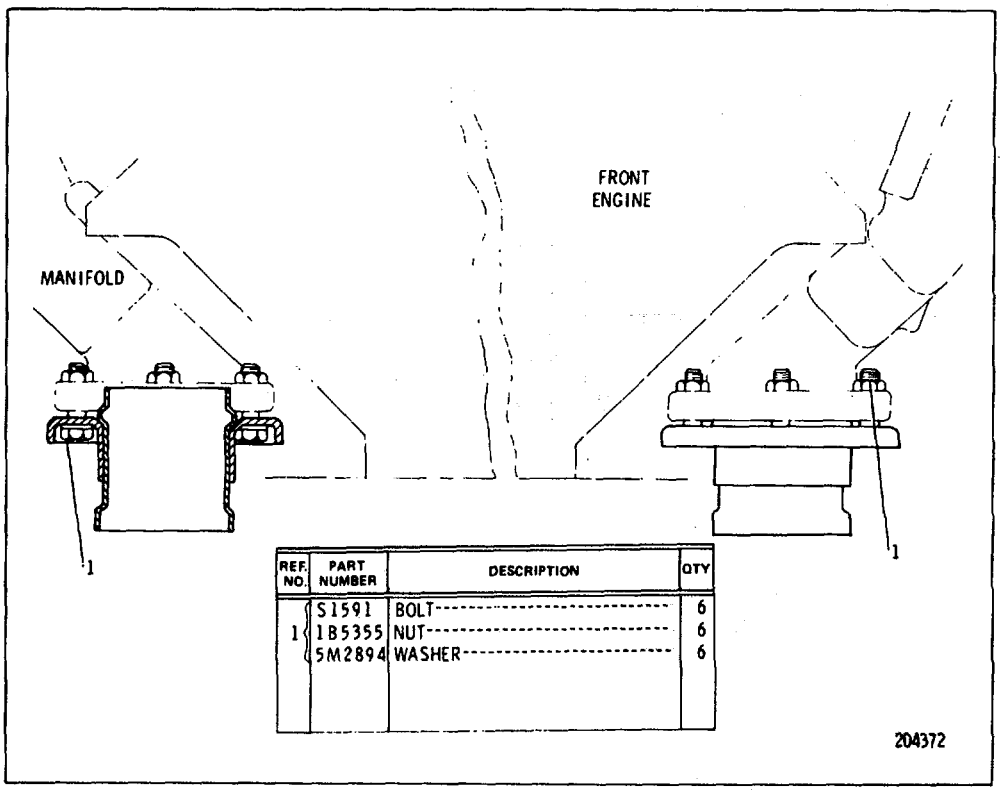
2N2467 MANIFOLD GROUP
NOT FOR USE WITH TURBOCHARGED ENGINE
AN ATTACHMENT



REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	9L7630	GASKET	2
2	9L9115	STUDBOLT	1
3	9M6527	WASHER	8
4	3N2901	PIPE	1
5	S1588	BOLT	7

201685

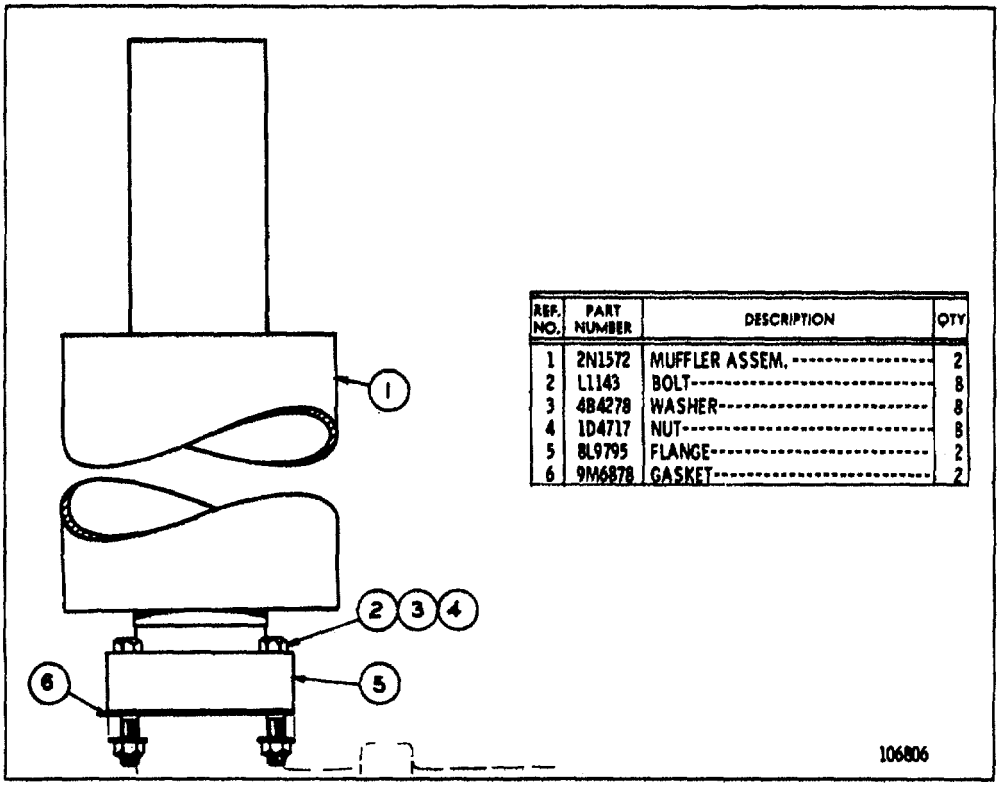
INLET MANIFOLD (9N555 N/S)



REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	S1591	BOLT	6
	1B5355	NUT	6
	5M2894	WASHER	6

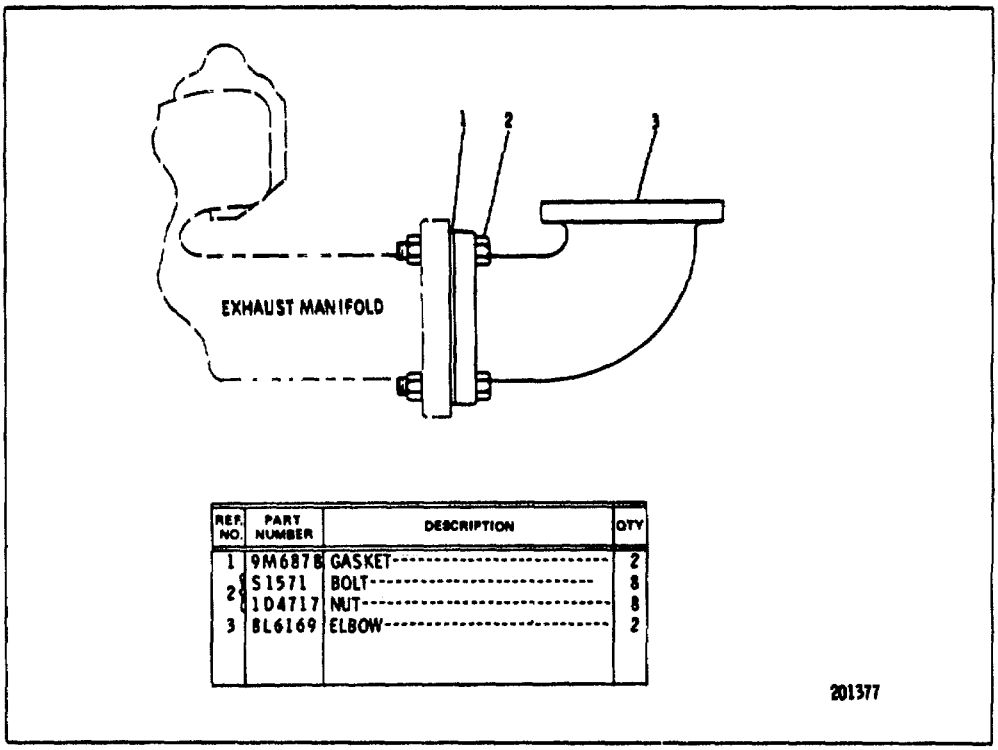
204372

9N1069 EXHAUST FITTING GROUP
AN ATTACHMENT



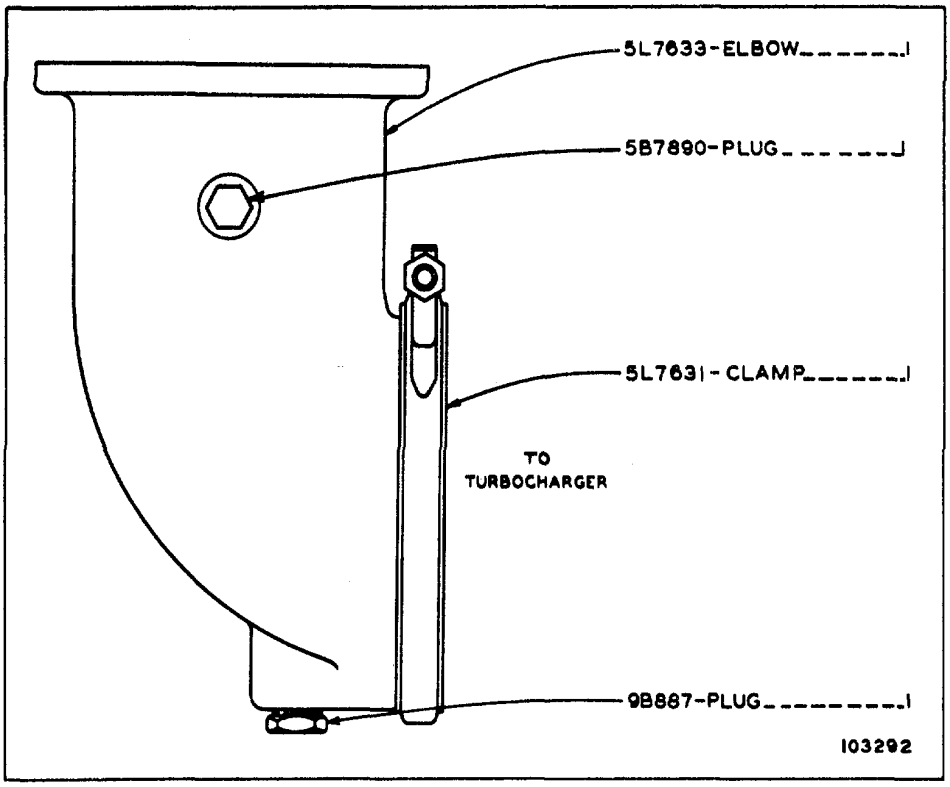
REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	2N1572	MUFFLER ASSEM.	2
2	L1143	BOLT	8
3	4B4278	WASHER	8
4	1D4717	NUT	8
5	8L9795	FLANGE	2
6	9M6878	GASKET	2

2N1646 MUFFLER GROUP
AN ATTACHMENT

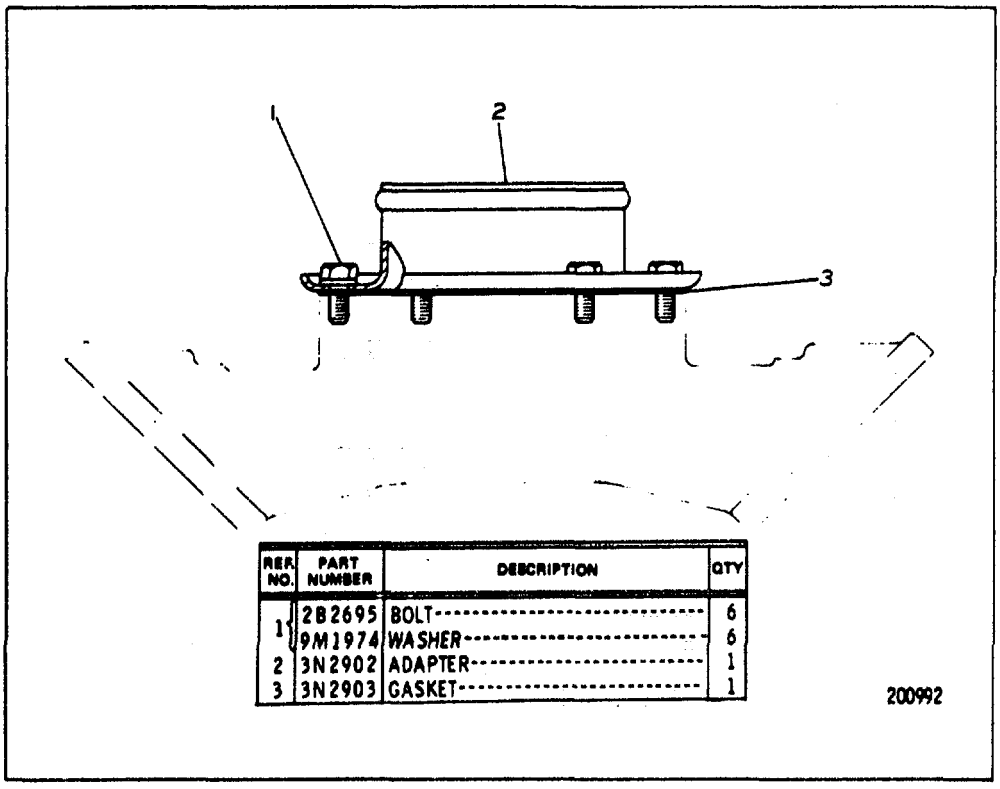


REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	9M6878	GASKET	2
2	S1571	BOLT	8
	1D4717	NUT	8
3	8L6169	ELBOW	2

EXHAUST ELBOW (4N58677 NIS)
ALSO AN ATTACHMENT

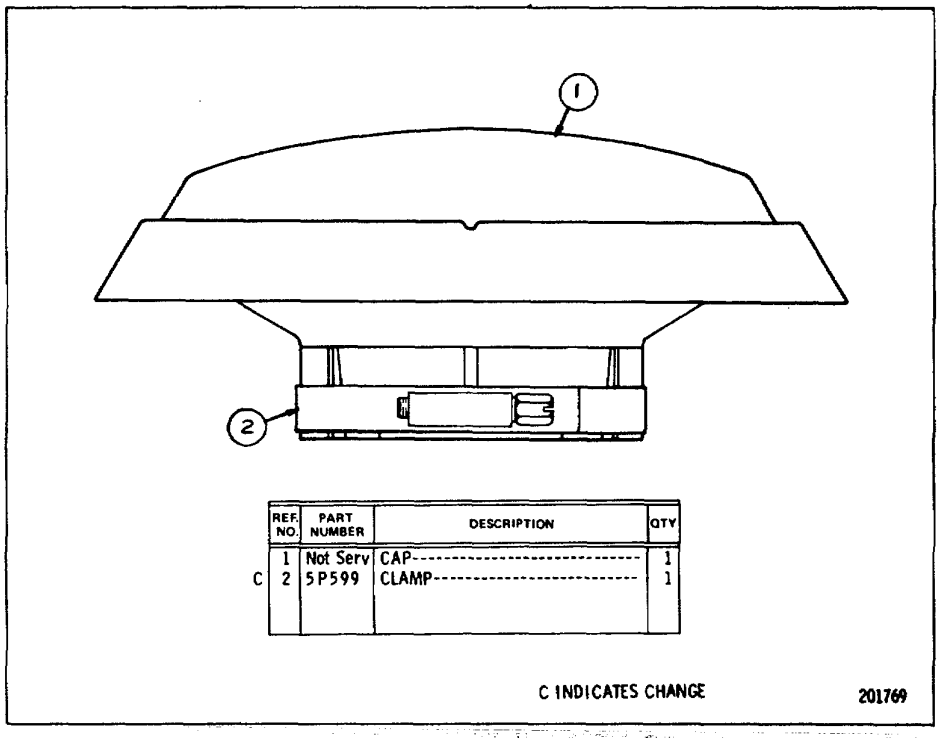


5L7660 EXHAUST ELBOW GROUP
AN ATTACHMENT



REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	2B2695	BOLT	6
	9M1974	WASHER	6
2	3N2902	ADAPTER	1
3	3N2903	GASKET	1

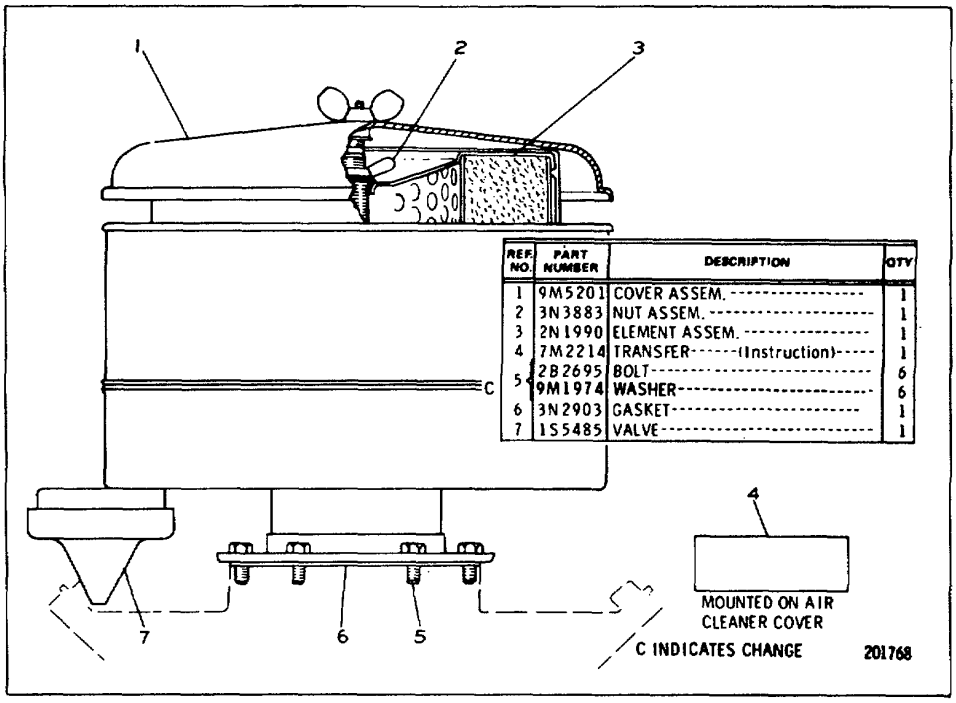
AIR CLEANER ADAPTER (3N2915 N/S)



	REF. NO.	PART NUMBER	DESCRIPTION	QTY
	1	Not Serv	CAP----------	1
C	2	5P599	CLAMP----------	1

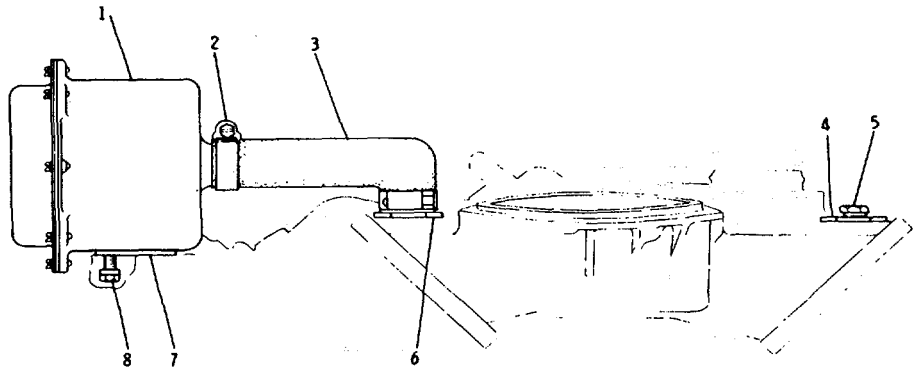
C INDICATES CHANGE 201769

5L8091 AIR CLEANER CAP GROUP
FOR USE WITH 6N155 AIR CLEANER GROUP
AN ATTACHMENT



REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	9M5201	COVER ASSEM.----------	1
2	3N3883	NUT ASSEM.----------	1
3	2N1990	ELEMENT ASSEM.----------	1
4	7M2214	TRANSFER------(Instruction)-----	1
5	2B2695	BOLT----------	6
	9M1974	WASHER----------	6
6	3N2903	GASKET----------	1
7	1S5485	VALVE----------	1

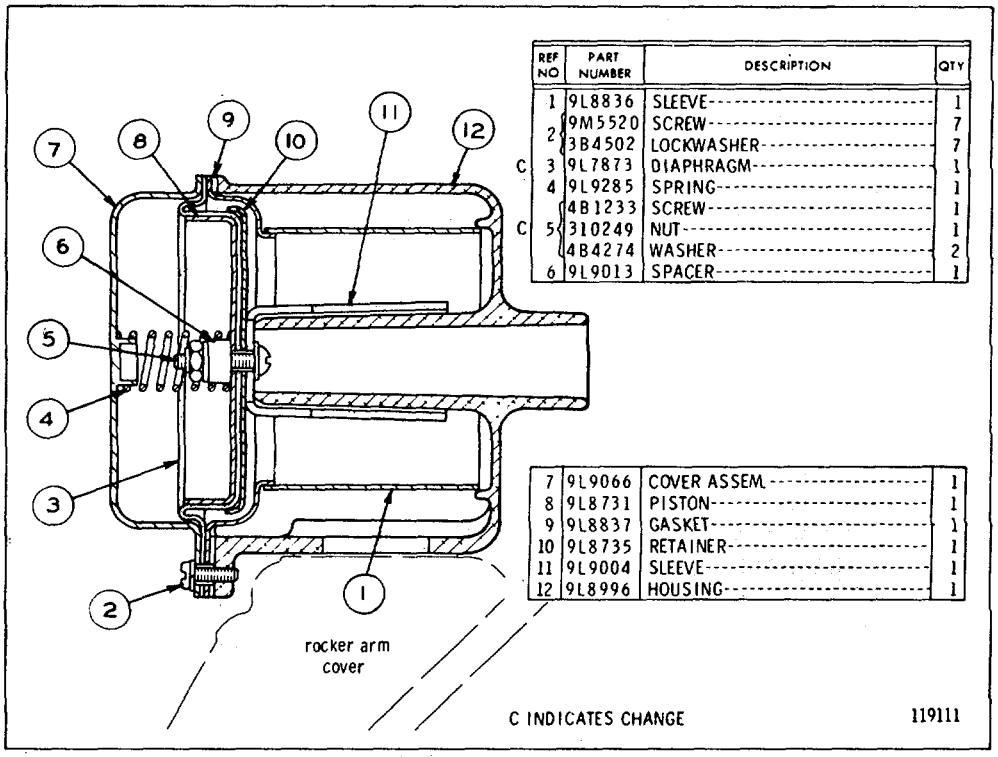
3N3212 AIR CLEANER GROUP
NOT FOR USE WITH TURBOCHARGED ENGINE
AN ATTACHMENT



REF NO	PART NUMBER	DESCRIPTION	QTY
1	9L8790	VALVE ASSEM. (Separate Illustration)	1
2	2S3440	CLAMP	2
3	9L8745	HOSE	1
4	9L8860	PLUG	1
5	5M6213	PLUG	1
6	9L8733	ADAPTER	1
7	9L8786	GASKET	1
8	9L9850	BOLT	4
	9L9021	LOCK	2

201694

POSITIVE CRANKCASE VENTILATION VALVE (9N735 N/S)

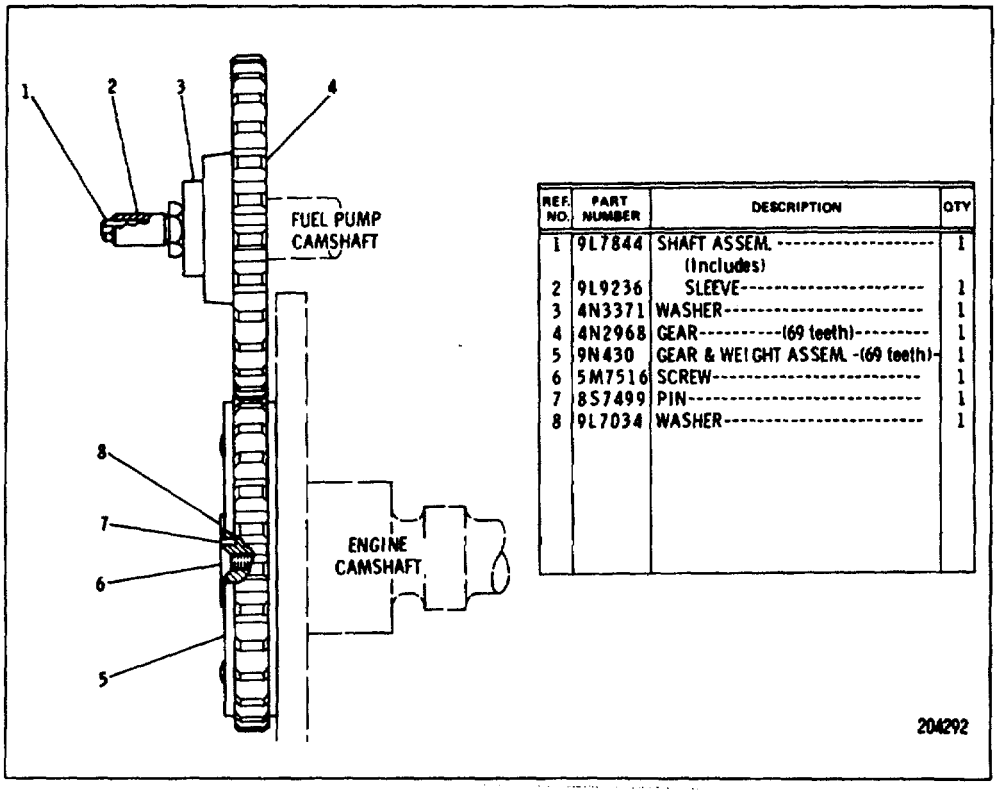


	REF NO	PART NUMBER	DESCRIPTION	QTY
	1	9L8836	SLEEVE	1
	2	9M5520	SCREW	7
		3B4502	LOCKWASHER	7
C	3	9L7873	DIAPHRAGM	1
	4	9L9285	SPRING	1
	5	4B1233	SCREW	1
C		310249	NUT	1
		4B4274	WASHER	2
	6	9L9013	SPACER	1
	7	9L9066	COVER ASSEM.	1
	8	9L8731	PISTON	1
	9	9L8837	GASKET	1
	10	9L8735	RETAINER	1
	11	9L9004	SLEEVE	1
	12	9L8996	HOUSING	1

C INDICATES CHANGE

119111

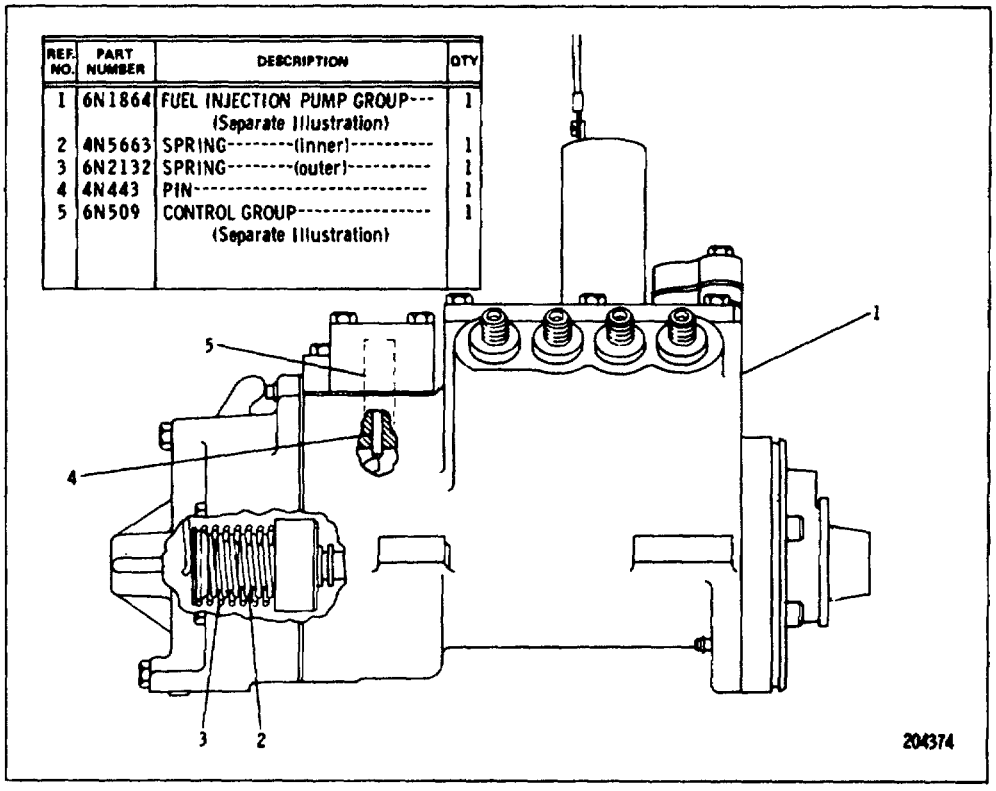
9L8790 CRANKCASE VENTILATION VALVE ASSEMBLY
Part of Positive Crankcase Ventilation Valve



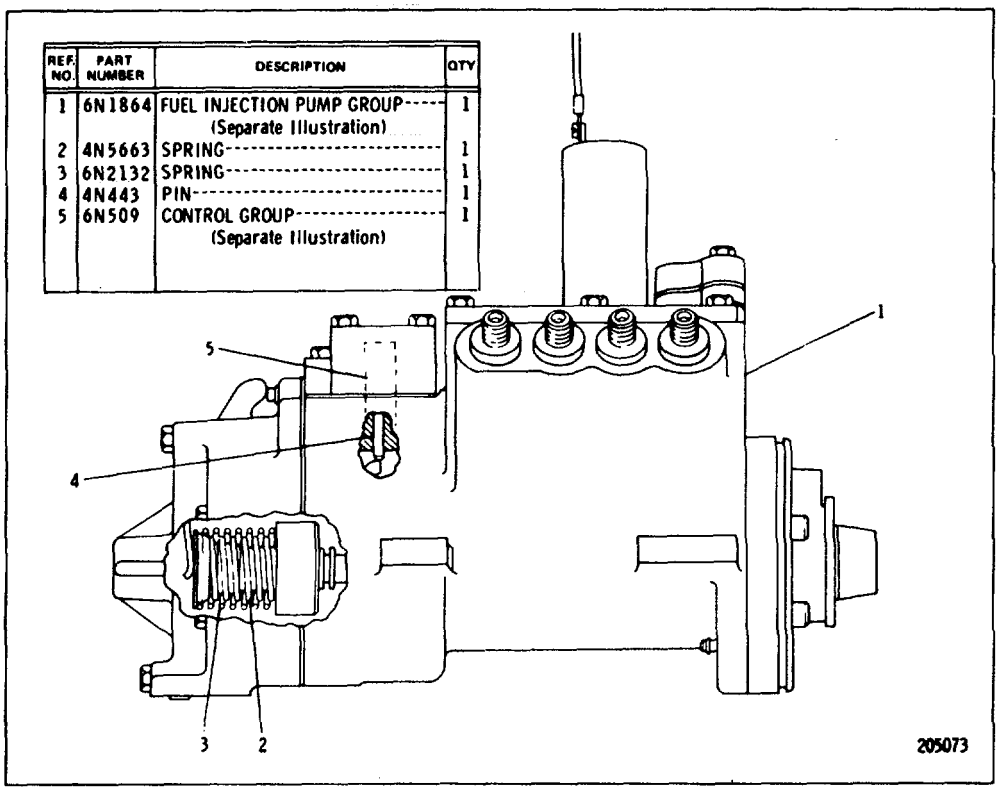
REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	9L7844	SHAFT ASSEM. (Includes)	1
2	9L9236	SLEEVE	1
3	4N3371	WASHER	1
4	4N2968	GEAR (69 teeth)	1
5	9N430	GEAR & WEIGHT ASSEM. (69 teeth)	1
6	5M7516	SCREW	1
7	8S7499	PIN	1
8	9L7034	WASHER	1

GOVERNOR & FUEL PUMP DRIVE (9N740 N/S)

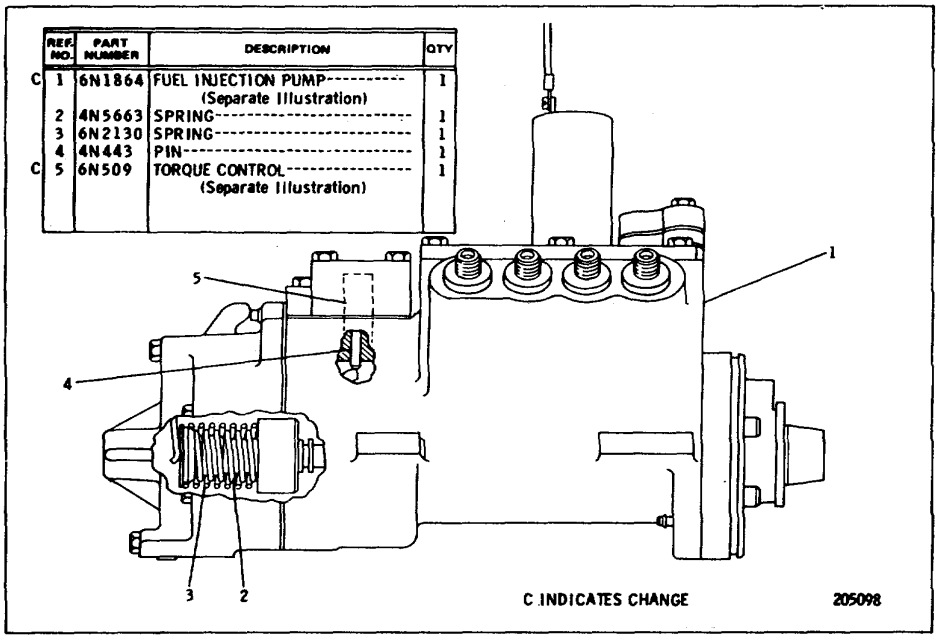
REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	6N1864	FUEL INJECTION PUMP GROUP (Separate Illustration)	1
2	4N5663	SPRING (inner)	1
3	6N2132	SPRING (outer)	1
4	4N443	PIN	1
5	6N509	CONTROL GROUP (Separate Illustration)	1



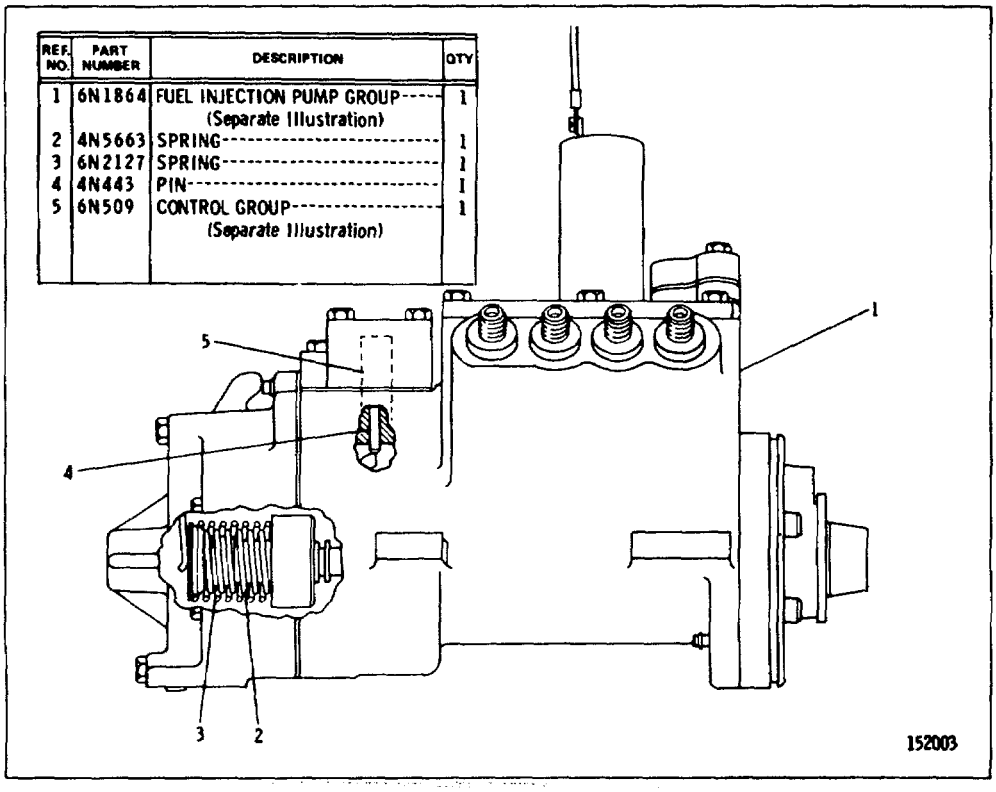
9N1351 GOVERNOR & FUEL INJECTION PUMP GROUP
6N1864 Governor 8 Fuel Injection Pump and 6N509 Torque Control parts are shown on Pages 99 and 111



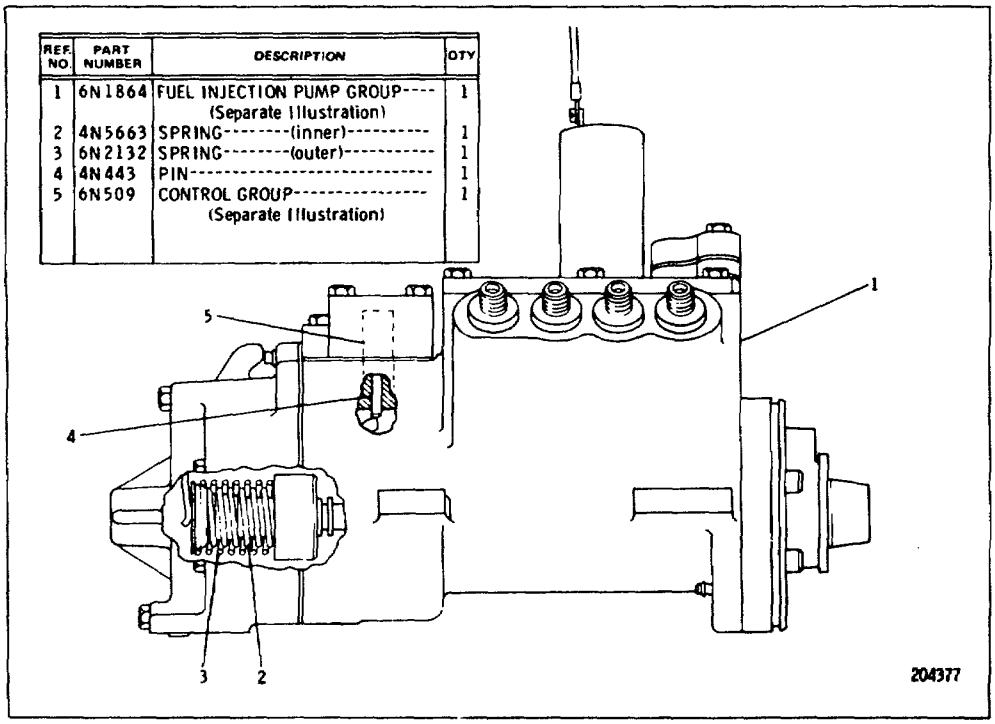
6N3567 GOVERNOR AND FUEL INJECTION PUMP GROUP
6N1864,Governor & Fuel Injection Pump and 6N509 Torque Control parts are shown on Pages 99 and 111



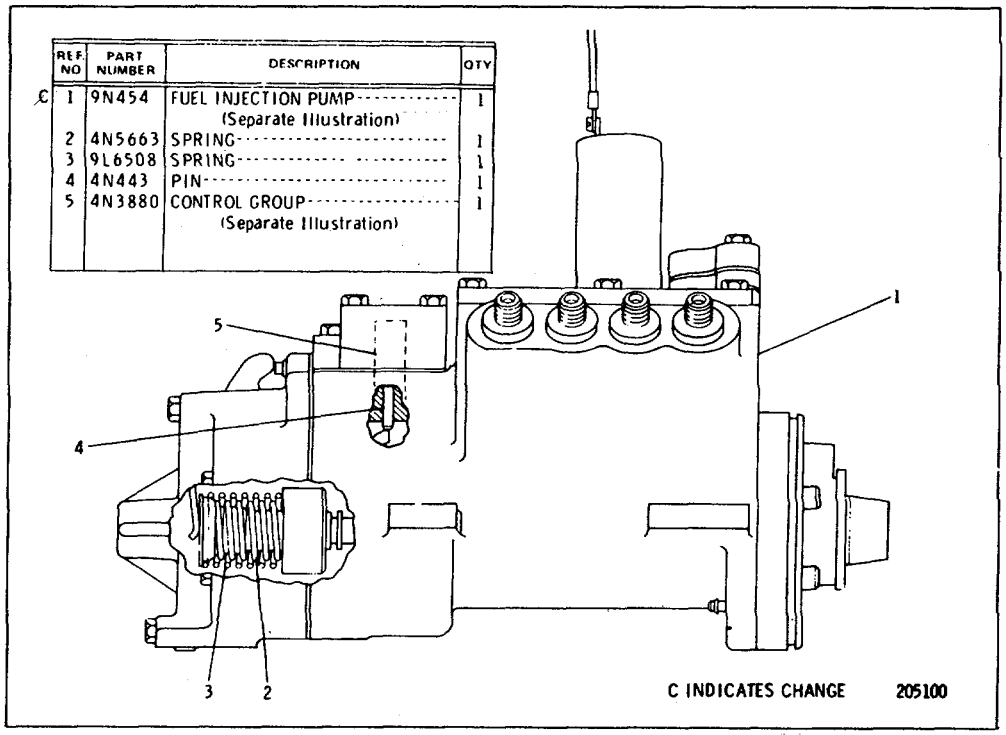
4N9233 GOVERNOR AND FUEL INJECTION PUMP GROUP
6N1864 Governor & Fuel Injection Pump and 6N509 Torque Control parts are shown on Pages 99 and 111



6N1865 GOVERNOR AND FUEL INJECTION PUMP GROUP
6N1864 Governor and Fuel Injection Pump and 6N509 Torque Control parts are shown on Pages 99 and 111

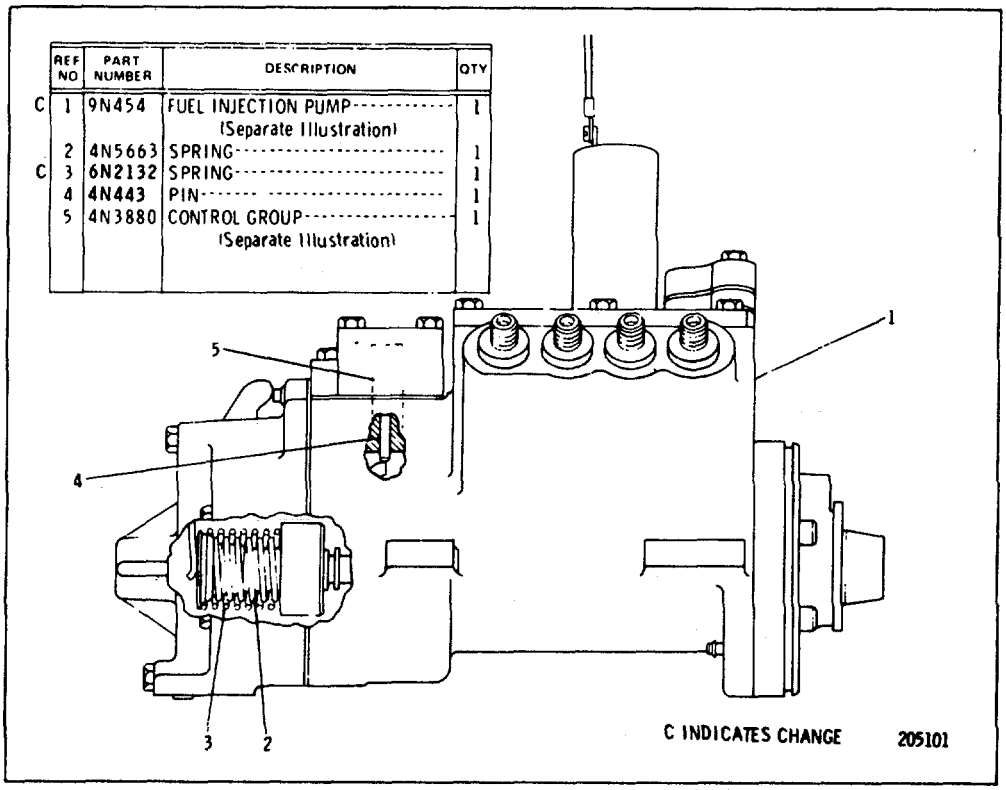


9N1352 GOVERNOR AND FUEL INJECTION PUMP GROUP
6N 1864 Governor and Fuel Injection Pump and 6N509 Torque Control parts are shown on Pages 99 and 111



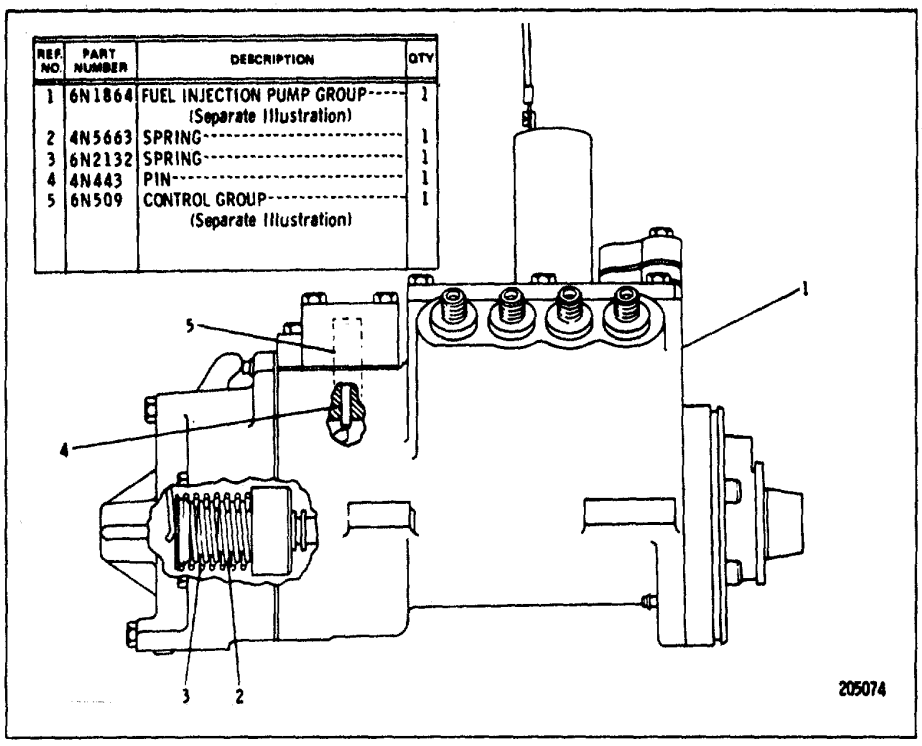
REF NO	PART NUMBER	DESCRIPTION	QTY
C 1	9N454	FUEL INJECTION PUMP (Separate Illustration)	1
2	4N5663	SPRING	1
3	9L6508	SPRING	1
4	4N443	PIN	1
5	4N3880	CONTROL GROUP (Separate Illustration)	1

4N9227 GOVERNOR AND FUEL INJECTION PUMP GROUP
9N454 Governor and Fuel Injection and 4N3880 Control parts are shown on Pages 99 and 112

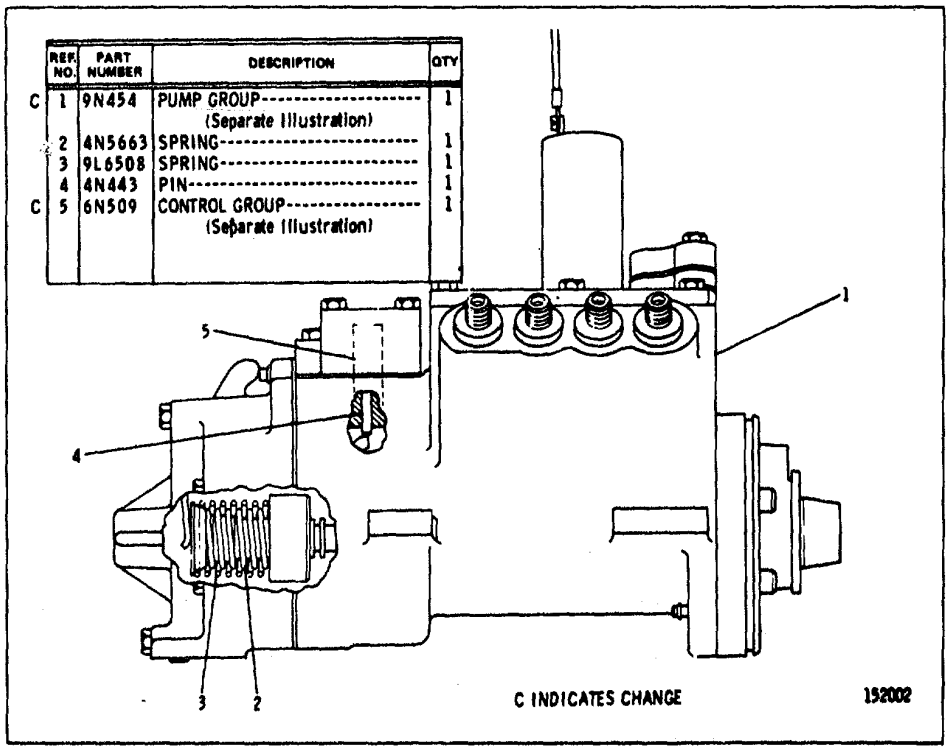


REF NO	PART NUMBER	DESCRIPTION	QTY
C 1	9N454	FUEL INJECTION PUMP (Separate Illustration)	1
2	4N5663	SPRING	1
C 3	6N2132	SPRING	1
4	4N443	PIN	1
5	4N3880	CONTROL GROUP (Separate Illustration)	1

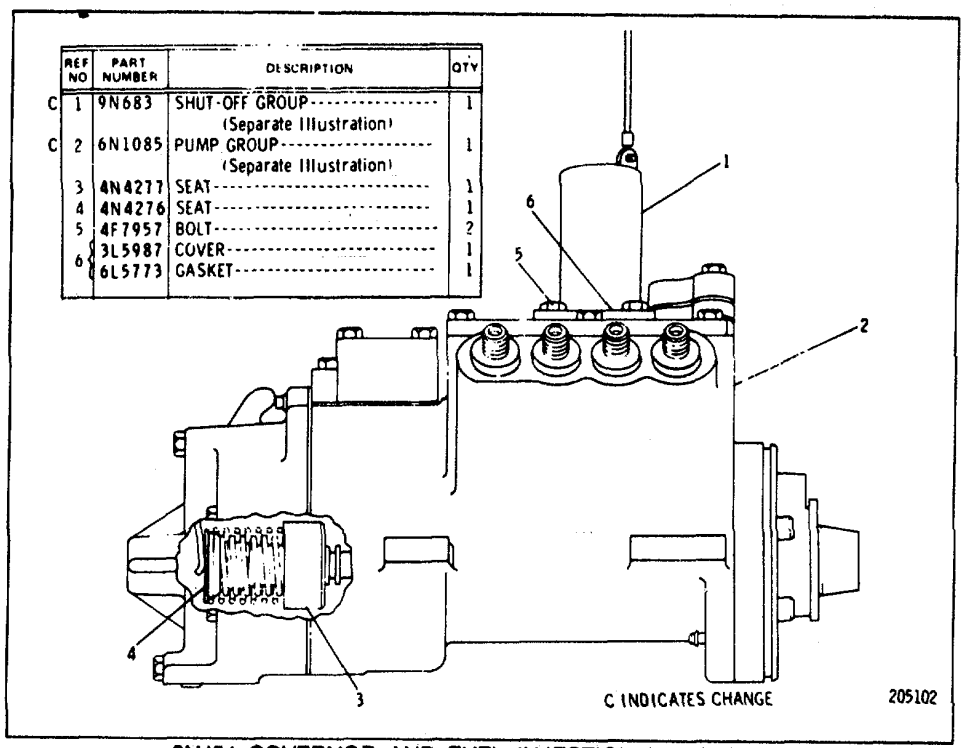
4N9231 GOVERNOR AND FUEL INJECTION PUMP GROUP
9N454 Governor and Fuel Injection Pump and 4N3880 Control parts are shown on Pages 99 and 112



6N3563 GOVERNOR AND FUEL INJECTION PUMP GROUP
6N1864 Governor and Fuel Injection Pump and 6N509 Torque Control parts are shown on Pages 99 & 111

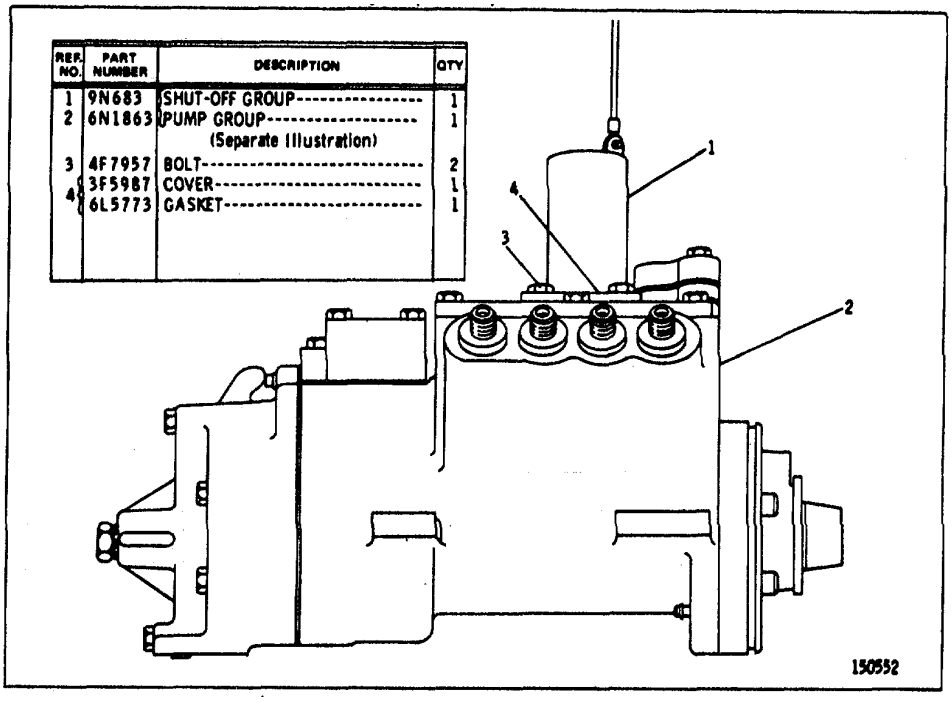


4N9229 GOVERNOR AND FUEL INJECTION PUMP GROUP
9N454 Governor and Fuel Injection Pump and 6N609 Torque Control parts are shown on Pages 99 and 111



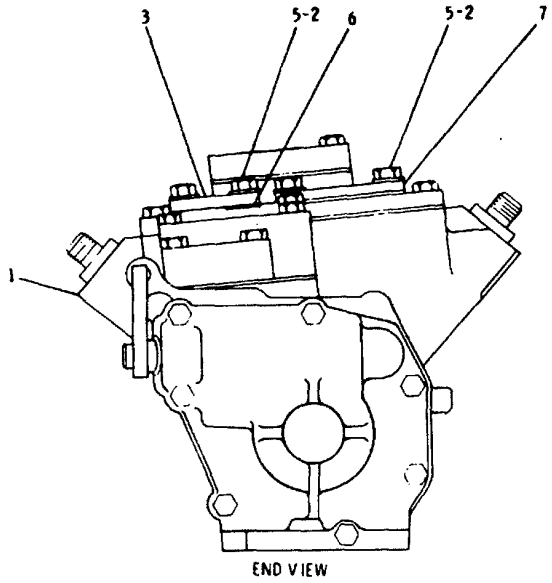
REF NO	PART NUMBER	DESCRIPTION	QTY
C 1	9N683	SHUT-OFF GROUP (Separate Illustration)	1
C 2	6N1085	PUMP GROUP (Separate Illustration)	1
3	4N4277	SEAT	1
4	4N4276	SEAT	1
5	4F7957	BOLT	2
6	3L5987	COVER	1
	6L5773	GASKET	1

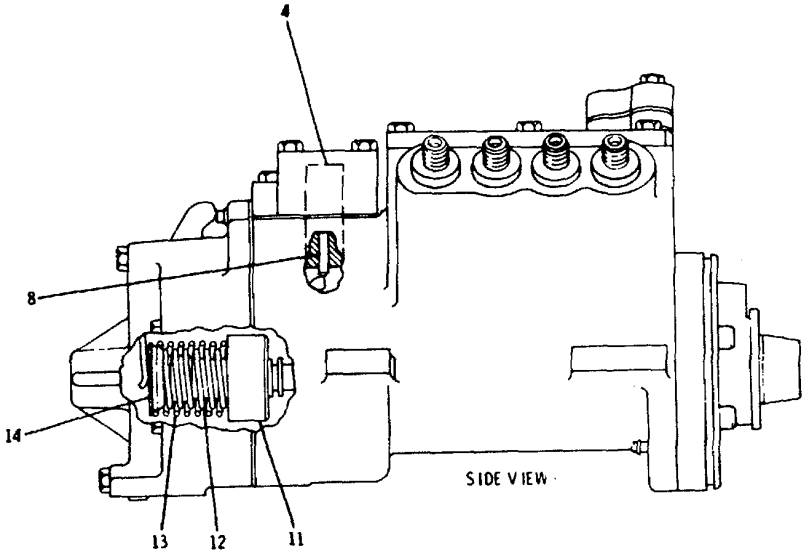
9N454 GOVERNOR AND FUEL INJECTION PUMP GROUP
6N1085 Governor and Fuel Injection Pump and 9N683 Shut-Off parts are shown on Pages 106, 107, 108, 109 and 111. Part of 4N9227, 4N9231 and 4N9299 Governor and Fuel Injection Pump Groups shown on Pages 97 and 98 Only separate parts serviced



REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	9N683	SHUT-OFF GROUP	1
2	6N1863	PUMP GROUP (Separate Illustration)	1
3	4F7957	BOLT	2
4	3F5987	COVER	1
	6L5773	GASKET	1

6N1864 GOVERNOR AND FUEL INJECTION PUMP GROUP
6N1863 Governor and Fuel Injection Pump and 9N83 Shut-Off parts are shown on Pages 102, 103, 104, 105 and 111. Part of 9N1351, 6N3567, 4N9233, 6N1865, 9N1352 and 6N3563 Governor and Fuel Injection Pumps shown on Pages 94, 95, 98 and 98. Only separate parts serviced





	REF NO	PART NUMBER	DESCRIPTION	QTY
C	1	6N1085	PUMP GROUP (Separate Illustration)	1
	2	5P537	WASHER	4
	3	4N8507	COVER	1
C	4	6N509	CONTROL GROUP (Separate Illustration)	1

5	5I616	BOLT	4
6	4N117	GASKET	1
7	3L5987	COVER	1
	6L5773	GASKET	1
8	4N443	PIN	1

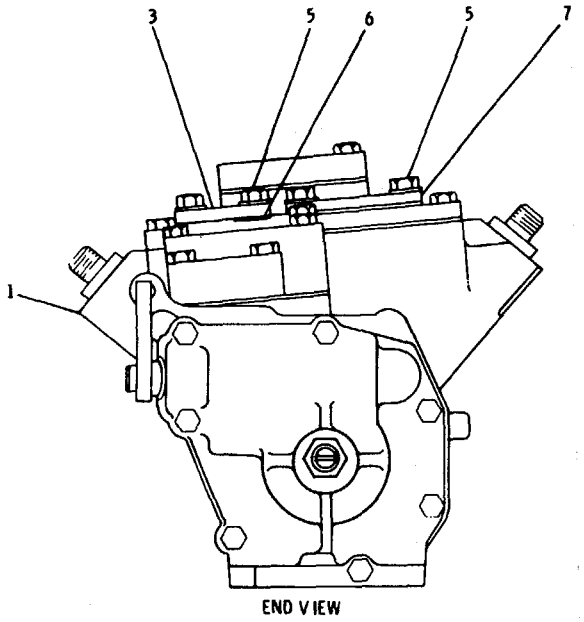
11	4N4277	SEAT	1
12	4N5663	SPRING (inner)	1
13	9L6508	SPRING (outer)	1
14	4N4276	SEAT	1

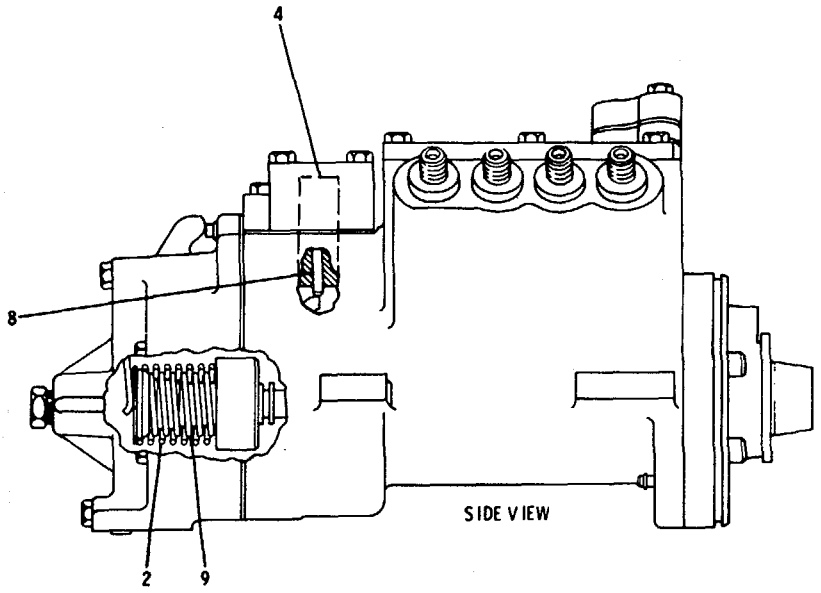
C INDICATES CHANGE

205103

9N681 GOVERNOR AND FUEL INJECTION PUMP GROUP

6N1085 Governor and Fuel Injection Pump and 6N509 Control parts are shown on Pages 106, 107, 108, 109 and 111
Provides Field Replacement for 4N9227 and 4N9231 Governor and Fuel Injection Pump Groups shown on Page 97 when used in conjunction with 9N683 Shut-Off Group shown on Page 111





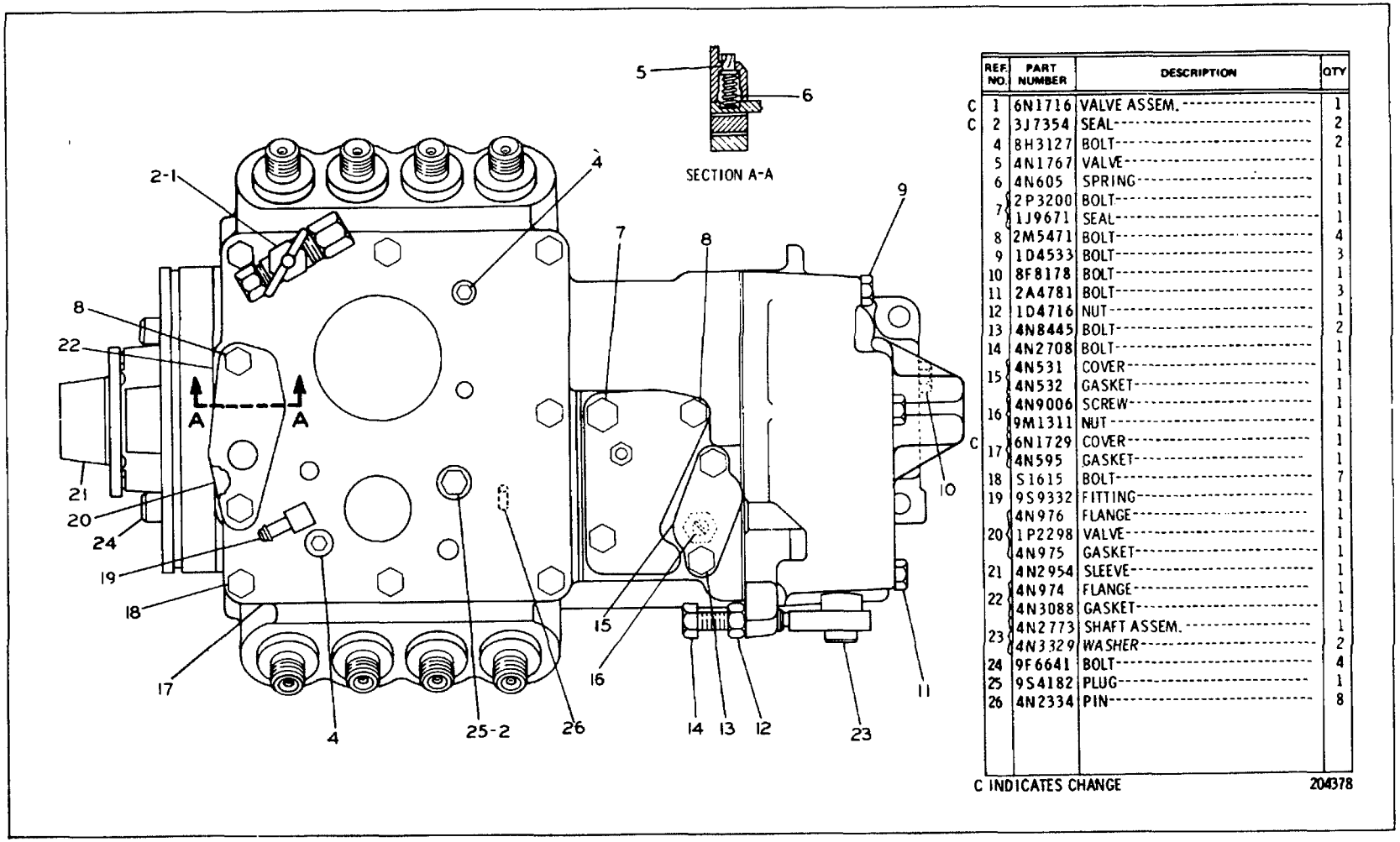
REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	6N1863	PUMP GROUP---------- (Separate Illustration)	1
2	6N2132	SPRING------(outer)----------	1
3	4N8507	COVER----------	1
4	6N509	CONTROL GROUP---------- (Separate Illustration)	1
5	4F7957	BOLT----------	4
6	4N117	GASKET----------	1
7	3L5987	COVER----------	1
	6L5773	GASKET----------	1
8	4N443	PIN----------	1
9	4N5663	SPRING-------(inner)----------	1

150557

6N2337 GOVERNOR AND FUEL INJECTION PUMP GROUP

6N1863 Governor and Fuel Injection Pump and 6N509 Torque Control parts are shown on Pages 102, 103, 104, 105 & 111

Part of 9N495 Governor and Fuel Injection Pump Group listed on Page 110

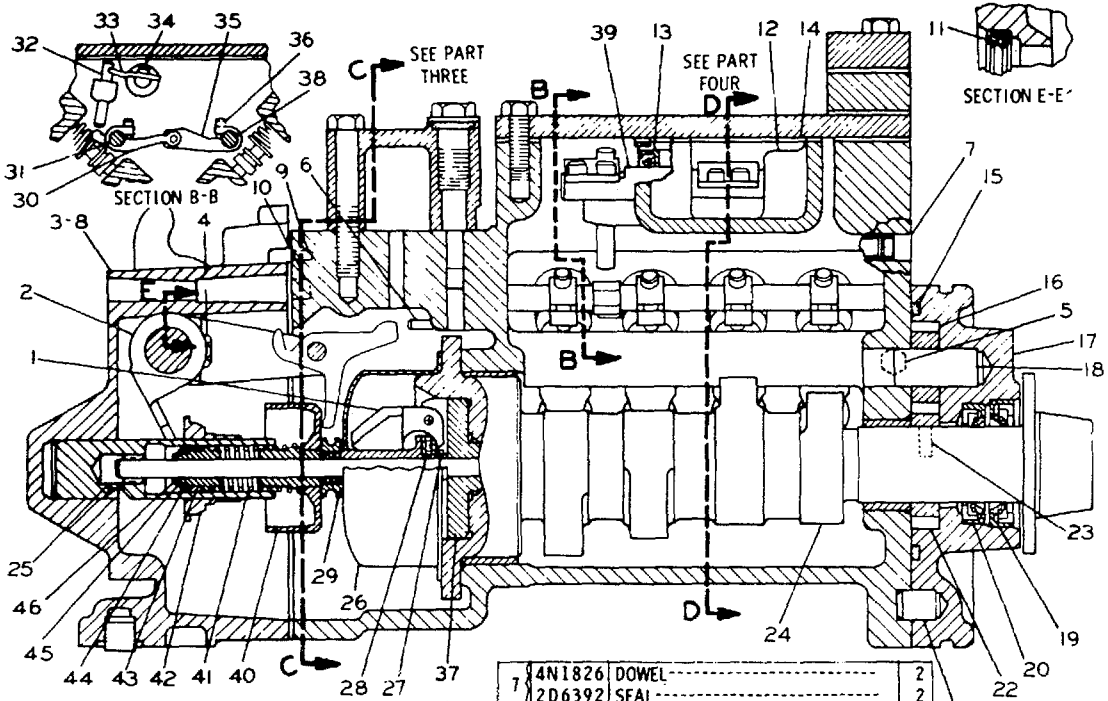


	REF. NO.	PART NUMBER	DESCRIPTION	QTY
C	1	6N1716	VALVE ASSEM.	1
C	2	3J7354	SEAL	2
	4	8H3127	BOLT	2
	5	4N1767	VALVE	1
	6	4N605	SPRING	1
	7	2P3200	BOLT	1
		1J9671	SEAL	1
	8	2M5471	BOLT	4
	9	1D4533	BOLT	3
	10	8F8178	BOLT	1
	11	2A4781	BOLT	3
	12	1D4716	NUT	1
	13	4N8445	BOLT	2
	14	4N2708	BOLT	1
	15	4N531	COVER	1
		4N532	GASKET	1
	16	4N9006	SCREW	1
		9M1311	NUT	1
C	17	6N1729	COVER	1
		4N595	GASKET	1
	18	S1615	BOLT	7
	19	9S9332	FITTING	1
	20	4N976	FLANGE	1
		1P2298	VALVE	1
		4N975	GASKET	1
	21	4N2954	SLEEVE	1
	22	4N974	FLANGE	1
		4N3088	GASKET	1
	23	4N2773	SHAFT ASSEM.	1
		4N3329	WASHER	2
	24	9F6641	BOLT	4
	25	9S4182	PLUG	1
	26	4N2334	PIN	8

C INDICATES CHANGE 204378

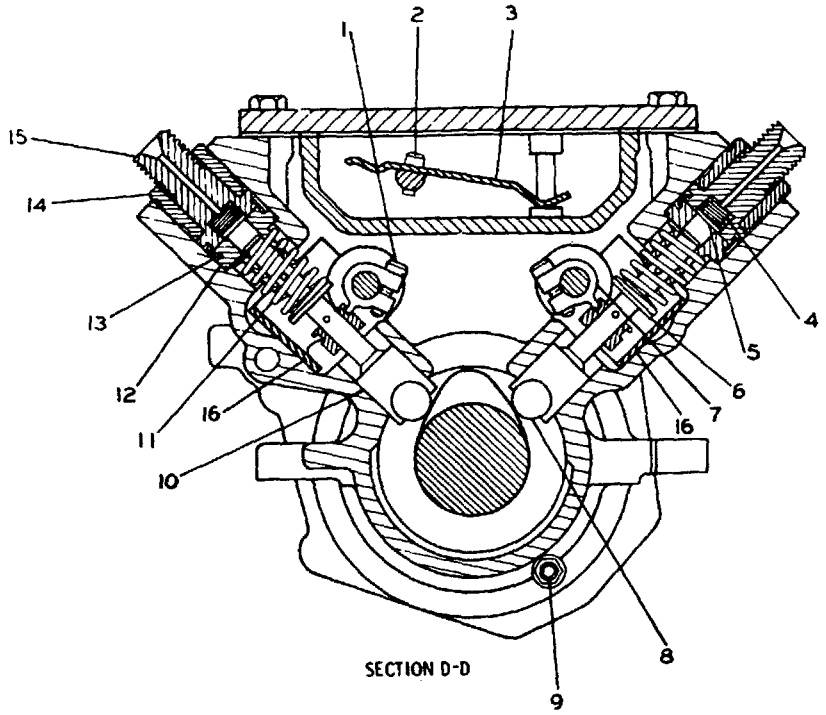
6N1863 GOVERNOR AND FUEL INJECTION PUMP GROUP-Part 1 of 4
Part of 6N1864 and 6N2337 Governor and Fuel Injection Pump Groups shown on Pages 99 and 101
Only separate parts serviced

Only separate parts serviced



REF NO	PART NUMBER	DESCRIPTION	QTY
1	4N425	WEIGHT	3
	4N511	DOWEL	3
2	4N1809	LEVER ASSEM.	1
3	4N556	GASKET	1
4	2P910	BOLT	2
5	4N5050	PLUG	1
6	4N2333	PIN	1
7	4N1826	DOWEL	2
	2D6392	SEAL	2
8	6N1744	HOUSING ASSEM.	1
	9L9503	DOWEL	1
9	4N2333	PIN	1
10	8S6814	DOWEL	2
11	4N2786	SEAL	1
12	4N935	HOUSING ASSEM.	1
13	4N3713	SEAL	1
14	4N505	GASKET	1
15	5M6509	SEAL	1
16	4N406	GEAR	1
17	4N1132	BODY ASSEM.	1
18	8H9804	SHAFT	1
19	4N1584	SEAL	1
20	4N636	SEAL	1
21	8S6814	DOWEL	1
22	4N429	GEAR	1
23	4N3779	KEY	1
24	9L6542	CAMSHAFT	1
	4N2955	BOLT	3
25	4N5482	SHAFT	1
	4N9019	DOWEL	1
26	4N1723	SHIELD	1
27	4N2953	RING	1
28	4N2401	BEARING	1
	4N2927	RACE	2
29	4N434	RISER	1
	4N527	SPRING	1
30	4N3922	LEVER ASSEM.	1
31	4N9828	SHAFT ASSEM.	1
32	4N937	SHAFT	1
33	4N940	LEVER	1
34	6D3031	SCREW	2
35	4N563	LEVER	1
36	2N2658	SCREW	2
37	4N446	CARRIER	1
38	9L6807	SHAFT	1
39	4N938	SHAFT	1
40	4N5579	SEAT ASSEM.	1
C 41	6N2517	SPRING	1
42	4N4276	SEAT	1
43	4N6408	PISTON ASSEM.	1
	4N6407	SPOOL	1
44	4N6406	RING	1
45	4N6404	RING	1
46	4N6403	SEAT	1

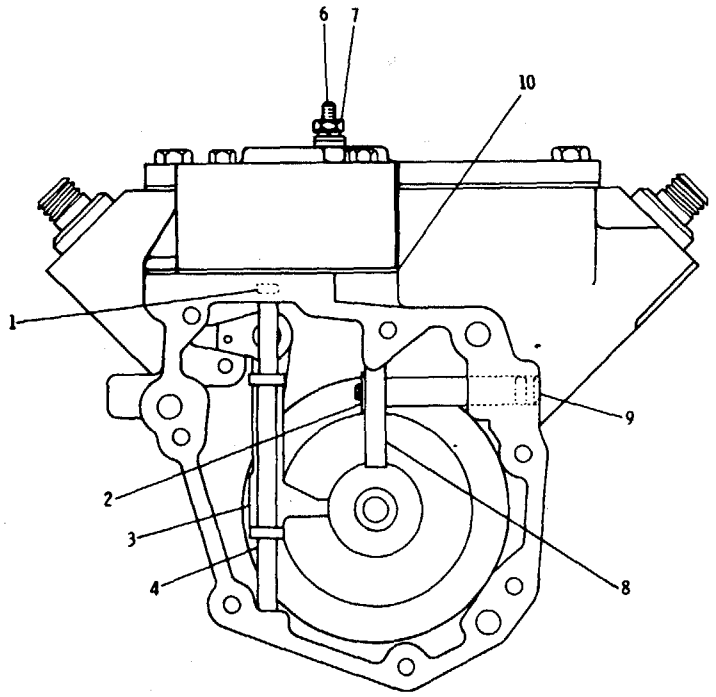
6N1863 GOVERNOR AND FUEL INJECTION PUMP GROUP-Part 2 of 4
Part of 6N1864 and 6N2337 Governor and Fuel Injection Pump Groups shown on Pages 99 and 101
Only separate parts serviced



REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	2N2658	SCREW	8
2	6D3031	SCREW	2
3	4N941	LEVER	1
4	9L9424	SPRING	8
5	4N2655	VALVE	8
6	4N2728	WASHER	8
7	4N1763	LEVER	8
8	4N2685	ROLLER	8
9	1P4001	FITTING	1
10	4N1750	LIFTER	8
11	4N4318	SPRING	8
12	4N1765	PLUNGER AND BARREL ASSEM.	8
13	4N224	RING	8
14	4N218	BUSHING	8
15	4N209	BONNET	8
16	4N9150	DEFLECTOR	2

204380

6N1863 GOVERNOR AND FUEL INJECTION PUMP GROUP-Part 3 of 4
Part of 6N1864 and 6N2337 Governor and Fuel Injection Pump Groups shown on Pages 99 And 101
Only separate parts serviced



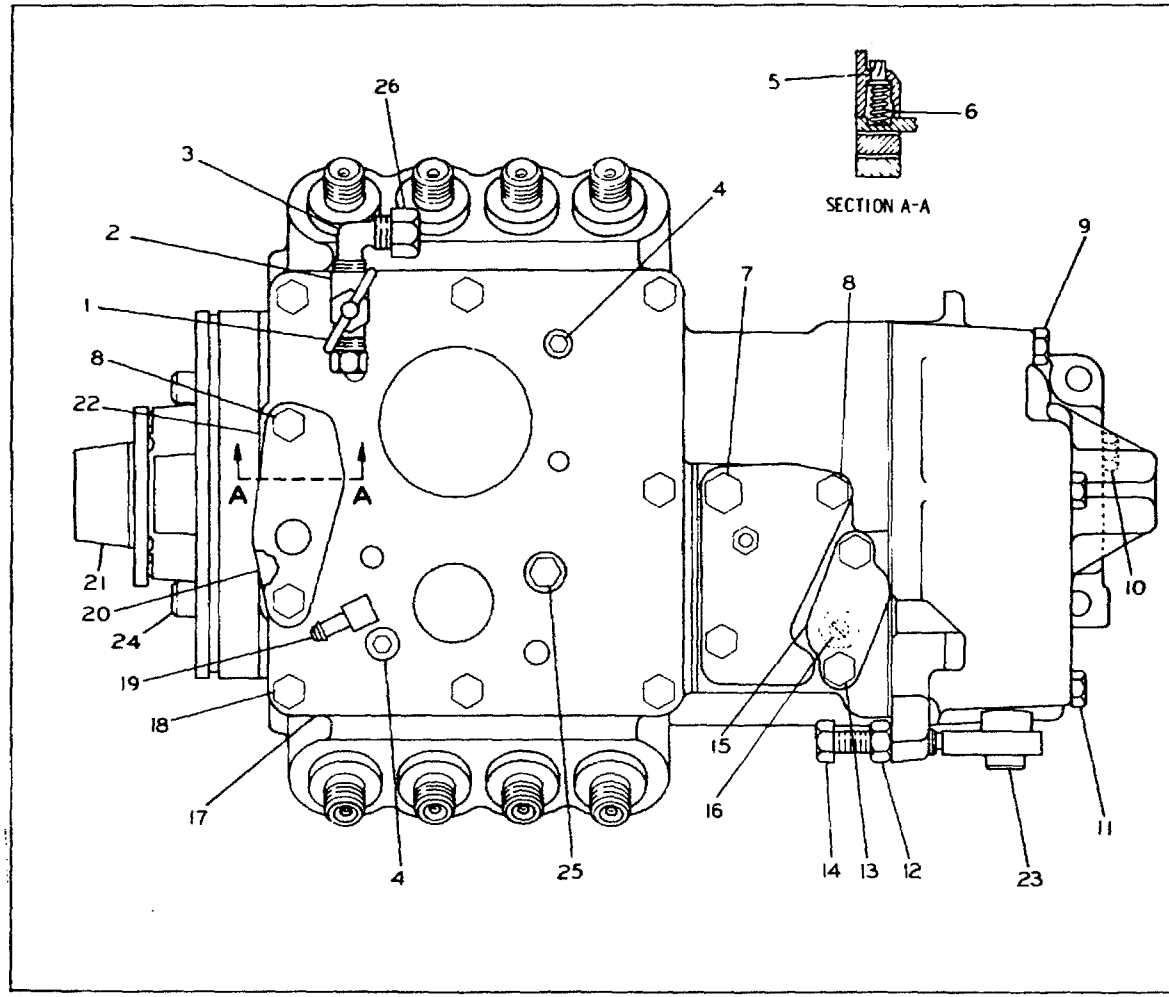
SECTION C-C

	REF. NO.	PART NUMBER	DESCRIPTION	QTY
	1	3H442	SEAL	1
	2	2M7819	RING	1
	3	4N2677	LEVER ASSEM.	1
	4	4N528	SHAFT	1
	5	4N1591	COVER ASSEM.	1
			(Includes)	
C		6N411	COVER	1
C	6	6N412	SCREW	1
	7	1P7326	WASHER	1
		8F1326	WASHER	1
		4B2042	NUT	1
		3B4501	LOCKWASHER	1
	8	4N445	LEVER	1
	9	4N523	DOWEL	1
		2D6392	SEAL	1
	10	4N508	GASKET	1

C INDICATES CHANGE

204381

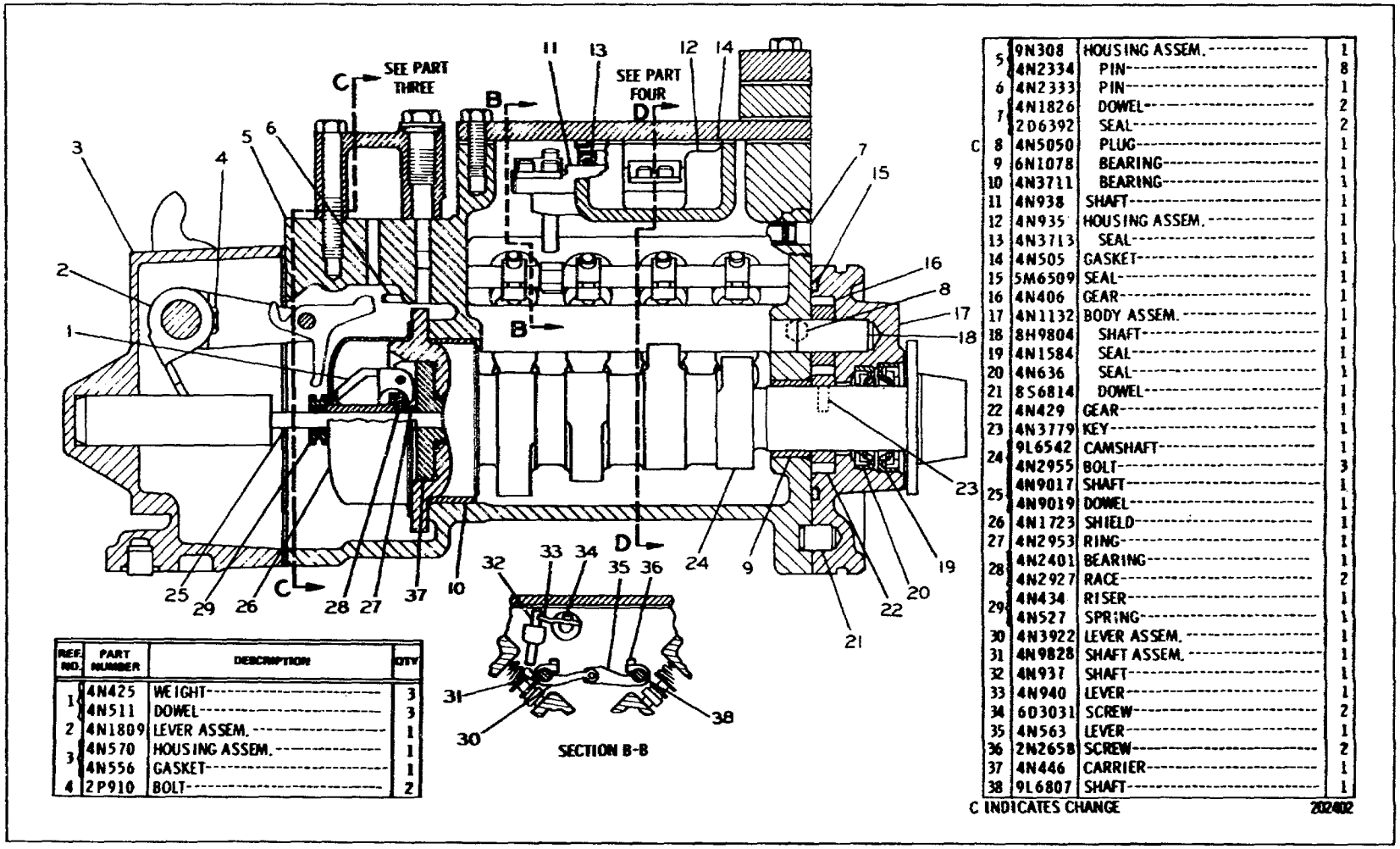
6N1863 GOVERNOR AND FUEL INJECTION PUMP GROUP-Part 4 of 4
Part of 6N1864 and 6N2337 Governor and Fuel Injection Pump Groups shown on Pages 99 and 101
Only separate parts serviced



REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	6N238	VALVE ASSEM.	1
2	309208	TEE	1
3	4N1828	FITTING	1
4	8H3127	BOLT	2
5	4N1767	VALVE	1
6	4N605	SPRING	1
7	2P3200	BOLT	1
	1J9671	SEAL	1
8	2M5471	BOLT	4
9	1D4533	BOLT (2.25 in. long)	3
10	8F8178	BOLT (3.25 in. long)	1
11	2A4781	BOLT (2.75 in. long)	3
12	1D4716	NUT	1
13	4N8445	BOLT	2
14	4N2708	BOLT	1
15	4N531	COVER	1
	4N532	GASKET	1
16	4N9006	SCREW	1
	9M1311	NUT	1
17	6N1079	COVER	1
	4N595	GASKET	1
18	S1615	BOLT	7
19	9S9332	FITTING	1
20	4N976	FLANGE	1
	1P2298	VALVE	1
	4N975	GASKET	1
21	4N2954	SLEEVE	1
22	4N974	FLANGE	1
	4N3088	GASKET	1
23	4N2773	SHAFT ASSEM.	1
	4N3329	WASHER	2
24	9F6641	BOLT	4
25	9S4182	PLUG	1
	3J7354	SEAL	1
26	9L8493	CAP	1

202401

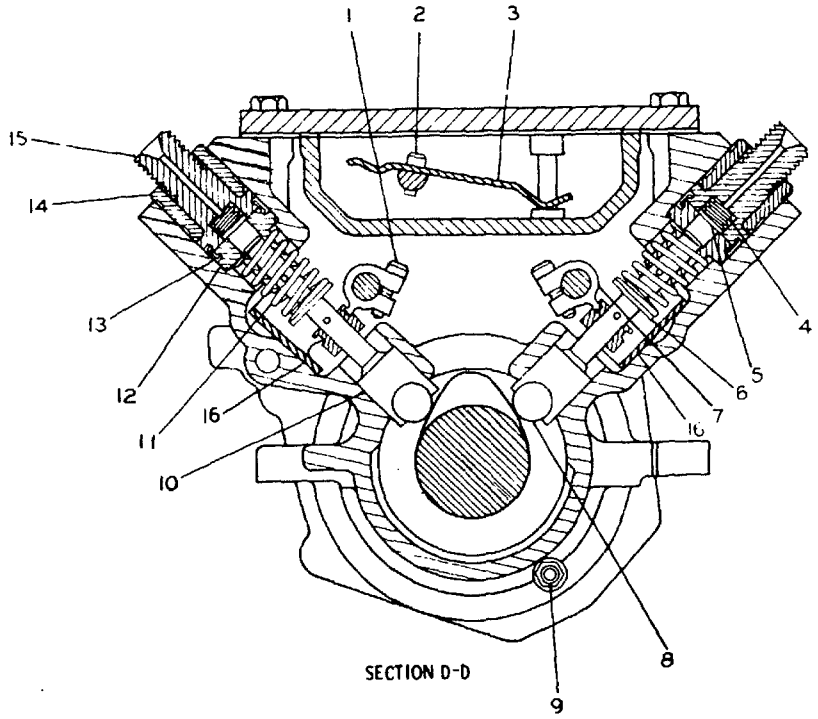
6N1085 GOVERNOR AND FUEL INJECTION PUMP GROUP-Part 1 of 4
Part of 9N454 and 9N681 Governor and Fuel Injection Pump Groups shown on Pages 99 and 100
Only separate parts serviced



REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	4N425	WEIGHT	3
	4N511	DOWEL	3
2	4N1809	LEVER ASSEM.	1
3	4N570	HOUSING ASSEM.	1
	4N556	GASKET	1
4	2P910	BOLT	2
5	9N308	HOUSING ASSEM.	1
	4N2334	PIN	8
6	4N2333	PIN	1
7	4N1826	DOWEL	2
	2D6392	SEAL	2
C 8	4N5050	PLUG	1
9	6N1078	BEARING	1
10	4N3711	BEARING	1
11	4N938	SHAFT	1
12	4N935	HOUSING ASSEM.	1
13	4N3713	SEAL	1
14	4N505	GASKET	1
15	5M6509	SEAL	1
16	4N406	GEAR	1
17	4N1132	BODY ASSEM.	1
18	8H9804	SHAFT	1
19	4N1584	SEAL	1
20	4N636	SEAL	1
21	8S6814	DOWEL	1
22	4N429	GEAR	1
23	4N3779	KEY	1
24	9L6542	CAMSHAFT	1
	4N2955	BOLT	3
25	4N9017	SHAFT	1
	4N9019	DOWEL	1
26	4N1723	SHIELD	1
27	4N2953	RING	1
28	4N2401	BEARING	1
	4N2927	RACE	2
29	4N434	RISER	1
	4N527	SPRING	1
30	4N3922	LEVER ASSEM.	1
31	4N9828	SHAFT ASSEM.	1
32	4N937	SHAFT	1
33	4N940	LEVER	1
34	6D3031	SCREW	2
35	4N563	LEVER	1
36	2N2658	SCREW	2
37	4N446	CARRIER	1
38	9L6807	SHAFT	1

C INDICATES CHANGE 202402

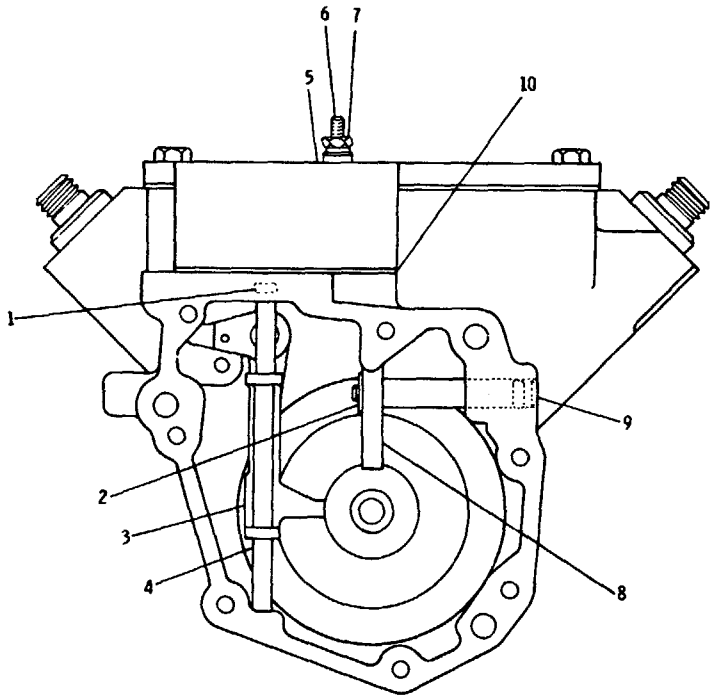
6N1085 GOVERNOR AND FUEL INJECTION PUMP GROUP-Part 2 of 4
Part of 9N454 & 9N681 Governor and Fuel Injection Pump Group shown on Pages 99 & 100
Only separate parts serviced



REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	2N2658	SCREW	8
2	6D3031	SCREW	2
3	4N941	LEVER	1
4	9L9424	SPRING	8
5	4N2655	VALVE	8
6	4N2728	WASHER	8
7	4N1763	LEVER	8
8	4N2685	ROLLER	8
9	1P4001	FITTING	1
10	4N1750	LIFTER	8
11	4N4318	SPRING	8
12	4N1765	PLUNGER AND BARREL ASSEM.	8
13	4N224	RING	8
14	4N218	BUSHING	8
15	4N209	BONNET	8
16	4N9150	DEFLECTOR	2

202403

6N1085 GOVERNOR AND FUEL INJECTION PUMP GROUP--Part 3 of 4
Part of 9N454 & 9N681 Governor and Fuel Injection Pump Group shown on Pages 99 & 100
Only separate parts serviced



SECTION C-C

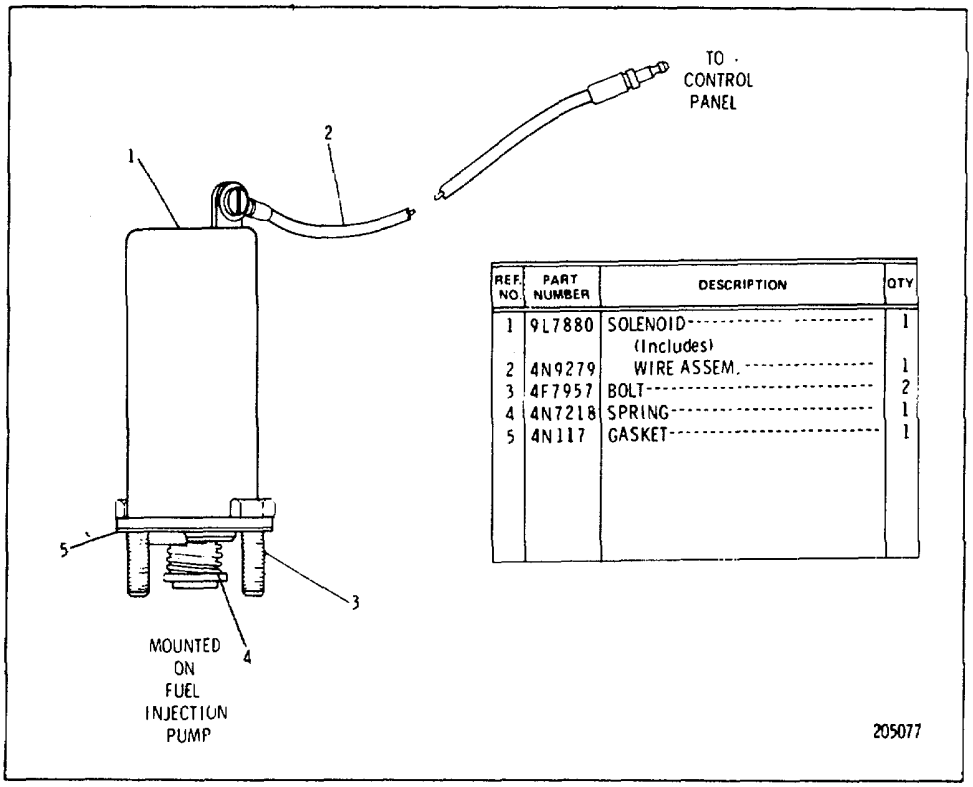
REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	3H442	SEAL	1
2	2M7819	RING	1
3	4N2677	LEVER ASSEM.	1
4	4N528	SHAFT	1
5	4N1591	COVER ASSEM.	1
		(Includes)	
	4N506	COVER	1
6	4N1594	SCREW	1
7	1P7326	WASHER	1
	8F1326	WASHER	1
	4B2042	NUT	1
	3B4501	LOCKWASHER	1
8	4N445	LEVER	1
9	4N523	DOWEL	1
	2D6392	SEAL	1
10	4N508	GASKET	1

202404

6N1085 GOVERNOR AND FUEL INJECTION PUMP GROUP-Part 4 of 4
Part of 9N454 & 9N681 Governor and Fuel Injection Pump Group shown on Pages 99 & 100
Only separate parts serviced

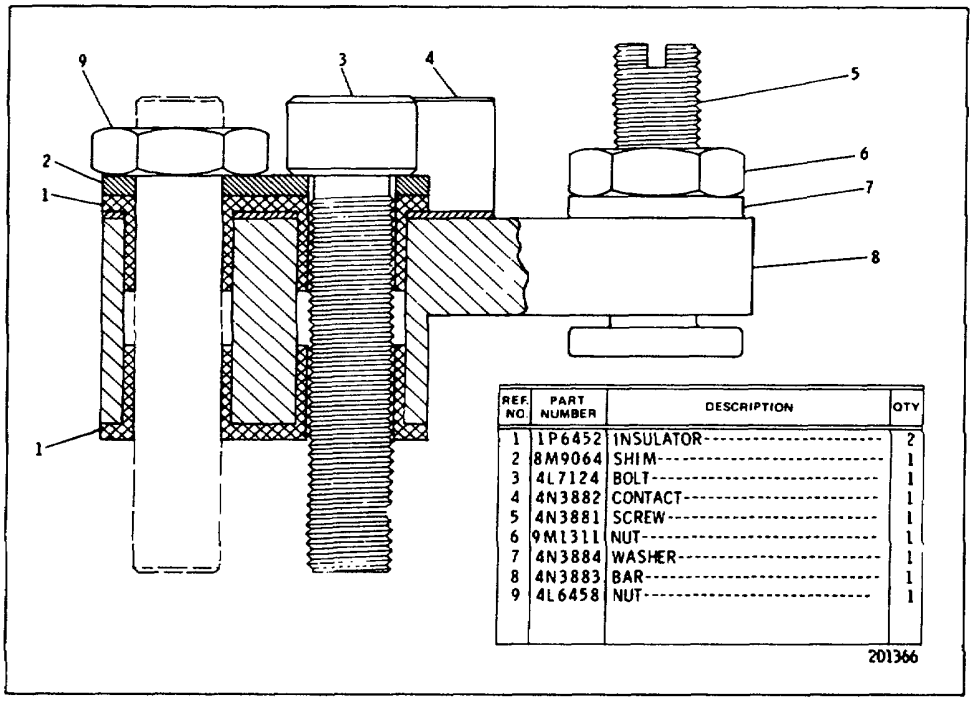
		CONSISTS OF:	PAGE
1	6N2337	GOVERNOR AND FUEL INJECTION PUMP GROUP.....	101
1	6N2132	SPRING	
1	4N5661	SPRING	
1	6N2130	SPRING	
1	4N9226	SPRING	
1	4N556	GASKET	
1	4N532	GASKET	
1	4N508	GASKET	
1	8M9064	SHIM	
2	1P6452	INSULATOR	
1	4N3882	CONTACT	
3	9L8235	SHIM	
3	4N7777	SPACER	
I	4N9098	SPACER	
1	1P6453	BAR	
6	8L8601	SPACER	
1	5S2619	SPRING	
1	9L9347	SHIM	
1	4L6458	NUT	
1	9L3625	SPRING	
1	9M9729	SEAL	
1	8M5661	SEAL	
2	9L7630	GASKET	
1	6N2127	SPRING	
1	.....	FORM GMG02556	

9N495 GOVERNOR AND FUEL INJECTION PUMP GROUP
.Provides Field Replacement for 4N9233, 6N1865, 6N3563, 6N3567, 9N1351 and 9N1352 Governor & Fuel Injection Pump Groups shown on Pages 94, 95, 96 & 98 when used in conjunction with 9N683 Shut-Off Group



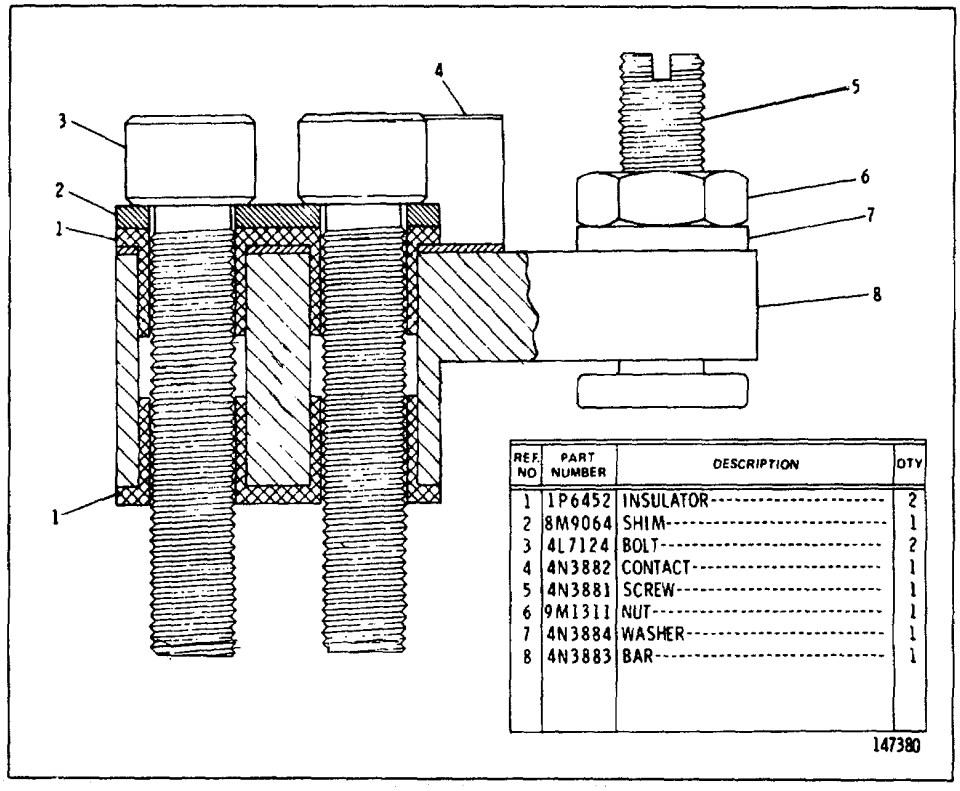
REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	9L7880	SOLENOID (Includes)	1
2	4N9279	WIRE ASSEM.	1
3	4F7957	BOLT	2
4	4N7218	SPRING	1
5	4N117	GASKET	1

9N683 ELECTRIC SHUT-OFF GROUP--12 Volt
Part of 6N1864 and 9N454 Governor and Fuel Injection Pump Groups shown on Page 99



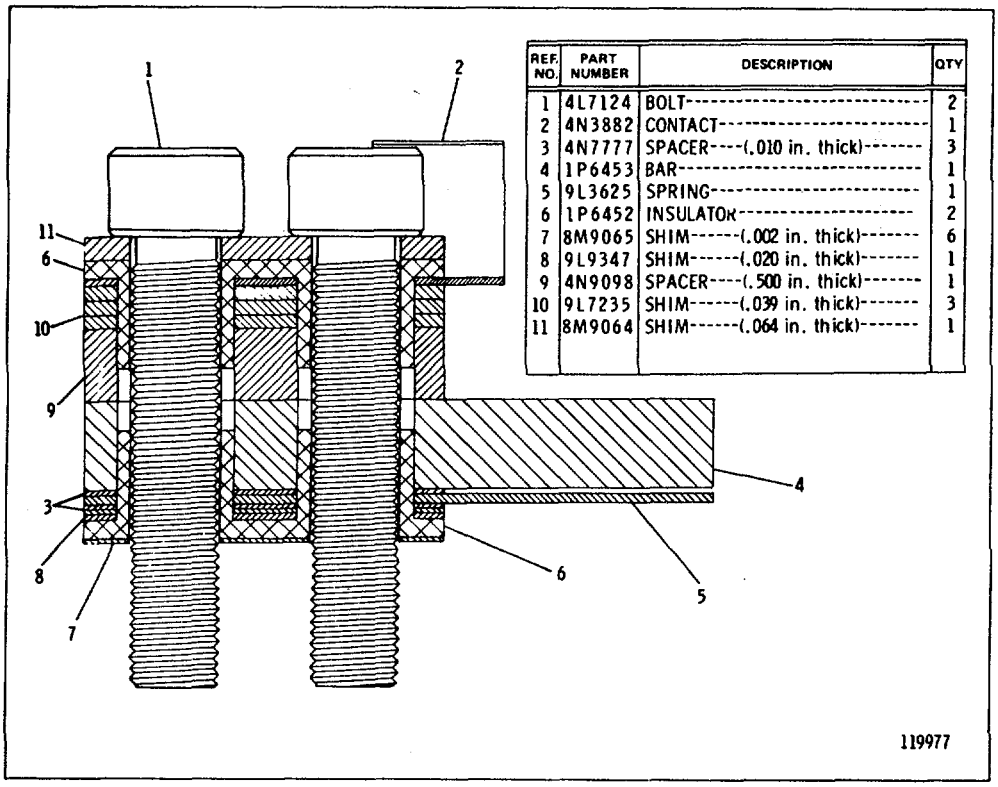
REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	1P6452	INSULATOR	2
2	8M9064	SHIM	1
3	4L7124	BOLT	1
4	4N3882	CONTACT	1
5	4N3881	SCREW	1
6	9M1311	NUT	1
7	4N3884	WASHER	1
8	4N3883	BAR	1
9	4L6458	NUT	1

6N509 TORQUE CONTROL GROUP
Part of 9N1351, 6N3567, 4N9233, 6N1865, 9N1352, 6N3563, 4N9229, 9N681 and 6N2337 Governor and Fuel Injection Pump Groups shown on Pages 94, 95, 96, 98, 100 and 101. Only separate parts serviced



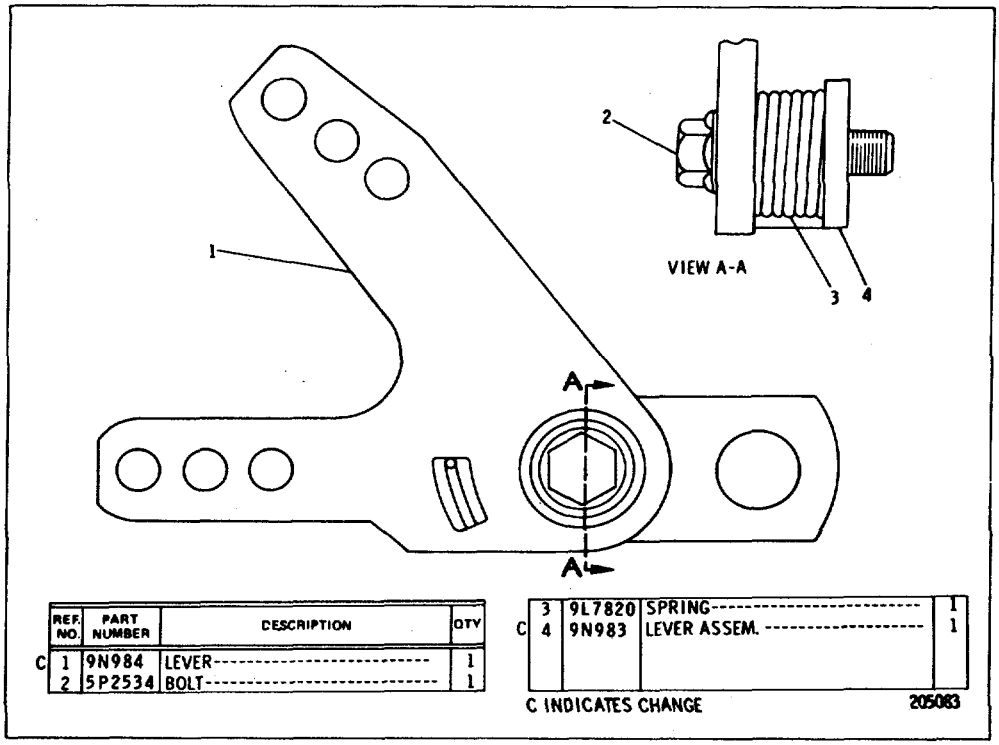
REF. NO	PART NUMBER	DESCRIPTION	QTY
1	1P6452	INSULATOR	2
2	8M9064	SHIM	1
3	4L7124	BOLT	2
4	4N3882	CONTACT	1
5	4N3881	SCREW	1
6	9M1311	NUT	1
7	4N3884	WASHER	1
8	4N3883	BAR	1

4N3880 TORQUE CONTROL GROUP
Part of 4N9227, 4N9231 Governor and Fuel Injection Pumps shown on Page 97



REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	4L7124	BOLT	2
2	4N3882	CONTACT	1
3	4N7777	SPACER----(.010 in. thick)	3
4	1P6453	BAR	1
5	9L3625	SPRING	1
6	1P6452	INSULATOR	2
7	8M9065	SHIM------(.002 in. thick)	6
8	9L9347	SHIM------(.020 in. thick)	1
9	4N9098	SPACER----(.500 in. thick)	1
10	9L7235	SHIM------(.039 in. thick)	3
11	8M9064	SHIM------(.064 in. thick)	1

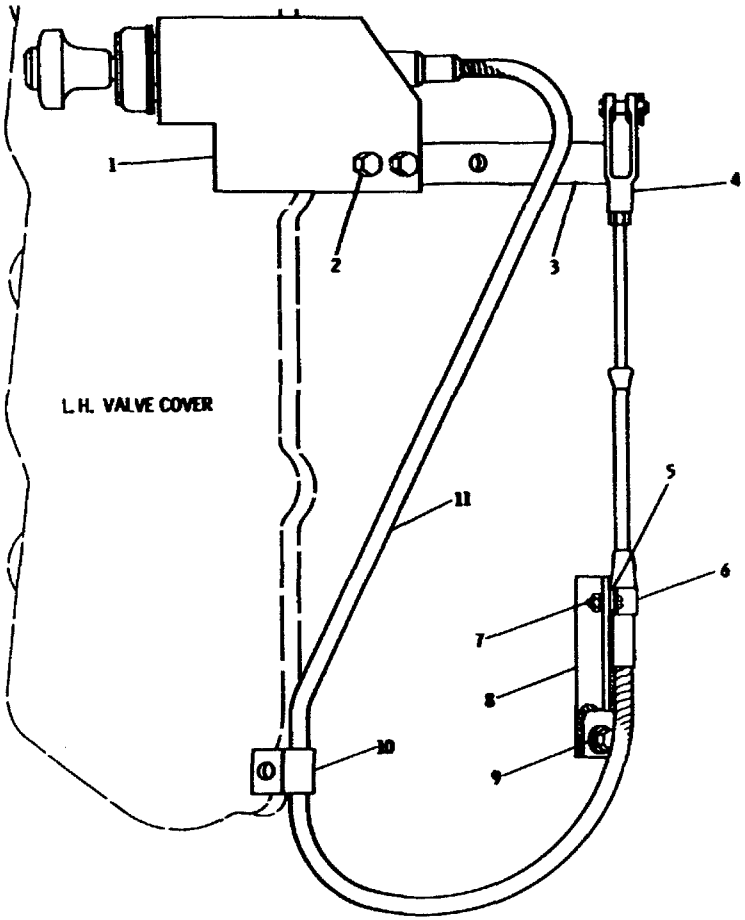
4N9993 TORQUE CONTROL GROUP
AN ATTACHMENT



	REF. NO.	PART NUMBER	DESCRIPTION	QTY
C	1	9N984	LEVER	1
	2	5P2534	BOLT	1
	3	9L7820	SPRING	1
C	4	9N983	LEVER ASSEM.	1

C INDICATES CHANGE

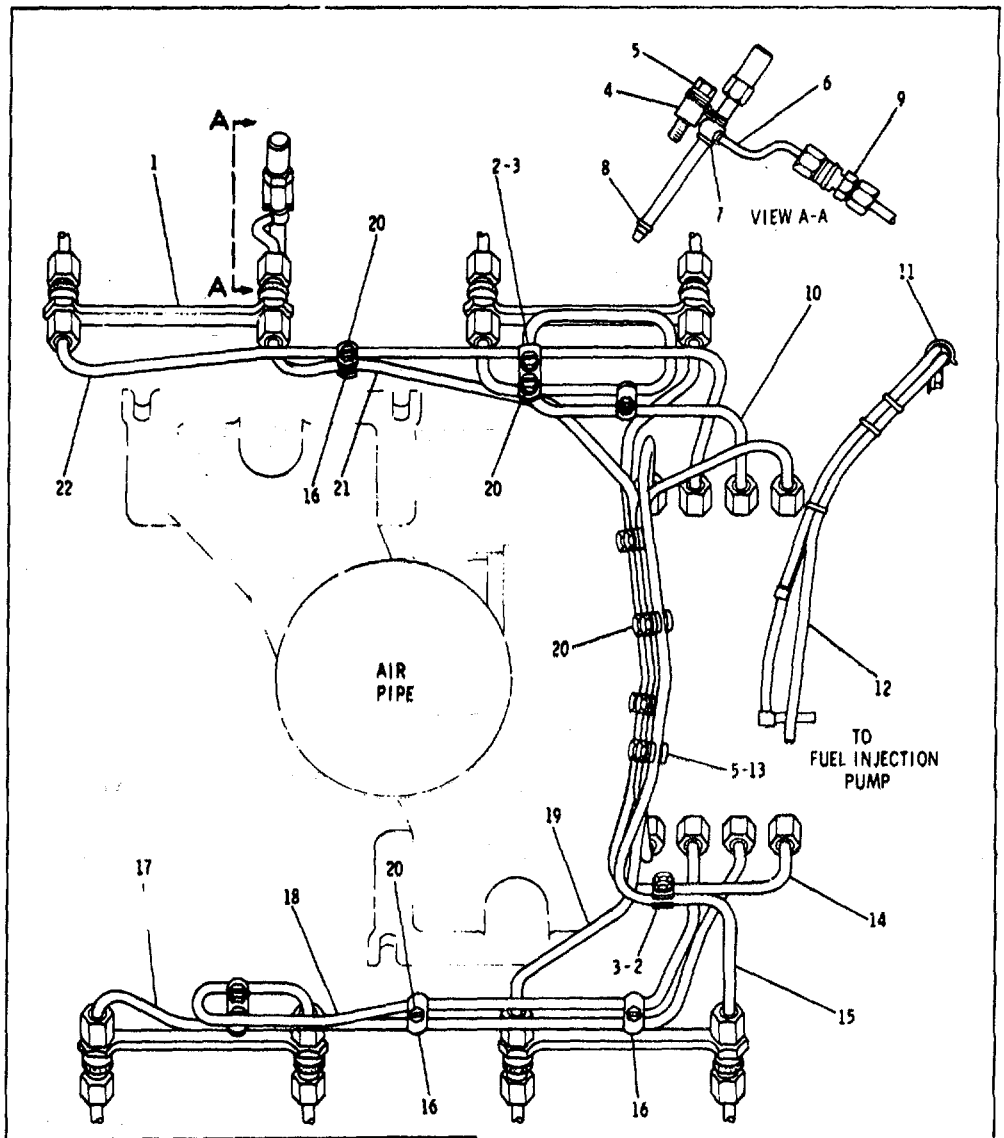
GOVERNOR CONTROL (9L6743 N/S)



REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	2N1315	BRACKET	1
	4F7957	BOLT	2
2	1B4330	NUT	2
	3B4504	LOCKWASHER	2
3	2N1040	SUPPORT	1
		(Use as Required)	
4	7L7784	CLEVIS ASSEM.	1
5	7L7786	SHIM	1
6	7L7785	CLAMP	1
	4B1229	SCREW	2
7	4B2047	NUT	2
	3B4502	LOCKWASHER	2
8	3N7820	BRACKET	1
9	S1594	BOLT	2
	5M2894	WASHER	2
10	7M4579	CLIP	1
11	2N1274	CONTROL	1
		(Use as Required)	

140075

3N7815 GOVERNOR CONTROL GROUP-Positive Lock



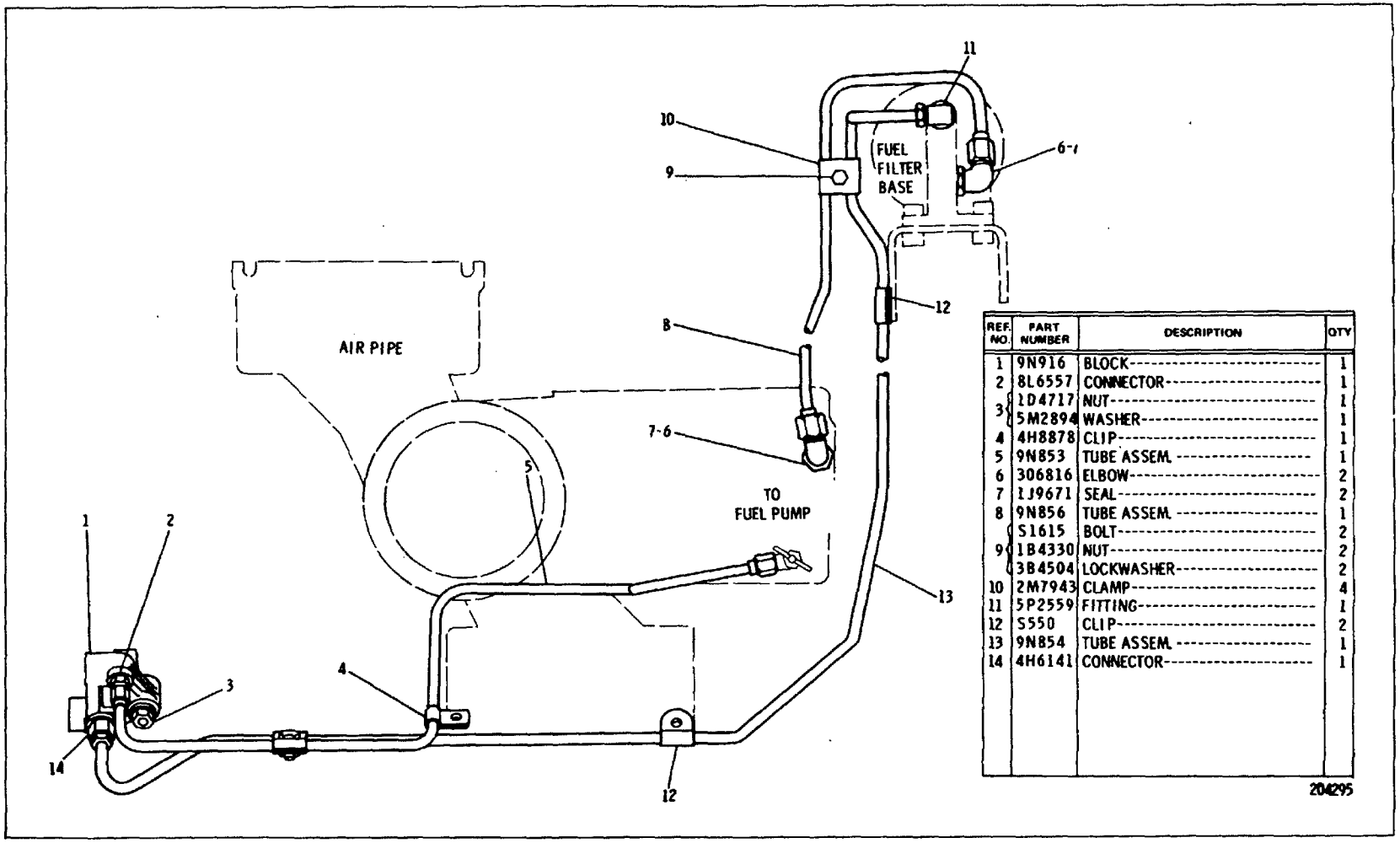
REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	9L9372	LOCK	4
2	9L9160	CLAMP ASSEM.	3
3	9L8714	CLAMP--------(tapped)	7
4	9L8388	SPACER	8
5	9L8134	CLAMP ASSEM.	8
6	9L6969	NOZZLE ASSEM. (Each Includes)	8
	1H1023	SEAL	1
7	9L9099	WASHER	1
8	9L9098	SEAL	1
9	9L7675	ADAPTER ASSEM.	8
C 10	9N1374	LINE ASSEM. -------(no. 4)-------	1
11	9L9251	CLIP	1
	9M1974	WASHER	1
12	9N911	TUBE ASSEM. ------(bleed)--------	1
	7K8332	INSERT	1
13	9L8713	CLAMP	4
14	9L6042	LINE ASSEM. ----(no. 2)----------	1
15	9N861	LINE ASSEM. -----(no. 1)---------	1
C 16	9L8715	CLAMP	4
C	9L8716	CLAMP----------(tapped)---	4
C 17	9L6047	LINE ASSEM. ----(no. 7)---------	1
C 18	9L6045	LINE ASSEM. ----(no. 5)---------	1
19	9N863	LINE ASSEM. ----(no. 3)----------	1
C 20	9L9014	SCREW	18
C	3B4502	LOCKWASHER	18
21	9L6046	LINE ASSEM. ------(no. 6)-------	1
22	9L6048	LINE ASSEM. ------(no. 8)-------	1
	9L7663	PROTECTIVE PLUG (Fuel Nozzle Inlet)	8
C ▲	6H3687	PROTECTIVE CAP (Fuel Nozzle Tip)	8
	4N5730	SHIM----.005 in. (.127 mm) thick (Pressure Adjusting)	8

▲ NOT SHOWN- Not Part of 9N119 Fuel Injection Lines Group

C INDICATES CHANGE

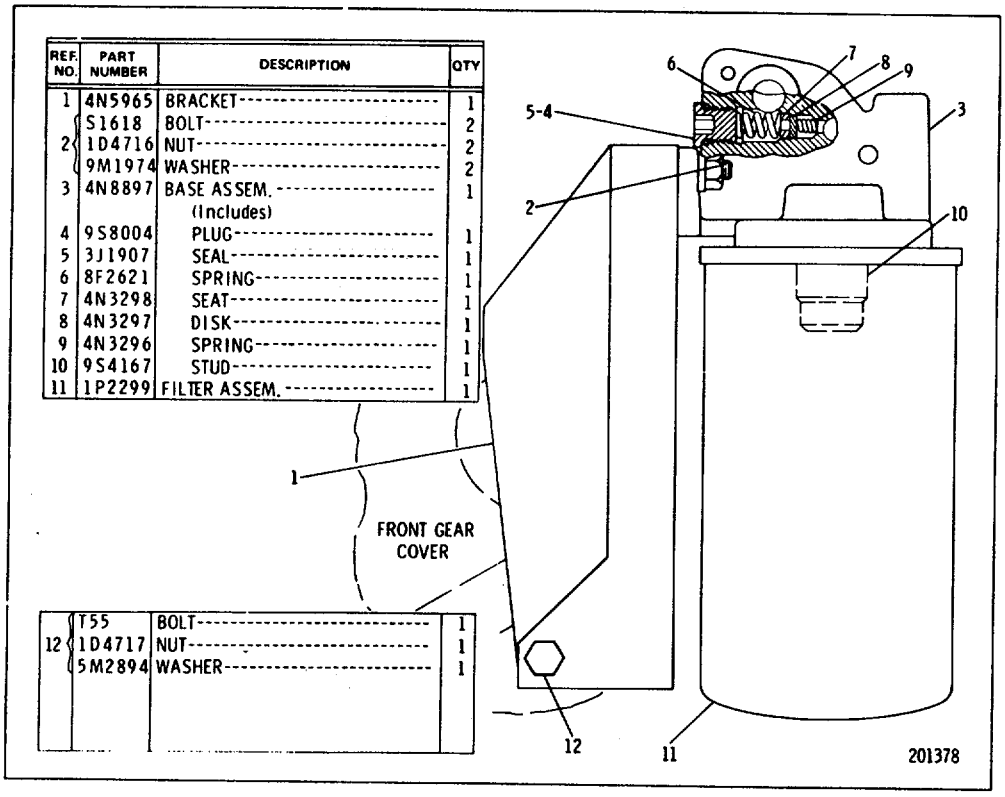
205096

FUEL INJECTION LINES GROUP (9N119 N/S)



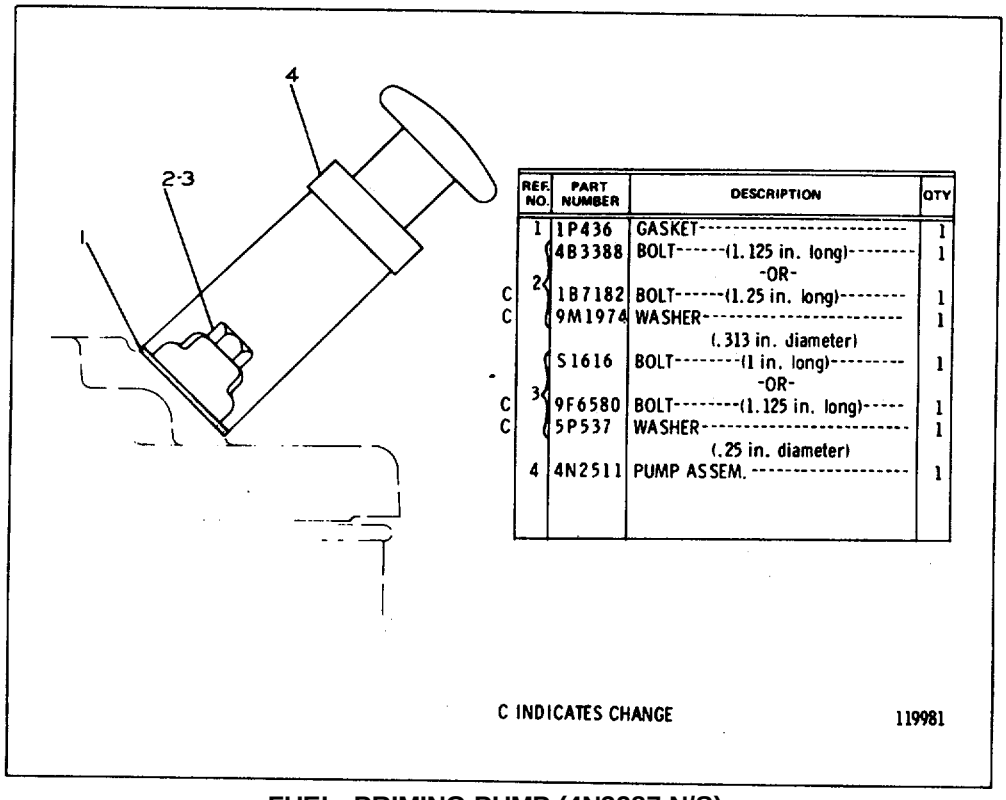
REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	9N916	BLOCK	1
2	8L6557	CONNECTOR	1
3	1D4717	NUT	1
	5M2894	WASHER	1
4	4H8878	CLIP	1
5	9N853	TUBE ASSEM.	1
6	306816	ELBOW	2
7	1J9671	SEAL	2
8	9N856	TUBE ASSEM.	1
9	S1615	BOLT	2
	1B4330	NUT	2
	3B4504	LOCKWASHER	2
10	2M7943	CLAMP	4
11	5P2559	FITTING	1
12	S550	CLIP	2
13	9N854	TUBE ASSEM.	1
14	4H6141	CONNECTOR	1

FUEL FILTER UNES (9N435 N/S)



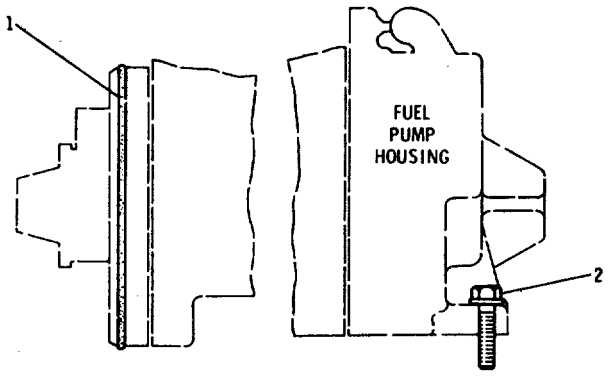
REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	4N5965	BRACKET	1
2	S1618	BOLT	2
	1D4716	NUT	2
	9M1974	WASHER	2
3	4N8897	BASE ASSEM. (Includes)	1
4	9S8004	PLUG	1
5	3J1907	SEAL	1
6	8F2621	SPRING	1
7	4N3298	SEAT	1
8	4N3297	DISK	1
9	4N3296	SPRING	1
10	9S4167	STUD	1
11	1P2299	FILTER ASSEM.	1
12	T55	BOLT	1
	1D4717	NUT	1
	5M2894	WASHER	1

Fuel Filter (4N5868 N/S)



REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	1P436	GASKET	1
2	4B3388	BOLT (1.125 in. long) -OR-	1
C	1B7182	BOLT (1.25 in. long)	1
C	9M1974	WASHER (.313 in. diameter)	1
3	S1616	BOLT (1 in. long) -OR-	1
C	9F6580	BOLT (1.125 in. long)	1
C	5P537	WASHER (.25 in. diameter)	1
4	4N2511	PUMP ASSEM.	1

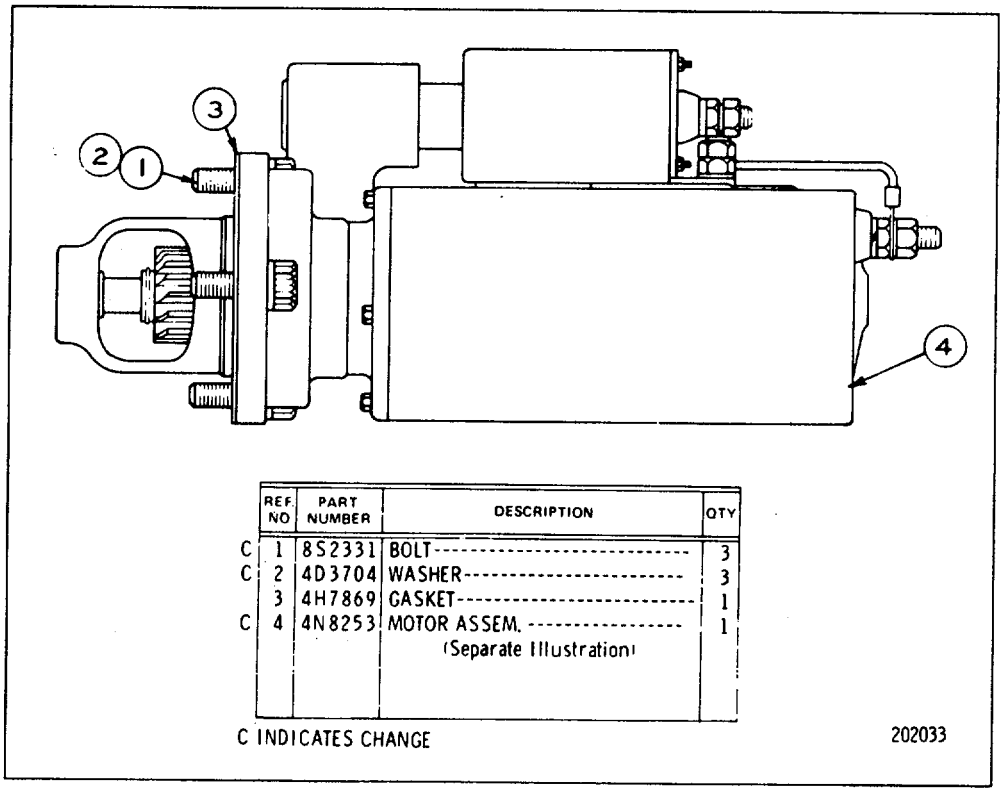
FUEL -PRIMING PUMP (4N3287 N/S)
Only separate parts serviced



REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	9M9729	SEAL----------	1
2	4B3388	BOLT----------	2
	9M1974	WASHER----------	2

201122

FUEL SYSTEM FASTENERS (9L6925 N/S)

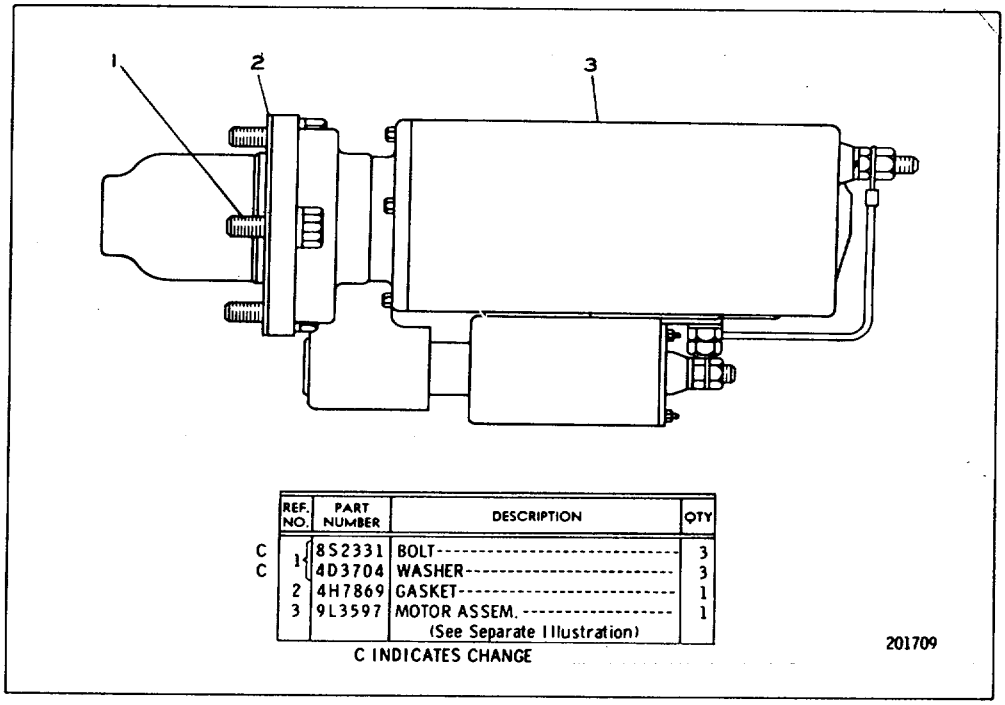


	REF NO	PART NUMBER	DESCRIPTION	QTY
C	1	8S2331	BOLT	3
C	2	4D3704	WASHER	3
	3	4H7869	GASKET	1
C	4	4N8253	MOTOR ASSEM. (Separate Illustration)	1

C INDICATES CHANGE

202033

ELECTRIC STARTING MOTOR (2N3538 N/S)-12 Volt
4N8253 Motor parts are shown on Pages 122 & 123
ALSO AN ATTACHMENT

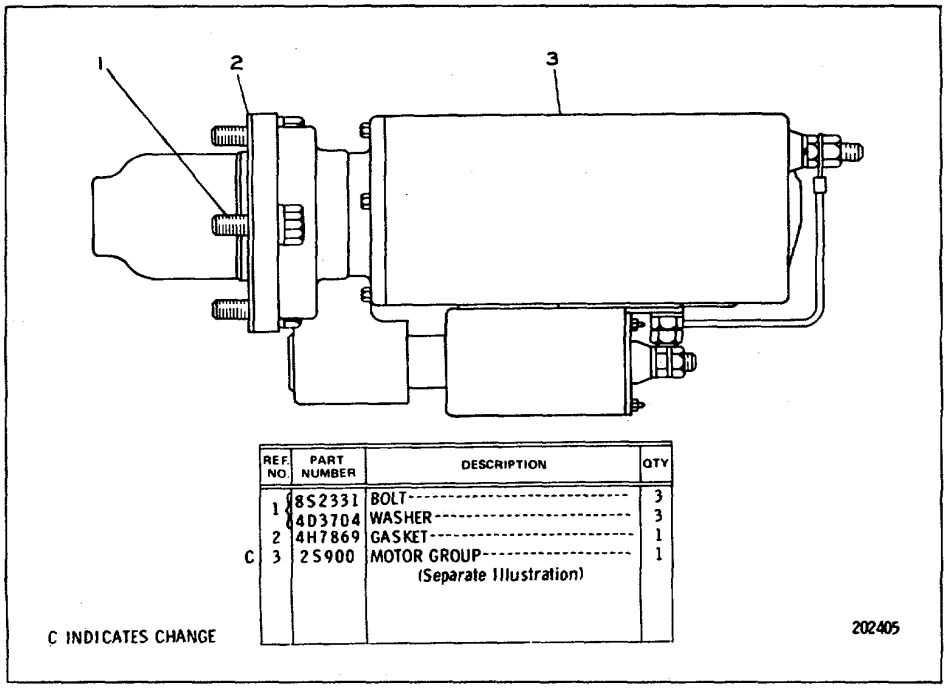


	REF. NO.	PART NUMBER	DESCRIPTION	QTY
C	1	8S2331	BOLT	3
C		4D3704	WASHER	3
	2	4H7869	GASKET	1
	3	9L3597	MOTOR ASSEM. (See Separate Illustration)	1

C INDICATES CHANGE

201709

2N9305 ELECTRIC STARTING MOTOR GROUP--12 Volt
9L3597 Motor parts are shown on Pages 124 and 125
ALSO AN ATTACHMENT

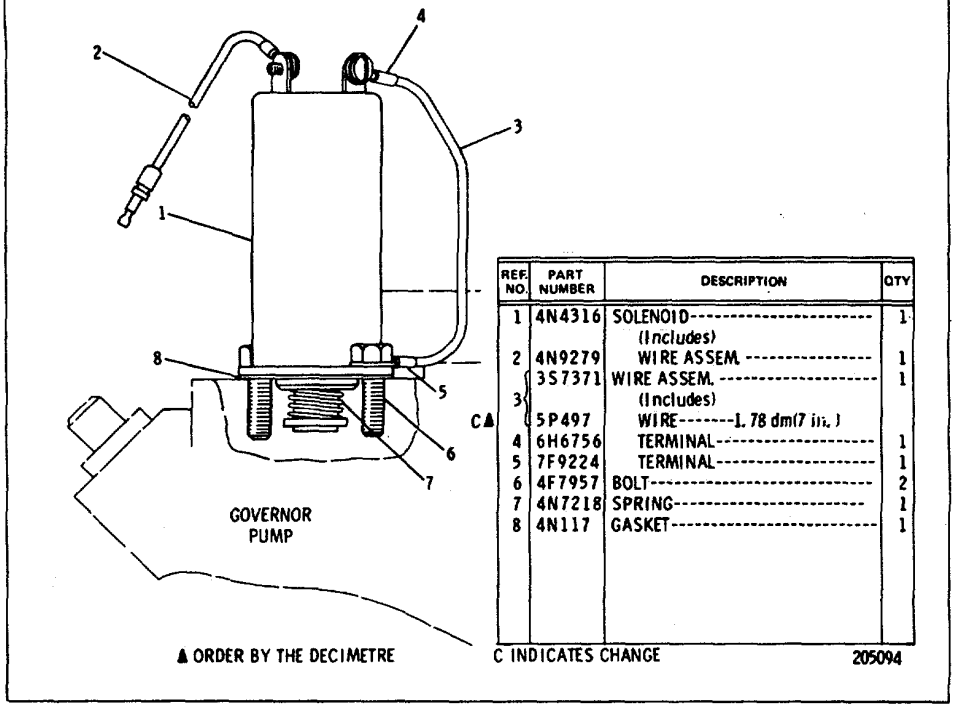


	REF. NO.	PART NUMBER	DESCRIPTION	QTY
	1	8S2331	BOLT	3
		4D3704	WASHER	3
	2	4H7869	GASKET	1
C	3	2S900	MOTOR GROUP (Separate Illustration)	1

C INDICATES CHANGE

202405

4N9312 ELECTRIC STARTING MOTOR GROUP-24 Volt
2S900 Motor parts are shown on Pages 126 and 127
AN ATTACHMENT



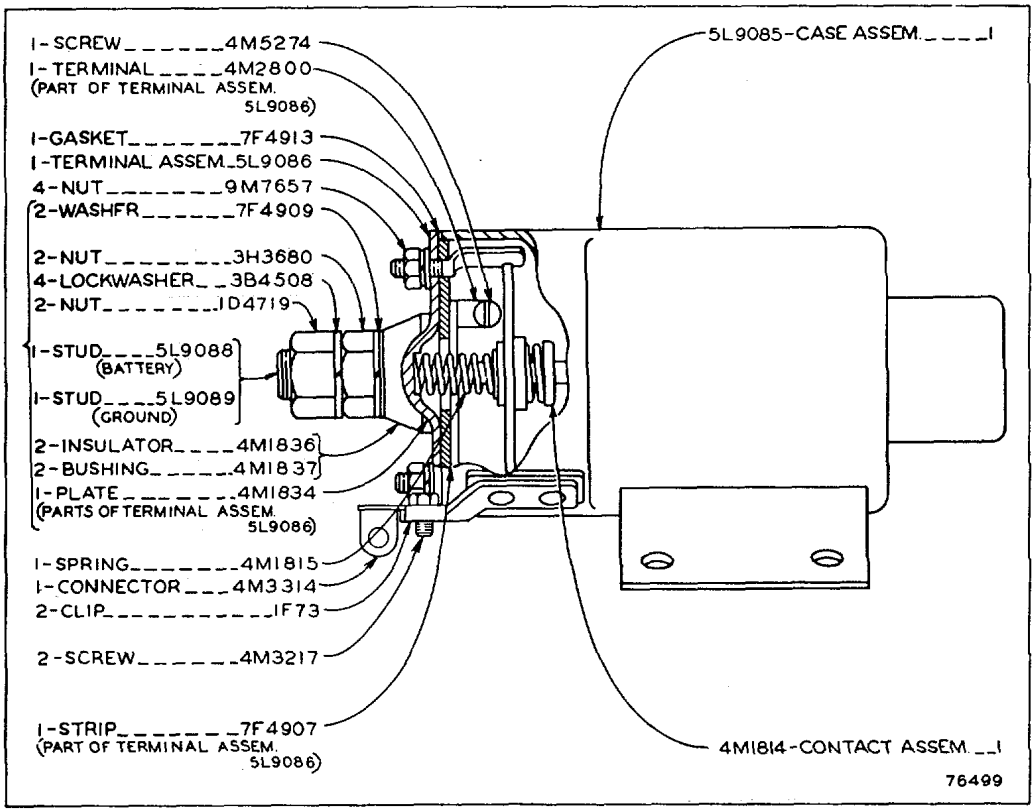
	REF. NO.	PART NUMBER	DESCRIPTION	QTY
	1	4N4316	SOLENOID (Includes)	1
	2	4N9279	WIRE ASSEM.	1
	3	3S7371	WIRE ASSEM. (Includes)	1
C▲		5P497	WIRE-------1.78 dm(7 in.)	
	4	6H6756	TERMINAL	1
	5	7F9224	TERMINAL	1
	6	4F7957	BOLT	2
	7	4N7218	SPRING	1
	8	4N117	GASKET	1

▲ ORDER BY THE DECIMETRE

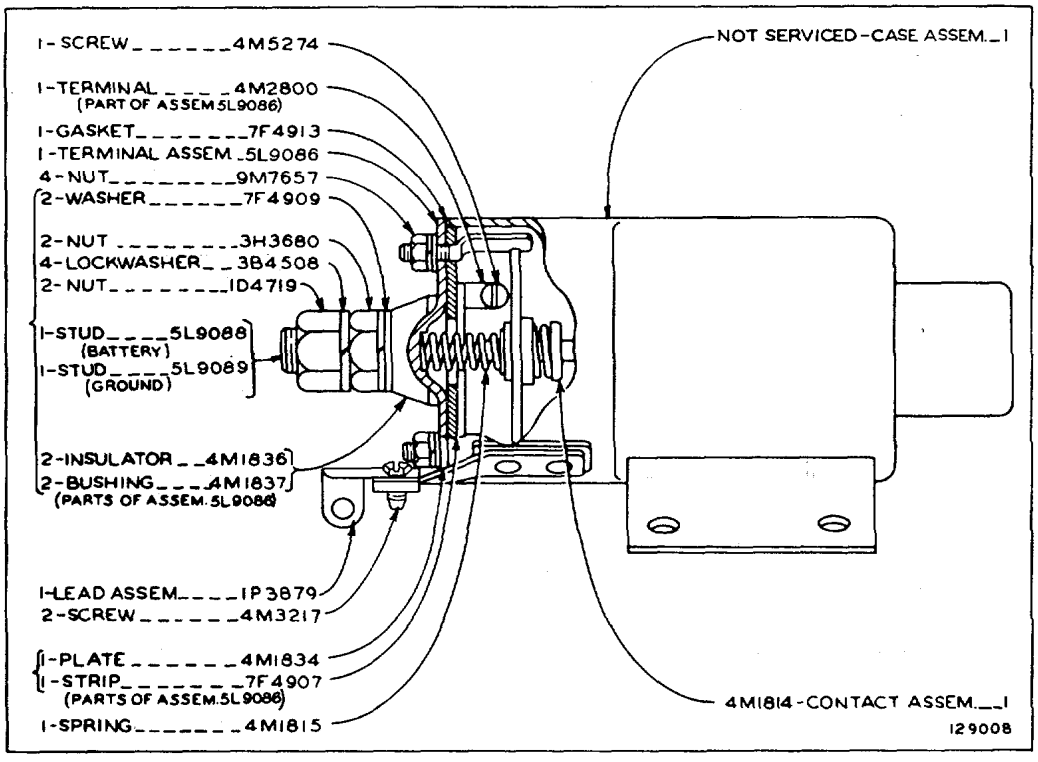
C INDICATES CHANGE

205094

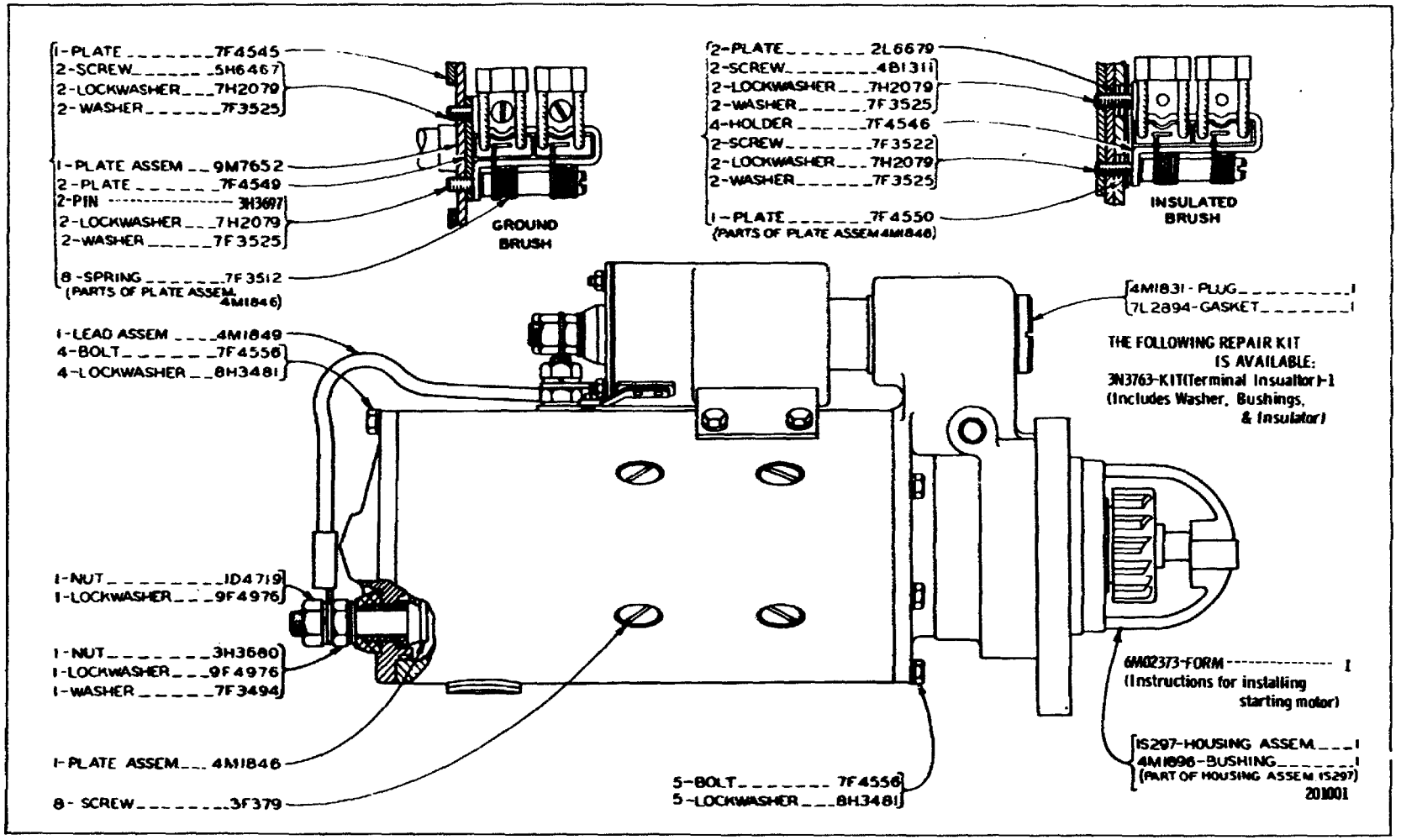
4N9314 ELECTRIC SHUT-OFF GROUP-24 Volt
AN ATTACHMENT



5L8735 SOLENOID SWITCH ASSEMBLY--12 Volt
Part of 4N8253 Motor Assembly shown on Page 123

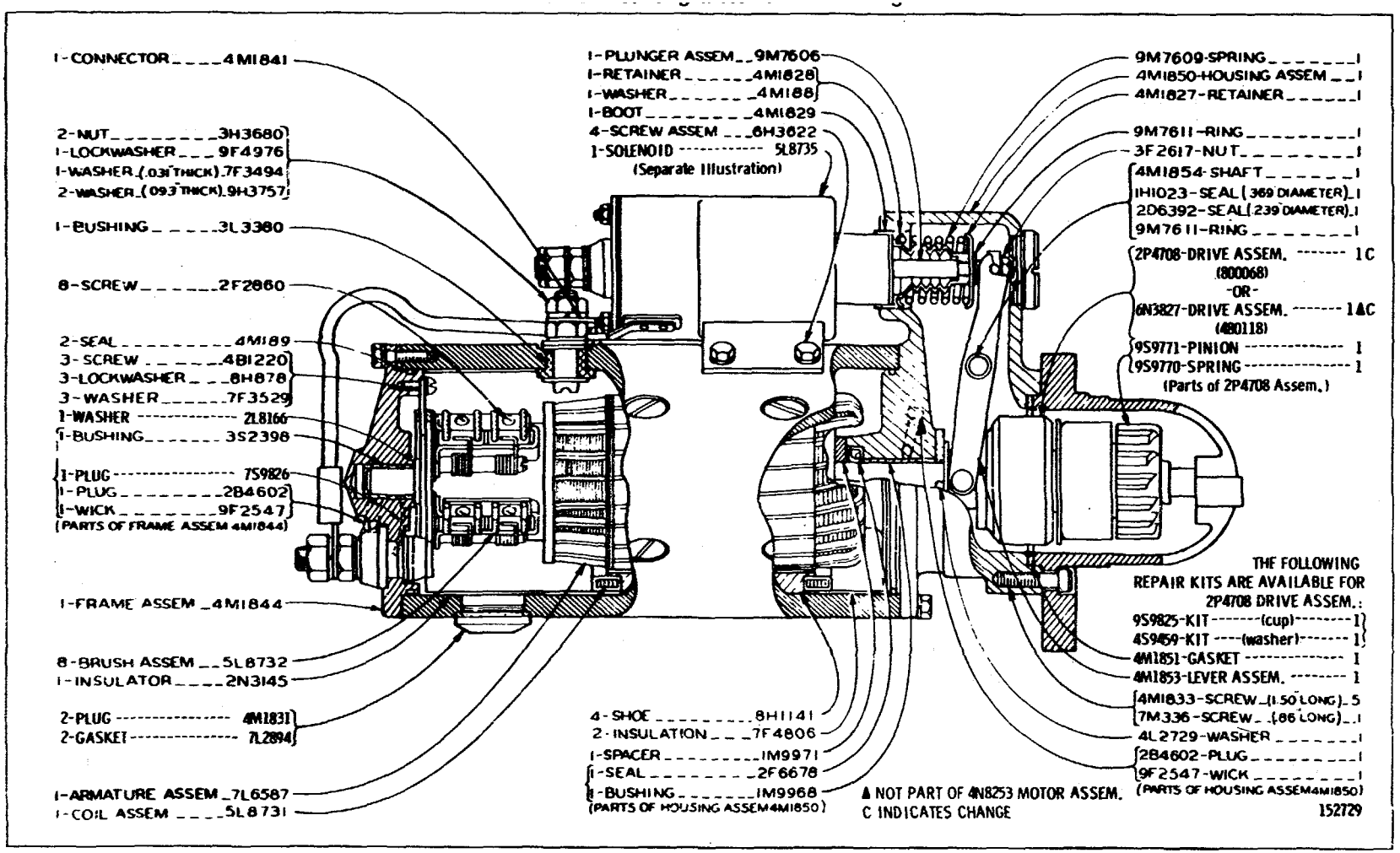


7L6586 SOLENOID SWITCH ASSEMBLY--12 Volt
Part of 9L3597 Electric Starting Motor Assembly shown on Page 124

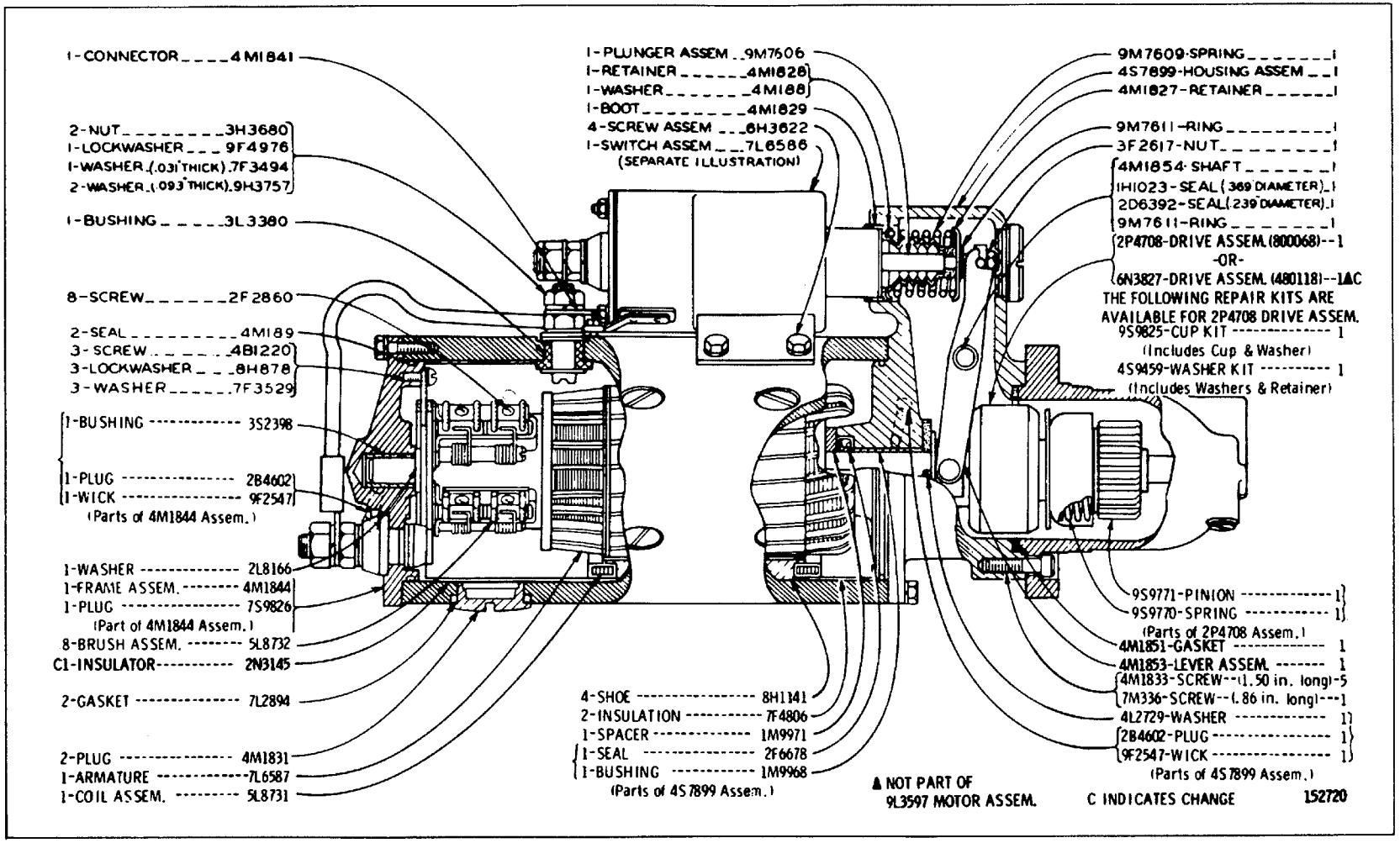


4N8253 MOTOR ASSEMBLY-12 Volt--Part 1

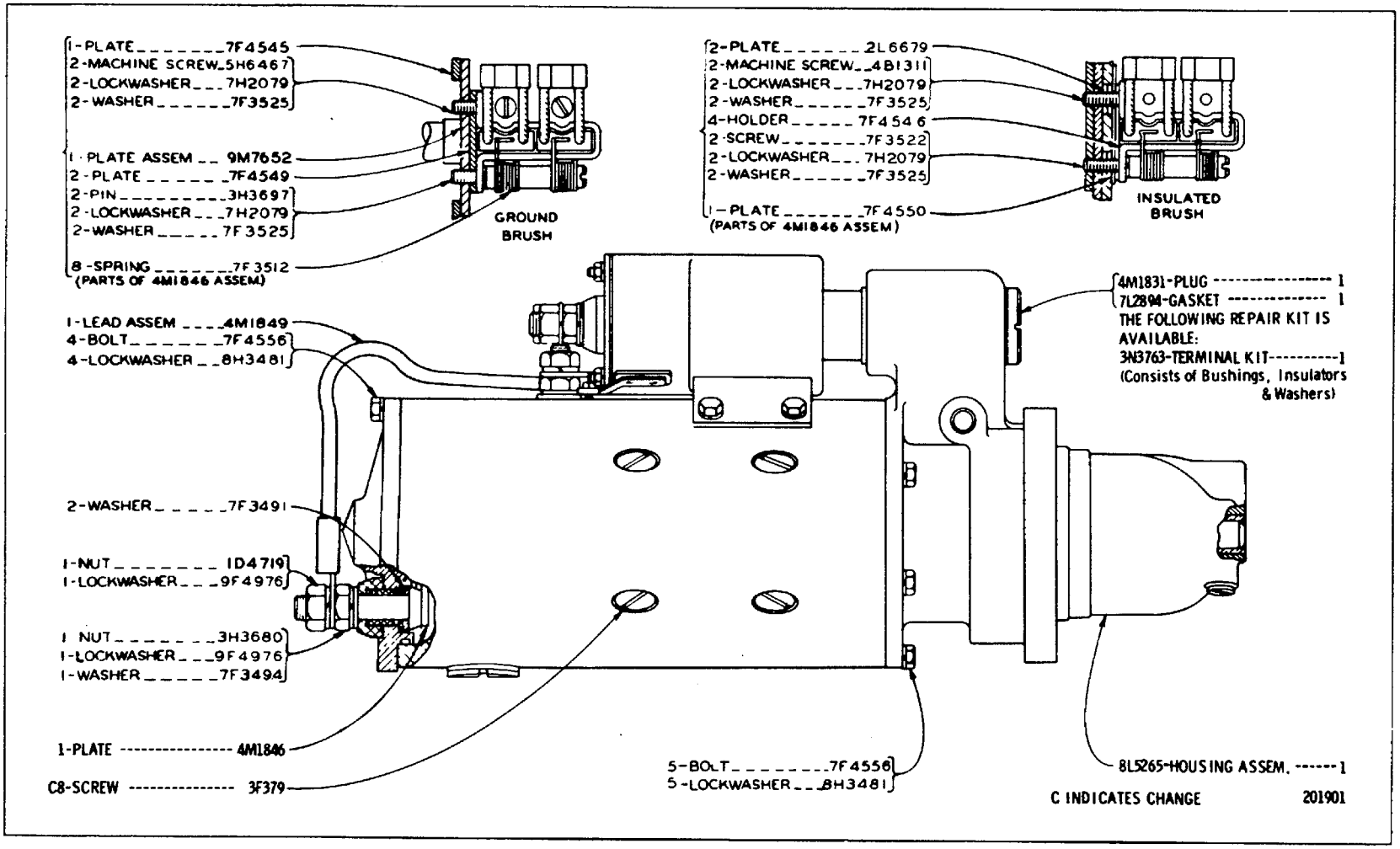
Part of Electric Starting Motor shown on Page 119



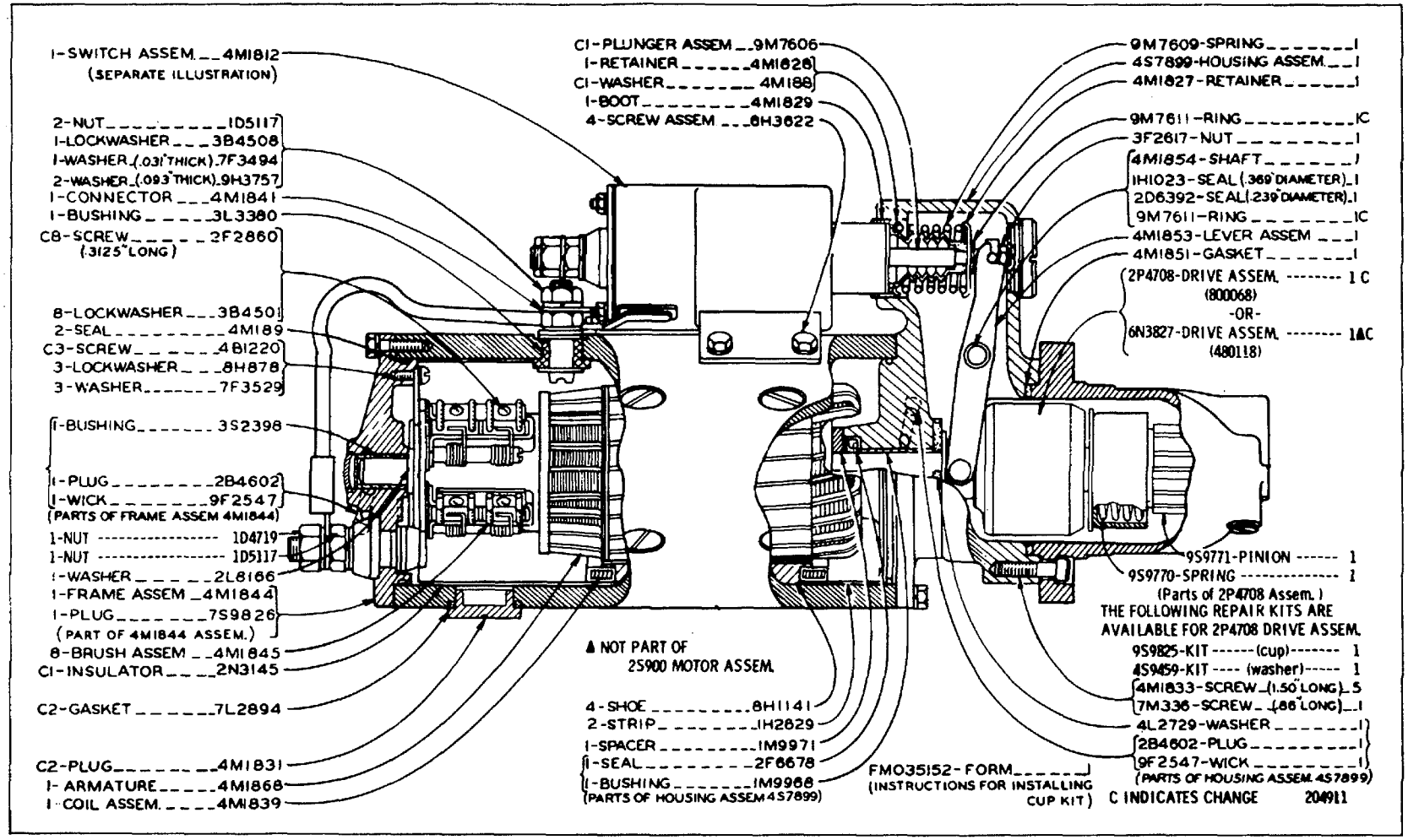
4N8253 MOTOR ASSEMBLY-12 Volt-Part 2
5LB735 Switch parts are shown on Page 121
Part of Electric Starting Motor shown on Page 119



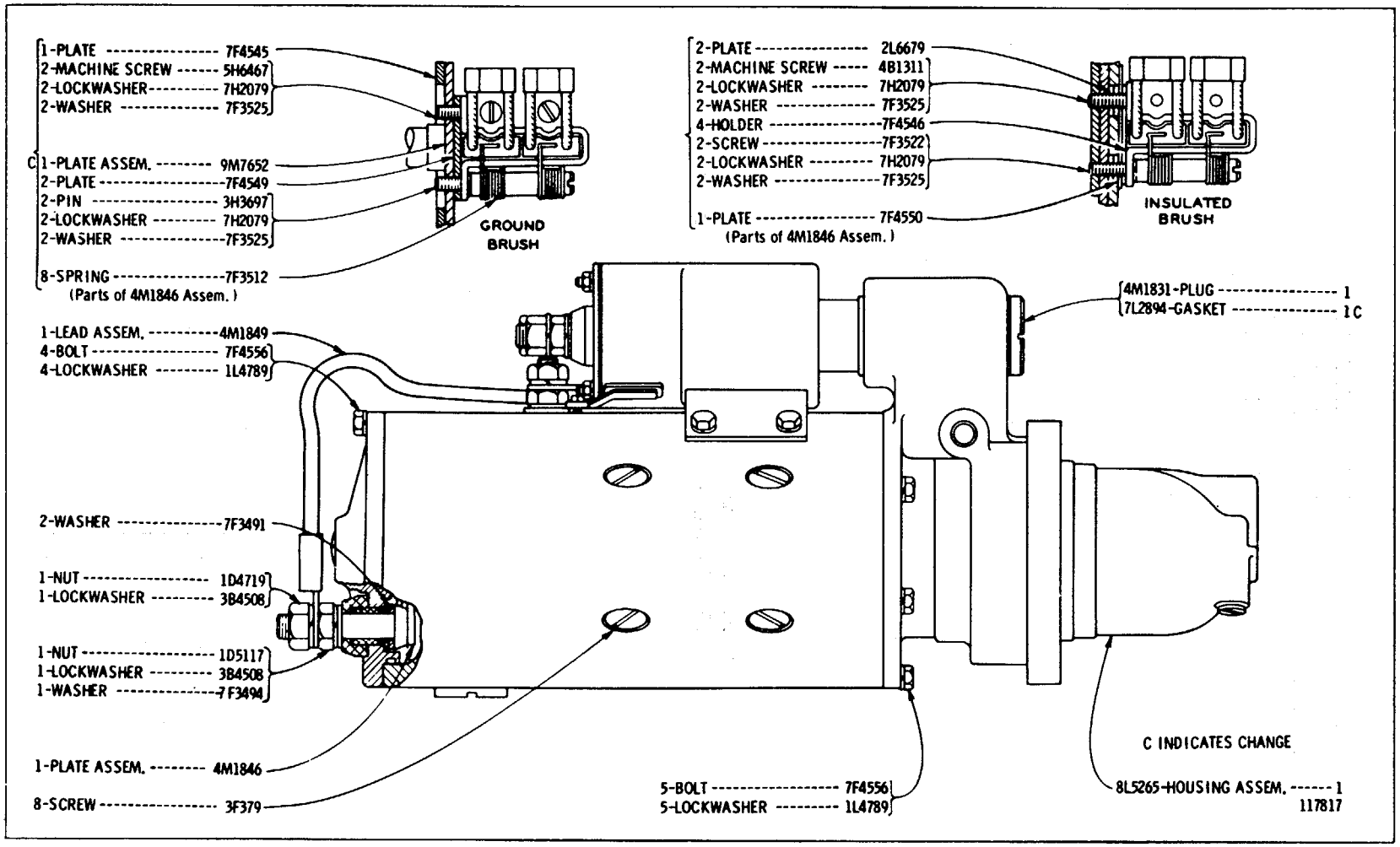
9L3597 ELECTRIC STARTING MOTOR ASSEMBLY-12 Volt-Part 1
7L6586 Switch parts are shown on Page 121
Part of 2N9305 Electric Starting Motor Group shown on Page 119



9L3597 ELECTRIC STARTING MOTOR ASSEMBLY--12 Volt-Part 2
Part of 2N9305 Electric Starting Motor Group shown on Pace 119

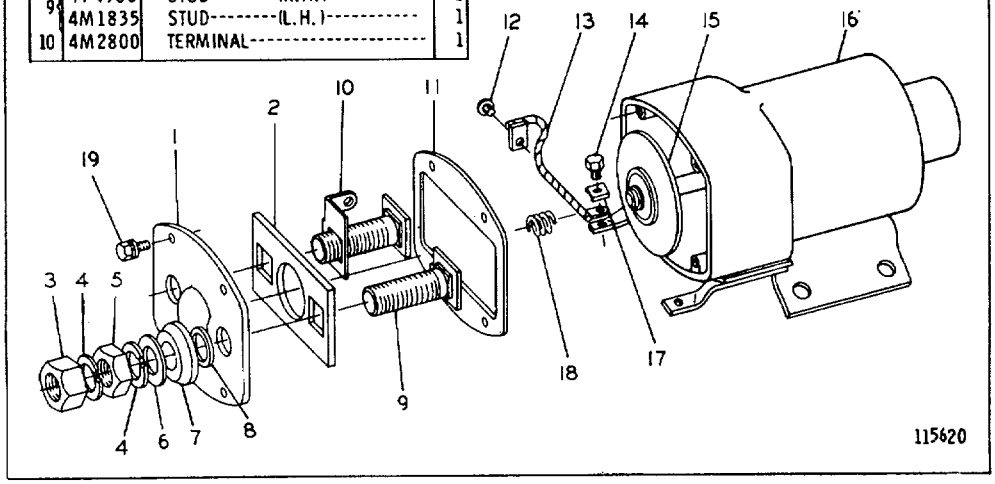


2S900 STARTING MOTOR ASSEMBLY-24 Volt-Part 1
4M1812 Switch parts are shown on Page 128
Part of 4N9312 Electric Starting Motor Group shown on Page 120

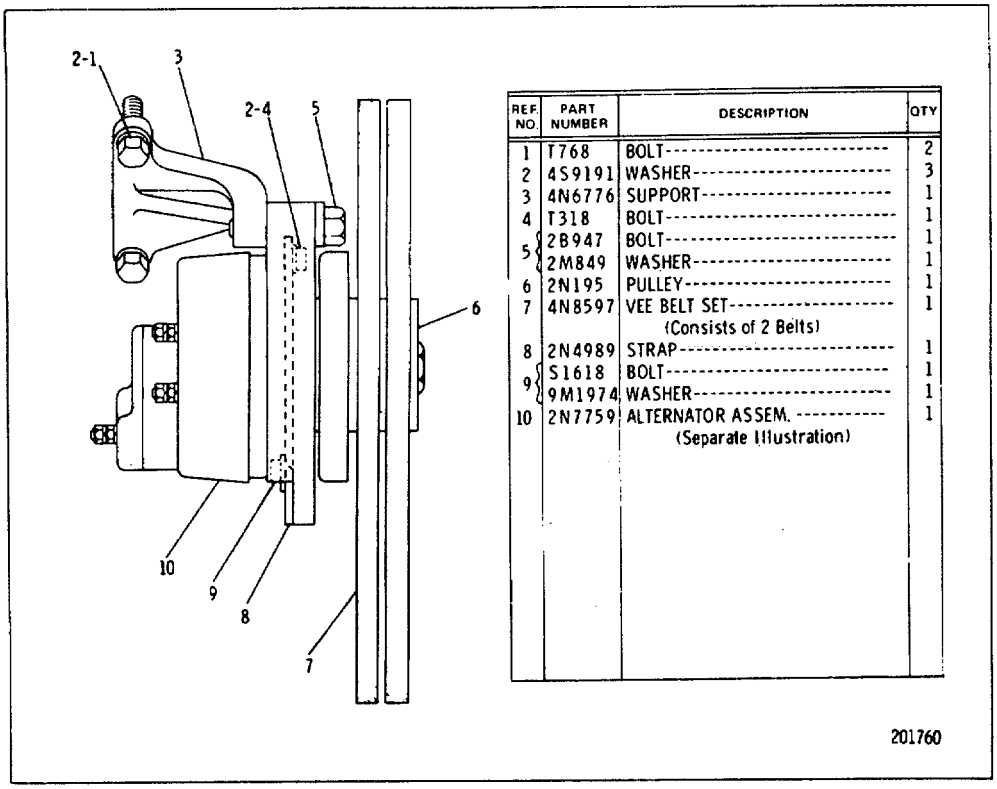


2S900 STARTING MOTOR ASSEMBLY-24 Volt-Part 2
Part of 4N9312 Electric Starting Motor Group shown on Page 120

REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	4M1816	TERMINAL ASSEM.	1
	4M1834	PLATE	1
2	7F4907	STRIP	1
3	3H3681	NUT	2
4	3B4508	LOCKWASHER	4
5	3H3680	NUT	2
6	7F4909	WASHER	2
7	4M1836	INSULATOR	2
8	4M1837	BUSHING	2
9	7F4906	STUD--------(R.H.)	1
	4M1835	STUD--------(L.H.)	1
10	4M2800	TERMINAL	1
11	9S4490	GASKET	1
12	4M5274	SCREW	1
13	1P3879	LEAD ASSEM.	1
14	4M3217	SCREW	2
15	4M1814	CONTACT ASSEM.	1
16	4M1813	CASE ASSEM.	1
17	1F73	CLIP	2
18	4M1815	SPRING	1
19	9M7657	NUT	4
		-OR-	
	9S4489	SCREW ASSEM.	4

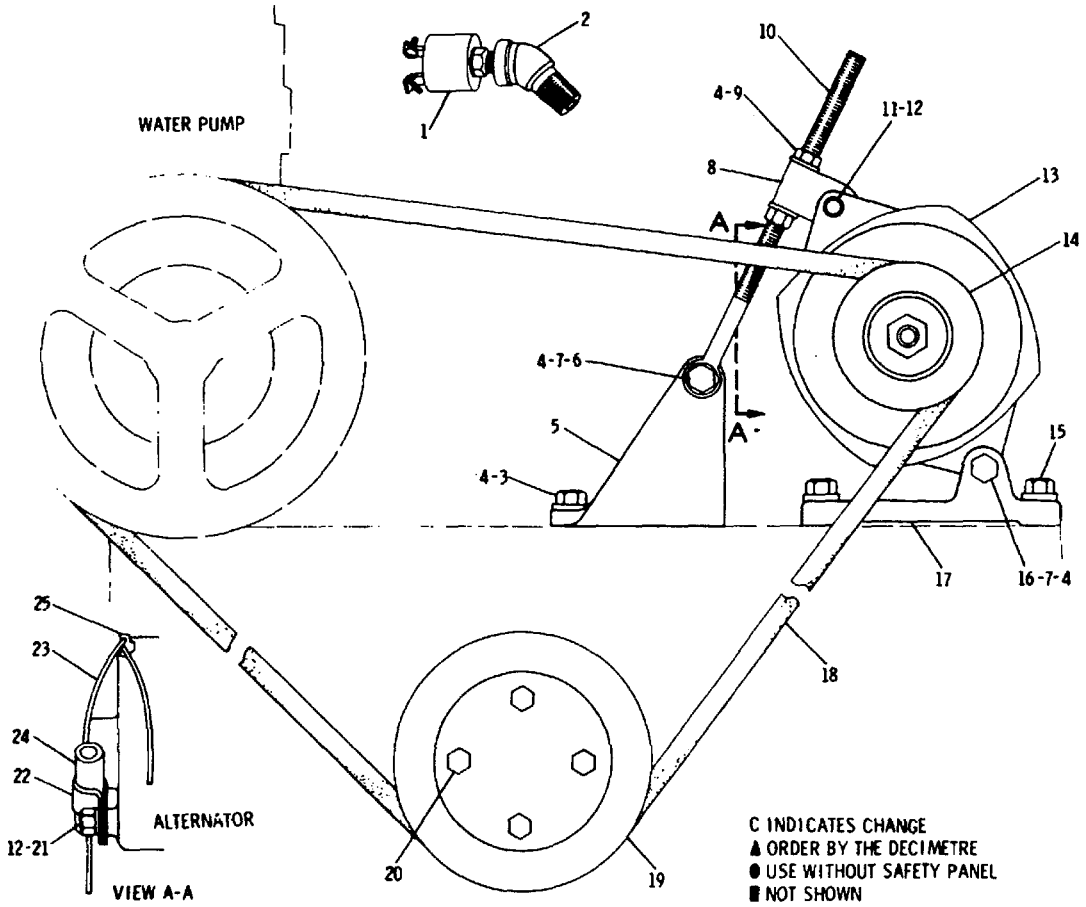


4M1812 SOLENOID SWITCH ASSEMBLY-24 Volt
Part of 2S900 Starting Motor Assembly shown on Page 126



REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	T768	BOLT	2
2	4S9191	WASHER	3
3	4N6776	SUPPORT	1
4	T318	BOLT	1
5	2B947	BOLT	1
	2M849	WASHER	1
6	2N195	PULLEY	1
7	4N8597	VEE BELT SET	1
		(Consists of 2 Belts)	
8	2N4989	STRAP	1
9	S1618	BOLT	1
	9M1974	WASHER	1
10	2N7759	ALTERNATOR ASSEM.	1
		(Separate Illustration)	

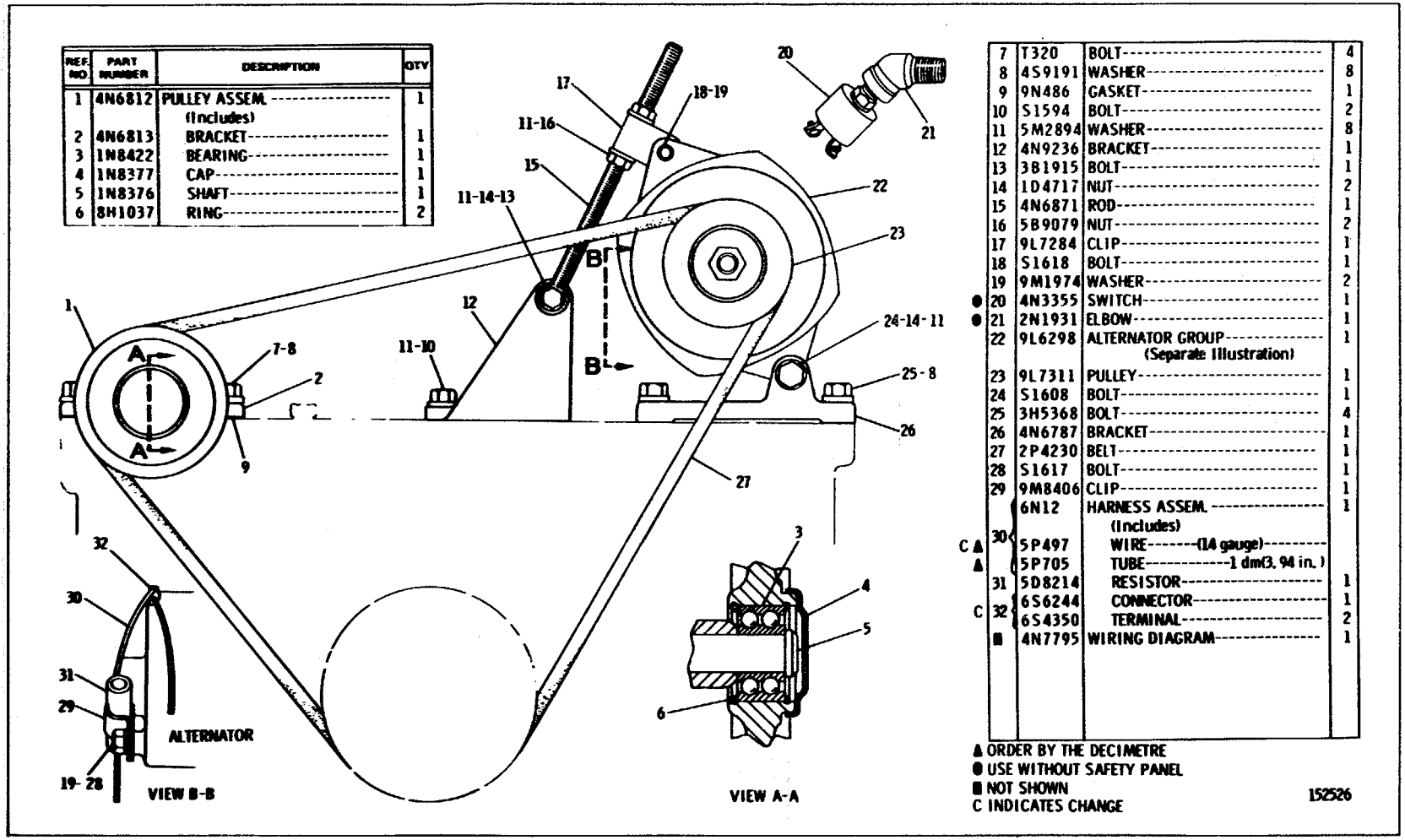
ALTERNATOR (6N467 N/S) - 12 Volt, 55 Ampere
2N7759 Alternator parts are shown on Page 135



	REF. NO.	PART NUMBER	DESCRIPTION	QTY
●	1	4N3355	SWITCH	1
●	2	2N1931	ELBOW	1
	3	S1594	BOLT	2
	4	5M2894	WASHER	8
	5	4N9236	BRACKET	1
	6	3B1915	BOLT	1
	7	1D4717	NUT	2
	8	9L7284	CLIP	1
	9	5B9079	NUT	2
	10	4N6871	ROD	1
	11	S1618	BOLT	1
	12	9M1974	WASHER	2
	13	9L6298	ALTERNATOR GROUP (Separate Illustration)	1
	14	9L7311	PULLEY	1
	15	3H5368	BOLT	4
		4S9191	WASHER	4
	16	S1608	BOLT	1
	17	4N6787	BRACKET	1
	18	9L6130	VEE BELT SET (2 belts)	1
	19	9L7626	PULLEY	1
	20	2B2695	BOLT	4
	21	S1617	BOLT	1
	22	9M8406	CLIP	1
	23	6N12	HARNESS ASSEM. (Includes)	1
C▲		5P497	WIRE (14 gauge)	
▲		5P705	TUBE 1 dm(3.94 in.)	
	24	5D8214	RESISTOR	1
C	25	6S6244	CONNECTOR	1
		6S4350	TERMINAL	2
■		4N7795	WIRING DIAGRAM	1

152527

4N7256 ALTERNATOR GROUP-12 Volt, 55 Ampere
9L6298 Alternator parts are shown on Page 136
NOT FOR USE WITH 4N7393 RADIATOR GROUP SHOWN ON PAGE 86
AN ATTACHMENT

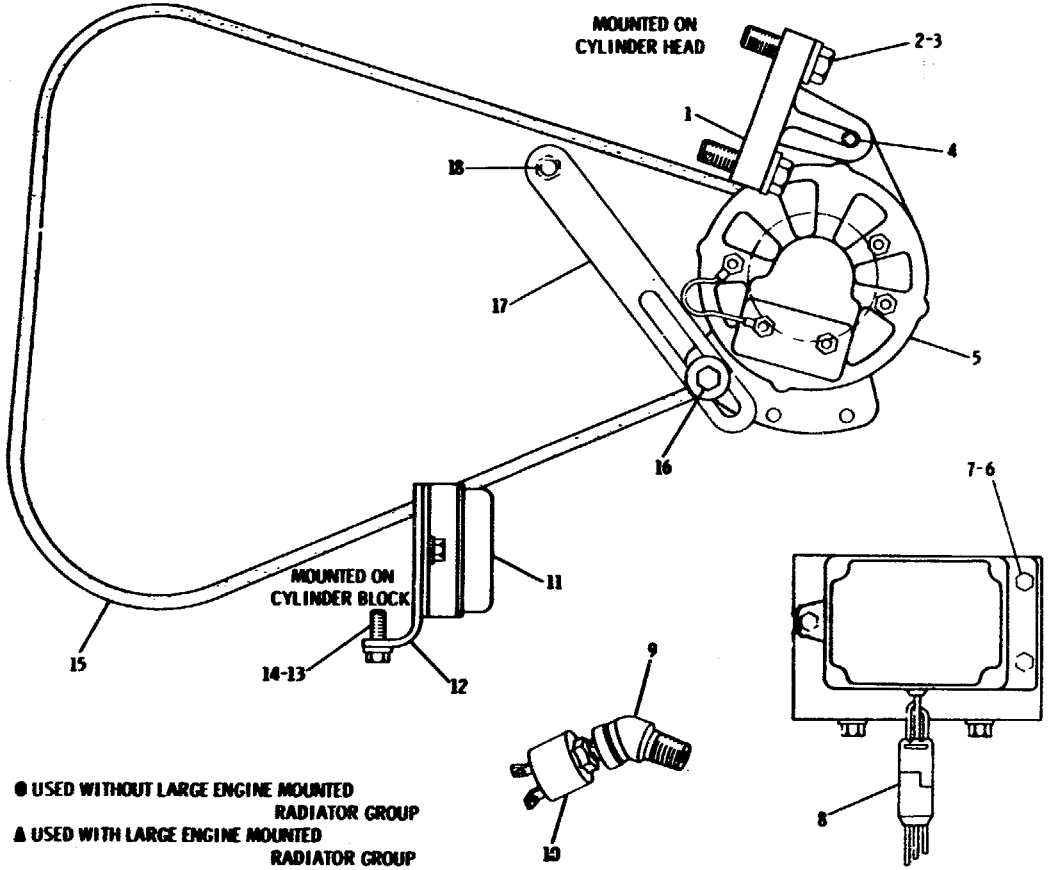


REF NO	PART NUMBER	DESCRIPTION	QTY
1	4N6812	PULLEY ASSEM. (Includes)	1
2	4N6813	BRACKET	1
3	1N8422	BEARING	1
4	1N8377	CAP	1
5	1N8376	SHAFT	1
6	8H1037	RING	2
7	T320	BOLT	4
8	4S9191	WASHER	8
9	9N486	GASKET	1
10	S1594	BOLT	2
11	5M2894	WASHER	8
12	4N9236	BRACKET	1
13	3B1915	BOLT	1
14	1D4717	NUT	2
15	4N6871	ROD	1
16	5B9079	NUT	2
17	9L7284	CLIP	1
18	S1618	BOLT	1
19	9M1974	WASHER	2
● 20	4N3355	SWITCH	1
● 21	2N1931	ELBOW	1
22	9L6298	ALTERNATOR GROUP (Separate Illustration)	1
23	9L7311	PULLEY	1
24	S1608	BOLT	1
25	3H5368	BOLT	4
26	4N6787	BRACKET	1
27	2P4230	BELT	1
28	S1617	BOLT	1
29	9M8406	CLIP	1
C ▲ 30	6N12	HARNESS ASSEM. (Includes)	1
C ▲ 30	5P497	WIRE--------(14 gauge)	
▲ 30	5P705	TUBE----------1 dm(3.94 in.)	
31	5D8214	RESISTOR	1
C 32	6S6244	CONNECTOR	1
C 32	6S4350	TERMINAL	2
■	4N7795	WIRING DIAGRAM	1

▲ ORDER BY THE DECIMETRE
● USE WITHOUT SAFETY PANEL
■ NOT SHOWN
C INDICATES CHANGE

152526

4N7231 ALTERNATOR GROUP - 12 Volt, 55 Ampere
9L6298 Alternator parts are shown on Page 136
NOT FOR USE WITH 4N7393 RADIATOR GROUP SHOWN ON PAGE 86
AN ATTACHMENT

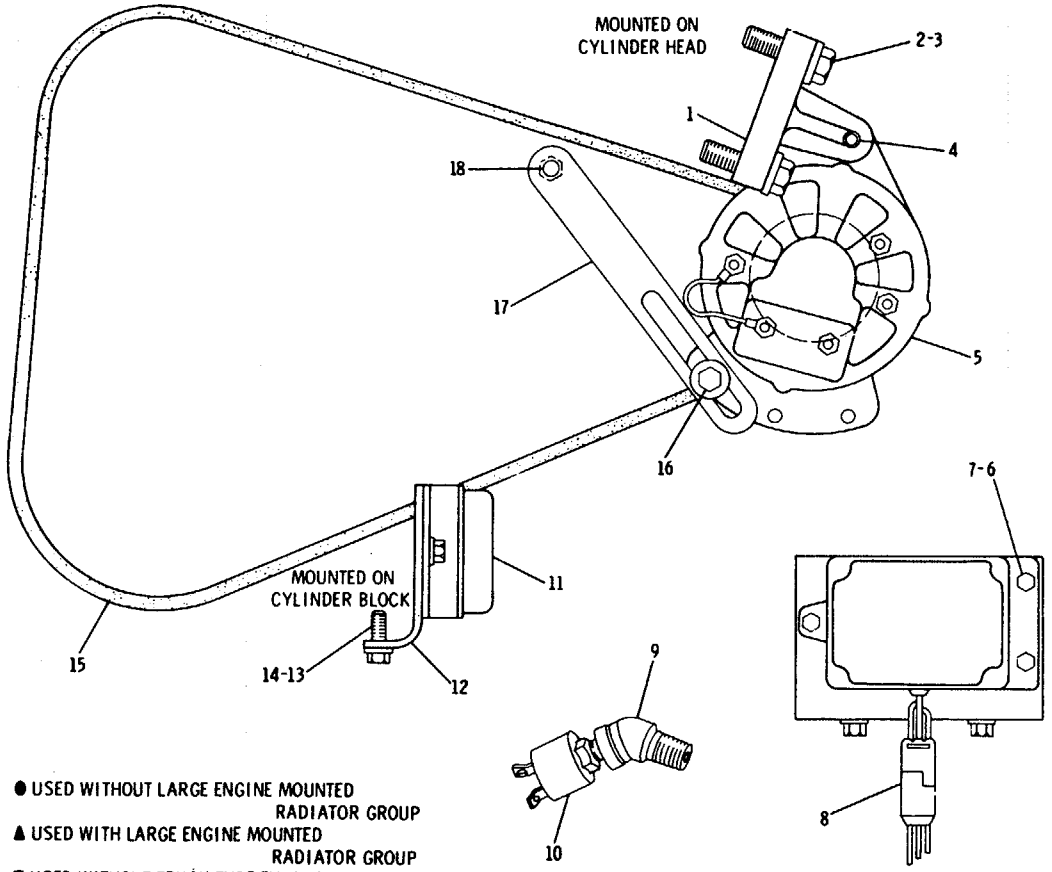


REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	4N6776	SUPPORT	1
2	T768	BOLT	2
3	4S9191	WASHER	2
4	1A1460	BOLT	1
	2M849	WASHER	1
	2N7759	ALTERNATOR ASSEM. (Separate Illustration)	1
5	2N195	PULLEY	1
● 6	6F7027	BOLT	3
	5P537	WASHER	3
▲ 7	S1615	BOLT	3
	1B4330	NUT	3
8	2N5880	HARNESS ASSEM.	1
9	2N1931	ELBOW	1
10	4N3355	SWITCH (Used Without Safety Instrument Panel Group)	1
11	2N7278	REGULATOR ASSEM.	1
● 12	2N8985	BRACKET ASSEM.	1
■● 13	4B3388	BOLT	2
■● 14	9M1974	WASHER	2
15	4N8597	VEE BELT SET (Consists of 2 Belts)	1
16	S1618	BOLT	1
C	9M6527	WASHER	1
17	2N4989	STRAP	1
18	T318	BOLT	1
	4S9191	WASHER (Used Without Low Air Compressor Drive Group, and Low Speed High Fan Drive Group)	1
	8L5950	WIRING DIAGRAM---(not shown)--	1

C INDICATES CHANGE

205092

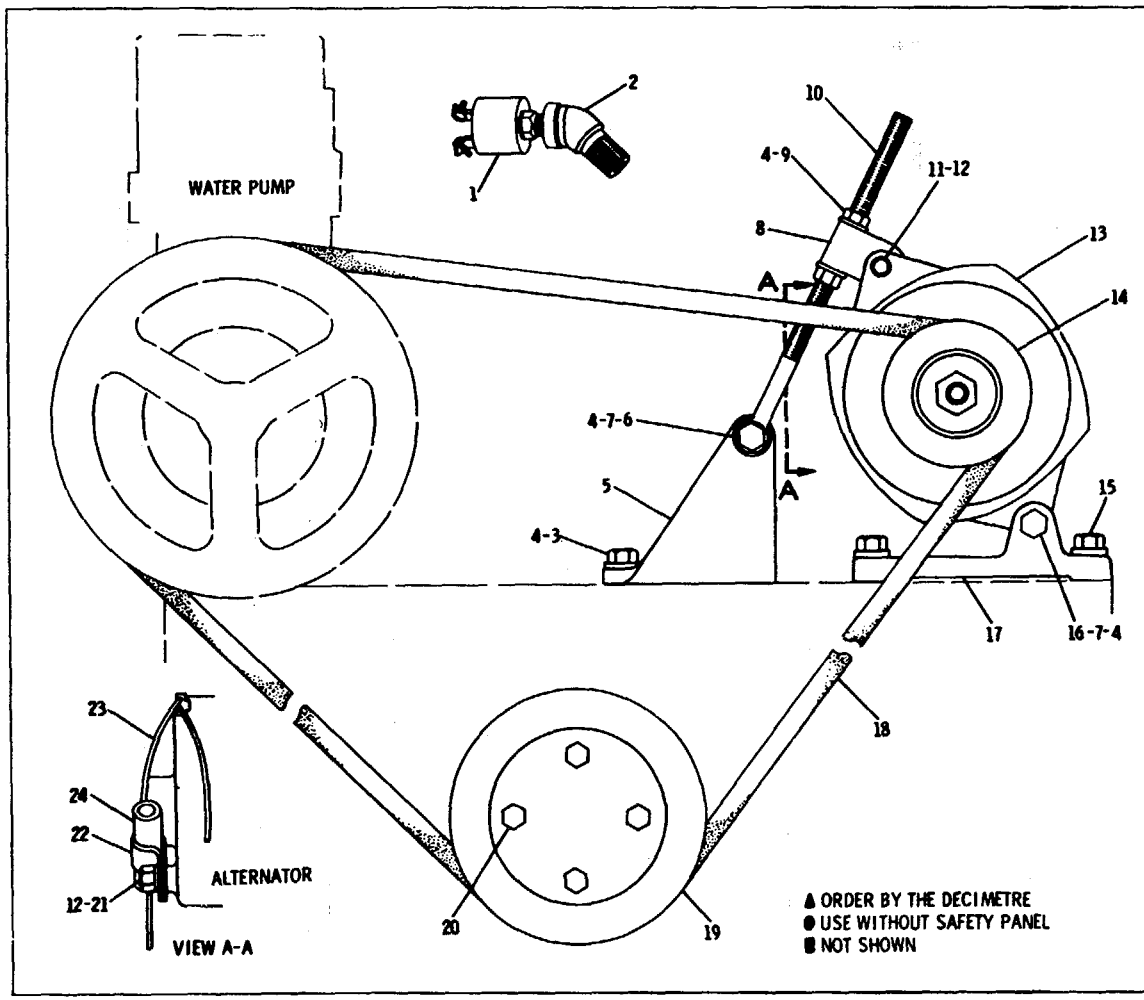
4N6981 ALTERNATOR GROUP-12 Volt, 55 Ampere
2N7759 Alternator parts are shown of Page 135
NOT FOR USE WITH 4N7390 WATER PUMP DRIVE GROUP SHOWN ON PAGE 78
AN ATTACHMENT



REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	4N6776	SUPPORT	1
2	T768	BOLT	2
3	4S9191	WASHER	2
4	2B947	BOLT	1
	2M849	WASHER	1
5	2N6398	ALTERNATOR ASSEM. (Separate Illustration)	1
	2N195	PULLEY	1
● 6	6F7027	BOLT	3
	5P537	WASHER	3
▲ 7	S1615	BOLT	3
	1B4330	NUT	3
8	2N5880	HARNESS ASSEM.	1
9	2N1931	ELBOW	1
10	4N3355	SWITCH (Used Without Safety Instrument Panel Group)	1
11	2N7279	REGULATOR ASSEM.	1
● 12	2N8985	BRACKET ASSEM.	1
■● 13	4B3388	BOLT	2
■● 14	9M1974	WASHER	2
15	4N8597	VEE BELT SET (Consists of 2 Belts)	1
16	S1618	BOLT	1
C	9M6527	WASHER	1
17	2N4989	STRAP	1
18	T318	BOLT	1
	4S9191	WASHER (Used Without Low Air Compressor Drive Group, and Low Speed High Fan Drive Group)	1
	8L5950	WIRING DIAGRAM---(not shown)--	1

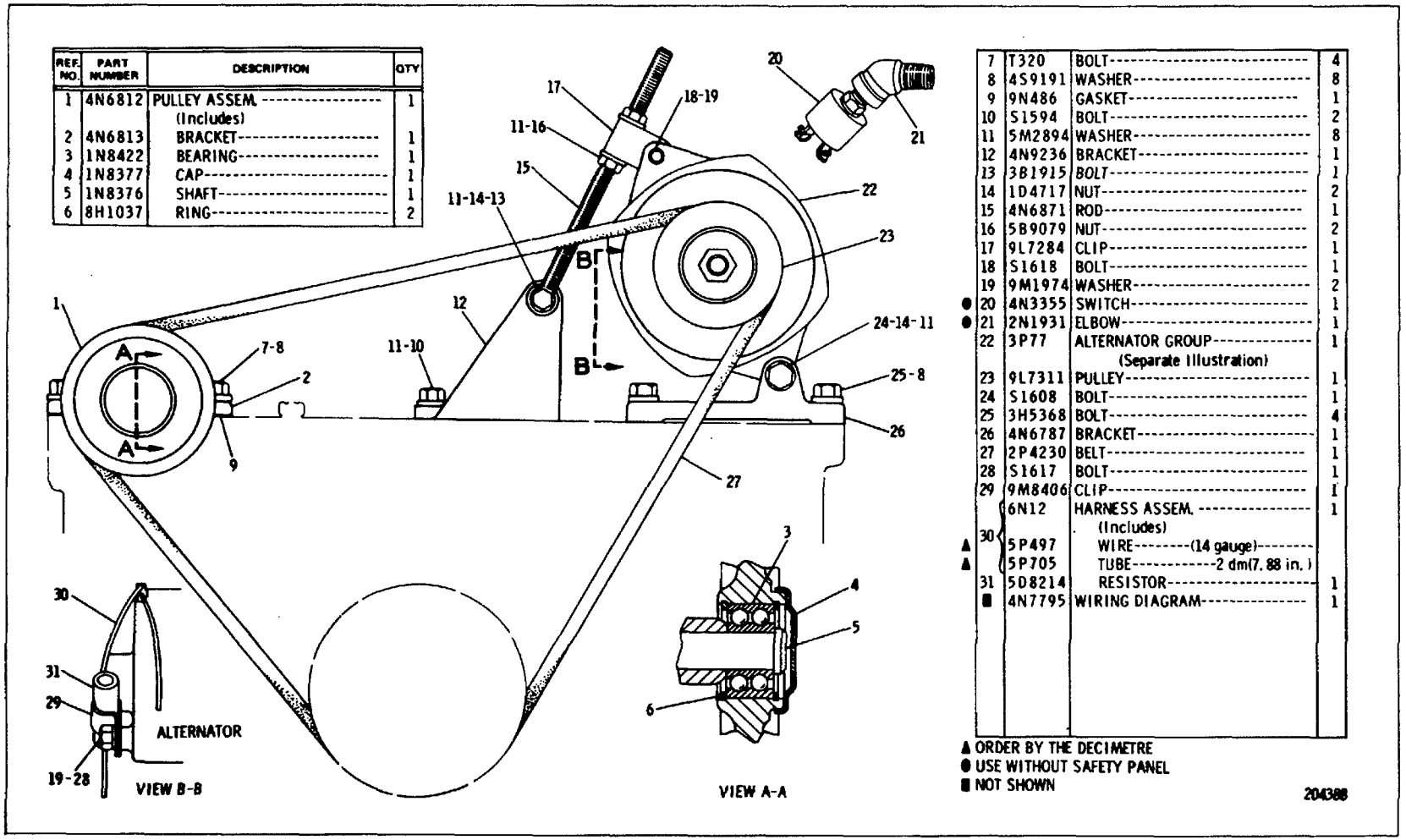
C INDICATES CHANGE 205091

4N9313 ALTERNATOR GROUP-24 Volt, 35 Ampere
2N6398 Alternator parts as shown on Page 137
FOR USE WITH 4N9314 ELECTRIC SHUT-OFF GROUP SHOWN ON PAGE 120
AN ATTACHMENT



	REF. NO.	PART NUMBER	DESCRIPTION	QTY
●	1	4N3355	SWITCH	1
●	2	2N1931	ELBOW	1
	3	S1594	BOLT	2
	4	5M2894	WASHER	8
	5	4N9236	BRACKET	1
	6	3B1915	BOLT	1
	7	1D4717	NUT	2
	8	9L7284	CLIP	1
	9	5B9079	NUT	2
	10	4N6871	ROD	1
	11	S1618	BOLT	1
	12	9M1974	WASHER	2
	13	3P77	ALTERNATOR GROUP (Separate Illustration)	1
	14	9L7311	PULLEY	1
	15	3H5368	BOLT	4
		4S9191	WASHER	4
	16	S1608	BOLT	1
	17	4N6787	BRACKET	1
	18	9L6130	VEE BELT SET-------(2 belts)-------	1
	19	9L7626	PULLEY	1
	20	2B2695	BOLT	4
	21	S1617	BOLT	1
	22	9M8406	CLIP	1
	23	6N12	HARNESS ASSEM. (Includes)	1
▲		5P497	WIRE--------(14 gauge)-------	
▲		5P705	TUBE----------2 dm(7.88 in.)	
	24	5D8214	RESISTOR	1
■		4N7795	WIRING DIAGRAM	1

9N147 ALTERNATOR GROUP-24 Volt, 40 Ampere
3P77 Alternator parts are shown on Page 138
FOR USE WITH 4N9312 ELECTRIC STARTING MOTOR GROUP and 4N9314 ELECTRIC SHUT-OFF GROUP SHOWN ON PAGE 120 AN ATTACHMENT



REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	4N6812	PULLEY ASSEM. (Includes)	1
2	4N6813	BRACKET	1
3	1N8422	BEARING	1
4	1N8377	CAP	1
5	1N8376	SHAFT	1
6	8H1037	RING	2
7	T320	BOLT	4
8	4S9191	WASHER	8
9	9N486	GASKET	1
10	S1594	BOLT	2
11	5M2894	WASHER	8
12	4N9236	BRACKET	1
13	3B1915	BOLT	1
14	1D4717	NUT	2
15	4N6871	ROD	1
16	5B9079	NUT	2
17	9L7284	CLIP	1
18	S1618	BOLT	1
19	9M1974	WASHER	2
● 20	4N3355	SWITCH	1
● 21	2N1931	ELBOW	1
22	3P77	ALTERNATOR GROUP (Separate Illustration)	1
23	9L7311	PULLEY	1
24	S1608	BOLT	1
25	3H5368	BOLT	4
26	4N6787	BRACKET	1
27	2P4230	BELT	1
28	S1617	BOLT	1
29	9M8406	CLIP	1
30	6N12	HARNESS ASSEM. (Includes)	1
▲	5P497	WIRE--------(14 gauge)--------	
▲	5P705	TUBE----------2 dm(7.88 in.)	
31	5D8214	RESISTOR	1
■	4N7795	WIRING DIAGRAM	1

▲ ORDER BY THE DECIMETRE
● USE WITHOUT SAFETY PANEL
■ NOT SHOWN

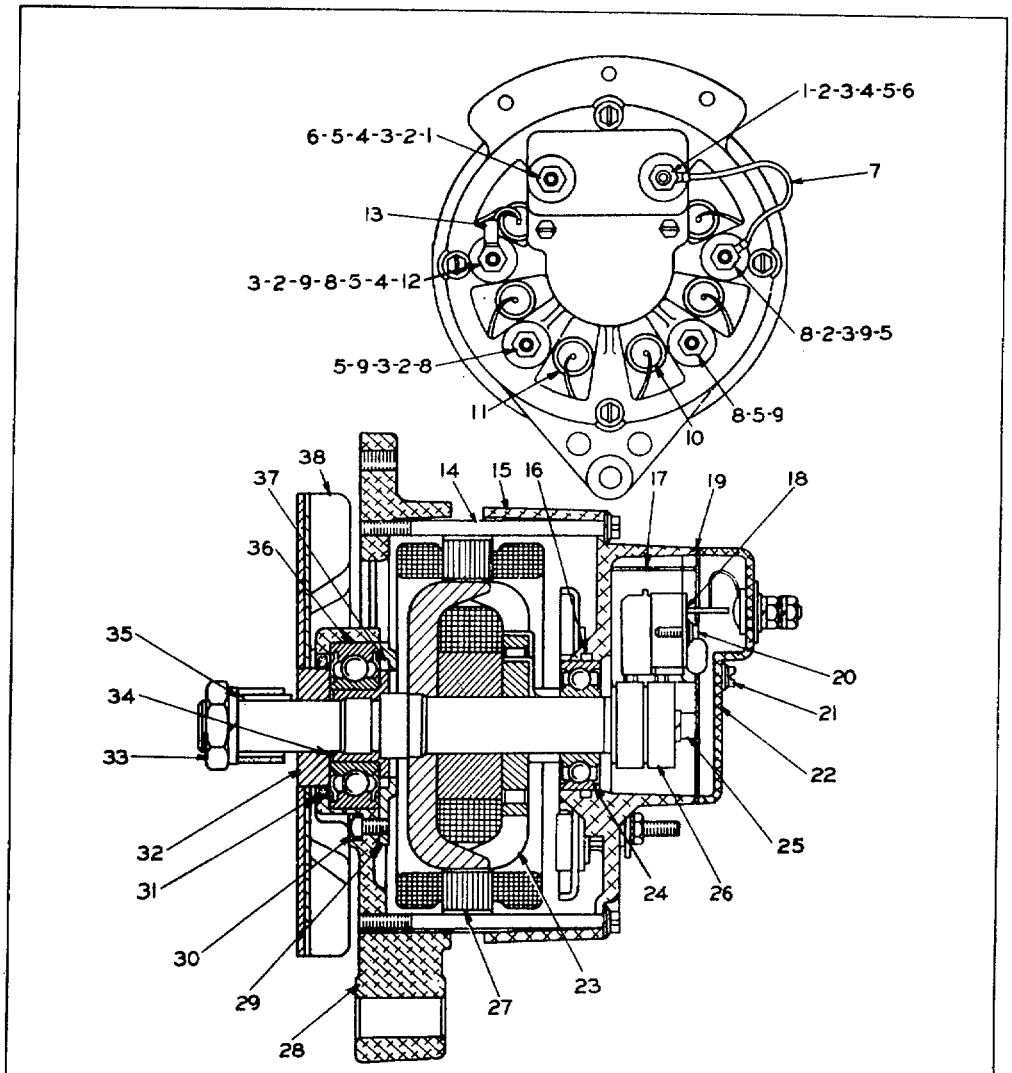
204388

9N148 ALTERNATOR GROUP-24 Volt, 40 Ampere

3P77 Alternator parts are shown on Page 138

FOR USE WITH 4N9312 ELECTRIC STARTING MOTOR GROUP AND 4N9314 ELECTRIC SHUT-OFF VALVE GROUP SHOWN ON PAGE 120

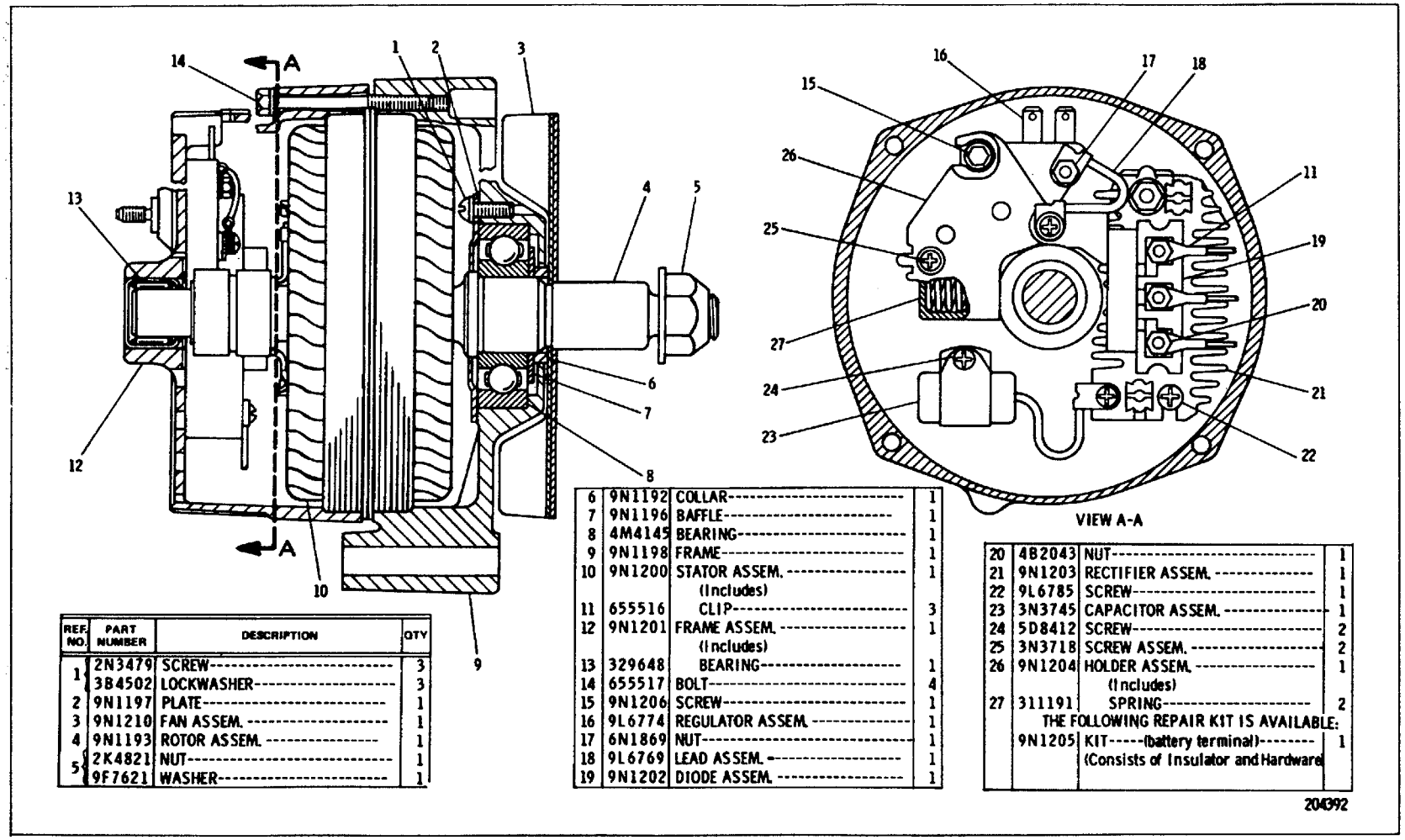
AN ATTACHMENT



REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	8L9375	BOLT	2
2	4B2047	NUT	7
3	7H2079	LOCKWASHER	7
4	8L9347	INSULATOR	3
5	8L9352	WASHER	10
6	8L9377	WASHER	2
7	8L9358	CABLE ASSEM.	1
8	8L9380	NUT & LOCK ASSEM.	4
9	3N1204	INSULATOR	4
10	8L9365	DIODE ASSEM.-(3 Diodes-Negative)	1
11	8L9363	DIODE ASSEM. -(3 Diodes-Positive)	1
12	8L9359	BOLT	1
13	8L9709	CABLE ASSEM.	1
14	2N7367	BOLT	4
15	8L9368	HOUSING--------(Rear)----------	1
16	8L9355	RETAINER	1
17	8L9348	INSULATOR	1
18	2N6399	BRUSH ASSEM.	1
19	8L9362	GASKET	1
20	8L9381	SCREW	2
21	8L9376	SCREW	2
22	8L9361	COVER	1
23	3N1203	ROTOR ASSEM.	1
24	4M2995	BEARING	1
25	3K6168	SCREW	1
	7H2079	LOCKWASHER	1
	3N1223	WASHER	1
26	3N1200	RING ASSEM.	1
	GMG00835	FORM (Instructions for Installing Alternator and Brush Kits)	1
27	2N7364	STATOR ASSEM.	1
28	8L9655	HOUSING ---------(Front)--------	1
29	8L9657	RETAINER	1
30	5L7200	SCREW	3
	3B4501	LOCKWASHER	3
31	8L9663	SEAL	1
32	1N9087	SPACER	1
33	8L9357	NUT	1
	5D3184	LOCKWASHER	1
34	8L9654	SLEEVE	1
35	1B8704	KEY	1
36	1S7056	BEARING	1
37	8L9656	WASHER	1
38	8L9661	FAN	1

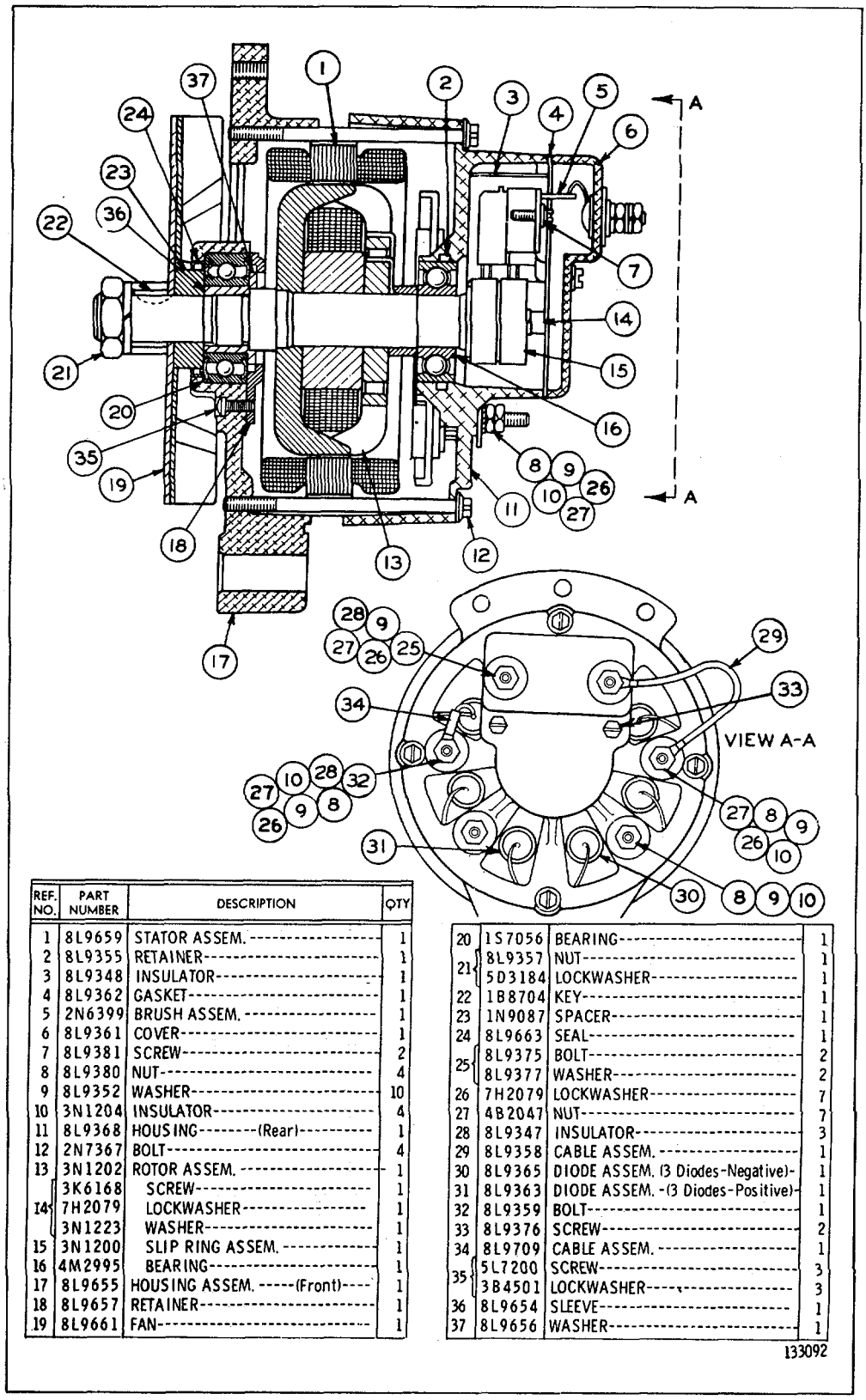
134507

2N7759 ALTERNATOR ASSEMBLY - 12 Volt, 55 Ampere
Part of Alternator shown on Page 128 and 4N6981 Alternator Group shown on Page 131



REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	2N3479	SCREW	3
	3B4502	LOCKWASHER	3
2	9N1197	PLATE	1
3	9N1210	FAN ASSEM.	1
4	9N1193	ROTOR ASSEM.	1
5	2K4821	NUT	1
	9F7621	WASHER	1
6	9N1192	COLLAR	1
7	9N1196	BAFFLE	1
8	4M4145	BEARING	1
9	9N1198	FRAME	1
10	9N1200	STATOR ASSEM. (Includes)	1
11	655516	CLIP	3
12	9N1201	FRAME ASSEM. (Includes)	1
13	329648	BEARING	1
14	655517	BOLT	4
15	9N1206	SCREW	1
16	9L6774	REGULATOR ASSEM.	1
17	6N1869	NUT	1
18	9L6769	LEAD ASSEM.	1
19	9N1202	DIODE ASSEM.	1
20	4B2043	NUT	1
21	9N1203	RECTIFIER ASSEM.	1
22	9L6785	SCREW	1
23	3N3745	CAPACITOR ASSEM.	1
24	5D8412	SCREW	2
25	3N3718	SCREW ASSEM.	2
26	9N1204	HOLDER ASSEM. (Includes)	1
27	311191	SPRING	2
		THE FOLLOWING REPAIR KIT IS AVAILABLE:	
	9N1205	KIT-----(battery terminal)-------- (Consists of Insulator and Hardware)	1

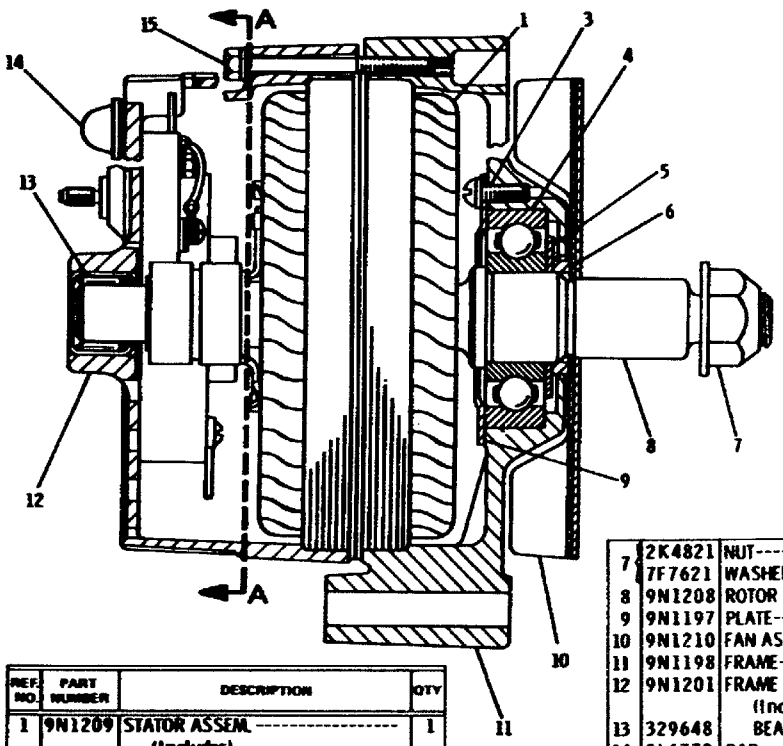
9L6298 ALTERNATOR GROUP - 12 Volt, 55 Ampere
Part of 4N7256 and 4N7231 Alternator Groups shown on Pages 129 and 130.

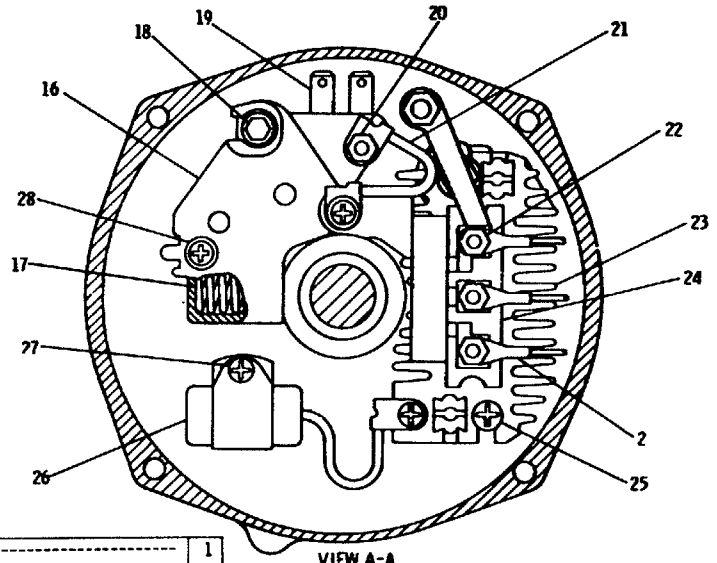


REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	8L9659	STATOR ASSEM.	1
2	8L9355	RETAINER	1
3	8L9348	INSULATOR	1
4	8L9362	GASKET	1
5	2N6399	BRUSH ASSEM.	1
6	8L9361	COVER	1
7	8L9381	SCREW	2
8	8L9380	NUT	4
9	8L9352	WASHER	10
10	3N1204	INSULATOR	4
11	8L9368	HOUSING-(Rear)	1
12	2N7367	BOLT	4
13	3N1202	ROTOR ASSEM.	1
14	3K6168	SCREW	1
	7H2079	LOCKWASHER	1
	3N1223	WASHER	1
15	3N1200	SLIP RING ASSEM.	1
16	4M2995	BEARING	1
17	8L9655	HOUSING ASSEM.-(Front)	1
18	8L9657	RETAINER	1
19	8L9661	FAN	1
20	1S7056	BEARING	1
21	8L9357	NUT	1
	5D3184	LOCKWASHER	1
22	1B8704	KEY	1
23	1N9087	SPACER	1
24	8L9663	SEAL	1
25	8L9375	BOLT	2
	8L9377	WASHER	2
26	7H2079	LOCKWASHER	7
27	4B2047	NUT	7
28	8L9347	INSULATOR	3
29	8L9358	CABLE ASSEM.	1
30	8L9365	DIODE ASSEM. (3 Diodes-Negative)	1
31	8L9363	DIODE ASSEM. -(3 Diodes-Positive)	1
32	8L9359	BOLT	1
33	8L9376	SCREW	2
34	8L9709	CABLE ASSEM.	1
35	5L7200	SCREW	3
	3B4501	LOCKWASHER	3
36	8L9654	SLEEVE	1
37	8L9656	WASHER	1

133092

2N6397 ALTERNATOR ASSEBMLY-24 Volt, 35 Ampere
Part of 4N9313 Alternator Group shown of Page 132



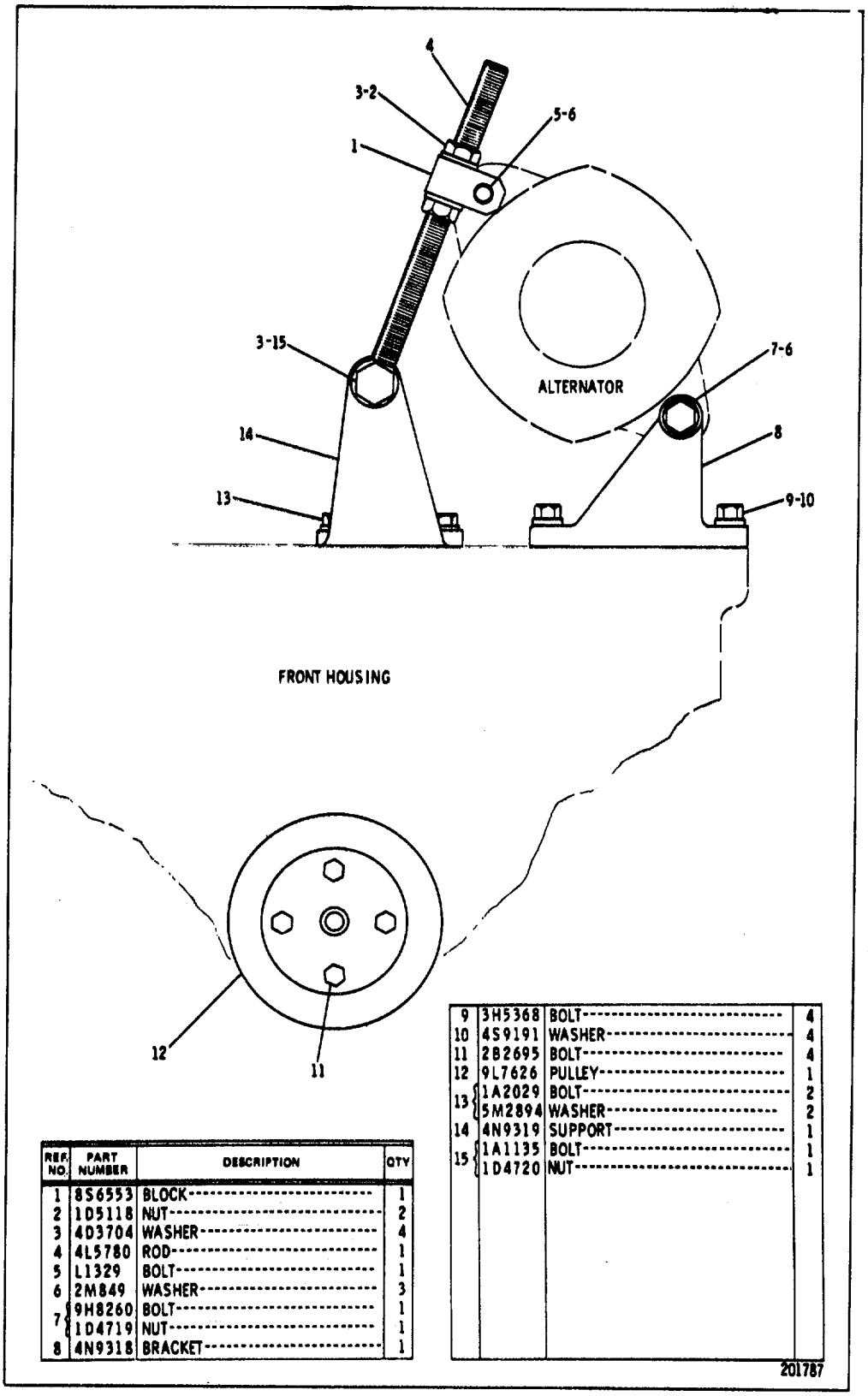


VIEW A-A

REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	9N1209	STATOR ASSEM.	1
		(Includes)	
2	655516	CLIP	3
3	2N3479	SCREW	3
	3B4502	LOCKWASHER	3
4	4M4145	BEARING	1
5	9N1196	BAFFLE	1
6	9N1192	COLLAR	1
7	2K4821	NUT	1
	7F7621	WASHER	1
8	9N1208	ROTOR ASSEM.	1
9	9N1197	PLATE	1
10	9N1210	FAN ASSEM.	1
11	9N1198	FRAME	1
12	9N1201	FRAME ASSEM.	1
		(Includes)	
13	329648	BEARING	1
14	9L6770	CAP	1
15	655517	BOLT	4
16	9N1204	HOLDER ASSEM.	1
		(Includes)	
17	311191	SPRING	2
18	9N1206	SCREW	1
19	9N1207	REGULATOR ASSEM.	1
20	6N1869	NUT	1
21	9L6769	LEAD ASSEM.	1
22	4B2043	NUT	3
23	9N1203	RECTIFIER ASSEM.	1
24	9N1202	DIODE ASSEM.	1
25	9L6785	SCREW	1
26	3N3745	CAPACITOR ASSEM.	1
27	5D8412	SCREW	2
28	3N3718	SCREW ASSEM.	2
		THE FOLLOWING REPAIR KITS ARE AVAILABLE:	
	9L6786	KIT-------(relay terminal)-------	
		(Consists of Terminal & Hardware)	
	9N1205	KIT-------(Battery terminal)-----	
		(Consists of Insulator and Hardware)	

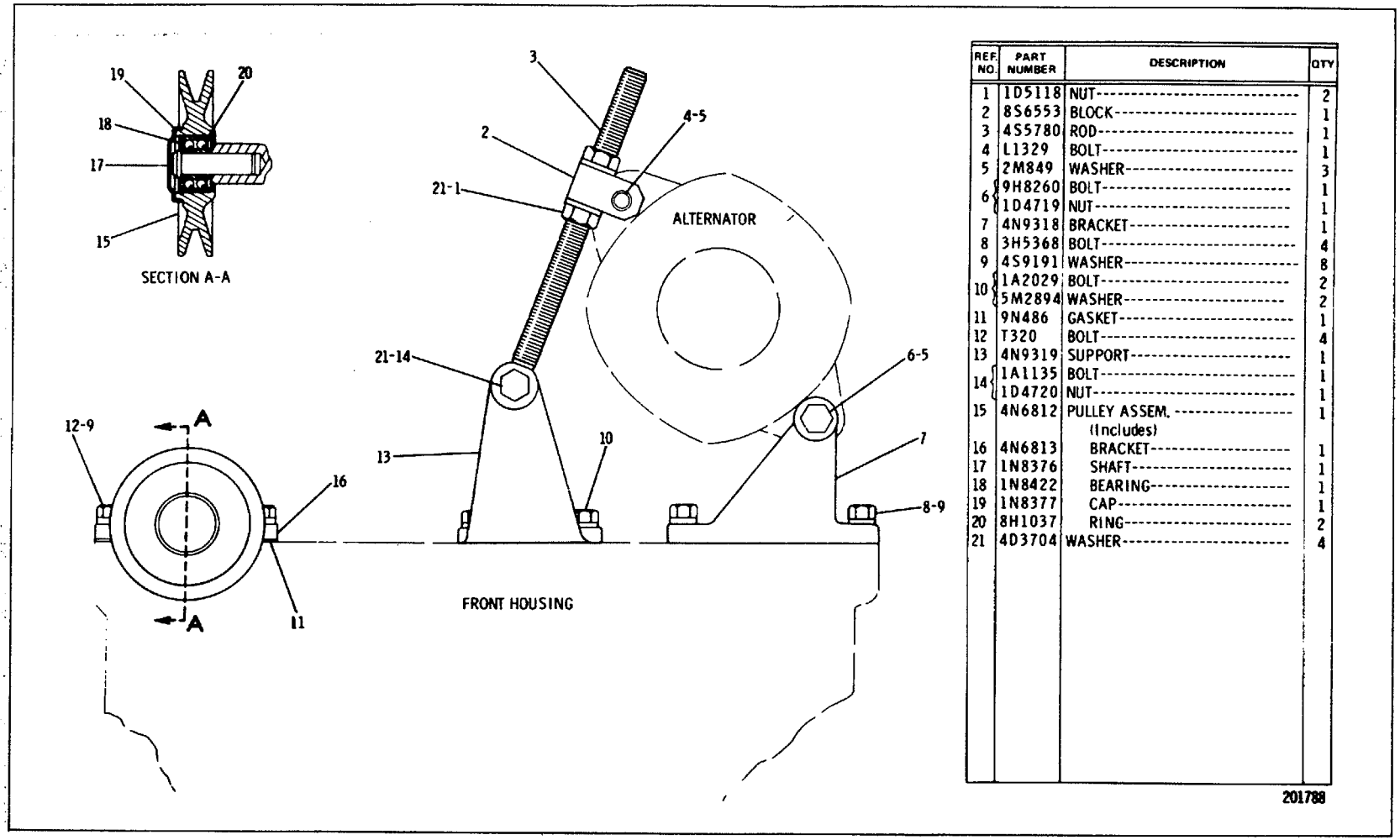
204389

3P77 ALTERNATOR GROUP-24 Volt, 40 Ampere
Part of 9N147 and 9N148 Alternator Groups shown on Pages 133 and 134.



REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	8S6553	BLOCK	1
2	1D5118	NUT	2
3	4D3704	WASHER	4
4	4L5780	ROD	1
5	L1329	BOLT	1
6	2M849	WASHER	3
7	9H8260	BOLT	1
	1D4719	NUT	1
8	4N9318	BRACKET	1
9	3H5368	BOLT	4
10	4S9191	WASHER	4
11	2B2695	BOLT	4
12	9L7626	PULLEY	1
13	1A2029	BOLT	2
	5M2894	WASHER	2
14	4N9319	SUPPORT	1
15	1A1135	BOLT	1
	1D4720	NUT	1

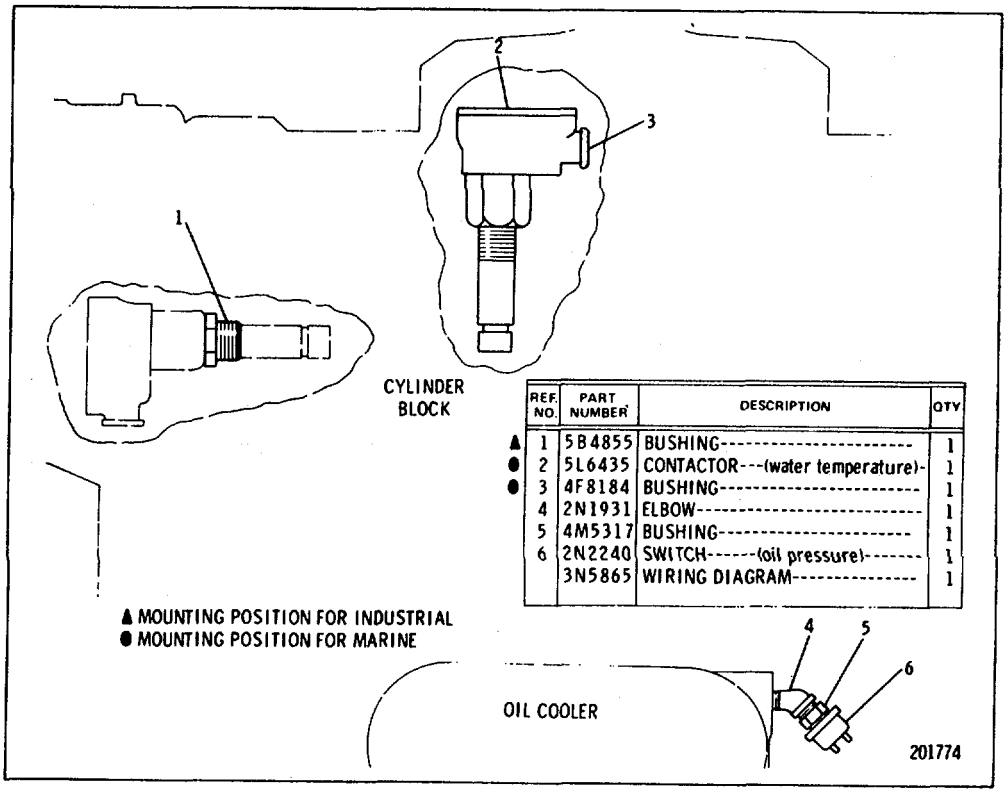
4N9315 ALTERNATOR MOUNTING GROUP
NOT FOR USE WITH 4N9314 ELECTRIC SHUT-OFF GROUP SHOWN ON PAGE 120
AN ATTACHMENT



REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	1D5118	NUT	2
2	8S6553	BLOCK	1
3	4S5780	ROD	1
4	L1329	BOLT	1
5	2M849	WASHER	3
6	9H8260	BOLT	1
	1D4719	NUT	1
7	4N9318	BRACKET	1
8	3H5368	BOLT	4
9	4S9191	WASHER	8
10	1A2029	BOLT	2
	5M2894	WASHER	2
11	9N486	GASKET	1
12	T320	BOLT	4
13	4N9319	SUPPORT	1
14	1A1135	BOLT	1
	1D4720	NUT	1
15	4N6812	PULLEY ASSEM. (Includes)	1
16	4N6813	BRACKET	1
17	1N8376	SHAFT	1
18	1N8422	BEARING	1
19	1N8377	CAP	1
20	8H1037	RING	2
21	4D3704	WASHER	4

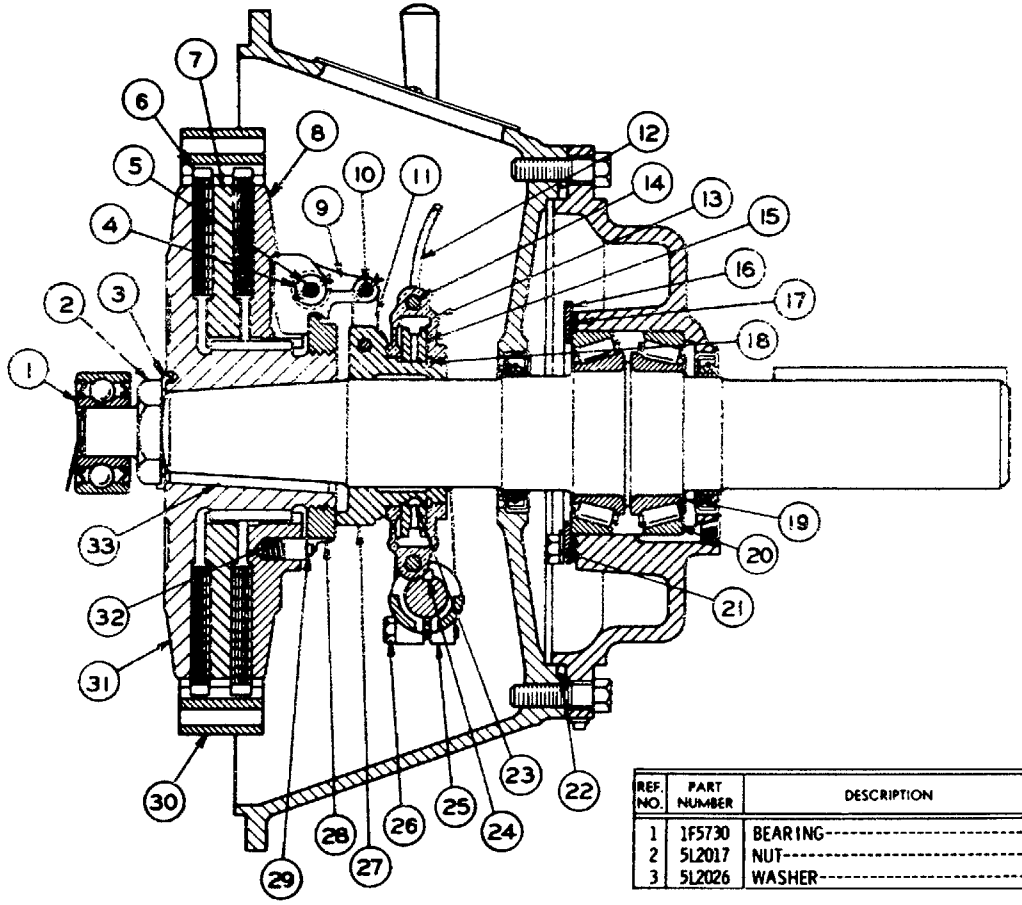
201788

4N9316 ALTERNATOR MOUNTING GROUP
NOT FOR USE WITH 4N9314 ELECTRIC SHUT-OFF GROUP SHOWN ON PAGE 120
AN ATTACHMENT



REF. NO.	PART NUMBER	DESCRIPTION	QTY
▲ 1	5B4855	BUSHING----------	1
● 2	5L6435	CONTACTOR---(water temperature)-	1
● 3	4F8184	BUSHING----------	1
4	2N1931	ELBOW----------	1
5	4M5317	BUSHING----------	1
6	2N2240	SWITCH------(oil pressure)-------	1
	3N5865	WIRING DIAGRAM----------	1

3N5835 OIL PRESSURE AND WATER TEMPERATURE ALARM CONTACTOR GROUP AN ATTACHMENT



REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	1F5730	BEARING	1
2	5L2017	NUT	1
3	5L2026	WASHER	1

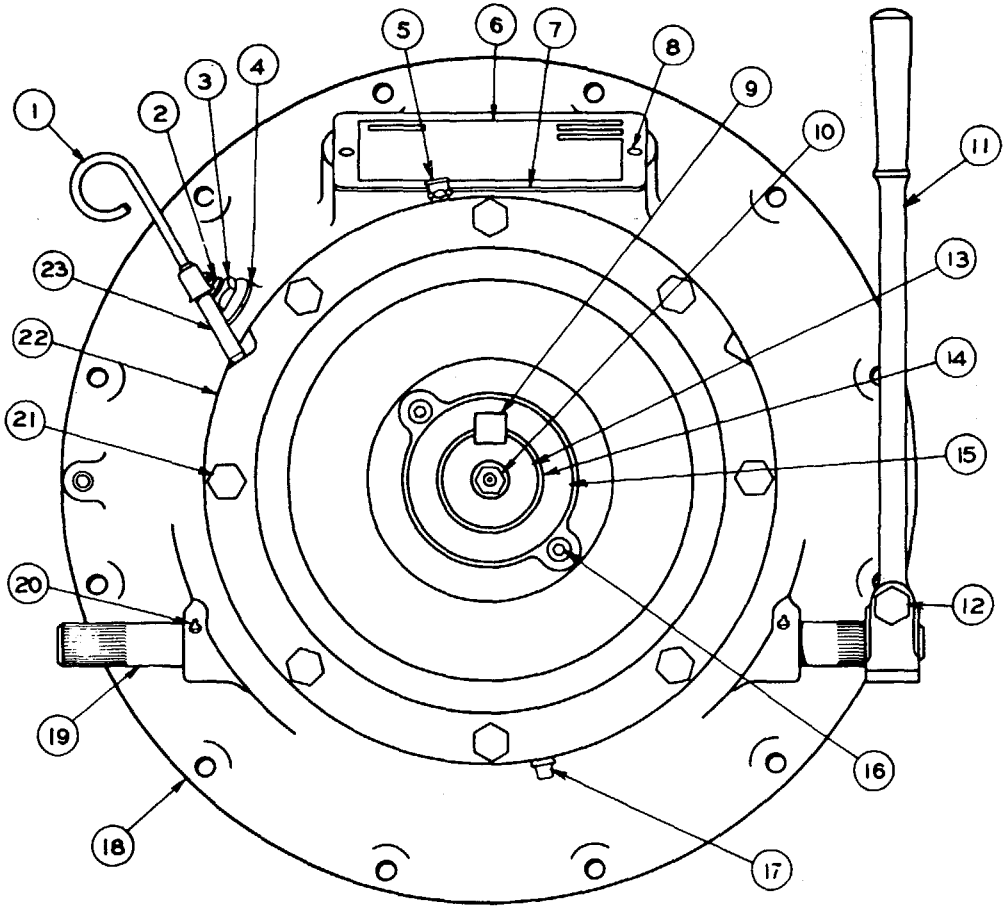
	4	2L8314	WASHER	6
	5	6L3966	PIN	3
		6L3964	COTTER PIN	3
	6	7S7934	PLATE ASSEM. (72 Teeth)	2
	7	5L2012	PLATE	1
	8	2L8263	PLATE	1
	9	2L8259	LEVER	3
	10	6L3965	PIN	6
		6L3960	COTTER PIN	6
	11	5B5251	LINK	6
C	12	5B2410	HOSE ASSEM. (15.5 in. long)	1
	13	2N2146	COLLAR ASSEM.	1
		5L3561	SHIM	2
	14	L1648	BOLT	2
		2L6267	NUT	2
			(Parts of 2N2146 Collar Assem.)	
	15	2N2145	RING	1
	16	2N2142	RETAINER	1
	17	2N2148	SHIM (.005" Thick)	1
		2N2149	SHIM (.007" Thick)	1
		2N2150	SHIM (.010" Thick)	1
		2N2151	SHIM (.020" Thick)	1
	18	1K6730	RING	1
	19	2N2139	CONE	2
	20	2N2138	CUP	2
	21	S1594	BOLT	6
		2N2147	PLATE	3
	22	2N2152	SEAL	1
	23	1B8702	KEY	1
	24	6L5151	KEY	2
	25	2K2753	YOKE	1
	26	S1591	BOLT	2
	27	2N2144	SLEEVE	1
	28	2L8262	RING	1
	29	2L8261	PIN	1
	30	2N1372	RING	1
	31	5L2016	PLATE	1
	32	4B4713	SPRING	1
	33	1N7513	KEY	1

C INDICATES CHANGE

145453

2N1373 CLUTCH ASSEMBLY-Part 1

Part of 2N1374 Clutch Group shown on Page 144

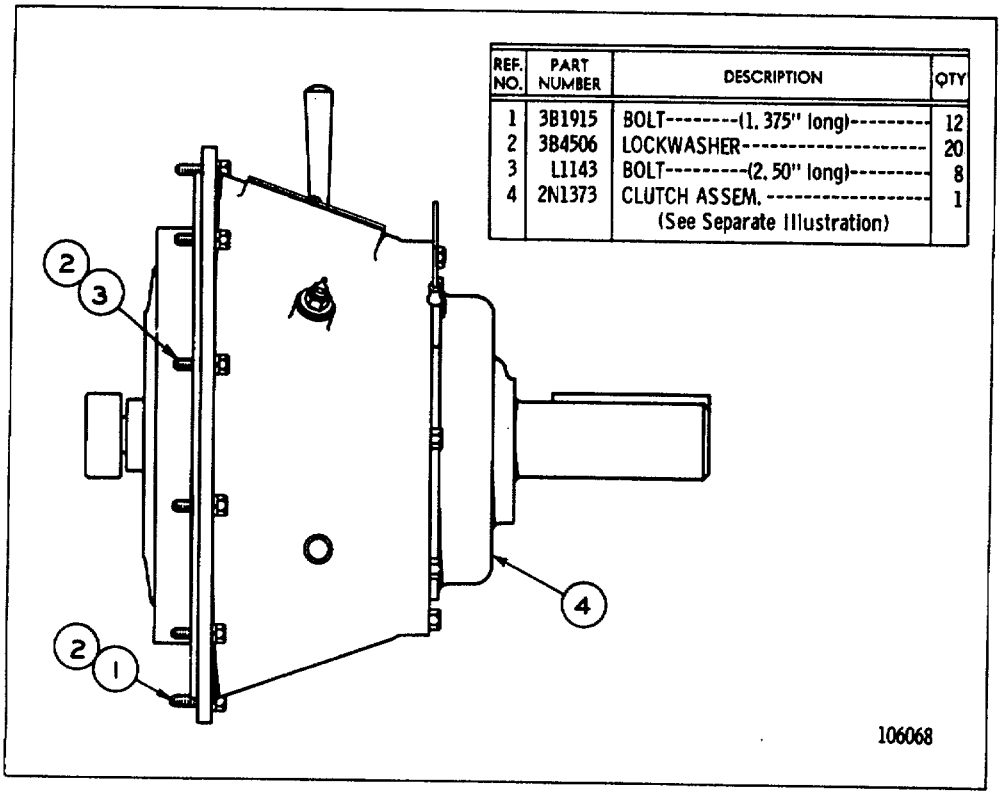


REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	2N2141	GAUGE	1
2	3B8489	FITTING	1
3	9S1354	NUT	1
4	6F253	LOCKWASHER	1
5	4B350	OIL CUP	1
6	1N5392	PLATE-(Instruction)	1
7	4B4755	GASKET	1
8	1L6931	SCREW	2
9	4L4866	KEY	1
10	3B8490	FITTING	1
11	4B4787	LEVER ASSEM.	1
12	S1587	BOLT (Part of 4B4787 Lever Assem.)	1
13	2N2137	SHAFT	1
14	2N2143	SLEEVE	2
15	4L7248	SEAL	2
16	7H3171	PLUG	2
17	2B7408	PLUG	1
18	2N2136	HOUSING-(Clutch)	1
19	4B4756	SHAFT	1
20	8B7121	FITTING	2
21	S1587	BOLT	8
22	2N2140	CARRIER ASSEM.	1
C 23	2F6938	TUBE (Part of 2N2140 Assem.)	1

145454

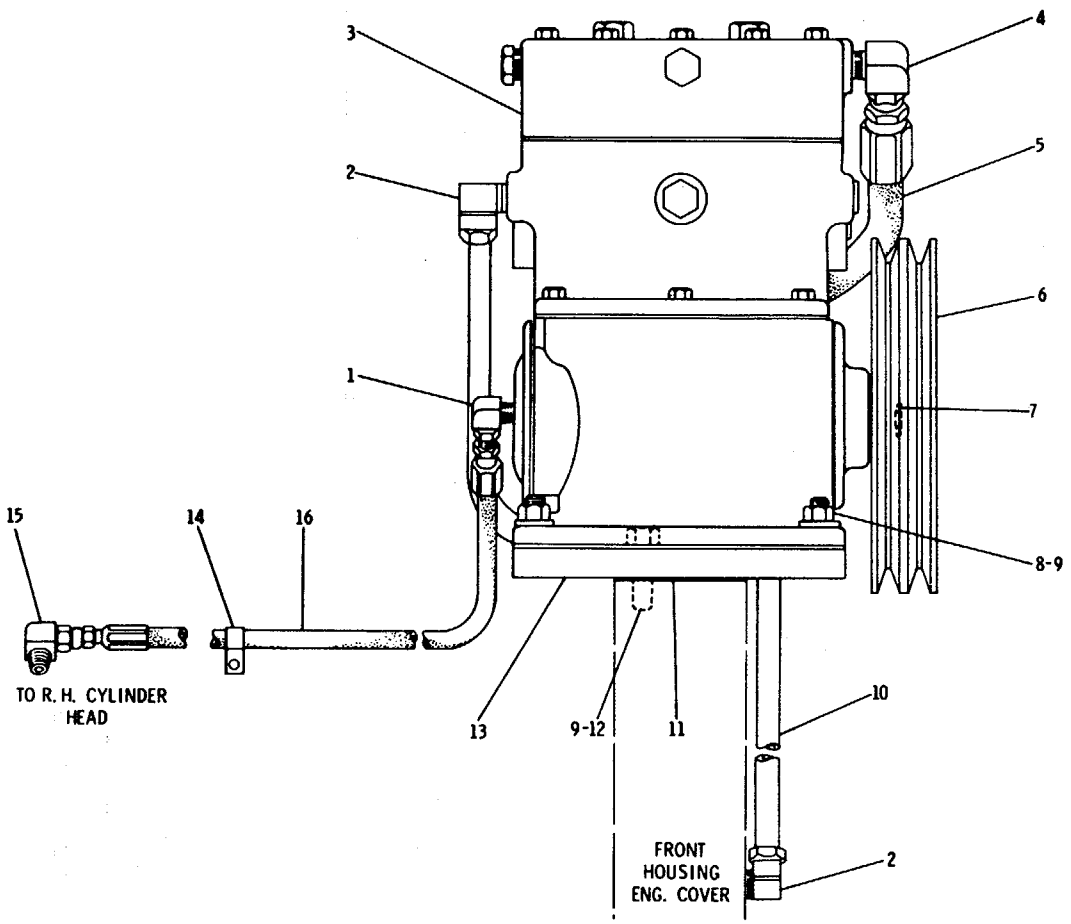
C INDICATES CHANGE

2N1373 CLUTCH ASSEMBLY-Part 2
Part of 2N1374 Clutch Group shown on Page 144.



REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	3B1915	BOLT--------(1.375" long)--------	12
2	3B4506	LOCKWASHER----------	20
3	L1143	BOLT---------(2.50" long)--------	8
4	2N1373	CLUTCH ASSEM.---------- (See Separate Illustration)	1

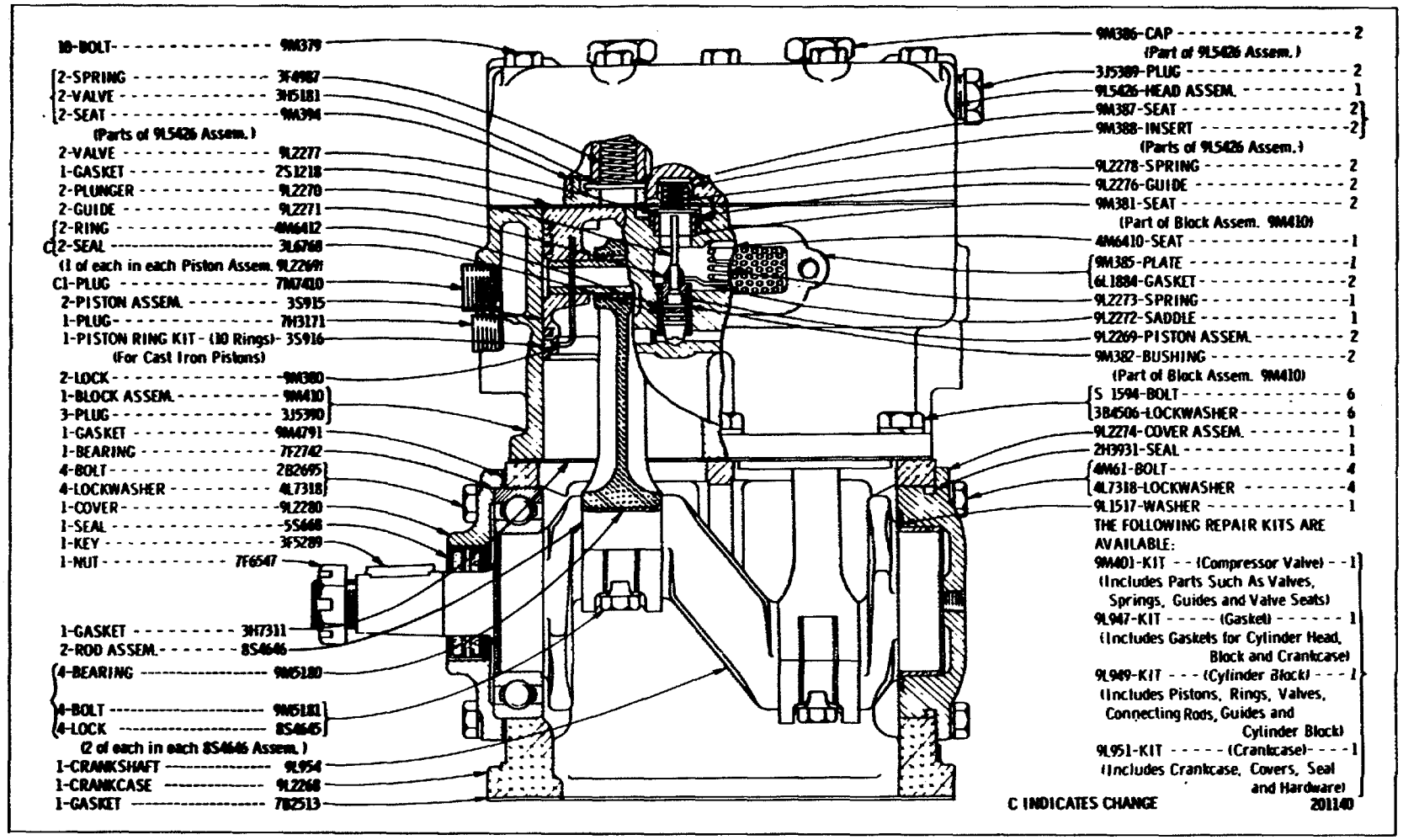
2N1374 CLUTCH GROUP-Rear Power Take-Off
2N1373 Clutch parts are shown on Pages 142 &143



REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	2N1287	FITTING	1
2	5K9244	FITTING	2
3	8L3565	COMPRESSOR ASSEM. (Separate Illustration)	1
4	2N3378	FITTING	1
5	2N1343	HOSE ASSEM. ----(15 in. long)----	1
	3R5387	CONNECTOR	1
6	4N6708	PULLEY	1
7	3B4618	COTTER PIN	1
8	9M5082	STUD	4
	1D4718	NUT	4
9	4S9191	WASHER	8
10	4N6747	TUBE ASSEM.	1
	5K3294	CLIP	1
11	9N486	GASKET	1
12	T772	BOLT	4
13	4N6662	PLATE	1
C 14	1H5166	CLIP	1
15	6K1972	FITTING	1
16	616750	HOSE ASSEM. ----(25 in. long)----	1

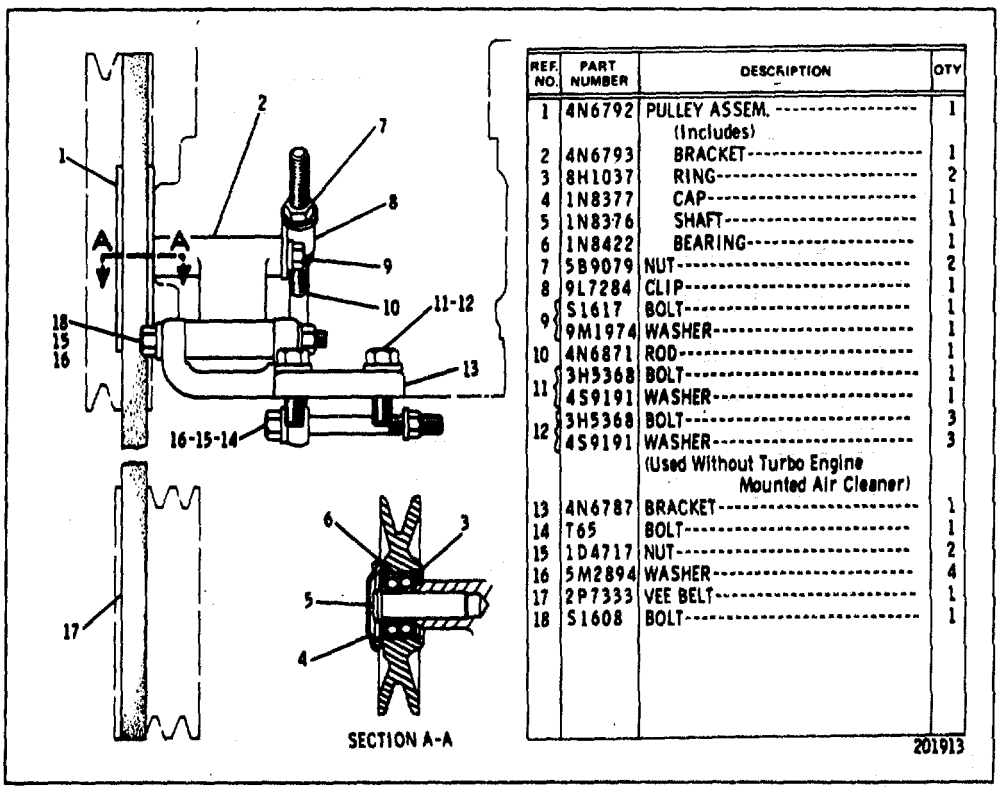
C INDICATES CHANGE 204384

4N7184 AIR COMPRESSOR GROUP
NOT FOR USE WITH 4N7231 ALTERNATOR GROUP SHOWN ON PAGE 130



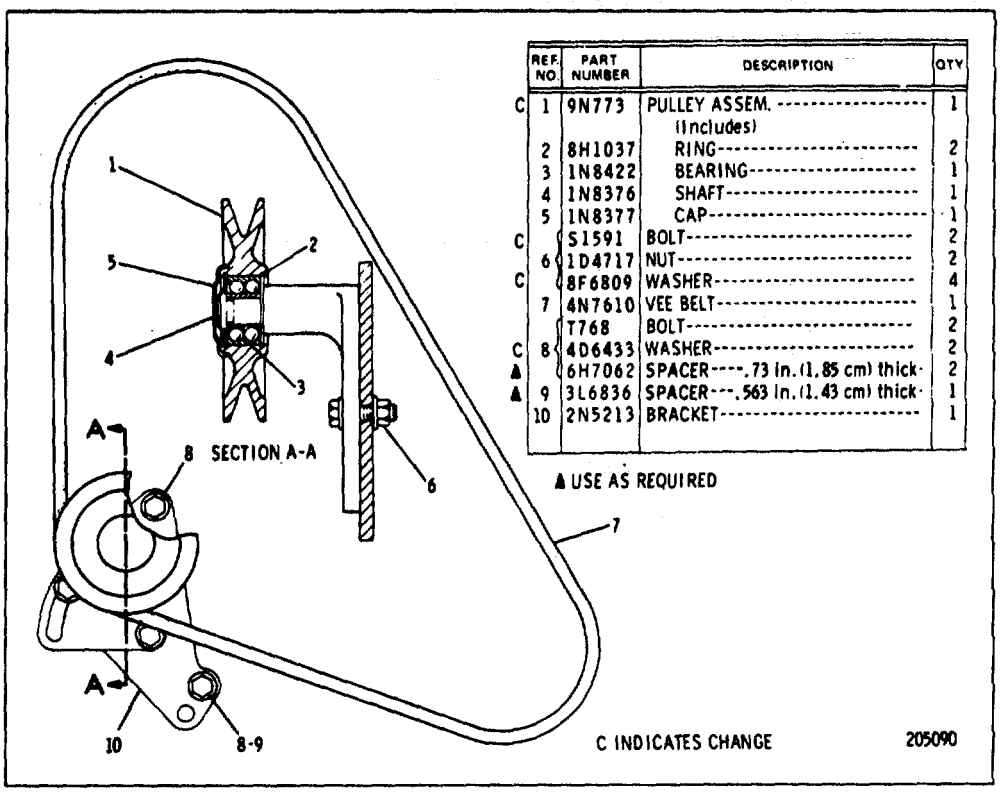
8L3565 AIR COMPRESSOR ASSEMBLY

Part of 4N7184 Air Compressor Group shown on Page 145



REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	4N6792	PULLEY ASSEM. (Includes)	1
2	4N6793	BRACKET	1
3	8H1037	RING	2
4	1N8377	CAP	1
5	1N8376	SHAFT	1
6	1N8422	BEARING	1
7	5B9079	NUT	2
8	9L7284	CLIP	1
9	S1617	BOLT	1
	9M1974	WASHER	1
10	4N6871	ROD	1
11	3H5368	BOLT	1
	4S9191	WASHER	1
12	3H5368	BOLT	3
	4S9191	WASHER (Used Without Turbo Engine Mounted Air Cleaner)	3
13	4N6787	BRACKET	1
14	T65	BOLT	1
15	1D4717	NUT	2
16	5M2894	WASHER	4
17	2P7333	VEE BELT	1
18	S1608	BOLT	1

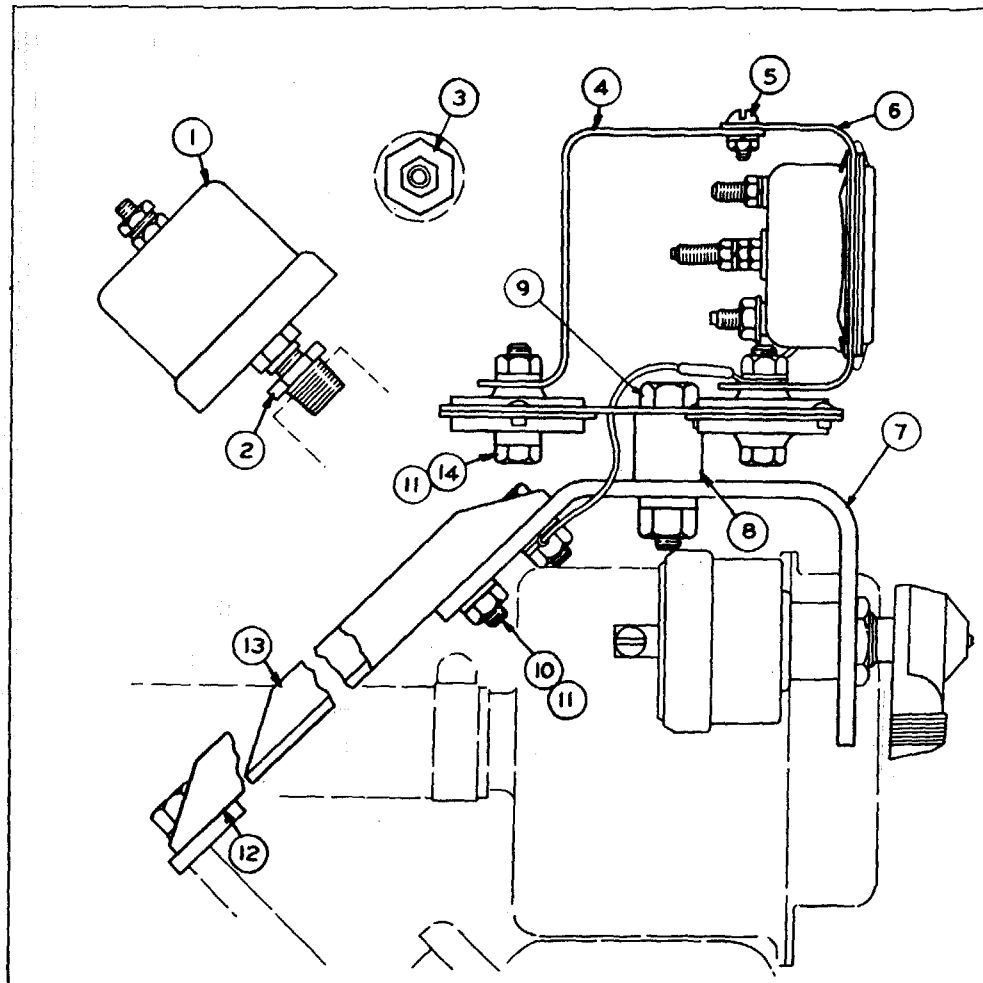
4N7351 ACCESSORY DRIVE GROUP
NOT FOR USE WITH 4N7393 RADIATOR GROUP SHOWN ON PAGE 86



	REF. NO.	PART NUMBER	DESCRIPTION	QTY
C	1	9N773	PULLEY ASSEM. (Includes)	1
	2	8H1037	RING	2
	3	1N8422	BEARING	1
	4	1N8376	SHAFT	1
	5	1N8377	CAP	1
C	6	S1591	BOLT	2
		1D4717	NUT	2
C		8F6809	WASHER	4
	7	4N7610	VEE BELT	1
	8	T768	BOLT	2
C		4D6433	WASHER	2
▲		6H7062	SPACER----.73 in. (1.85 cm) thick	2
▲	9	3L6836	SPACER---.563 in. (1.43 cm) thick	1
	10	2N5213	BRACKET	1

▲ USE AS REQUIRED

4N7200 ACCESSORY DRIVE GROUP
NOT FOR USE WITH 4N7390 WATER PUMP DRIVE GROUP SHOWN ON PAGE 78

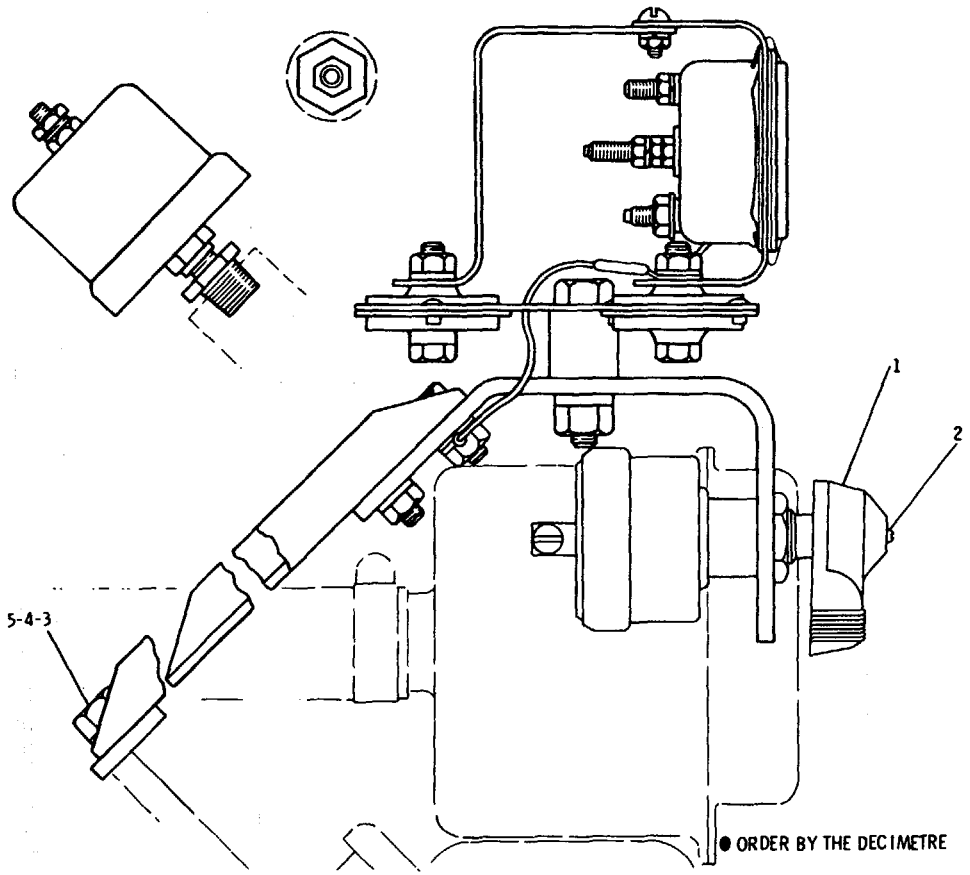


REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	2N782	SENDING UNIT---(oil pressure)----	1
2	4M5317	BUSHING----------	1
3	2N1311	SENDING UNIT-(water temperature)-	1
4	2N179	COVER----------	1
5	4B1219	SCREW----------	2
	4B2040	NUT----------	2
	9B1117	LOCKWASHER----------	2
6	6N355	INSTRUMENT PANEL GROUP------- (Separate Illustration)	1
7	2N219	BRACKET----------	1
8	9L9167	SPACER----------	2
9	S1571	BOLT----------	2
	1D4717	NUT----------	2
	5M2894	WASHER----------	4
10	4F7957	BOLT----------	4
11	1B4330	NUT----------	5
	5P537	WASHER----------	10
12	2N1053	ANGLE----------	1
13	2N1052	ANGLE----------	1
14	7B2742	BOLT----------	1
	8L5950	WIRING DIAGRAM----------	1

201775

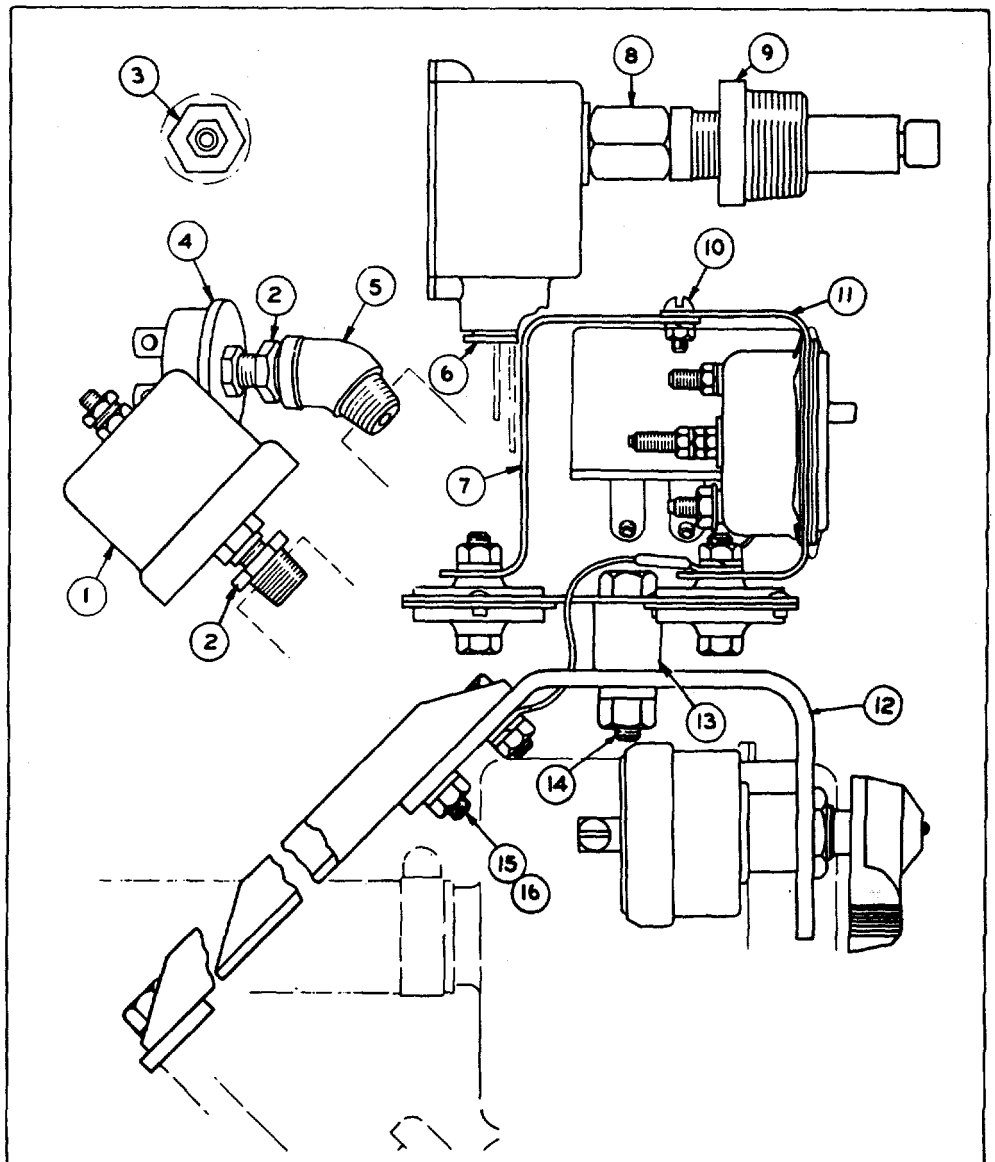
6N57 INSTRUMENT PANEL GROUP-12 Volt-Part 1
6N355 Instrument Panel parts are shown on Page 152

6N357 INSTRUMENT PANEL GROUP-12 Volt-Part 2



REF NO.	PART NUMBER	DESCRIPTION	QTY
1	2P4749	SWITCH ASSEM.	1
		(Includes)	
	8F3437	LEVER	1
2	5L7200	SCREW	1
	3B4501	LOCKWASHER	1
3	S1571	BOLT	3
	5M2894	WASHER	3
4	9M6527	WASHER	2
5	4B4278	WASHER	1
		(Used With L. H. Mounting)	
●	6A3348	WIRE(No. 12 Gauge)13 dm(51. 18 in.)	
●	6A3353	WIRE(No. 10 Gauge)32 dm(125. 98 in.)	
●	5P2759	WIRE(No. 6 Gauge)38 dm(149. 61 in.)	
●	6A3626	WIRE(No. 14 Gauge)74 dm(291. 34 in.)	
	2L8065	TERMINAL -----(No. 8 Screw)------	1
	2L8066	TERMINAL-----(No. 10 Screw)-----	4
	2L8071	TERMINAL-----(. 50 in. Screw)----	1
		(Used With No. 12 & No. 10 Wire)	
	2L8054	TERMINAL-----(. 50 in. Screw)-----	3
	2L8049	TERMINAL-----(No. 10 Screw)-----	4
	2L8051	TERMINAL-----(. 31 in. Screw)-----	2
	2L8050	TERMINAL-----(. 25 in. Screw)-----	1
		(Used With No. 6 Wire)	
▲	2L8076	TERMINAL-----(No. 10 Screw)-----	9
	2L8075	TERMINAL-----(No. 8 Screw)-----	4
	2L8081	TERMINAL-----(. 50 in. Screw)-----	1
		(Used With No. 14 Wire)	
	6L3483	COVER	1
	4B2051	NUT	1
	3B4503	LOCKWASHER	1
	4B4674	WASHER	1
	7S7182	BOOT	2
	3S2093	TIE	10
	8L8413	TIE	40
	1H5166	CLIP	3
	2L9724	CLIP	3

● ORDER BY THE DECIMETRE ▲ 6N349 WIRING GROUP-NOT SHOWN-Use as Required 202390

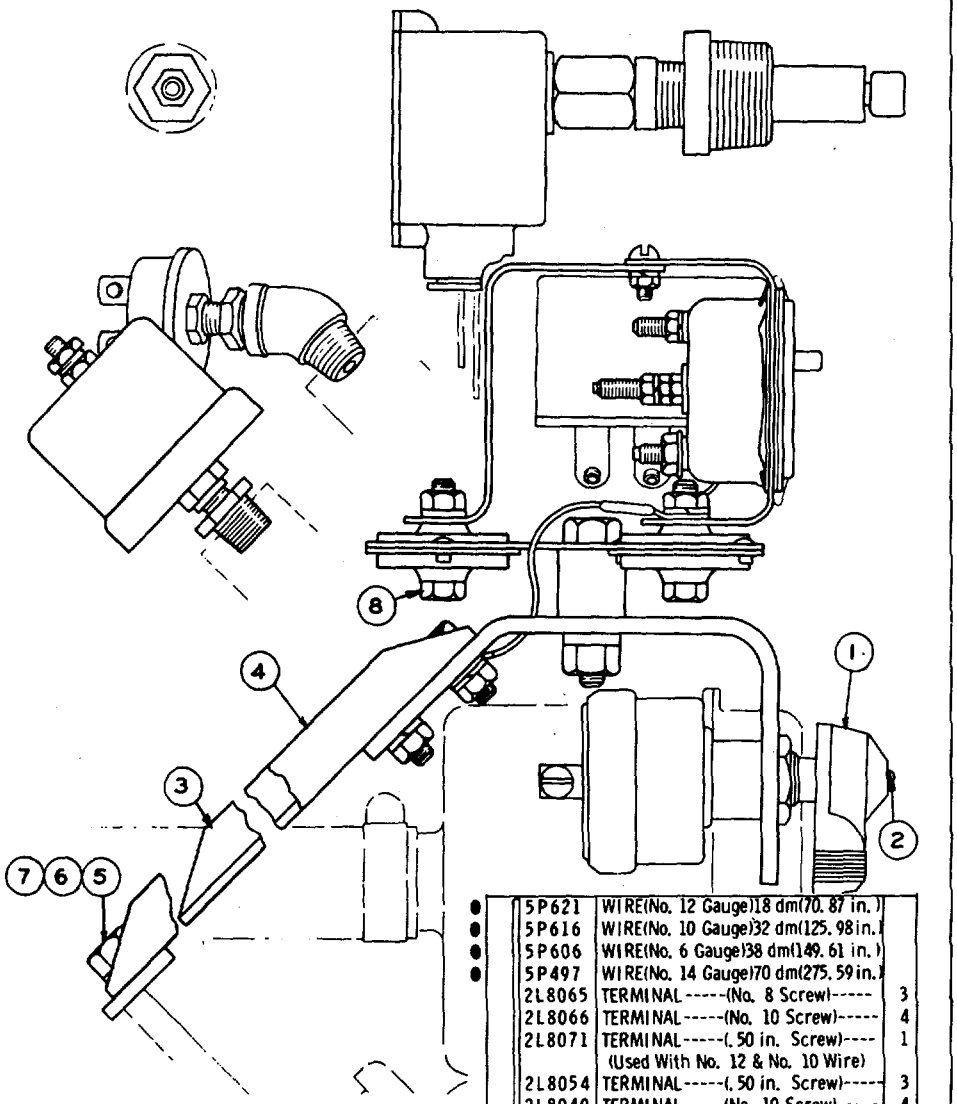


REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	2N782	SENDING UNIT---(oil pressure)----	1
2	4M5317	BUSHING----------	2
3	2N1311	SENDING UNIT-(water temperature)	1
4	2N2240	SWITCH----------	1
5	2N1931	ELBOW----------	1
6	4F8184	BUSHING----------	1
7	2N821	COVER----------	1
8	2N2920	CONTACTOR----------	1
9	5B4855	BUSHING----------	1
10	4B1219	SCREW----------	2
	4B2040	NUT----------	2
	9B1117	LOCKWASHER----------	2
11	6N356	INSTRUMENT PANEL GROUP----- (Separate Illustration)	1
12	2N219	BRACKET----------	1
13	9L9167	SPACER----------	2
	S1571	BOLT----------	2
14	1D4717	NUT----------	2
	5M2894	WASHER----------	4
15	4F7957	BOLT----------	4
16	1B4330	NUT----------	4
	5P537	WASHER----------	8
	8L5950	WIRING DIAGRAM----------	1

201778

6N358 SAFETY INSTRUMENT PANEL GROUP -12 Volt-Part 1

6N356 Instrument Panel parts are shown on Page 152

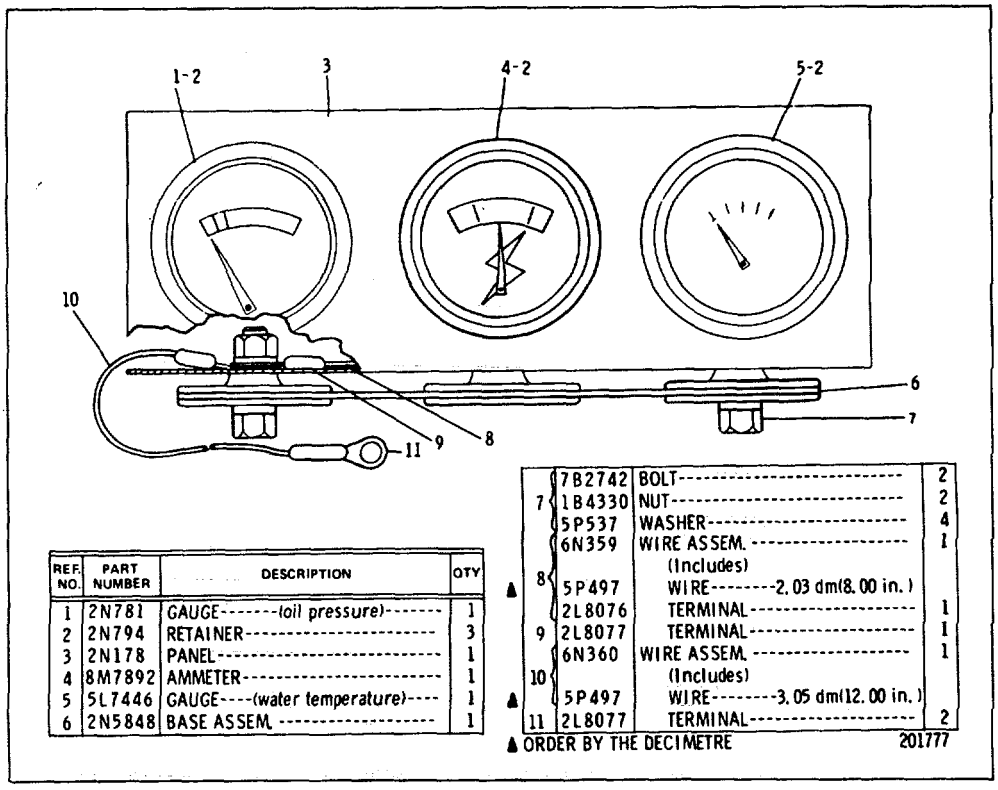


REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	2P4749	SWITCH ASSEM.	1
		(Includes)	
	8F3437	LEVER	1
2	5L7200	SCREW	1
	3B4501	LOCKWASHER	1
3	2N1052	ANGLE	1
4	2N1053	ANGLE	1
5	S1571	BOLT	3
	5M2894	WASHER	3
6	9M6527	WASHER	2
7	4B4278	WASHER	1
		(Used With L. H. Mounting)	
8	7B2742	BOLT	1
	1B4330	NUT	1
	5P537	WASHER	2

●	5P621	WIRE(No. 12 Gauge)18 dm(70. 87 in.)	
●	5P616	WIRE(No. 10 Gauge)32 dm(125. 98in.)	
●	5P606	WIRE(No. 6 Gauge)38 dm(149. 61 in.)	
●	5P497	WIRE(No. 14 Gauge)70 dm(275. 59 in.)	
	2L8065	TERMINAL-----(No. 8 Screw)-----	3
	2L8066	TERMINAL-----(No. 10 Screw)-----	4
	2L8071	TERMINAL-----(. 50 in. Screw)----	1
		(Used With No. 12 & No. 10 Wire)	
	2L8054	TERMINAL-----(. 50 in. Screw)-----	3
	2L8049	TERMINAL-----(No. 10 Screw)-----	4
	2L8051	TERMINAL-----(. 31 in. Screw)----	2
	2L8050	TERMINAL-----(. 25 in. Screw)----	1
		(Used With No. 6 Wire)	
▲	2L8076	TERMINAL-----(No. 10 Screw)-----	9
▲	2L8074	TERMINAL-----(No. 6 Screw)------	2
▲	2L8081	TERMINAL-----(. 50 in. Screw)----	2
▲	2L8075	TERMINAL-----(No. 8 Screw)------	6
▲	2L8078	TERMINAL-----(. 31 in. Screw)----	1
▲		(Used With No. 14 Wire)	
▲	6L3483	COVER	1
▲	4B2051	NUT	1
▲	3B4503	LOCKWASHER	1
▲	4B4674	WASHER	1
▲	8L8413	TIE	40
▲	3S2093	TIE	10
▲	1H5166	CLIP	3
▲	2L9724	CLIP	3
▲	7S7182	BOOT	2

● ORDER BY THE DECIMETRE ▲ 6N350 WIRING GROUP-NOT SHOWN-Use as Required 150539

6N358 SAFETY INSTRUMENT PANEL GROUP-12 Volt-Part 2

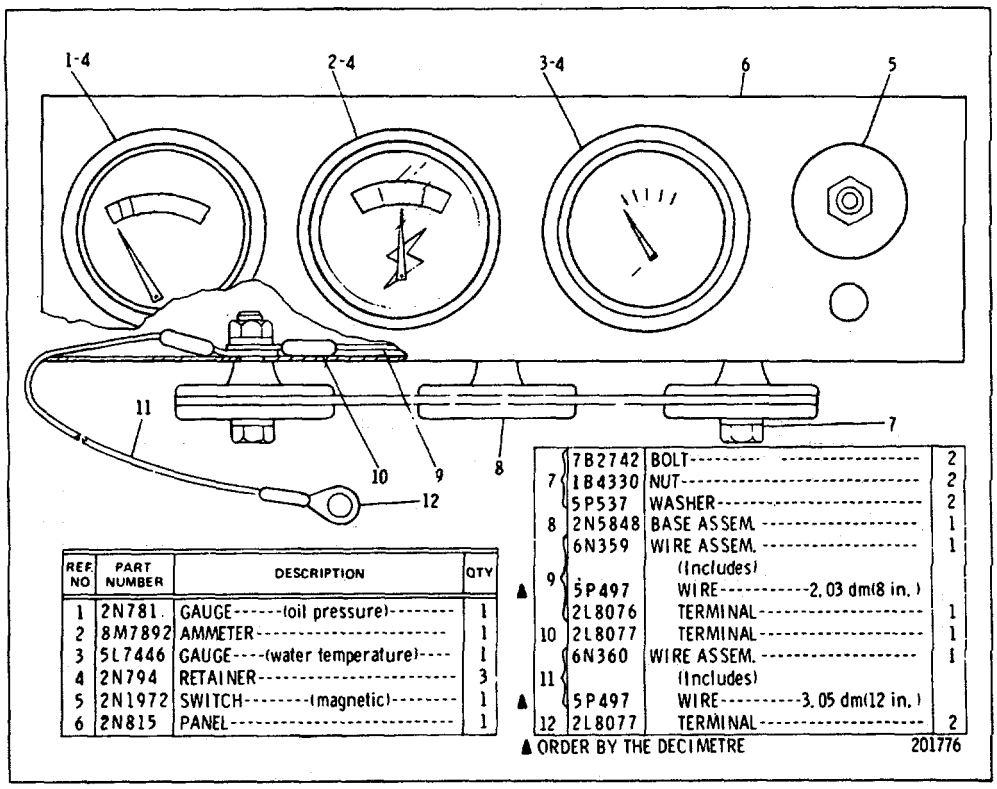


REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	2N781	GAUGE-------(oil pressure)-------	1
2	2N794	RETAINER----------	3
3	2N178	PANEL----------	1
4	8M7892	AMMETER----------	1
5	5L7446	GAUGE----(water temperature)----	1
6	2N5848	BASE ASSEM. ----------	1
7	7B2742	BOLT----------	2
	1B4330	NUT----------	2
	5P537	WASHER----------	4
8	6N359	WIRE ASSEM. ---------- (Includes)	1
▲	5P497	WIRE--------2.03 dm(8.00 in.)	
	2L8076	TERMINAL----------	1
9	2L8077	TERMINAL----------	1
10	6N360	WIRE ASSEM. ---------- (Includes)	1
▲	5P497	WIRE--------3.05 dm(12.00 in.)	
11	2L8077	TERMINAL----------	2

▲ ORDER BY THE DECIMETRE 201777

6N355 INSTRUMENT PANEL GROUP

Part of 6N357 Instrument Panel Group shown on Page 148

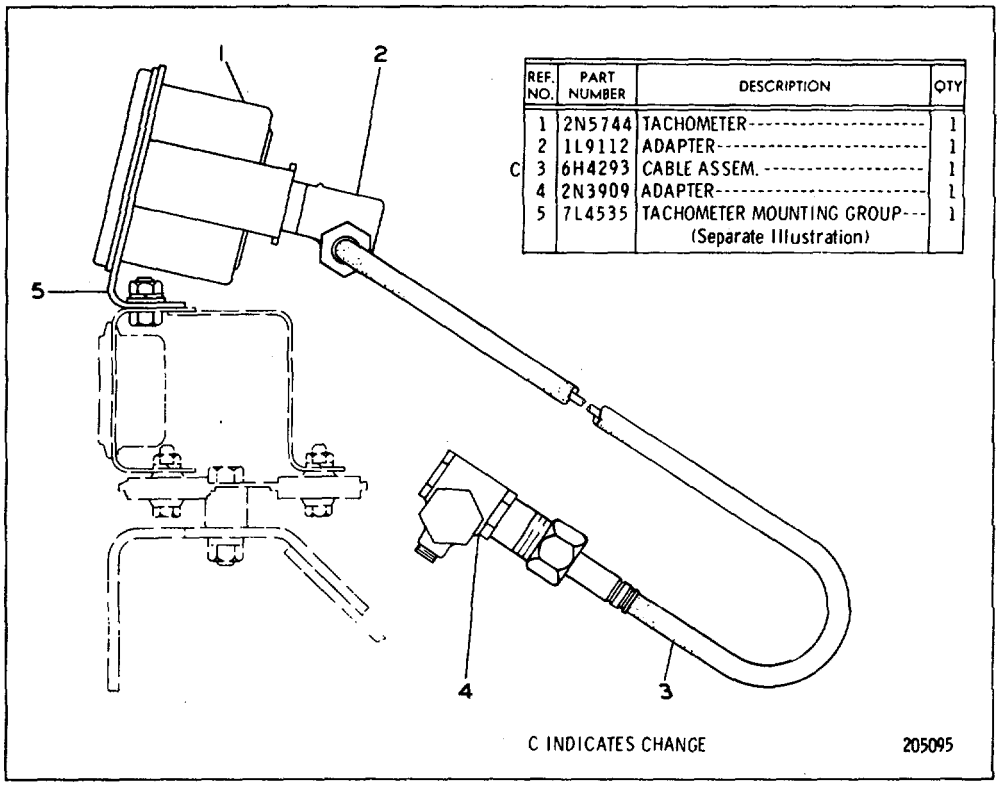


REF NO	PART NUMBER	DESCRIPTION	QTY
1	2N781	GAUGE------(oil pressure)--------	1
2	8M7892	AMMETER----------	1
3	5L7446	GAUGE----(water temperature)----	1
4	2N794	RETAINER----------	3
5	2N1972	SWITCH--------(magnetic)--------	1
6	2N815	PANEL----------	1
7	7B2742	BOLT----------	2
	1B4330	NUT----------	2
	5P537	WASHER----------	2
8	2N5848	BASE ASSEM. ----------	1
	6N359	WIRE ASSEM. ---------- (Includes)	1
9 ▲	5P497	WIRE----------2.03 dm(8 in.)	
	2L8076	TERMINAL----------	1
10	2L8077	TERMINAL----------	1
11	6N360	WIRE ASSEM. ---------- (Includes)	1
▲	5P497	WIRE----------3.05 dm(12 in.)	
12	2L8077	TERMINAL----------	2

▲ ORDER BY THE DECIMETRE 201776

6N356 INSTRUMENT PANEL GROUP

Part of 6N358 Instrument Panel Group shown on Page 150

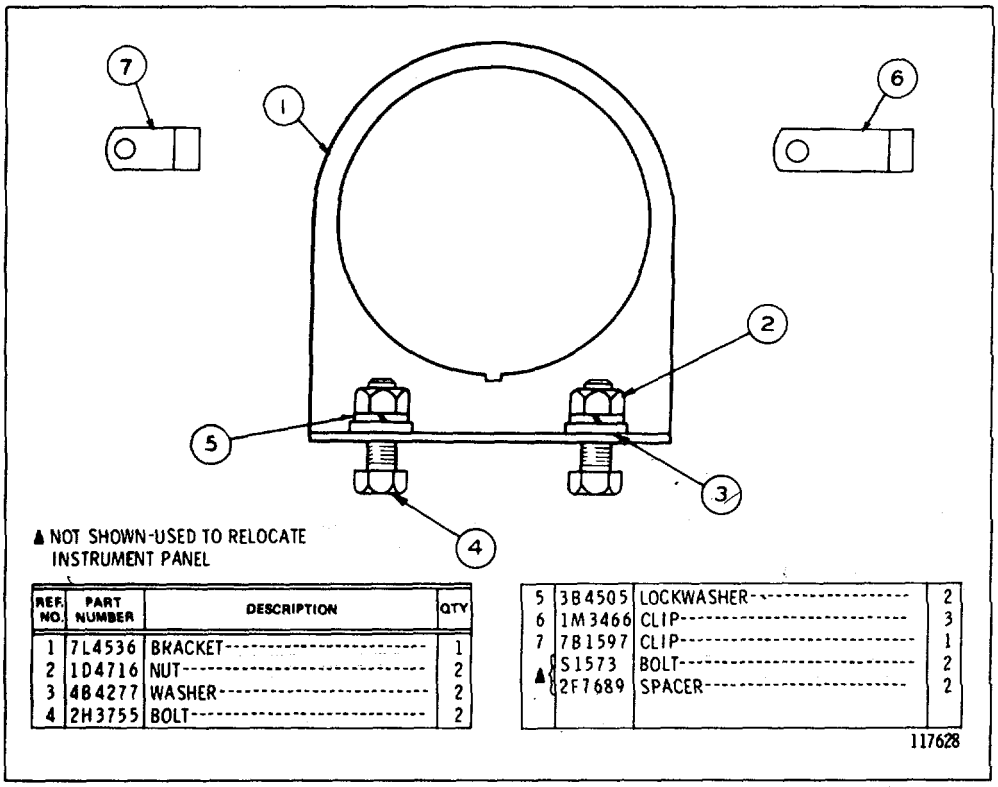


REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	2N5744	TACHOMETER	1
2	1L9112	ADAPTER	1
C 3	6H4293	CABLE ASSEM.	1
4	2N3909	ADAPTER	1
5	7L4535	TACHOMETER MOUNTING GROUP (Separate Illustration)	1

C INDICATES CHANGE

205095

2N5745 TACHOMETER MOUNTING AND DRIVE GROUP

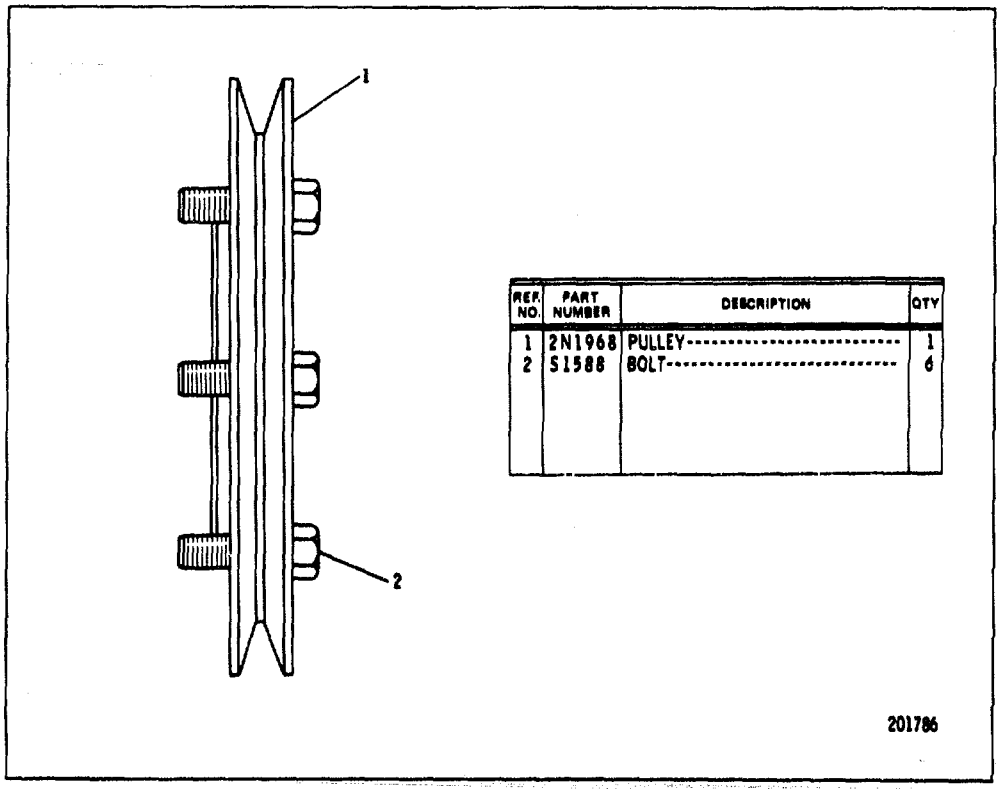


▲ NOT SHOWN-USED TO RELOCATE INSTRUMENT PANEL

REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	7L4536	BRACKET	1
2	1D4716	NUT	2
3	4B4277	WASHER	2
4	2H3755	BOLT	2
5	3B4505	LOCKWASHER	2
6	1M3466	CLIP	3
7	7B1597	CLIP	1
▲	1S1573	BOLT	2
▲	2F7689	SPACER	2

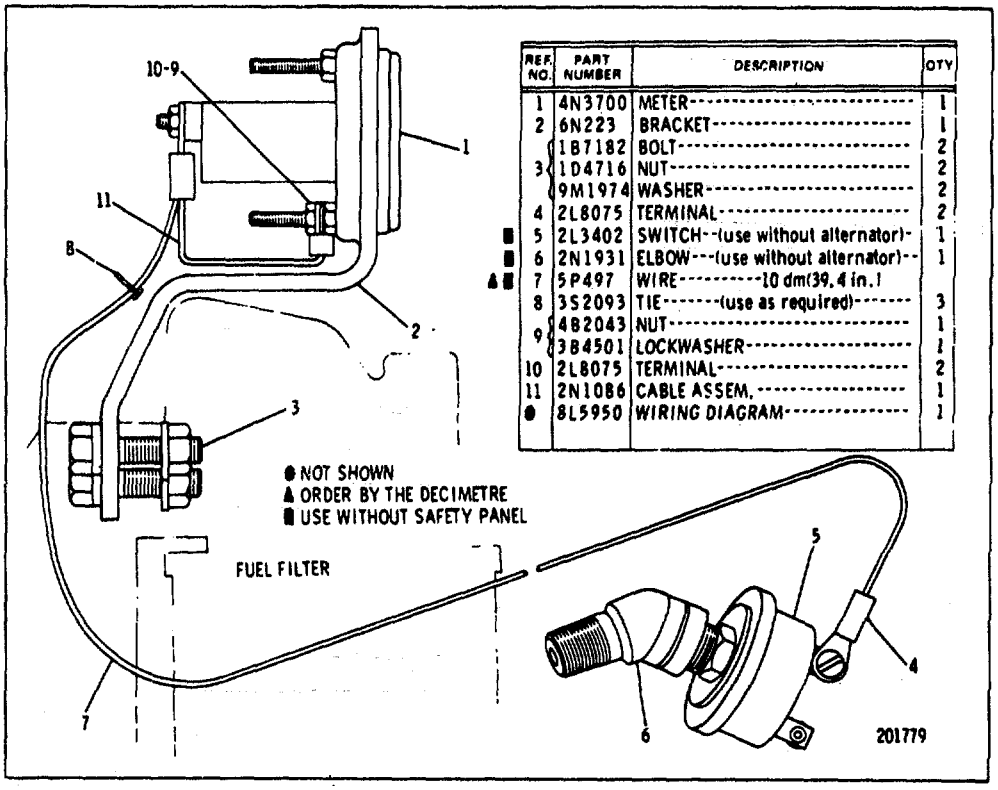
117628

7L4535 TACHOMETER MOUNTING GROUP
Part of 2N5745 Tachometer Mounting and Drive Group



REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	2N1968	PULLEY	1
2	S1588	BOLT	6

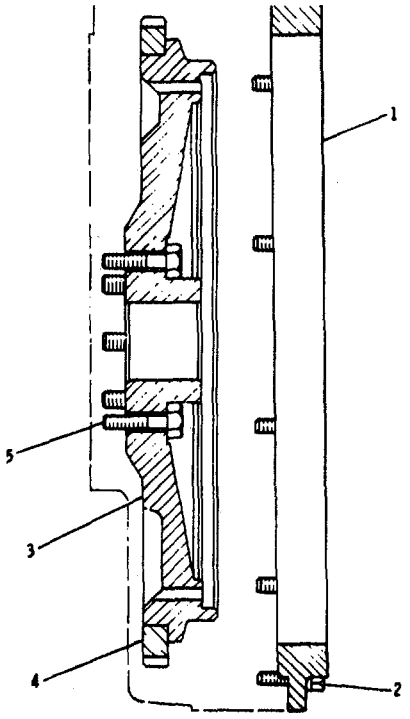
4N8670 AUXILIARY DRIVE PULLEY GROUP
NOT FOR USE WITH 4N7393 RADIATOR GROUP SHOWN ON PAGE 86



REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	4N3700	METER	1
2	6N223	BRACKET	1
3	1B7182	BOLT	2
	1D4716	NUT	2
	9M1974	WASHER	2
4	2L8075	TERMINAL	2
■ 5	2L3402	SWITCH--(use without alternator)-	1
■ 6	2N1931	ELBOW---(use without alternator)--	1
▲■ 7	5P497	WIRE----------10 dm(39.4 in.)	
8	3S2093	TIE-------(use as required)-------	3
9	4B2043	NUT	1
	3B4501	LOCKWASHER	1
10	2L8075	TERMINAL	2
11	2N1086	CABLE ASSEM.	1
●	8L5950	WIRING DIAGRAM	1

● NOT SHOWN
▲ ORDER BY THE DECIMETRE
■ USE WITHOUT SAFETY PANEL

6N224 HOUR METER GROUP



REF. NO.	PART NUMBER	DESCRIPTION	QTY
1	3L9191	ADAPTER	1
2	2P3203	BOLT	12
3	4N8547	FLYWHEEL ASSEM. (Includes)	1
4	9L8113	GEAR (134 teeth)	1
5	9L7816	BOLT	10

4N8849 TORQUE CONVERTER MOUNTING GROUP
FOR USE WITH S.A.E. #2 FLYWHEEL HOUSING

5P3636 CYLINDER BLOCK
COMPLETE ENGINE OVERHAUL WHEN USED WITH TWO VALVE GRINDING KITS. DOES NOT INCLUDE INJECTION PUMP AND GOVERNOR GROUP INTERNAL GASKETS, LOCKS AND SEALS

5P4546 VALVE GRINDING
COMPLETE FOR ONE CYLINDER HEAD

6N3723 SLEEVE METERING FUEL SYSTEM

GASKET KITS

QUANTITY USED	PART NUMBER	DESCRIPTION
1	8L8413	STRAP--CABLE
1	9L6531	PLATE--CAUTION AND INFORMATION TOP OF L.H. ROCKER ARM COVER, CENTERED ON #4 FUEL INJECTOR LINE
1	9L7746	PLATE--VALVE LASH TOP SIDE OF L.H. ROCKER ARM COVER BEHIND CAUTION AND INFORMATION PLATE
1	4N6710	PLATE--FUEL PUMP INFORMATION TOP OF R.H. ROCKER ARM COVER

NAME PLATES AND TRANSFERS (6N471 N/S)

QUANTITY USED	PART NUMBER	DESCRIPTION
1	8L8413	STRAP--CABLE
1	9L6531	PLATE--CAUTION AND INFORMATION TOP OF L.H. ROCKER ARM COVER, CENTERED ON #4 FUEL INJECTOR LINE
1	9L7746	PLATE--VALVE LASH TOP SIDE OF L.H. ROCKER ARM COVER BEHIND CAUTION AND INFORMATION PLATE
1	4N6710	PLATE--FUEL PUMP INFORMATION TOP OF R.H. ROCKER ARM COVER

NAME PLATES AND TRANSFERS (6N468 N/S)

QUANTITY USED	PART NUMBER	DESCRIPTION
1	8L8413	STRAP--CABLE
1	9L6531	PLATE--CAUTION AND INFORMATION TOP OF L.H. ROCKER ARM COVER, CENTERED ON #4 FUEL INJECTOR LINE
1	9L7746	PLATE--VALVE LASH TOP SIDE OF L.H. ROCKER ARM COVER BEHIND CAUTION AND INFORMATION PLATE
1	4N6710	PLATE--FUEL PUMP INFORMATION TOP OF R.H. ROCKER ARM COVER

NAME PLATES AND TRANSFERS (4N9613 N/S)

QUANTITY USED	PART NUMBER	DESCRIPTION
1	8L8413	STRAP--CABLE
1	9L6531	PLATE--CAUTION AND INFORMATION TOP OF L.H. ROCKER ARM COVER, CENTERED ON #4 FUEL INJECTOR LINE
1	9L7746	PLATE--VALVE LASH TOP SIDE OF L.H. ROCKER ARM COVER BEHIND CAUTION AND INFORMATION PLATE
1	4N6710	PLATE--FUEL PUMP INFORMATION TOP OF R.H. ROCKER ARM COVER

NAME PLATES AND TRANSFERS (6N1203 N/S)

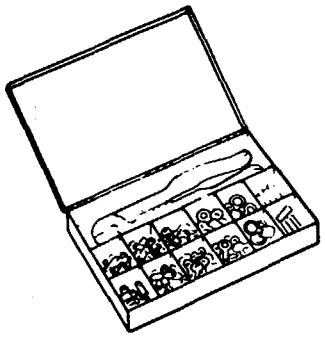
QUANTITY USED	PART NUMBER	DESCRIPTION
1	8L8413	STRAP--CABLE
1	9L6531	PLATE--CAUTION AND INFORMATION TOP OF L.H. ROCKER ARM COVER, CENTERED ON #4 FUEL INJECTOR LINE
1	9L7746	PLATE--VALVE LASH TOP SIDE OF L.H. ROCKER ARM COVER BEHIND CAUTION AND INFORMATION PLATE
1	4N6710	PLATE--FUEL PUMP INFORMATION TOP OF R.H. ROCKER ARM COVER

NAME PLATES AND TRANSFERS (4N8943 N/S)

QUANTITY USED	PART NUMBER	DESCRIPTION
1	8L8413	STRAP--CABLE
1	9L6531	PLATE--CAUTION AND INFORMATION TOP OF L.H. ROCKER ARM COVER, CENTERED ON #4 FUEL INJECTOR LINE
1	9L7746	PLATE--VALVE LASH TOP SIDE OF L.H. ROCKER ARM COVER BEHIND CAUTION AND INFORMATION PLATE
1	4N6710	PLATE--FUEL PUMP INFORMATION TOP OF R.H. ROCKER ARM COVER

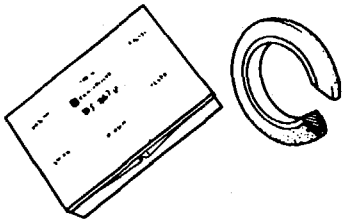
NAME PLATES AND TRANSFERS (6N3741 N/S)

RELATED REPAIR ITEMS



1P2305 ELECTRIC TERMINAL KIT

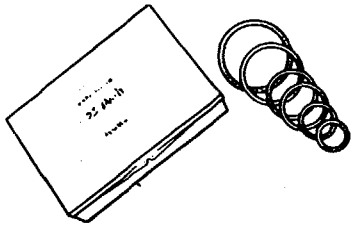
(Insulated)
(Includes terminals, wire joints and crimping tool)



9S3138 SEAL KIT

(Includes 28 metal - backed seals)

Qty.	Nominal Size	Part No.
2	1/2 inch (1,27 cm)	5J1583
6	3/4 inch (1,905 cm)	6J3575
6	1 inch (2,54 cm)	6J3600
6	1 1/4 inch (3,175 cm)	6J3625
4	1 1/2 inch (3,81 cm)	6J3650
4	2 inches (5,08 cm)	6J3800



9S3135 SEAL KIT

(Includes 60 rubber O-ring seals)

Qty.	Nominal Size	Part No.
10	1/2 inch (1,27 cm)	4J5140
10	3/4 inch (1,905 cm)	4J5267
10	1 inch (2,54 cm)	4J0520
10	1 1/4 inch (3,175 cm)	4J0522
10	1 1/2 inch (3,81 cm)	4J0524
10	2 inches (5,08 cm)	4J0527

THREADED INSERTS KITS

Master (Includes inserts and tools)

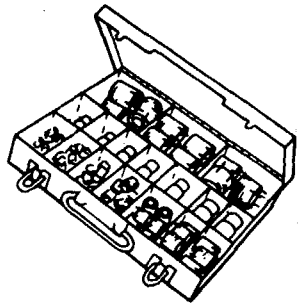
Coarse	Fine	Size
9S3700	9S3500	Assorted

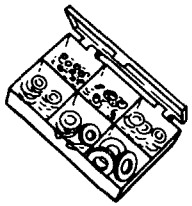
Repair (Includes inserts and tools)

9S3510	9S3509	#10
9S3512	9S3511	1/4
9S3514	9S3513	5/16
9S3618	9S3515	3/8
9S3620	9S3619	7/16
9S3622	9S3621	1/2
9S3624	9S3623	9/16
9S3626	9S3625	5/8
9S3628	9S3627	3/4
9S3630	9S3629	7/8
9S3632	9S3631	1
9S3633		1 1/8
9S3635		1 1/4
9S3637		1 1/2

Refill (Includes inserts)

9S3674	9S3673	#10
9S3649	9S3639	1/4
9S3650	9S3640	5/16
9S3651	9S3641	3/8
9S3652	9S3642	7/16
9S3653	9S3643	1/2
9S3654	9S3644	9/16
9S3655	9S3645	5/8
9S3656	9S3646	3/4
9S3657	9S3647	7/8
9S3658	9S3648	1
9S3675		1 1/8
9S3677		1 1/4
9S3679		1 1/2





HARDWARE ASSORTMENT KITS

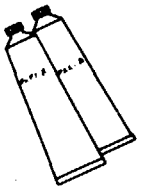
8S7198 Course Thread Hex Nut
8S7197 Fine Thread Hex Nut
8S7196 Lockwasher Assortment
8S7195 Flatwasher Assortment
8S7193 Woodruff Key Assortment

139338



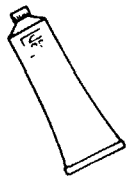
GASKET CEMENT

5H2471 8 oz. (227 g)



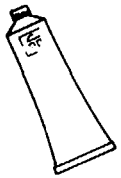
EPOXY CEMENT

5M2941 2 - 2 oz. (57g) Tube



BEARING LUBRICANT

2S3230 14 1/2 oz. (411 g)



GASKET SEALER

4H5363 11 oz. (312 g)
(fast drying-hard setting)
8H5137 11 oz. (312 g)
(non-hardening)



ANTI-SEIZURE COMPOUND

4S9416 16 oz. (454 g) Aerosol
9M3710 16 oz. (454 g) Paste



GLASS OR PLASTIC CEMENT

3S1831 1 pint (0.473 L)



LIQUID GASKET

7M7260 8 oz. (227 g)



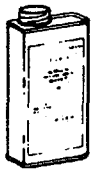
SEALING COMPOUND

5S1454 1 pint (0.473 L)



GREASE - SILICONE

4L7464 8 oz. (227 g)



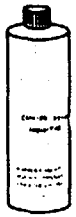
SILICONE FLUID

8M553 145 cc.
9M5165 150 cc.



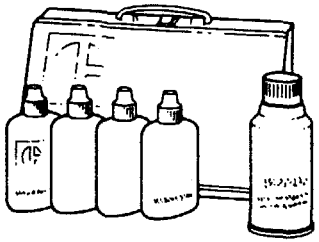
GREASE GUN CARTRIDGE

1P808 14 1/2 oz. (411 gms)



COOLING SYSTEM INHIBITOR

3P2043 1 pint (0.473 L)
P0001 1 case of 12
3P2044 1 quart (0.946 L)
P0002 1 case of 12



9S3262 SEALANT REPAIR KIT

contains:

Bearing Mount	7M7456	1 2/3 fl. oz. (50 cc)
Thread Lock	9S3263	1 2/3 fl. oz. (50 cc)
Pipe Sealant	9S3264	1 2/3 fl. oz. (50 cc)
Retaining Compound	9S3265	1 2/3 fl. oz. (50 cc)
Quick Cure Primer	8M8060	6 oz. (170 g) Aerosol



CHAIN & CABLE LUBRICANT

9S6106 16 oz. (454 g) Aerosol
2P2737 Case of 12

BELT DRESSING

9S6107 16 oz. (454 g) Aerosol
2P2738 Case of 12

ELECTRO-INSULATION SPRAY

9S6108 16 oz. (454 g) Aerosol
2P2739 Case of 12

PENETRATING OIL

9S6109 16 oz. (454 g) Aerosol
2P2740 Case of 12

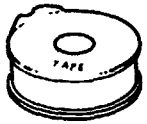
BATTERY SAVER & CLEANER

9S6110 16 oz. (454 g) Aerosol
2P2741 Case of 12

139339

RELATED REPAIR ITEMS

RELATED REPAIR ITEMS



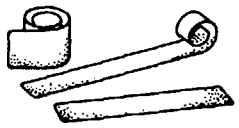
ELECTRICAL TAPE

1P810 (plastic) 2/3" (20mm) width
66 ft. (20m) length
9B4287 (cloth) 3/4" (20mm) width
30 ft. (9M) length
(Plastic tape comes in dispenser. Cloth tape does not.)



BUTTON PLUGS

Hole Diameter Inches	mm	Part Number
.219	5,6	4L0820
.310	7,9	7L6479
.380	9,7	5L6688
.438	11,1	4L0821
.469	11,9	3D9871
.484	12,3	8M3839
.500	12,7	3D9872
.625	15,9	2M4009
.687	17,5	6K2660
.750	19,0	5K3546
.875	22,2	5H4871
1.000	25,4	2D3406
1.250	31,8	4S6336
1.375	34,9	4F8711
1.500	38,1	3L1979
2.000	50,8	1L6377
2.250	57,2	7M3248
2.500	63,5	3L8852
3.000	76,2	1L6366



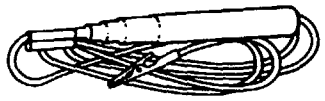
9S8703 ANTI-SKID TREADS

(May be ordered by foot lengths up to 60 feet (18,30m), width 4" (100mm)



MAGNETIC DRAIN PLUGS

Type	Thread Size-Threads Per Inch	Head Inches	A Inches	A mm	Part No.
I	5/8 - 11	7/8 Hex	1 3/16	26,9	5K1555
I	5/8 - 18	7/8 Hex	3/4	19,1	2R166
I	7/8 - 14	1 1/8 Hex	1 3/16	30,2	3H4190
I	1 1/8 - 12	1 1/2 Hex	1 1/2	38,1	8M3837
I	1 1/8 - 12	1 1/2 Hex	1 7/8	47,8	2J1559
I	1 1/2 - 12	1 Hex	1 1/2	38,1	8M5576
I	1 1/2 - 12	1 7/8 Hex	1 7/8	47,8	2D8390
II	1/2 - 14	9/16 Sq.	1 1/8	28,5	2F3628
II	3/4	5/8 Sq.	1 1/4	31,8	2H3865
II	7/8 - 14	7/8 Hex	1 5/8	41,3	2R1491
II	1 Std. Pipe Thd.	13/16 Sq.	1 7/16	36,6	2H3864
II	1 1/4 Std. Pipe Thd.	15/16 Sq.	1 11/16	42,9	2H3863
II	1 1/4 Std. Pipe Thd.	15/16 Sq.	1 3/8	35,0	7H3664
III	3/4 - 14 Pipe Thd., Fine	1/2 Sq.	1 3/16	30,2	5D1894
III	1 - 11 1/2 Pipe Thd., Fine	1/2 Sq.	1 5/16	33,4	2K744
III	1 1/4 - 11 1/2 Pipe Thd., Fine	3/4 Sq.	13/16	20,6	5S4017
III	2 - 12	3/4 Sq.	1 11/16	42,9	8B6599



8S4627 CIRCUIT TESTER

(Maximum Capacity: 10 oms)

139340

SPECIFICATIONS

(SUBJECT TO CHANGE WITHOUT NOTICE)

Weight, shipping (approximate) .....1350 lbs.

DIMENSIONS

Length .....36.1"
Width.....31.7"
Height.....33.8"

CAPACITIES

Lubrication: Engine: Lobe type Pump.
Crankcase Capacity: With Filters.....3.0 U.S. Gal.
Cooling System: Engine .....6.3 U.S. Gal.

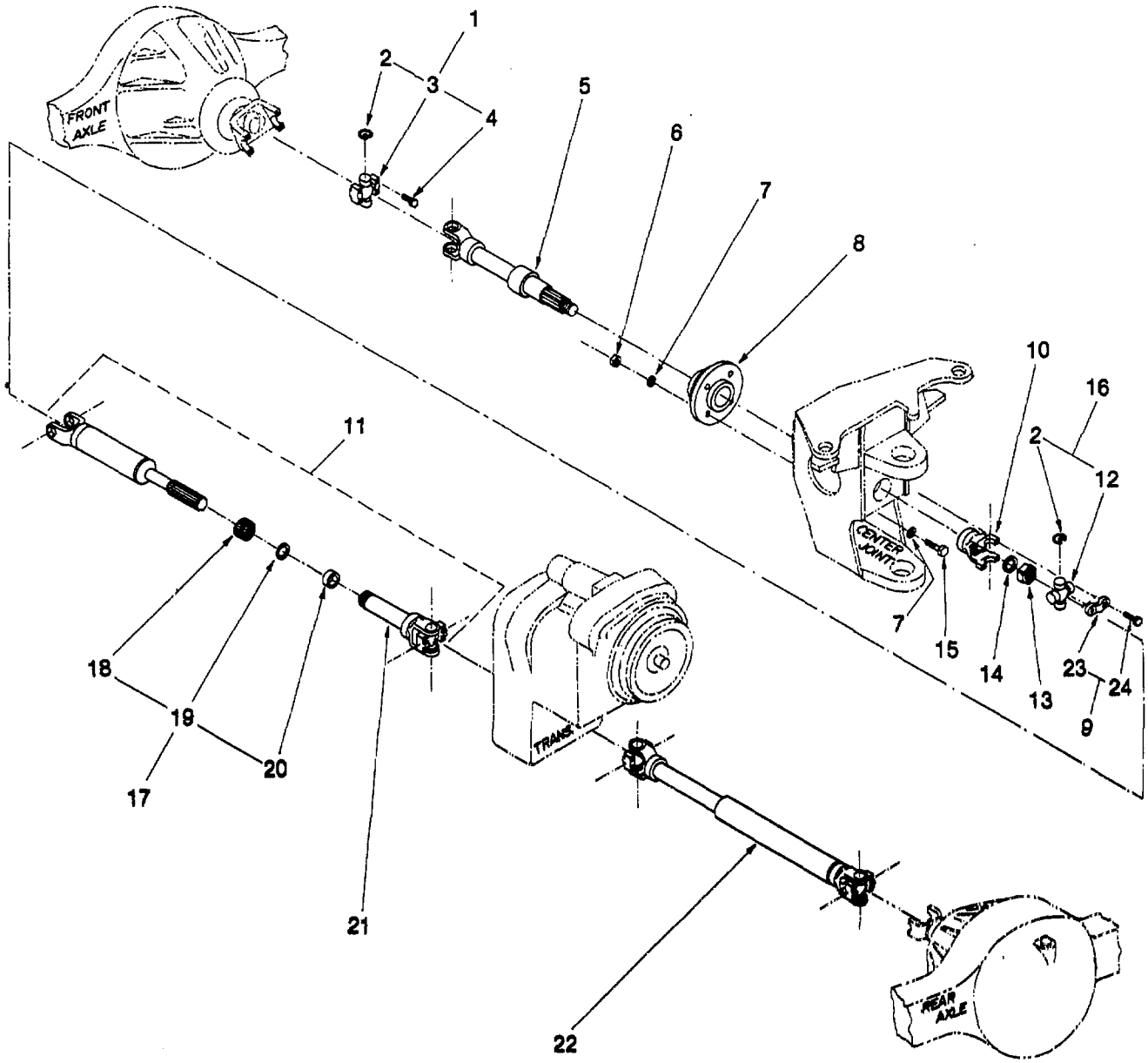
MACHINE SERIAL NUMBER PLATE LOCATION

Serial number plate is located on the right-hand side of the cylinder block.

DRIVE LINE SECTION

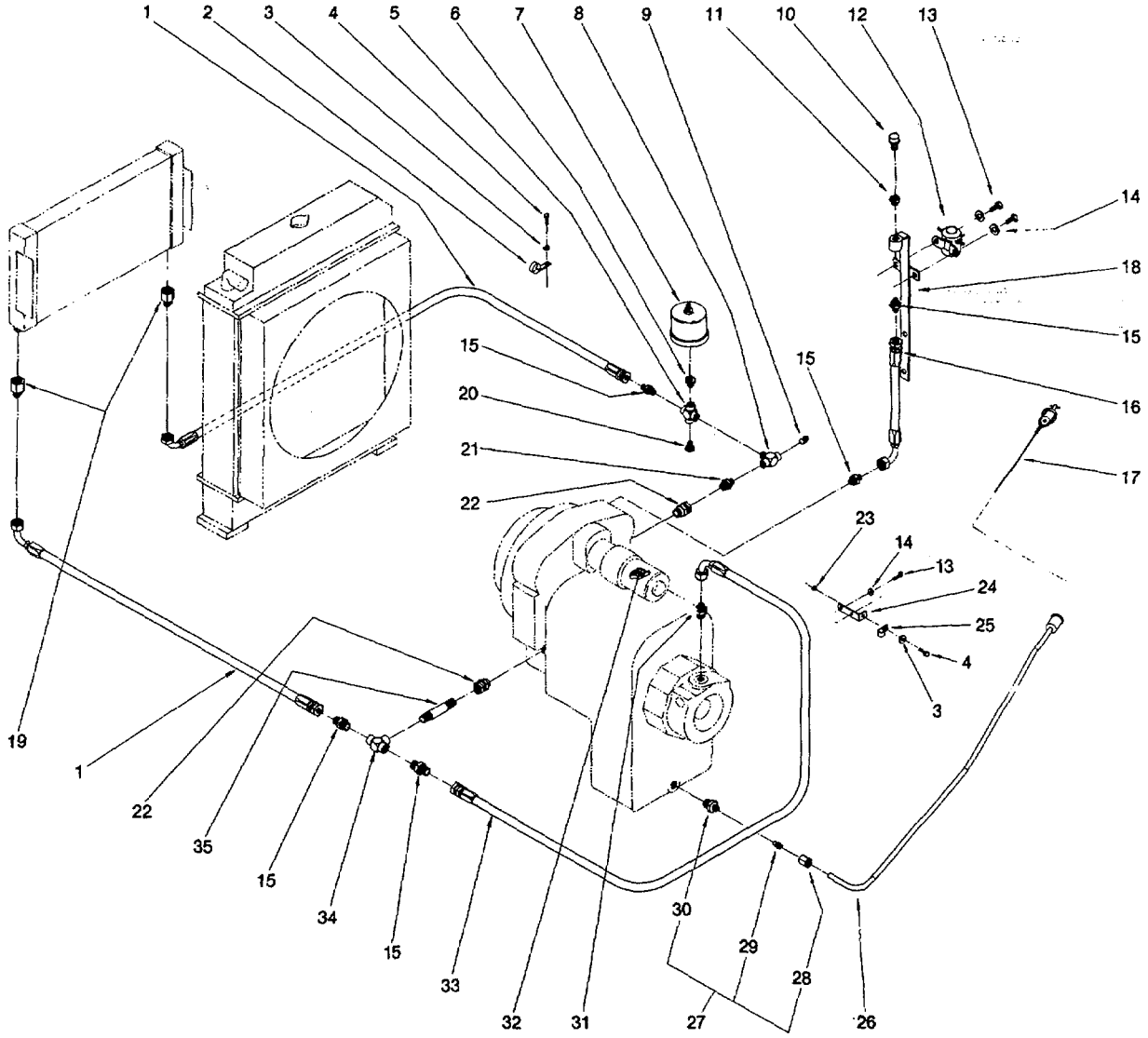
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FRONT AXLE
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CENTER JOINT
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TRANS
22
REAR AXLE

DRIVE SHAFT GROUP

REF. NO.	DESCRIPTION	QTY.	PART NO.
1	Kit, Repair (includes items 2 to 4)	4	4255
2	Ring, Snap	12	4256
3	Cross & Bearing Assembly, Journal	4	4257
4	Bolt, Locking	16	4237
5	Shaft Assembly, Front Drive (includes Item8 2 and 3)	1	4234
6	Locknut, Hex 5/8- 11 UNC	4	-
7	Washer, Hardened Flat 5/8 Diameter	8	-
8	Bearing, Center	1	3005
9	Kit, Bearing Race Cap (includes items 23 and 24)	2	4236
10	Yoke, End	1	4235
11	Shaft Assembly, Center Drive (Includes Items 16 to 21)	1	4232
12	Cross & Bearing Assembly, Journal	1	4259
13	Nut, Yoke	1	3037
14	Washer, Yoke	1	3217
15	Bolt, Hex 5/8- 11 UNC x 21/2 Long	4	-
16	Kit, Repair(includes items 2 and 12)	1	4258
17	Kit, Cover (includes Items 18 to 20)	1	4260
18	Cap, Dust	3	4307
19	Washer, Steel	3	4308
20	Washer, Cork.	3	4309
21	Yoke Assembly, Sleeve	3	4254
22	Shaft Assembly, Rear Drive	1	4233
23	Cap, Bearing Race	2	4238
24	Bolt, Bearing Race Cap	4	4239


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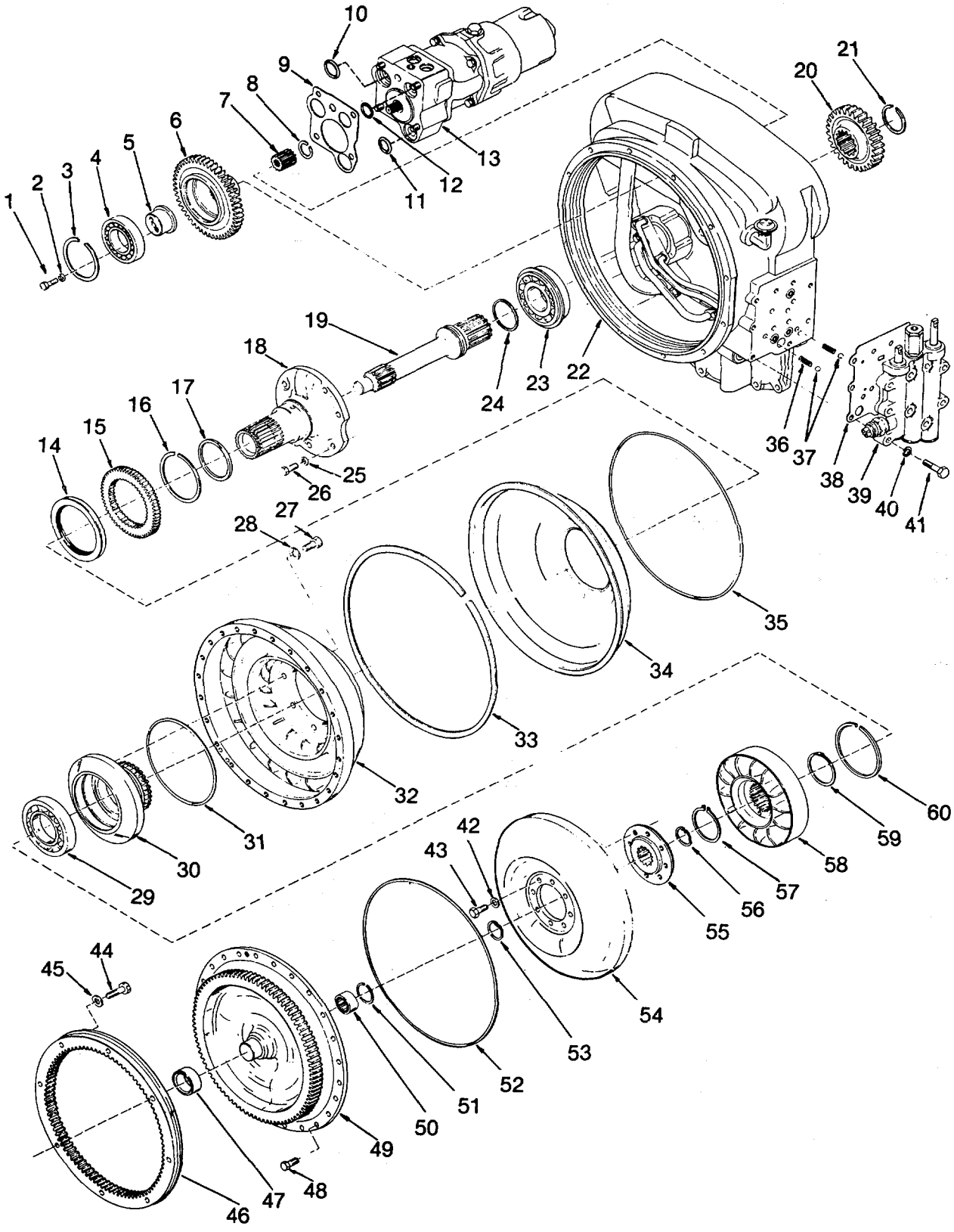
TRANSMISSION OIL SYSTEM

REF. NO.	DESCRIPTION	QTY.	PART NO.
1	Hose Assembly, Cooler	2	4244
2	Clamp	2	2628-48
3	Washer, Hardened Flat 3/8 Diameter	6	--
4	Bolt, Hex 3/8 -16 UNC x 1 Long	3	--
5	Cross, Adapter	1	15850-12
6	Reducer	1	3819
7	Sender, Transmission Oil Pressure	1	1253
8	Tee, Adapter	1	16913-12-12
9	Plug, 3/4 NPT Pipe	1	--
10	Cap, Filler-Breather	1	211433
11	Reducer	1	1093-12-6
12	Relay, Starter Switch	1	145027
13	Bolt, Hex 1/4 - 20 UNC x 3/4 Long	4	--
14	Washer, Hardened Flat 1/4 Diameter	4	--
15	Adapter	5	1012-12-12
16	Hose Assembly, Filler-Breather	1	2700
17	Dipstick, Transmission Oil	1	2707
18	Bracket, Filler-Breather	1	3288
19	Adapter	2	1015-12-12
20	Reducer	1	1093-12-8
21	Adapter	1	1042-12-12
22	Swivel, Adapter	2	15858-12-12
23	Locknut, Hex 3/8 -16 UNC	3	--
24	Bracket, Dipstick	1	3194
25	Clamp	1	2628-19
26	Tube, Dipstick	1	3193
27	Fitting Assembly (includes items 28 to 30)	1	2709
28	Nut, Dipstick Tube	1	3112
29	Sleeve, Dipstick Tube	1	3111
30	Adapter, Dipstick Tube	1	3110
31	Adapter	1	1040-12-12
32	Element, Transmission Oil Filter	1	3605
33	Hose Assembly, Tee to Brake	1	3107
34	Tee, Adapter	1	15862-12-12
35	Nipple, Pipe	1	3109

TRANSMISSION PARTS CATALOG

REF. NO.	DESCRIPTION	QTY.	PART NO.
1	Transmission Assembly	1	3790

TRANSMISSION TORQUE CONVERTER ASSEMBLY



CLARK MODEL: 13.1HR28364-1
CLARK P.N.: 285250
BOMAG P.N.: 3790

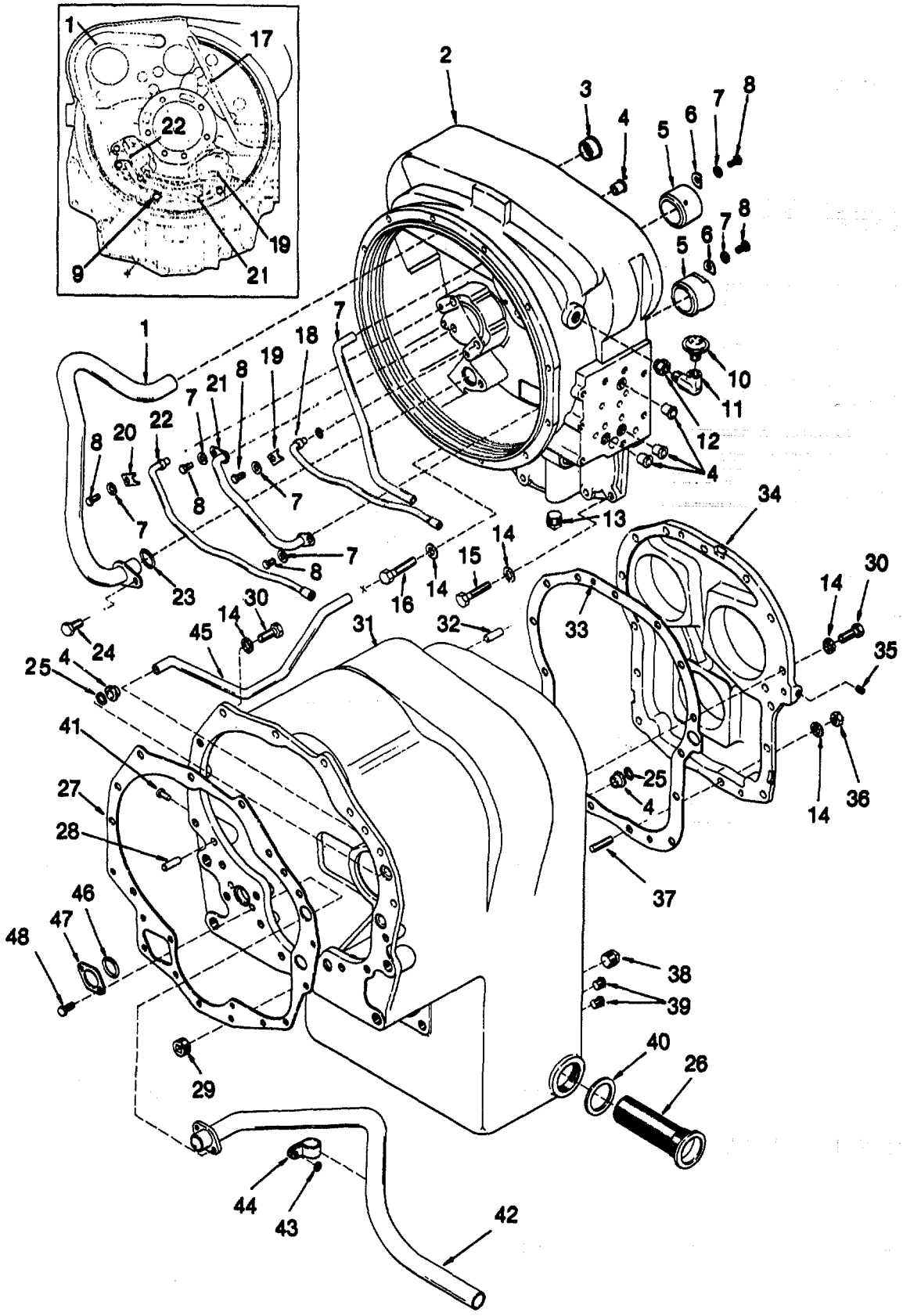
TRANSMISSION TORQUE CONVERTER ASSEMBLY

ITEM	QTY.	PART NO.	PSR	DESCRIPTION
1	6	2C-720		Screw, Bearing Support
2	6	4E-07		Lockwasher, Bearing Support Screw
3	3	223925		Snap Ring, Drive Gear
4	3	225601		Bearing, Drive Gear
5	3	230811		Support, Drive Gear Bearing
6	3	230812	D	Gear, Drive
7	2	236292	D	Sleeve and Snap Ring (incl. item 8)
8	2	224039		Snap Ring, External
9	1	231080	B	Gasket, Valve Body
10	1	60K-40106	B	O Ring, Valve Body
11	1	60K-40100	B	O Ring, Valve Body
12	1	60K-40026	B	O Ring, Valve Body
13	1	--		Valve, Regulator (Charging Pump) (see parts list)
14	1	214941	B	Seal, Oil
15	1	230805	D	Gear, Impeller Hub
16	1	224009	D	Snap Ring, Impeller Hub Gear
17	1	221653	B	Sealing Ring, Stator Support
18	1	230808	D	Support, Stator
19	1	214933	D	Shaft, Turbine
20	1	233705	D	Gear, Turbine Shaft
21	1	224026	D	Retainer Ring, Gear
22	1	231614	E	Converter Housing and Tube Assembly
23	1	225597	C	Bearing, Turbine Shaft
24	1	222079	B	Sealing Ring, Turbine Shaft
25	6	7E-08		Lockwasher, Stator Support Screw
26	6	1C-820		Screw, Stator Support
27	8	4C-714		Screw, Hub to Impeller
28	8	25E-19		Washer, Hub to Impeller Screw
29	1	214596	C	Bearing, Impeller Hub
30	1	214958	E	Hub, Impeller

TRANSMISSION TORQUE CONVERTER ASSEMBLY:

ITEM	QTY.	PART NO.	PSR	DESCRIPTION
31	1	60K-40616	B	O Ring, Impeller Hub
32	1	216362	E	Impeller
33	1	230855	D	Retainer Ring, Oil Baffle
34	1	230810	E	Baffle, Oil
35	1	231458	B	Seal Ring, Oil Baffle
36	2	202200		Spring, Detent
37	2	10J-12		Ball, Detent
38	1	234663	B	Gasket, Valve to Converter
39	1	--		Control Valve Assembly (see parts list)
40	9	4E-06		Lockwasher, Valve Screw
41	9	1C-632		Screw, Valve to Converter Housing
42	8	619023		Washer, Turbine Hub Screw
43	8	209313		Screw, Turbine Hub
44	16	233092		Screw, Ring Gear
45	16	215909		Washer, Ring Gear Screw
46	1	801780	E	Ring Gear, Flywheel (incl. items 44 and 45)
47	1	222006	E	Sleeve, Impeller Cover
48	24	233128		Screw, Impeller Cover
49	1	234503	E	Cover, Impeller
50	1	214988	C	Bearing, Impeller Cover
51	1	666542	D	Retainer Ring, Cover Bearing
52	1	232535	B	O Ring, Impeller Cover
53	1	659065	D	Retainer Ring, Turbine
54	1	223833	E	Turbine
55	1	214924	E	Hub, Turbine
56	1	659065	D	Locating Ring, Turbine
57	1	743035	D	Retainer Ring, Reaction Member
58	1	229564	E	Member, Reaction
59	1	229566		Spacer, Reaction Member
60	1	214953	D	Retainer Ring, Hub Bearing

PSR **-** Parts Stock Recommendation


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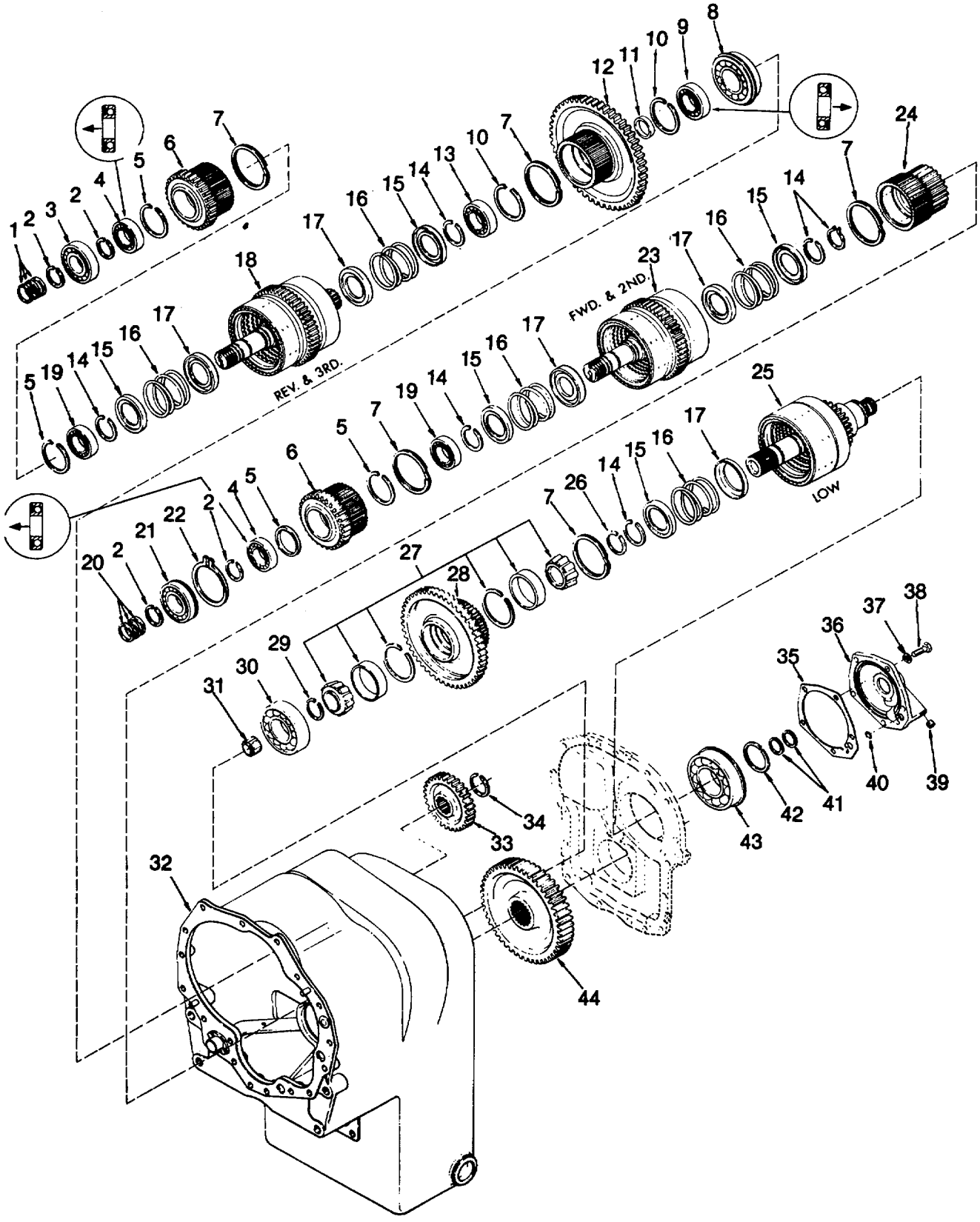
HOUSING AND TUBE ASSEMBLY

ITEM	QTY.	PART NO.	PSR	DESCRIPTION
1	1	232136		Suction Tube Assembly
2	1	231614		Converter Housing and Tube Assembly (incl. Items 1, 3-12, 16, 22-40)
3	1	230854		Sleeve, Tube
4	6	222067		Sleeve, Tube
5	2	231056		Sleeve, Converter Housing
6	2	230851		Lock, Converter Housing Sleeve
7	6	4E-05		Lockwasher
8	6	1C-510		Screw, Retaining
9	1	235987		Spacer Ring, Suction Tube
10	1	211433	D	Breather
11	1	26F-3		Ell, Street
12	1	19F-8		Bushing, Breather to Street Ell
13	1	11F-12		Plug, Pipe
14	33	4E-07		Lockwasher
15	4	1C-728		Screw, Converter Housing
16	4	1C-744		Screw, Converter Housing
17	1	231166		Tube, Valve OII Supply
18	2	25K-30012	C	O Ring, Tube
19	1	231095		3rd Speed Tube Assembly
20	2	231048		Clip, Tube
21	1	231093		Lube Tube Assembly
22	1	231094		Reverse Tube Assembly
23	1	25K-40030	C	O Ring, Suction Tube
24	1	5C-612		Screw, Suction Tube Retainer
25	2	25K-40026	C	O Ring, Pressure Tube
26	1	231390		Screen Assembly
27	1	231606	B	Gasket, Converter Housing to Trans Case
28	2	214295		Pin, Transmission Case Dowel
29	2	13F-16		Plug, Pipe
30	23	1C-720		Screw, Converter Housing
31	1	231611		Case Assembly, Transmission (incl. items 4, 41-48)

HOUSING & TUBE ASSEMBLY:

ITEM	QTY.	PART NO.	PSR	DESCRIPTION
32	2	214118		Pin, Rear Cover Dowel
33	1	231781	B	Gasket, Trans. Case to Rear Cover
34	1	233889		Cover, Transmission Case Rear
35	1	16F-01		Plug, Rear Cover Pipe
36	2	2D-07		Nut, Transmission Case Stud
37	2	200991		Stud, Trans. Case to Rear Cover
38	1	215757		Plug, Drain
39	2	40K-04		Plug, Oil Level
40	1	219373	B	Gasket, Screen Assembly
41	1	1H-418		Rivet, Suction Line Tube Clip
42	1	234836		Tube Assembly, Suction
43	1	25E-13		Washer, Suction Tube Clip
44	1	6H-36		Clip, Suction Tube
45	1	230900		Tube, Low Speed Clutch Pressure
46	1	25K-40104	C	O Ring, Suction Tube
47	1	230921		Washer, Suction Tube Retainer
48	2	4C-516		Screw, Suction Tube Retainer

PSR - Parts Stock Recommendation

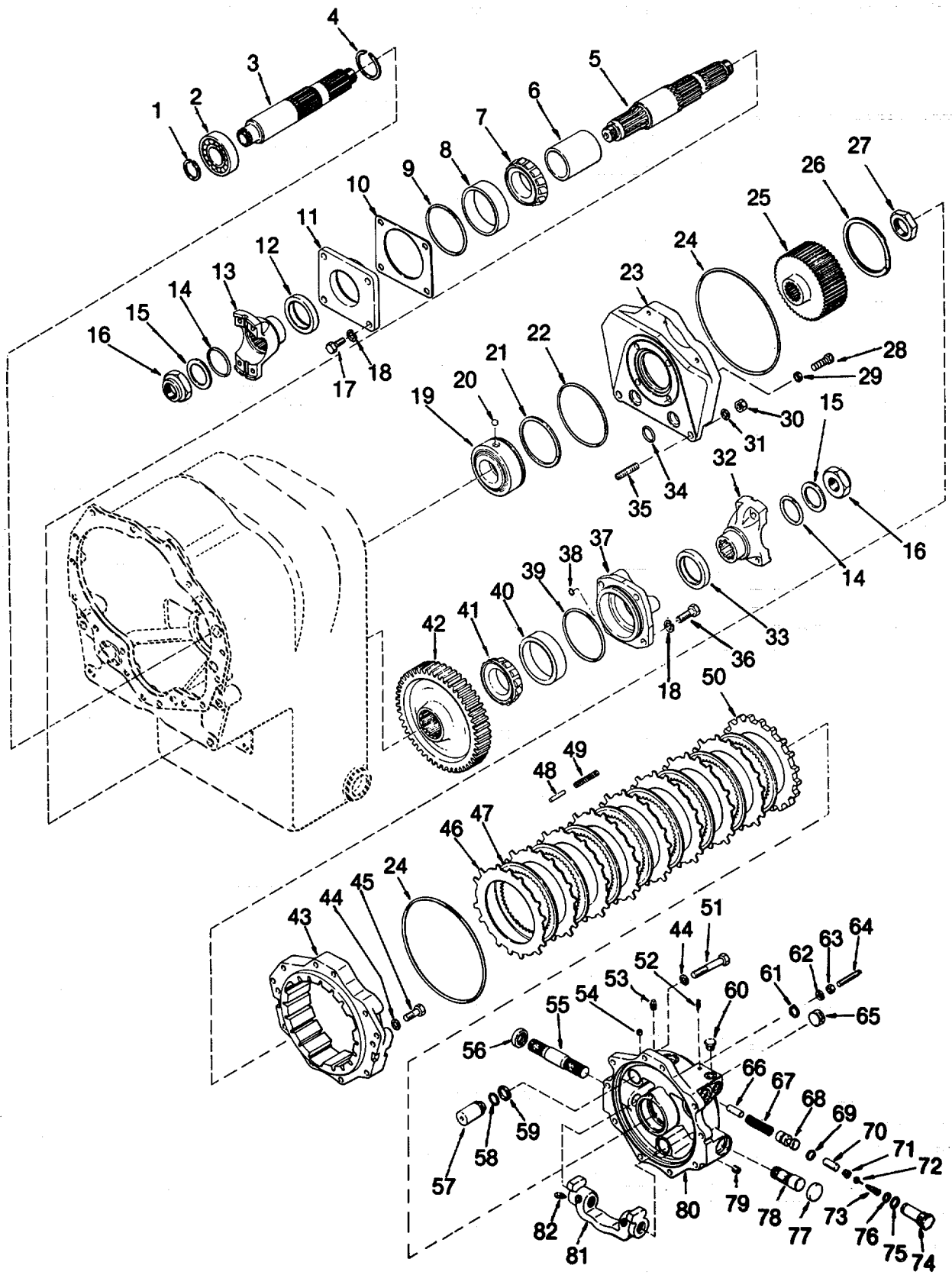

REV. & 3RD.
FWD. & 2ND.
LOW

GEAR AND CLUTCH GROUP

ITEM	QTY.	PART NO.	PSR	DESCRIPTION
1	3	215183	B	Piston Ring, Reverse and High Shaft
2	4	224083	D	Retainer Ring, Bearing
3	1	225603	C	Bearing, Reverse and High Front
4	2	233389	C	Bearing-Shield Out
5	4	223877	D	Snap Ring, Bearing
6	2	233706	D	Gear, Clutch Driven
7	5	731160		Ring, Oil Baffle
8	1	658038	C	Bearing, Reverse and High Rear
9	1	233390	C	Bearing, High Gear-Shield Out
10	2	223874	D	Snap Ring
11	1	230906		Spacer, High Gear Bearing
12	1	232313	D	Gear, High Range
13	1	230860		Bearing, High Gear
14	6	654613	D	Snap Ring
15	5	232089		Retainer, Spring
16	5	230822		Spring, Piston Return
17	5	232088		Retainer, Spring
18		--		Reverse and High Clutch Assembly (see parts list)
19	2	230829	C	Bearing, Gear
20	3	215183	D	Piston Ring, Shaft
21	1	223349	C	Bearing, Front
22	1	230889	C	Retainer Ring, Front Bearing
23		--		Forward and 2nd Shaft and Clutch Ass'y (see parts list)
24	1	232314	D	2nd Gear
25		--		Low Speed Shaft and Clutch Ass'y (see parts list)
26	1	232076	C	Retainer Ring, Bearing
27	1	231780	C	Bearing Assembly, Low Speed Gear
28	1	232451	D	Gear, Low Speed
29	1	801819	C	Snap Ring, Bearing
30	1	231554	C	Bearing, 2nd Gear
31	1	230886	C	Bearing, Pilot
32	1	231611		Transmission Case Assembly (see parts list)

GEAR AND CLUTCH GROUP:

ITEM	QTY.	PART NO.	PSR	DESCRIPTION
33	1	232453	D	Gear
34	1	224106	C	Retainer Ring, Gear
35	1	231193	B	Gasket, Rear Bearing Cap
36	1	231176	E	Cap, Rear Bearing
37	5	4E-06		Lockwasher
38	5	1C-618		Screw
39	1	16F-02		Plug
40	1	25K-30016	B	O Ring
41	2	220079	B	Ring, Piston
42	1	232081	D	Retainer Ring, Bearing
43	1	230968	C	Bearing, Rear
44	1	234868	E	Gear, Idler Shaft


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OUTPUT AND HYDRAULIC BRAKE GROUP

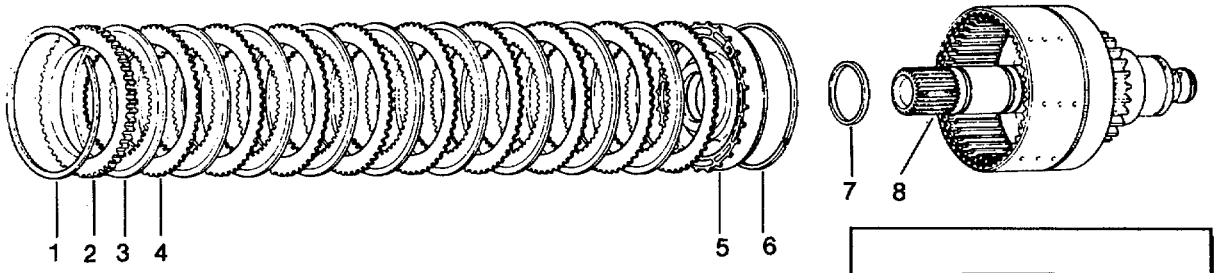
ITEM	QTY.	PART NO.	PSR	DESCRIPTION
1	1	224083	D	Retainer Ring, Bearing
2	1	743439	C	Bearing, Idler Shaft Front
3	1	231695	E	Shaft, Idler
4	1	224065	D	Ring, Retaining
5	1	231406	E	Shaft, Output
6	1	231405		Spacer, Output Shaft Gear
7	1	1314713	C	Cone, Front Bearing
8	1	666697	C	Cup, Front Bearing
9	1	25K-40400	B	O Ring, Front Bearing Cap
10a	AR	231848	D	Shim, .004" Bearing Cap
10b	AR	231849	D	Shim, .007" Bearing Cap
10c	AR	231850	D	Shim, .010" Bearing Cap
10d	AR	231851	D	Shim, .020" Bearing Cap
11	1	231818	E	Cap, Front Bearing
12	1	230954	B	Seal, Oil
13	1	231749	D	Flange, Output
14	2	25K-60116	B	O Ring
15	2	222179		Washer, Flange
16	2	222960		Nut, Flange
17	4	1C-920		Screw, Bearing Cap
18	8	4E-09		Lockwasher
19	1	231646	C	Bearing Assembly, Idler Shaft
20	1	10J-15		Ball, Lock
21	1	230952		Ring, Locating
'22	1	60K-40608	C	O Ring, Brake Adaptor
23	1	233888		Adaptor, Brake Housing
24	2	60K-40916	C	O Ring, Housing
25	1	231707		Hub, Brake Disc
26	1	217509		Ring, Oil Baffle
27	1	231639		Nut, Disc Hub
28	4	233534		Screw
29	4	106547		Lockwasher
30	4	64D-10		Nut, Adaptor to Case
31	2	4E-10		Lockwasher, Adaptor to Case
32	1	231749		Flange, Output

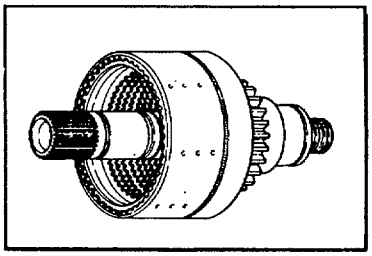
OUTPUT AND HYDRAULIC BRAKE GROUP:

ITEM	QTY.	PART NO.	PSR	DESCRIPTION
33	1	225823	B	Seal, Oil
34	2	60K-40108	B	O Ring, Brake Adaptor
35	2	233895		Stud, Adaptor to Case
36	4	1C-928		Screw, Bearing Cap
37	1	231817	E	Cap, Output Bearing
38	1	25K-30026	C	O Ring
39	1	25K-40412	C	O Ring
40	1	742240	C	Cup, Rear Bearing
41	1	1315447	C	Cone, Rear Bearing
42	1	232811	D	Gear, Output Shaft
43	1	231693		Housing, Brake Disc
44	12	4E-07		Lockwasher
45	2	1C-720		Screw
46	8	232394	C	Disc, Outer
47	8	227495	C	Disc, Inner
48	6	231055		Pin, Return Spring
49	6	231022		Spring, Return
50	1	231699		Plate, End
51	10	1 C-752		Screw
52	1	641297		Screw, Bleeder
53	1	24K-2		Plug, Brake Housing
54	1	24K-3		Plug, Brake Housing
55	1	231704		Shaft, Brake Operating
56	1	231708	B	Seal, Oil
57	3	236892	D	Piston
58	6	60K-20102	B	O Ring, Piston
59	3	231701	B	Ring, Piston Glyd
60	2	47K-5		Plug, Brake Housing
61	1	231709		Washer, Sealing
62	1	619023		Washer, Adjusting Screw
63	1	61D-06		Locknut, Adjusting Screw
64	1	231705		Screw, Brake Adjusting

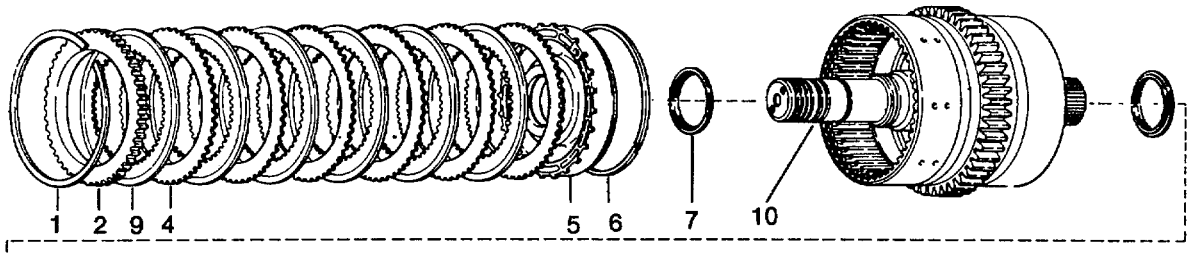
OUTPUT AND HYDRAULIC BRAKE GROUP:

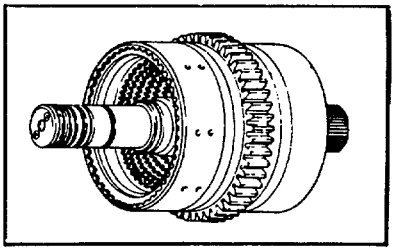
ITEM	QTY.	PART NO.	PSR	DESCRIPTION
65	1	218353		Plug, Brake Cover Bore
66	1	231035		Stop, Brake Valve
67	1	231034	C	Spring, Brake Valve
68	1	231706		Spool, Brake Valve
69	1	60K-20014		0 Ring, Piston
70	1	236893		Piston, Brake Valve
71	1	227881	B	Cup, Sealing
72	1	233264	B	Cup, Back-Up
73	1	227880	C	Spring, Balance
74	1	231742		Housing, Piston
75	1	57K-8	B	O Ring
76	1	60K-20022	B	O Ring, Piston Housing
77	1	231751		Plug, Brake. Housing Bore
78	1	231703		Shaft, Brake Yoke Stub
79	1	47K-5		Plug
80	1	231741	E	Brake Cover & Valve Assembly (incl. Items 58, 62-64, 72-82)
81	1	235435	E	Yoke, Brake
82	2	201607		Screw, Stud Shaft



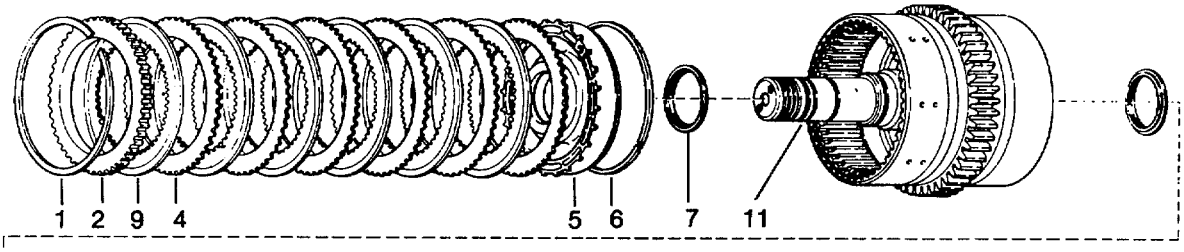


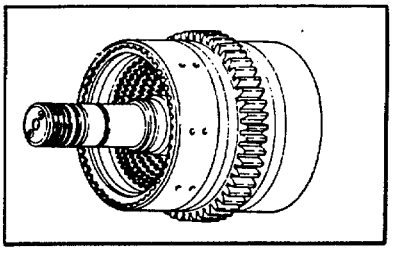
LOW CLUTCH GROUP





REVERSE & 3RD CLUTCH GROUP



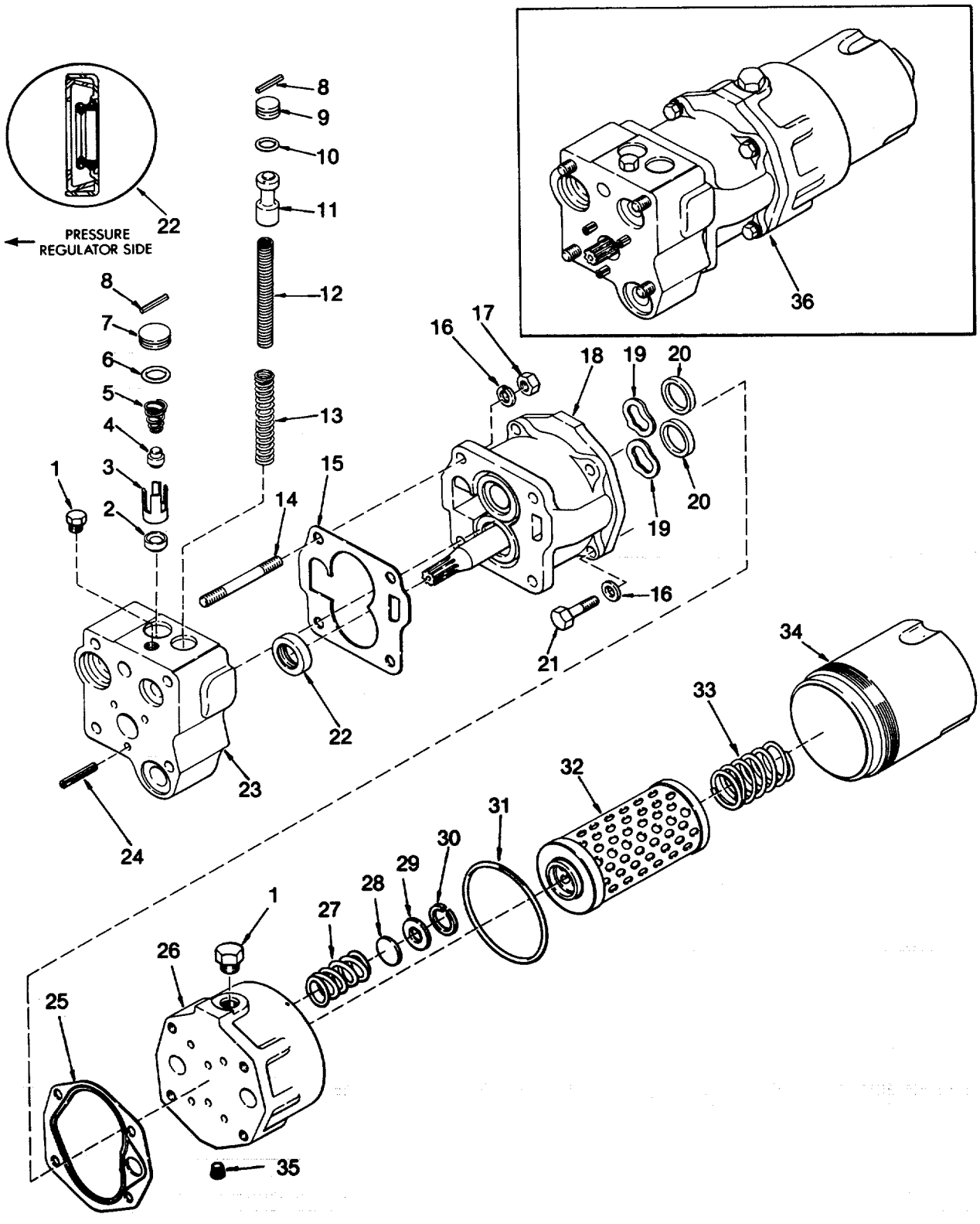


FORWARD & 2ND CLUTCH GROUP

CLUTCH GROUPS

ITEM	QTY.	PART NO.	PSR	DESCRIPTION
1	5	215190	D	Retainer Ring, End Plate
2	5	224774	E	Plate, End
3	9	230911	C	Disc, Low Clutch Inner
4	3	224772	C	Disc, Clutch Outer
5	5	230850	D	Piston, Clutch
6	5	224771	B	Seal Ring, Outer
7	5	230857	B	Seal Ring, Inner
8	1	232810	E	Drum and Shaft, Low Speed Clutch
9	24	233166	C	Disc, Clutch Inner
10	1	235034	E	Drum and Shaft, Reverse and 3rd Clutch
11	1	235038	E	Drum and Shaft, Forward and 2nd Clutch

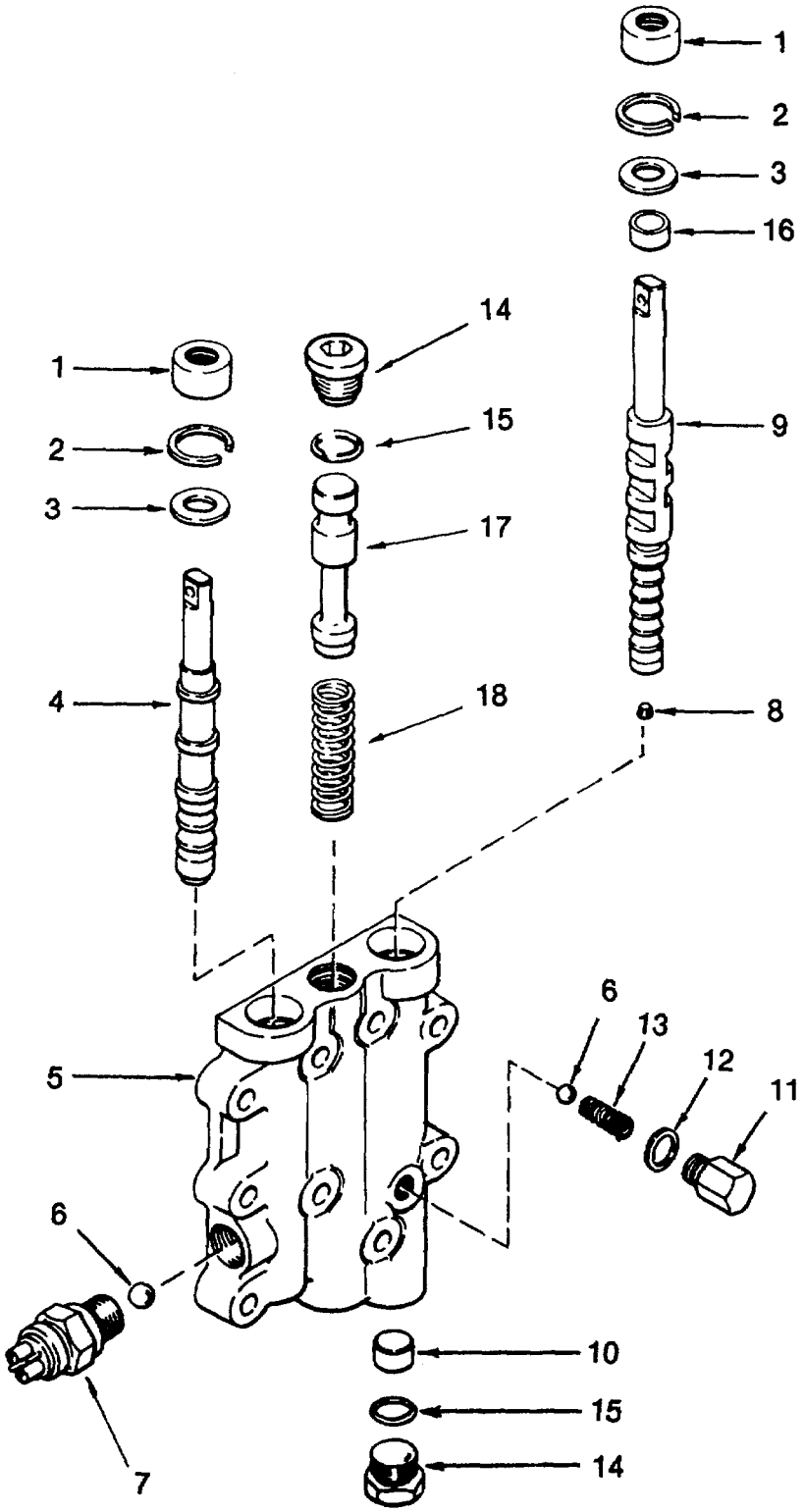
CHARGING PUMP AND VALVE ASSEMBLY



CHARGING PUMP AND VALVE ASSEMBLY

ITEM	QTY.	PART NO.	PSR	DESCRIPTION
1	2	40K-04		Plug, Pipe
2	1	233278		Seat, Safety Valve
3	1	233279	D	Spacer, Safety Valve
4	1	222318		Plunger, Safety Valve
5	1	222312	D	Spring, Safety Valve
6	1	25K-30022	B	O Ring, Valve Stop
7	1	229296		Stop, Valve
8	2	763795	E	Roll Pin, Valve Stop
9	1	220983		Stop, Valve
10	1	25K-30018	B	O Ring, Valve Stop
11	1	231077	E	Piston, Valve
12	1	224368	D	Spring, Inner Valve
13	1	235676	D	Spring, Outer Valve
14	4	231083		Stud, Valve to Converter
15	1	231081	B	Gasket, Valve to Pump
16	8	4E-07		Lockwasher
17	4	62D-07		Nut, Stud to Pump
18	1	235045	D	Charging Pump Assembly
19	2	234640	D	Spring, Wave
20	2	234643	B	Seal, Pump Shaft
21	4	1C-724		Capscrew, Pump to Adaptor
22	1	456294	B	Seal, Oil
23	1	231075	D	Pressure Regulator Valve Assembly (incl. items 1-13, 22 and 24)
24	3	233280		Roll Pin, Valve Body
25	1	231199	B	Gasket, Pump to Filter
26	1	234644	E	Adapter, Filter
27	1	230959	E	Spring, By-Pass Filter Disc
28	1	230960		Disc, By-Pass Filter
29	1	230961		Seat, By-Pass Filter Disc
30	1	230965	D	Retainer Ring, Filter Seat
31	1	25K-40404	B	O Ring, Filter Housing
32	1	230962	C	Element, Oil Filter (incl. item 31)
33	1	230963	D	Spring, Element
34	1	230964		Housing, Filter
35	1	16F-02		Plug, Pipe
36	1	235299		Charging Pump and Oil Filter Assembly (inc. items 18-21, 25-35)

CONTROL VALVE ASSEMBLY



CONTROL VALVE ASSEMBLY

ITEM	QTY.	PART NO.	PSR	DESCRIPTION
1	2	234651	B	Seal, Valve Spool Oil
2	2	664140		Retainer Ring, Oil Seal
3	2	217657		Washer, Oil Seal
4	1	231158	E	Spool, Forward and Reverse Valve
5	1	235051	D	Control Valve Housing Assembly (incl. items 1-9)
6	2	10J-12		Ball, Neutral Switch Detent
7	1	236395	C	Switch, Neutral
8	1	16F-01		Plug, Spool Pipe
9	1	231146	E	Spool, Speed Selector (incl. item 8)
10	1	231839		Spacer, Overshift
11	1	235058		Plug, Detent Spring
12	1	235061		Washer, Detent Spring Plug
13	1	202200		Spring, Detent
14	2	24K-7		Plug, (incl. item 15)
15	2	91F-7	B	O Ring, Plug
16	1	231840		Spacer, Overshift
17	1	231155	E	Spool, Valve
18	1	231164	D	Spring, Valve Spool

PART STOCK RECOMMENDATION

A minimum spare parts inventory recommendation is incorporated in this illustrated service parts list and is designated by a letter.

The following listing indicates the percentage factor in letter code which should be used in determining your stocking quantities. Any quantity less than 1 or partial quantities need not be stocked.

A.	**15%**
B.	**10%**
C.	**6%**
D.	**4%**
E.	**2%**

EXAMPLE 1: Letter Code "E"= 2%
Part quantity per unit 1
If field population or quantity units=75
Recommended stock Is 75 units x 1 per unit x .02 = 1.5 or 1 part minimum stock.

EXAMPLE 2: Letter Code "'B"= 10%
Part quantity per unit 4
If field population or quantity units=66
Recommended stock is 66 units x 4 per unit x .10 = 26.4 or 26 parts minimum stock.

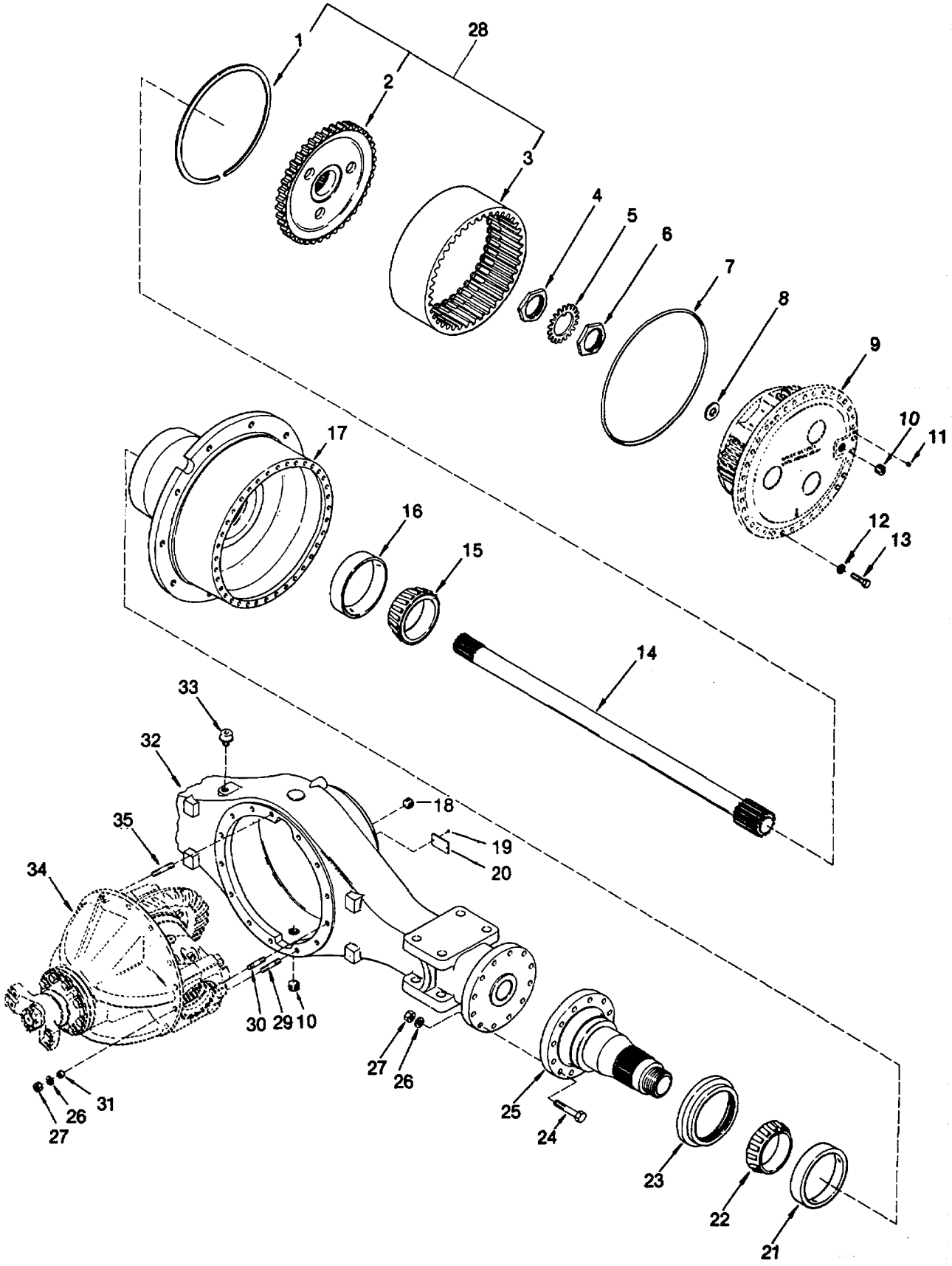
EXAMPLE 3: Letter Code "D"= 4%
Part quantity per unit is AR. Parts quantities denoted by AR (as required) such as shims, should be ordered by a quantity of 3 times the percentage factor.
If field population or quantity units=42
Recommended stock is 42 units x 3 factor x .04= 5.04 or 5 parts minimum stock.

EXAMPLE 4: Letter Code "C"= 6%
Part quantity per unit 2
If field population or quantity units=203
Recommended stock is 203 units x 2 per unit x .06 = 24.4 or 24 parts minimum stock.

NOTE: ADD PART QUANTITIES PER UNIT TIMES FIELD POPULATION WHEN ORDERING STOCK PARTS.

AXLE PARTS CATALOG

REF. NO.	DESCRIPTION	QTY.	PART NO.
1	Axle Assembly FD	1	4250
2	Axle Assembly	1	4246


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Koehring Canada Limited
BOMAG Division

CLARK MODEL	D-33301
CLARK P.N.	195096 (FRONT)
	195097 (REAR)
BOMAG P.N.	4250 (FRONT)
	4245 (REAR)

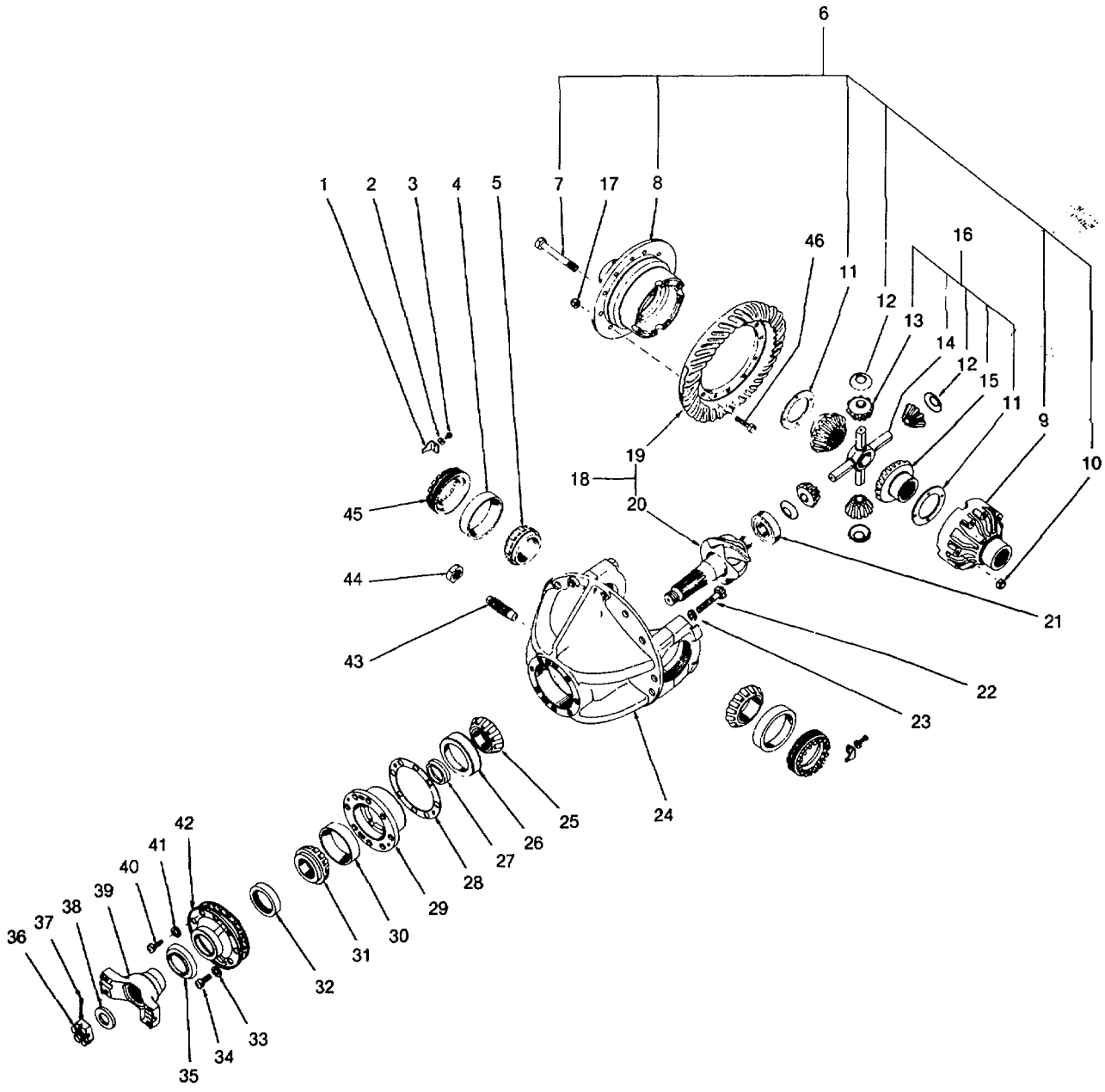
ITEM	QTY.	PART NO.	PSR	DESCRIPTION
1	2	127035	D	**Ring,** Gear Retaining
2	2	127033	D	**Hub**, Internal Gear
3	2	127859	D	**Gear**, Internal Ring
4	2	110559	D	**Nut,** Internal Gear Hub Retaining
5	2	118786	D	**Lock,** Internal Gear Hub Retaining Nut
6	2	110559		**Nut**, Internal Gear Hub Retaining
7	2	118791	B	**Ring**, Planet Carrier Sealing
8	2	113021	E	**Washer**, Sun Gear Thrust
9	.2	127856	E	**Carrier Assembly**, Planet (See Parts List)
10	3	119469		**Plug**, Hole
11	6	19G-808		**Screw,** Planet Puller Hole
12	72	104412		**Washer,** Planet Carrier
13	72	17C-1032H		**Screw**, Planet Carrier Attaching
14	2	128289	D	**Shaft,** Axle and Sun Gear
15	2	791555	C	**Cone**, Outer Hub Bearing
16	2	791554	C	**Cup,** Outer Hub Bearing
17	2	128287	E	**Hub and Cup Assembly** (includes items 16 and 21)
18	1	16F-12	C	**Plug**, Housing Filler Hole
19	2	6C-605H	C	**Screw,** Name Plate
20	1	120707		**Plate,** Name

AXLE ASSEMBLY:

ITEM	QTY.	PART NO.	PSR	DESCRIPTION
21	2	731982	C	**Cup**, Inner Hub Bearing
22	2	731984	C	**Cone**, Inner Hub Bearing
23	2	111476	B	**Seal**, Hub Oil
24	36	18C-948H		**Bolt,** Spindle Attaching
25	2	128290	D	**Spindle**
26	50	106547		**Washer**, Screw
27	50	64D-09H		**Nut**
28	2	127858	E	**Gear and Hub Assembly**, Internal (includes items 1-3)
29	2	119889		**Stud,** Differential and Carrier (3.250" Long)
30	10	112587		**Stud**, Differential and Carrier (2.375" Long)
31	3	112295		**Dowe**l, Differential and Carrier
32	1	121826	E	**Housing**, Axle
33	1	121214	C	**Breather**
34a	1	127669	E	**Differential and Carrier Assembly**, Front Drive (See Parts List)
34b		128284	E	**Differential and Carrier Assembly**, Rear Drive (See Parts List)
35	2	119931		**Stud**, Differential and Carrier (2.562" Long)

PSR - Parts Stock Recommendation

DIFFERENTIAL AND CARRIER ASSEMBLY



DIFFERENTIAL AND CARRIER ASSEMBLY

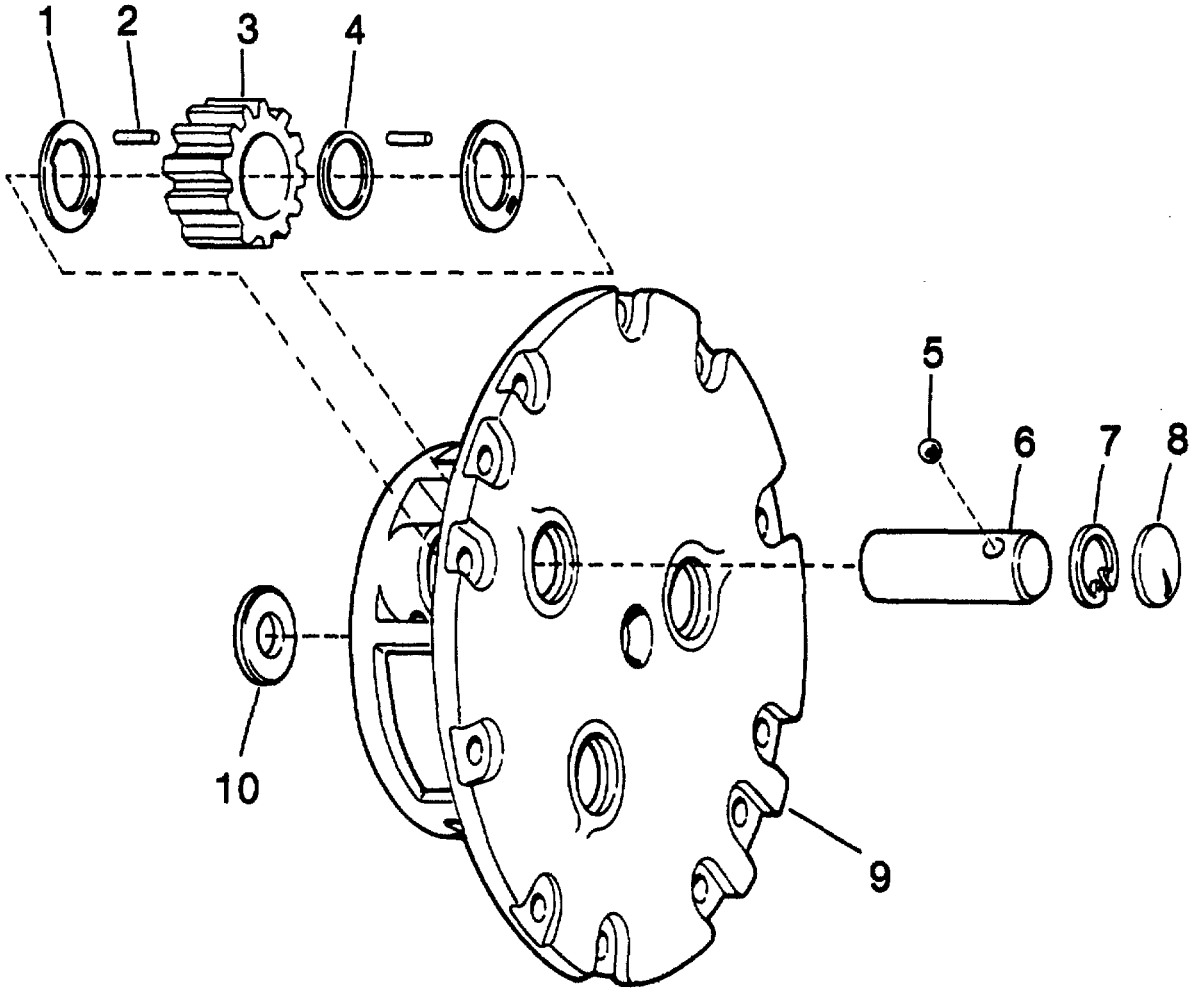
ITEM	QTY.	PART NO.	PSR	DESCRIPTION
1	2	100941		**Lock**, Adjusting Nut
2	2	4E-06		**Lockwasher**, Adjusting Nut Lock
3	2	1C-614		**Bolt**, Adjusting Nut Lock
4	2	675252	C	**Cup,** Differential Bearing
5	2	675254	C	**Cone**, Differential Bearing
6	1	126951		**Case Kit**, Differential (includes items 7-12)
7	8	126625		**Bolt**, Differential Case
8	1	N.S.S.		**Flanged Half**, Differential Case (see item 6)
9	1	N.S.S.		**Plain Half**, Differential Case (see item 6)
10	8	126614		**Nut,** Case Bolt
11	2	118478	C	**Washer**, Side Gear Thrust
12	4	101204	C	**Washer**, Pinion Thrust
13	1	815746	D	**Kit**, Differential Pinion
14	1	117105	D	**Spide**r, Differential
15	2	126048	D	**Gear**, Side
16	1	127671	E	**Differential Body Sub-Assembly** (includes Items 6, 11-15)
17	12	104168		**Nut,** Ring Gear Bolt
18a	1	815357	E	**Drive Gear and Pinion Set**, Front (includes items 19 and 20)
18b		815338	E	**Drive Gear and Pinion Set**, Rear (includes items 19 and 20)
19	1	N.S.S.		**Gear**, Ring (see item 18)
20	1	N.S.S.		**Pinion** (see item 18)
21	1	675265	C	**Bearing**, Inner Pinion
22	4	123831		**Bolt**, Carrier Cap
23	4	26E-14H		**Lockwashe**r, Carrier Cap

DIFFERENTIAL AND CARRIER ASSEMBLY

ITEM	QTY.	PART NO.	PSR	DESCRIPTION
24	1	112292	E	Carrier Assembly (includes items 20 and 21)
25	1	675263	C	Cone, Center Pinion Bearing
26	1	675262	C	Cup, Center Pinion Bearing
27	1	815200	D	Spacer Kit, Pinion Bearing
28a	AR	114351	D	Shim, Bearing Cage Thir,
28b	AR	125578	D	Shim, Bearing Cage Medium
28c	AR	125579	D	Shim, Bearing Cage Thick
29	1	107477		Cage Assembly, Pinion Bearing (includes items 24 and 28)
30	1	675259	C	Cup, Pinion Bearing Outer
31	1	675260	C	Cone, Pinion Bearing Outer
32	1	118068	B	Seal, Pinion Oil
33	7	4E-10		Lockwasher, Oil Seal Retainer
34	7	17C-1040H		Capscrew, Oil Seal Retainer
35	1	101222		Shield, Pinion Dust
36	1	101223		Nut, Pinion Shaft
37	1	1 F-740		Cotter, Pinion Shaft Nut
38	1	101224		Washer, Pinion Shaft Nut
39	1	108871	E	Flange, Companion
40	1	17C-836H		Screw, Pinion Cage Locating
41	1	4E-08		Lockwasher, Locating Screw
42	1	122734	D	Retainer, Pinion Oil Seal
43	1	121241		Screw, Thrust
44	1	8D-18		Nut, Thrust Screw
45	2	123748	E	Nut, Differential Adjusting
46	12	101196		Bolt, Ring Gear

PSR - Parts Stock Recommendation **AR** - As Required **N.S.S**. - Not Sold Separately

PLANETARY CARRIER ASSEMBLY



PLANETARY CARRIER ASSEMBLY

ITEM	QTY.	PART NO.	PSR	DESCRIPTION
1	6	107991	C	**Washe**r, Thrust
2	186	1324396	C	**Needle**, Roller
3	3	127857	C	**Gear**, Planet
4	3	107993	C	**Spacer**, Pinion Needle Roller
5	3	10J-16		**Ball,** Pinion Shaft Lock
6	3	127029	C	**Shaft**, Planet Pinion
7	3	661312	C	**Ring,** Planet Shaft Snap
8	3	12F-212		**Plug**, Planet Shaft Hole
9	1	127028	E	**Carrier**, Planet
10	1	121168	C	**Washer**, Thrust

PSR - Parts Stock Recommendation

PART STOCK RECOMMENDATION

A minimum spare parts inventory recommendation is incorporated in this illustrated service parts list and is designated by a letter.

The following listing indicates the percentage factor in letter code which should be used in determining your stocking quantities. Any quantity less than 1 or partial quantities need not be stocked.

A.	**15%**
B.	**10%**
C.	**6%**
D.	**4%**
E.	**2%**

EXAMPLE 1 Letter Code "E"= 2%
Part quantity per unit 1
If field population or quantity units =75
Recommended stock is 75 units x 1 per unit x .02 = 1.5 or 1 part minimum stock.

EXAMPLE 2 Letter Code "B"= 10%
Part quantity per unit 4
If field population or quantity units= 66
Recommended stock is 66 units x 4 per unit x .10 = 26.4 or 26 parts minimum stock.

EXAMPLE 3 Letter Code "D"= 4%
Part quantity per unit is AR. Parts quantities denoted by AR (as required) such as shims, should be ordered by a quantity of 3 times the percentage factor.
If field population or quantity units =42
Recommended stock is 42 units x 3 factor x .04 = 5.04 or 5 parts minimum stock.

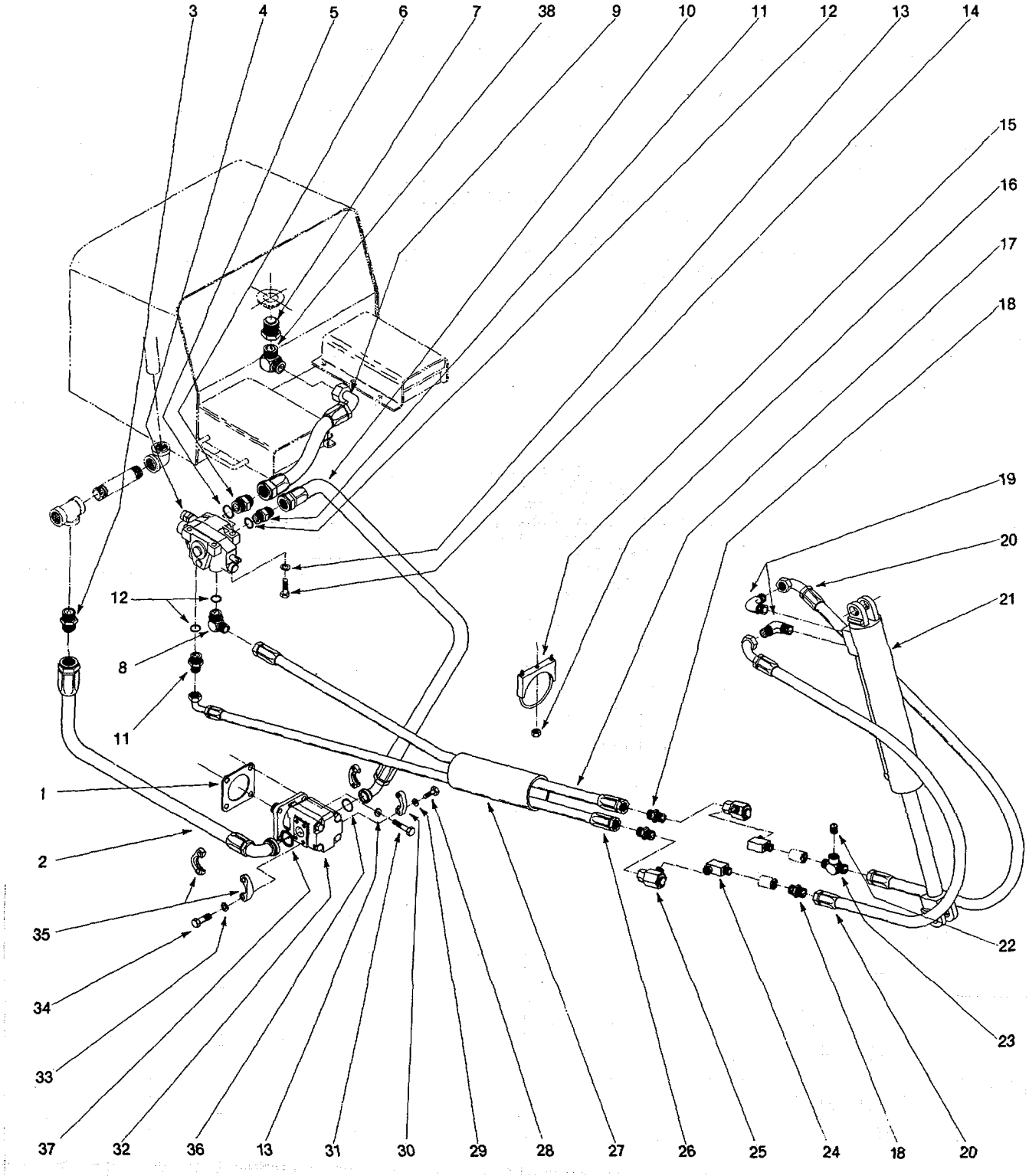
EXAMPLE 4: Letter Code "C"= 6%
Part quantity per unit 2
If field population or quantity units-203
Recommended stock is 203 units x 2 per unit x .06 = 24.4 or 24 parts minimum stock.

NOTE: ADD PART QUANTITIES PER UNIT TIMES FIELD POPULATION WHEN ORDERING STOCK PARTS.

HYDRAULICS SECTION

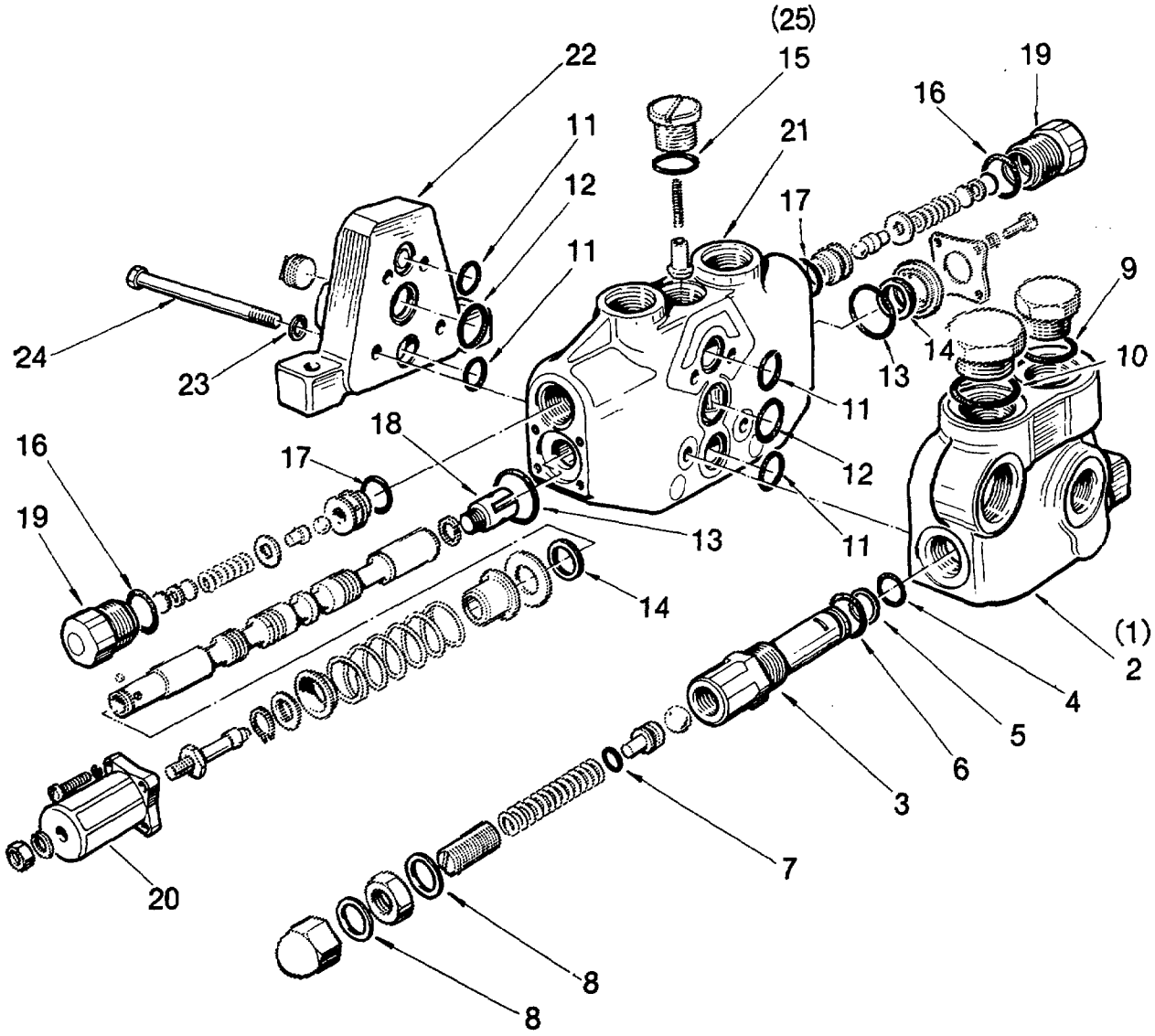
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Steering Valve Assembly 6-5
Steering Pump Assembly 6-6
Steering Relief Valve 6-7
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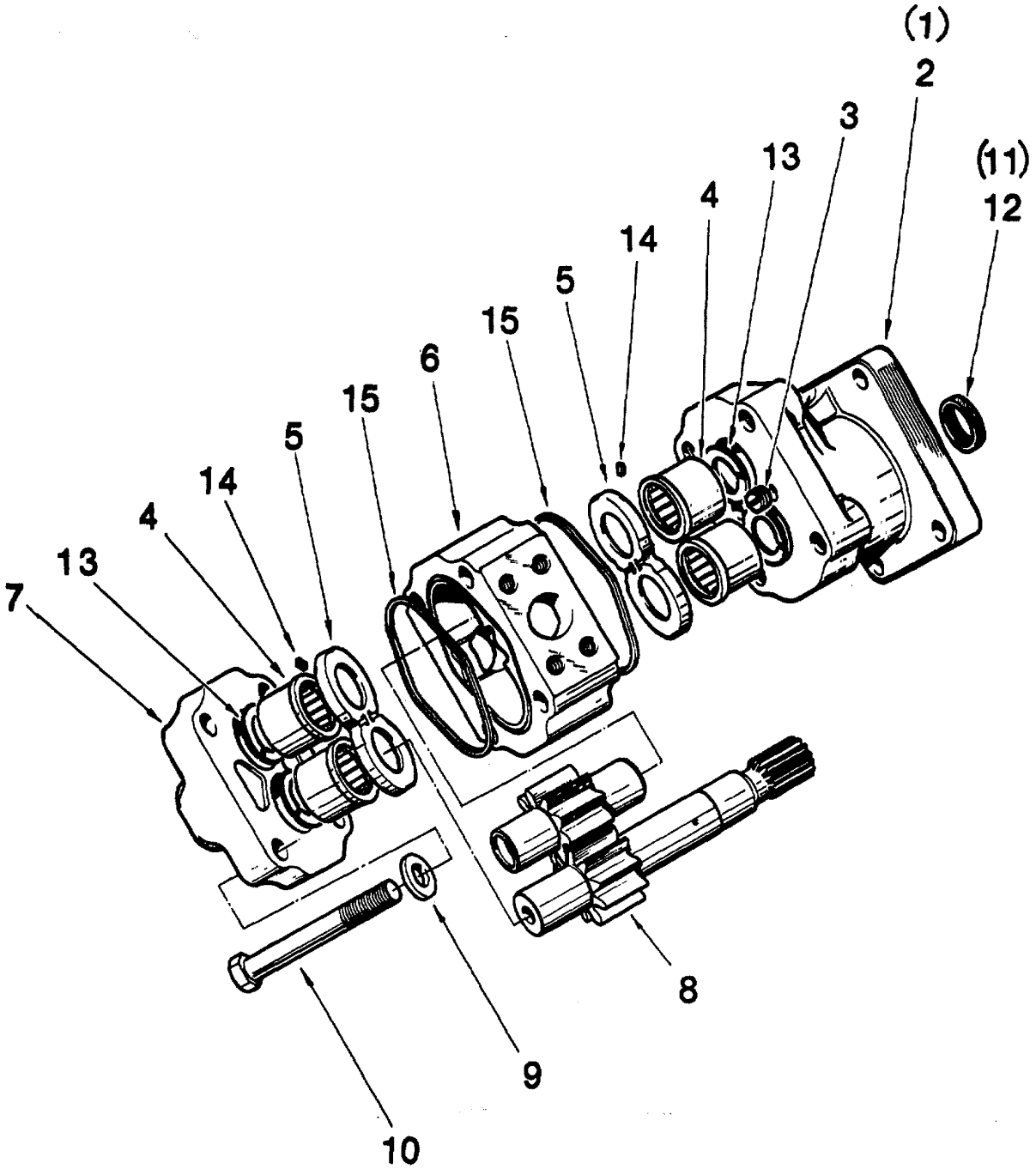
DOZER HYDRAULIC SYSTEM

REF. NO.	DESCRIPTION	QTY.	PART NO.
1	**Gasket,** Dozer Pump	1	3121
2	**Hose Assembly**, Hydraulic Tank to Pump	1	3842
3	**Adapter**	1	1012-20-20
4	**Valve,** Dozer Hydraulic (See Page 6-2 for details)	1	3780
5	**Seal,** O Ring	1	1249-20
6	**Adapter** (includes item 5)	1	1040-20-20
7	**Valve,** Check	1	3846
8	**Elbow**, Adapter (includes item 12)	1	1048-16-16
9	**Hose Assembly**, Valve to Hydraulic Tank	1	2528
10	**Hose Assembly**, Pump to Valve	1	3843
11	**Adapter** (includes item 12)	2	1040-16-16
12	**Seal,** O Ring	3	1249-16
13	**Washer,** Hardened Flat 1/2 Diameter	7	-
14	**Bolt,** 1/2- 13 UNC x 2 Long	3	-
15	**Clamp**	2	2634
16	**Locknut**, Hex 3/8 - 16 UNC	2	-
17	**Hose Assembly**, Valve to Bulkhead	1	3021
18	**Adapter**	3	1012-16-16
19	**Elbow**, Adapter	2	1025-16-16
20	**Hose Assembly**, Dozer Cylinder	2	3022
21	**Cylinder,** Dozer (See Page 6-9 for details)	1	2793
22	**Plug,** 1" NPT Pipe	1	-
23	**Tee,** Adapter	1	3720
24	**Elbow,** Adapter	2	1037-16-16
25	**Swivel,** Adapter	2	216F-316M
26	**Hose Assembly**, Valve to Bulkhead	1	3020
27	**Protector**, Hose	2	2363
28	**Bolt,** Hex 3/8 - 16 UNC x 1-1/4 Long	4	-
29	**Lockwasher**, Spring 3/8 Diameter	4	-
30	**Flange**, Split	2	2550-16
31	**Bolt,** Hex 1/2 - 13 UNC x 1-1/4 Long	4	-
32	**Pump,** Dozer (See Page 6-3 for details)	1	3766
33	**Bolt**, Hex 7/16 - 14 UNC x 1-1/4 Long	4	-
34	**Lockwashe**r, Spring 7/16 Diameter	4	-
35	**Flange**, Split	2	2550-20
36	**Seal,** O Ring	1	1248-219
37	**Seal,** O Ring	1	1248-222
38	**Adapter**	1	1025-20-20


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DOZER VALVE

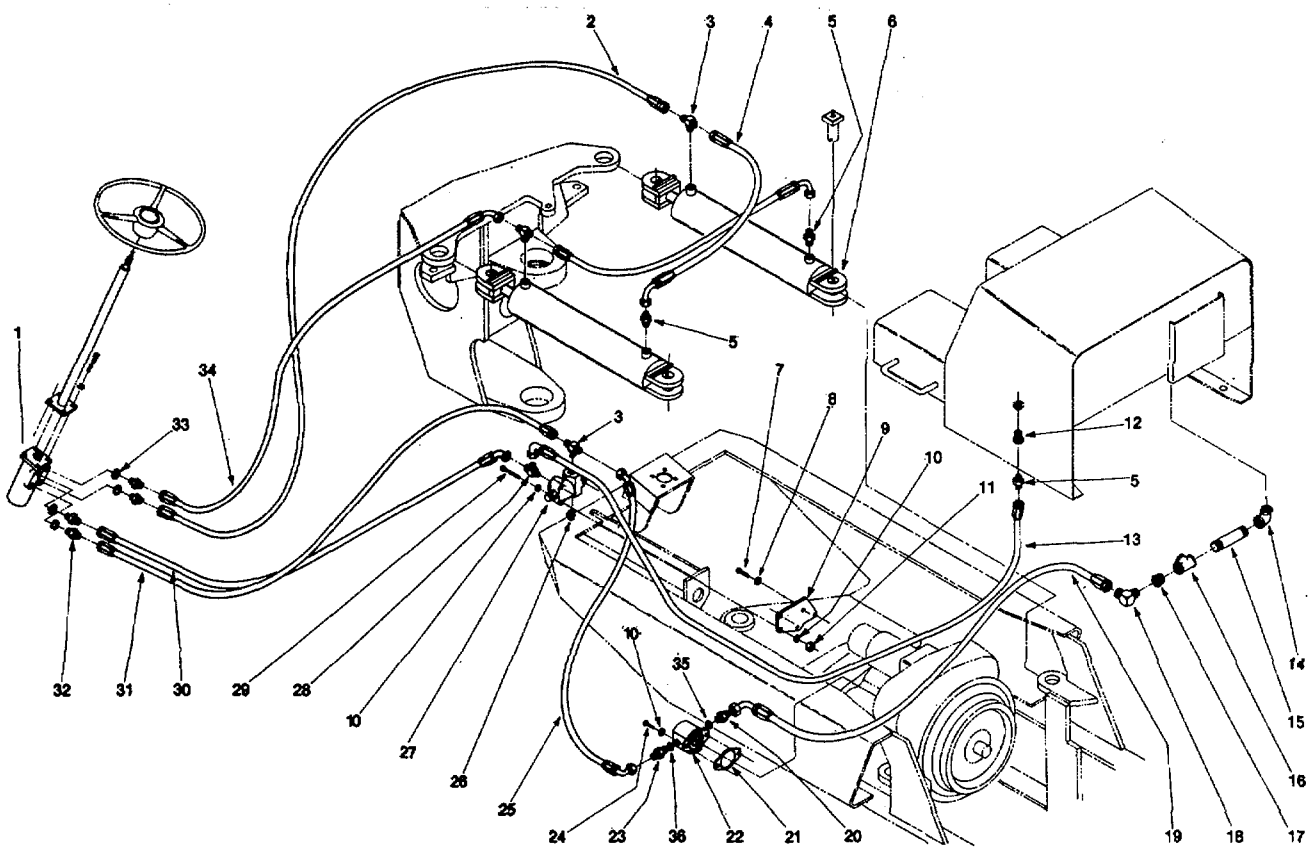
REF. NO.	DESCRIPTION	QTY	PART NO.
1	**Valve** Assembly, Dozer (includes items 2 to 25)	1	3780
2	**Sections Assembly**, Relief (includes items 3 to 10)	1	3626
3	**Relief Assembly**, Main (includes items 4 to 8)	1	3881
4	**Seal,** Relief	1	4379
5	**Washer**, Relief Back Up	1	4380
6	**Seal,** Relief Body	1	4375
7	**Seal**, Ball Guide	1	3885
8	**Washe**r, Screw Seal	2	3886
9	**Seal**, No. 16 Plug	1	3887
10	**Seal**, No. 20 Plug	1	3888
11	**Seal,** Small Section	4	3787
12	**Seal,** Large Section	2	3788
13	**Seal**, Outer Spool	2	3889
14	**Seal,** Quad Spool	2	3781
15	**Seal**, Check Plug	1	4375
16	**Seal,** Port Relief, Body	2	3890
17	**Seal**, Port Relief, Seat	2	3891
18	**Yoke**, Spool	1	3633
19	**Relief Assembly**, Cylinder Port (includes items 16 and 17)	1	3882
20	**Bonnet,** Float Positioner	1	3883
21	**Section Assembly**, Float (includes items 13 to 20)	1	3628
22	**Cover Assembly**, Right	1	3629
23	**Lockwashe**r	4	3632
24	**Bolt,** Hex Head	4	3884
25	**Seal Kit,** Valve (includes items 4 to 17)	1	3830


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DOZER PUMP

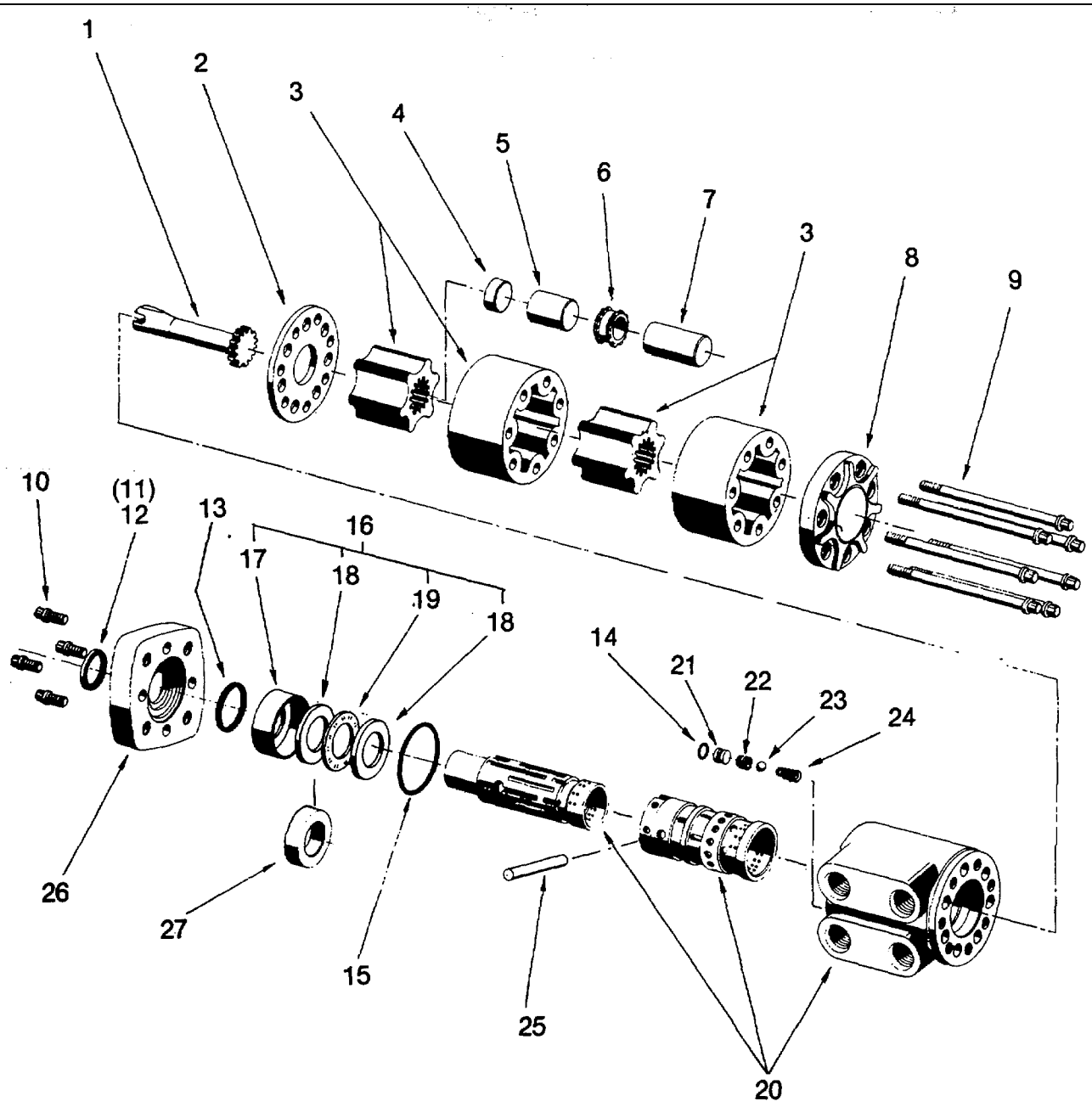
REF. NO	DESCRIPTION	OTY.	PART NO.
1	**Pump Assembly**, Dozer Hydraulic (includes Items 2 to 15)	1	3766
2	**Cover**, Shaft End	1	3611
3	**Plug,** Port	1	3816
4	**Bearing**, Roller	4	3613
5	**Plate,** Thrust	2	3617
6	**Housing**, Gear	1	3767
7	**Cover**, Port End	1	3620
8	**Gear and Shaft Set**	1	3768
9	**Washe**r	4	3622
10	**Screw**, Mounting	4	3769
11	**Seal Kit**, Pump (includes Items 11 to 15)	1	3815
12	**Seal**, Shaft Lip	1	3610
13	**Seal**, Ring	4	3619
14	**Seal Strip**, Pocket (consists of 12 Pocket Seals)	1	3618
15	**Seal**, Gasket	2	3614

STEERING HYDRAULIC SYSTEM



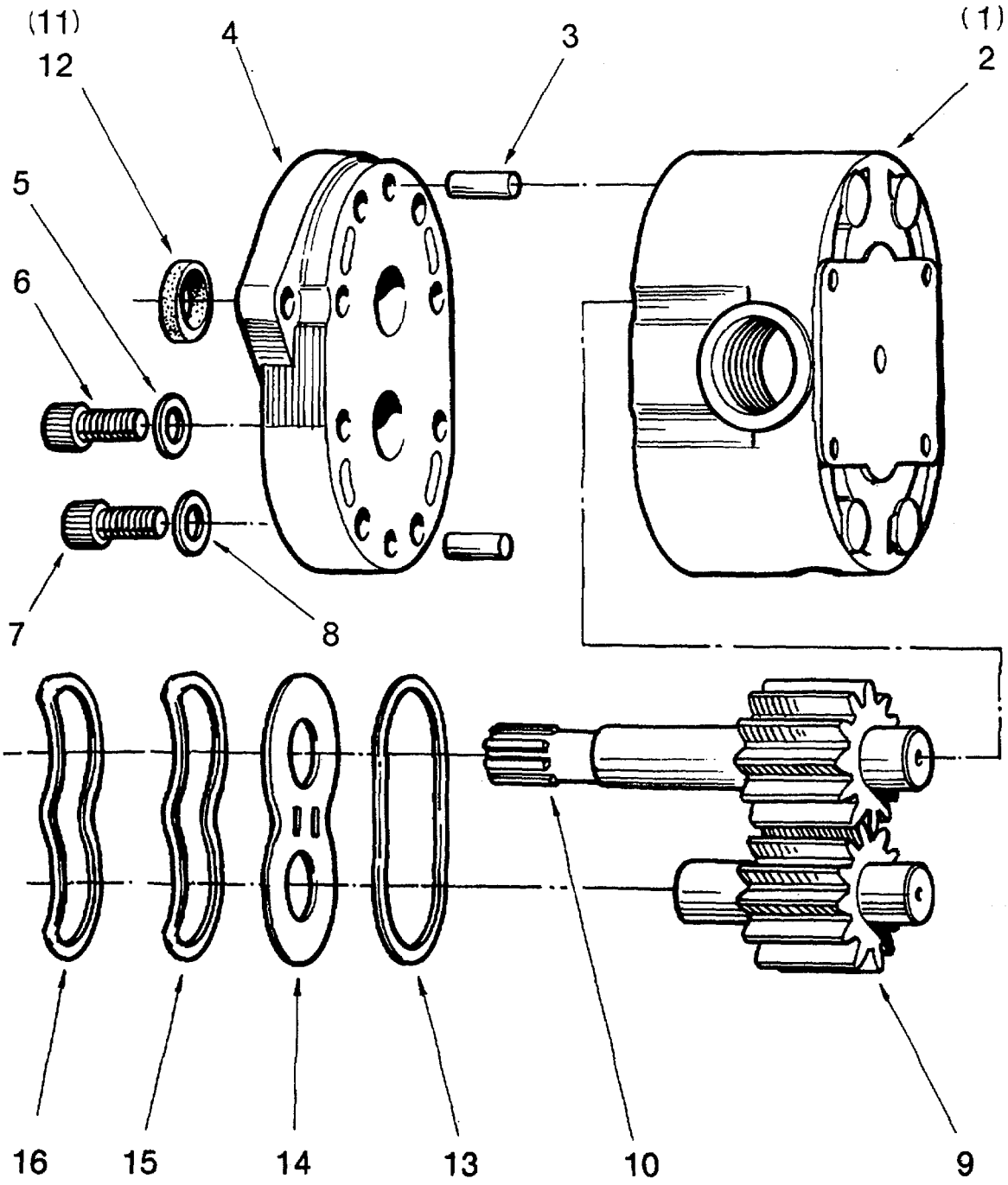
STEERING HYDRAULIC SYSTEM

REF. NO.	DESCRIPTION	QTY.	PART NO.
1	**Valve Assembly**, Steering (See Page 6-5 for details)	1	4203
2	**Hose Assembly**, Valve to Cylinder	1	4208
3	**Tee,** Adapter	3	1033-12-104
4	**Hose Assembly**, Cylinder Cross Over	2	4210
5	**Adapter**	3	1012-12-10
6	**Cylinder Assembly**, Steering (See Page 6-8 for details)	2	4122
7	**Bolt**, Hex 7/16 - 14 UNC x 1-3/4 Long	2	
8	**Washer,** Hardened Flat 7/16 Diameter	2	
9	**Bracket**, Relief Valve Mounting	1	3791
10	**Washer**, Hardened Flat 3/8 Diameter	8	
11	**Locknu**t, Hex 3/8 -16 UNC	3	-
12	**Valve,** Check	1	3845
13	**Hose Assembly**, Relief to Tank	1	4207
14	**Elbow,** Pipe 1-1/4 NPT x 90	1	
15	**Nipple**, Pipe 1-1/4 NPT x 6 Long	1	4206
16	**Tee,** Pipe 1-1/4 NPT	1	
17	**Reducer**	1	1093-20-16
18	**Elbow**, Adapter	1	1025-16-16
19	**Hose Assembly**, Tank to Pump	1	4211
20	**Adapter** (includes item 35)	1	1040-12-16
21	**Gasket**, Steering Pump	1	4223
22	**Pump Assembly**, Steering (See Page 6-6 for details	1	3910
23	**Adapter** (includes item 36)	1	1040-10-10
24	**Bolt**, Hex 3/8 - 16 UNC x 1-1/4 Long	2	
25	**Hose Assembly**, Pump to Relief	1	4204
26	**Plug**, Pipe 3/4 NPT	1	
27	**Valve Assembly**, Steering Relief (See Page 6-7 for details)	1	4202
28	**Tee**, Adapter	1	1032-12-10
29	**Bolt**, Hex 3/8 -16 UNC x 2-1/4 Long	3	
30	**Hose Assembly**, Relief to Valve	1	4224
31	**Hose Assembly**, Valve to Relief	1	4205
32	**Adapte**r(includes item 33)	4	1040-8-10
33	**Seal,** O Ring	4	1249-8
34	**Hose Assembly**, Valve to Cylinder	1	4209
35	**Seal,** O Ring	1	1249-12
36	**Sea**l, O Ring	1	1249-10


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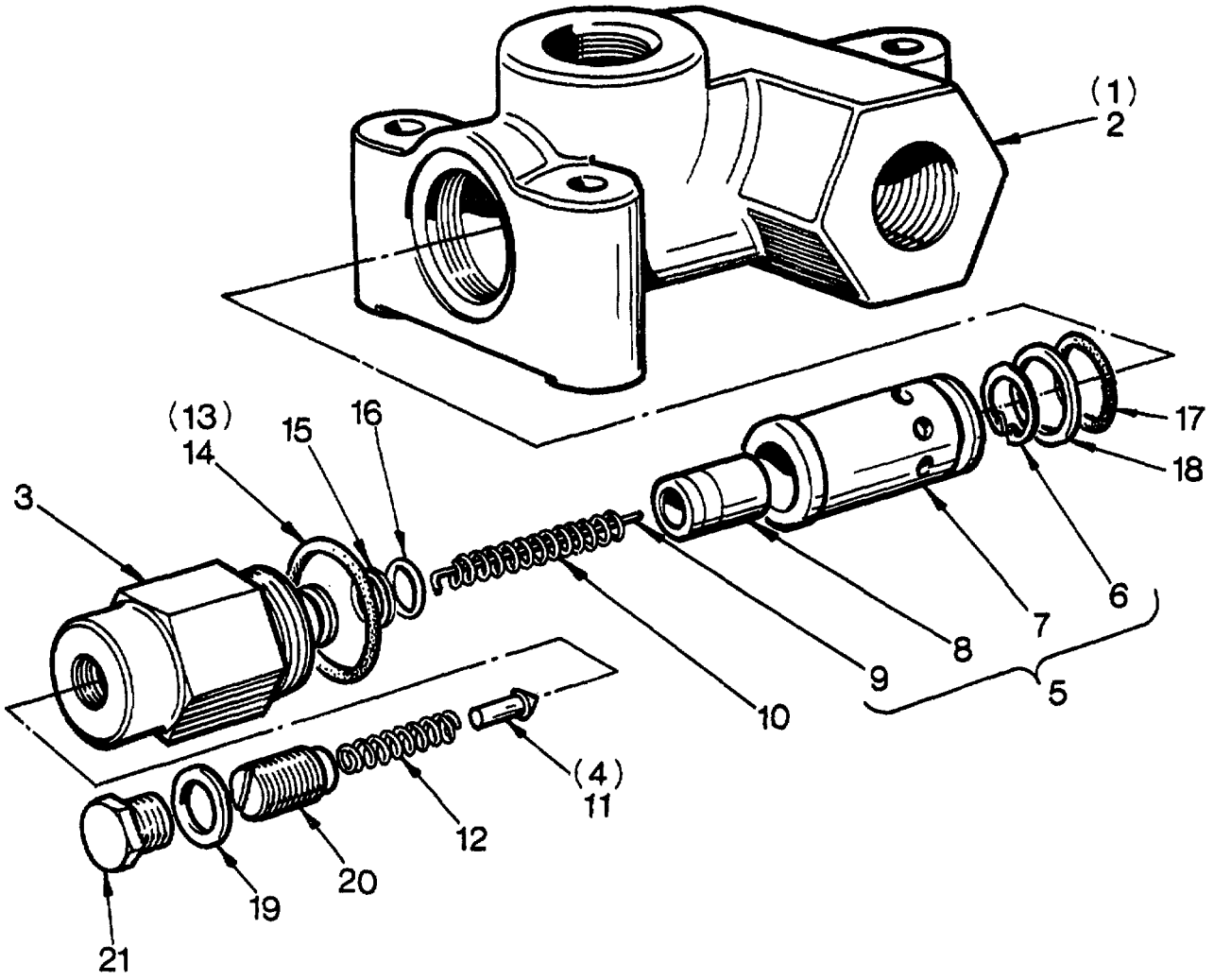
STEERING VALVE

REF. NO.	DESCRIPTION	QTY.	PART NO.
1	**Drive,** Steering Valve	1	4282
2	**Plate,** Valve	1	4283
3	**Gerotor** Set	2	4284
4	**Spacer,** Gerotor	1	4285
5	**Spacer,** Gerotor	1	4286
6	**Spline**, Gerotor	1	4287
7	**Spacer**, Gerotor	1	4288
8	**Cap**, End	1	4289
9	**Screw**, Cap	7	4290
10	**Screw**, Cap	4	4291
11	**Seal Kit** (includes items 12 to 15)	1	4292
12	**Seal**, Oil	1	4360
13	**Seal**, Quad Ring	1	4361
14	**Seal**, O Ring	1	4362
15	**Seal,** O Ring	1	4363
16	**Bearing Kit** (includes items 17 to 19)	1	4295
17	**Locator**, Bearing	1	4296
18	**Race,** Bearing	2	4297
19	**Bearing**, Needle Thrust	1	4298
20	**Control Assembly** (includes items 14, 21 to 25)	1	4299
21	**Plug**, Seal	1	4300
22	**Seat,** Check	1	4301
23	**Ball,** Steel	1	4302
24	**Spring**, Compression	1	4303
25	**Pin**, Centering	1	4304
26	**Plate**, Valve Housing Mounting	1	4293
27	**Bushing,** Cap Locator	1	4294


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STEERING PUMP

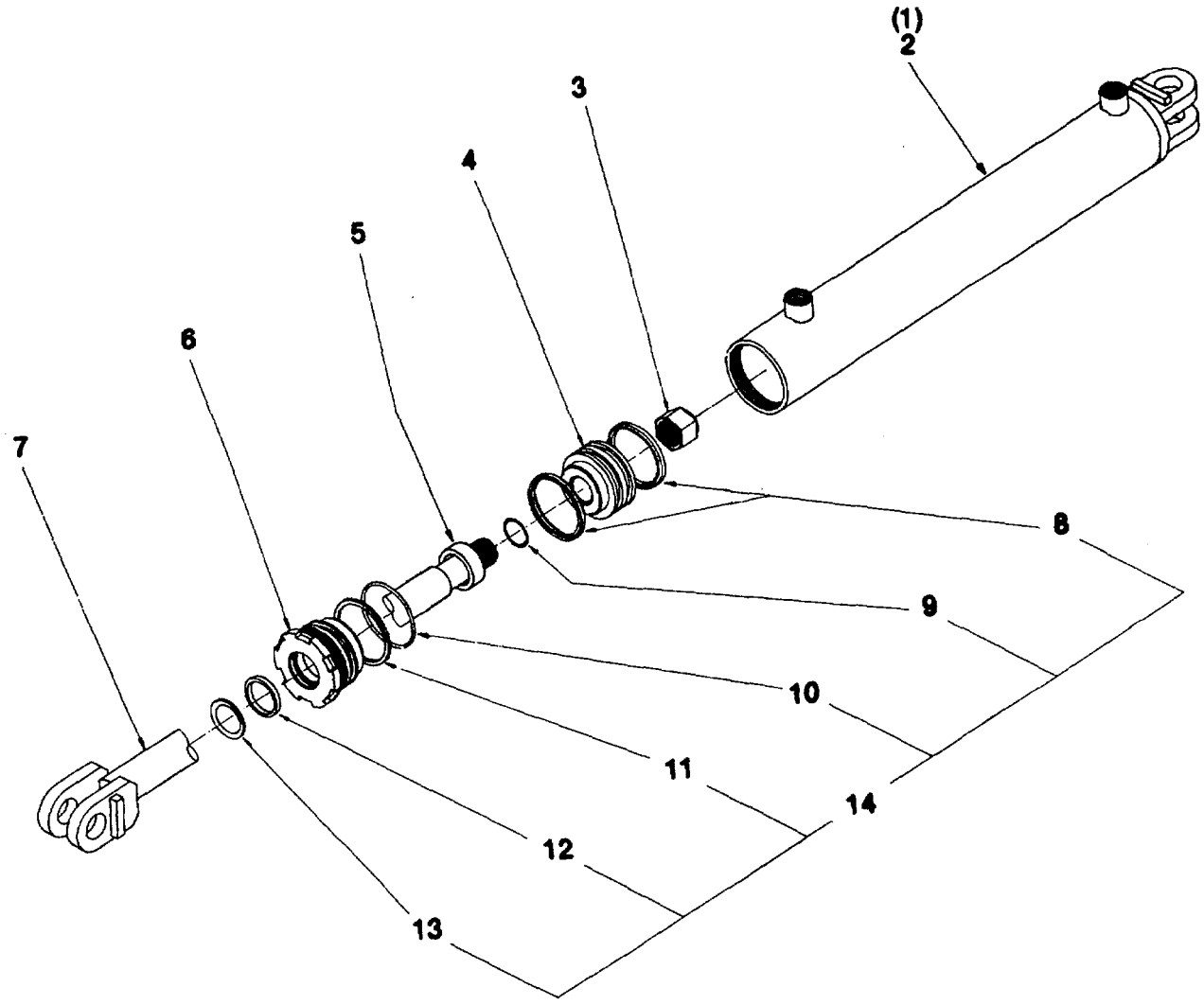
REF. NO.	DESCRIPTION	QTY.	PART NO.
1	**Pump Assembly**, Steering (includes items 2 to 16)	1	3910
2	**Body,** Steering Pump	1	3911
3	**Pin**, Dowel	2	3912
4	**Cover,** Front	1	3913
5	**Washer,** 3/8 Diameter	4	3914
6	**Screw,** Socket Head 3/8 - 16 UNC x 1 /2 Long	4	-
7	**Screw**, Socket Head 5/16 - 18 UNC x 1/4 Long	4	-
8	**Washer**, 5/16 Diameter	4	3915
9	**Gear,** Driven	1	3916
10	**Gear and Shaft**, Drive	1	3917
11	**Seal Kit** (includes items 12 to 16)	1	3919
12	**Seal**, Shaft	1	3921
13	**Seal**, Body	1	3920
14	**Plate**, Wear	1	3923
15	**Seal**, Wear Plate	1	3918
16	**Seal,** Rubber	1	3922


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STEERING RELIEF VALVE

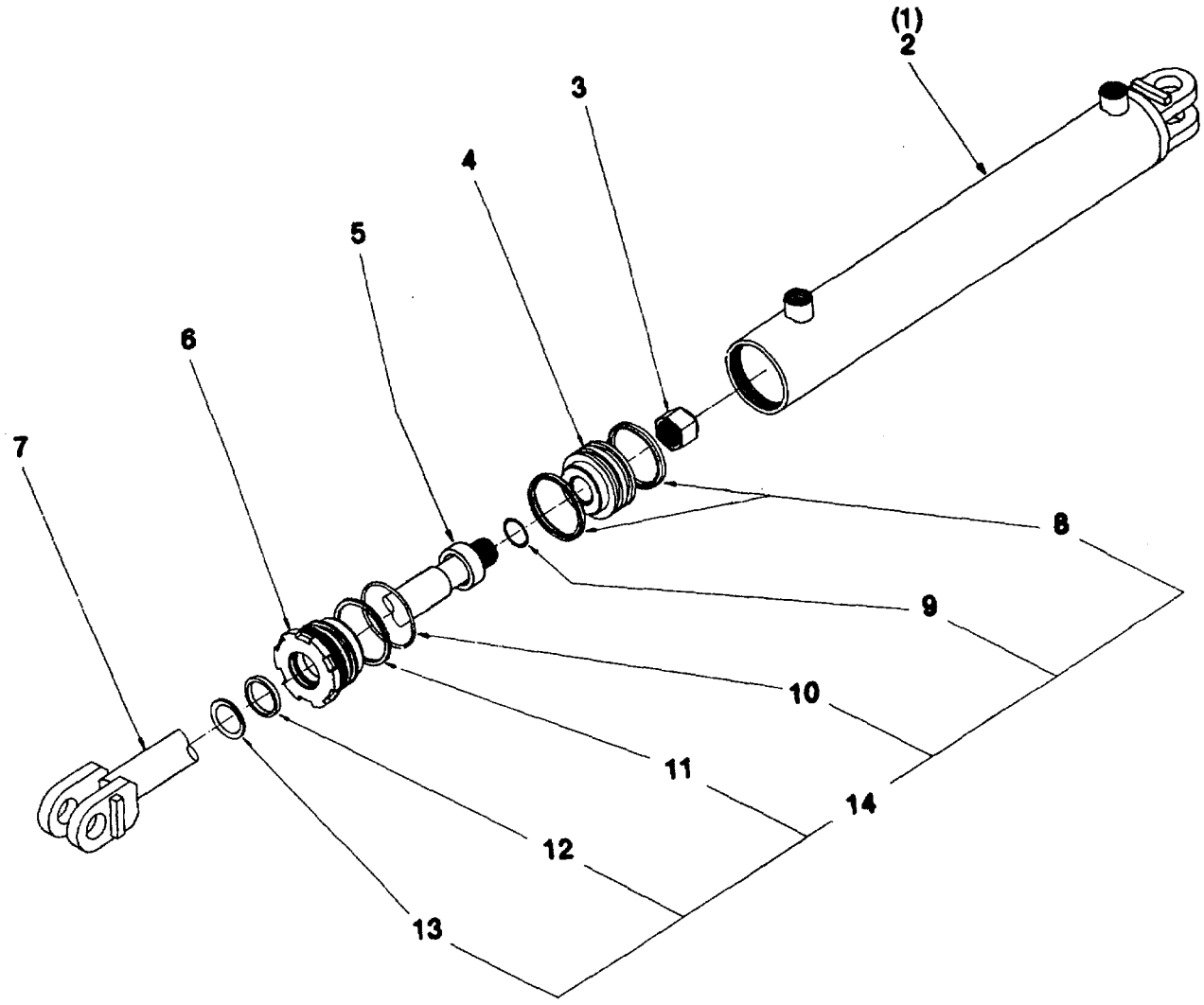
REF. NO.	DESCRIPTION	QTY.	PART NO.
I	**Valve Assembly**, Steering Relief (includes items 2 to 21)	1	4202
2	**Housing**, Steering Relief Valve	1	4381
3	**Bod**y, Relief Valve	1	4313
4	**Kit**, Valve Rebuilding (includes Items 5 to 19)	1	4314
5	**Kit,** Piston and Cylinder (includes items 6 to 9)	1	4317
6	**Ring**, Retaining	1	4385
7	**Cylinder**	1	4383*
8	**Piston**	1	4384*
9	Pin, Wire	1	4386
10	**Spring**, Piston	1	4318
11	**Poppet**	1	4319
12	**Spring**, Pilot	1	4316
13	**Seal Kit** (includes items 14 to 19)	1	4315
14	**Seal**, Relief Body	1	4375
15	**Washer**, Back Up	1	4376
16	**Seal**, Body	1	4374
17	**Seal**, Relief Body	1	4379
18	**Washe**r, Back Up	1	4380
19	**Gaske**t, Cap	1	4382
20	**Screw**, Adjusting	1	4320
21	**Cap**	1	4311

*** Note**: Piston 4384 and Cylinder 4383 are sold only in matched sets.


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STEERING CYLINDER

REF. NO.	DESCRIPTION	QTY.	PART NO.
1	**Cylinder Assembly**, Steering (includes items 2 to 14)	1	4122
2	**Tube and Base Assembly**	1	4276
3	**Locknut,** Piston	1	4278
4	**Piston**, Cylinder	1	4279
5	**Tube,** Stop	1	4281
6	**Head**, Cylinder .	1	4280
7	**Rod Assembly**, Piston.	1	4277
8	**Seal,** Piston	2	3807
9	**Seal**, Piston Rod	1	3808
10	**Seal**, Head Tube.	1	3809
11	**Washer**, Head Tube	1	3810
12	**Seal,** Rod .	1	3811
13	**Wiper**, Rod .	1	3812
14	**Seal Kit** (includes items 8 to 13) .	1	4118


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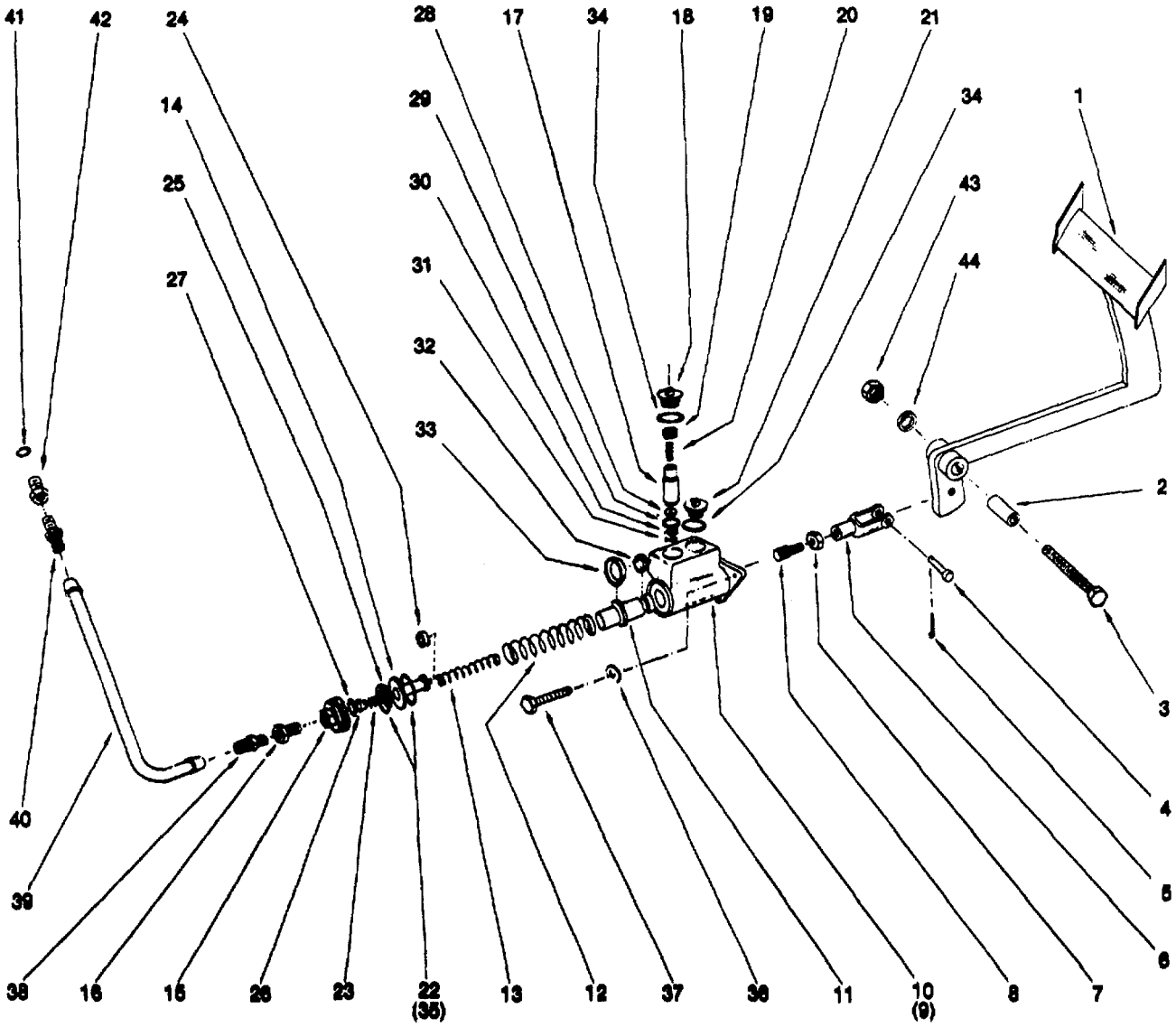
DOZER CYLINDER

REF. NO.	DESCRIPTION	QTY.	PART NO.
1	**Cylinder Assembly**, Dozer (includes items 2 to 13)	1	2793
2	**Tube and Base Assembly**	1	2165
3	**Locknu**t, Piston	1	2167
4	**Piston**, Cylinder	1	2159
5	**Head**, Cylinder	1	2160
6	**Rod Assembly**, Piston .	1	2158
7	**Seal**, Piston	2	3801
8	**Seal**, Piston Rod	1	3802
9	**Seal,** Head Tube	1	3803
10	**Washer**, Head Tube	1	3804
11	**Seal,** Rod	1	3805
12	**Wiper**, Rod	1	3806
13	**Seal Kit** (includes items 7 to 12)	1	2119

CONTROLS SECTION

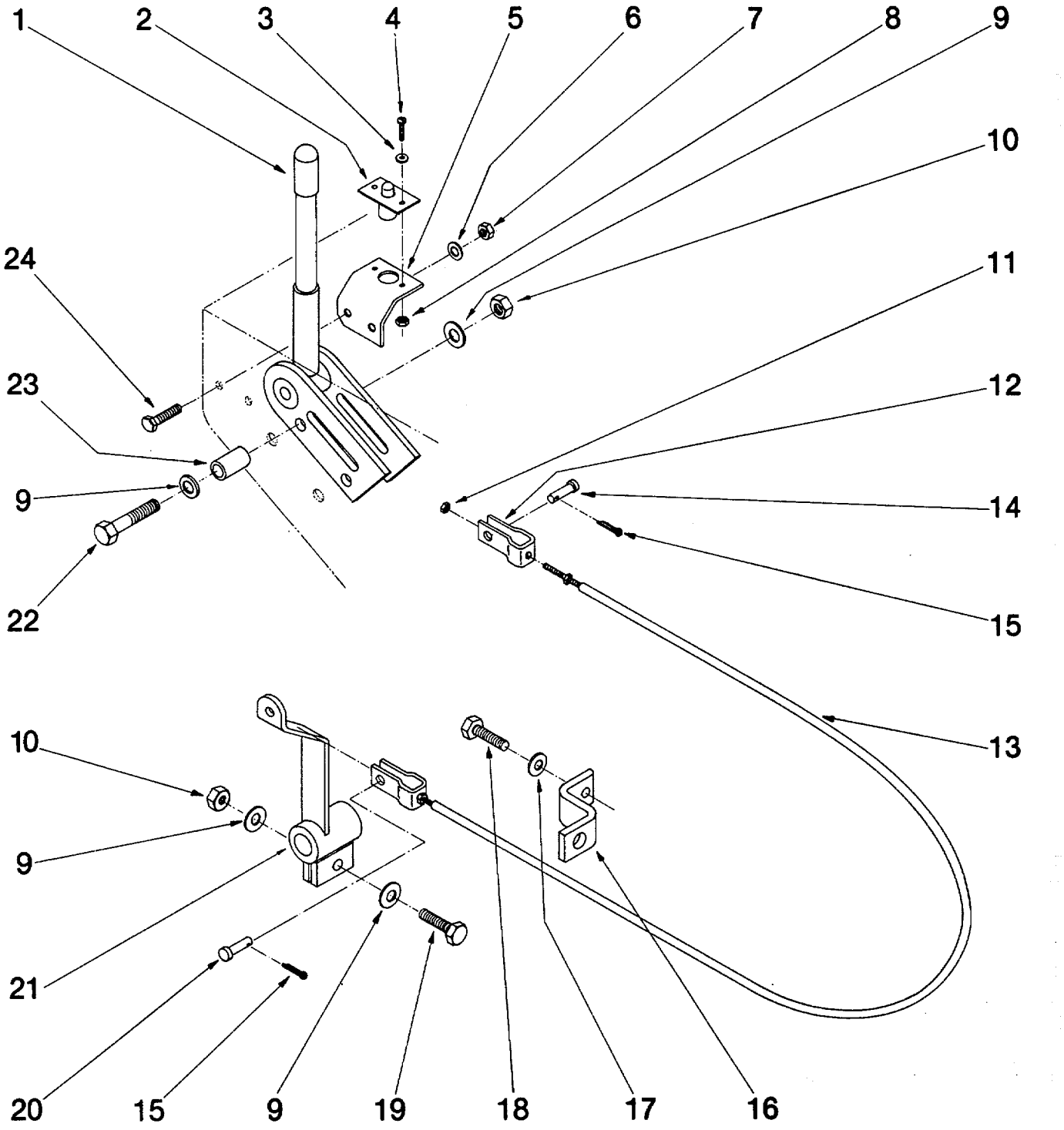
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Steering Control 7-4
Throttle Control..... 7-5
Transmission Control 7-6


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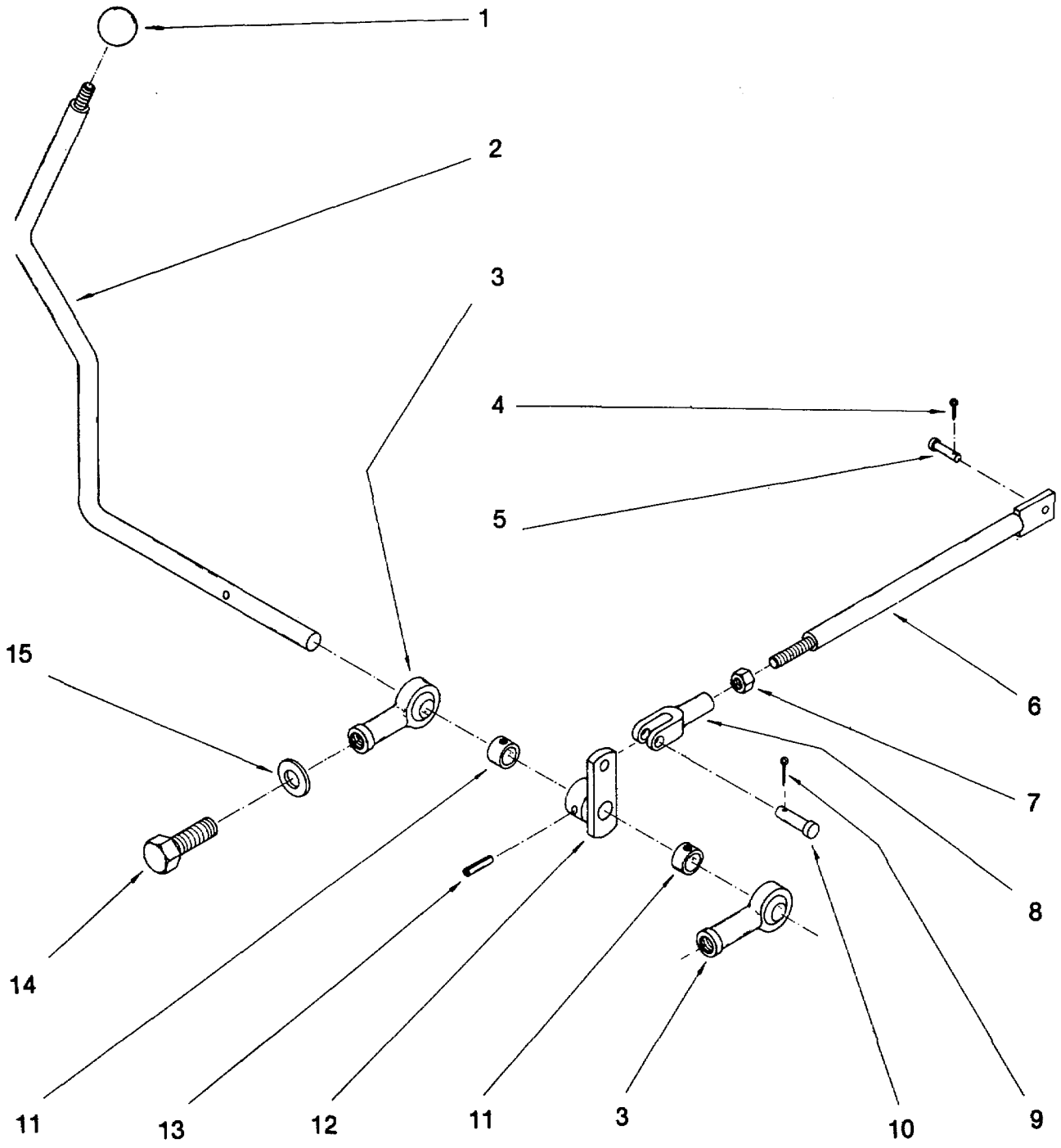
BRAKE CONTROL

REF. NO.	DESCRIPTION	QTY.	PART NO.
1	**Pedal,** Brake	1	2638
2	**Bushing,** Pedal	1	1480
3	**Bolt,** Hex 1/2 -13 UNC x 3 Long	1	---
4	**Pin,** Clevis	1	3231
5	**Pin,** Cotter 3/32 x 3/4 Long	1	---
6	**Yoke,** Clevis	1	1869
7	**Nut,** Hex 3/8 - 24 UNF	1	---
8	**Stud,** Brake Cylinder	1	2069
9	**Cylinder Assembly,** Master Brake (includes items 10 to 34)	1	2088
10	**Housing,** Cylinder	1	3721
11	**Piston,** Low Pressure	1	3722
12	**Spring,** Secondary Return	1	3723
13	**Spring,** Primary Return	1	3724
14	**Piston,** High Pressure	1	3725
15	**Plug,** End	1	3726
16	**Fitting,** Brake	1	2731
17	**Piston Assembly,** Relief Valve	1	3728
18	**Plug,** Filler	1	2729
19	**Screw,** Relief Valve Adjusting	1	3730
20	**Spring,** Relief Valve	1	3731
21	**Plug Assembly,** Filler	1	3732
22	**Gasket,** End Plug	2	3733
23	**Spring,** Check Valve	1	3734
24	**Cup,** High Pressure	1	3735
25	**Seal,** End Plug	1	3736
26	**Valve,** Check	1	3737
27	**Seat,** Check Valve	1	3738
28	**Disc,** Relief Valve Check	1	3739
29	**Gasket,** Relief Valve	1	3740
30	**Spring,** Check Disc	1	3741
31	**Pin,** Disc Spring Cotter	1	3742
32	**Cup,** Secondary	1	3743
33	**Cup,** Low Pressure	1	3727
34	**Gasket,** Filler Plug	2	3729
35	**Kit,** Cylinder Repair (Includes Items 22 to 34)	1	2281
36	**Washer,** Hardened Flat 3/8 Diameter	3	---
37	**Bolt,** Hex 3/8 - 16 UNC x 1 Long	3	---
38	**Adapter**	1	1018-5-5
39	**Hose,** Brake	1	2562
40	**Adapter**	1	1012-4-5
41	**Seal, O Ring**	1	1249-6
42	**Adapter**	1	1015-4-6
43	**Locknut,** Hex 1/2 - 13 UNC	1	---
44	**Washer,** Hardened Flat 1/2 Diameter	2	---


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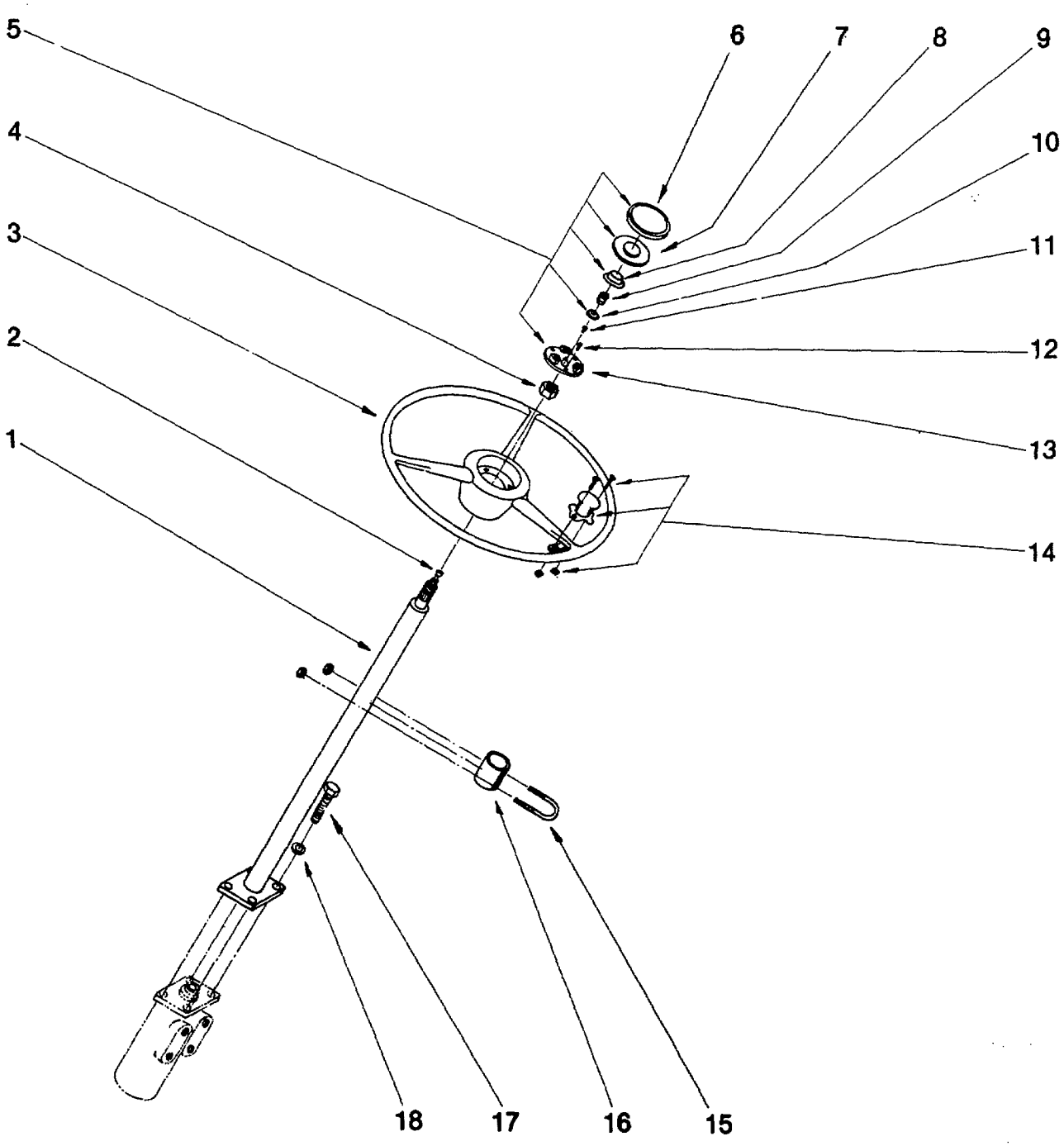
PARKING BRAKE CONTROL

REF. NO.	DESCRIPTION	QTY.	PART NO.
1	**Lever,** Parking Brake (includes item 14)	1	2057
2	**Switch,** Hand Brake	1	3441
3	**Lockwasher,** External Tooth No. 6 Diameter	4	---
4	**Screw,** Round Head No. 6 - 32 UNC x 3/4 Long	2	---
5	**Bracket,** Hand Brake Switch	1	3421
6	**Washer,** Hardened Flat 1 4 Diameter	4	---
7	**Locknut,** Hex 1/4- 20 UNC	2	---
8	**Nut,** Hex No. 6 - 32 UNC	2	---
9	**Washer,** Hardened Flat 3/8 Diameter	6	---
10	**Locknut,** Hex 3/8 -16 UNC	3	---
11	**Nut,** Hex 1/4- 28 UNF	4	---
12	**Yoke,** Cable Clevis	2	3648
13	**Cable,** Parking Brake (includes items 11 and 12)	1	2058
14	**Pin,** Clevis	1	3813
15	**Pin,** Cotter 3/32 x 3/4 Long	2	---
16	**Bracket,** Cable	1	3493
17	**Washer,** Hardened Flat 7/16 Diameter	1	---
18	**Bolt,** Hex 7/16 -14 UNC x 1-3/4 Long	1	---
19	**Bolt,** Hex 3/8 - 16 UNC x 1-1/2 Long	1	---
20	**Pin,** Clevis	1	3161
21	**Sub-Lever,** Brake	1	3492
22	**Bolt,** Hex 3/8 -16 UNC x 3 Long	2	---
23	**Spacer**	4	2353
24	**Bolt,** Hex 1/4 - 20 UNC x 1 Long	2	---


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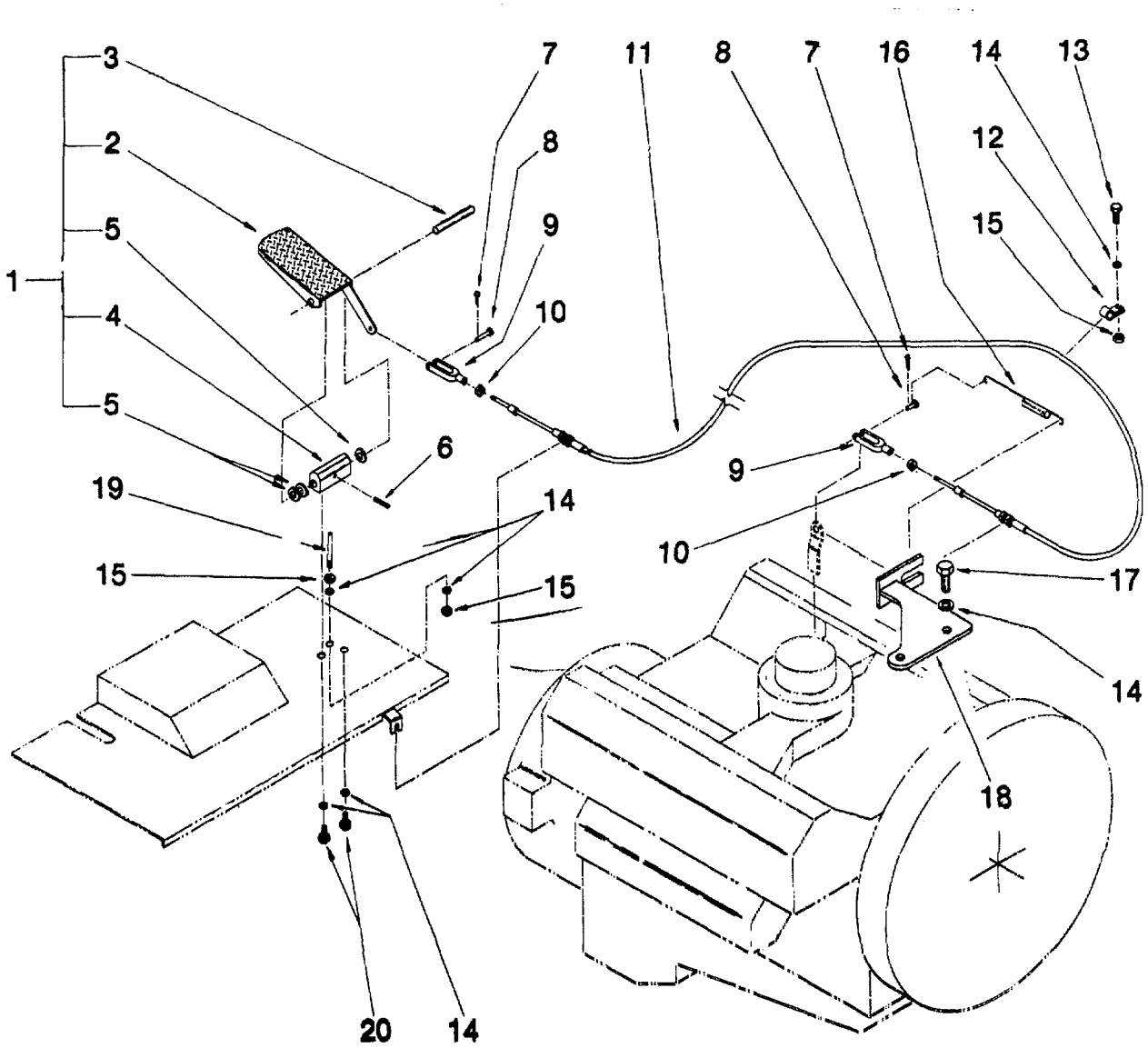
DOZER CONTROL

REF. NO.	DESCRIPTION	QTY.	PART NO.
1	**Knob,** Shift Hand	1	1222
2	**Lever,** Dozer Control	1	2994
3	**Joint,** Ball	2	1207
4	**Pin,** Cotter 1/16 x 1/2 Long	1	---
5	**Pin,** Clevis	1	3230
6	**Pushrod,** Dozer Valve	1	2423
7	**Nut,** Hex 3/8 - 24 UNF	1	---
8	**Yoke,** Clevis	1	1869
9	**Pin,** Cotter 3/32 x 3/4 Long	1	---
10	**Pin,** Clevis	1	3231
11	**Collar,** Shaft	2	1208
12	**Lever Weldment,** Dozer Control	1	2997
13	**Pin,** Roll 1/4 x 1-1/4 Long	1	---
14	**Bolt,** Hex 5/8 -18 UNF x 1-1/4 Long	2	---
15	**Washer,** Hardened Flat 5/8 Diameter	2	---


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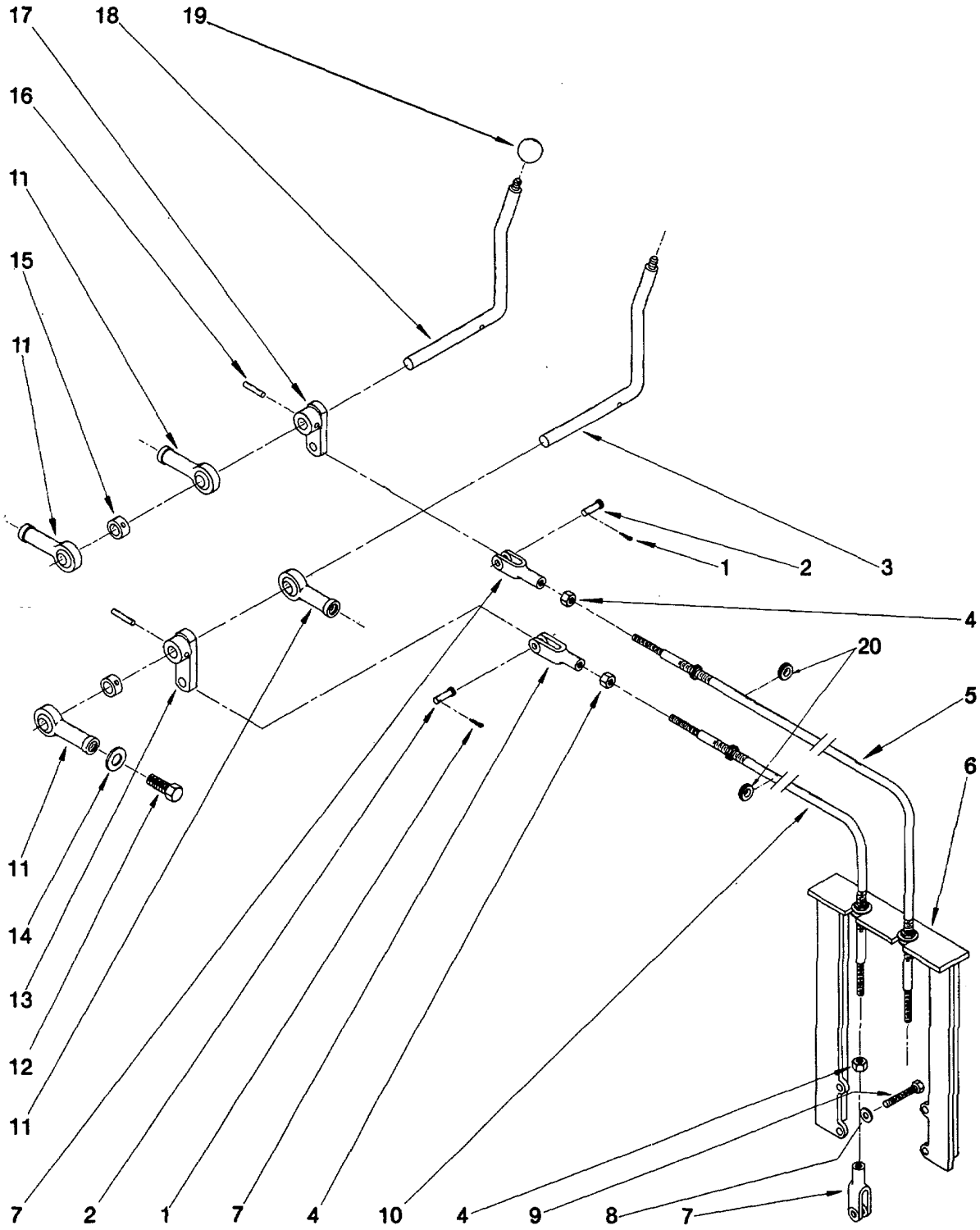
STEERING CONTROL

REF. NO.	DESCRIPTION	QTY.	PART NO.
1	**Column,** Steering (includes item 2)	1	4215
2	**Cable,** Horn Button	1	4349
3	**Wheel,** Steering	1	4216
4	**Nut,** Steering Wheel	1	4218
5	**Kit,** Horn Button (includes items 6 to 13)	1	4217
6	**Cover,** Horn Button	1	4391
7	**Button,** Horn	1	4390
8	**Contact,** Horn	1	4389
9	**Spring,** Contact	1	4392
10	**Retainer,** Spring	1	4388
11	**Spacer,** Contact	1	4393
12	**Screw,** Horn Button	3	4394
13	**Plate,** Striker	1	4387
14	**Spinner Assembly,** Wheel	1	2091
15	**Clamp,** Column	1	2689
16	**Sleeve,** Column	1	2379
17	**Bolt,** Hex 3/8 - 16 UNC x 1-1/2 Long	4	---
18	**Washer,** Hardened Flat 3/8 Diameter	4	---


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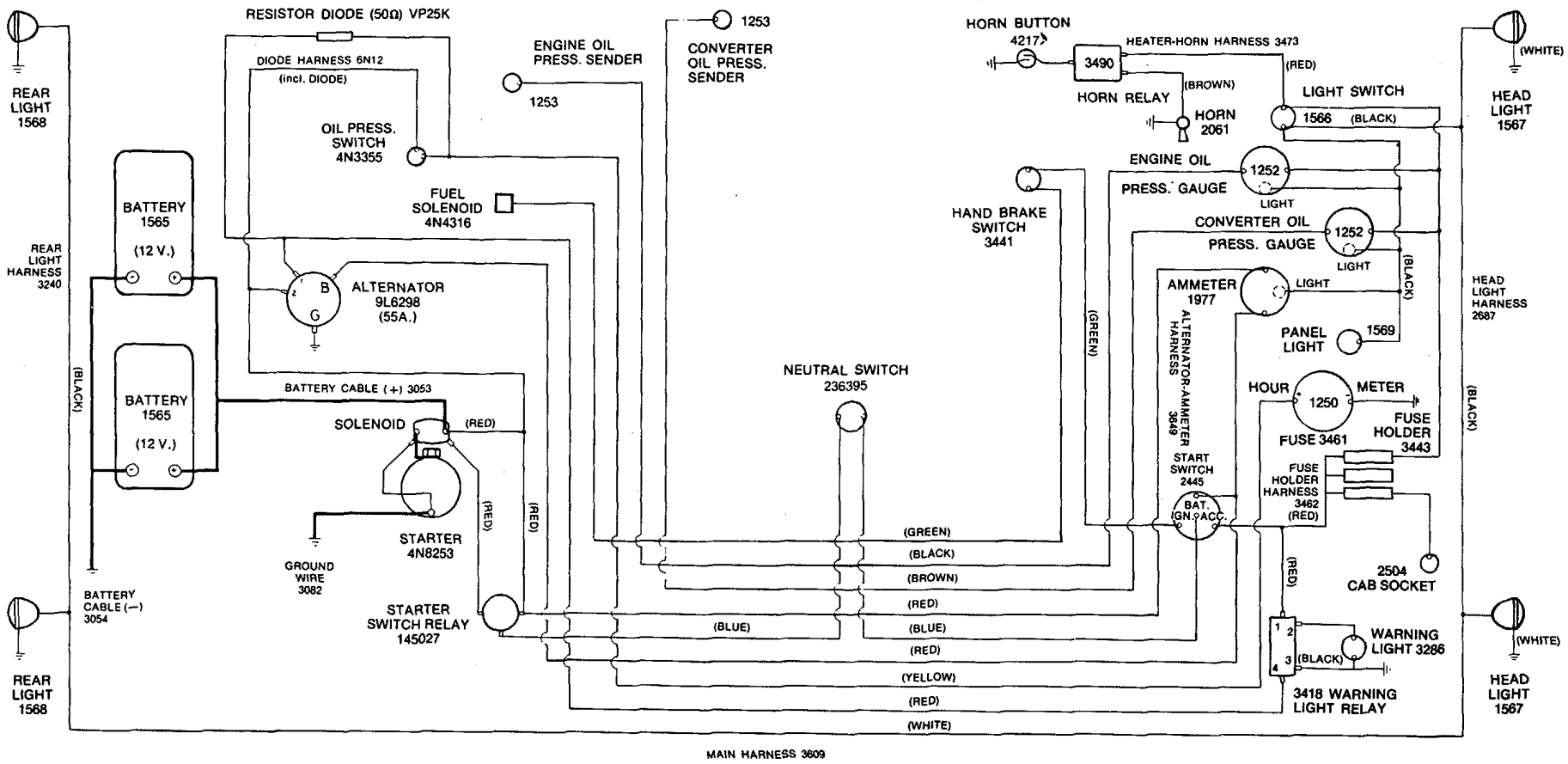
THROTTLE CONTROL

REF. NO.	DESCRIPTION	QTY.	PART NO.
1	**Pedal Assembly** (includes Items 2 to 6)	1	3135
2	**Pedal Weldment,** Throttle	1	3136
3	**Pin,** Pedal Pivot	1	3137
4	**Block,** Hinge	1	1285
5	**Washer,** Hardened Flat 1/2 Diameter	3	---
6	**Pin,** Roll 3/16 x 1 Long	1	---
7	**Pin,** Cotter 1/16 x 1/2 Long	2	---
8	**Pin,** Clevis	2	3132
9	**Yoke,** Clevis	2	3131
10	**Nut,** Hex No. 10 - 32 UNF	2	---
11	**Cable,** Throttle	1	3130
12	**Clamp,** Cable	3	2628-19
13	**Bolt,** Hex 3/8 -16 UNC x 1 Long	3	---
14	**Washer,** Hardened Flat 3/8 Diameter	12	---
15	**Locknut,** Hex 318 -16 UNC	5	---
16	**Spring,** Throttle Return	1	1966
17	**Bolt,** Hex 3/8 - 16 UNC x 1 ¼ Long	2	---
18	**Bracket,** Throttle Cable	1	3541
19	**Stop,** Pedal	1	3086
20	**Bolt,** Hex 3/8 - 16 UNC x 3/4 Long	2	---


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TRANSMISSION CONTROL

REF. NO.	DESCRIPTION	QTY.	PART NO.
1	**Pin,** Cotter 3/32 x 3/4 Long	4	
2	**Pin,** Clevis	4	3161
3	**Lever,** Speed Shift	1	2992
4	**Nut,** Hex 1/4 - 28 UNF	4	---
5	**Cable,** F-R Control	1	2420
6	**Bracket,** Transmission Cable	1	2725
7	**Yoke,** Clevis	4	2668
8	**Washer,** Hardened Flat 3/8 Diameter	4	---
9	**Bolt,** Hex 3/8 -16 UNC x 2-1/4 Long	4	---
10	**Cable,** Speed Control	1	2421
11	**Joint,** Ball	4	1207
12	**Bolt,** Hex 5/8 18 UNF x 1-1/4 Long	4	---
13	**Lever Weldment,** Speed	1	2996
14	**Washer,** Hardened Flat 5/8 Diameter	4	---
15	**Collar,** Shaft	2	1208
16	**Pin,** Roll 1/4 x 1-1/4 Long	2	---
17	**Lever Weldment,** F-R	1	2995
18	**Lever,** F-R Shift	1	2993
19	**Knob,** Hand	2	1222
20	**Grommet,** Rubber	2	3848

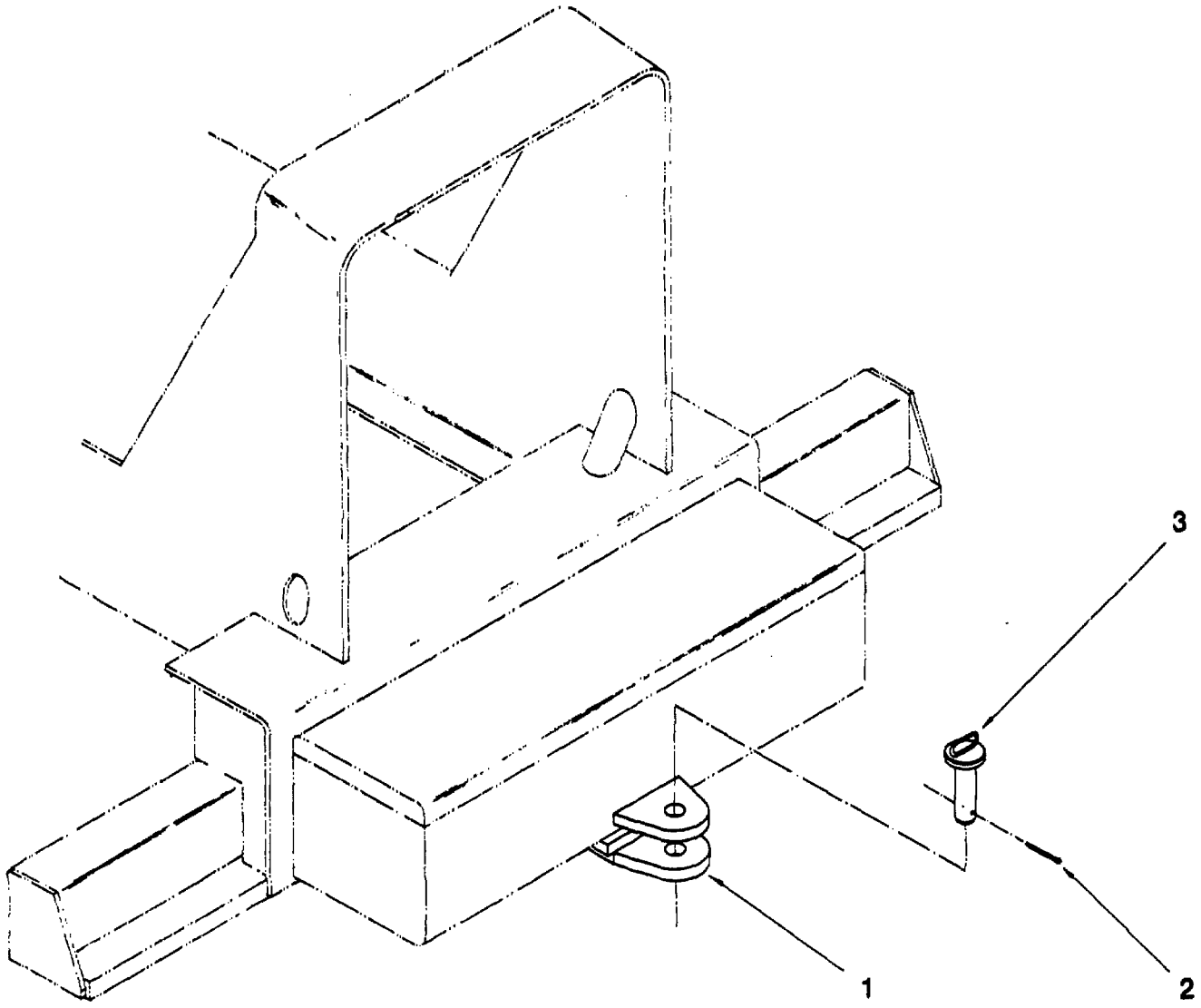

RESISTOR DIODE (50Ω) VP25K
DIODE HARNESS 6N12
(incl. DIODE)
ENGINE OIL
PRESS. SENDER
1253
1253
CONVERTER
OIL PRESS.
SENDER
HORN BUTTON
4217
HEATER-HORN HARNESS 3473
3490
(RED)
(BROWN)
HORN RELAY
HORN
2061
LIGHT SWITCH
1566 (BLACK)
(WHITE)
HEAD
LIGHT
1567
REAR
LIGHT
1568
OIL PRESS.
SWITCH
4N3355
FUEL
SOLENOID
4N4316
ENGINE OIL
PRESS. GAUGE
1252
LIGHT
HAND BRAKE
SWITCH
3441
CONVERTER OIL
PRESS. GAUGE
1252
LIGHT
BATTERY
1565
(12 V.)
REAR
LIGHT
HARNESS
3240
ALTERNATOR
9L6298
(55A.)
B
G
AMMETER
1977
LIGHT
(BLACK)
HEAD
LIGHT
HARNESS
2687
PANEL
LIGHT
1569
ALTERNATOR-AMMETER
HARNESS
3849
(GREEN)
NEUTRAL SWITCH
236395
BATTERY CABLE (+) 3053
SOLENOID
(RED)
HOUR
METER
1250
FUSE
HOLDER
3443
FUSE 3461
START
SWITCH
2445
BAT.
IGN.
ACC.
FUSE
HOLDER
HARNESS
3462
(RED)
(BLACK)
BATTERY
CABLE (—)
3054
GROUND
WIRE
3082
STARTER
4N8253
STARTER
SWITCH RELAY
145027
(GREEN)
(BLACK)
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(RED)
(BLUE)
(BLUE)
(RED)
(YELLOW)
(RED)
(WHITE)
2504
CAB SOCKET
WARNING
LIGHT 3286
(BLACK)
3418 WARNING
LIGHT RELAY
REAR
LIGHT
1568
HEAD
LIGHT
1567
(WHITE)
MAIN HARNESS 3609

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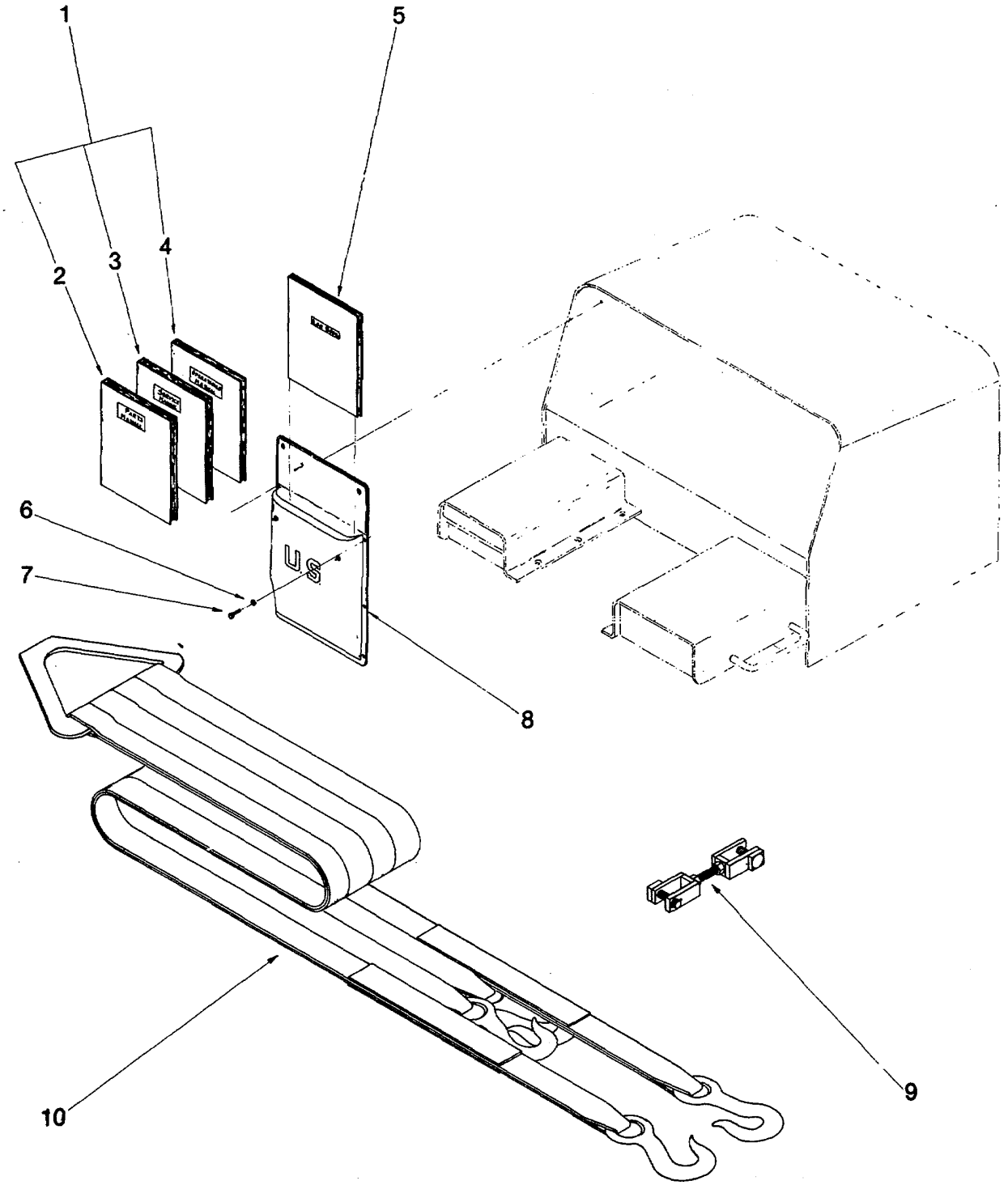
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Miscellaneous Accessories 9-12

TOW HOOK



TOW HOOK

REF. NO.	DESCRIPTION	QTY.	PART NO.
1	**Tow Hook Assembly** (includes items 2 and 3)	1	3218
2	**Pin,** Cotter 3/16 x 2-1/2 Long	1	---
3	**Pin,** Tow Hook	1	3222


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MISCELLANEOUS ACCESSORIES

REF. NO.	DESCRIPTION	QTY.	PART NO.
1	**Manual Set,** Parts/Service/Operation (includes items 2 to 4)	2	3600
2	**Manual,** Parts	2	3680
3	**Manual,** Service	2	3681
4	**Manual,** Operation	2	3682
5	**Book,** Log	1	3792
6	**Washer,** Countersunk Screw 1/4 Diameter	6	---
7	**Screw,** Slotted Countersunk 1/4 - 20 UNC x 3/4 Long	6	---
8	**Bag,** Accessory	1	3674
9	**Link Assembly,** Safety	2	2628
10	**Sling Assembly,** Machine Lifting	---	3770

SERVICE MANUAL

This manual contains complete information on components used in the manufacture of machine model K300, serial number range 9001-9075.

MODEL IDENTIFICATION

The machine model and serial number appear on a metal plate attached to the left hand side of the rear frame, located directly below the operator station.

MACHINE MODEL No. K300 *MACHINE SERIAL No.* SPARE COPY

ENGINE MODEL CATERPILLAR 3208 *ENGINE SERIAL No.*

BOOK PART No. 3681 *BOOK No.* A 098

LOCATION OF SERIAL NUMBERS

MACHINE:	As described above and also stamped on the left rear frame structure, forward of the operator position, outlined in red.
ENGINE:	Right rear (lower) corner of engine.
TRANSMISSION:	Right front (lower) corner of transmission.
AXLE:	Centre of differential housing.

PARTS ORDERING PROCEDURE

1. The terms 'right hand' and 'left hand' when referring to a machine component are determined by sitting in the operator's seat and facing toward front of machine.
2. Order parts from the BOMAG distributor in your territory.
3. Always provide the model and serial numbers of the machine and for assembly.
4. Provide part number and complete description.
5. Provide complete address of destination and specify clearly preferred shipping method.
6. Confirm all telephone, telex or cable orders in writing.
7. Engine parts should be ordered from the engine manufacturers' authorized service dealers.
8. Credit will *not* be allowed on parts unless they are returned to the BOMAG distributor from whom they were purchased. Distributors please refer to BOMAG 'Parts Return Policy'.
9. Claims for shortages or errors will not be considered unless such claim is immediately reported on agent on the Bill of Lading whereupon full damage can be collected from the transport company.
11. We do not accept liability for delay or damage to merchandise while in transit. Liability ceases once the shipment is accepted by the transportation company from whom receipt is received, acknowledging the good condition of the shipment when received by them.

KOEHRING

Koehring Canada Limited
BOMAG Division

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GENERAL SPECIFICATIONS
K300 - Caterpillar 3208

ENGINE

Make / Model	Caterpillar 3208
Number of Cylinders	V-8
Bore	4.5" (114 mm)
Stroke	5" (127 mm)
Displacement	636 cu. in (10425 cc)
H.P. @ RPM	21002800
Lubrication	Pressure feed
Oil Capacity	2.5 Imp. gal (3 US gal) (11,4 lit)
Fuel Capacity	66.5 Imp. gal (80 US gal) (302 lit)
Weight	1225 lbs (556 kg)

ELECTRICAL

Battery	Two 12V-204 amp-hr
Alternator	12V-75 amp

COOLING

Radiator	Round tube, fin type
Coolant Capacity	12.5 Imp. gal (15 US gal) (57 lit)
Water Pump Capacity	60 Imp. gpm (72 US gpm) (273 lit min)
Type	Centrifugal
Drive	Belt
Fan Diameter	22" (559 mm)
Type	Blower - 4 blade

FILTERS

Engine Oil	Replaceable cartridge
Air	Replaceable cartridge
Transmission Oil	Replaceable cartridge
Hydraulic Oil	Replaceable cartridge
Fuel	Spin on cartridge

TRANSMISSION (with integral torque converters

Make/Series		Clark 28000
Speeds -	Forward	3
	Reverse	3
Converter		13" SS
System Oil Capacity		8 Imp. gal (9.6 US gal) (36,4 lit)

SPECIFICATIONS:

AXLES

Make/Type	Clark/Hypoid, outside planetaries
Planetary Capacity (per planet)	1.6 Imp. gal (1.9 US gal) (7,3 lit)
Differential Capacity	3.2 Imp. gal (3.8 US gal) (14,5 lit)
Total Lubricant per Axle	6.4 Imp. gal (7.6 US gal) (28,2 lit)

DRIVELINES

Make/Type	Spicer Universal Joint
Size	1650 Series

STEERING

Make	Char-Lynn
Type	Articulated, full hydraulic Orbitrol system
Pump Capacity @ 2800 RPM	11.8 Imp. gpm (14.2 US gpm) (53.7 lit / min)

THROTTLE

Control	Mechanical linkage over cable

BRAKE

Type	Hydro-mechanical
Cylinder Capacity	0.13 Imp. gal (0.16 US gal) (0,6 lit)

FRAME

Separate front and rear frames connected by a center joint assembly providing 80º articulated steering and 30° oscillation.

WHEELS	**Front**	**Rear**
Width	38" (965 mm)	30" (762 mm)
Drum Diameter	48" (1219 mm)	48" (1219 mm)
Outside Diameter	64" (1626 mm)	64" (1626 mm)
Number of Teeth	100	80
Total Ballast	360 Imp. gal (432 US gal) (1636 lit)	

SPREADER BLADE

Control	Raise, hold, lower and float positions on lever
Width	107.5" (2731 mm)
Height	32.5" (826 mm)
Depth Below Ground Level	3.25" (83 mm)
Height Above Ground Level	36" (914 mm)
Edge	One piece, replaceable, self-sharpening

CLEANER TEETH

Type	Two-way, individual, adjustable, replaceable
Construction	Cast manganese steel mounted on steel bars

HYDRAULICS

System Type	Open center
System Capacity	48 Imp. gal (57.6 US gal) (218,2 lit)
Dozer System Pressure	1500 psi (10335 kPa) (105 kg / sq. cm)
Steering System Pressure	2000 psi (13780 kPa1/3 141 kg / sq. cm)
Pump Capacity @ 2800 RPM	30 Imp. gpm (36 US gal) (136 lit / min)
Valve	Gresen, double spool
Steering Cylinder	Two 3" (76 mm) x 23" (584 mm) stroke
Dozer Cylinder	4" (102 mm) x 23" (584 mm) stroke

GENERAL DIMENSIONS

Overall Length with Blade in Top Position	250" (6350 mm)
Overall Length with Blade at Ground Level	245.5" (6236 mm)
Overall Width - Front	107.5" (2731 mm)
- Rear	98" (2489 mm)
Height less Windshield	100.75" (2559 mm)
Height with Windshield	121.5" (3086 mm)
Wheelbase	118"(2997 mm)
Ground Clearance	19" (483 mm)
Total Weight	35,000 Ibs. (15876 kg)
Steering Angle	40°, left and right
Oscillation Angle	30°
Turning Radius	108" (2743 mm) to inside wheel

SPEEDS

Forward and Reverse	- 1 st	3.5 MPH (5,63 km / hr)
	- 2 nd	5.5 MPH (8,85 km / hr)
	- 3 rd	7.0 MPH (11,3 km / hr)

INSTRUMENTS

Transmission Oil Temperature Gauge	Alternator Warning Light
Converter Oil Pressure Gauge	Tachometer
Engine Oil Pressure Gauge	Hourmeter
Engine Water Temperature Gauge	Ammeter

LIGHTING

Double Seal Beams, Front and Rear	Ammeter Gauge Light
Dash Panel Light	Converter Oil Pressure Gauge Light
Engine Oil Pressure Gauge Light	

SPECIFICATIONS:

MISCELLANEOUS ACCESSORIES

Seat	Heavy duty contoured foam rubber, with adjustable hydraulic suspension mechanism and seat belt.
Tool Box	Locking tool box with grease gun and tool kit.

Air Filter Restriction Indicator
Hydraulic Tank Level Gauge
Fuel Tank Level Gauge
Windshield
Fan Guard
Tow Hook
Horn

MAINTENANCE AND LUBRICATION

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MAINTENANCE SCHEDULE

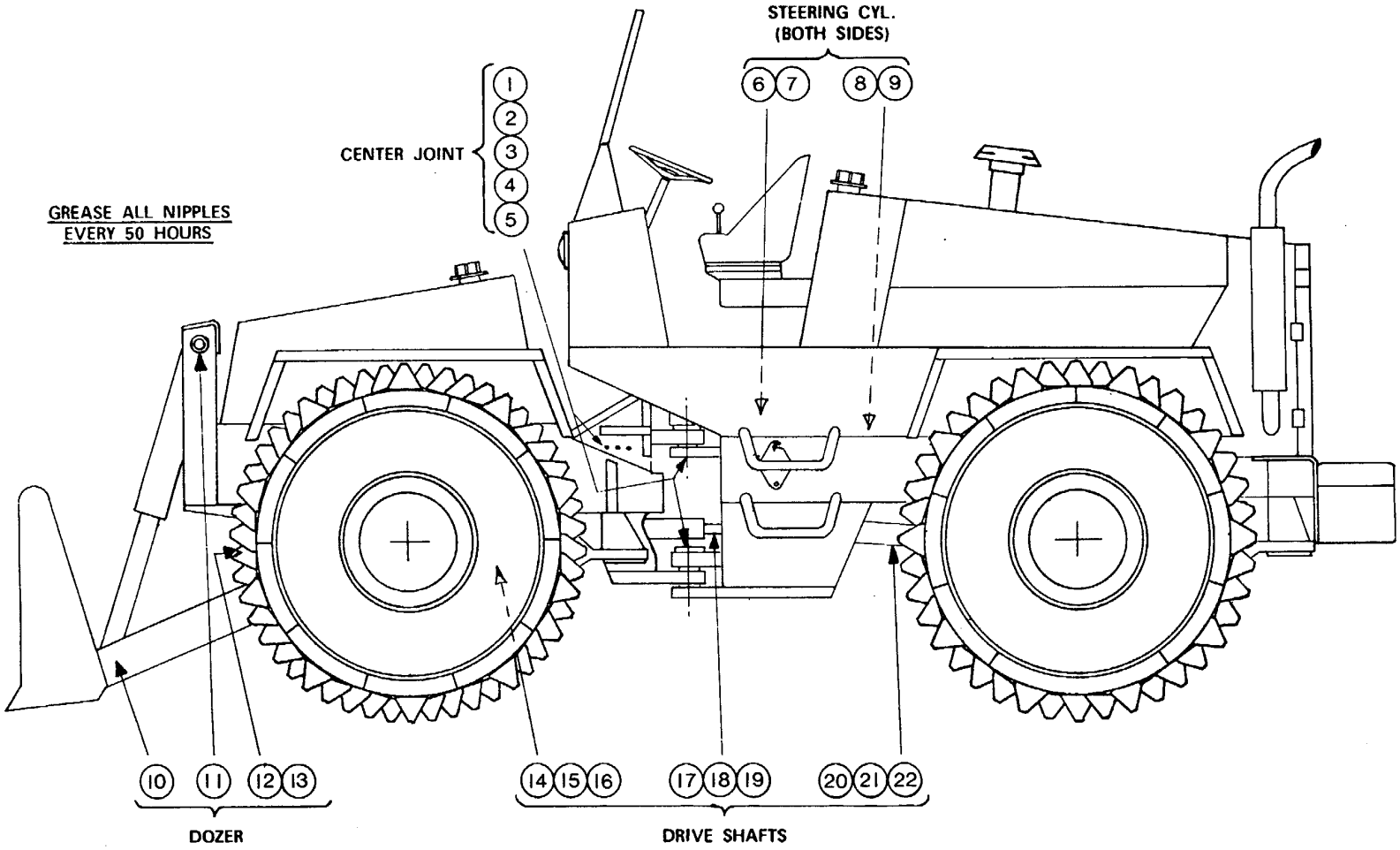
	DESCRIPTION	Daily	HOURS				
			50	100	200	400	800
ENGINE	CHECK OIL LEVEL	X					
	CHECK COOLANT LEVEL	X					
	CHECK AIR CLEANER RESTRICTION INDICATOR	X					
	FAN BELT ADJUSTMENT		X				
	CHECK BATTERIES		X				
	CHECK ANTI-FREEZE		X				
	CHECK AIR INLET HOSE AND CONNECTIONS		X				
	CHECK RAD HOSE AND CONNECTIONS		X				
	STEAM CLEAN RADIATOR		X	or A.R.			
	CLEAN AIR FILTER			X	or A.R.		
	OIL CHANGE				X		
	FILTER CHANGE				X		
	CHANGE AIR FILTER ELEMENT				X		
	CHANGE FUEL FILTER				X		
	CHECK THROTTLE LINKAGE				X		
	RECORD OIL PRESSURE				X		
	VALVE ADJUSTMENT						X
	CLEAN INJECTORS						X
	CHECK FAN HUB AND FAN MOUNTING						X
	CHECK ENGINE MOUNTS						X
	CHECK EXHAUST SYSTEM						X
	DRAIN AND CLEAN FUEL TANK						X
	COMPLETE ALL SERVICE FUNCTIONS AS INDICATED IN VENDOR ENGINE MANUAL						
TRANSMISSION	CHECK OIL LEVEL (at operating temperature)	X					
	CHANGE OIL FILTER				X		
	CHECK TORQ CONVERTER AND TRANSMISSION PRESSURE				X		
	OIL AND FILTER CHANGE					X	
	ADJUST BRAKE						X

	DESCRIPTION	Daily	HOURS				
			50	100	200	400	800
AXLES	CHECK DIFFERENTIAL AND PLANETARY OIL LEVEL		X				
	CHECK WHEEL MOUNTING NUTS (450 ft-lbs/62 m-kg)			X			
	CHECK AXLE MOUNTING NUTS (700 ft-lbs/97 m-kg)				X		
	CHANGE OIL						X
	ADJUST WHEEL HUB BEARING PRELOAD						X
	CHECK DIFFERENTIAL FLANGE BEARING END PLAY (if any, adjust preload)						X
HYDRAULIC	CHECK HYDRAULIC TANK LEVEL	X					
	REMOVE DEBRIS FROM DOZER CYLINDER RODS	X					
	CHECK HOSES AND CONNECTIONS		X				
	CHECK FOR CYLINDER LEAKAGE			X			
	CHANGE HYDRAULIC FILTER				X		
	CHECK PUMP MOUNTING BOLTS				X		
	DRAIN AND CLEAN HYDRAULIC TANK					X	
	CHECK HYDRAULIC PRESSURE					X	
GENERAL	VISUAL INSPECTION FOR LEAKS	X					
	GREASE ALL POINTS ACCORDING TO CHART		X				
	CHECK BRAKE CYLINDER FLUID LEVEL		X				
	CLEAN DEBRIS FROM UNDERCARRIAGE		X				
	INSPECT MOUNTED PARTS			X			
	INSPECT ROPS BUSHINGS AND PINS				X		
	CHECK FOR LOOSE NUTS AND BOLTS				X		
	ADJUST PARKING BRAKE LEVER				X or A.R.		
	ADJUST CONTROL LEVERS AND LINKAGES					X	
	STEAM CLEAN MACHINE					X	
	CHECK FRAME & DOZER WELDMENTS						X

NOTES:

1. **COMPLETE OIL AND FILTER CHANGE HAS TO BE DONE AFTER THE FIRST 50 HOURS.**
2. ***Detailed instructions follow the schedule.***
3. **A.R. — As Required.**

LUBRICATION DIAGRAM



LUBRICANTS SPECIFICATION CHART

APPLICATION	CHANGE [HOURS]	CAPACITY			SPECIFICATIONS	VENDOR EQUIVALENTS					
		LITER	U.S. GAL.	IMP. GAL.		B.P.	ESSO	GULF	MOBIL	SHELL	TEXACO
ENGINE OIL	200	13,6	3.6	3	SUPERIOR LUBRICANTS (SERIES 3) MIL-L-2104B, MS 68-69 MIL-L-45 199A 1.85% MAX. ASH	BP ENERGOL DIESEL S3-30	ESSOLUBE XD-3	GULFLUBE XHB MOTOR OIL SAE 10W30	MOBIL DELVAC 1330	SHELL RIMULA CT-30	TEXACO URSA LA-3 SUPER DUTY SAE 30
ENGINE GREASE	50	—	—	—	NLGI No. 2 W / CORROSION INHIBITOR MOLYBDENUM DISULFIDE 3-5% TO MIL-L-7866	BP LS-2 ENERGREASE	ESSO MP GREASE MOLY	GULFLEX MOLY No. 2	MOBIL GREASE MP No. 2	SHELL ALVANIA No. 2	TEXACO MOLYTEX No. 2
FUEL	—	302	80	66.5	No. 2 DIESEL FUEL — MIN. CETANE No. 40 (ASTM D-613) — MAX. 1% SULFUR BY WEIGHT						
ENGINE COOLANT	800	57	15	12.5	CLEAN WATER (LOW MINERAL CONTENT) WITH ANTI-FREEZE AND RUST INHIBITOR ADDITIVES — DO NOT USE ANTI-LEAK ADDITIVES.						
BATTERY WATER	A.R.	—	—	—	DISTILLED WATER IF AVAILABLE — CLEAN WATER WITH LOW MINERAL CONTENT						
TRANSMISSION AND TORQUE CONVERTER	400	32,7	8.6	7.2	AUTOMATIC TRANSMISSION FLUID TYPE A SUFFIX A OR DEXRON	BP DEXRON ATF	ESSO AUTOMATIC TRANSMISSION	GULF AUTOMATIC TRANSMISSION FLUID TYPE DEXRON	MOBIL ATF 220	SHELL DONAX T6	TEXOMATIC FLUID
MASTER BRAKE CYLINDER	400	0,55	0.15	0.12							
AXLE [DIFFERENTIAL] [per axle]	800	14,6	3.8	3.2	MIL-L-10 324 A SAE 90 EXTREME PRESSURE EP SCL SULFO-CHLORO-LEAD	BP ENERGOL MP 80-90 (SCP)	ESSO GEAR OIL LC-90	GULF 47-906 GEARLUBE SCL SAE 90	MOBILUBE 46 SAE90	SHELL HDR-90	TEXACO MULTIGEAR EP85W-90
AXLE [PLANETARY] [per planet]	800	7,3	1.9	1.6							
HYDRAULIC	400	218	57.6	48	HYDRAULIC OIL VISCOSITY 158-100°F SUV 43.5-210°F GRAVITY 32° API	BP ENERGOL HL 65	ESSO NUTTO H44	GULF HARMONY 44 HYDRAULIC OIL	MOBIL DTE OIL 24	SHELL TELLUX 27	TEXACO RANDO OIL HDA or HD 32 / 150
ARTICULATE BEARINGS AND DRIVE SHAFTS	50	—	—	—	NLGI No. 2 D POINT 373°F TYPE L1-CA VISCOSITY 1183-100°F SUV 87-210°F	BP LS-2 ENERGREASE	ESSO GREASE BEACON No. 2	GULF CROWN GREASE EP-2	MOBIL GREASE MP No. 2	SHELL ALVANIA No. 2	TEXACO MULTI-PURPOSE GREASE No. 2

NOTE: Other suppliers may be used providing above specifications are met. Machine originally filled with TEXACO products.

Rev. 760501

SERVICE TIPS

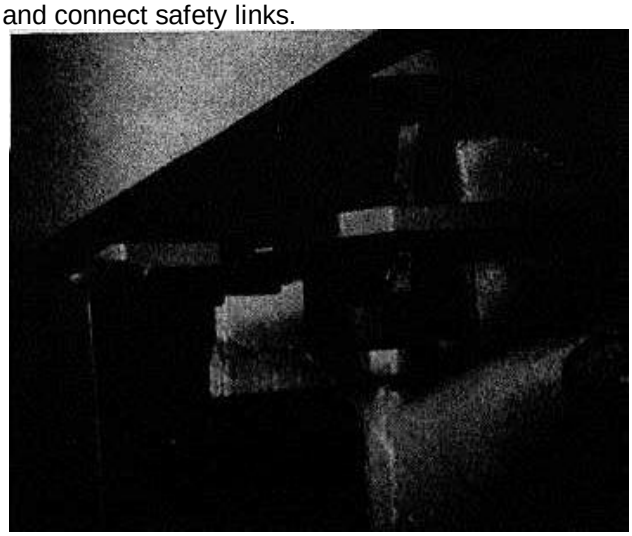
1. Always park machine on level ground, set parking brake and lower blade unless otherwise stated.

2. When disassembling components, cleanliness is essential. Always place parts in order of disassembly for easier assembly. Use new gaskets and O ring seals when reassembling.

3. Always disconnect the batteries during service operations. NEVER weld on the ma- chine with batteries connected.

4. When welding on the machine, always ground on the same component (e.g. front frame, rear frame, wheel) as you are welding on. Grounding through bearings will damage them.

5. If service operation requires the batteries to be connected, remove the key from the start switch. If engine running is a requirement, block the wheels and connect safety links.



Safely Links Installed

6. The terms "right", "left", "front" and "rear" when referring to a machine component are determined by sitting in the operator's seat and facing toward front of machine.

7. Refer to corresponding parts section for parts breakdown and assembly sequence.

GENERAL MAINTENANCE INSTRUCTIONS

Daily:

VISUAL CHECK FOR LEAKS in hoses, cylinders, tanks etc., should be made daily. Unexplained leaks or spills must be carefully Investigated and corrected. Also inspect general machine for noticeable damage.

50 Hours:

GREASE ALL FITTINGS according to LUBRICATION DIAGRAM with proper lubricant (refer to LUBRICANTS SPECIFICATION CHART). Before servicing machine, always wipe dirt and foreign material from grease fittings.



Center Joint Lubrication

CLEAN DEBRIS FROM BELLY PANS AND AXLES to prevent damage to drive train.

100 Hours:

INSPECT ALL MOUNTED PARTS for looseness or noticeable damage.

200 Hours:

CHECK FOR LOOSE NUTS AND BOLTS.

Mounting bolts, especially on such components as engine, transmission, pump, steering gear and drive shafts will occasionally work loose and may cause unnecessary wear or even structural damage. Replace damaged or missing fasteners and tighten loose bolts according to TORQUE SPECIFICATIONS CHART.

400 Hours:

STEAM CLEAN MACHINE every 400 hours or periodically as required. Dirt accumulation may become detrimental to machine operation. Protect alternator and starter motor by covering them before steam cleaning. Steam is recommended as the most effective method but If unavailable, use a spray of mineral spirits or similar solvent which is non-harmful to hoses or exposed electrical harnesses.

800 Hours:

INSPECT FRAME AND DOZER WELDMENTS for cracks or noticeable damage. Structural damage should be repaired immediately to prevent further damage.

Note: For further maintenance instructions, peculiar to a machine component, refer to component In applicable service section.

STORAGE PROCEDURE

If machine is to be stored for any period or indefinite length of time (MAXIMUM 6 months), perform the following service functions.

1. Store machine in dry area with wheels on blocks and blade lowered onto blocks. Put gear levers in neutral position.
2. Steam clean entire machine, paying special attention to engine and wheels. If wheels are not properly cleaned, built-up material may harden and result in broken cleaner teeth.
3. Complete full maintenance checks. Include checking all fluid levels, coolant anti-freeze protection, grease all fittings, and lubricate control levers, linkages and cables.
4. Drain any water from fuel system. Fill fuel tank to avoid formation of condensation.
5. Operate engine until thoroughly warm. Stop engine, shut fuel tank drain cock and disconnect fuel lines to engine fuel filter and injector drain line. Fill two containers, one with diesel fuel (refer to LUBRICANTS SPECIFICATION CHART) and a second with preservative oil US Military Spec MIL-L 644 Type P9. Preservative Oil to this specification is Daubert Chemical Co., Nox-Rust No. 518 or equivalent.

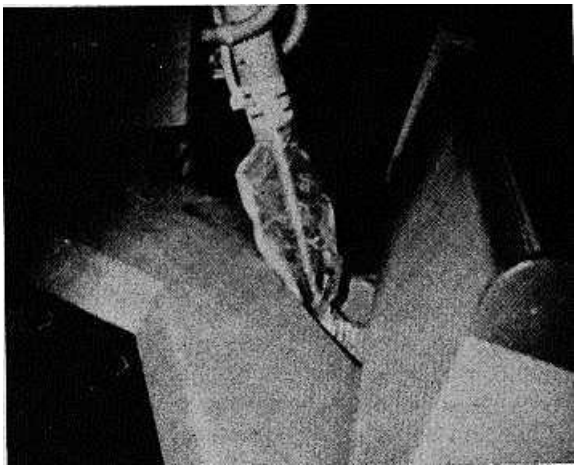
Start engine with fuel line to filter using diesel fuel with injector drainline flowing into same container. After engine is running smoothly, switch fuel line to container with preservative oil. Operate engine for five to ten minutes on preservative oil, then stop engine and reconnect fuel lines.

Brush or spray rust preventive compound conforming to Type P-2, Grade 1 or 2, US Military Spec MIL-C-16173C on all exposed, unpainted engine surfaces.

Spray lubricating oil into intake manifold while cranking engine slowly.

Cover all engine openings with heavy paper and tape. Bar engine crankshaft two or three revolutions each three or four weeks.

6. Set parking brake.
7. Remove batteries; store in warm place and recharge every 6 months.
8. Brush or spray rust preventive compound on chrome and polished surfaces-gauges, cylinder rods, etc.
9. Remove key and close starter switch protector cap. Cover seat and entire operator station with tarp if available.
10. Tag machine as "IN STORAGE" and include date.



Protecting Dozer Cylinder Rod

OUT OF STORAGE SERVICE

To prepare a stored machine for service:

1. Clean any accumulated dirt from exterior of engine. Remove covers and tape.
2. Use suitable cleaner to remove rust preventive compound from engine and machine surfaces.
3. Change engine oil and filter.
4. Flush and refill cooling system. Use a suitable antifreeze with rust inhibitor added if required. *Do not use antifreeze with antileak additives.*
5. Reinstall and reconnect batteries.
6. Complete full maintenance checks. Include checking all fluid levels, grease all fittings and lubricate all control levers, linkages and cables.
7. Bleed fuel system. Open fuel tank drain cock.
8. Release handbrake. Start engine and warm up as recommended (refer to PRESTART AND STARTING PROCEDURE and WARM-UP CHECKS in OPERATION MANUAL).

TORQUE SPECIFICATIONS FOR FASTENERS

SAE GRADE NUMBER	 Grade 2		 Grade 5		 Grade 8	
NOMINAL THREAD SIZE	Torque Specifications in ft.-lbs. (m-kg)					
	DRY	LUBRICATED OR PLATED	DRY	LUBRICATED OR PLATED	DRY	LUBRICATED OR PLATED
1/4 - 20 UNC	5 (0,69)	4 (0,55)	8 (1,1)	5 (0,69)	–	–
28 UNF	6 (0,83)	5 (0,69)	10 (1,4)	6 (0,83)	–	–
5/16 - 18 UNC	11 (1,5)	8 (1,1)	17 (2,4)	11 (1,5)	–	–
24 UNF	13 (1,8)	10 (1,4)	19 (2,6)	15 (2,1)	–	–
3/8 - 16 UNC	18 (2,5)	13 (1,8)	31 (4,3)	22 (3,0)	45 (6,2)	30 (4,1)
24 UNF	20 (2,8)	15 (2,1)	35 (4,8)	25 (3,5)	50 (6,9)	35 (4,8)
7/16 - 14 UNC	28 (3,9)	19 (2,6)	49 (6,8)	35 (4,8)	70 (9,7)	50 (6,9)
20 UNF	30 (4,1)	22 (3,0)	55 (7,6)	40 (5,5)	80 (11,1)	60 (8,3)
1/2 - 13 UNC	39 (5,4)	27 (3,7)	75 (10,4)	60 (8,3)	105 (14,5)	80 (11,1)
20 UNF	41 (5,7)	28 (3,9)	85 (11,8)	65 (9,0)	120 (16,6)	90 (12,4)
9/16 - 12 UNC	–	–	110 (15,2)	80 (11,1)	155 (21,4)	115 (15,9)
18 UNF	–	–	120 (16,6)	90 (12,4)	170 (23,5)	130 (18,0)
5/8 - 11 UNC	–	–	150 (20,7)	115 (15,9)	210 (29,0)	160 (22,1)
18 UNF	–	–	170 (23,5)	130 (18,0)	240 (33,2)	180 (24,9)
3/4 - 10 UNC	–	–	270 (37,3)	200 (27,7)	375 (51,9)	285 (39,4)
16 UNF	–	–	295 (40,8)	225 (31,1)	420 (58,1)	315 (43,6)
7/8 - 9 UNC	–	–	395 (54,6)	295 (40,8)	605 (83,7)	455 (62,9)
14 UNF	–	–	435 (60,2)	325 (44,9)	675 (93,4)	500 (69,2)
1 - 8 UNC	–	—	590 (81,6)	445 (61,5)	910 (125,9)	685 (94,7)
14 UNF	–	–	660 (91,3)	485 (67,1)	990 (136,9)	745 (103,0)

NOTES:

1. Use torque values listed above unless otherwise noted.
2. Use of Loctite classes the fastener as lubricated.
3. Fasteners threaded into components of a softer material (e.g. aluminum, zinc) may require reductions in torque specifications.



Koehring Canada Limited
BOMAG Division

TROUBLE-SHOOTING GUIDE

CAUSE	INDICATED BY	REMEDY
ENGINE FAILS TO CRANK OVER:		
1. Dead battery	Low electrolyte reading	Charge battery
2. Machine in gear neutral	Forward-reverse lever not in	Select neutral position
3. No electrical current to start switch	Electrical system inoperative	Check wiring from starter relay to ammeter for broken circuit
4. Defective neutral start switch	No electrical current to starter relay	Check by installing a jumper wire across neutral switch. Replace if defective.
5. Defective starter relay	Electrical current but no operation	Check for proper ground. Replace if defective.
ENGINE CRANKS OVER BUT FAILS TO START:		
1. Insufficient fuel	Low fuel level reading	Fill fuel tank
2. Restricted fuel flow	a) Dirty fuel filter b) Restricted or broken fuel lines c) Air in fuel system	Change fuel filter Blow out all fuel lines with compressed air Replace damaged lines Locate and correct leak Bleed fuel system
3. Water in fuel		Drain, clean and refill fuel tank
4. Insufficient air	Excessive black smoke while cranking engine	a) Check for intake restriction b) Change air filter element
5. Fuel solenoid not opening	No smoke while cranking engine	a) Release handbrake b) Check wiring from ignition switch to fuel solenoid for broken circuit c) Check fuel solenoid for proper operation
6. Low engine compression	a) Excessive black smoke b) Low compression reading	Refer to engine manual Refer to engine manual
ENGINE RUNS ROUGH:		
1. Air system		Check for air intake restriction
2. Fuel system	a) Dirty fuel filter b) Restricted or broken fuel lines c) Air in fuel system d) Water in fuel	Change fuel filter Blow out all fuel lines with compressed air Locate and correct leak Bleed fuel system Drain, Clean and refill fuel tank

TROUBLE-SHOOTING GUIDE

CAUSE	INDICATED BY	REMEDY
EXCESSIVE ENGINE NOISE:		
1. Worn or damaged engine components	-	Inspect and replace damaged parts. Refer to engine manual
2. Engine mounts	-	Inspect and replace damaged engine mounts. Torque fasteners
3. Loose or worn fan belts	-	Replace or adjust belts
EXCESSIVE ENGINE VIBRATION:		
1. Faulty vibration mounts	-	Inspect and replace mounts if necessary
2. Unbalanced or loose flywheel	-	Tighten flywheel
ENGINE SMOKES:		
1. Insufficient air	Black or gray smoke	Check for intake restriction
2. Insufficient fuel	Black or gray smoke	a) Check for fuel line restriction b) Refer to engine manual
3. Restriction in exhaust	Black or gray smoke	Inspect and correct
4. Excess lubrication oil	White or blue smoke	Remove extra oil
LOW ENGINE OIL PRESSURE:		
1. Defective oil pressure gauge	-	Install new gauge
2. Insufficient oil flow	-	a) Check oil filter, changing if necessary b) Oil suction line restriction c) Low in crankcase oil d) Wrong grade of oil for weather conditions
3. Diesel fuel in lubrication oil	-	Locate and correct leak. Change lubrication oil and filter
4. Oil pump malfunction	-	a) Replace oil pump suction pipe b) Clean or repair oil pump relief valve c) Repair or replace oil pump
5. Cooling system malfunction	a) Insufficient coolant	Check coolant level, adding if necessary
	b) Dirty radiator	Steam clean radiator
	c) Dirty engine	Steam clean engine exterior
	d) Loose or worn fan belts	Replace or adjust fan belts

TROUBLE-SHOOTING GUIDE

CAUSE	INDICATED BY	REMEDY
COOLANT TEMPERATURE TOO HIGH		
1. Defective temperature gauge	-	a) Check gauge grounding b) Check if sender lead is shorted to ground c) Replace defective gauge
2. Defective thermostat	-	Replace thermostat
3. Defective water pump	-	Replace water pump
4. Restricted or damaged water line	- -	Inspect rad hoses, changing if necessary
5. Restricted air flow through radiator	- -	a) Remove restrictions b) Steam clean radiator c) Inspect and adjust fan belts
6. Insufficient coolant	-	Add coolant
COOLANT IN LUBRICATION OIL:		
1. Defective oil cooler	-	Replace oil cooler core
2. Failure of cylinder head gasket	-	Install new gasket
3. Cracked or defective cylinder head or block	-	Install new parts as necessary
OIL IN COOLING SYSTEM:		
1. Defective oil cooler -	-	Replace oil cooler core
2. Failure of cylinder head gasket	-	Install new gasket
LOSS OF POWER:		
1. Air system -	-	Check for air intake restriction
2. Fuel system	a) Air in fuel system	Locate and correct leak. Bleed fuel system
	b) Dirty fuel filter	Change fuel filter
	c) Restricted or broken fuel lines	Blow out all fuel lines with compressed air. Bleed fuel system
	d) Water in fuel	Drain, clean and refill fuel tank
	e) Cannot reach governed RPM	Check and adjust throttle linkage
3. Excess engine lubrication oil	High reading on dipstick	Remove extra oil
4. Insufficient transmission fluid	Low reading on dipstick level	Fill transmission to proper

TROUBLE-SHOOTING GUIDE

CAUSE	INDICATED BY	REMEDY
ENGINE RUNS BUT MACHINE WILL NOT DRIVE IN EITHER DIRECTION:		
1. Insufficient transmission fluid	Low reading on dipstick	Fill transmission to proper level
2. Faulty transmission control linkage	-	Check all linkage and cables for proper adjustment
3. Plugged charge pump suction line or filter	Low or zero charge pressure and filter	Replace or clean suction line
4. Defective charge pump or relief valve	Low or zero charge pressure	Replace defective assembly
5. Defective fiber ring gear	Zero charge pressure. Hydraulic system inoperative	Remove engine and replace ring gear
MACHINE OPERATES IN ONE DIRECTION ONLY:		
1. Defective control linkage	-	Check and adjust
2. Defective clutch pack	Low or zero clutch pressure	Refer to transmission service manual
TRANSMISSION OVERHEATS:		
1. Insufficient transmission fluid	Low reading on dipstick	Fill to proper level
2. Insufficient cooling	Dirty or plugged cooler	Remove transmission oil cooler and clean rad and cooler assembly
3. Insufficient oil flow thru cooler	Low gpm reading	Remove and flush oil cooler
4. Transmission brake not released	-	Check control and adjustment
5. Plugged charge pump suction line or filter	Low charge pressure	Replace or clean suction line and filter
6. Defective charge pump or relief valve	Low charge pressure	Replace defective assembly
TRANSMISSION PRESSURE SYSTEM ANALYSIS:		
1. Low oil level	Converter out pressure low Clutch pressure low	Fill to proper level
2. Cooler or system restriction	Converter out, pressure high Cooler out pressure drop low	a) Check cooler hoses for restriction b) Clean cooler c) Replace defective cooler
3. Defective pump or relief valve	a) Converter out pressure low Converter pressure low Clutch pressure low	Repair or replace defective pump or relief valve
	b) Converter pressure high Clutch pressure high	Repair or replace defective relief valve

TROUBLE-SHOOTING GUIDE

CAUSE	INDICATED BY	REMEDY
4. Defective control valve	Converter pressure low	Repair or replace defective control valve
5. Defective converter	Converter pressure low	Repair or replace converter
6. Plugged filter or suction screen	Converter and clutch pressure low	Clean or replace filter or suction screen
7. Worn or damaged clutch seal rings	Clutch pressure low	Replace clutch seal rings
TRANSMISSION OIL FLOW SYSTEM ANALYSIS:		
1. Cooler or system restriction	Flow reading low	a) Check cooler hoses for restriction b) Clean cooler c) Replace defective cooler
2. Defective pump	Flow reading low	Repair or replace pump
3. Plugged filter or suction screen	Flow reading low suction screen	Clean or replace filter or
DRIVELINE VIBRATION OR NOISE:		
1. Lack of lubricant	-	Grease drive line fittings
2. Backlash due to worn bearings	-	Replace bearings
3. Yokes not In line	-	Separate drive line and reassemble correctly
4. Out of balance drive line	-	Disassemble drive line, clean and replace defective parts
HYDRAULIC SYSTEM INOPERATIVE:		
1. Insufficient hydraulic fluid	Low level reading	Fill to proper level
2. Plugged suction line or filter filter	Low or zero pressure reading	Replace or clean suction line
3. Defective pump or relief valve	Low or zero pressure reading	Replace defective unit
4. Defective fiber ring gear ring gear	Machine will not drive	Remove engine and replace

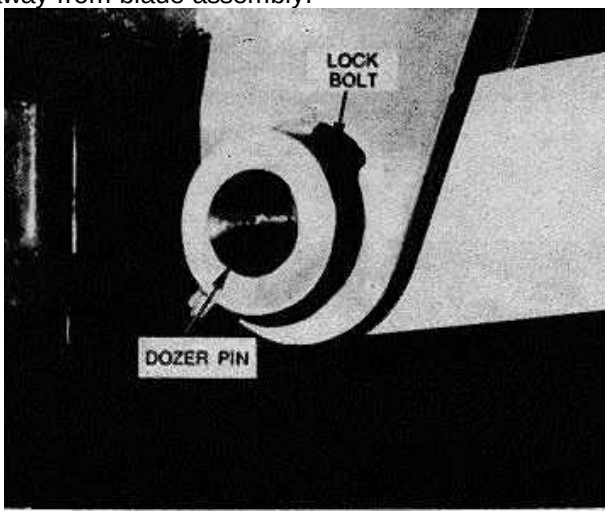
TROUBLE-SHOOTING GUIDE

CAUSE	INDICATED BY	REMEDY
DOZER NOT OPERATING:		
1. Faulty control linkage	-	Check all linkages for proper adjustment
2. Worn or damaged control valve	Low or zero pressure to dozer cylinder	Replace defective unit
3. Defective dozer cylinder	Blade drops when the control lever Is in the hold position	Replace or repair dozer cylinder
HYDRAULIC BRAKES INOPERATIVE:		
1. Insufficient fluid In master cylinder	-	Refill master cylinder and bleed brakes Note: *Use only Type A trans. fluid*
2. Defective master cylinder	Pedal goes slowly to floor and fluid level remains constant	Replace or repair master cylinder
3. Defective transmission cylinder seals	Pedal goes slowly to the floor and fluid level decreases (Note: No external leaks)	Remove transmission brake assembly and replace seals
4. Defective brake spool valve or seals	Pedal goes slowly to the floor and fluid level decreases (Note: No external leaks)	Remove brake spool valve and replace seals
STEERING DIFFICULT OR INOPERATIVE:		
1. Oil level Is low	Slow or hard steering	Fill to proper level
2. Dirt In system	a) Slow or hard steering b) Continuous steering wheel rotation	Drain, flush and refill with clean fluid
3. Plugged line	Slow or hard steering	Check lines
4. Worn sleeve, spool or orbit gear	Slow or hard steering	Check and replace
5. Defective pump or actuator	a) Slow or hard steering b) No response	Repair or replace defective pump or actuator
6. Linkage or valve binding	a) Steering wheel does not center b) Continuous steering wheel rotation	Realign linkage or valve
7. Lines hooked up incorrectly	Wrong response to steering wheel	Reconnect lines
8. Orbit gear misaligned	Wrong response to steering wheel	Realign orbit gear

CAUSE	INDICATED BY	REMEDY
9. Defective steering cylinder	a) Slow steering operation b) Oil leaking from seals	Replace or repair cylinder
ALTERNATOR WARNING LIGHT ON:		
1. Key on-engine not running	-	
2. Key on-engine not accelerated	-	Depress throttle pedal
3. Worn or damaged alternator belt	-	a) Adjust belt tension b) Replace worn belts
4. Charging circuit malfunction	Alternator not charging	Check charging circuit

DOZER REMOVAL:

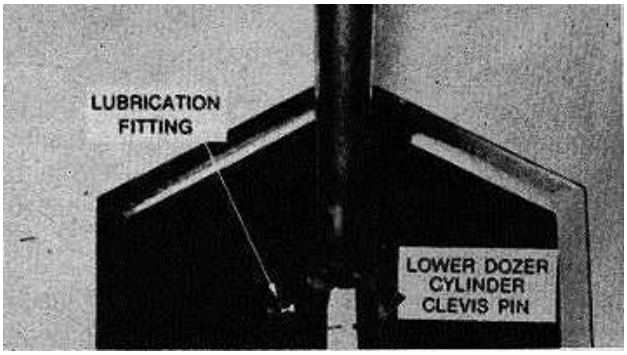
1. Park machine on level ground, set parking brake, lower blade, and block wheels.
2. After removing cotter pin from lower dozer cylinder clevis pin, remove clevis pin and retract cylinder.
3. Block blade arms in position and remove dozer pin lock bolts.
4. Press dozer pins out with caution, keeping from under dozer assembly at all times.
5. With pins removed, carefully back machine away from blade assembly.



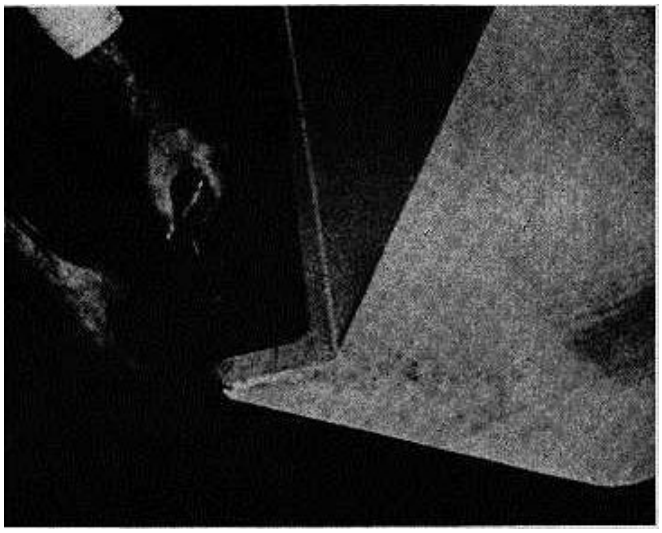
Dozer Mounting to Frame

DOZER EDGE REPLACEMENT:

1. Park machine on level ground with blade raised to top position and set parking brake.
2. Block blade securely in position.
3. Remove dozer edge retaining nuts and bolts.
4. Remove dozer edge and install new dozer edge. If edge has already been rotated or if it is cracked or damaged, install new dozer edge.
5. Install new dozer edge retaining bolts and self-locking nuts.



Dozer Cylinder Mounting to Dozer



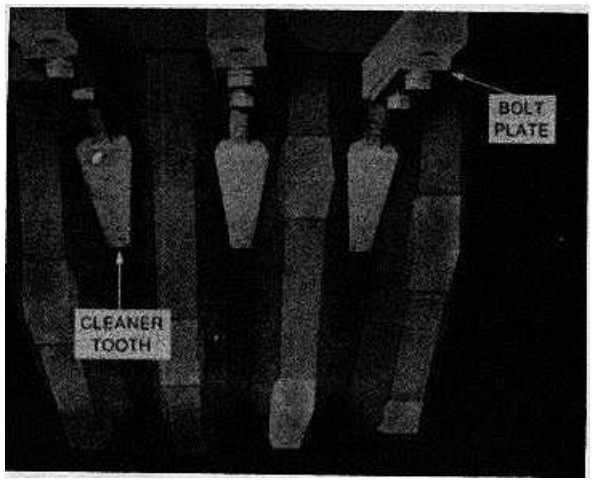
Dozer Edge Installation

CLEANER TEETH

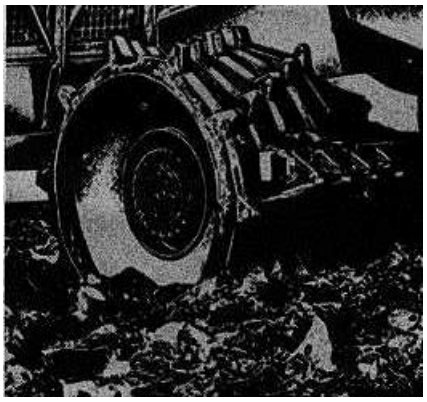
ADJUSTMENT:

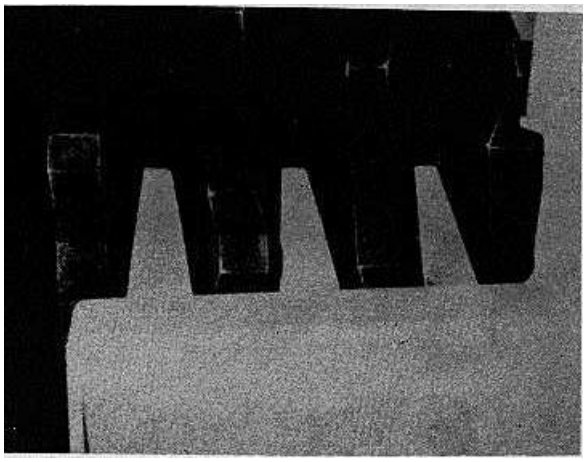
1. Loosen cleaner tooth mounting bolts.
2. Move tooth forward until it is close to wheel but does not contact it.
3. Move machine slowly forward to ensure that there is no contact at any point.
4. Tighten all bolts to proper torque (refer to TORQUE SPECIFICATION CHART) and make sure that cleaner teeth remain centered.
5. Drive machine slowly at first to ensure proper clearance of cleaner teeth.

Caution: *Wheels may require before adjustment, as hardened build-up of material may damage cleaner teeth.*

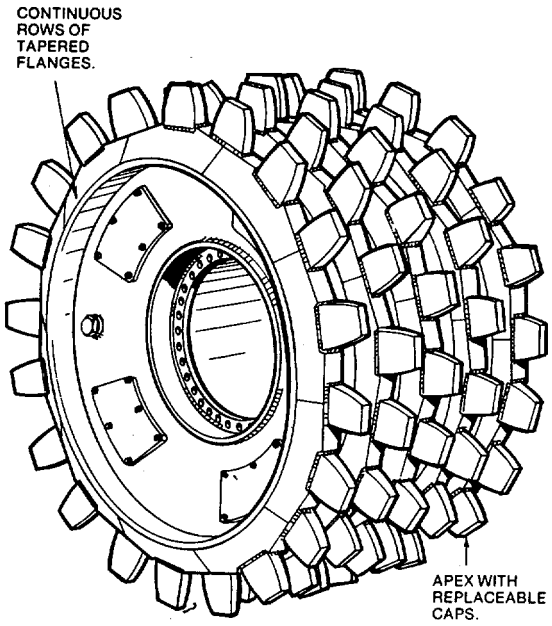


Cleaner Teeth Adjustment



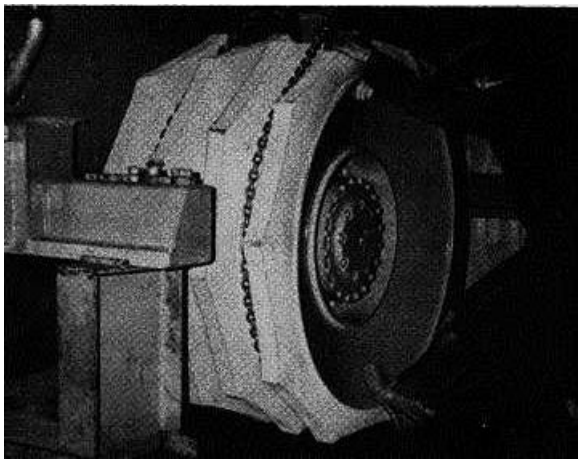


Cleaner Teeth



WHEEL REMOVAL:

1. Park machine on level ground, set parking brake and lower blade.
2. Jack up each wheel individually, blocking securely so that wheels clear ground.
3. Remove all wheel cleaner teeth and fenders.
4. Attach hoist and sling to wheel and hold taut.



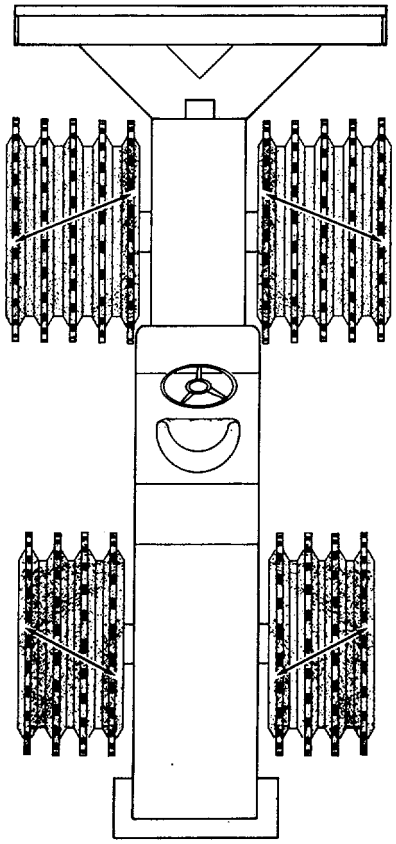
Wheel Installation

Note: *Mark wheels before removing for easier assembly.*

5. Remove wheel nuts and lift wheel from axle.
6. Reverse procedure for installation, torque nuts to 450 ft-lbs (62 m-kg) and readjust wheel cleaner teeth.

WHEEL INSTALLATION:

When remounting wheels, care must be taken to install the wheel on the correct side. Wheels should be installed so that tooth pattern forms a diamond as illustrated below.



Wheel Installation

WHEEL SHOE AND CAP REPLACEMENT:

1. To remove wheel shoes or wheel caps use 3/16" (5 mm) diameter arc-air stick (Canox 36022-033 or equivalent) on DC straight polarity at maximum voltage and 250 to 280 amps. Also required is an air line with approximately 80 psi (5, 6 kg/sq. cm) pressure.

2. After shoes or caps have been removed, clean mounting surface on wheel or wheel shoe with grinder and wire brush.

Note: *Prior to using any stick electrode, preheat components to approximately 200° F [93° C]. On all flex core wire use 35 C. F. CO and on solid wire use 8 C. F. CO plus 20 C. F. argon.*

3. Welding shoe castings to steel wheel drum should be done with 3 1 32" (2, 5 mm) diameter flux core wire. If not available, use low hydrogen 7018 electrode.

4. Weld wheel shoe ends together with National Standard No. 116 .035" (0, 8 mm) diameter wire or 1/ 8" (3 mm) diameter 7018 electrode.

5. When welding wheel caps to shoes, use 1 16" (1, 6 mm) T-5 flux core wire at 26-27 volts and 250 to 280 amps. If not available, use 'McKay 1/8" (3 mm) diameter 110-18 or equivalent.

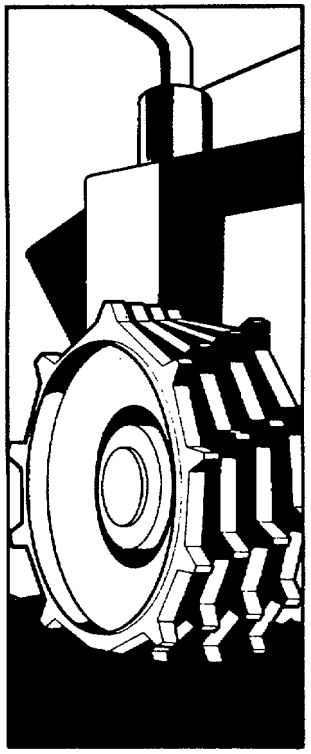
WHEEL BALLAST:

When soil compaction requirements cannot be met by conventional means, ballast may be added to the wheels to increase the applied compacting forces. Ballast material such as diesel fuel or calcium chloride may be added through the four cover plates on the side of the wheel. The wheel should be removed and put on its side to ensure completely filling the wheel.

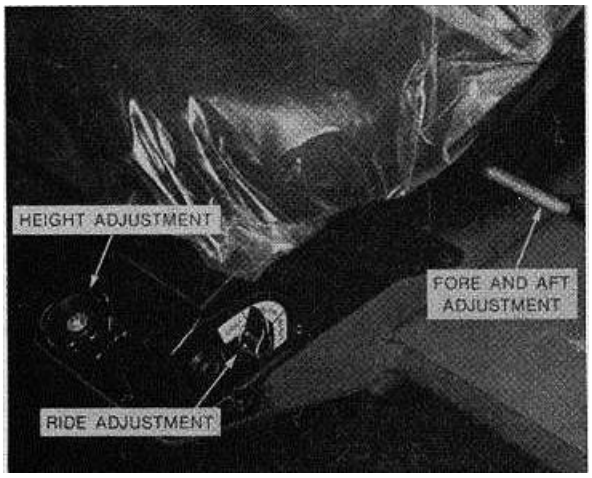
Warning: *Always completely fill all wheels as surging caused by partially filled wheels may result in transmission, axle or driveline damage.*

The total ballast volume for a K300 is 360 Imp. gallons (430 US gal 1630 liters). At this volume the following ballast weights can be achieved:

DIESEL FUEL	2500 lbs /1200 kg
WATER (with anti-freeze, anti-rust)	3500 lbs / 1600 kg
CALCIUM CHLORIDE AND WATER	4200 lbs 11900 kg

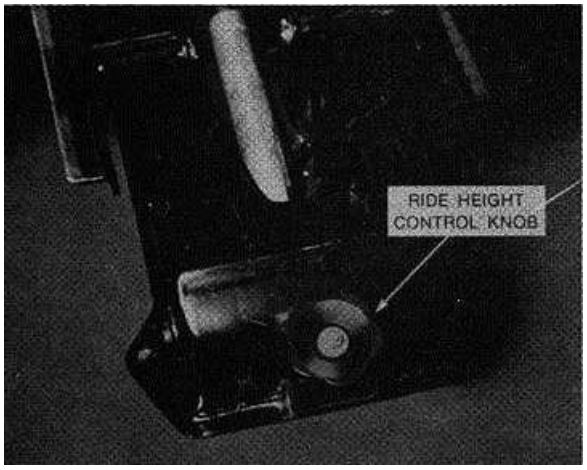


SEAT ADJUSTMENT:



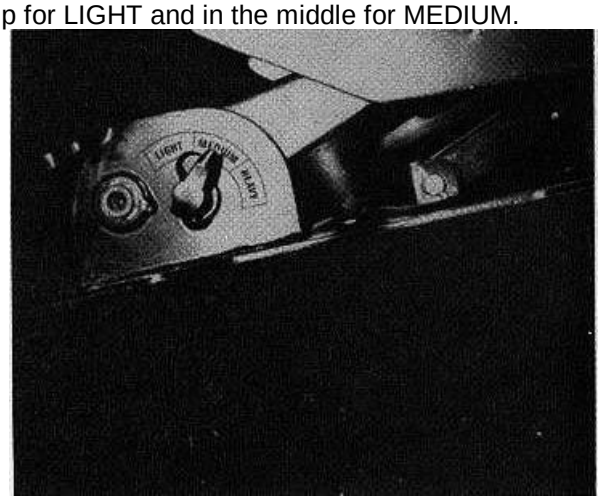
Seat Adjustment

1. The adjustment knob at the front of the seat suspension controls the ride height of the seat. When looking down, a counter-clockwise rotation will raise the seat.



Ride Height Adjustment

2. The lever at the operator's left side of the seat suspension adjusts the firmness of the suspension. Lever to the rear for HEAVY, pointing up for LIGHT and in the middle for MEDIUM.



Seat Firmness Adjustment

3. Fore and aft adjustment of the seat is accomplished by lever on left side of seat. Push lever back to release the lock and allow the seat to slide on its rails. Release lever when desired position is reached and push seat back to ensure lock is engaged.

CENTER JOINT REMOVAL:

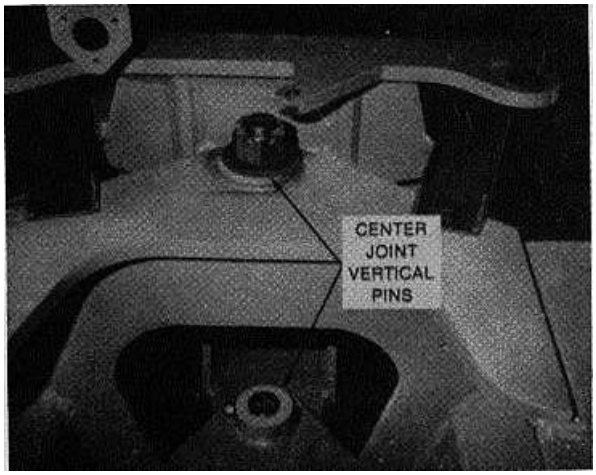
1. Park machine on level surface, set parking brake and lower blade.
2. Remove ignition key and disconnect battery cables.
3. Remove front and rear fenders.
4. Raise machine so that wheels clear the ground and securely block the machine.
5. Remove cleaner teeth and wheels.
6. Lower machine so that axles are on the ground and block machine securely.
7. Remove front and rear floor plates.
8. Close the fuel valve at the fuel tank and disconnect and cap fuel supply and fuel return hoses at the engine. Remove hose support bracket.
9. Secure dozer blade at its lowest position, with control lever secured in the HOLD position. Disconnect and cap dozer hoses from the valve.

Note: *It is recommended to block the control lever In the HOLD position to prevent loss of hydraulic oil resulting from accidental movement of the lever.*

10. Remove cotter pins and both front steering cylinder clevis pins.
11. Disconnect the drive shaft from the center joint yoke end.
12. With the front and rear frame sections securely blocked, remove cotter pin, slotted nut and washer retaining the top vertical pin. This pin must then be pressed DOWNWARD for removal. Care should be taken not to damage the thread on removal.

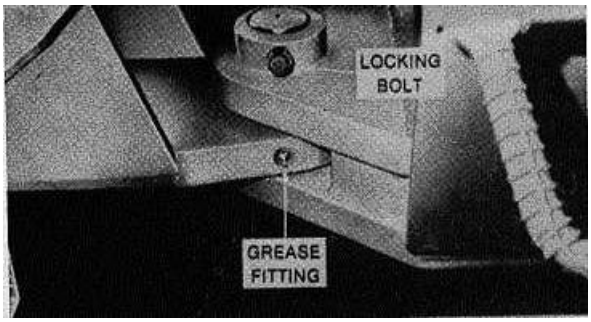


Top Center Joint Vertical Pin



Center Joint Vertical Pins

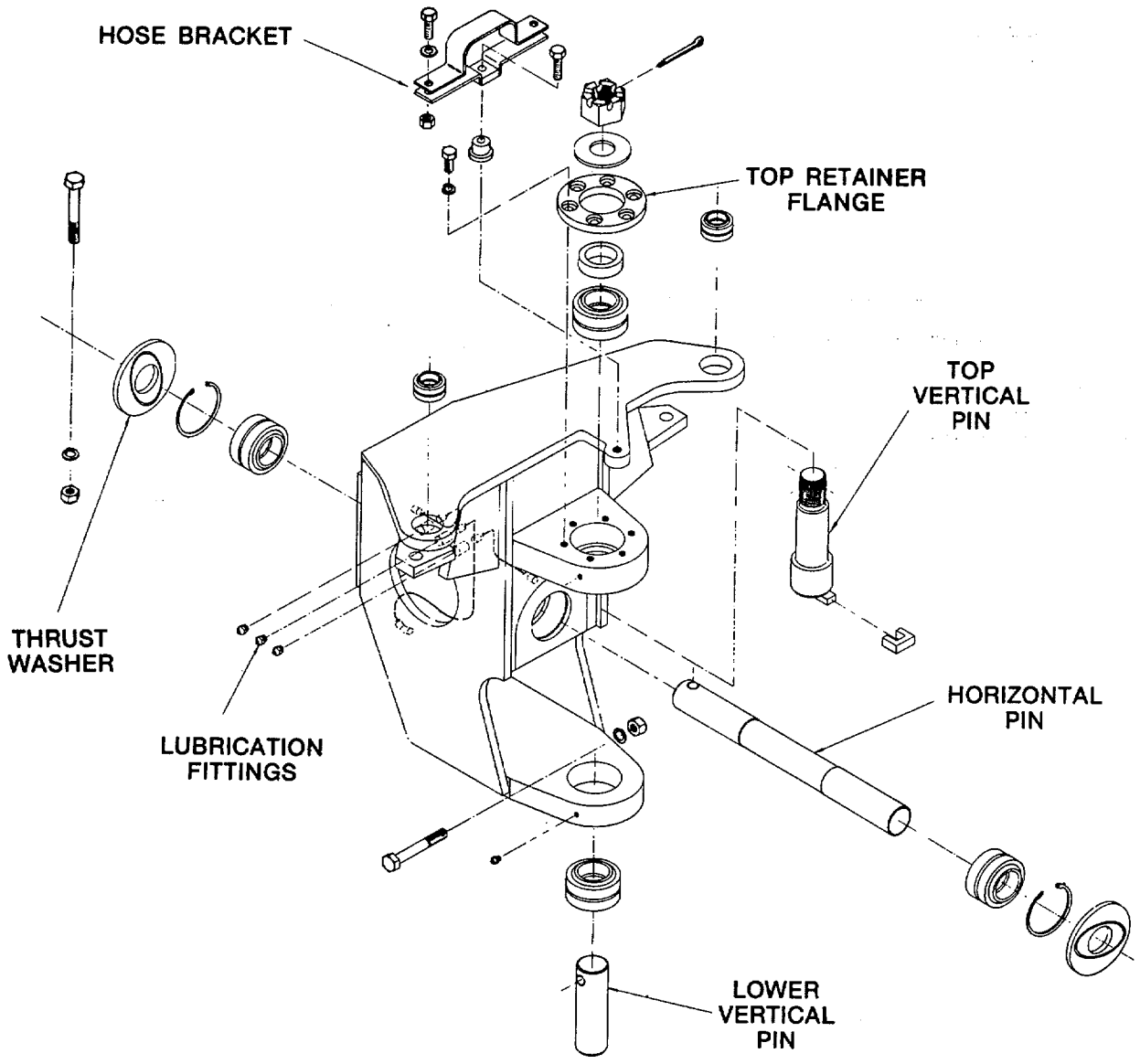
13. Remove locking bolt and press out lower vertical pin. This pin will remove In either direction.
14. With the rear frame section secure, the front frame section may now be moved forward and blocked to allow center Joint assembly to be removed.



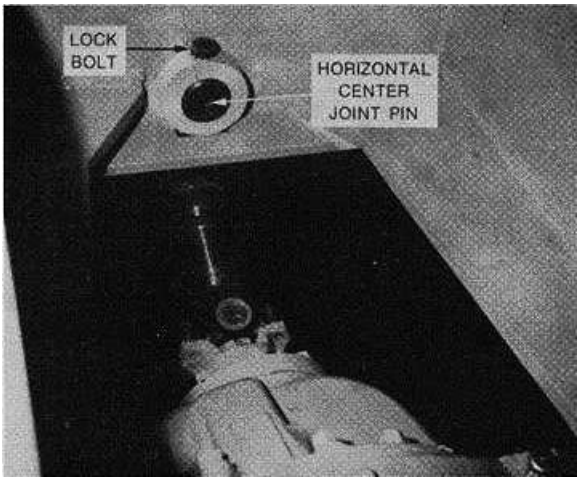
Lower Vertical Center Joint Pin

15. Remove drive shaft assembly and drive shaft center bearing from center joint assembly.
16. With the center joint assembly secured, remove locking bolt and press out horizontal pin towards the REAR of the machine. The pin cannot be pressed out towards the front as It will contact the front axle housing before it is clear.
17. Remove horizontal thrust washers and lift out the center joint assembly. As the assembly Is being lifted out, the top must be tilted to the rear to allow the lower bearing plate to clear the front frame.

CENTER JOINT:



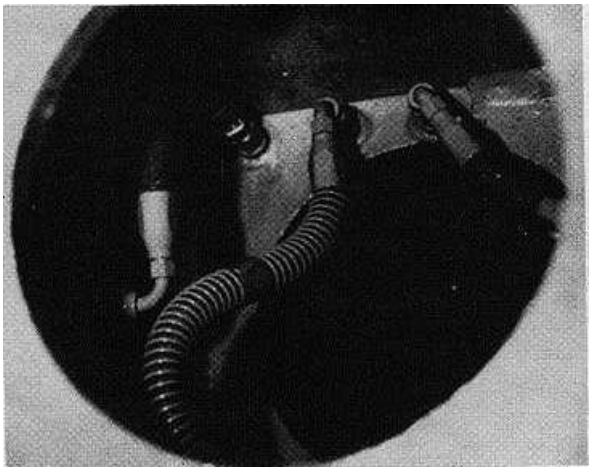
Center Joint Assembly



Center Joint Horizontal Pin

CENTER JOINT REPAIR:

1. With the center joint assembly removed from the front frame, remove the top bearing retainer flange mounting bolts and retainer flange. Remove the two horizontal pin bearing circlips.
2. With retainers removed, the bearings can now be pressed out for replacement.
3. When replacing the bearings, it must be noted that only the two vertical bearings are the sealed type. Care must be taken that these are not installed as horizontal bearings.
4. Check all pins for signs of wear and clean pin bosses on front and rear frames.
5. Check and clean all grease hoses and passages.
6. If bearings are replaced, check bearing grease channel alignment by greasing the assembly before it is installed in the frame.



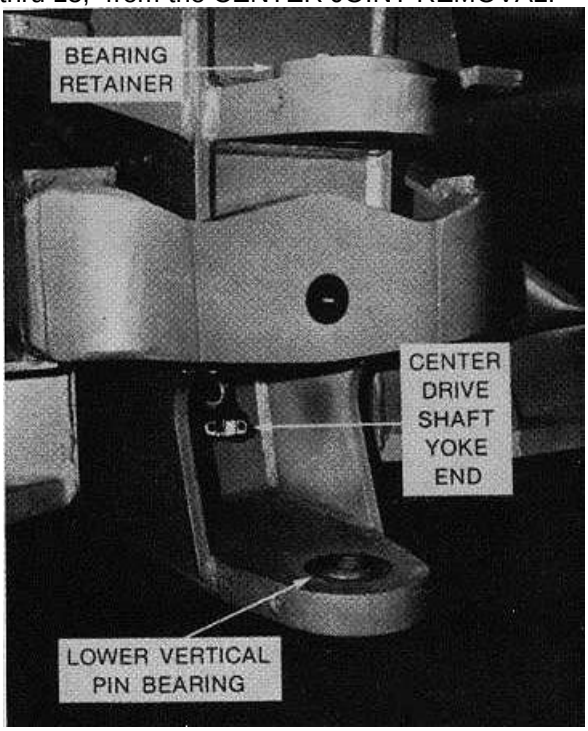
Center Joint Grease Hoses

CENTER JOINT INSTALLATION:

1. Reverse removal procedure.
2. When installing center bearing and front drive shaft assembly, make sure that the splined yoke end is in direct alignment with the front yoke end before installing retaining nut.
3. When installing top vertical pin, torque the retaining nut to approximately 800 ft-lbs (110 m-kg) before aligning retaining hole and installing cotter pin.

FRAME SEPARATION:

Frame separation is made by completing steps 1 thru 15, from the CENTER JOINT REMOVAL.



Center Joint

MAINTENANCE:

Daily:

CHECK DAILY AIR CLEANER RESTRICTION INDICATOR mounted on air cleaner inlet. The red flag in window rises as element loads with dirt. When the red flag reaches the top and is locked in position, clean or replace air cleaner element. Indicator is then reset by pushing reset button.

50 Hours:

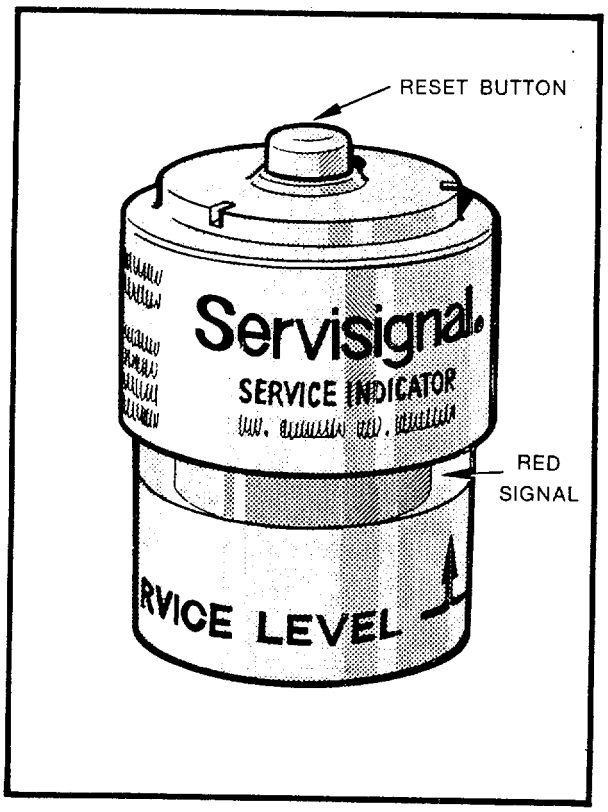
INSPECT AIR INLET CONNECTIONS every 50 hours for leaks or damaged tubing. If air by- passes the air filter and enters directly into the engine serious damage may result.

100 Hours:

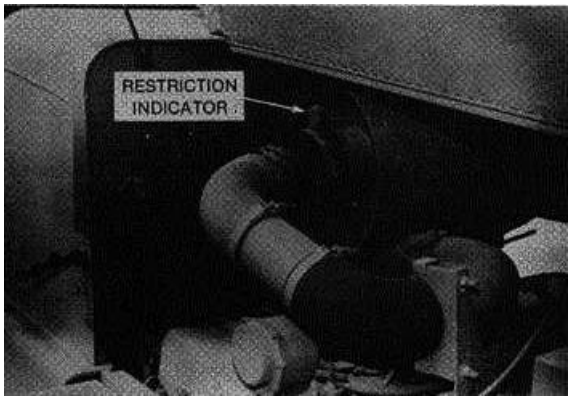
CLEAN AIR FILTER ELEMENT every 100 hours or as indicated by .air inlet restriction gauge. For cleaning procedure, refer to air cleaner vendor booklet.

200 Hours:

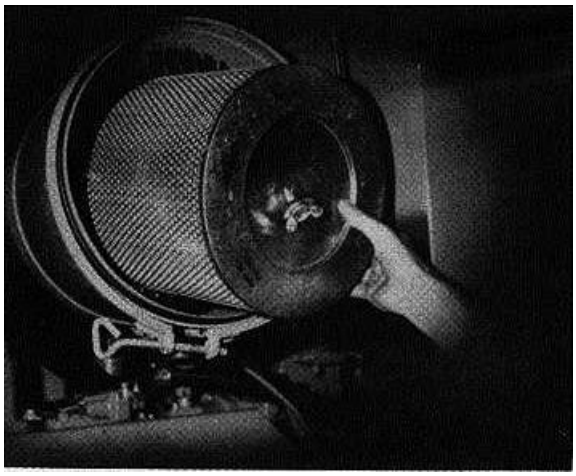
CHANGE AIR FILTER ELEMENT every 200 hours. Refer to air cleaner vendor booklet.



Air Cleaner Restriction Indicator

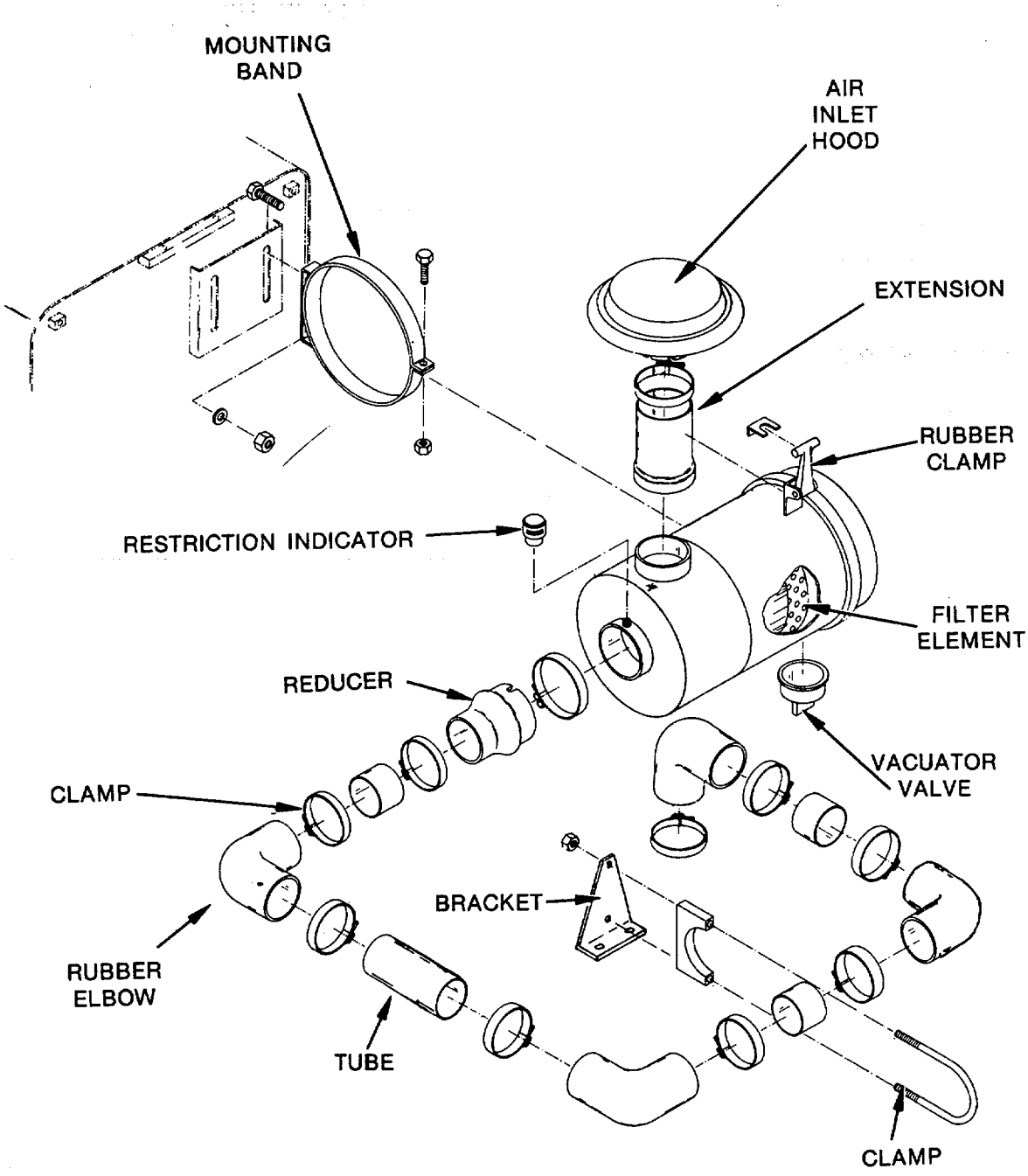


Air Inlet Connections



Removing Air Filter Element

K300

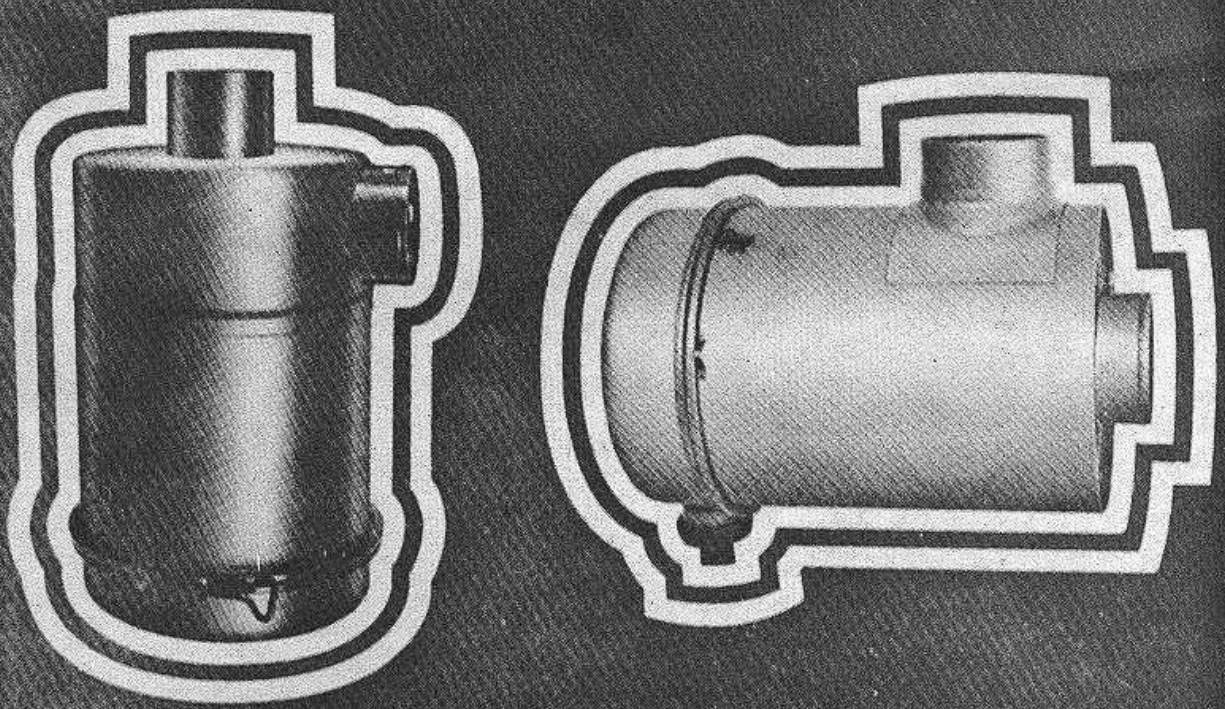


Air Cleaner Assembly

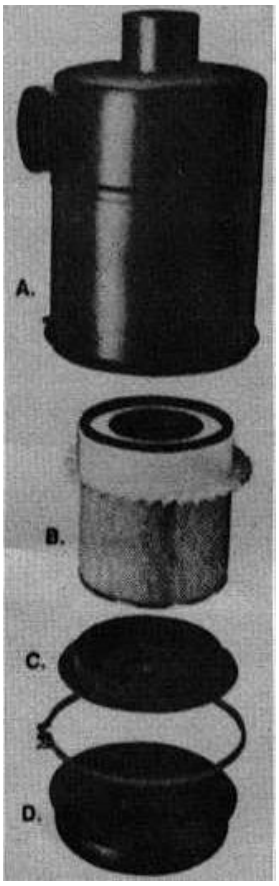
donaldson

service bulletin

Service Instructions for Cyclopac® Series Air Cleaners



Proper service improves cuts operating costs



FW Series Cyclopac® Air Cleaners

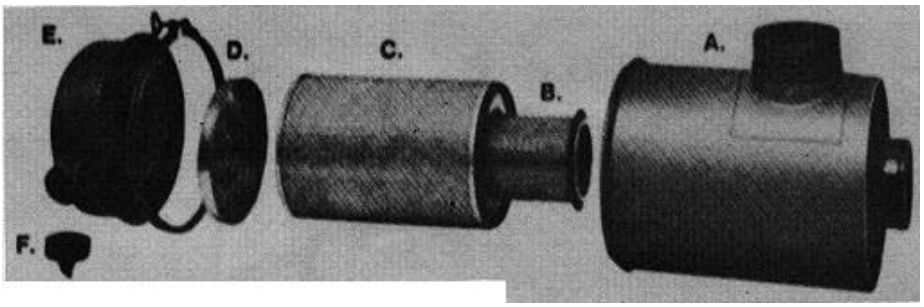
The Donaldson FW Series air cleaner has only a minimum number of parts. The heart of the air cleaner is the Duralife® II double-life element which can be cleaned and reused. The air cleaner is designed for fast, easy disassembly so that it may be serviced efficiently and quickly.

A. Body Assembly — This sturdy shell contains the ducting and sealing surface of the air cleaner.

B. Duralife® II Filter Element — The heart of the air cleaner consists of the initial separator (fins), the final filter and the sealing gasket in one cleanable and reusable part. Rigid manufacturing specifications and controls are the key to the built-in quality of this part.

C. Baffle Assembly — Retains the dirt in the dust cup.

D. Dust Cup is reservoir for dust separated from air stream by the integral separator. The slotted baffle is an integral part of the separator which forms a barrier to hold dust in the cup. Dust cup can be equipped with a vacuator valve to dump collected dust automatically.



FH Series Cyclopac® Air Cleaners

The FH Series air cleaner is a low-maintenance cleaner featuring built-in pre-cleaner fins, Duralife® II primary element, and a "back-up" safety filter element for extra protection.

A. Body Assembly — Rugged construction for long operating life.

B. Safety Element — An added insurance policy which protects the engine in case of damage to the primary filter — also guards engine during servicing of primary element.

C. Duralife® II Primary Element — The double-life element — provides much more filter surface in the same size cleaner, holds more dust — lasts much longer.

D. Baffle Assembly — Retains the dirt in the dust cup.

E. Dust Cup is reservoir for dust separated from air stream by the pre-cleaner.

F. Vacuator Valve (optional) — Ejects dust and water continuously. Eliminates regular cup servicing, cuts service time.

performance-

Service Procedure

Maximum engine protection against the ravages of dust is possible ONLY if the air cleaner is serviced at regular intervals. Over-servicing does not utilize the air cleaner features to the fullest. The procedure is simple — just follow these easy steps as shown.

1 Measure the restriction of the air cleaner with a Donaldson restriction indicator, service gauge, or a water manometer at the restriction tap provided in the air cleaner, the transfer pipe, or the blower intake. Replace or clean the element only when the restriction has reached the maximum allowed by the engine or equipment manufacturer.

2 Empty the dust cup as required. Dust should not be allowed to build up closer than one inch from the baffle. On vacuator valve equipped models, dust cup service is cut to a minimum; a quick check to see that the vacuator valve is not inverted, damaged, or plugged is all that is necessary.

3 **Element Servicing**
When restriction indicates that element servicing is required, loosen wing nut and remove primary element. Before installing new element, inspect the element and gasket for shipping or storage damage. Carefully install element and wing nut. Reset the restriction indicator to green.

For minimum vehicle downtime, replace dirty filter with a new or properly cleaned Duralite filter element. If element is to be serviced for immediate re-use, reinstall outer cover to protect induction system while cleaning element.

4 Reinstall the dust cup, making sure it seals 360° around the air cleaner body. Reset the restriction indicator to green.

5 Check all connections between the air cleaner and the engine to be certain they are tight and leak-free.

Safety Element Service

The safety element is not intended to be cleaned. For maximum engine protection and air cleaner service life, replace the safety element with a new safety element every third primary element change.

Element Cleaning Methods

Clean Duralife element by one of the following methods:

Compressed Air or Washing.

Compressed air is recommended when element will be re-used immediately because a washed element must be dried before re-use. However, washing does a better job and must be used when exhaust soot has lodged in fine pores of the filter media. Use Donaldson D-1400 detergent which contains a special additive for removing soot and carbon.

Replace element after 6 cleanings or annually, whichever occurs first.

Do not remove plastic fin assembly — back-flowing with compressed air or washing will remove dust from beneath the fin assembly.

Request Form P45-7188 "How to Service Duralife® and Duralife® II Elements" for additional information.



Compressed Air

Direct air through element in the direction *opposite to normal air flow through the element.* Move nozzle up and down while rotating element. Keep nozzle at least one inch from pleated paper. Maximum air pressure to prevent damage of element is 100 P.S.I.



Washing

1. Soak element 15 minutes or more in Donaldson D-1400 and water solution. See carton for full instructions.
2. Rinse until water is clear (Maximum water pressure 40 P.S.I.)
3. Air-dry or use warm flowing air, max. 160°F. Do not use compressed air or light bulbs.



Inspection

Place bright light inside element and rotate element slowly. If any rupture, holes or damaged gaskets are discovered — replace.

General Service Tips

The air cleaner should be inspected periodically to maintain maximum engine protection and maximum service life. These inspections should include the following points:

1— Inspect the air transfer duct between the air cleaner and the engine to be sure all clamps are tight, all flange joints are tight, and there are no cracks in the ducting.

2 — Air cleaner mounting bolts and clamps must be tight to hold the air cleaner securely.

3— Check the dust cup to make sure it is sealing 360° around the air cleaner body.

4 — Vacuator valve must be in place, not inverted or damaged, and free from obstruction.

5 — Check for dents and damage to the air cleaner which could mean a leak.

6 — Make sure all inlet accessories are free from obstructions and securely mounted.

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donaldson

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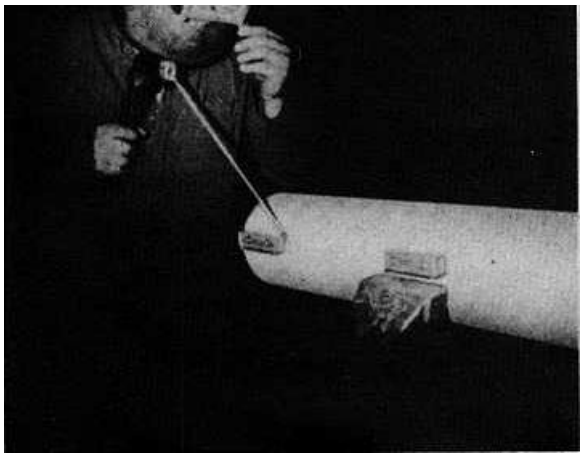
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(4020) 250. FINISH HAULING

MAINTENANCE:
INSPECT MUFFLER AND EXHAUST connections every 800 hours for leaks or damaged tubing.



MUFFLER REPLACEMENT:
When muffler replacement is necessary, it should be noted that mufflers do not come with mounting blocks attached. The mufflers must be mounted and properly aligned and the mount blocks should be tack welded to the muffler while on the machine. The muffler can then be removed and the blocks welded. Care should be taken not to burn through the muffler casing when welding.
Warning: *When welding on the machine, it is necessary that the batteries be disconnected to prevent damage to the alternator.*



Welding Muffler

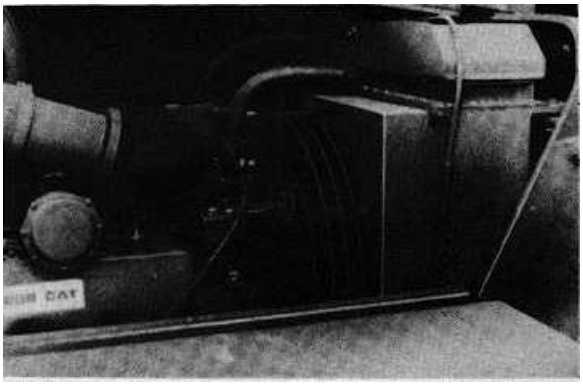
MAINTENANCE:

CHECK COOLANT LEVEL daily with engine cool and stopped. Maintain coolant level to within 1/2 inch (1,5 cm) below bottom of fill pipe. Do not fill completely as coolant will expand as it is heated. Add water or antifreeze with rust inhibitor as required, avoiding use of dirty water or water with high mineral content. Do not use antileak additives or antifreeze with antileak additives. Do not use 'DOWTHERM 209'. Causes of constant coolant loss should be investigated.

Caution: *If it is necessary to add coolant while engine is warm, extreme care should be taken when removing radiator fill cap. Adding coolant to a hot engine may crack or distort engine components. If engine overheats, add coolant slowly with engine running.*

CHECK ANTIFREEZE protection every 50 hours. Maintain readings well below anticipated temperatures, adding permanent type antifreeze with rust inhibitors as required. Do not use antifreeze with antileak additives. Do *not use* antifreeze 'DOWTHERM 209'.

INSPECT RAD HOSES AND CONNECTIONS every 50 hours for leaks or damaged hoses.

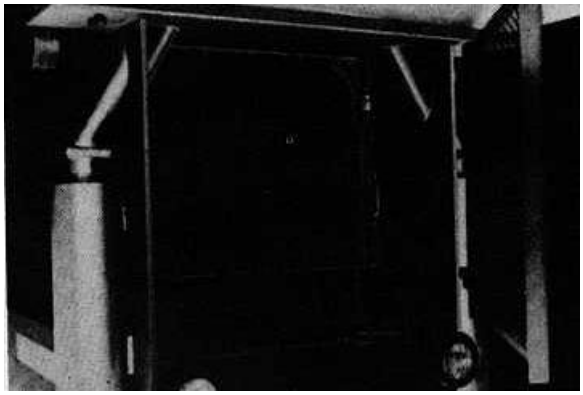


Radiator Hoses

STEAM CLEAN RADIATOR every 50 hours or as required to maintain optimum cooling efficiency. The importance of a clean radiator cannot be overstressed. Remove air-oil cooler leaving hoses connected. Clean carefully and inspect core for bent or damaged fins before reinstalling.

OIL COOLER REMOVAL:

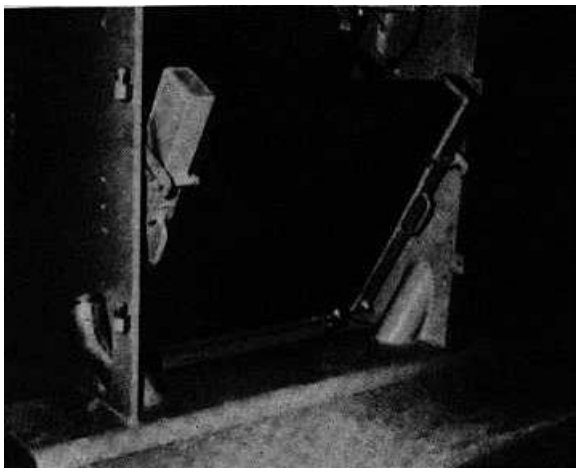
1. Remove guard retaining bolts and swing open radiator guard.



Access to Radiator

2. Disconnect and cap transmission oil cooler hoses if cooler is to be removed completely. For rad cleaning purposes, hoses may be left connected.

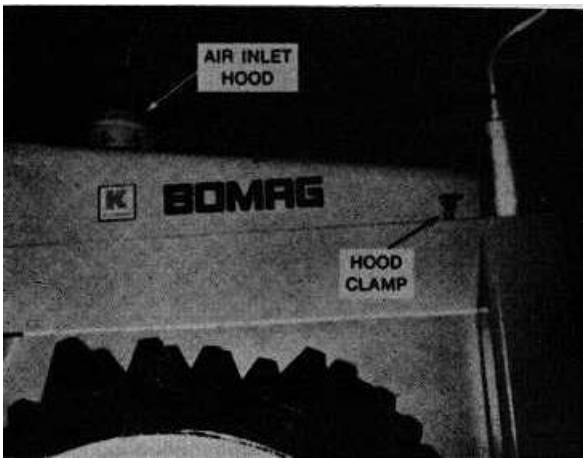
3. The radiator is equipped with a hinged oil cooler. Loosen bolts top and bottom to swing oil cooler down. Remove bolts if oil cooler is to be completely removed.

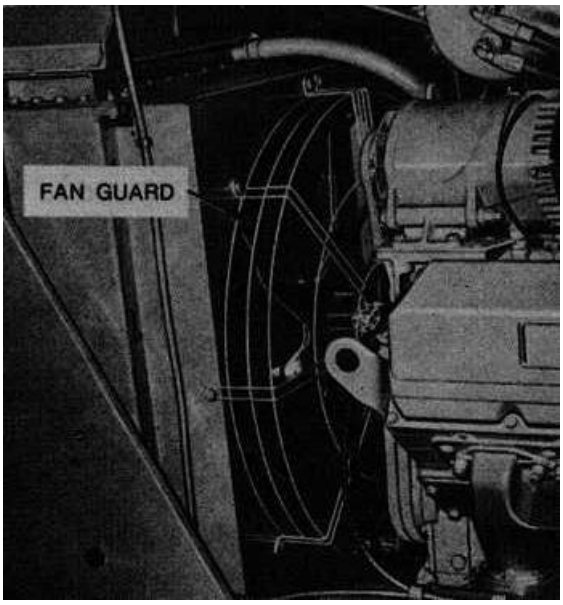


Hinged Air-Oil Cooler

RADIATOR REMOVAL:

1. Remove battery cover and disconnect battery cables.
2. Remove air cleaner inlet hood.
3. Remove hood.



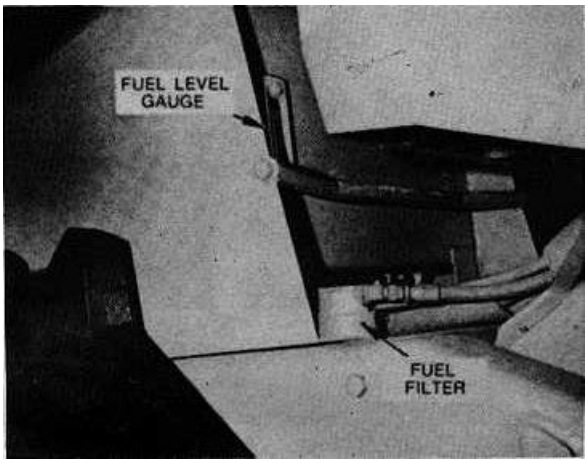


Radiator Fan Guard

4. Remove fan guard and blower fan.
5. Drain coolant by drain tap at bottom of radiator. Remove and cap all radiator hoses.
6. Disconnect and cap transmission oil cooler hoses.
7. Remove bottom and top radiator mount bolts. Radiator and cooler assembly may now be carefully lifted out of machine.
8. Inspect all hoses and rubber mounts before radiator is reinstalled.

MAINTENANCE:

CHECK FUEL LEVEL daily before machine operation. Always use a reliable, clean fuel (refer to LUBRICANTS SPECIFICATION CHART) handled in clean containers. The fuel tank level gauge is located on rear side of fuel tank on *operator's* left.



Fuel Tank

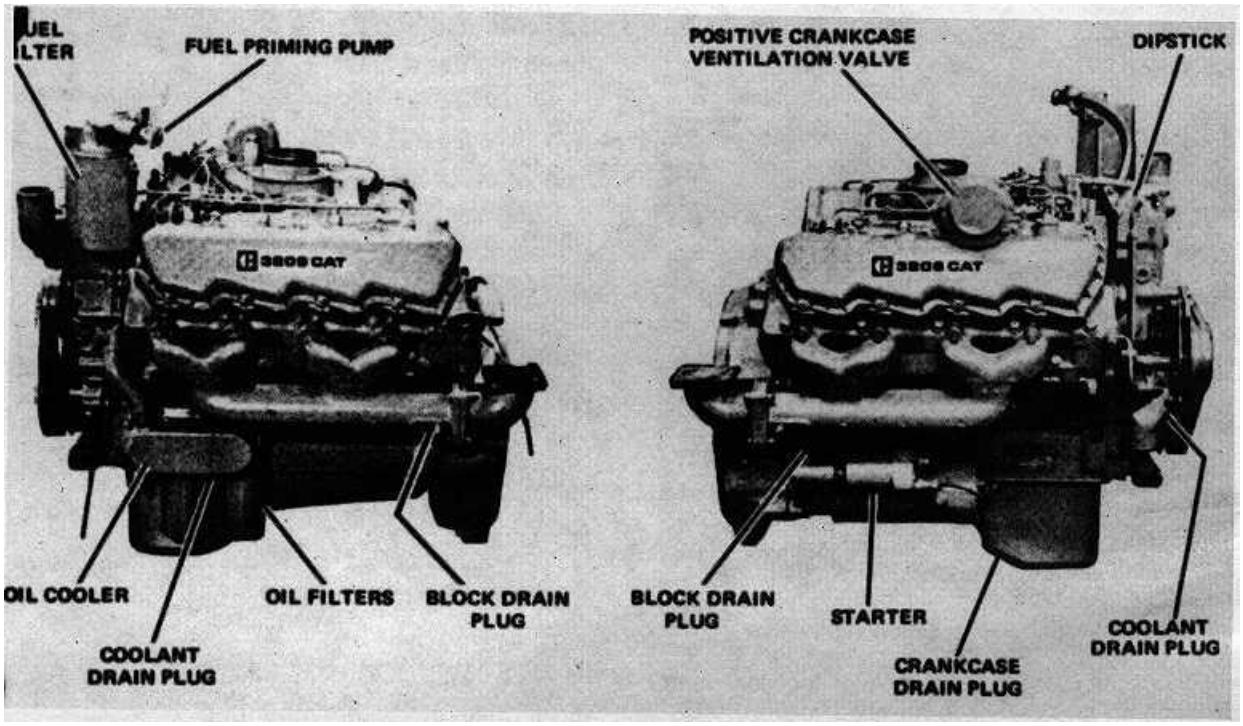
FUEL TANK

CHANGE FUEL FILTERS every 200 hours, located on underside of fuel tank and on engine.

DRAIN AND CLEAN FUEL TANK every 800 hours. After draining fuel into container, remove sediment from bottom of tank. Flush tank with clean diesel fuel and refill with clean fuel (refer to LUBRICANTS SPECIFICATION CHART).
INSPECT FUEL HOSES AND CONNECTIONS every 800 hours. Correct any fuel leak immediately and replace any damaged hoses.

FUEL TANK REMOVAL:

1. Park machine on level ground, set parking brake and lower blade.
2. Drain the fuel tank.
3. Disconnect and cap fuel supply and fuel return lines at tank.
4. Remove dozer hose support bracket and remove front fenders.
5. Remove fuel tank mounting bolts and lift tank assembly.
6. Reverse procedure for installation.



MAINTENANCE:

CHECK ENGINE OIL LEVEL daily with dipstick oil level gauge, with machine parked on level surface. Check should be made before starting or at least 15 minutes after engine shut down. Do not operate machine with oil level below the low mark or above the high mark. If necessary, add oil of the same quality and brand as already is in engine (refer to LUBRICANTS SPECIFICATION CHART).

CHECK AND ADJUST FAN BELTS every 50 hours. Check tension of each belt as described in vendor engine operation manual and check for excessive belt wear. If one belt in a set requires replacement, always install a new set of matched belts.

COMPLETE OIL AND FILTER CHANGE after initial 50 hours of operation.

CHANGE ENGINE OIL AND FILTER every 200 hours. Change should be made after machine operation as hot oil will drain away sediment. Refer to vendor engine operation manual for detailed instructions.

RECORD OIL PRESSURE after oil change with oil at operating temperature and engine at idle. Comparative readings will give an indication of progressive wear of engine components.

CHECK THROTTLE LINKAGE every 200 hours to see if in good operating condition. Make sure that linkage travel is free and unhindered.

ADJUST VALVES after the first 200 hours of operation. Thereafter, valve adjustment is required only every 800 hours. Refer to vendor engine manual for detailed instructions.

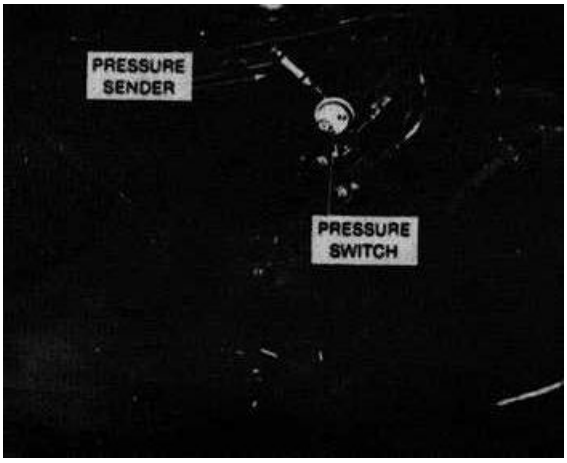
CHECK FAN HUB AND FAN MOUNTING every 800 hours for damage. Torque fasteners according to TORQUE SPECIFICATIONS CHART. For assembly and disassembly instructions refer to vendor engine manual.

INSPECT ENGINE MOUNTS every 800 hours for damage or deterioration, replacing if necessary.

COMPLETE ALL SERVICE FUNCTIONS as indicated in vendor engine operation manual.

ENGINE REMOVAL:

1. Park machine on level surface, set parking brake, lower blade and securely block machine.
2. Remove rear fenders and engine side plates.
3. Remove radiator (refer to COOLING SYSTEM).



Engine Oil Pressure Sender and Switch

4. Close fuel shut-off valve at fuel tank and disconnect and cap fuel supply and fuel return hoses at engine.
5. Disconnect and label all electrical connections at engine. Remove engine temperature sending unit from the engine.
6. Disconnect throttle and tachometer cables at engine.



Tachometer Cable Drive Adapter

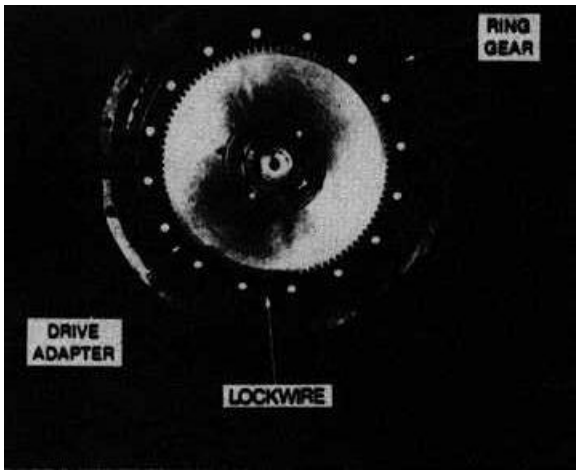
7. Disconnect and cap air intake hose and remove air cleaner assembly. Disconnect exhaust pipes at the manifolds.
8. Remove transmission fill pipe from engine lifting eye.
9. Install a suitable lifting device on engine and support engine weight. Remove rear engine mounting bolts.

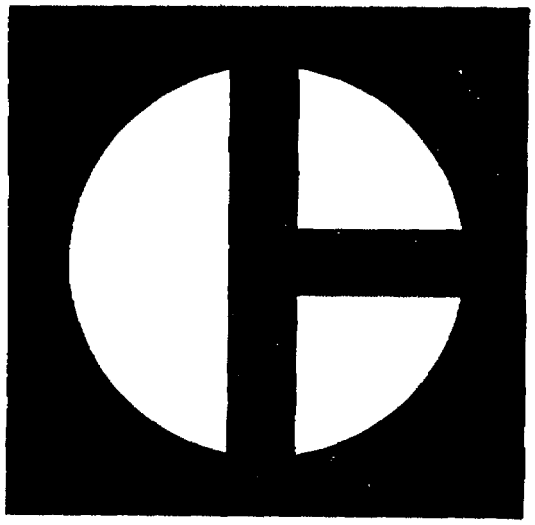
Note: *The terms "front" and "rear" when referring to a machine component are determined by sitting in the operator's seat and facing toward front of machine.*

10. Remove mounting bolts securing flywheel housing to transmission side plates.
11. Remove bolts from the *transmission* to engine mounting flange.
12. The engine may now be carefully *moved* to rear of the, machine to clear the hydraulic tank, and raised out of the machine.

INSTALLATION:

1. To Install engine, reverse removal procedure.
2. Care must be taken when coupling the engine to the transmission, not to damage the fibre ring gear on engine flywheel.
3. If installing a new ring gear on the engine flywheel, check to see that it fits on the converter drive ring before mounting.
4. Mount the fibre ring gear on engine flywheel, install bolts and torque evenly to 21 ft-lbs (3 m-kg).





OPERATION GUIDE

3208 INDUSTRIAL ENGINE

9ON1-UP

FOREWORD

This Operation Guide contains operation instructions, and lubrication and maintenance information. Application of this information should maximize performance and life of the engine; and minimize the costs of engine operation.

Caterpillar engines are found in many applications. Therefore, the illustrations in this Guide are typical and may not be of your specific engine or application.

Familiarize yourself with the components installed on your engine as described in the instructions. Some components described in the instructions may not be on your engine or installation.

Continuing improvement and advancement of product design may cause changes to your engine which may not be included in this publication. Each publication is reviewed and revised, as required, to update and include these changes in later editions.

Whenever a question arises regarding your Caterpillar product, or this publication, please consult your Caterpillar dealer for the latest available information.

The services of authorized Caterpillar dealers are recommended. Your dealer is staffed with trained personnel who are equipped with proper tools, necessary Caterpillar parts, and are trained in the latest service procedures.

ENGINE OPERATION

GENERAL

Proper engine operation and maintenance are essential to long engine life and maximum performance. The essentials for proper operation and normal periodic maintenance are outlined in this guide. However, your Caterpillar dealer is available for troubleshooting and/or repairs when required.

Before starting the engine, familiarize yourself with these procedures and apply the principles to your particular installation.

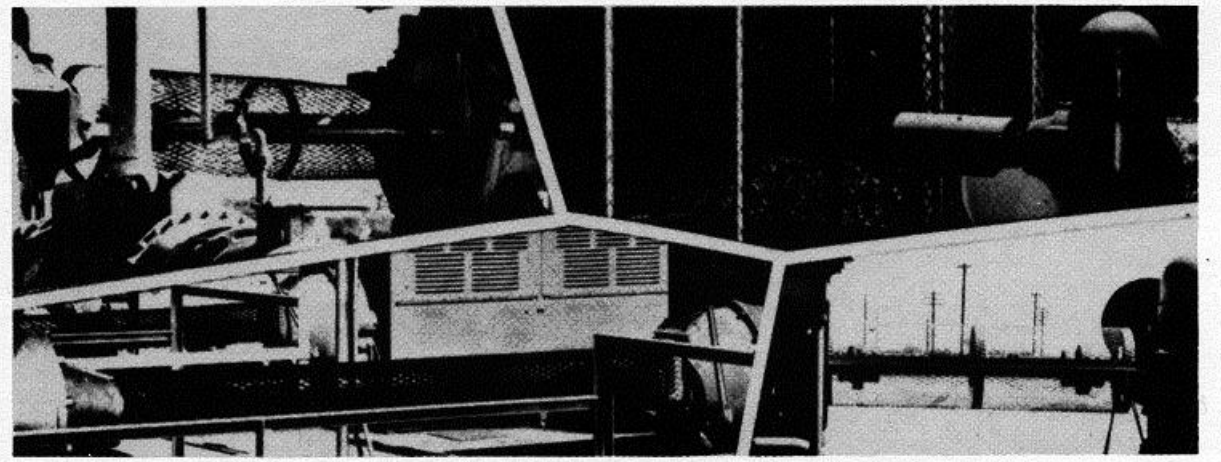
SAFETY PRECAUTIONS

Safety is basically common sense. There are standard safety rules but each situation has its own peculiarities which cannot always be covered by rules. Therefore with your experience and common sense, you are in a position to do something about safety. Lack of attention to safety can result in: accidents, personal injury, reduction of efficiency and worst of all-loss of life. Watch for safety hazards. Correct deficiencies promptly.

Use the following safety precautions as a general guide to safe operation.

1. Never adjust or repair a machine while it is in operation.
2. Remove all tools and electrical cords before starting.
3. Keep the engine room and floor area clean.
4. Store oily rags in containers.
5. Never store flammable liquids near the engine.
6. Observe NO SMOKING signs.
7. Do not smoke around batteries. Hydrogen gas generated by charging is explosive. Keep batteries in a well ventilated area.
8. Do not wear loose clothing around machinery.
9. Be sure the engine room is properly ventilated.
10. Always disconnect and tape the ground battery lead before working on the electrical system.
11. All electrical equipment must be grounded according to local building ordinances.
12. Be sure an automatic start-stop system is inoperative when the engine or generator is being worked on. Disconnect and tape the ground battery lead.

Remember, safety is everyone's business.



INSTALL GUARDS ON ALL EXPOSED ROTATING COMPONENTS

PERIODS OF LIMITED USE

A prolonged period without use is not good for any piece of machinery. Engines should be started and cycled every week. Load the engine every two weeks to the extent that it would be in normal operation. This is particularly important for standby power. Prolonged idling or running under a reduced load may cause oil consumption and carboning in the combustion chamber and result in poor performance and-a loss of power. If long periods of idling are necessary, run the engine under load every four hours to clear carbon from the combustion chambers.

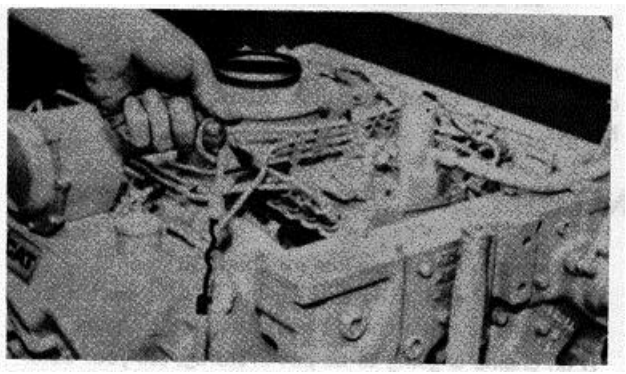
If an engine is going to be put in storage see your Caterpillar dealer for storage instructions.

STARTING

Perform required periodic maintenance before starting the engine. Make a "walk-around" check of the installation. It takes only a few minutes to correct minor discrepancies that can develop into major repair jobs.

PRE-START CHECKS

1. Correct any leaks, loose bolts or covers, and obstructions. The fan and radiator must be clear of restrictions.
2. Check the coolant level. Maintain coolant level to within 1/2 inch (1 cm) below bottom of fill pipe.
3. The crankcase oil level must be above the ADD mark on the dipstick.
4. Disconnect any battery chargers that are not protected against the starter current drain.
5. All guards must be in place. If guards are inadequate or in need of repair, notify your supervisor.



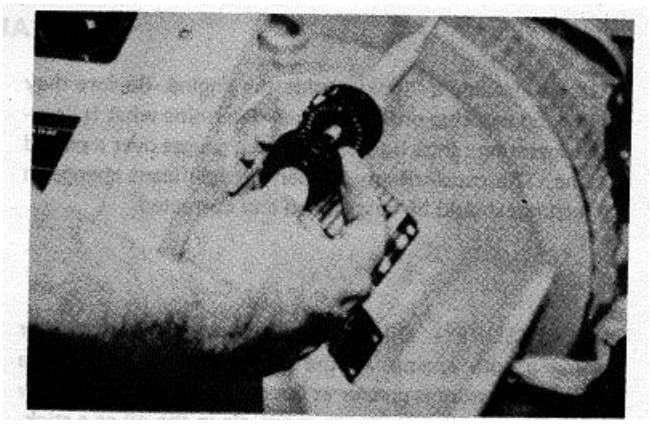
OIL LEVEL

If an engine has not been run for several weeks, fuel may have drained from or air accumulated in the filter housing. When fuel filters have been changed, some air space will be left in the housing. In these instances, prime the fuel system until pressure registers on the gauge.

STARTING PROCEDURE

ELECTRIC START

1. Open the fuel supply valve. The fuel return line must be open to prevent engine damage.
2. Disengage the clutch or open the circuit breaker. Do not start an engine under load.
3. Move the controls to half engine speed position. Push in on the center knob and simultaneously pull back the control knob.



OPERATING GOVERNOR CONTROL

4. Turn the start switch to START position. Start the engine using starting aids as necessary.

If the engine fails to start after 30 seconds of cranking, allow the starter to cool for two minutes before repeating the starting procedure.

CAUTION

Do not engage the starter when the flywheel is moving.

5. As the engine starts, release the start switch. It will return to the RUN position.

Clearances and tolerances are designed for operating conditions including operating temperature. After the engine is started it takes several minutes to establish the lubricating oil film and allow the moving parts to heat up and expand. Loading a cold engine will cause shortened service life; i.e., broken rings, seized pistons, etc. This warm up period allows time for another "walk-around" check for leaks, etc.

WARNING

Do not attempt repairs or adjustments while the engine is running.

COLD WEATHER STARTING

These engine; are designed to start at temperatures above 10°F without using starting aids. If temperature is below 10°F, a starting aid may be necessary and/or crankcase oil may need to be heated.

ETHER- - Ether is much more volatile than diesel fuel and is used to start combustion of the fuel-air mixture.

WARNING

Ether is volatile and must be stored away from heat and direct sunlight See the instructions on the container.

Engine mounted either dispensers are available commercially. Aerosol cans can also be used. Point the can opening at the air inlet and give a quick spray while cranking the engine. Too much ether will cause excessively high pressure and detonation. Liquid ether can be used by pouring a small amount on a cloth and holding the cloth in front of the air cleaner while the engine is cranking. Be sure the cloth is outside the air cleaner and cannot be drawn into the engine.

WARNING

DO NOT use ether after the engine has started. DO NOT inhale ether fumes.

In extremely cold climates, additional aids such as water heaters and battery heaters may be used. Contact your Caterpillar dealer before installing submersible crankcase oil heaters.

STOPPING

1. Remove the load from the engine.
2. Allow the engine to run at about half speed for five minutes. This allows internal temperatures to reduce gradually and prevents the loss of coolant by "afterboil".
3. Reduce speed to low idle for about 30 seconds.
4. Stop the engine by turning the START switch to OFF. The governor control will not stop the engine. If an engine is going to be put in storage see your Caterpillar dealer for storage instructions.

ATTACHMENTS

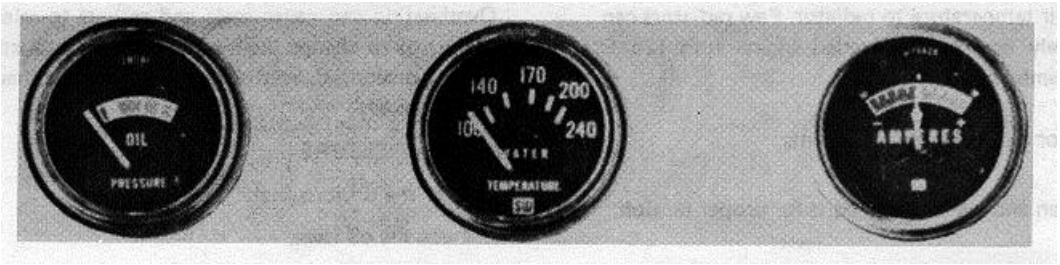
GAUGES

Gauges provide a "look" inside the engine. Be sure they are in good working order. You can determine what is "normal" operating range by observing the gauges over a period of time. The cause of any sudden or significant change in the readings should be determined and corrected.

OIL PRESSURE Oil pressure is normally greatest after starting a cold engine. As the oil warms up the pressure drops. Oil pressure is greater at operating speeds than at low idle. Fluctuating readings can mean air in the oil or a sticking pressure relief valve. Stop the engine immediately if a sudden loss of oil pressure occurs.

WATER TEMPERATURE The operating temperature is maintained by the water temperature regulator. High coolant temperatures mean the cooling system is not dissipating enough engine heat.

The minimum operating temperature should not be below 1750. If the temperature gauge continues to indicate below 1750 while operating, have the gauge checked for accuracy and the thermostats checked for proper operation.



OIL PRESSURE **WATER TEMPERATURE** **AMMETER**

In cold weather the temperature gauge may fluctuate in or near the cold range. This indicates the engine is being overcooled. In these instances the use of radiator louvers is suggested.

AMMETER The am meter should register in the charging range when the engine is running above low idle. If the gauge still registers a discharge as the engine speed is increased, determine the cause.

AUTOMATIC START-STOP

An automatic start-stop system ensures that power is supplied to a load when the normal power source is Interrupted. The cranking panel is the heart of the system and consists of the failure warning system and relays to start and stop the engine. When a power failure occurs the system senses the failure, starts the engine and transfers the load to standby. When power is restored, it senses power restoration, transfers the load from standby and stops the engine. The major use of automatic start-stop systems is standby electric sets. This discussion is limited to that application.

The remote contacts close when a power failure occurs and completes the circuit to the cranking timer and the start slave relay. The start slave relay completes the circuit to the starter motor and the engine begins cranking.

As the engine starts and increases In speed, the frequency sensing relay turns off the cranking timer and starts the slave relay. This disconnects the starter motor circuit and protects the starter from overspeed damage. If the engine fails to start, the cranking timer will time out and lock the start circuit open, preventing the batteries from being discharged.

During the cranking cycle, the safety shutoffs are inoperative to prevent a low oil pressure shut down. When oil pressure reaches a safe level the safety circuit is armed by the arming relay. High water temperature or low oil pressure will now stop the engine and prevent major damage.

If an unsafe engine condition exists, a sending unit completes the circuit to the safety relay and locking relay. The safety relay de-energizes the fuel solenoid and stops the engine. The locking relay insures that the circuit to the safety relay is complete even if the remote contacts open.

The safety circuit must be reset by moving the start selector switch to the OFF position. Before restarting any unit which has been shut down by the safety circuit, the cause must be determined and corrected.

DETERMINING THE CAUSE OF SHUTDOWN

Anytime an engine is shut down by its safety circuit, the cause must be determined. In some cases the cause will be obvious but often an investigation will have to be made. Do not put the engine back into service without determining and correcting the cause of the shutdown.

HIGH WATER TEMPERATURE

Look for the obvious first.

1. Check for water on the floor from spilled or leaking coolant.
2. Check the water temperature gauge for accuracy.
3. Check air flow through the radiator.

WARNING

DO NOT remove the pressure cap of an overheated unit. The coolant is under pressure and relieving this pressure will cause the coolant to flash into steam. Serious burns and engine damage can result from the escaping coolant. Pressure in a radiator or surge tank may be reduced by pouring warm water on the top tank to condense the steam.

CAUTION

NEVER add cold water to an overheated engine.

4. Check air temperature to radiator. Few radiators can adequately cool a fully loaded engine with 125°F (52°C) ambient air.
5. Check for recirculating air currents.
6. Check fan and water pump belts for proper tension.
7. See that engine room vents and louvers are open.
8. Check water hoses for leaks. Is the water pump inlet hose collapsed. Hoses have been known to peel off Internally and restrict water flow.
9. If the engine is overloaded, overheating can result.

Overheating can cause seals and gaskets to relax and fuel nozzles to change their operating characteristics. If severe or prolonged overheating has occurred, have the engine checked.

LOW OIL PRESSURE

Look for the obvious first.

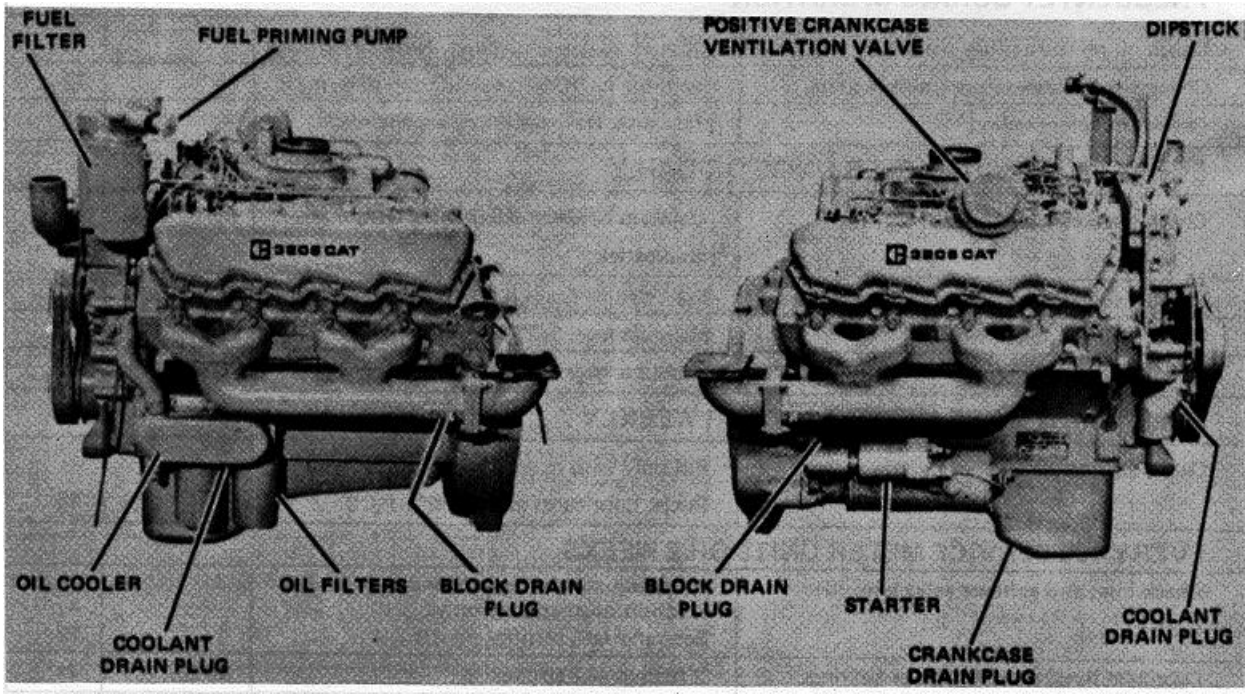
1. Check the oil level.
2. Check floor for oil from leaks.
3. To determine If low oil pressure was the cause of the shut down, crank the engine with the fuel valve disconnected. If unusual noises come from the engine, discontinue cranking. If oil pressure fails to build up, and no external leaks are found, the problem is probably internal.

LUBRICATION AND MAINTENANCE CHART

The LUBRICATION AND MAINTENANCE CHART lists all serviceable items commonly ordered on this engine. The items are listed according to their frequency of maintenance, followed by those items needing only "As Required" maintenance.

Diesel fuels, lubricants, types of battery and the coolant make-up water to use are explained in the topic "Key to Fuels, Lubricants and Water" which follows this chart.

Page numbers refer to the LUBRICATION AND MAINTENANCE PROCEDURES where the detailed service instruction for that item can be found.



SERVICE INTERVALS

The service meter is the most reliable method of determining *service* intervals. The service meter shows the total number of units your engine has run. Perform the maintenance at multiple intervals of units shown. For example when the service meter shows "100" on the dial, all items listed under "EVERY 10 SERVICE METER UNITS" should be serviced now for the tenth time, and all items under "EVERY 50 SERVICE METER UNITS" should be serviced for the second time.

If your engine does not have a service meter, use the calendar interval. These figures are based on a 10 hour day and a 2000 hour year. If your operation differs from these limits, base your service intervals on actual running time. Keep an accurate record of operating time.

Items which do not pertain to your engine may be lined out to customize your charts.

SERVICE ITEMS AND PROCEDURES		LUBE	PAGE
FREQUENTLY DURING OPERATION			
Check oil pressure gauge reading.	Observe all gauge readings. Note any change	-	11
Check water temperature gauge reading.	from the NORMAL reading and determine	-	17
Check ammeter reading.	the cause. Have necessary repairs made.	-	18
EVERY 10 SERVICE METER UNITS OR DAILY			
Check crankcase oil level.	Maintain between ADD and FULL mark on dipstick.	CD or CC	11
Fill fuel supply tank after stopping.	See "Key to Fuels, Lube & Water", Pg. 9	-	15
Check engine coolant level.	Maintain level 1/2" below fill pipe.	-	17
Check clutch adjustment.	Should engage with distinct snap.		21
EVERY 50 SERVICE METER UNITS OR WEEKLY			
Check electrolyte level of battery cells.	Fill only with make-up water, See "Key to Fuels, Lubricants and Water", Pg. 9	-	18
EVERY 100 SERVICE METER UNITS OR 2 WEEKS			
Check inlet and exhaust valve lash. (See Note 4)	Initial adjustment for new and reconditioned engines only. See valve lash setting, Pg. 10		12
Lubricate flywheel clutch lever bearings.	2 fittings - 2 strokes	MPGM	21
EVERY 150 SERVICE METER UNITS OR 3 WEEKS			
Change engine oil and oil filter. (See Note 2)	Drain and refill. Refill capacity 12 qts. (11.5 ltrs.)	CC (See Note 1)	11
Change air cleaner elements. (See Note 3)	Install a new or a cleaned element.		12
Check fan and drive belt wear and tension.	Maintain belt tension as indicated in chart		22
Check flywheel clutch oil level.	Keep at proper level.	CD or CC	21

		LUBE	PAGE
EVERY 500 SERVICE METER UNITS OR 3 MONTHS			
Check inlet and exhaust valve lash. (See Note 4)	See valve lash setting, Pg. 10		12
Change oil in flywheel clutch housing.	Drain and refill. Refill capacity 1 qt. (1 ltr.)	CD or CC	21
EVERY 1000 SERVICE METER UNITS OR 6 MONTHS			
Check safety shutoff operation.	Check by authorized personnel only.		23
Drain water and sediment from fuel tank.			15
Clean primary fuel filter element (if equipped).			15
EVERY 2000 SERVICE METER UNITS OR 1 YEAR			
Change final fuel filters.	Change more often if loss of power is experienced.		15
PCV Valve	Check-replace diaphragm		14

Note 1: Oil period can be extended to 200 hours when CD type oil is used.
Note 2: Normal change interval when fuel sulphur is 0.4% or less.
When sulphur content is 0.4% to 1.0% reduce oil change interval one-half.
When sulphur content is above 1% reduce oil change to one-fourth the normal interval.
Regardless of hours, change oil and filters every six months.
Note 3: More often in dusty conditions. If after servicing the air cleaner, the exhaust smoke and/or loss of power continues, discard that element and install a new element at least once a year.
Note 4: Check valve lash after the first 80100 hours of operation and then at least every 6 months regardless of service hours.

KEYS TO FUELS, LUBRICANTS AND WATER

FUEL: Use only distillate fuels (ASTM No. 1 or No. 2 Fuel Oil, or No. 1D or No. 2D Diesel Fuel Oil are examples) with a minimum cetane number of 40. Heavier oil is generally preferable because of its higher energy content.

CD: Use oils which meet Engine Service Classification CD, or MIL-L-2104C, in Caterpillar diesel engine crankcases and gear compartments.

CC: Use oils which meet Engine Service Classification CC, MIL-L-2104B or MIL-L-46152 in these Diesel engine crankcases and/or gear compartments.

MPGM: Use Multipurpose-type Grease which contains both 3 to 5% molybdenum disulfide conforming to MIL-L-7866, and a suitable corrosion inhibitor. NLGI No. 2 Grade is suitable for most temperatures NLGI No. 1 or No. 0 are suitable for extremely low temperatures.

BATTERY: WATER Use either distilled water; or, odorless, tasteless drinking water. Do not use mineral water, water containing iron, salt water or softened water.

ENGINE: COOLANT Use clean water that is low in scale forming minerals not softened water. When the temperature is below 320F (0°C), a sufficient amount of permanent type anti-freeze must be added to adequately protect your engine against freezing. Adding Caterpillar Coolant System Conditioner is recommended if protection is for temperatures above -20°F (-29°C).

RECOMMENDED VISCOSITIES AT VARIOUS STARTING TEMPERATURES

COMPONENT	ABOVE 32°F (ABOVE 0°C)	BELOW 32°F (BELOW 0°C)
Diesel engine crankcase	SAE 30 SAE 10W-30	SAE 10W[(1)] SAE 10W-30
Flywheel clutch rear bearing	SAE 30	SAE 10W

(1) SAE 10 OW oil may be used even if daytime ambient temperatures rise to 70°F (210C).

In temperatures below 10°F (-12°C) it may be necessary to warm the oil so the engine can be cranked and the oil will circulate freely.

REFILL CAPACITIES (Approximately)

COMPONENT	U.S. Qts.	Imp. Qts.	Liters
Diesel engine lubrication system	12	10	11.5
Flywheel clutch rear bearing	1	1	1
Cooling system Engine only	26.0	21.5	24.5
High capacity radiator	40.0	33.5	38
Standard radiator	38.75	32.5	37.5

VALVE LASH

(Engine stopped and cold.)

Exhaust valves	.025 inch (0,63 mm)
Inlet valves	.015 inch (0,38 mm)

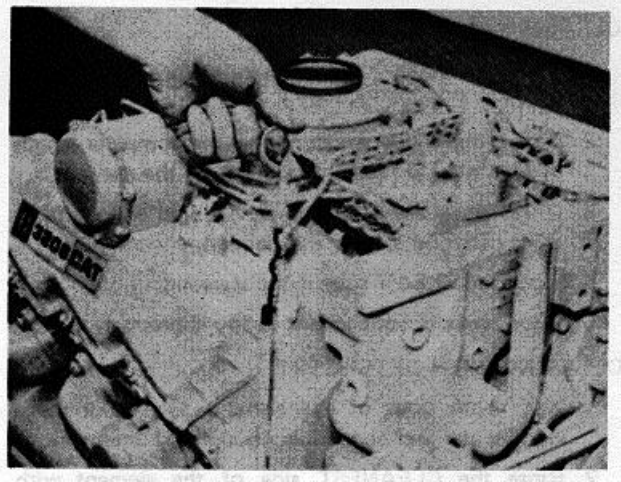
ENGINE LUBRICATION SYSTEM

CHECKING OIL PRESSURE GAUGE READING

Observe the oil pressure gauge frequently. If the indicator registers below NORMAL, or fluctuates, determine the cause and take the necessary corrective measures.

CHECKING OIL LEVEL

Check the oil level before starting. Maintain the oil level between the ADD and FULL marks on the dipstick. See the Lubrication and Maintenance Chart for proper oil.

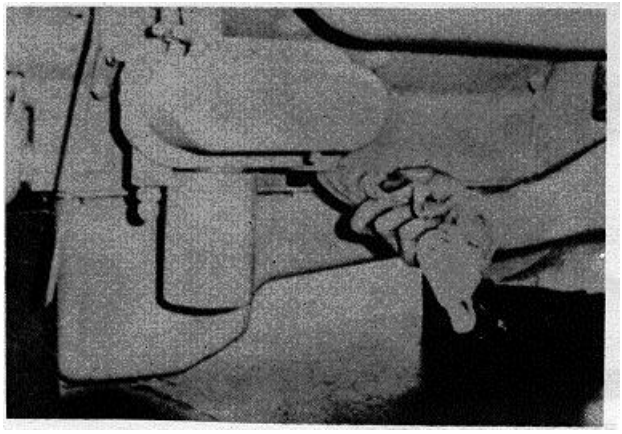


CHECKING THE OIL LEVEL

CHANGING CRANKCASE OIL AND FILTERS

Drain the crankcase with the engine stopped and oil warm.

1. Remove the crankcase drain plug.
2. Unscrew and remove the filters. Be sure the old filt**er gasket does not** remain attached to the filter **base:** Leaking between the new and old filter gaskets will result.
3. Wipe the filter base.



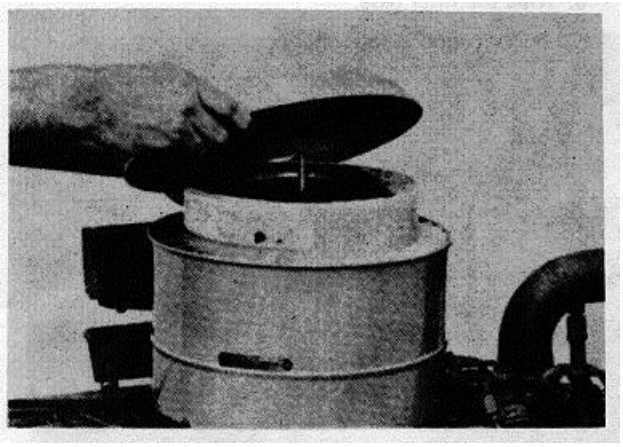
WIPING THE FILTER BASE

4. Apply a thin coat of clean oil to the gasket of each new filter.
5. Install new filters. Hand tighten the filter 1/2 turn after the gasket contacts the filter base.
6. Install the drain plug. Fill the crankcase with clean oil. See the Lubrication and Maintenance Chart for refill capacity and proper oil to use.
7. Check oil level before starting.
8. Start and run the engine until it is warm; check for oil leaks.

AIR INDUCTION AND EXHAUST SYSTEM

AIR CLEANER

1. Remove the wing nut, cover and element.
2. Clean the inside of the cover. The base should be clean. If the base is dusty, the air cleaner gasket leaked; discard the element.
3. Inspect the new element for damage and dirt.



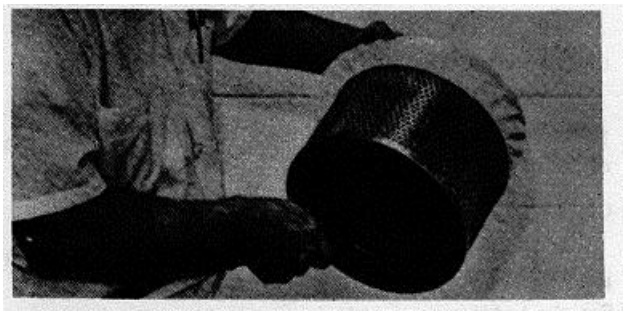
REMOVING THE ELEMENT

4. Install the new element and cover.

The element removed may be cleaned or discarded, depending upon the apparent condition of the pleats. If a cleaned element is installed, and the exhaust smoke and/or loss of power continues, remove and discard that element and install a new element. Install a new element at least once a year.

CLEANING WITH PRESSURE AIR

1. Use clean, dry air - 30 PSI maximum. Hold the nozzle at least one inch from the element and at a slight angle. (A direct blast can rip the pleating.)
2. Direct the air stream along the complete length of each pleat on the CLEANEST side of the element. (This will loosen the dirt from the dirtier side.)
3. Blow the loosened dirt from the DIRTY side.
4. Direct the air from the CLEAN side through to the DIRTY side to remove any dirt blown into the pleats.



CLEANING THE ELEMENT WITH PRESSURE AIR

CLEANING WITH WATER

1. Use clean water - 40 PSI maximum. Do not use a nozzle.
2. Direct the water stream along the complete length of each pleat on the CLEAN side of the element.
3. Direct water along the complete length of each pleat on the DIRTY side of the element.
4. Rinse the CLEAN side of the element.
5. Allow the cleaned element to dry thoroughly.

CLEANING WITH DETERGENT

1. Wash both sides of the element in a solution of warm water and non-sudsing household detergent.
2. Rinse the CLEANEST side of the element with clean water (40 PSI maximum) along the complete length of each pleat.
3. Rinse the opposite side of the element along the complete length of each pleat.
4. Rinse the first side again to remove all loosened dirt.
5. Allow the cleaned element to dry thoroughly.

CHECKING CLEANED ELEMENT

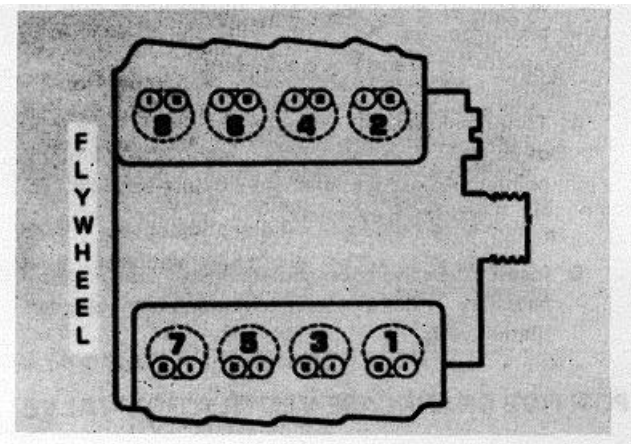
Hold the dried element in front of a lighted electric bulb. Carefully inspect the element for tiny, pin-points of light. Any light showing indicates a pleat has ruptured and will tear with further use. Discard the element.

1. Wrap usable elements in heavy paper.
2. Store the wrapped element in a dry, clean place.

VALVE LASH

PREPARING TO CHECK ADJUSTMENT

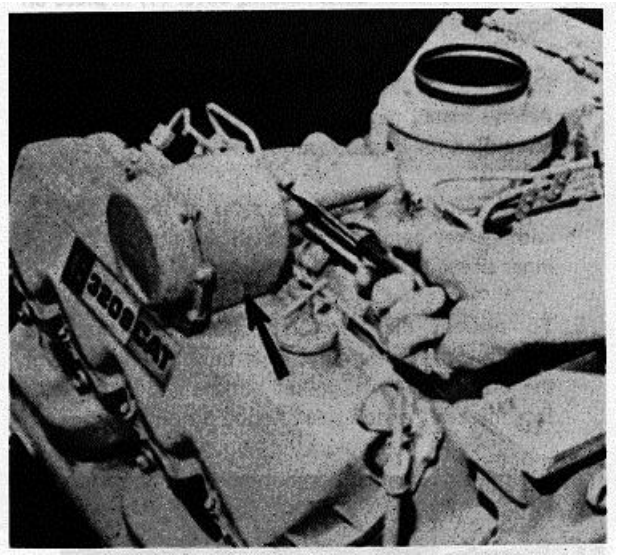
TDC of the No. 1 piston on the compression stroke is the reference point. The No. 1 piston is at TDC compression stroke when the timing mark on the damper or the pulley is aligned with the timing pointer, and No. 1 and No. 2 exhaust and inlet valves are closed. (The rocker arms are free and the push rod is at its lowest point.)



NUMBERING OF CYLINDERS AND VALVE LOCATION

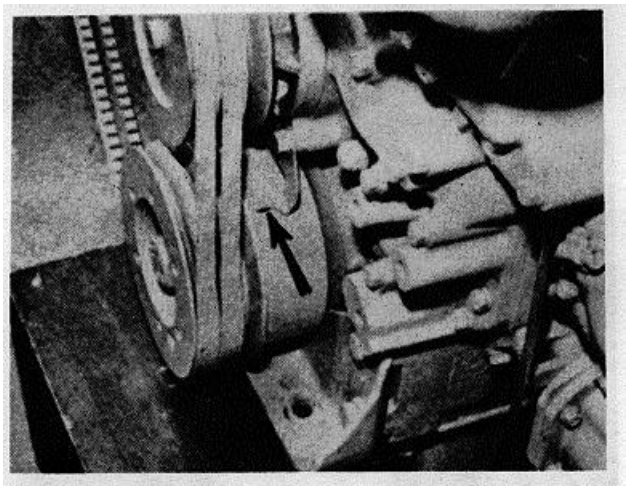
TO CHECK VALVE LASH

1. Stop the engine.
2. Clean around the valve covers.
3. Remove the crankcase ventilation valve.
4. Remove both valve covers.



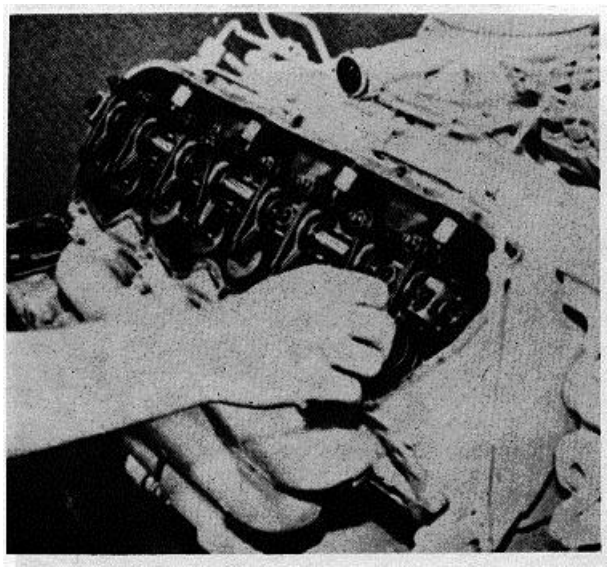
REMOVING CRANKCASE VENTILATION VALVE

5. Turn the crankshaft until No. 1 cylinder is on top dead center ("TC1") compression stroke. Align the ('TC1") timing mark on the damper with the timing pointer located on the front of the engine block.



TIMING MARK AND POINTER

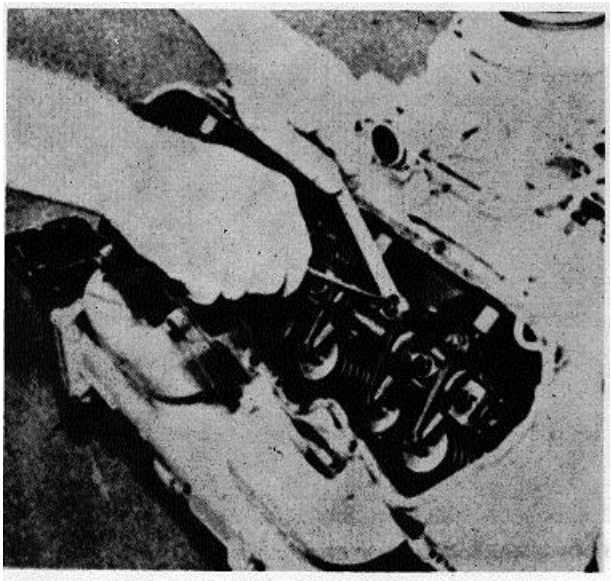
Both the exhaust and inlet valves for No. 1 and No. 2 cylinders will be closed: The four rocker arms will rotate with finger pressure.



ROTATING ROCKERS

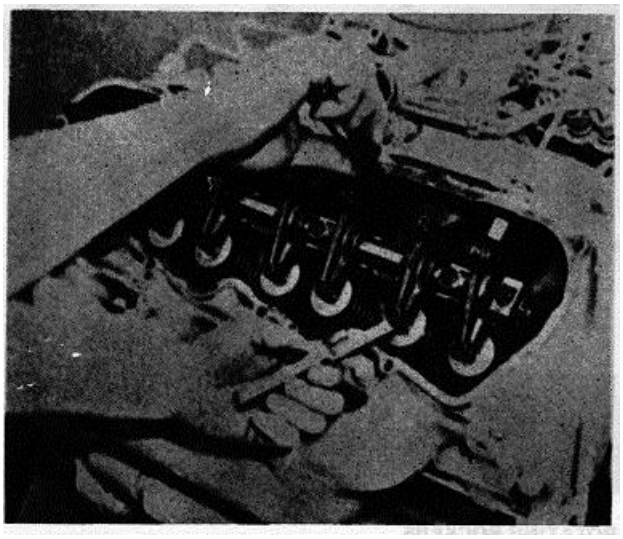
ADJUSTING VALVE LASH

1. Adjust the inlet and exhaust valve lash for No. 1 and No. 2 cylinders:
   a. Loosen the valve adjusting screw locknut.



LOOSENING LOCKNUT

b. Turn the adjusting screw to allow a clearance gauge to pass between the top of the valve stem and the valve rocker arm. See the LUBRICAT- ION AND MAINTENANCE CHART for correct lash measurement,



ADJUSTING VALVE LASH

c. Tighten the adjusting screw locknut.
d. Check valve lash clearance.

2. Turn the crankshaft 180° clockwise (viewed from the front of the engine). On later engines, align the "VS" timing mark with the timing pointer. Adjust the inlet and exhaust valve lash for No. 3 and No. 7 cylinders.

3. Turn crankshaft 180° clockwise (viewed from front of engine), and align "TC1" timing mark with the timing pointer. Adjust the inlet and exhaust valve lash for No. 4 and No. 5 cylinders.

4. Turn crankshaft 180° clockwise (viewed from front of engine); align "VS" timing mark with the timing pointer. Adjust the inlet and exhaust valve lash for No. 6 and No. 8 cylinders.

5. Inspect the valve cover gaskets. Install new gaskets if necessary. Install the valve covers and crankcase ventilation valve.

POSITIVE CRANKCASE VENTILATION VALVE

The PCV valve directs blow-by gases to the combustion chambers where they are burned. An oily accumulation around the cover could indicate the diaphragm has worn through. Replace diaphragm every 2,000 service hours, or annually.

Replacing Diaphragm:

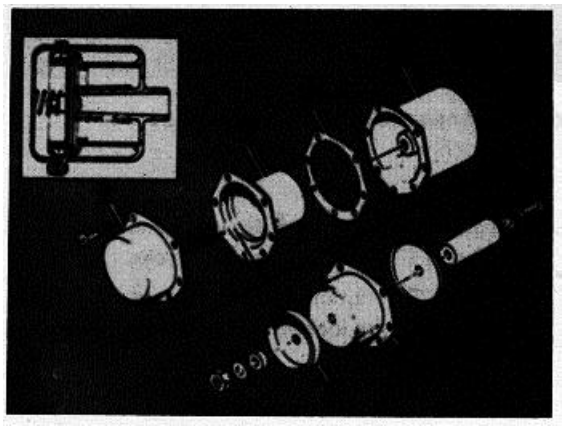
1. Clean area around PCV valve.

2. Remove series of bolts holding cover (1) in place on housing (4).

3. Clean and inspect all parts and replace as necessary. Always install new gaskets and diaphragm when disassembled for inspection.

4. When installing, coat both sides of the gasket (3) with gasket cement and install against rear face of inner sleeve (2).

5. To prevent diaphragm (6) from distorting and tearing during assembly, coat both flange sides of the diaphragm with gasket cement and install with face marked "piston side" facing piston (5).



FUEL SYSTEM

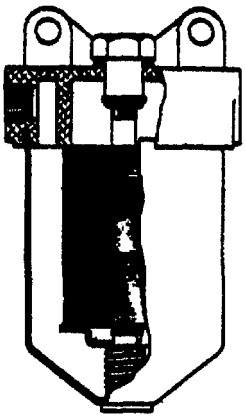
FUEL TANK

Open the fuel tank drain valve to drain water and sediment from the fuel tank. To minimize water contamination, fill the fuel tank in the late afternoon: As the fuel is consumed, air with some humidity must replace the fuel In the tank. By filling the tank In the late afternoon, this humid air Is expelled before the moisture can condense on the cool inside walls of the fuel tank.

FUEL FILTERS

CLEANING PRIMARY FILTER ELEMENT

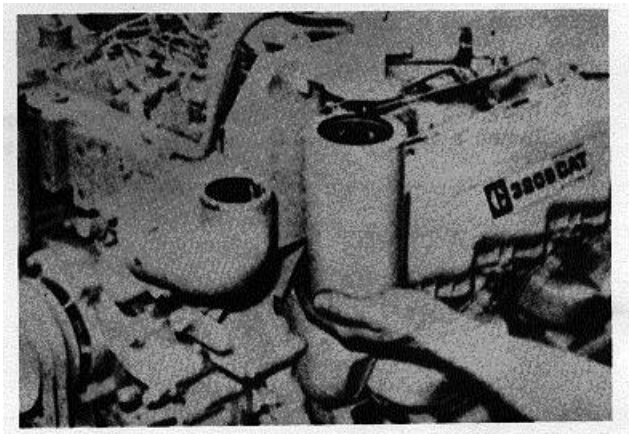
1. Stop the engine,
2. Close the diesel fuel supply valve.
3. Loosen the nut on the cover and remove the case and filter.
4. Clean the element and case in clean kerosene or diesel fuel.
5. Before Installing the filter, Inspect the gaskets. Install new gaskets if necessary.
6. Install the cleaned filter element and case.
7. Prime the fuel system,



PRIMARY FUEL FILTER

INSTALLING NEW FINAL FUEL FILTER ELEMENTS

1. Unscrew and remove the filter. Be sure the old filter gasket doe not remain attached to the filter bas: Leaking between the new and old filter gaskets will result.



REMOVINO THE FUEL FILTER

2. Clean the gasket sealing surface of the filter b**ase.**
3. Lubricate the new filter gasket with clean diesel fuel.
4. Tighten filter by hand until gasket contacts base; then tighten 1/2 turn more.
5. Prime the fuel system.

NOTE

Do not pour fuel Into the new filter element before installing.

PRIMING THE FUEL SYSTEM

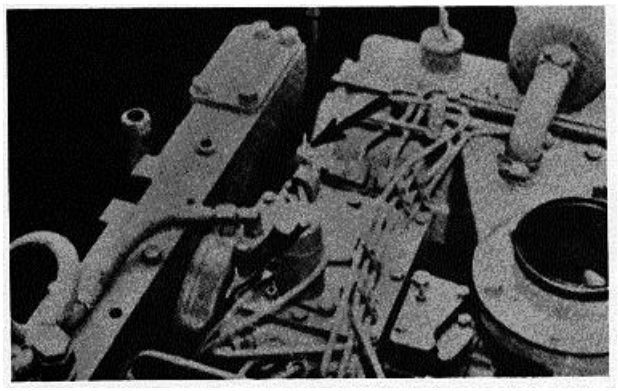
If air is trapped in the fuel **system,** the diesel engine will either not start, or will misfire.

To prime the system:
1. Stop the engine.
2. Loosen the vent valve on the fu**el** pump housing.

CAUTION

Operate the priming pump only when the bleed valve is open. Avoid bleeding excessive fuel.

3. Operate the electric starter, or the hand priming pump if so equipped, until the flow of fuel from the filter Is continuous and free of bubbles.

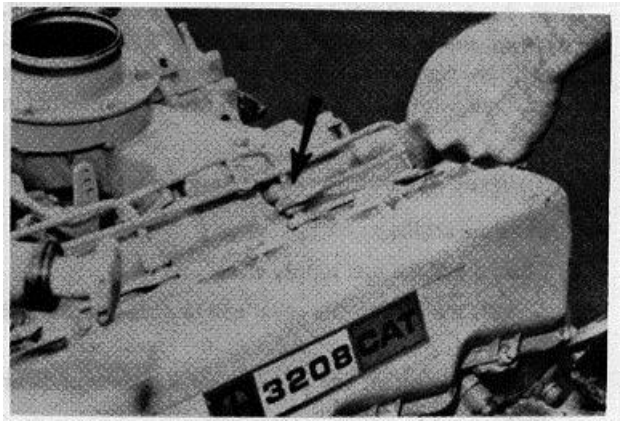


VENT VALVE



OPERATING THE PRIMING PUMP

4. Tighten the vent valve.
5. Start the engine. If the engine misfires or smokes, loosen a fuel injection line nut; allow the fuel to flow until free of air bubbles. Tighten the line nut, open the next line nut and continue priming each successive line.



BLEEDING THE FUEL LINE

COOLING SYSTEM

ENGINE JACKET WATER

CHECKING COOLANT LEVEL

Check coolant level with the engine cool and stopped:

1. Slowly loosen the filler cap and release pressure.

WARNING

Be careful if engine is warm; steam may spray. Avoid being burned.

2. Push downward and turn the cap until it is released.
3. Maintain coolant level to within 1/2 inch (1 cm) below bottom of fill pipe. The coolant will expand as it is heated.
4. Make-up coolant must be one of the following:
   a. Permanent anti-freeze and water solution.
   b. Drinkable water and rust inhibitor solution.

For emergencies, and only as a "temporary fix" until the cooling system can be returned to either (a) or (b), use either:

   c. Drinkable water.
   d. Any available water.

"Drinkable water" is clean water that is low in scale forming minerals - not softened water. Never add coolant to an overheated engine; allow it to cool first.

Check specific gravity of anti-freeze solution frequently in cold weather to assure adequate protection.

CAUTION

Add coolant slowly to a hot engine to prevent possible cracking or distorting the cylinder head.

DRAINING RADIATOR

Whenever it is necessary to drain the cooling system for repairs:

1. Remove the filler cap.
2. Open the drain valve for the radiator.

DRAINING COMPLETE COOLING SYSTEM

1. Drain the radiator; see the topics above.
2. Remove front cover drain plug.
3. Remove both engine block drain plugs.
4. Remove the oil cooler coolant drain plug.
5. Remove the coolant; then install all drain plugs.

FLUSHING COOLING SYSTEM

To clean the cooling system, any good commercial radiator cleaning solution can be used. Follow the instructions included with the cleaner.

The cooling system can be cleaned using oxalic acid and sodium carbonate as follows:

1. Fill the cooling system with a solution consisting of one pound of oxalic acid or sodium bisulfate (NaHSO4) with every 5 gallons of water (mix 0,24 kg. with every 10 liters of water).
2. Start the engine and operate at operating temperatures for 1/2 to 1 hour.
3. Stop the engine and drain the cooling system.
4. Flush the system with clean water until the draining water is clear.
5. Install all drain plugs.
6. Fill with a solution consisting of 1/2 pound of sodium carbonate crystals (Na2CO3, 10H20) with every 10 gallons of water (mix 0,06 kg with every 10 liters of water).
7. Start and run the engine for 10 minutes.
8. Stop the engine and drain the cooling system.
9. Flush the cooling system with clean water.
10. Install all drain plugs.

FILLING COOLING SYSTEM

1. Add anti-freeze, if required.
2. Fill to correct level with coolant which is free as possible from scale forming minerals. Do not use softened water.
3. Start and run engine for 10 minutes.
4. Remove the radiator cap and check the coolant level.
5. Add coolant, if needed, until coolant level is within 1/2 inch (1 cm) below bottom of the filler tube.
6. Install the radiator cap.

Most commercial antifreeze solutions contain rust inhibitors, however, it is recommended the adding of Caterpillar Coolant System Conditioner to glycol base antifreeze if protection is for temperatures above -20°F (-29°C). If protection is for temperatures -20°F (-20°C) or below, do not add conditioner. Follow instructions given on the container.

WARNING

Inhibitor contains alkali. Avoid contact with eyes. Avoid prolonged or repeated contact with skin.

ELECTRICAL SYSTEM

BATTERY INSTALLATION

PREPARING DRY CHARGE BATTERIES

One day before installing a new dry charge battery, add the electrolyte solution to each cell.

1. Fill each cell to the bottom of the vent with electrolyte solution.

CAUTION

If the battery is initially filled with water by mistake, the battery is ruined and must be replaced.

2. Allow the battery to sit for several minutes to permit the battery plates to absorb the electrolyte.
3. Add make-up electrolyte solution until the level stabilizes. Once the level stabilizes, never add anything but water.
4. Install the vent caps.
5. Remove the tape covering the vent hole in each cap.
6. Slowly charge the battery on a battery charger until the specific gravity of the solution is at least 1.240 at a temperature of 80°F (27°C).

NOTE

If the electrolyte solution temperature nears 125°F (53°C) reduce the charging rate. Temperature in excess of 125°F (53°C) will ruin the battery.

PREPARING WET CHARGE BATTERIES

The electrolyte solution was added by the manufacturer. Make-up solution must be water; never add electrolyte or acid to a wet charge battery. If necessary, slowly charge the battery before using.

USING A BATTERY CHARGER

A desirable charging rate can be calculated by multiplying the amp-hour rating of the battery by .07 (7%).

Shut off the battery charger before disconnecting the booster charger clamps from the battery terminals. While the battery is charging, hydrogen gas is being given off through each vent cap. When hydrogen gas is mixed with air, the mixture is highly explosive and will explode in the presence of a spark or small flame.

WARNING

Never smoke near the area where batteries are being charged.

INSTALLING BATTERY

1. Be sure the tray is free of objects which may puncture the battery case when the hold down straps are tightened.
2. Be sure terminal posts and cable clamps are clean.
3. Place the battery in the tray. Tighten the hold downs evenly until the battery is snug. Do not overtighten.
4. Connect the "hot" terminal first.
5. Connect the ground terminal last.

CAUTION

Always connect the "hot" terminal first.

When the "hot" terminal is connected first, no arcing can occur if the wrench accidentally contacts both the terminal and the frame or tray. The part that is contacted will take the same polarity as the battery terminal.

By connecting the ground terminal first, the frame or tray is connected to ground. Then, if the wrench accidentally contacts the frame while connecting the "hot" terminal, a circuit is completed through the wrench. A hot spark will occur which could burn the person holding the wrench, or possibly explode the battery if an excess of hydrogen gas is present at any one of the vent holes.

After connecting both cables, apply a thin coating of grease over the cable clamps, terminals and hold down fasteners.

BATTERY MAINTENANCE

TESTING THE ELECTROLYTE SOLUTION

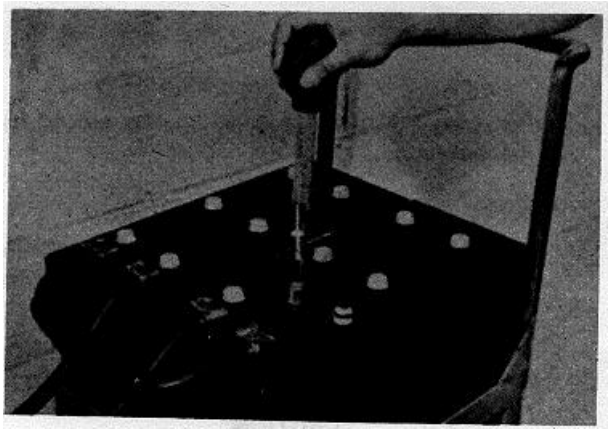
The general condition of a battery can be determined by measuring the specific gravity of the electrolyte solution and adjusting the reading to 800F (270C). If the electrolyte level is too low to allow taking a hydrometer reading, add make-up water to the correct level and then charge the battery 2 to 4 hours before taking a reading.

1. Insert the hydrometer into a cell. Fill the hydrometer barrel while holding it vertically. The float must not drag on the wall of the barrel.

2. Read the hydrometer:

   1.250 or above - fully charged battery cell
   1.250-1.225 - full to half charged battery cell
   1.225-1.150 - half to low charged battery cell
   Below 1.150 - dead cell
   1.000 - water

3. Test each cell in the same manner.



MEASURING SPECIFIC GRAVITY

4. If there is more than .050 (50 gravity points) variation between the highest and lowest reading, the battery should be replaced.
5. Adjust the readings to 80°F (27°C).

a. For every 10F° (5.5C°) the electrolyte tempera-
ture is above 80°F (27°C), add .004 (4 gravity points) to the specific gravity reading.

Example: Electrolyte temperature = 100°F; 38°C
Corrected temperature = 80°F; 27°C
Difference: = 20°F; 11°C
Increments: 10; 5.5
20 ÷ 10 = 2 ; 11 + 5.5 = 2
2 x 4 gravity points = 8 gravity points

Add 8 gravity points to your hydrometer reading to obtain the adjusted reading at 100°F. If the uncorrected hydrometer is 1.240 the corrected reading would be: 1.240 + 8, or 1.248

b. For every 10F° (5.5°C) the electrolyte temperature is below 80°F (27°C), subtract .004 (4
gravity points) from the specific gravity reading.

Example: Electrolyte Temperature = 10°F; -13°C
Corrected temperature = 80°F; 27°C
Difference = 70°F; 40°C
Increments: 10; 5.5
70 ÷ 10= 7; 40 ÷ 5.5 = 7
7 x 4 gravity points = 28 gravity points

If the uncorrected hydrometer reading is 1.210 the corrected reading would be 1.210- 28 = 1.182

The corrected reading is of most importance during cold weather when the hydrometer reading is always corrected to a lower specific gravity reading. A low reading signifies the battery has less available power to crank the engine and that booster batteries may be required.

ADDING MAKE-UP WATER

Check the electrolyte level of each cell and the general condition of the battery.

1. Maintain the electrolyte level to the base of each vent well.
2. The make-up water must be one of the following (in order of preference):

a. Distilled water.
b. Odorless, tasteless drinking water.
c. Iron free water.
d. Any available water.

WARNING
Never add acid or electrolyte.

READING THE AMMETER

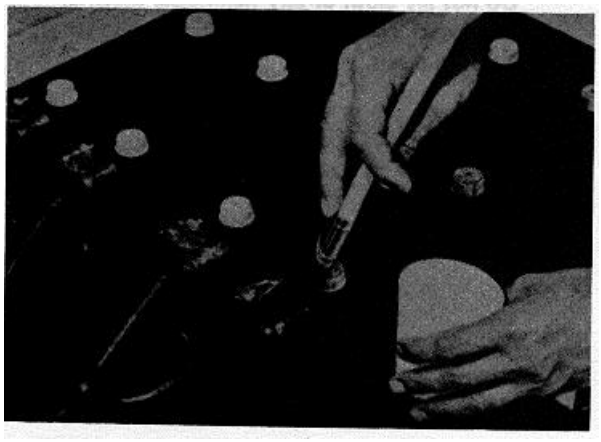
1. After starting the engine, the ammeter indicator should register to the right of zero, but should never be "pegged".
2. After the engine has been running, the indicator should be just to the right of zero.

If the indicator either "pegs" to the right, or remains to the left of zero with an increases of engine speed, have the electrical charging system checked.

The alternator charging rate maintains the battery's electrolyte specific gravity reading, and the battery's performance, An undercharge rate cannot maintain a desired 1.250 specific gravity reading. An overcharge rate will boil the water from the electrolyte solution. A proper charging rate should require no more than one ounce (30 cc) of water per cell per week-to maintain a fully charged battery.

CLEANING BATTERY

1. Mix a weak solution of baking soda and water. Apply the solution with a bristle brush.



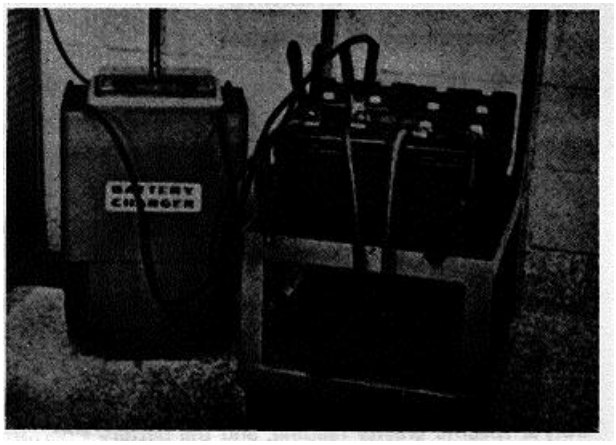
CLEANING BATTERY TERMINALS

2. Thoroughly rinse the battery and battery tray with clean water.
3. Apply grease to the battery cable clamps and terminals and to all threads.

COLD WEATHER BATTERY MAINTENANCE

The following instructions aid in obtaining maximum performance in cold weather:

1. After adding make-up water, charge the battery. The added water will dilute the electrolyte. This will lower the specific gravity of the solution, raise the freezing point of the solution and lower the charge of the battery.



2. Keep the batteries fully charged either by operating the charging system or by using a battery charger.
3. Keep the electrolyte warm when the battery is not in use. The heat from an electric light bulb usually is sufficient.

CAUTION

Do not lay cloth or any flammable material in contact with a lighted bulb. Charring, or fire, can result.

4. Use starting aids as instructed when starting.
5. Use booster batteries as required. Connect as instructed below.

CONNECTING A BOOSTER BATTERY

1. Using a pair of jumper cables, connect the red jumper cable to the "hot" terminal of the 12 Volt booster battery.
2. Connect the black jumper cable to the ground terminal of the booster battery.

CAUTION

Keep the red and black cable terminals from touching each other.

3. Connect the other end of the red jumper cable to the "hot" terminal of the engine battery.
4. Connect the other end of the black jumper cable to the ground terminal of the engine battery.
5. Start the engine using starting aids as instructed.

REMOVING JUMPER CABLES

As soon as the engine starts:

1. Disconnect the black jumper cable from the engine battery ground terminal.
2. Disconnect the red jumper cable from the engine battery "hot" terminal.
3. Disconnect the black jumper cable from the booster batteries.
4. Disconnect the red jumper cable from the booster batteries.
5. Disconnect the booster batteries. Charge them to full capacity with a battery charger.

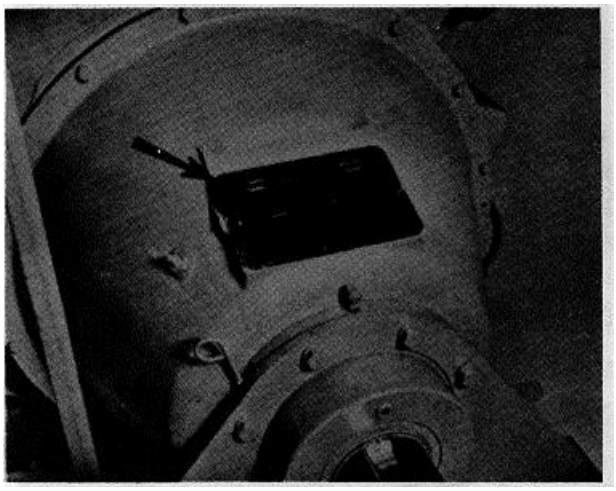
ENCLOSED CLUTCHES AND/OR FRONT POWER TAKE-OFF

CHECKING CLUTCH ADJUSTMENT

While engaging the clutch to pick up the load, check the clutch adjustment. The clutch should engage with a hard push and distinct snap. If engagement is "soft", adjust the clutch.

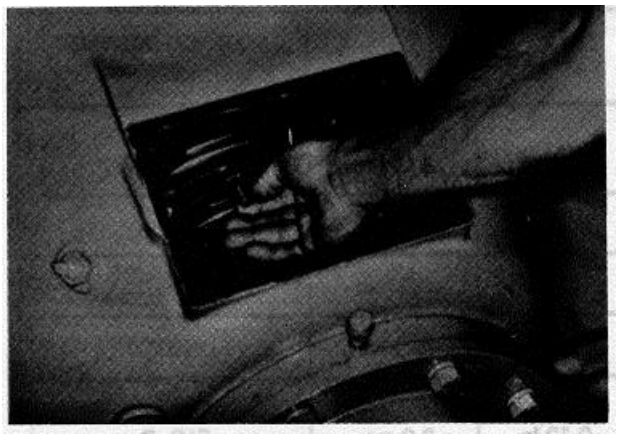
ADJUSTING CLUTCH

1. Stop the engine and remove the clutch inspection cover.



CLUTCH INSPECTION COVER

2. Turn the clutch until the lock pin, engaged in the locking ring, is visible.
3. Pull the lock pin out and rotate the locking ring clockwise until the lock pin pops into the next notch.



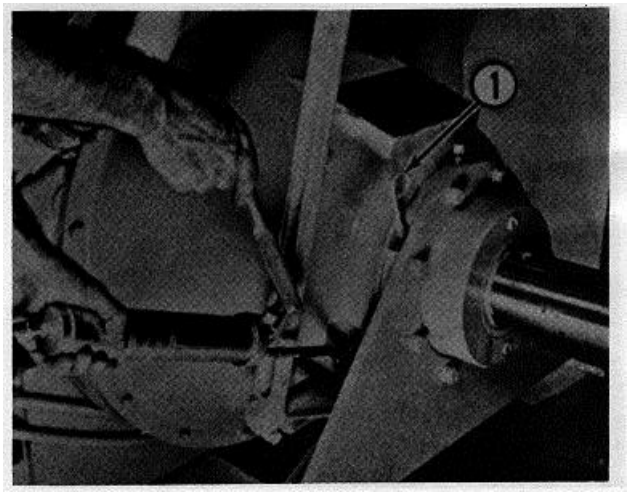
DISENGAGING LOCKING PIN

4. Test the clutch adjustment. If still too "soft", rotate the ring to the next notch. If the adjustment is too tight-turn the ring back one notch.
5. Install the cover.

LUBRICATING FLYWHEEL CLUTCH

The flywheel clutch bearings are grease lubricated, except the main shaft bearing. The main shaft bearing is oil lubricated.

1. Lubricate the shift lever bearings; 1 fitting on each side of clutch housing.



LUBRICATING SHIFT LEVER BEARINGS

1. Oil level gauge

2. Lubricate the pilot bearing; 1 fitting at the end of shaft. If this fitting is not accessible, remove the plug located on the circumference of the shaft near the rear of the housing, and install a fitting.
3. Lubricate the shift-collar bearings; 1 fitting at top-left of center.
4. Check the main shaft bearing oil reservoir level with engine stopped. Maintain the oil level at the FULL mark on the oil level gauge. Add oil through the filler tube on top of the bearing cage housing. See the Lubrication and Maintenance Chart for proper oil.
5. To drain the reservoir: Remove the drain plug located on the lower right side of the shaft bearing reservoir. Drain and install the drain plug. Fill to the FULL mark on the oil level gauge. Install filler cap.

MISCELLANEOUS MAINTENANCE

VEE BELTS

CHECKING BELTS

1. Check belt wear.
2. Check tension of each belt.

If one belt in a set requires replacement, always intall a new matched set of belts-never replace just the worn belt. If only the worn belt is replaced, the new belt will be carrying all of the load-as it will not be stretched r much as the older belts-and all of the belts will fall in rapid succession.

In the following illustrations the pulley marked X is the adjusting pulley. The pulley marked C Is the crank-shaft. Force Is applied at the arrow. See the chart for the force and belt deflection.

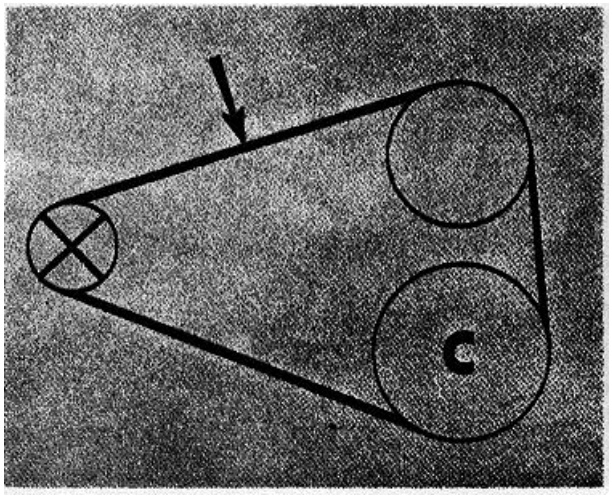


FIG. A ALTERNATOR DRIVE AND WATER PUMP DRIVE

ADJUSTING BELT TENSION

Alternator Drive (Fig. A)

1. Loosen the bolts on the alternator.
2. Move the alternator until the belt is properly ad-Justed. Tighten the adjustment bolt.
3. Check the adjustment.
4. Tighten the bolt.

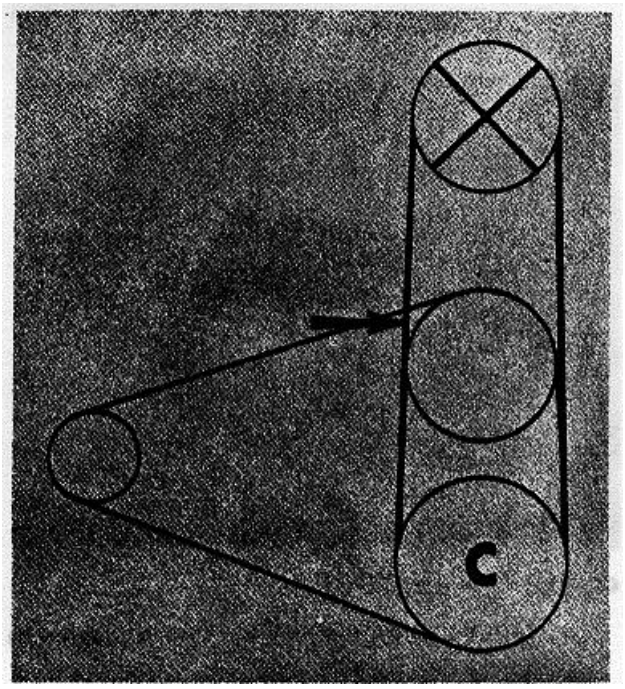


FIG. HIGH MOUNT FAN DRIVE

ATTACHMENT	FORCE		BELT DEFLECTION		FOR SCHEMATIC SEE:
Alternator Drive	5 lbs.	227 gms.	0.25 In.	6.5 mm	FIG. A
Water Pump-Fan Drive	5 lbs.	227 gms.	0.25 in.	6,5 mm	FIG. A
High Mount Fan Drive	5 lbs.	227 gms.	0.26 In.	6,5 mm	FIG. B
Air Compressor Drive	6 lbs.	272 gms.	0.25 in.	6,6 mm	FIG. C
Air Compressor Drive w/high mount fan	4 lbs.	182 gms.	0.12 in.	3,0 mm	FIG. D

Water Pump-Fan Drive (Fig. A), and Air Compressor Drive (Fig. C & D);

1. Loosen the adjusting bolt and pivot bolt on the idler.
2. Move the idler outward until the belt is properly adjusted. Tighten the adjustment bolt.
3. Check the adjustment.
4. Tighten the pivot bolt.

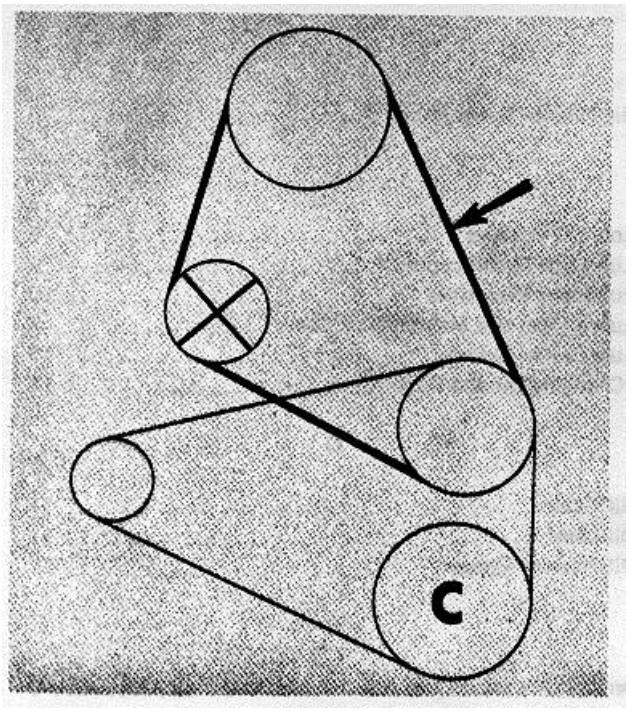


FIG C AIR COMPRESSOR DRIVE

High-Mount Fan Drive (Fig. B)

1. Loosen the four bolts holding the adjustment plate.
2. Loosen the adjustment bolt locknut.
3. Turn the adjustment bolt to obtain correct bolt adjustment.
4. Tighten the four bolts holding the adjustment plate.
5. Tighten the adjustment bolt locknut.

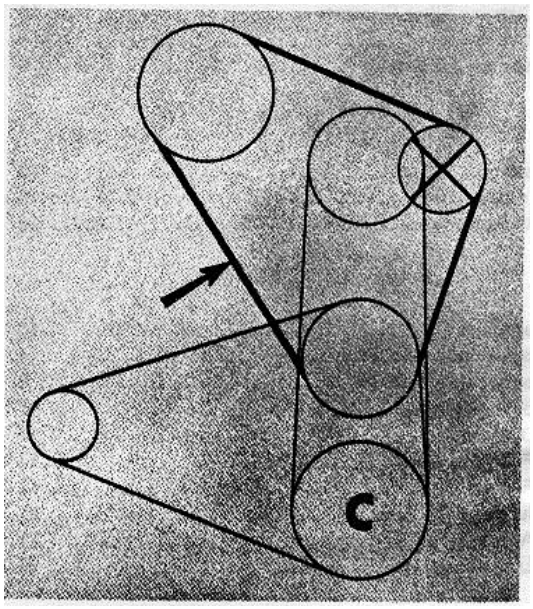


FIG. D AIR COMPRESSOR DRIVE WITH HIGH MOUNT FAN DRIW

SAFETY SHUT-OFF CONTROLS

The shut-off controls must be checked to Insure proper functioning if and when needed. To prevent damage to your engine while making the required test, only authorized personnel should perform the checks. Contact your Caterpillar dealer,

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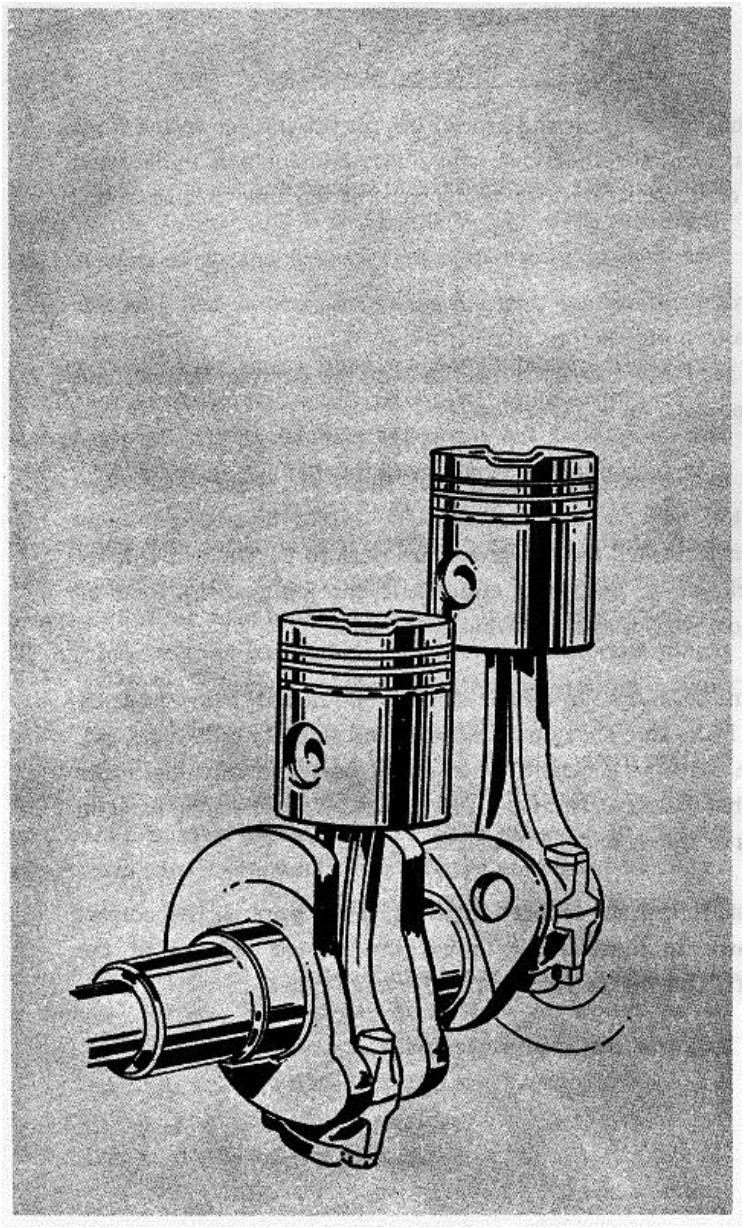
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FORM NO. REG01683-01

FOR USE IN SERVICE MANUAL:
3208 ENGINE, REG01658
V160 THRU V300 LIFT TRUCKS, REG01275

SYSTEMS OPERATION
TESTING AND ADJUSTING

3208 INDUSTRIAL & MARINE ENGINES

SERIAL NUMBERS
75V1- UP
90N1-UP

INTRODUCTION

This publication has instructions and procedures for the subject on the front cover. The information, specifications, and illustrations in this publication are on the basis of information that was current at the time this issue was written.

Correct operation, maintenance, test and repair procedures will give this product a long service life. Before starting a test, repair or rebuild job, the serviceman must read the respective sections of the Service Manual, and know all the components he will work on.

Your safety, and the safety of others, is at all times very important. When you see this symbol **(+)**or this symbol **(!)**in the manual, you must know that caution is needed for the procedure next to it. The symbols are warnings. To work safely, you must understand the job you do. Read all instructions to know what is safe and what is not safe.

It is very important to know the weight of parts. Do not lift heavy parts by hand. Use a hoist. Make sure heavy parts have a good stability on the ground. A sudden fall can cause an accident. When lifting part of a machine, make sure the machine has blocks at front and rear. Never let the machine hang on a hoist, put blocks or stands under the weight.

When using a hoist, follow the recommendation in the manual. Use correct lift tools as shown in illustrations to get the correct balance of the component you lift. This makes your work safer at all times.

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NOTE: For Specifications with illustrations, make reference to ENGINE SPECIFICATIONS FOR 3208 INDUSTRIAL & MARINE ENGINES Form No. REG01684. If the Specifications in Form No. REG01684 are not the same as in the Systems Operation and the Testing and Adjusting, look at the printing date on the back cover of each book. Use the Specifications given in the book with the latest date.

FUEL SYSTEM
Engines with Serial Numbers 90N1-90N6120

The sleeve metering fuel system is a pressure type fuel system. The name for the fuel system is from the method used to control the amount of fuel sent to the cylinders. This fuel system has an injection pump for each cylinder of the engine. It also has a fuel transfer pump on the front of the injection pump housing. The governor is on the rear of the injection pump housing.

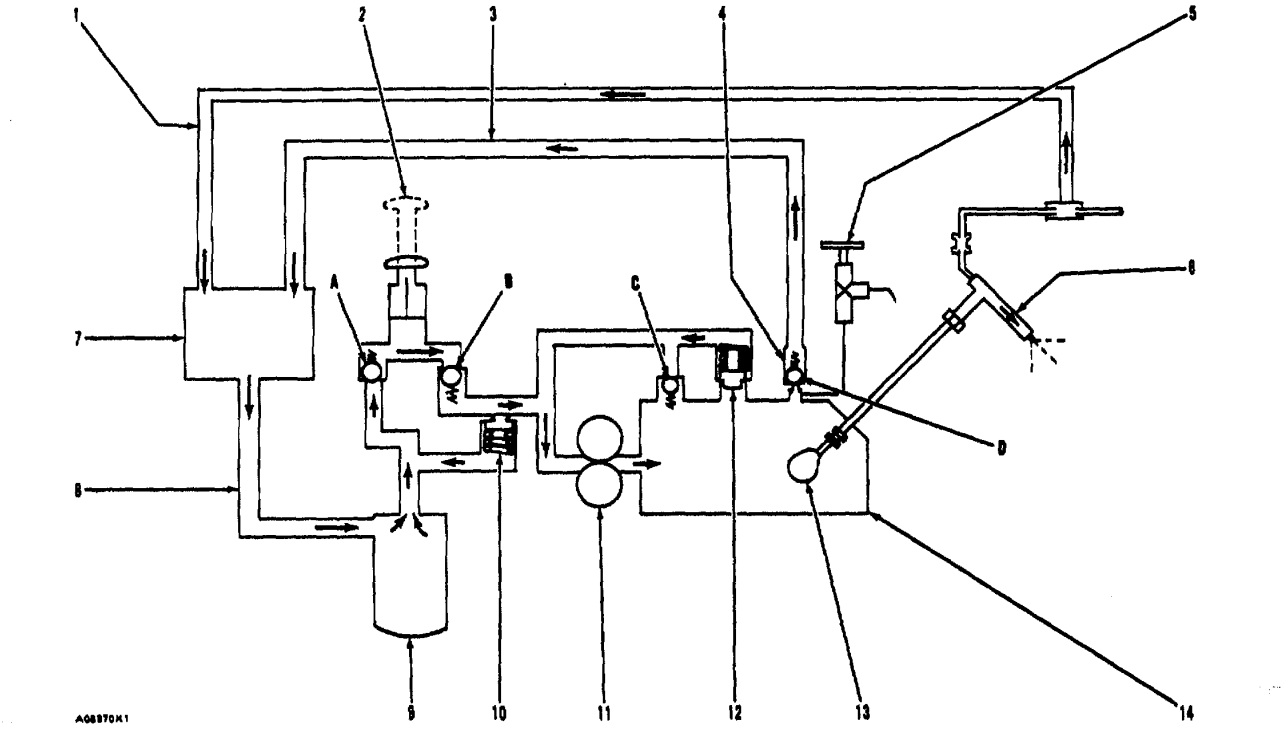
The drive gear for the fuel transfer pump is on the front of the camshaft for the injection pumps. The carrier for the governor weights is bolted to the rear of the camshaft for the injection pumps. The injection pump housing has a bearing at each end to support the camshaft. The camshaft for the sleeve metering fuel system is driven by the timing gears at the front of the engine.

The injection pumps, lifters and rollers, and the camshaft are all inside of the pump housing. The pump housing and the governor housing are full of fuel at transfer pump pressure (fuel system pres. sure).

CAUTION: Diesel fuel is the only lubrication for the moving parts in the 'transfer pump, injection pump housing, and the governor. The injection pump housing must be full of fuel before turning the camshaft.

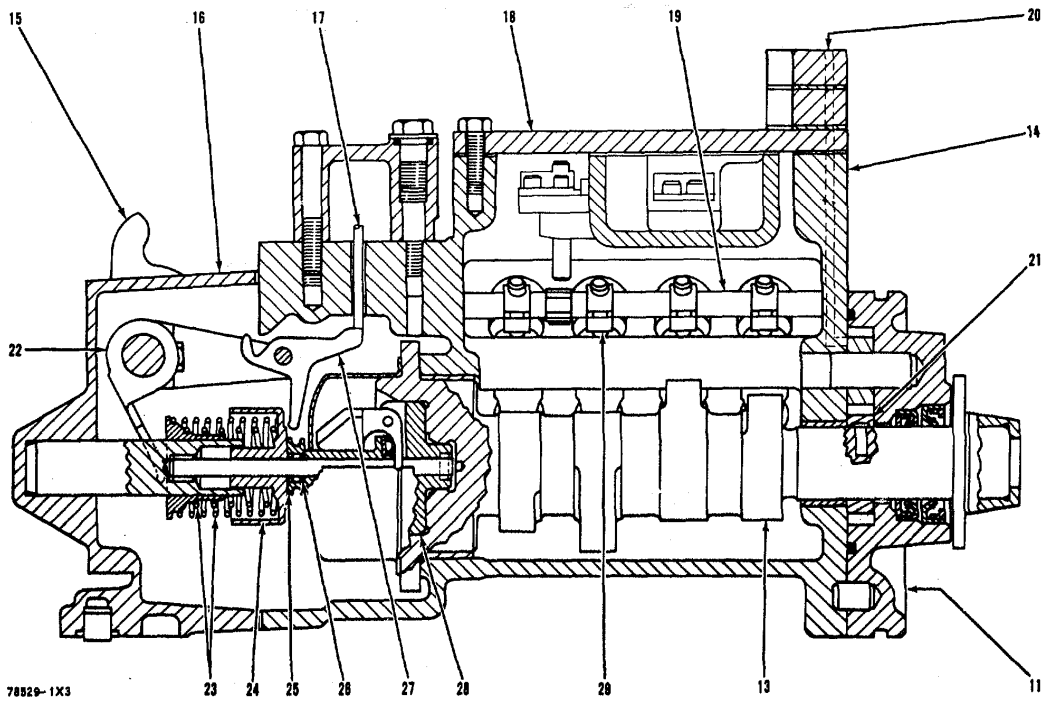
This fuel system has governor weights, a thrust collar and two governor springs. One governor spring is for high idle and the other governor spring is for low idle. Rotation of the shaft for governor control, compression of the governor springs, movement of connecting linkage in the governor and injection pump housing controls the amount of fuel sent to the engine cylinders.

Fuel from fuel tank (7) is pulled by fuel transfer pump (11) through fuel filter (9). From fuel filter (9) the fuel goes to housing for fuel injection pumps (14). The fuel goes in housing (14) at the top and goes through inside passage (20) to fuel transfer pump (11).



SCHEMATIC OF FUEL SYSTEM

1. Return line for fuel Injection nozzles. 2. Fuel priming pump. 3. Return line for constant bleed valve. 4, Constant bleed valve. 5. Manual bleed valve. 6. Fuel injection nozzle. 7. Fuel tank. ,8.Fuel Inlet Line. 9. Fuel filter. 10. Bypass for fuel priming pump. 11. Fuel transfer pump. 12. Fuel bypass valve. 13. Camshaft. 14. Housing for fuel Injection pumps. A. Check valve. 5. Check valve. C. Check valve. D. Check valve.



CROSS SECTION OF FUEL SYSTEM

11. Fuel transfer pump. 13. Camshaft. 14. Housing for fuel injection pumps. 15. Lever. 16. Governor housing. 17. Load stop pin. 18. Cover. 19. Sleeve control shafts (two). 20. Inside fuel passage. 21. Drive gear for fuel transfer pump. 22. Lever on governor shaft. 23. Governor springs (inner spring is for low idle: outer spring is for high idle). 24. Spring seat. 25. Thrust collar. 26. Over fueling spring. 27. Load stop lever. 28. Carrier and governor weights. 29. Sleeve levers.

From fuel transfer pump (11), fuel under pressure, fills the housing for the fuel injection pumps (14). Pressure of the fuel in housing (14) is controlled by bypass valve (12). Pressure of the fuel at FULL LOAD is 30 ± 5 psi (2.1 ± 0.4 kg/cm2). If the pressure of fuel in housing (14) gets too high, bypass valve (12) will move (open) to let some of the fuel return to the inlet of fuel transfer pump (11).

Lever (15) for the governor is connected by linkage and governor springs (23) to the sleeve control shafts (19). Any movement of lever (22) will cause a change in the position of sleeve control shafts (19).

When lever (15) is moved to give more fuel to the engine, lever (22) will put governor springs (23) in compression and move thrust collar (26) forward. As thrust collar (25) moves forward, the connecting linkage will cause sleeve control shafts (19) to turn. With this movement of the sleeve control shafts, levers (29) will lift sleeves (30) to make an increase in the amount of fuel sent to the engine cylinders.

When starting the engine, the force of over fueling spring (26) is enough to push thrust collar (25) to the full fuel position. This lets the engine have the maximum amount of fuel for injection when starting. At approximately 400 rpm, governor weights (28) make enough force to push spring (26) together. Thrust collar (25) and spring seat (24) come into contact. From this time on, the governor works to control the speed of the engine.

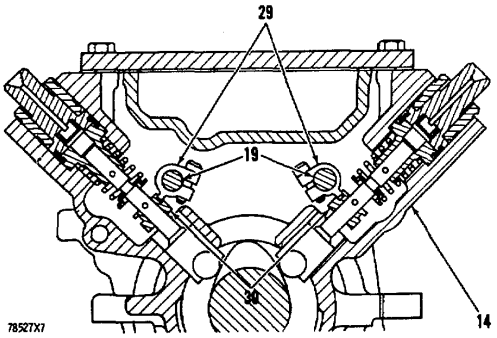
When governor springs (23) are put in compression, the spring seat at the front of the governor springs will make contact with load stop lever (27). Rotation of the load stop lever moves load stop pin (17) up until the load stop pin comes in contact with the stop bar or stop screw. This stops the movement of thrust collar (25), the connecting levers, and sleeve control shafts (19). At this position, the maximum amount of fuel per stroke is being injected by each injection pump.

The carrier for governor weights (28) is held on the rear of camshaft (13) by bolts. When engine rpm goes up, injection pump camshaft (13) turns faster. Any change of camshaft rpm will change the

rpm and position of governor weights (28). Any change of governor weight position will cause thrust collar (25) to move. As governor weights (28) turn faster, thrust collar (25) is pushed toward governor springs (23). When the force of governor springs (23) is balanced by the centrifugal force of the governor weights, sleeves (30) of the injection pumps are held at a specific position to send a specific amount of fuel to the engine cylinders.

When the governor control lever is turned toward the FUEL-OFF position with the engine running, there is a reduction of force on governor springs (23). The movement of the linkage in the governor will cause fuel control shafts (19) to move sleeves (30) down, and less fuel will be injected in the engine cylinders.

To stop the engine, turn the ignition switch to the "OFF" position. This will cause the shut-off solenoid to move linkage in the fuel pump housing. Movement of the linkage will cause sleeve levers (29) to move sleeves (30) down, and no fuel is sent to the engine cylinders. With no fuel going to the engine cylinders, the engine will stop.



FUEL SYSTEM COMPONENTS

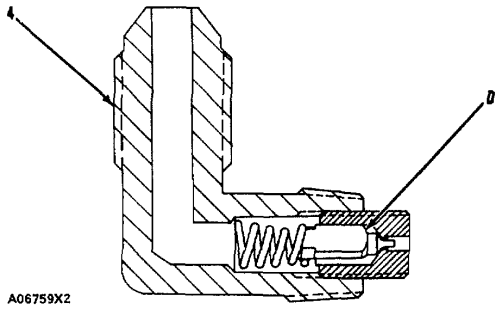
14. Housing for fuel injection pumps. 19. Sleeve control shafts. 29. Sleeve levers. 30. Sleeves.

FLOW OF FUEL USING THE PRIMING PUMP

When the handle of priming pump (2) is pulled out, negative air pressure in priming pump (2) opens check valve (A) and pulls fuel from fuel tank (7). Pushing the handle in closes check valve (A) and opens check valve (B). This pushes air and/pr fuel into housing (14) through the fuel passages and check valve (C). More operation of priming pump (2) will pull fuel from fuel tank (7) until the fuel lines, fuel filter (9) and housing (14) are full of fuel. Do this until the flow of fuel from manual bleed valve (5) is free of air bubbles. Relief valve (10) will open and let the fuel go to the inlet for fuel priming pump (2} if the pressure gets higher than 20 psi (1.4 kg/cm) when using priming pump (2).

CONSTANT BLEED VALVE

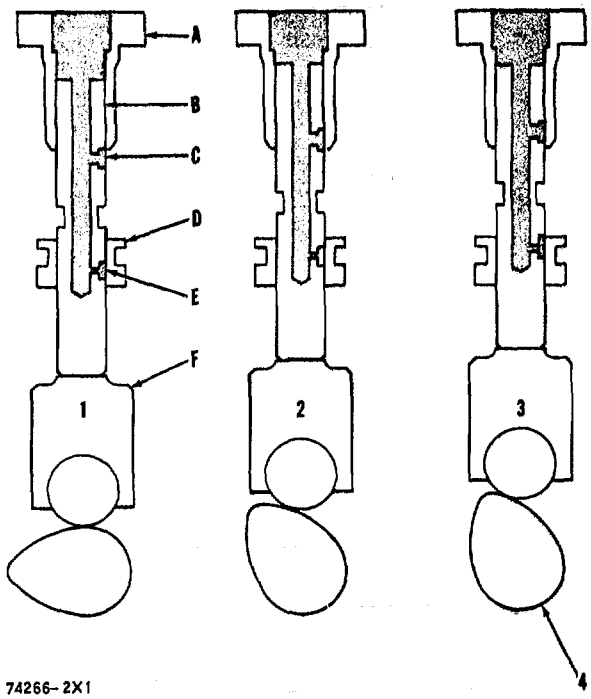
Constant bleed valve (4) lets approximately 9 gallons of fuel per hour go back to fuel tank (7). This fuel goes back to fuel tank (7) through return line for constant bleed valve (3). This flow of fuel removes air from housing (14) and also helps to cool the fuel injection pump. Check valve (D) makes a restriction in this flow of fuel until the pressure in housing (14) is at 8 ± 3 psi (0.6 ± 0.2 kg/cm2).



CONSTANT BLEED VALVE

4. Constant bleed valve. D. Check valve.

OPERATION OF FUEL INJECTION PUMPS



FUEL INJECT!ON SEQUENCE

1, 2. 3. Injection stroke (positions) of a fuel injection pump. 4. Injection pump camshaft. A. Barrel. B. Plunger. C. Fuel inlet. D. Sleeve. E. Fuel outlet. F. Lifter.

The main components of a fuel injection pump in the sleeve metering fuel system are barrel (A), plunger (B), and sleeve (D). Plunger (B) moves up and down inside the barrel (A) and sleeve (D). Barrel (A) is stationary while sleeve (D) is moved up and down on plunger (B) to make a change in the amount, of fuel for injection.

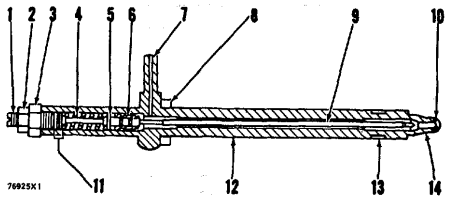
When the engine is running, fuel under pressure from the fuel transfer pump goes in the center of plunger (B) through fuel inlet (C) during the down stroke of plunger (B). Fuel can not go through fuel outlet (E) at this time because it is stopped by sleeve (D), (see position 1).

Fuel injection starts (see position 2) when plunger (B) is lifted up in barrel (A) enough to close fuel inlet (C). There is an increase in fuel pressure above plunger (B), when the plunger is lifted by camshaft (4). The fuel above plunger (B) is injected in to the engine cylinder.
Injection will stop (see position 3) when fuel outlet (E) is lifted above the top edge of sleeve (D) by camshaft (4). This movement lets the fuel that is above, and in, plunger (B) go through fuel outlet (E) and return to the fuel injection pump housing.

When the sleeve (D) is raised on plunger (B), fuel outlet (E) is covered for a longer time, causing more fuel to be injected in the engine cylinders. If sleeve (D) is low on plunger (B), fuel outlet (E) is covered for a shorter time, causing less fuel to be injected.

OPERATION OF 9L7883 FUEL INJECTION NOZZLE

The fuel inlet (7) and nozzle tip (14) are parts of the nozzle body (12). Valve (9) is held in position by force of spring (4). Force of spring (4) is controlled by shims (11). The lift of valve (9) is controlled by lift adjusting screw (1). Locknut (2) holds lift adjusting screw (1) in position. Compression seal (8) goes on nozzle body (12).



FUEL INJECTION NOZZLE

1. Lift adjusting screw. 2. Locknut. 3. Pressure screw. 4. Spring. 5. Spring seat. 6. Valve guide. 7. Fuel inlet. 8. Compression seal. 9. Valve. 10. Orifices four). 11. Shims. 12. Nozzle body. 13. Carbon dam. 14. Nozzle trip.

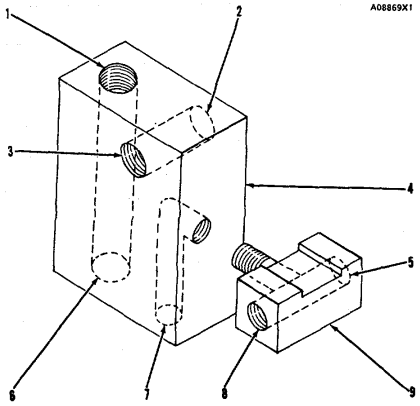
The compression seal goes against inlet fitting (7) and prevents the leakage of compression from the cylinder. Carbon dam (13), at the lower end of nozzle body (12), prevents the deposit of carbon in the bore in the cylinder head.

Fuel, under high pressure from the fuel injection pump goes through the hole in fuel inlet (7). The fuel then goes around valve (9), fills the inside of nozzle body (12) and pushes against valve guide (6). When the force made by the pressure of the fuel is more than the force of spring (4), valve (9) will lift. When valve (9) lifts, fuel under high pressure will go through the four .0128 in. (0.325 mm) orifices (10) into the cylinder. When the fuel is sent to the cylinder, the force made by the pressure *of* the fuel in the nozzle body will become less. The force of spring (4) will then be more than the force of the pressure of the fuel in the nozzle body. Valve (9) will move to the closed position.

Valve (9) is a close fit with the inside of nozzle tip (14), this makes a positive seal for the valve.

When the fuel is sent to the cylinder, a small quantity of fuel will leak by valve guide (6). This fuel gives lubrication to the moving parts of the fuel injection nozzle This fuel then goes through a leak off boot at the top of nozzle body (12) and is returned to the fuel tank.

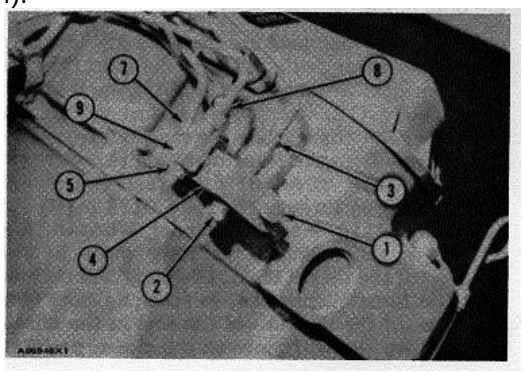
FUNCTION OF FUEL JUNCTION BLOCK



CONNECTIONS FOR FUEL LINES AT THE FUEL JUNCTION BLOCK

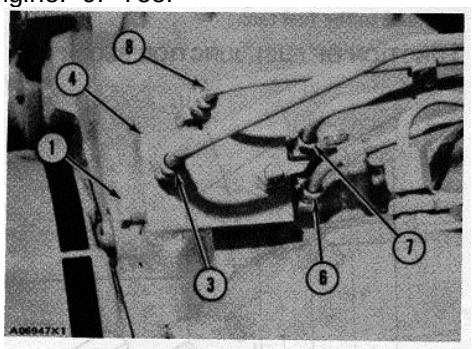
1. Connection for constant bleed line to fuel tank. 2. Connection for fuel supply line to fuel tank. 3. Connection for fuel supply line to fuel filter. 4. Fuel injunction block. 5. Connection for bleed line for fuel injection nozzles to fuel tank. 6. Connection for constant bleed line to housing for fuel injection pumps. 7. Connection for bleed line for fuel injection nozzles on right side of engine. 8. Connection for bleed line for fuel injection nozzles on left side of engine. 9. Tee.

The location of the fuel junction block (4) is at the right rear of the engine. The fuel lines from the fuel tank and the engine connect at fuel junction block (4).



CONNECTIONS FOR FUEL LINES AT THE FUEL JUNCTION BLOCK

1. Connection for constant bleed line to fuel tank. 2. Connection for fuel supply line to fuel tank. 3. Connection for fuel supply line to fuel filter. 4. Fuel junction block. 5. Connection for bleed line for fuel injection nozzles to fuel tank. 7. Connection for bleed line for fuel injection nozzles on right side of engine. 8. Connection for bleed line for fuel injection nozzles on left side of engine. 9. Tee.

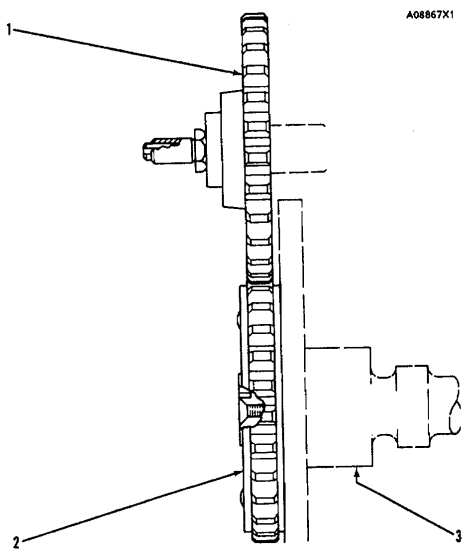


CONNECTIONS FOR FUEL LINES AT THE FUEL JUNCTION BLOCK

1. Connection for constant bleed line to fuel tank. 3. Connection for fuel supply line to fuel filter. 4. Fuel junction block. 6. Connection for constant bleed line to housing for fuel injection pumps. 7. Connection for bleed line for fuel injection nozzles on right side of engine. 8. Connection for bleed line for fuel injection nozzles on left side of engine.

AUTOMATIC TIMING ADVANCE UNIT

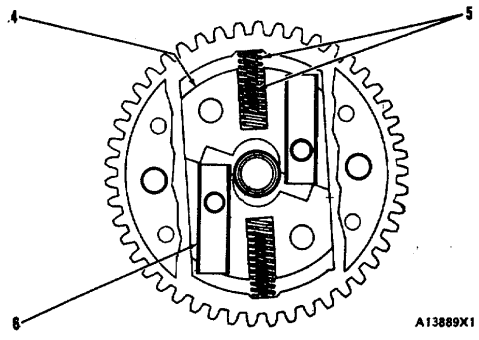
The automatic timing advance unit (2) is installed on the front of the camshaft (3) for the engine. The automatic timing advance unit (2) drives the gear (1) on the camshaft for the fuel injection pump. This gear is the drive for the camshaft for the fuel injection pump.



AUTOMATIC TIMING ADVANCE UNIT

1. Gear on camshaft for fuel injection pump. 2. Automatic timing advance unit. 3. Camshaft for the engine.

The weights (4) in the timing advance are driven by two slides (6) that fit into notches made on an angle in the weights. The slides (6) are driven by two dowels which are in the drive gear for the engine camshaft. As centrifugal force (rotation) moves weights (4) outward against the force of springs (5), the movement of the notches in weights (4) will cause the slides to make a change in the angle between the timing advance gear and the two drive dowels in the drive gear for the engine camshaft. Since the timing advance unit drives the gear (1) on the camshaft for the fuel injection pump, the fuel injection timing is also changed.



AUTOMATIC TIMING ADVANCE UNIT

4. Weights. 5. Springs. 6. Sides.

The automatic timing advance unit will change the timing 8 degrees. This change starts at approximately low idle rpm and is operating up through the rated speed of the engine. No adjustment can be made to the automatic timing advance unit.

Lubrication oil for the timing advance unit comes from drilled holes that connect with the front bearing for the engine camshaft.

FUEL SYSTEM
Engines with Serial Numbers 75V1-UP, 90N6121-UP

The sleeve metering fuel system is a pressure type fuel system. The name for the fuel system is from the method used to control the amount of fuel sent to the cylinders. This fuel system has an injection pump for each cylinder of the engine. It also has a fuel transfer pump on the front of the injection pump housing. The governor is on the rear of the injection pump housing.

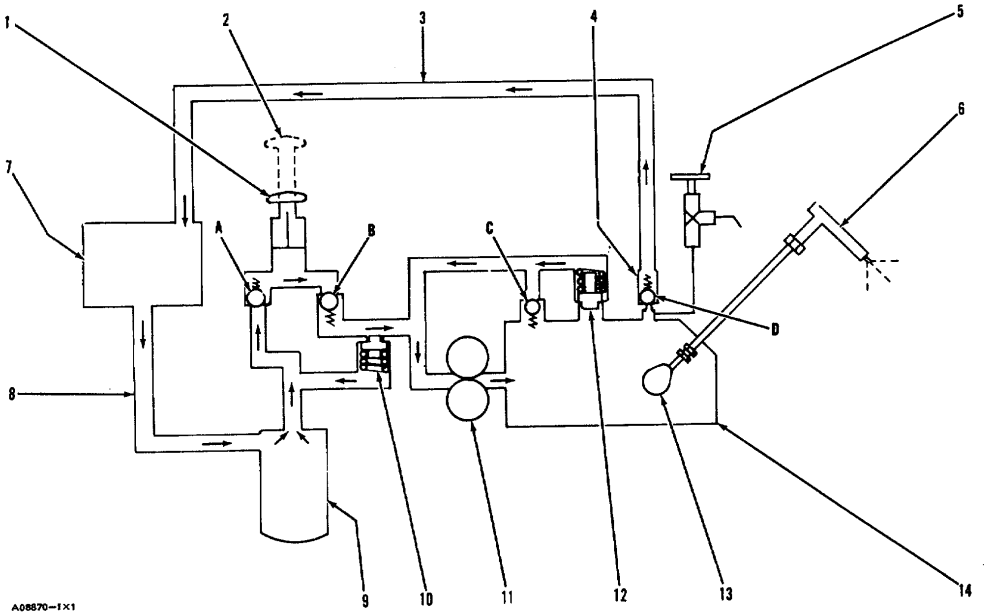
The drive gear for the fuel transfer pump is on the front of the camshaft for the injection pumps. The carrier for the governor weights is bolted to the rear of the camshaft for the injection pumps. The injection pump housing has a bearing at each end to support the camshaft. The camshaft for the sleeve metering fuel system is driven by the timing gears at the front of the engine.

The injection pumps, lifters and rollers, and the camshaft are all inside of the pump housing. The pump housing and the governor housing are full of fuel at transfer pump pressure (fuel system pressure).

CAUTION: Diesel fuel is the only lubrication for the moving parts in the transfer pump, injection pump housing, and the governor. The injection pump housing must be full of fuel before turning the camshaft.

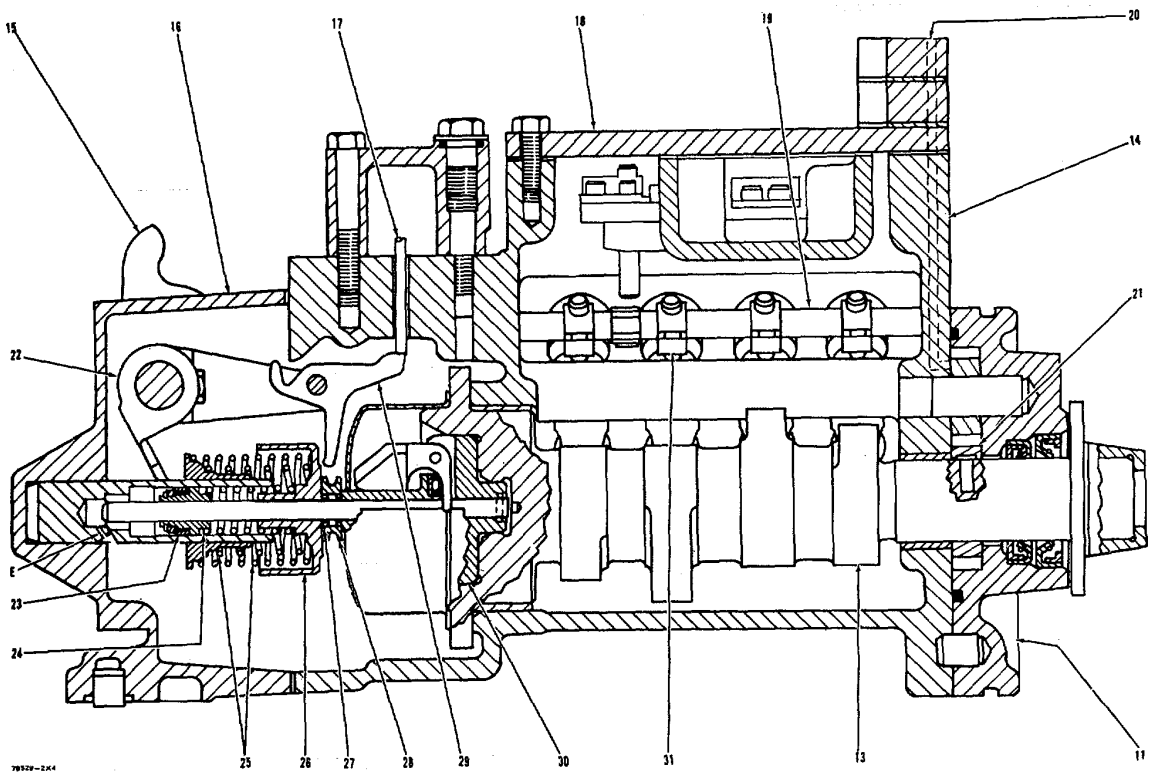
This fuel system has governor weights, a thrust collar and two governor springs. One governor spring is for high idle and the other governor spring is for low idle. Rotation of the shaft for governor control, compression of the governor springs, movement of connecting linkage in the governor and injection pump housing controls the amount of fuel sent to the engine cylinders.

Fuel from fuel tank (7) is pulled by fuel transfer pump (11) through fuel filter (9). From fuel filter (9) the fuel goes to housing for fuel injection pumps (14). The fuel goes in housing (14) at the top and goes through inside passage (20) to fuel transfer pump (11).



SCHEMATIC OF FUEL SYSTEM

1. Fuel priming pump (closed position). 2. Fuel priming pump (open position). 3. Return line for constant bleed valve. 4. Constant bleed valve. 5. Manual bleed valve. 6. Fuel injection nozzle. 7. Fuel tank. 8. Fuel inlet line. 9. Fuel filter. 10. Bypass valve for fuel priming pump. 11. Fuel transfer pump. 12. Fuel bypass valve. 13. Camshaft. 14. Housing for fuel injection pumps. A. Check valve. B. Check valve. C. Check valve. D. Check valve.



CROSS SECTION OF FUEL SYSTEM WITH DASHPOT GOVERNOR

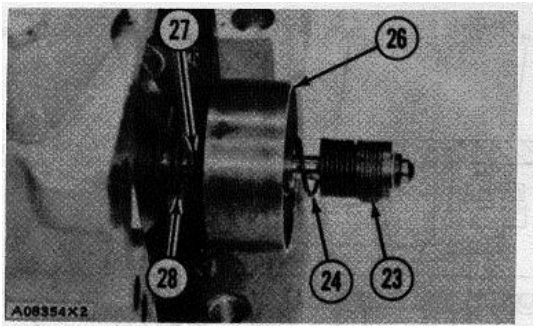
11. Fuel transfer pump. 13. Camshaft. 14. Housing for fuel injection pumps. 15. Lever. 16. Governor housing. 17. Load stop pin. 18. Cover. 19. Sleeve control shafts {(two). 20. Inside fuel passage.'21. Drive gear for fuel transfer pump. 22. Lever on governor shaft. 23. Piston for dashpot governor. 24. Spring for dashpot governor. 25. Governor springs (inner spring is for low idle: outer spring is for high idle). 26. Spring seat. 27. Over fueling spring. 28. Thrust collar. 29. Load stop lever. 30. Carrier and governor weights. 31. Sleeve levers. E. Orifice for dashpot.

From fuel transfer pump (11), fuel under pressure, fills the housing for the fuel injection pumps (14). Pressure of the fuel in housing (14) is controlled by bypass valve (12). Pressure of the fuel at FULL LOAD is 30 ± 5 psi (2.1 ± 0.4 kg/cm2). If the pressure of fuel in housing (14) gets too high, bypass valve (12) will move (open) to let some of the fuel return to the inlet of fuel transfer pump (11).

Lever (15) for the governor is connected by linkage and governor springs (25) to the sleeve control shafts (19). Any movement of lever (22) will cause a change in the position of sleeve control shafts (19).

When lever (15) is moved to give more fuel to the engine, lever (22) will put governor springs (25) in compression and move thrust collar (28) forward. As thrust collar (28) moves forward, the connecting linkage will cause sleeve control shafts (19) to turn.' With this movement of the sleeve control shafts, levers (31) will lift sleeves (32) to make an increase in the amount of fuel sent to the engine cylinders.

When starting the engine, the force of over fueling spring (27) is enough to push thrust collar (28) to the full fuel position. This lets the engine have the maximum amount of fuel for injection when starting. At approximately 400 rpm, governor weights (30) make enough force to push spring (27) together. Thrust collar (28) and spring seat (26) come into contact. From this time on, the governor works to control the speed of the engine.



GOVERNOR PARTS

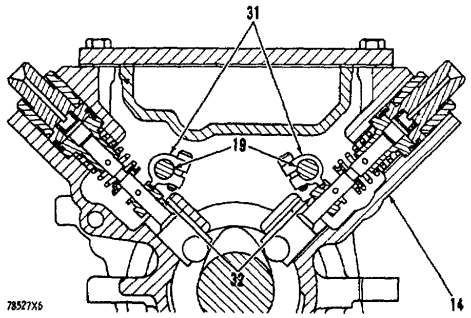
23. Piston for dashpot governor. 24. Spring for dashpot governor. 26. Spring seat. 27. Over fueling spring. 28. Thrust collar.

When governor springs (25) are put in compression, the spring seat at the front of the governor springs will make contact with load stop lever (29). Rotation of the load stop lever moves load stop pin (17) up until the load stop pin comes in contact with the stop bar or stop screw. This stops the movement of thrust collar (28), the connecting levers, and sleeve control shafts (19). At this position, the maximum amount of fuel per stroke is being injected by each injection pump.

The carrier for governor weights (30) is held on the rear of camshaft (13) by bolts. When engine rpm goes up, injection pump camshaft (13) turns faster. Any change of camshaft rpm will change the rpm and position of governor weights (30). Any change of governor weight position will cause thrust collar (28) to move. As governor weights (30) turn faster, thrust collar (28) is pushed toward governor springs (25). When the force of governor springs (25) is balanced by the centrifugal force of the governor weights, sleeves (32) of the injection pumps are held at a specific position to send a specific amount of fuel to the engine cylinders.

When the governor control lever is turned toward the FUEL-OFF position with the engine running, there is a reduction of force on governor springs (25). The movement of the linkage in the governor will cause fuel control shafts (19) to move sleeves (32) down, and less fuel will be injected in the engine cylinders.

To stop the engine, turn the ignition switch to the "OFF" position. This will cause the shut-off solenoid to move linkage in the fuel pump housing. Movement of the linkage will cause sleeve levers (31) to move sleeves (32) down, and no fuel is sent to the engine cylinders. With no fuel going to the engine cylinders, the engine will stop.



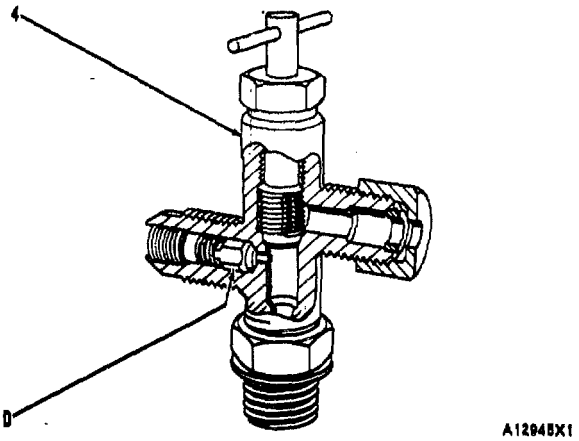
FUEL SYSTEM COMPONENTS

14. Housing for fuel injection pumps. 19. Sleeve control shaft. 31. Sleeve levers. 32. Sleeves.

FLOW OF FUEL USING THE PRIMING PUMP

When the handle of priming pump (2) is pulled out, negative air pressure in priming pump (2) opens check valve (A) and pulls fuel from fuel tank (7). Pushing the handle in closes check valve (A) and opens check valve (B). This pushes air and/or fuel into housing (14) through the fuel passages and check valve (C). More operation of priming pump (2) will pull fuel from fuel tank (7) until the fuel lines, fuel filter (9) and housing (14) are full of fuel. Do this until the flow of fuel from manual bleed valve (5) is free of air bubbles. Relief valve (10) will open and let the fuel go to the inlet for fuel priming pump (21 if the pressure gets higher than 20 psi (1.4 kg/cm) when using priming pump (2).

CONSTANT BLEED VALVE



CONSTANT BLEND VALVE

4. Constant bleed valve. D. Check valve.

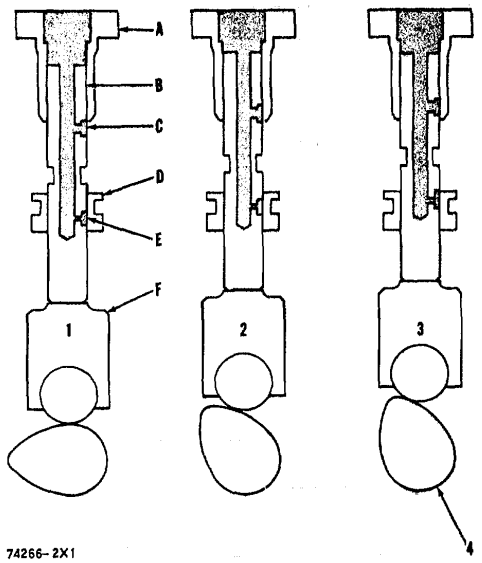
Constant bleed valve (4) lets approximately 9 gallons of fuel per hour go back to fuel tank (7). This fuel goes back to fuel tank (7) through return line for constant bleed valve (3). This flow of fuel removes air from housing (14) and also helps to cool the fuel injection pump. Check valve (D) makes a restriction in this flow of fuel until the pressure in housing (14) is at 8 ± 3 psi (0.6 ± 0.2 kg/cm2).

OPERATION OF FUEL INJECTION PUMPS

The main components of a fuel injection pump in the sleeve metering fuel system are barrel (A), plunger (B), and sleeve (D), Plunger (B) moves up and down inside the barrel (A) and sleeve (D). Barrel (A) is stationary while sleeve (D) is moved up and down on plunger (B) to make a change in the amount of fuel for injection.

When the engine is running, fuel under pressure from the fuel transfer pump goes in the center of plunger (B) through fuel inlet (C) during the down stroke of plunger (B), Fuel can not go through fuel outlet (E) at this time because it is stopped by sleeve (D), (see position 1),

Fuel injection starts (see position 2) when plunger (B) is lifted up in barrel (A) enough to close fuel inlet (C). There is an increase in fuel pressure above plunger (B), when the plunger is lifted by camshaft (4). The fuel above plunger (B) is injected in to the engine cylinder.



FUEL INJECTION SEQUENCE

1, 2, 3. Injection stroke (position) of a fuel Injection pump. 4. Injection pump camshaft. A, Barrel. 0. Plunger. C. Fuel Inlet. D, Sleeve. E. Fuel outlet. F, Lifter.

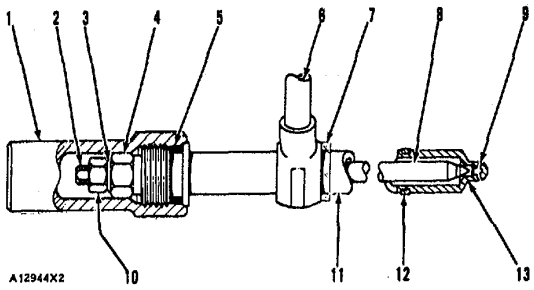
Injection will stop (see position 3) when fuel outlet (E) is lifted above the top edge of sleeve (D) by camshaft (4). This movement lets the fuel that is above, and in, plunger (B) go through fuel outlet (E) and return to the fuel injection pump housing.

When the sleeve (D) is raised on plunger (B), fuel outlet (E) is covered for a longer time, causing more fuel to be injected in the engine cylinders. If sleeve (D) is low on plunger (B), fuel outlet (E) is covered for a shorter time, causing less fuel to be injected.

OPERATION OF 9L6969 FUEL INJECTION NOZZLE

The fuel inlet (6) and nozzle tip (13) are parts of the nozzle body (11). Valve (8) is held in position by spring force. Force of the spring is controlled by pressure adjustment screw (3). Locknut (4) holds pressure adjustment screw (3) in position. The lift of valve (8) is controlled by lift adjustment screw (2), Locknut (10) holds lift adjustment screw (2) in position, Compression seal (7) goes on nozzle body (11).

The compression seal goes against inlet fitting (6) and prevents the leakage of compression from the cylinder. Carbon dam (12), at the lower end of nozzle body (11), prevents the deposit of carbon in the bore in the cylinder head.



FUEL INJECTION NOZZLE

1. Cap. 2. Lift adjustment screw. 3. Pressure adjustment screw. 4. Locknut for pressure adjustment screw. 5. O-ring seal. 6. Fuel Inlet. 7. Compression seal. 8. Valve. 9. Orifice (four). 10. Locknut for lift adjustment screw. 11. Nozzle body. 12. Carbon dam. 13. Nozzle tip.

Fuel, under high pressure from the fuel injection pump goes through the hole in fuel inlet (6). The fuel then goes around valve (8), fills the inside of nozzle body (11) and pushes against the valve guide. When the force made by the pressure of the fuel is more than the force of the spring, valve (8) will lift. When valve (8) lifts, fuel under high pressure will go through the four .0128 in. (0.325 mm) orifices (9) into the cylinder. When the fuel is sent

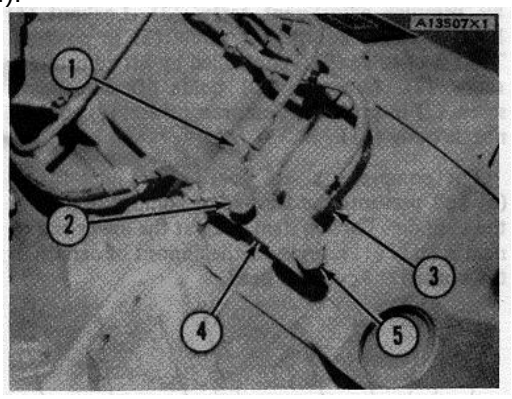
to the cylinder, the force made by the pressure of the fuel in the nozzle body will become less. The force of the spring will then be more than the force of the pressure of the fuel in the nozzle body. Valve (8) will move to the closed position.

Valve. (8) is a close fit with the inside of nozzle tip (13), this makes a positive seal for the valve.

When the fuel is sent to the cylinder, a very small quantity of fuel will leak by the valve guide. This fuel gives lubrication to the moving parts of the fuel injection nozzle.

FUNCTION OF FUEL JUNCTION BLOCK

The location of the fuel junction block (4) is at the right rear of the engine. The fuel lines from the fuel tank and the engine connect at fuel junction block (4).



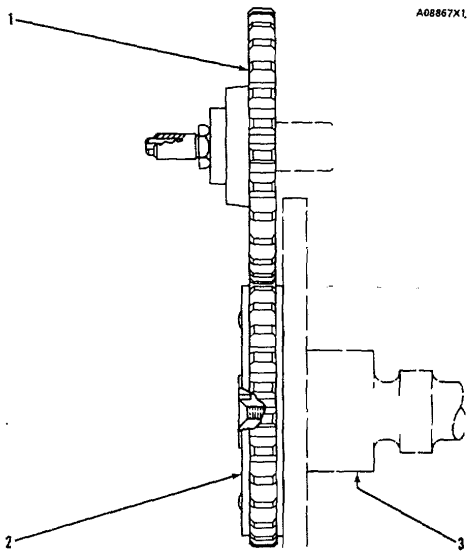
CONNECTIONS FOR FUEL LINES AT THE FUEL JUNCTION BLOCK

1. Connection for constant bleed line to housing for fuel injection pumps. 2. Connection for constant bleed line to fuel tank. 3. Connection for fuel supply line to fuel filter. 4. Fuel junction block. 5. Connection for fuel supply line to fuel tank.

AUTOMATIC TIMING ADVANCE UNIT

The automatic timing advance unit (2) is installed on the front of the camshaft (3) for the engine. The automatic timing advance unit (2) drive the gear (1) on the camshaft for the fuel injection pump. This gear is the drive for the camshaft for the fuel injection pump.

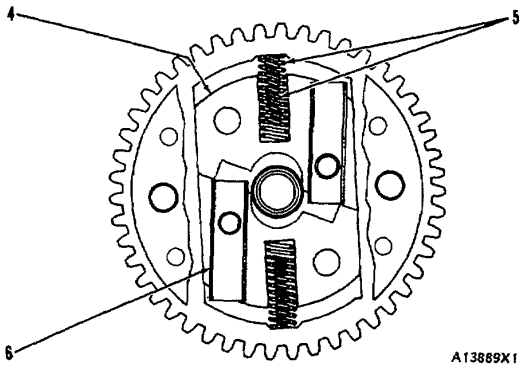
The weights (4) in the timing advance are driven by two slides (6) that fit into notches made on an angle in the weights. The slides (6) are driven by two dowels which are in the drive gear for the engine camshaft. As centrifugal force (rotation) moves weights (4) outward against the force of springs (5), the movement of the notches in weights (4) will cause the slides to make a change in the



AUTOMATIC TIMING ADVANCE UNIT

1. Gear on camshaft for fuel injection pump. 2. Automatic timing advance unit. 3. Camshaft for the engine.

angle between the timing advance gear and the two drive dowels in the drive gear for the engine camshaft. Since the timing advance unit drives the gear (I) on the camshaft for the fuel injection pump, the fuel injection timing is also changed.



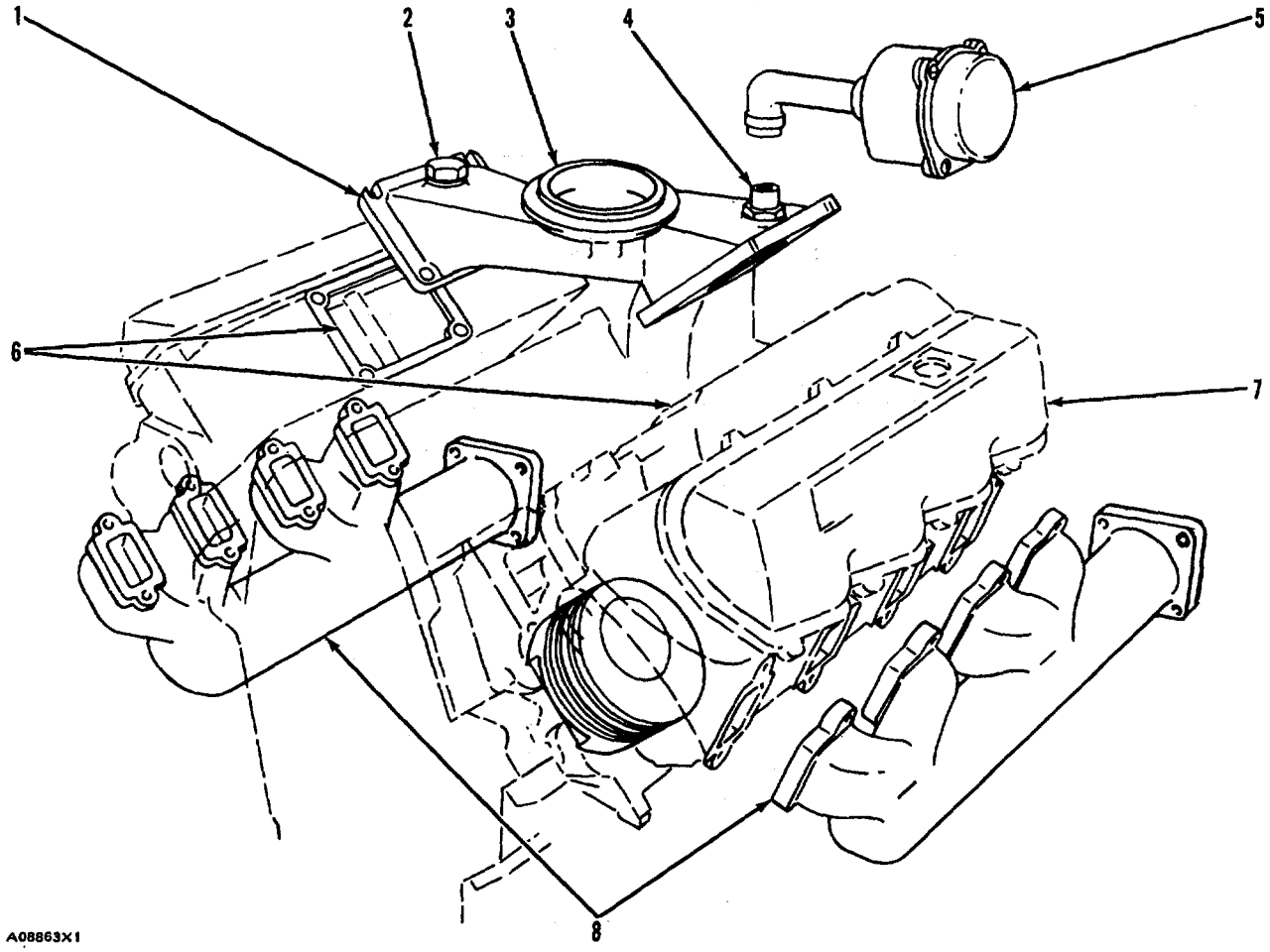
AUTOMATIC TIMING ADVANCE UNIT

4. Weights. 5. Springs. 6. Slides.

The automatic timing advance unit will change the timing 5 degrees. This change starts at approximately low idle rpm and is operating up through the rated speed of the engine. No adjustment can be made to the automatic timing advance unit.

Lubrication oil for the timing advance unit comes from drilled holes that connect with the front bearing for the engine camshaft.

AIR INLET EXHAUST SYSTEM



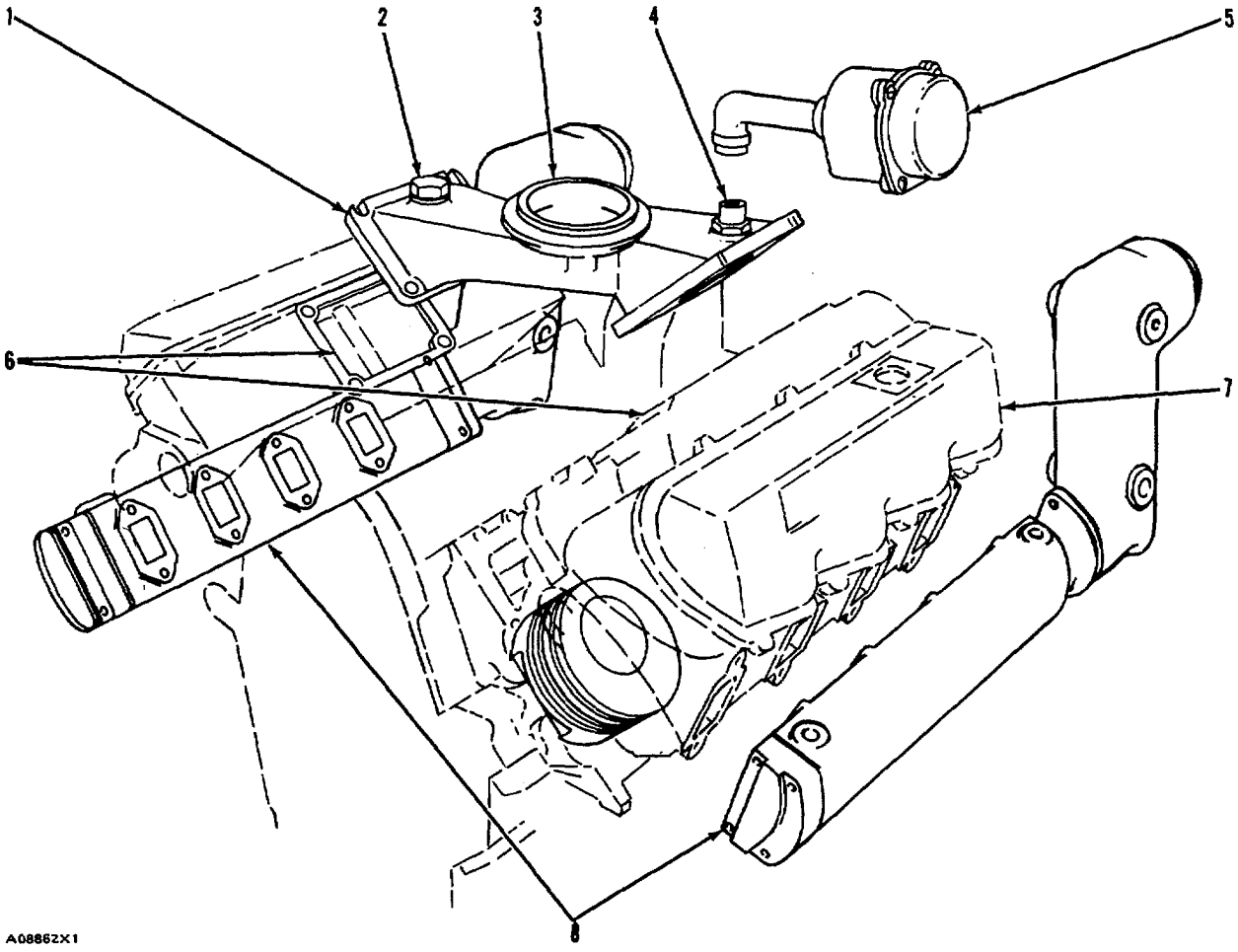
AIR INLET AND EXHAUST SYSTEM
(Industrial Engines)

1. Air inlet pipe. 2. Pipe plug. 3. Mounting flange for the air cleaner. 4. Fitting. 5. Positive crankcase ventilator valve. 6. Inlet manifolds. 7. Valve cover. 8. Exhaust manifolds.

The air inlet system is on the top side of the engine. The air cleaner goes on air inlet pipe (1). The air inlet pipe sends air to both cylinder heads. The air inlet pipe can not be turned end for end because the mounting flange for the air cleaner (3) has a small angle toward the front of the engine.

The air inlet manifolds (6) are made as a part of the cylinder heads. The air inlet openings and the design of the combustion chamber give the air needed for complete combustion.

The exhaust system is on each side of the engine. The exhaust manifolds (8) are along the outside of the cylinder heads. The exhaust manifold for the right side of the engine will not go on the left side of the engine. The exhaust manifold for the left side of the engine will not go on the right side of the engine.



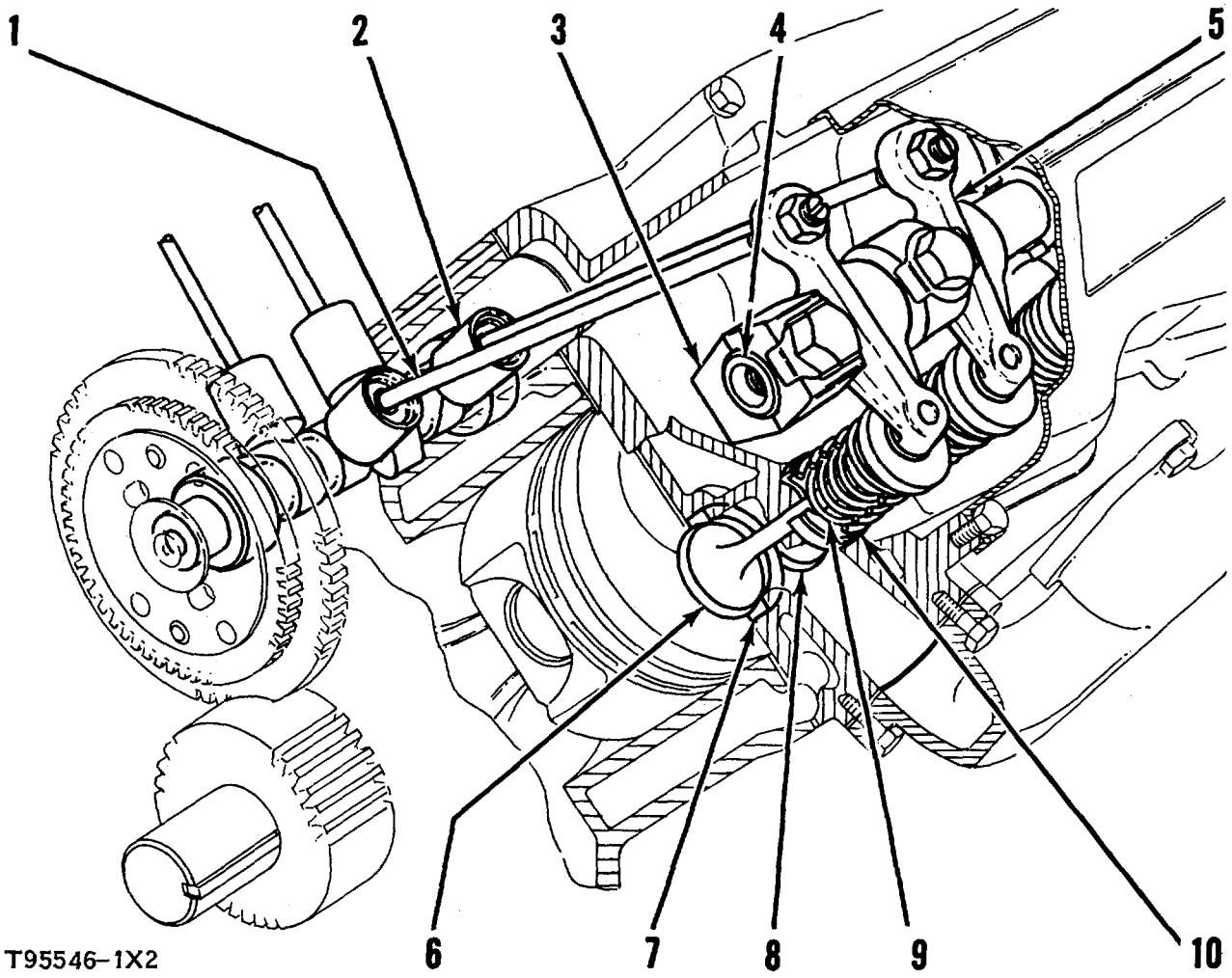
AIR INLET AND EXHAUST SYSTEM
(Marine Engines)

1. Air inlet pipe. 2. Pipe plug. 3. Mounting flange for the air cleaner. 4. Fitting. 5. Positive crankcase ventilator valve. 6. Inlet manifolds. 7. Valve cover. 8. Exhaust manifolds.

A positive crankcase ventilator valve (5) goes on valve cover (7). Valve (5) will return crankcase fumes to the engine through air inlet pipe (1).

Valve cover (7) can also be put on the other cylinder head. When valve cover (7) is put on the other cylinder heads fitting (4) must be exchanged with pipe plug (2) in the air inlet pipe (1).

CYLINDER HEAD AND VALVES
Engines with Serial Numbers 75V1-75V1446, 90N1-90N6120



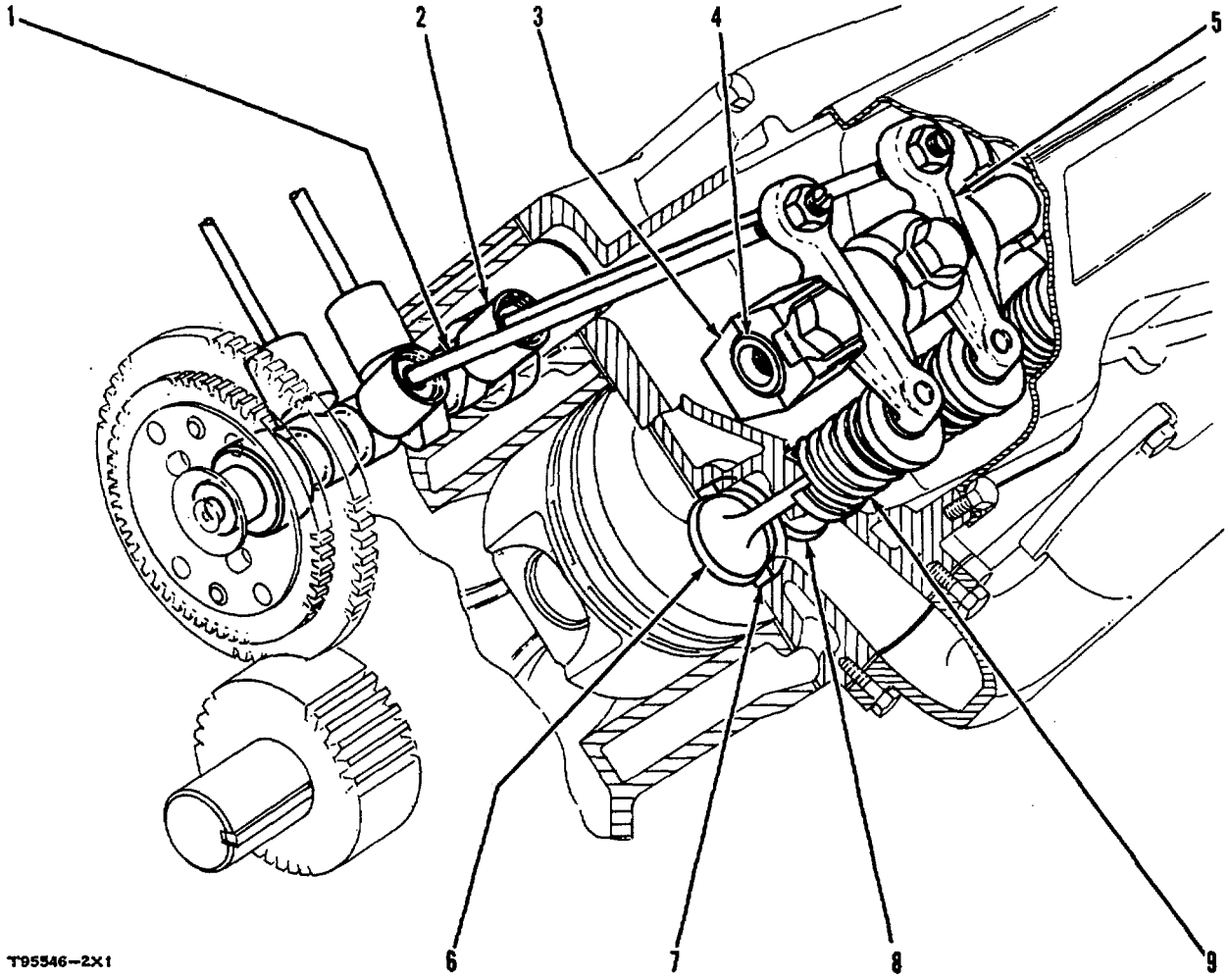
CYLINDER HEAD AND VALVES
1. Push Rod. 2. Cam follower. 3. Guide support. 4. Rocker arm shaft. 5. Rocker arm. 6. Exhaust valve. 7. Valve seat insert. 8. Intake Valve. 9. Inner valve spring. 10. Outer valve spring.

The valves and valve system components control the flow of inlet air and exhaust gases into and out of the cylinder during engine operation.

The intake and exhaust valves are opened and closed by movement of these components; crank- shaft camshaft cam followers push rods rocker arms and valve springs. Rotation of the crankshaft causes rotation of the camshaft. The camshaft gear is driven by and timed to a gear on the front of the crankshaft. When the camshaft turns the cams on the camshaft also turn and cause the cam followers to go up and down. This movement makes the push rods move the rocker arms. The movement of the rocker arms will make the intake and exhaust valves in the cylinder head open and close according to the firing order (injection sequence) of the engine. Two valve springs for each valve help to hold the valves in the closed position.

There is one intake and one exhaust valve for each cylinder. The valve seat insert for the exhaust valve can have replacement. The valve seat for the intake valve is machined in and is a part of the cylinder head. When the seat for the intake valve has been machined to the limits given in the SPECIFICATIONS it can be bored (machined) for a valve seat insert. The valve guide bore is machined in and is a part of the cylinder head.

CYLINDER HEAD AND VALVES
Engines with Serial Numbers 75V1447-UP, 90N6121-UP



CYLINDER HEAD AND VALVES

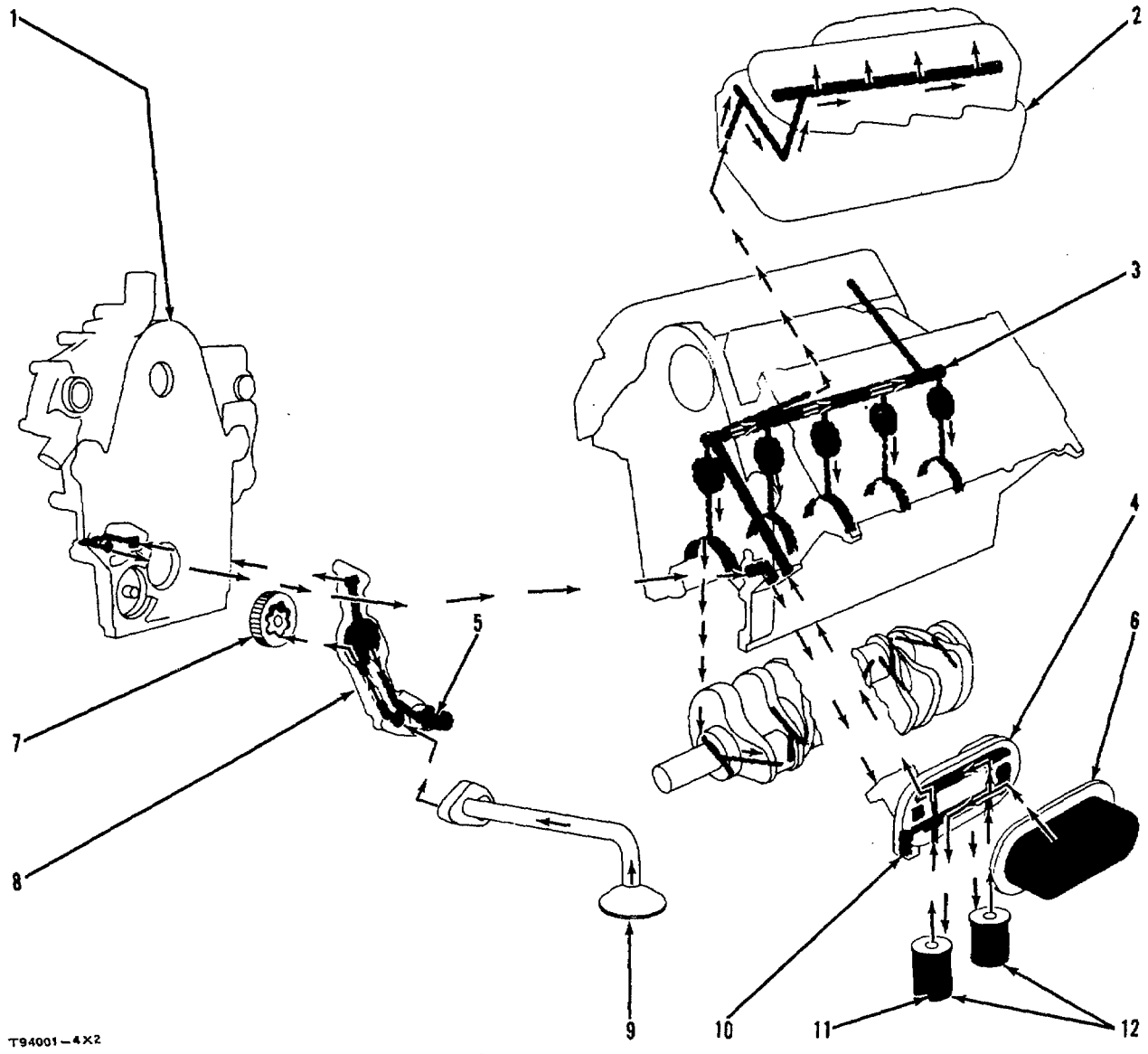
1. Push Rod. 2. Cam follower. 3.Guide support. 4. Rocker arm shaft. 5. Rocker arm. 6. Exhaust valve. 7. Valve seat insert. 8. Intake Valve. 9. Inner valve spring. 10. Outer valve spring.

The valves and valve system components control the flow of inlet air and exhaust gases into and out of the cylinder during engine operation.

The intake and exhaust valves are opened and closed by movement of these components; crank- shaft camshaft cam followers push rods rocker arms and valve springs. Rotation of the crankshaft causes rotation of the camshaft. The camshaft gear is driven by and timed to a gear on the front of the crankshaft. When the camshaft turns the cams on the camshaft also turn and cause the cam followers to go up and down. This- movement makes the push rods move the rocker arms. The movement of the rocker arms will make the intake and exhaust valves in the cylinder head open and close according to the firing order (injection sequence) of the engine. One valve spring for each valve helps to hold the valves in the closed position.

There is one intake and one exhaust valve for each cylinder. The valve seat insert for the exhaust valve can have replacement. The valve seat for the intake valve is machined in and is a part of the cylinder head. When the seat for the intake valve has been machined to the limits given in the SPECIFICATIONS it can be bored (machined) for a valve seat insert. The valve guide bore is machined in and is a part of the cylinder head.

LUBRICATION SYSTEM



SCHEMATIC OF LUBRICATION SYSTEM
(Industrial Engine Illustrated)

1. Front cover for the engine. 2. Cylinder head. 3. Oil manifold. 4. Base for the oil cooler. 5. Bypass valve. 6. Oil cooler. 7. Oil pump. 8. Cover for oil pump. 9. Suction bell for oil pump. 10. Bypass valve. 11. Bypass valve. 12. Oil filters.

The lubrication system uses a six lobe rotor type oil pump (7). Bolts hold the cover for the oil pump (8) on the front cover for the engine (1). The gear on the crankshaft drives the outer rotor. The outer rotor has rotation in a bearing in the front cover for the engine. The inner rotor goes on a short shaft in the front cover for the engine. The inner rotor is driven by the outer rotor.

A bypass valve (5) in the cover for the oil pump (8) controls the pressure of the oil coming from oil pump (7). The pump can put more oil into the system than needed. When the pressure of the oil going into the engine is more than 75 to 80 psi (5.3 to 5.6 kg/cm^2) the bypass valve (5) will open. This permits the oil that is not needed to go to the inlet oil passage of the oil pump.

Oil from the oil pan is pulled through the suction bell for the oil pump (9) by oil pump (7). The oil is sent by the pump to an oil passage in the front cover for the engine (1). Oil from this passage goes to the cylinder block and on to base for the oil cooler (4). The base for the oil cooler is on the left side of the engine near the front of the engine. Bypass valve (10) in the base for the oil cooler

will let the oil go around the oil cooler (6) when the oil is cold or if the restriction in the oil cooler is more than the other parts of the system. A difference in pressure of 12 to 15 psi (0.8 to 1.1 kg/cm2) between the oil inlet and the oil outlet will open the bypass valve.

There are two pressure outlets in the base for the oil cooler. The pressure outlets are on the outlet side of the oil cooler and oil filters. The pressure outlets are for the sending unit and switch for the oil pressure.

Oil from the oil filters (12) goes through a passage in the cylinder block to oil manifold (3). The oil manifold is in the center of the cylinder block above the camshaft and goes the full length of the cylinder block. Oil goes from the oil manifold to the bearings for the camshaft. There are grooves in the bore in the cylinder block around the bearings for the camshaft. The bearing surfaces (journals) on the camshaft get lubrication from these grooves through a hole in the bearings for the camshaft. Some of the oil goes around the grooves and down through a passage to a hole and groove in the top half of the main bearing. Oil from the hole and groove gives lubrication to the bearing surfaces (journals) of the crankshaft for the main bearings.

Oil gets into the crankshaft through holes in the bearing surfaces (journals) for the main bearings. Passages connect each bearing surface (journal) for the main bearing with the bearing surface (journal) for the connecting rod next to it. The piston pins get lubrication from oil thrown by other parts.

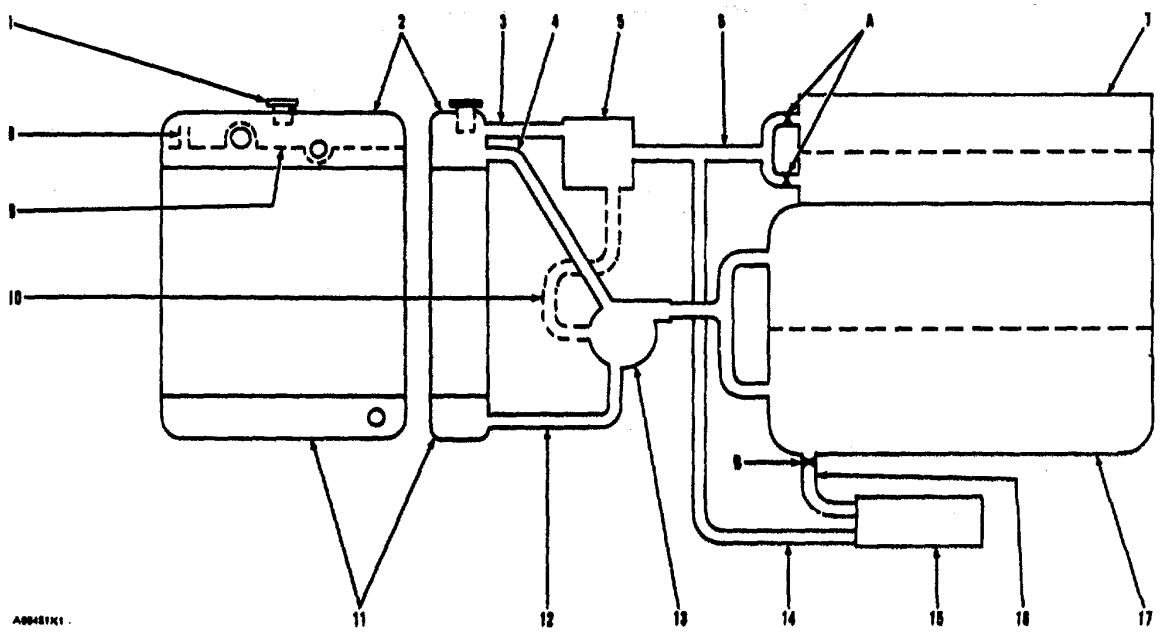
Oil for the rocker arms comes from the oil manifold (3) through passages in the cylinder block. The passages in the cylinder block are in alignment with a passage in each cylinder head.

The passage to the cylinder head on the left side is near the front of the cylinder block. The passage to the cylinder head on the right side is near the rear of the cylinder block.

The passage in each cylinder head sends the oil into an oil hole in the bottom of the mounting surface of the bracket that holds the shaft for the rocker arms. The oil hole is in the front bracket on the left side and in the rear bracket on the right side. The oil then goes up through the bracket and into the center of the shaft for the rocker arms. Oil goes along the center of the shaft to the bearings for the rocker arms. From the rocker arms the oil is pushed through small holes to give lubrication to the valves push rods cam followers and camshaft lobes. After the lubrication oil has done its work it will return to the oil pan for the engine.

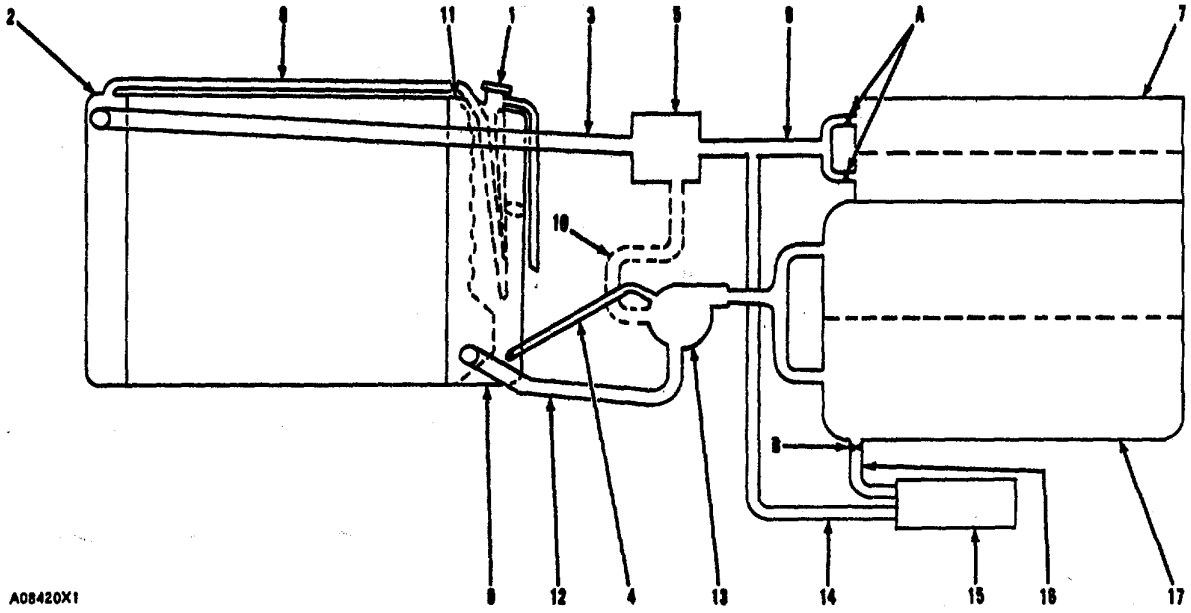
NOTE: On marine engines the location of the oil cooler for the marine gear is on top of the flywheel housing.

COOLING SYSTEM
(Industrial Engines)



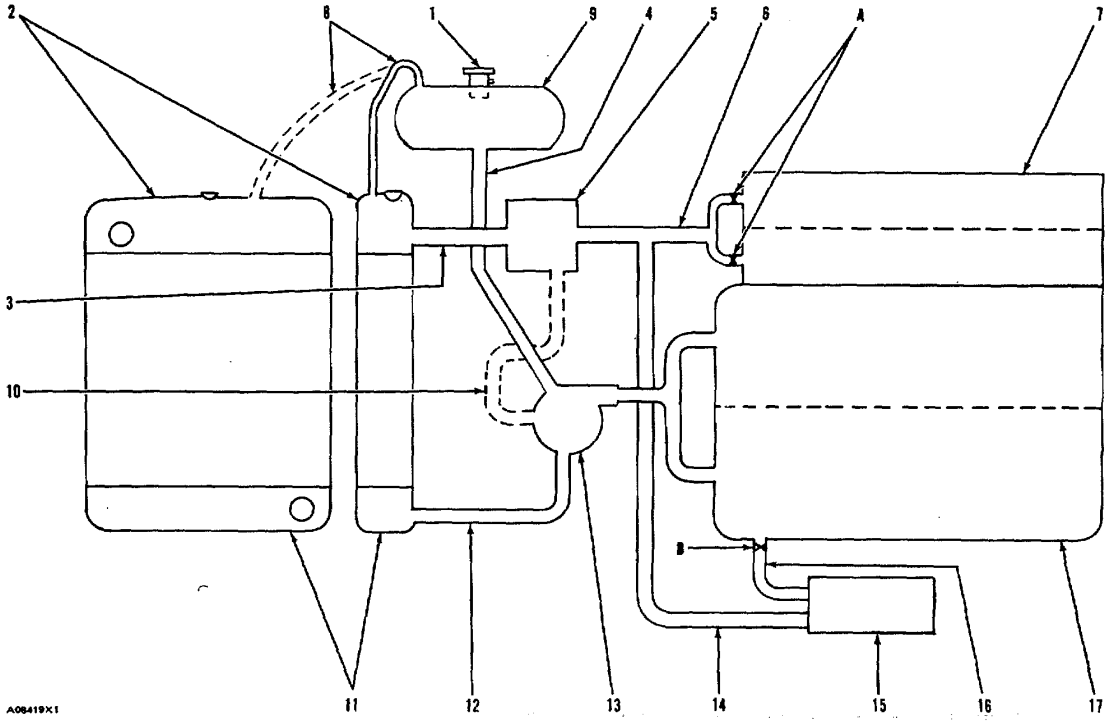
COOLING SYSTEM WITH STANDARD VERTICAL RADIATOR

1. Radiator cap. 2. Radiator top tank. 3. Radiator top hose. 4. Shunt line. 5. Housing for water temperature regulators. 6. Return to housing for water temperature regulators. 7. Cylinder heads (two). 8. Vent tube. 9. Surge tank. 10. Inside bypass. 11. Radiator bottom tank. 12. Radiator bottom hose. 13. Water pump. 14. Outlet line for oil cooler. 15. Oil cooler. 16. Inlet line for oil cooler. 17. Cylinder block. A. Orifices between cylinder heads and front cover. B. Orifice in oil cooler outlet.



COOLING SYSTEM WITH CROSS FLOW RADIATOR

1. Radiator cap. 2. Radiator top tank. 3. Radiator top hose. 4. Shunt line. 5. Housing for water temperature regulators. 6. Return to housing for water temperature regulators. 7. Cylinder heads (two). 8. Vent tube. 9. Surge tank. 10. Inside bypass. 11. Radiator bottom tank. 12. Radiator bottom hose. 13. Water pump. 14. Outlet line for oil cooler. 15. Oil cooler. 16. Inlet line for oil cooler. 17. Cylinder block. A. Orifices between cylinder heads and front cover. B. Orifice in oil cooler outlet.



COOLING SYSTEM WITH VERTICAL RADIATOR AND SEPARATE SURGE TANK

1. Radiator cap. 2. Radiator top tank. 3. Radiator top hose. 4. Shunt line. 5. Housing for water temperature regulators. 6. Return to housing for water temperature regulators. 7. Cylinder heads (two). 8. Vent tube. 9. Surge tank. 10. Inside bypass. 11. Radiator bottom tank. 12. Radiator bottom hose. 13. Water pump. 14. Outlet line for oil cooler. 15. Oil cooler. 16. Inlet line for oil cooler. 17. Cylinder block. A. Orifices between cylinder heads and front cover. B. Orifice in oil cooler outlet.

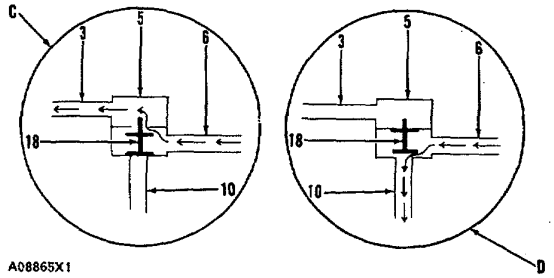
Water pump (13) is installed on the front face of the front cover for the engine and is driven by V belts from the crankshaft pulley. The inlet opening of water pump (13) is connected to radiator bottom hose (12). The outlet flow of coolant from water pump (13) goes through inside passages in the front cover for the engine.

As the coolant goes from the water pump it divides and goes through the inside passages in the front cover for the engine to cylinder block (17). Most of the coolant goes through cylinder block (17) and up to cylinder heads (7). From cylinder heads (7) the coolant goes forward through orifices (A) to the front cover for the engine.

Part of the coolant going to the left side (as seen from the flywheel) of cylinder block (17) goes through orifice (B) to inlet line (16) and on to oil cooler (15) to cool the oil for lubrication of the engine and back to the front cover for the engine through outlet line (14).

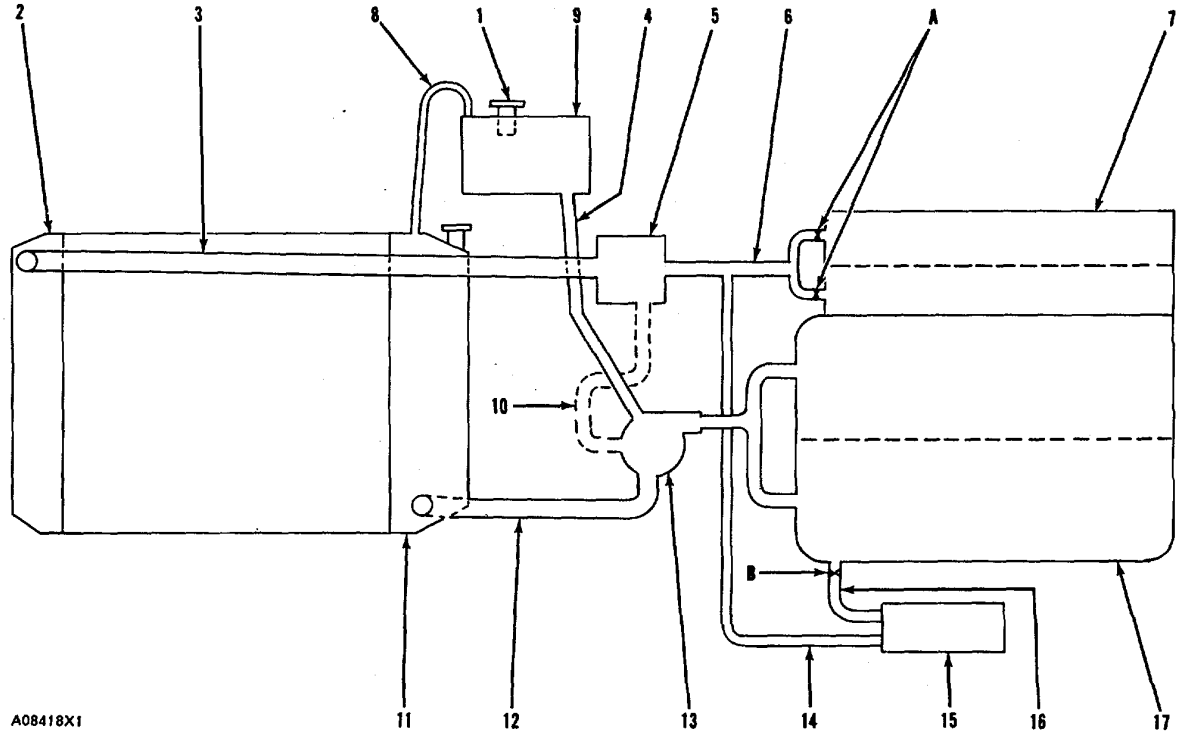
From the front cover for the engine the coolant either goes to the inlet for water pump (13) or to the radiator.

If the coolant is cold (cool) the water temperature regulators (18) will be closed. The coolant will go through inside bypass (10) to water pump (13). If the coolant is warm the water temperature regulators (18) will be open. When the water temperature regulators (18) are open they make a restriction in the inside bypass (10) and the coolant goes through radiator top hose (3) and into radiator top tank (2) or left side tank (2). Coolant then goes through the core of the radiator to the radiator bottom tank (11) or radiator right side tank (11) where it is again sent through the cooling system.



FLOW OF COOLANT

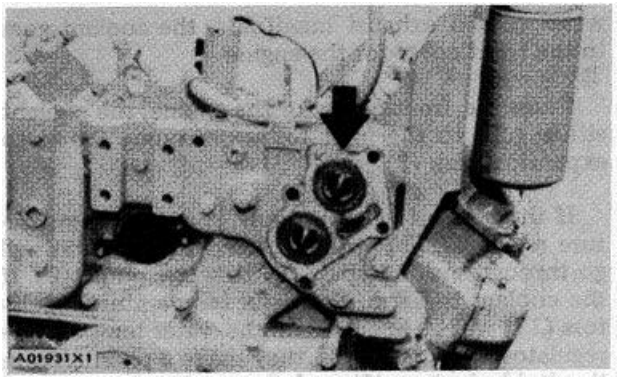
3. Radiator top hose. 5. Housing (water temperature regulators). 6. Return to housing for water temperature regulators. 10. Inside bypass. 18. Water temperature regulators (two). C. Flow with warm coolant. D. Flow with cold coolant.



COOLING SYSTEM WITH CROSS FLOW RADIATOR AND SEPARATE SURGE TANK
(Used on Caterpillar Lift Trucks)

1. Radiator cap. 2. Radiator top tank. 3. Radiator top hose. 4. Shunt line. 5. Housing for water temperature regulators. 6. Return to housing for water temperature regulators. 7. Cylinder heads (two). 8. Vent tube. 9. Surge tank. 10. Inside bypass. 11. Radiator bottom tank. 12. Radiator bottom hose. 13. Water pump. 14. Outlet line for oil cooler. 15. Oil cooler. 16. Inlet line for oil cooler. 17. Cylinder block. A. Orifices between cylinder heads and front cover. B. Orifice in oil cooler outlet.

CAUTION: Never run an engine unless the water temperature regulators are installed. With no water temperature regulators in the system the coolant will continually bypass the radiator and the engine will get too hot.



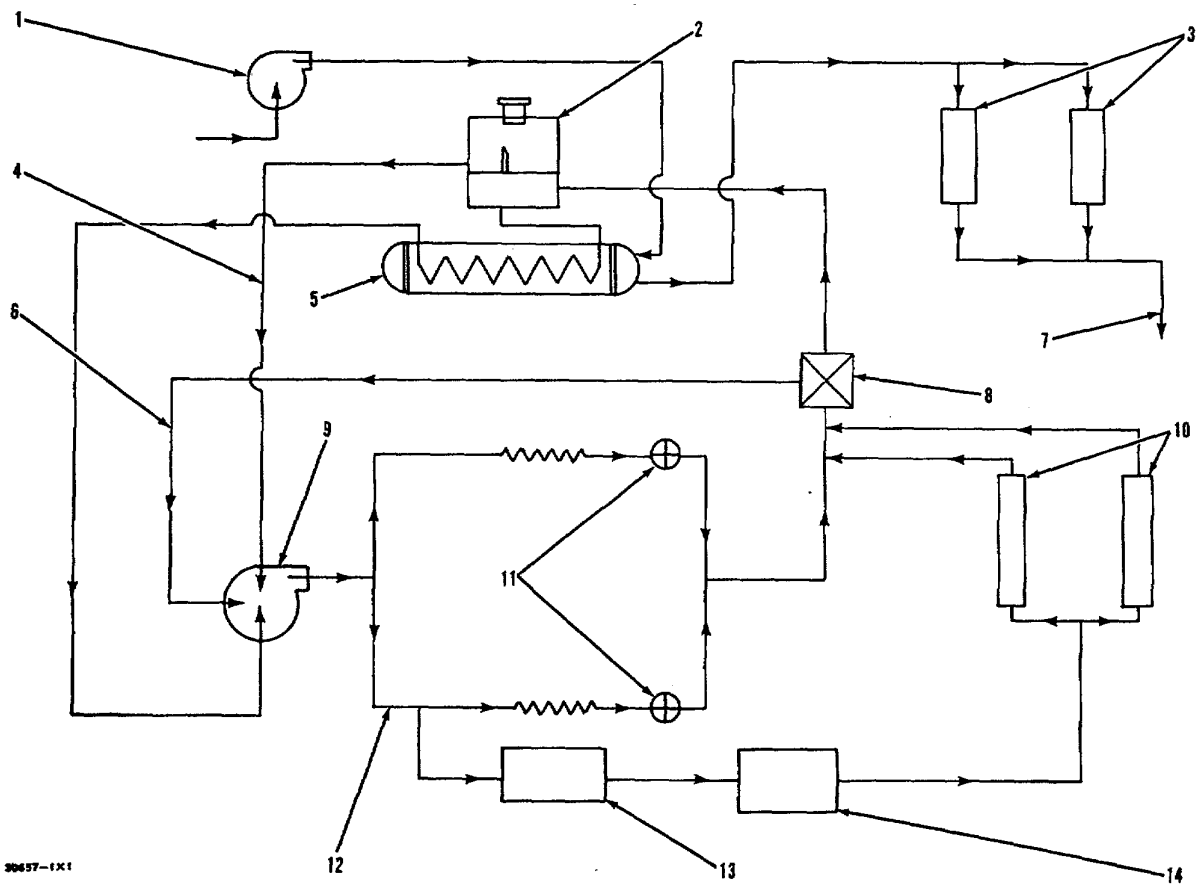
LOCATION OF WATER TEMPERATURE REGULATORS

The vertical radiator is made with a top tank (2) above the core and a surge tank (9) either above or separate from the top tank. Vent tube (8) connects radiator top tank (2) and surge tank (9). The cross flow radiator is made with a left side tank (2) and a right side tank (11). The surge tank (9) is either a part of right side tank (11) separated by an inside baffle or a tank separate from the radiator. Vent tube (8) connects the surge tank (9) to the radiator.

Surge tank (9) has a shunt line (4) that connects to the inlet of water pump (13). This shunt type system keeps a positive pressure on the inlet of water pump (13) at all times. When putting coolant in the cooling system coolant from surge tank (9) goes through shunt line (4) to the inlet of water pump (13) and fills cylinder block (17) from the bottom. By filling the system from the bottom any air in the system is pushed out through radiator top tank (2) through vent tube (8) into surge tank (9).

Radiator cap (1) is used to keep the correct pressure in the cooling system. This pressure keeps a constant supply of coolant to water pump (13). If this pressure goes too high a valve in radiator cap (1) moves (opens) to get a reduction of pressure. When the correct pressure is in the cooling system the valve in radiator cap (1) moves down (to the closed position).

COOLING SYSTEM
(Marine Engines)



COOLING SYSTEM SCHEMATIC

1. Sea water pump. 2. Expansion tank. 3. Exhaust risers. 4. Shunt line. 5. Heat exchanger. 6. Inside bypass. 7. Outlet for sea water. 8. Housing for water temperature regulators. 9. Water pump. 10. Water cooled exhaust manifolds. 11. Orifices between cylinder heads end front cover for the engine. 12. Cylinder block. 13. Coolant for marine gear oil. 14. Cooler for engine oil.

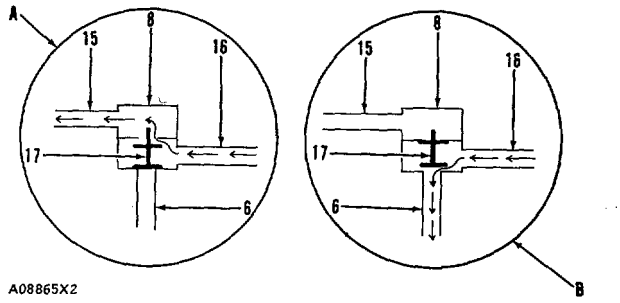
Water pump (9) is installed on the front face of the front cover for the engine and is driven by V belts from the crankshaft pulley. As the coolant goes from the water pump it divides and goes through inside passages in the front cover for the engine to cylinder block (12) and up to the cylinder heads. From the cylinder heads the coolant goes forward through orifices (11) to the front cover for the engine.

Part of the coolant going to the left side (as seen from the flywheel) of cylinder block (12) goes to cooler for marine gear oil (13) and on to the cooler for engine oil (14). Both of these oil coolers are in a common housing at the top rear of the engine.

After the coolant goes through the oil coolers it divides and goes to the rear of water cooled exhaust manifolds (10). After going through the water cooled exhaust manifolds the coolant goes to the front cover for the engine.

From the front cover for the engine the coolant either goes to the inlet for water pump (9) or to expansion tank (2).

If the coolant is cold (cool) the water temperature regulators (17) will be closed. The coolant will go through inside bypass (6) to water pump (9). If the coolant is warm the water temperature regulators (17) will be open. When the water temperature regulators (17) are open they make a restriction in the inside bypass (6) and the coolant goes to the lower part of expansion tank (2). (Expansion tank (2) is divided into an upper and lower compartment by a baffle.) From the lower compartment of expansion tank (2) most of the coolant goes through heat exchanger (5) and the inlet for water pump (9).

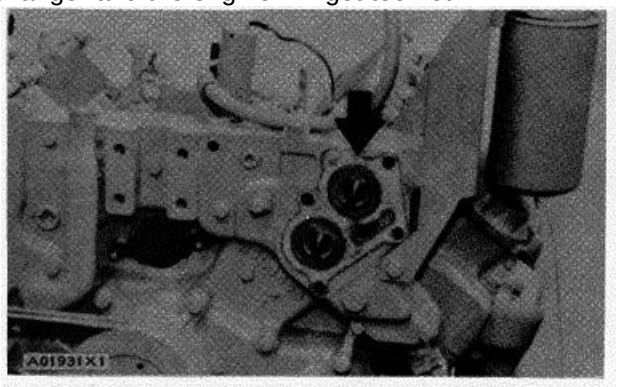


FLOW OF COOLANT

6. Inside bypass. 8. Housing for water temperature regulators. 15. Passage to lower part of expansion tank. 16. Return to housing for water temperature regulators. 17. Water temperature regulators (two). A. Flow with warm coolant. B. Flow with cold coolant.

A small part of the coolant from the lower compartment of expansion tank (2) goes through a small vent tube into the upper compartment of expansion tank (2). This coolant goes through shunt line (4) to the inlet of water pump (9). This shunt type system keeps a positive pressure on the inlet of water pump (9) at all times.

CAUTION: Never run an engine unless the water temperature regulators are installed. With no water temperature regulators in the system the coolant will continually bypass the expansion tank and heat exchanger and the engine will get too hot.



LOCATION OF WATER TEMPERATURE REGULATORS

Sea water pump (1) is installed on the left side of the front cover for the engine and is driven by a V belt from the crankshaft pulley.

Sea water is sent by sea water pump (1) to heat exchanger (5). From the heat exchanger the sea water goes to exhaust risers (3). After going through exhaust risers (3) the sea water mixes with the exhaust gases and goes through outlet for sea water (7).

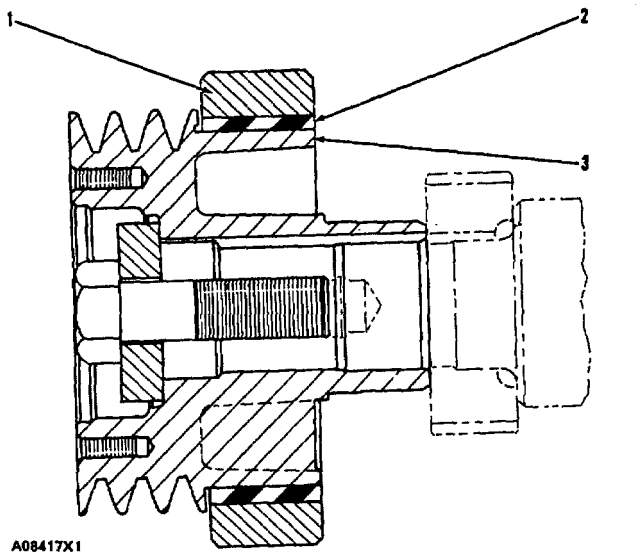
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BASIC BLOCK

VIBRATION DAMPER

The twisting of the crankshaft due to the regular power impacts along its length is called twisting (torsional) vibration. The vibration damper is installed on the front end of the crankshaft. It is used for reduction of torsional vibrations and stops the vibration from building up to amounts that cause damage.

The damper is made of a flywheel ring (1) connected to an inner hub (3) by a rubber ring (2). The rubber makes a flexible coupling between the flywheel ring and the inner hub.



CROSS SECTION OF A VIBRATION DAMPER

1. Flywheel ring. 2. Rubber ring. 3. Inner hub.

ELECTRICAL SYSTEM

The electrical system has three separate circuits: the charging circuit the starting circuit and the low amperage circuit. Some of the electrical system components are used in more than one circuit. The battery (batteries) circuit breaker ammeter cables and wires from the battery are all common in each of the circuits.

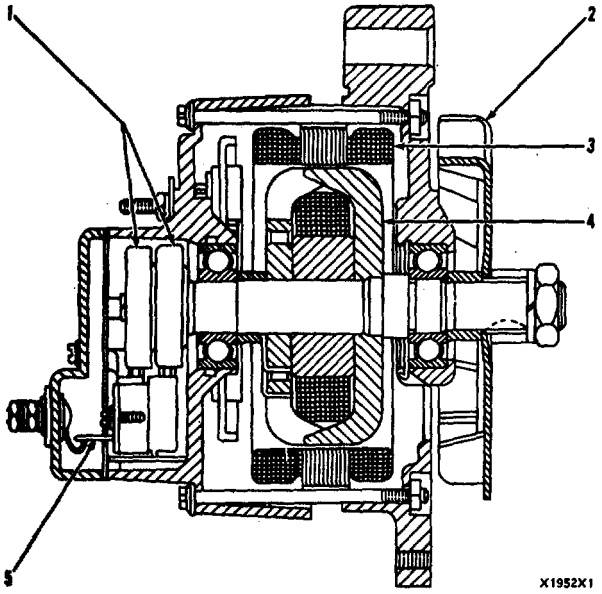
The charging circuit is in operation when the engine is running. An alternator makes electricity for the charging circuit. A voltage regulator in the circuit controls the electrical output to keep the battery at full charge.

The starting circuit is in operation only when the start switch is activated.

The low amperage circuit and the charging circuit are both connected to the same side of the ammeter. The starting circuit connects to the opposite side of the ammeter.

SYSTEM COMPONENTS

Alternator (Motorola)



ALTERNATOR

1. Slip rings. 2. Fan. 3. Stator. 4. Rotor. 5. Brush assembly.

The alternator is a three phase self rectifying charging unit. The alternator is driven from the crankshaft pulley by two V type belts.

The alternator has three main parts: a "rotating" (turning radial motion) rotor (4) which makes magnetic lines of force; a stationary stator (3) in which alternating current (AC) is made; and stationary rectifying diodes that change alternating current (AC) to direct current (DC).

The alternator field current goes through the brushes. The field current is 2 to 3 amperes. The rectifying diodes will send current from the alternator to the battery or load but will not send current from the battery to the alternator.

Regulator (Motorola)

The voltage regulator is a transistorized electronic switch. It feels the voltage in the system at the switch for oil pressure and gives the necessary field current to keep the needed system voltage. The voltage regulator has two basic circuits the load circuit and the control circuit.

The load circuit has a positive potential from the input lead-of the regulator to the rotor (field) winding. The control circuit makes the load circuit go off and on at a rate that will give the needed charging voltage.

Alternator (Delco-Remy)

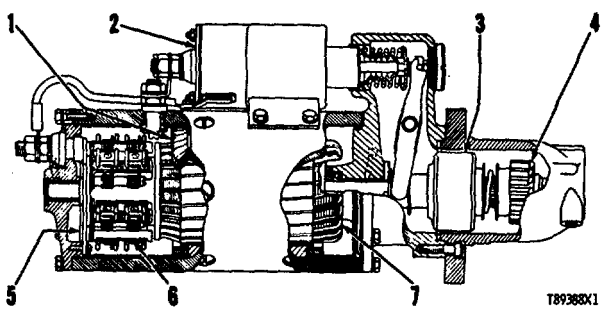
The alternator is a three phase self rectifying charging unit. The regulator for the alternator is part of the alternator. The alternator is driven from the crankshaft pulley by two V type belts.

The only part in the alternator which has movement is the rotor. The rotor is held in position by a ball bearing at the drive end and a roller bearing at the rectifier end.

The compartment for the regulator is sealed. The regulator controls the alternator output ac- cording to the needs of the battery and the other components in the electrical system.

Starting Motor

The starting motor is used to turn the engine flywheel fast enough to get the engine running.



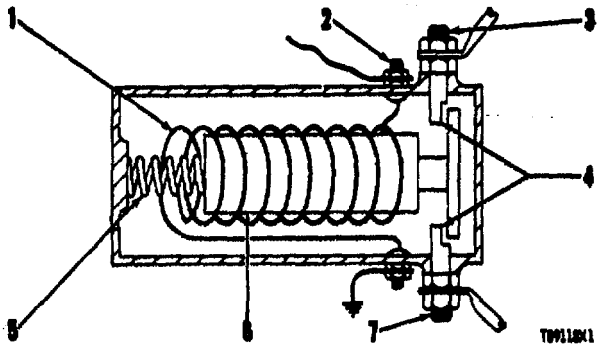
STARTING MOTOR

1. Field. 2. Solenoid. 3. Clutch. 4. Pinion. 5. Commutator. 6. Brush assembly. 7. Armature.

The starting motor has a solenoid. When the start switch is activated electricity from the electrical system will cause the solenoid to move the starter pinion to engage with the ring gear on the flywheel of the engine. The starter pinion will engage with the ring gear before the electric contacts in the solenoid close the circuit between the battery and the starting motor. When the start switch is released the starter pinion will move away from the ring gear of the flywheel.

Solenoid

A solenoid is a magnetic switch that uses low current to close a high current circuit. The solenoid has an electromagnet with a core (6) which moves.



SCHEMATIC OF A SOLENOID

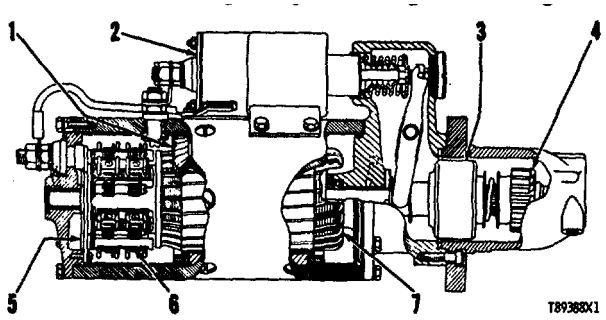
1. Coil. 2. Switch terminal. 3. Battery terminal. 4. Contacts . 5. Springs. 6. Core. 7. Component terminal.

There are contacts (4) on the end of core (6). The contacts are held in the open position by spring (6) that pushes core (6) from the magnetic center of coil (1). Low current will energize coil (1) and make a magnetic field. The magnetic field pulls core (6) to the center of coil (1) and the contacts close.

Circuit Breaker

The circuit breaker is a safety switch that opens the battery circuit if the current in the electrical system goes higher than the rating of the circuit breaker.

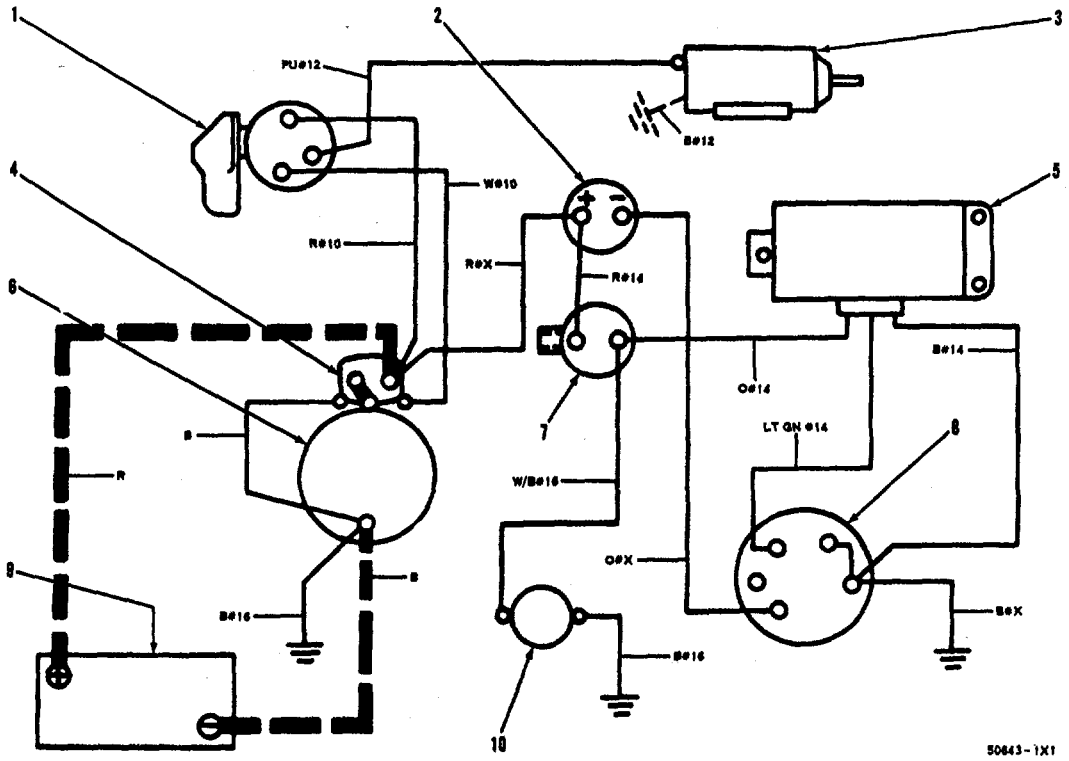
A heat activated metal disc with a contact point completes the electric circuit through the circuit breaker. If the current in the electrical system gets too high it causes the metal disc to get hot. This heat causes a distortion of the metal disc which opens the contacts and breaks the circuit. A circuit breaker that is open can be reset after it cools. Push the reset button to close the contacts and reset the circuit breaker.



CIRCUIT BREAKER SCHEMATIC

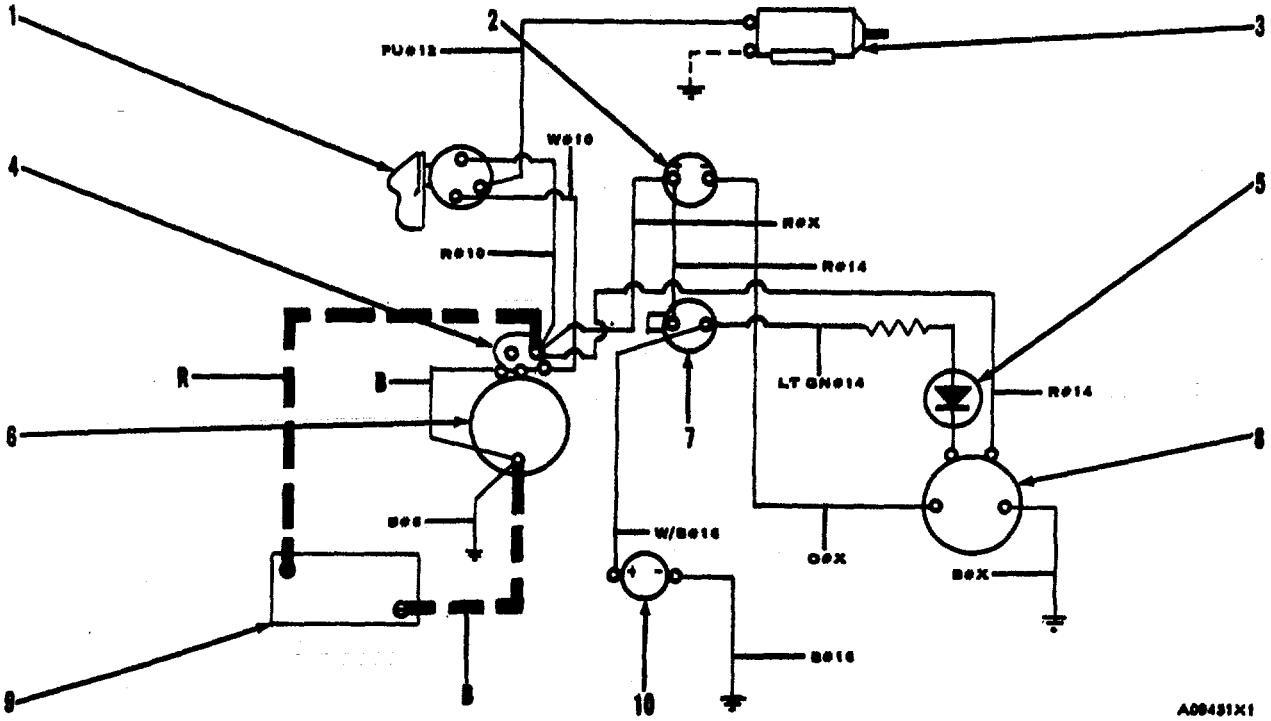
1. Reset button. 2. Disc in operation. 3. Contacts. 4. Disc. 5. Battery circuit terminals.

WIRING DIAGRAMS



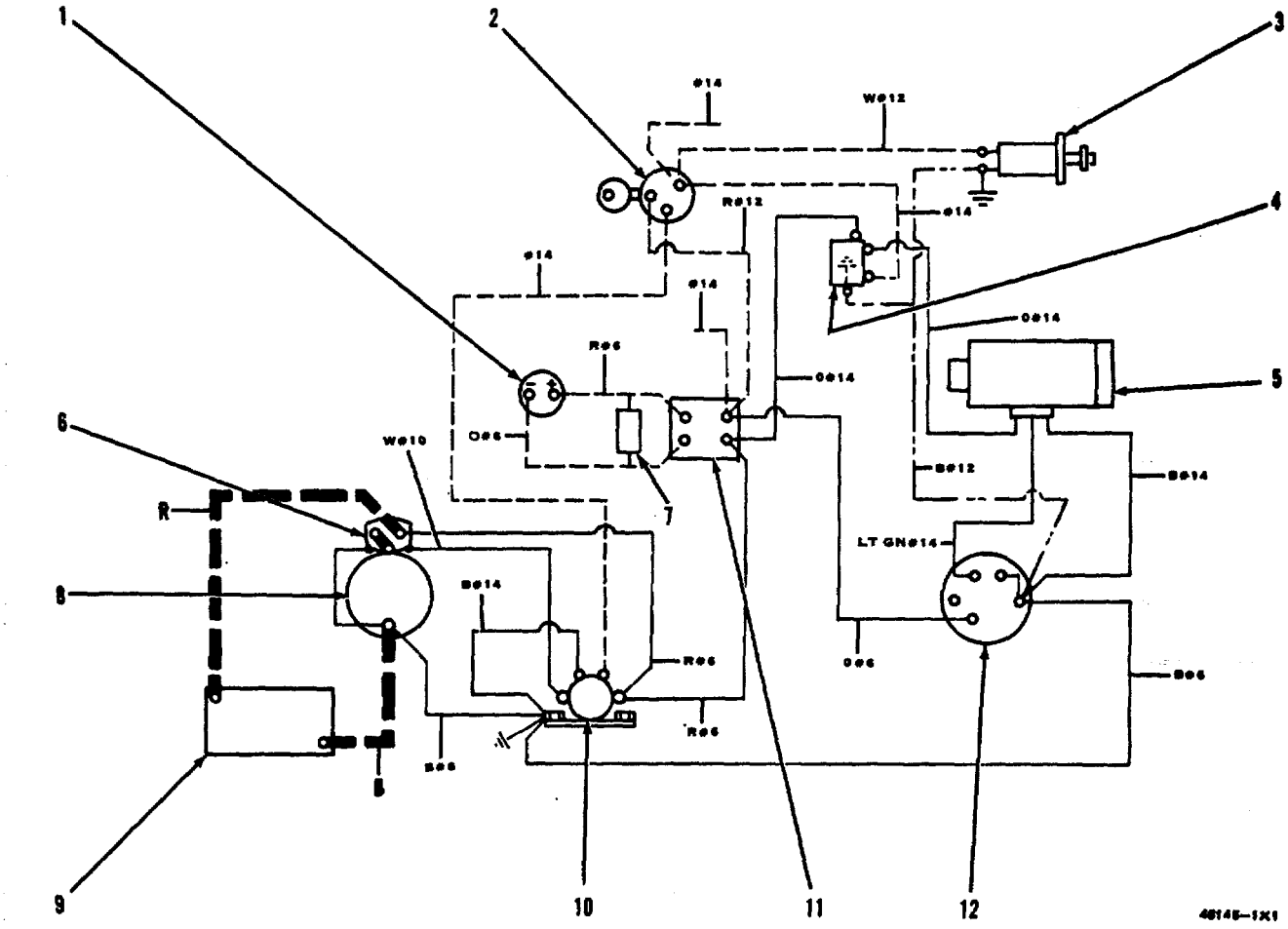
STARTING AND CHARGING SYSTEM

1. Off Start Switch. 2. Ammeter. 3. Fuel shut-off solenoid. 4. Starter solenoid. 5. Alternator regulator. 6..Starting motor. 7. Pressure switch (normally open). 8. Alternator. 9. Battery. 10. Hourmeter.



STARTING AND CHARGING SYSTEM

1. Off Start Switch. 2. Ammeter. 3. Fuel shut-off solenoid. 4. Starter solenoid. 5. Alternator regulator. 6. Starting motor. 7. Pressure switch (normally open). 8. Alternator. 9. Battery.



STARTING AND CHARGING SYSTEM

1. Ammeter. 2. Key switch. 3. Fuel shut-off solenoid. 4. Relay. 5. Alternator regulator . 6. Starter solenoid. 7. Shunt. 8. Starting motor. 9. Battery. 10. Solenoid switch. 11. Terminal strip. 12. Alternator.

NOTE: All wires shown as dash lines (----) are to be put on by the customer. All wires shown as phantom lines (-----) are for 24V systems only.

COLOR CODE	MAXIMUM RECOMMENDED TOTAL BATTERY CABLE LENGTH			WIRES MARKED #X	
B-Black W-White	CABLE SIZE	DIRECT ELECTRIC STARTING		CHARGING UNIT OUTPUT	WIRE SIZE
R-Red		12 VOLT	24-32 VOLT	0-18 amps.	#14
O-Orange	0	4.0 FEET	15.0 FEET	19.30 amps.	#10
BR-Brown	00	5.0 FEET	18.0 FEET	31-45 amps	#8
LT GN-Light Green	000	6.0 FEET	21.0 FEET	*46*-65 amps.	#6
PU-Purple	0000	7.5 FEET	27.0 FEET	NUMBER FOLLOWING COLOR DESIGNATION INDICATES RECOMMENDED WIRE SIZE	
W/B-White with Black Stripe					

X3560

TROUBLESHOOTING

Troubleshooting can be difficult. On the following pages there is a list of possible problems. To make a repair to a problem, make reference to the cause and correction.

This list of problems, causes, and corrections, will only give an indication of where a possible problem can be, and what repairs are needed. Normally, more or other repair work is needed beyond the recommendations in the list. Remember that a problem is not normally caused only by one part, but by the relation of one part with other parts. This list can not give all possible problems and corrections. The serviceman must find the problem and its source, then make the necessary repairs.

Item	Problem
1.	Engine Will Not Start.
2.	Misfiring or Running Rough.
3.	Stall at Low rpm.
4.	Sudden Changes in Engine rpm.
5.	Not Enough Power.
6.	Too Much Vibration.
7.	Loud Combustion Noise.
8.	Loud Noise (Clicking) From Valve Compartment.
9.	Oil in Cooling System.
10.	Mechanical Noise (Knock) in Engine.
11.	Fuel Consumption Too High.
12.	Loud Noise From Valves or Valve Drive Components.
13.	Little Movement of Rocker Arm and Too Much Valve Clearance.
14.	Valve Spring Lock is Free.
15.	Oil at the Exhaust.
16.	Little or No Valve Clearance.
17.	Engine Has Early Wear.
18.	Coolant in Lubrication Oil.
19.	Too Much Black or Gray Smoke.
20.	Too Much White or Blue Smoke.
21.	Engine Has Low Oil Pressure.
22.	Engine Uses Too Much Lubrication Oil.
23.	Engine Coolant is Too Hot.
24.	Starting Motor Does Not Turn.
25.	Alternator Gives No Charge.
26.	Alternator Charge Rate is Low or Not Regular.
27.	Alternator Charge Too High.
28.	Alternator Has Noise.
29.	Exhaust Temperature is Too High.

Problem	Cause	Correction
1. ENGINE WILL NOT START	Empty Fuel Tank	Put fuel in fuel tank
	Bad Quality Fuel	Remove the fuel from the fuel tank. Install a new fuel filter element. Put a good grade of clean fuel in the fuel tank.
	Dirty Fuel Filter	Install new fuel filter
	Dirty or Broken Fuel Lines	Clean or install new fuel lines as necessary.
	Linkage to Sleeve Control Shaft is Held in Shutoff Position	Check the operation of the shut-off solenoid and the shut-off linkage. Solenoid must pull up to compress spring for fuel turn on. Check governor linkage for free movement. Sleeves must turn freely on pump plungers in all positions of sleeve control shaft. The thrust collar must turn freely on the governor shaft at all positions between shut-off and full load. If linkage does not move freely under these conditions, clean all parts thoroughly. Inspect all parts for wear and make replacement where needed.
	Fuel Pressure is Too Low	Replace the fuel filter. Inspect the bypass valve for free movement. Install a new bypass valve if necessary.

Problem	Cause	Correction
1. ENGINE WILL NOT START (CONT.)	Air In The Fuel System	Find the air leak in the fuel system and correct it. Loosen each fuel line nut at the injection pumps and open the manual bleed valve. Loosen the bolts that hold the torque spring or stop bar cover. This will let out any air that is in the governor housing. After all air is out of fuel system, tighten bolts that hold torque spring or stop bar cover. Tighten fuel line nuts according to the SPECIFICATIONS. Close manual bleed valve.
	Fuel System Not Timed Correctly to Engine	Make adjustment to timing if necessary.
	Constant Bleed Valve Stays Open (Not enough fuel pressure for starting)	Replace constant bleed valve.
	No Over Fueling Spring	Install an over fueling spring.
2. MISFIRING OR RUNNING ROUGH	Fuel Pressure is Low	Make sure there is enough fuel in the fuel tank. Look for leaks or bad bends in the fuel line between fuel tank and fuel transfer pump. Look for air in the fuel system. Check fuel pressure. The outlet pressure of the fuel transfer pump at full load speed is 30 ± 5 psi (2.1 ± 0.4 kg/cm^2). If fuel pressure is lower than above pressure, install a new fuel filter element. Inspect the fuel bypass valve for free movement. Install a new fuel bypass valve if necessary.
	Air In The Fuel System	Find the air leak in the fuel system and correct it. Loosen each fuel line nut at the injection pumps and open the manual bleed valve. Loosen the bolts that hold the torque spring or stop bar cover. This will let out any air that is in the governor housing. After all air is out of fuel system, tighten bolts that hold torque spring or stop bar cover. Tighten fuel line nuts according to the SPECIFICATIONS. Close manual bleed valve.

Problem	Cause	Correction
2. MISFIRING OR RUNNING ROUGH (CONT.)	Leak or Break in Fuel Line Between Injection Pump and Injection Valve	Install a new fuel line.
	Wrong Valve Clearance	Make adjustment according to Specifications.
	Defect in Fuel Injection Nozzle	Run engine at rpm that gives maximum misfiring or rough running. Then loosen a fuel line nut on the injection line for each cylinder, one at a time. Find the cylinder where loosening the fuel line nut does not change the way the engine runs. Test the fuel injection nozzle for that cylinder. Install new parts where needed.
	Wrong Fuel Injection Timing	Make adjustment to timing.
3. STALL AT LOW RPM	Fuel Pressure is Low	Make sure there is enough fuel in the fuel tank. Look for leaks or bad bends in the fuel line between fuel tank and fuel transfer pump. Look for air in the fuel system. Check fuel pressure. The outlet pressure of the fuel transfer pump *at* full load speed is 30 ± 5 psi (2.1 ± 0.4 kg/cm2).
		If fuel pressure is lower than above pressure, install a new fuel filter element. Inspect the bypass valve for free movement. Install a new bypass valve if necessary.
	Idle rpm Too Low	Make adjustment to governor so idle rpm is the same as given in the RACK SETTING INFORMATION.
	Defect in Fuel Injection Nozzle	Install a new fuel injection nozzle.
	Wrong Valve Clearance	Make adjustment according to Specifications.
	Spring for Dashpot Governor Installed Wrong	Install spring correctly.

Problem	Cause	Correction
4. SUDDEN CHANGES IN ENGINE RPM	Air In The Fuel System	Find the air leak in the fuel system and correct it. Loosen each fuel line nut at the injection pumps and open the manual bleed valve. Loosen the bolts that hold the torque spring or stop bar cover. This will let out any air that is in the governor housing. After all air is out of fuel system, tighten bolts that hold torque spring or stop bar cover. Tighten fuel line nuts according to the SPECIFICATIONS. Close manual bleed valve.
	Broken Torsion Spring on Sleeve Control Shaft	Install new parts as needed.
	Linkage In Governor Does Not Move Freely	Clean all linkage and inside of governor housing. Install new parts for those parts that have damage
	Governor Springs Not Completely on Spring Seat	Put springs completely on spring seat.
	Spring for Dashpot Governor Installed Wrong	Install spring correctly.
5. NOT ENOUGH POWER	Bad Quality Fuel	Remove the fuel from the fuel tank. Install a new fuel filter element. Put a good grade of clean fuel in the fuel tank.
	Fuel Pressure is Low	Make sure there is fuel in the fuel tank. Look for leaks or bad bends in the fuel line between fuel tank and fuel transfer pump. Look for air in the fuel system. Check fuel pressure. The outlet pressure of the fuel transfer pump at full load speed is 30 ± 5 psi (2.1 ± 0.4 kg/cm^2).
		If fuel pressure is lower than above pressure, install a new fuel filter element. Inspect the fuel bypass valve for free movement. Install a new fuel bypass valve if necessary.
	Air In The Fuel System	Find the air leak in the fuel system and correct it. Loosen each fuel line nut at the injection pumps and open the manual bleed valve. Loosen the bolts that hold the torque spring or stop bar cover. This will let out any air that is in the governor housing. After all air is out of fuel system, tighten bolts that hold torque spring or stop bar cover. Tighten fuel line nuts according to the SPECIFICATIONS. Close manual bleed valve.
	Leaks in Air Inlet System	Check the pressure in the air intake manifold. Look for restrictions in the air cleaner.
	Wrong Fuel Setting	Make adjustments as necessary.

Problem	Cause	Correction
5. NOT ENOUGH POWER (CONT.)	Governor Linkage	Make adjustment to get full travel of linkage. Install new parts for those that have damage or defects
	Defect in Timing Advance Unit	Replacement of timing advance unit is needed.
	Wrong Valve Clearance	Make adjustment according to Specifications.
	Defect in Fuel Injection Nozzle	Run engine at rpm that gives maximum misfiring or rough running. Then loosen a fuel line nut on the injection line for each cylinder, one at a time. Tighten each fuel line nut before loosening the next one. Find the cylinder where loosening the fuel line nut does not change the way the engine runs. Test the fuel injection nozzle for that cylinder. Install new parts where needed.
	Wrong Fuel Injection Timing	Make adjustment to timing.
	Fuel Shut-off Solenoid or Shut-off Linkage Causing a Restriction in the Travel of the Shaft for the Sleeves	Check for correct full power with solenoid removed. If the engine has full power with the solenoid removed, the problem is in the solenoid or the shutoff linkage. Check for free travel of the
	Constant Bleed Valve Stays Closed	Replace constant bleed valve.
6. TOO MUCH VIBRATION	Loose Bolt or Nut Holding Pulley or Damper	Tighten bolt or nut.
	Pulley or Damper Has A Defect	Install a new pulley or damper.
	Engine Supports Are Loose,	Tighten all mounting bolts. Install new components if necessary.
	Misfiring or Running Rough	Make Reference to Item 2.
7. LOUD COMBUSTION NOISE (SOUND)	Bad Quality Fuel	Remove the fuel from the fuel tank. Install a new fuel filter element. Put a good grade of clean fuel in the fuel tank.
	Defect in Fuel Injection Nozzle	Install a new fuel injection nozzle.
	Wrong Fuel Injection Timing	Make adjustment to timing.

Problem	Cause	Correction
8. LOUD NOISE (CLICKING) FROM VALVE COMPARTMENT	Broken Valve Spring(s) or Locks	Install new parts where necessary. Broken locks can cause the valve to slide into the cylinder. This will cause much damage.
	Loose Bolts Holding Rocker Arm Assembly	Tighten to 18 ± 5 lb. ft. (2.5 ± 0.7 mkg).
	Too Much Valve Clearance	Make adjustment according to Specifications.
9. OIL IN COOLING SYSTEM	Defect in Core of Oil Cooler	Install a new core in the oil cooler.
	Defect in Head Gasket	Install a new head gasket.
10. MECHANICAL NOISE (KNOCK) IN ENGINE	Failure of Bearing For Connecting Rod	Inspect the bearing for the connecting rod and the bearing surface on the crankshaft. Install new parts where necessary.
	Damage to Crankshaft	Make replacement of the crankshaft.
	Defect in Attachment	Repair or install new components.
11. FUEL CONSUMPTION TOO HIGH	Fuel System Leaks	Replacement of parts is needed at points of leakage.
	Defect in Timing Advance Unit	Replacement of timing advance unit is needed.
	Wrong Fuel Injection Timing	Make adjustment to timing.
12. LOUD NOISE FROM VALVES OR VALVE DRIVE COMPONENTS	Broken Valve Spring(s)	Make replacement of parts with damage.
	Broken Camshaft	Make replacement of parts with damage. Clean engine thoroughly.
	Broken Timing Advance Gear	Make replacement of timing advance unit.

Problem	Cause	Correction
13. LITTLE MOVEMENT OF ROCKER ARM AND TOO MUCH VALVE CLEARANCE	Not Enough Lubrication	Check lubrication in valve compartment. There must be a strong flow of oil at engine high rpm, but only a small flow at low rpm. Oil passages must be clean, especially those sending oil to the cylinder head.
	Rocker Arm Parts Worn	If there is too much wear, install new parts or rocker arms. Make adjustment of valve clearance according to the Specifications.
	End of Valve Stem Worn	If there is too much wear, install new valves. Make adjustment of valve clearance according to Specifications.
	Too Much Valve Clearance	Make adjustment according to Specifications.
	Worn Push Rods	If there is too much wear, install new push rods. Make adjustment of valve clearance according to the Specifications.
	Cam Followers Worn	If there is too much wear, install new cam followers. Make adjustment of valve clearance according to the Specifications.
	Worn Cams on Camshaft	Check valve clearance. Check for free movement of valves or bent valve stems. Check for cam follower wear. Install a new camshaft. Make adjustment of valve clearance according to the Specifications.
	Loose Bolts Holding Rocker Arm Assembly	Tighten to 18 ± 5 lb. ft. (2.5 ± 0.7 mkg).
14. VALVE SPRING LOCK IS FREE	Broken Locks	Broken locks can cause the valve to slide into the cylinder. This will cause much damage.
	Broken Valve Spring(s)	Install new valve spring(s).
15. OIL AT THE EXHAUST	Too Much Oil in the Valve Compartment	Look at both ends of the rocker arm shaft. Be sure that there is a plug in each end.
	Worn Valve Guides	Reconditioning of the cylinder head is needed.
	Worn Piston Rings	Inspect and install new parts as needed.
16. LITTLE OR NO VALVE CLEARANCE	Worn Valve Seat or Face of Valve	Reconditioning of cylinder head is needed. Make adjustment of valve clearance according to the Specifications.

Problem	Cause	Correction
17. ENGINE HAS EARLY WEAR	Dirt in Lubrication Oil	Remove dirty lubrication oil. Install a new oil filter element. Put clean oil in the engine.
	Air Inlet Leaks	Inspect all gaskets and connections. Make repairs if leaks are found.
	Fuel Leakage Into Lubrication Oil	This will cause high fuel consumption and low engine oil pressure. Make repairs if leaks are found. Install new parts where needed.
18. COOLANT IN LUBRICATION OIL	Failure of Oil Cooler Core	Install a new core for the oil cooler.
	Failure of Cylinder Head Gasket	Install a new cylinder head gasket. Tighten the bolts holding the cylinder head, according to the Specifications.
	Crack or Defect in Cylinder Head	Install a new cylinder head.
	Crack or Defect in Cylinder Block	Install a new cylinder block.
	Failure of Front Cover Gasket	Install a new front cover gasket.
19. TOO MUCH BLACK OR GRAY SMOKE	Not Enough Air For Combustion	Check air cleaner for restrictions. [Max. 25 in. (635 mm) of water].
	Bad Fuel Injection Nozzle(s)	Install new fuel injection nozzle(s).
	Wrong Fuel Injection Timing	Make adjustment to timing.
20. TOO MUCH WHITE OR BLUE SMOKE	Too Much Lubrication Oil in Engine	Remove extra oil. Find where extra oil comes from. Put correct amount of oil in engine. Do not put too much oil in engine.
	Misfiring or Running Rough	Make reference to ITEM 2.
	Wrong Fuel Injection Timing	Make adjustment to timing.
	Worn Valve Guides	Reconditioning of cylinder head is needed.
	Worn Piston Rings	Install new parts as necessary.
	Defect in Timing Advance Unit	Replacement of timing advance unit is needed.

Problem	Cause	Correction
21. ENGINE HAS LOW OIL PRESSURE	Defect in Oil Pressure Gauge	Install new gauge.
	Dirty Oil Filter or Oil Cooler	Check the operation of bypass valve for the filter. Install new oil filter elements if needed. Clean or install new oil cooler core. Remove dirty oil from engine. Put clean oil in engine.
	Diesel Fuel in Lubrication Oil	Find the place where diesel fuel gets into the lubrication oil. Make repairs as needed. Remove the lubrication oil that has diesel fuel in it. Install a new oil filter element. Put clean oil in the engine.
	Too Much Clearance Between Rocker Arm Shaft and Rocker Arms	Check lubrication in valve compartment. Install new parts as necessary.
	Oil Pump Suction Pipe Has A Defect	Replacement of pipe is needed.
	Relief Valve for Oil Pump Does Not Operate Correctly	Clean valve and housing. Install new parts as necessary.
	Oil Pump Has A Defect	Make repair or replacement of oil pump if necessary.
	Too Much Clearance Between Crankshaft and Crankshaft Bearings	Check the oil filter for correct operation. Install new parts if necessary.
	Too Much Clearance Between Camshaft and Camshaft Bearings	Install new camshaft and camshaft bearings if necessary.
22. ENGINE USES TOO MUCH LUBRICATION OIL	Too Much Lubrication Oil in Engine	Remove extra oil. Find where extra oil comes from. Put correct amount of oil in engine. Do not put too much oil in engine.
	Oil Leaks	Find all oil leaks. Make repairs as needed.
	Oil Temperature is Too High	Check operation of oil cooler. Install new parts if necessary. Clean the core of the oil cooler. Check oil cooler bypass valve.
	Too Much Oil To Intake Valve Guides	Make reference to ITEM 15.
	Worn Valve Guides	Make reference to ITEM 15.
	Worn Piston Rings	Install new parts as necessary

Problem	Cause	Correction
23. ENGINE COOLANT IS TOO HOT	Restriction To Air Flow Through Radiator or Restriction To Flow Of Coolant Through the Heat Exchanger	Remove all restrictions of flow.
	Not Enough Coolant in System	Add coolant to cooling system.
	Pressure Cap Has A Defect	Check operation of pressure cap. Install a new pressure cap if necessary.
	Combustion Gases in Coolant	Find out where gases get into the cooling system. Make repairs as needed.
	Water Temperature Regulators (Thermostats) or Temperature Gauge Has A Defect	Check water temperature regulators for correct operation. Check temperature gauge operation. Install new parts as necessary.
	Water Pump Has A Defect	Install a new water pump.
	Too Much Load On The System	Make a reduction to the load.
	Wrong Fuel Injection Timing	Make adjustment to timing.
	Shunt Line Has A Defect	Make repairs as needed.
	Drive Belts Loose	Adjust drive belts.
24. STARTING MOTOR DOES NOT TURN	Battery Has Low Output	Check condition of battery. Charge battery or make replacement as necessary.
	Wiring or Switch Has A Defect	Make repairs or replacement as necessary.
	Starting Motor Solenoid Has A Defect	Install a new solenoid
	Starting Motor Has A Defect	Make repair or replacement of starting motor.

Problem	Cause	Correction
25. ALTERNATOR GIVES NO CHARGE	Loose Drive Belt For Alternator	Make an adjustment to put the correct tension on the drive belt.
	Charging or Ground Return Circuit or Battery Connections Have A Defect	Inspect all cables and connections. Clean and tighten all connections. Make replacement of parts that have a defect.
	Alternator Brushes Have A Defect	Install new brushes.
	Rotor (Field Coil) Has A Defect	Install a new rotor.
26. ALTERNATOR CHARGE RATE IS LOW OR NOT REGULAR	Loose Drive Belt For Alternator	Make an adjustment to put the correct tension on the drive belt.
	Charging or Ground Return Circuit or Battery Connections Have A Defect	Inspect all cables and connections. Clean and tighten all connections. Make replacement of parts that have a defect.
	Alternator Regulator Has A Defect	Make repair or replacement of alternator regulator.
	Alternator Brushes Have A Defect	Install new brushes.
	Rectifier Diodes Have A Defect	Make replacement of rectifier diode that has a defect.
	Rotor (Field Coil) Has A Defect	Install a new rotor.
27. ALTERNATOR CHARGE TOO HIGH	Alternator or Alternator Regulator Has Loose Connections	Tighten all connections to alternator or alternator regulator.
	Alternator Regulator Has A Defect	Install a new alternator regulator.

Problem	Cause	Correction
28. ALTERNATOR HAS NOISE	Drive Belt For Alternator is Worn or Has A Defect	Install a new drive belt for the alternator.
	Loose Alternator Drive Pulley	Check key groove in pulley for wear. If groove is worn, install a new pulley. Tighten pulley nut according to Specifications.
	Drive Belt and Drive Pulley For Alternator Are Not in Alignment	Make an adjustment to put drive belt and drive pulley in correct alignment.
	Worn Alternator Bearings	Install new bearings in the alternator.
29. EXHAUST TEMPERATURE IS TOO HIGH	Air Inlet System Has A Leak	Check pressure in the air inlet manifold. Look for restrictions at the air cleaner. Correct any leaks.
	Exhaust System Has A Leak	Find cause of exhaust leak. Make repairs as necessary.
	Air Inlet or Exhaust System Has A Restriction	Remove restriction.
	Wrong Fuel Injection Timing	Make an adjustment to the timing.

FUEL SYSTEM

Either too much fuel or not enough fuel for combustion can be the cause of a problem in the fuel system.

Many times work is done on the fuel system when the problem is really with some other part of the engine. Finding the source of the problem is difficult, especially when smoke is coming from the exhaust. Smoke coming from the exhaust can be caused by a bad fuel injection nozzle, but it can also be caused by the following:

a. Not enough air for good combustion.

b. An overload at high altitude.

c. Burning of too much oil.

d. Not enough compression.

FUEL SYSTEM INSPECTION

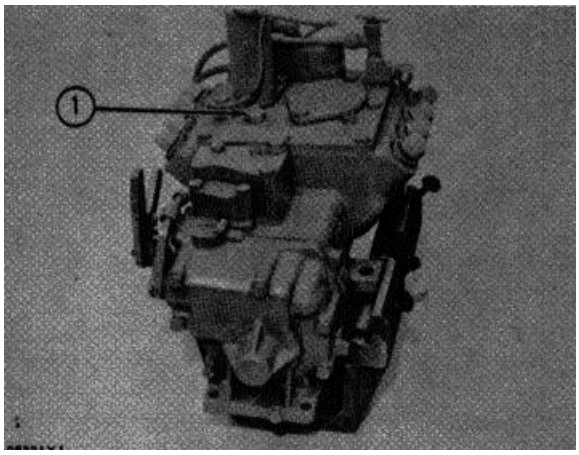
1. Check the fuel level in the fuel tank. Look at the cap for the fuel tank to make sure the vent is not filled with dirt.

2. Check the fuel lines for leakage. Be sure the fuel supply line does not have a restriction or a bad bend.

3. Install a new fuel filter. Clean the primary fuel filter if the machine is so equipped.

4. Remove any air that may be in the fuel system.

5. Check the flow of fuel from the constant bleed valve. The flow must be a minimum of 1 pint (0.47 liters) in one minute at full load speed.



LOCATION OF PLUG
1. Plug.

6. Check the fuel pressure in the fuel system. Fuel pressure at FULL LOAD must be 30 ± 5 psi (2.1 ± 0.4 kgcm2).

To check fuel pressure, remove plug (1) that is just behind the fuel shut-off solenoid on the top cover of the fuel pump housing. Install the necessary fittings and a gauge to check fuel pressure.

TESTING 9L6969 FUEL INJECTION NOZZLES

Tools Needed: **8S2242 Nozzle Testing Group.**
8S2245 Injector Cleaning Tool Group.
987354 Torque Wrench.
98S3093 Adapter.
8H8505 Combination Wrench.
8H85602 Combination Wrench.
8S2274 Socket.
8S1589 Socket.
9S5031 Socket.
Spanner-type screwdriver.
5/64" Hex Wrench.

An easy check can be made to find the cylinder that is misfiring, or running rough, and causing black smoke to come out of the exhaust pipe.

Run the engine at the speed that gives misfiring. Loosen the fuel line nut at a fuel injection pump. This will stop the flow of fuel to that cylinder. Do this for each cylinder until a loosened fuel line is found that makes no difference in engine running. Be sure to tighten each fuel line nut after the test before the next fuel line nut is loosened. Check each cylinder by this method. When a cylinder is found where the loosened fuel line nut does not make a difference in engine running, test the injection pump and injection nozzle for that cylinder.

Temperature of an exhaust manifold port, when the engine is running at low idle speed, can be an indication of the condition of a fuel injection nozzle. Low temperature at an exhaust manifold port, is an indication of no fuel to the cylinder. This can possibly be an indication of a nozzle with a defect. Extra high temperature at an exhaust manifold port, can be an indication of too much fuel to the cylinder, caused by a nozzle with a defect.

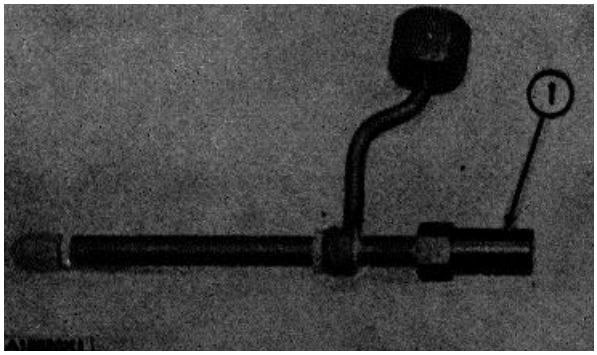
CAUTION: Do not test or disassemble nozzles unless you have the correct service tools.

Before testing a fuel injection nozzle, remove any loose carbon from the tip of the nozzle with the 8S2258 Brass Wire Brush. Remove the carbon seal dam. Clean the groove for the carbon seal dam and the body of the nozzle below the groove with

the 8S2258 Brass Wire Brush. A change in color in the area below the groove is normal and does not effect the body of the nozzle. Remove the carbon, but do not use the 8S2258 Brass Wire Brush to cause damage to the body of the nozzle. Do all tests before cleaning or making any adjustments to a nozzle. A test can show that the nozzle must not be used again.

WARNING: When testing a fuel injection nozzle, keep the tip of the nozzle pointed away from the operator and into the 8S2270 Fuel Collector. Fuel from the orifices in the tip of the nozzle is under high pressure and can cause injury to the operator.

NOTE: Remove cap (1) from the fuel injection nozzle before putting the nozzle on the 8S2267 Nozzle Tester.

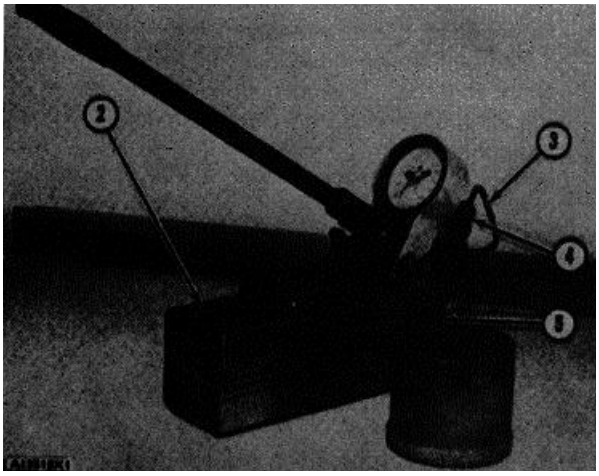


FULL INJECTION NOZZLE
1. Cap.

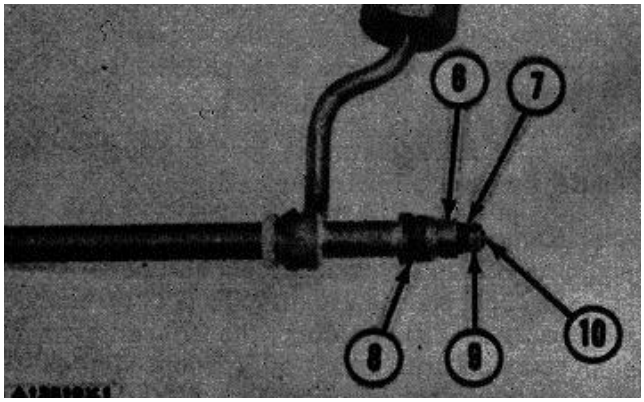
Put the fuel injection nozzle (5) to the 8S2267 Nozzle Tester (2) using the 8S2268 Tube Assembly (3) and the 9S3093 Adapter (4). The nut on the fuel injection nozzle can be tightened by hand if the 1 H 1023 Seal does not have damage.

CAUTION: Be sure to use clean SAE J967b oil or Kent-Moore J23300-585 or Shell 66631 calibration oil when testing. Dirty test oil will damage components of the fuel injection nozzle.

NOTE: Kent-Moore J23300-585 calibration oil can be purchased from Kent-Moore C Shell Oil Company.



CONNECTING NOZZLE TO TESTER
2. 82257 Nozzle Tester. 3. 8S2268 Tube Assembly. 4. 9S3093 Adapter. 5. Fuel injection nozzle.



FULL INJECTION NOZZLE
6. Locknut (for pressure adjustment screw). 7. Pressure adjustment screw. 8. 0-ring seal. 9. Locknut (for lift adjustment screw). 10. Lift adjustment screw.

Opening Pressure Test

CAUTION: Put a shop towel around the top of the fuel injection nozzle (pressure screw end) to take in any possible leakage of fuel.

1. Close the gauge protector valve. Close the on-off valve. Open the pump isolator valve. Flush the fuel injection nozzle by operating the nozzle tester for 10 to 15 strokes at a rate of 60 strokes per minute.
2. Open the gauge protector valve. Make a slow increase to the pressure until the valve in the

fuel injection nozzle opens. It is possible for the reading of the pressure on the gauge to go down fast if the valve makes a noise (chatters) when it opens. It is also possible for the reading of the pressure on the gauge to be almost constant when the valve in the fuel injection nozzle opens. The pressure needed to open the valve must be the same as shown in the chart. **If the opening pressure is less than 2200 psi (154.7 kg/cm2), do not use the fuel injection nozzle again.**

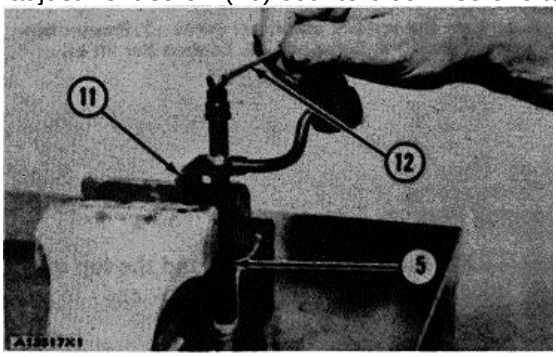
NOTE: The valve in the fuel injection nozzle can be good and still not make a noise (chatter), or not have a very fine vapor (spray) from the orifices in the tip of the fuel injection nozzle during Step 2.

VALVE NO.	OPENING PRESSURE	
	Used	New
9L6969	2400 to 2900 psi (168.7 to 203.9 kg/cm^2)	2750 to 2900 psi (193.3 to 203.9 kg/crn$^{2)}$

NOTE: The correct setting of the opening pressure for used nozzles that have been cleaned is 2700 to 2900 psi (189.8 to 203.9 kg/cm2).

3. To make an adjustment to the opening pressure, use the following procedure:

   a. Remove the fuel injection nozzle (5) from the 8S2267 Nozzle Tester and put it in the 8S2250 Nozzle Holding Tool (11). Loosen locknut (9) holding the lift adjustment screw. Turn the lift adjustment screw (10) counterclockwise one turn.

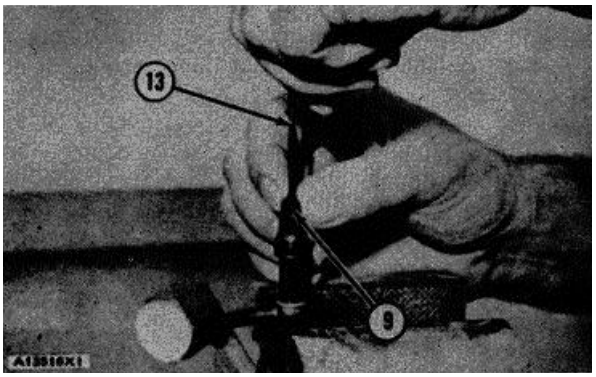


LOOSENING LOCKNUT

9. Fuel injection nozzle. 11. 8S2250 Nozzle Holding Tool. 12. 8H8502 Combination Wrench.

CAUTION: If the lift adjustment screw is not turned counterclockwise one turn, the valve can be bent or the seat for the valve can be damaged when the pressure adjustment screw is turned.

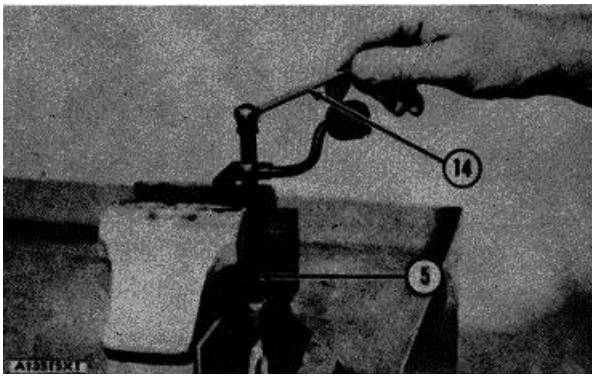
b. Hold the lift adjustment screw (10) with a 5/64" hex wrench (13) and remove the locknut (9).



REMOVING LOCKNUT

9. Locknut (for lift adjustment screw). 13. 5/64" hex wrench.

c. Loosen the locknut (6) that holds the pressure adjustment screw (7).

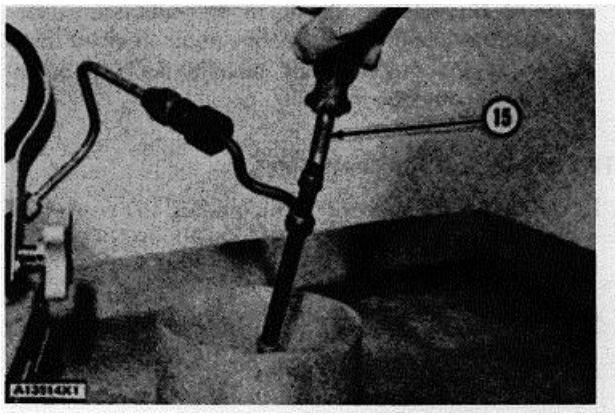


LOOSENING LOCKNUT

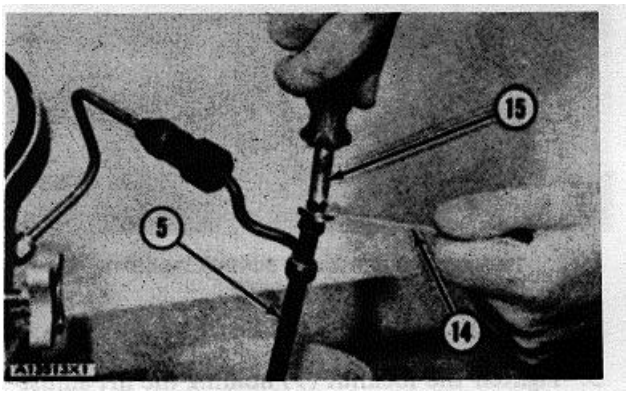
5. Fuel injection nozzle. 14. 8H8505 Combination Wrench.

d. Put the fuel injection nozzle (5) on the 8S2267 Nozzle Tester (2). Turn the pressure adjustment screw (7) clockwise using a spanner-type screwdriver (15). Each one-fourth of a turn will increase the opening pressure approximately 250 psi (17.8 kg/cm^2). Do not turn more than one-half of a turn to increase the opening pressure.

e. Hold the pressure adjustment screw (7) and tighten locknut (6) just enough so that the pressure adjustment screw (7) will not turn.



OPENING PRESSURE ADJUSTMENT
15. Spanner-type screwdriver.



TIGHTENING LOCKNUT
5. Fuel injection nozzle. 14. 8H8505 Combination Wrench. 15. Spanner-type screwdriver.

4. After the opening pressure adjustment is made, install the locknut (9) that holds lift adjustment screw (10). Make the valve lift adjustment. See VALVE LIFT ADJUSTMENT.

Valve Lift Adjustment

1. With the opening pressure correct arid while pumping test oil through the fuel injection nozzle, hold the locknut (9) and slowly turn the lift adjustment screw (10) clockwise until the pressure starts to increase above the opening pressure.

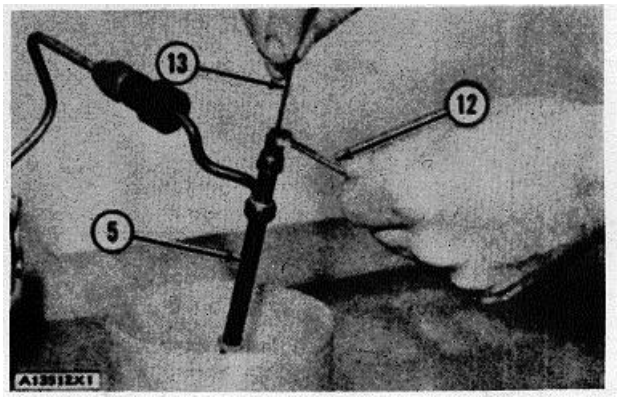
2. Check to be sure the valve is on the seat by making the pressure 200 to 500 psi (14.06 to 35.15 kg/cm2) more than the opening pressure.

CAUTION: Do not bend the valve or damage the seat by turning the lift adjustment screw (10) with too much force.

NOTE: Some fuel can be at the tip of the fuel injection nozzle but a rapid flow of drops (dribble) must not be seen.

3. Turn the lift adjustment screw (10) counterclockwise 3/4 ± 1/8 of a turn.

4. Hold the lift adjustment screw (10) with a 5/64" hex wrench and tighten locknut (9) just enough so that the lift adjustment screw (10) will not turn.



TIGHTENING LOCKNUT
5. Fuel injection nozzle. 12. 8H8502 Combination Wrench. 13. 5/64" Hex Wrench.

Checking Seat Condition

1. Put a shop towel around the top of the body of the fuel injection nozzle (pressure screw end) to take in the leakage. Close the gauge protector valve.

2. Point the tip of the fuel injection nozzle into the 8S2270 Fuel Collector and operate the pump rapidly for a minimum of five strokes to put the valve on the seat. Open the gauge protector valve. Be sure the nozzle tip is completely dry.

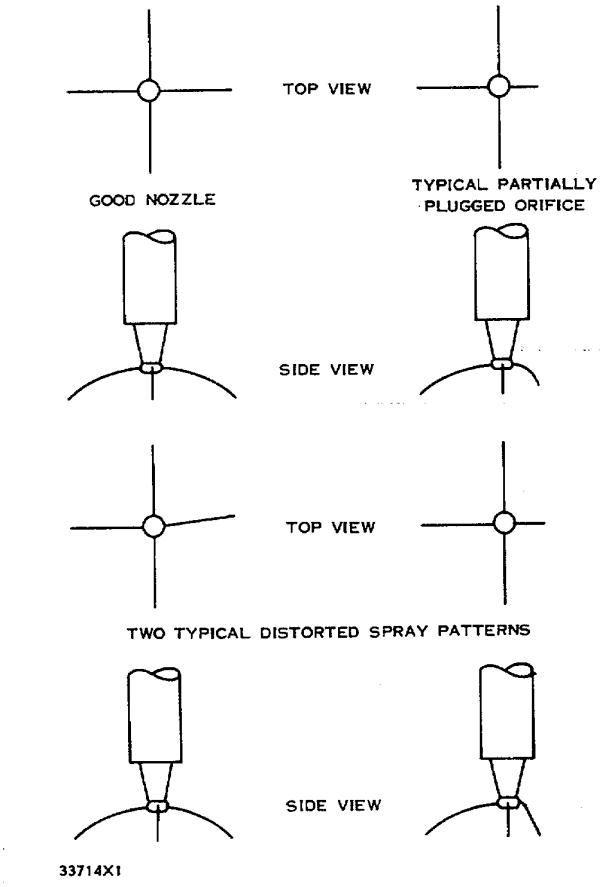
3. Make the pressure 250 to 300 psi (17.6 to 21.1 kg/cm) less than the opening pressure. If more than 3 drops of fuel get on the tip of the fuel injection nozzle in 15 seconds, clean or make replacement to the fuel injection nozzle.

Spray Characteristic (Pattern)

NOTE: The adjustment for the valve lift must be correct before checking the spray pattern.

1. Close the gauge protector valve and the on-off valve. Open the pump isolator valve.

2. Point the tip of the fuel injection nozzle into the 8S2270 Fuel Collector.



ANALYSIS OF NOZZLE SPRAY PATTERN

3. Make a slow increase in pressure and look at the spray pattern when fluid begins to flow through the fuel injection nozzle. The spray must be the same through all four orifices. Any change, either vertically or horizontally, is an indication of a bad nozzle. See the ANALYSIS OF NOZZLE SPRAY PATTERN.

Return Leakage Test

1. Put the tip of the fuel injection nozzle a little above the horizontal position. Tighten the nuts that connect the fuel injection nozzle to 'the tester.

2. Operate the tester until the pressure is at 1400 to 1600 psi (98.4 to 112.5 kg/cm2).

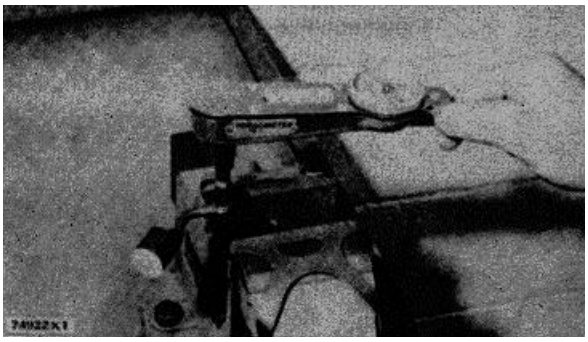
3. Look at the leakage from the return at the top (pressure screw end) of the fuel injection nozzle. After the first two drops fall, leakage is 1 to 10 drops in 15S seconds with SAE J967b oil or Kent-Moore J23300-585 or Shell 66631 calibration oil, with the temperature of the calibration oil at 65° to 75°F (18° to 24°C).

More than 10 drops in 15 seconds is an indication of parts with too much wear or bad parts, and replacement of the fuel injection nozzle is necessary.

Tightening Locknuts and Cap

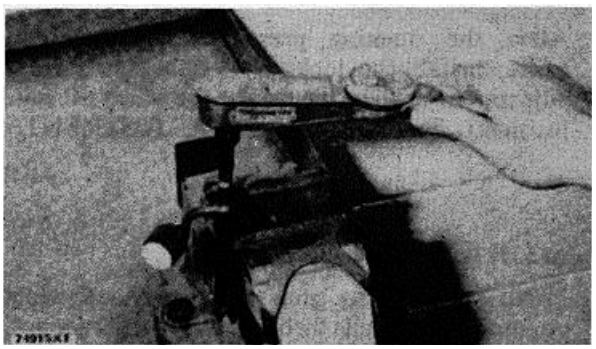
1. Remove the fuel injection nozzle (5) from the 8S2267 Nozzle Tester (2) and put it in the 8S2250 Nozzle Holding Tool (11).

2. Tighten the locknut (6) holding the pressure adjustment screw (7) to 70 to 80 lb. in. (80.7 to 92.2 cm. kg).



TIGHTENING PRESSURE SCREW LOCKNUT (Typical Example)

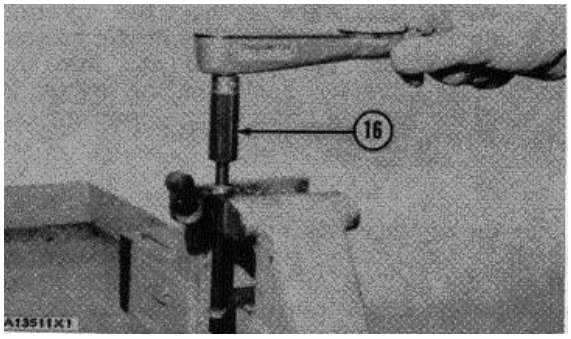
3. Tighten the locknut (9) holding the lift adjustment screw (10) to 35 to 45 lb. in. (40.4 to 51.9 cm. kg).



TIGHTENING VALVE LIFT SCREW LOCKNUT (Typical Example)

4. Install a new O-ring seal (8). Install cap (1) and tighten to 110 to 120 lb. in. (126.8 to 138.4 cm. kg).

NOTE: Be sure to install a new O-ring seal (8) before installing the cap.



TIGHTENING CAP
16. 9S5031 Socket.

Cap Leakage Test

With the adjustments and tests complete, check for leakage between the cap and the body of the fuel injection nozzle.

1. Put the fuel injection nozzle (5) on the 8S2267 Nozzle Tester (2).

2. Get the pressure to approximately 4000 psi (281.2 kg/cm2). Do this by pumping the tester until the cap is completely full of fuel, and then continue to pump until the pressure is 4000 psi (281.2 kg/cm2). There must not be any leakage between the cap and the body of the fuel injection nozzle. If there is leakage, make replacement of the O-ring seal (8) and check for cracks in the cap. Check nozzle again. If there is still leakage, make replacement of the fuel injection nozzle.

NOZZLE ASSEMBLY TROUBLE SHOOTING GUIDE		
PROBLEM	**CAUSE**	**CORRECTION**
Opening Pressure Not Correct	1. Adjustment wrong. 2. Bad Parts	1. Make adjustment 2. Make replacement of nozzle assembly
Nozzle Will Not Open	1. Orifices not open 2. Bent valve 3. Adjustment of lift not correct	1. Clean orifices 2. Make replacement of nozzle assembly 3. Make adjustment
Spray Pattern Not Correct	1. Orifices not open or bad 2. Crack at tip of nozzle 3. Adjustment of lift screw not correct	1. Clean orifices, if orifices are bad, make replacement of nozzle assembly 2. Make replacement of nozzle assembly 3. Make adjustment
Leakage At The Seat	1. Deposits in seat area 2. Seat for valve bad 3. Distortion of body 4. Crack at tip of nozzle	1. Disassemble and clean nozzle 2. Make replacement of nozzle assembly 3. Make replacement of nozzle assembly 4. Make replacement of nozzle assembly
Return Leakage High	1. Wear or scratches at guide 2. Bad parts	1. Make replacement of nozzle assembly 2. Make replacement of nozzle assembly
Return Leakage Low	1. Varnish on valve 2. Not enough clearance	1. Clean guide area with solvent 2. Make replacement of nozzle assembly

TESTING 9L7883 FUEL INJECTION NOZZLES

Tools Needed:
8S2242 Nozzle Testing Group.
8S2245 Injector Cleaning Tool Group.
9S7354 Torque Wrench.
9S3093 Adapter.
8H8505 Combination Wrench.
8H8502 Combination Wrench.
8S2274 Socket.
8S1589 Socket.
Screwdriver.

An easy check can be made to find the cylinder that is misfiring, or running rough, and causing black smoke to come out of the exhaust pipe.

Run the engine at the speed that gives misfiring. Loosen the fuel line nut at a fuel injection pump. This will stop the flow of fuel to that cylinder. Do this for each cylinder until a loosened fuel line is found that makes no difference in engine running. Be sure to tighten each fuel line nut after the test before the next fuel line nut is loosened. Check each cylinder by this method. When a cylinder is found where the loosened fuel line nut does not make a difference in engine running, test the injection pump and injection nozzle for that cylinder.

Temperature of an exhaust manifold port, when the engine is running at low idle speed, can be an indication of the condition of a fuel injection nozzle. Low temperature at an exhaust manifold port, is an indication of no fuel to the cylinder. This can possibly be an indication of a nozzle with a defect. Extra high temperature at an exhaust manifold port, can be an indication of too much fuel to the cylinder, caused by a nozzle with a defect.

CAUTION: Do not test or disassemble nozzles unless you have the correct service tools.

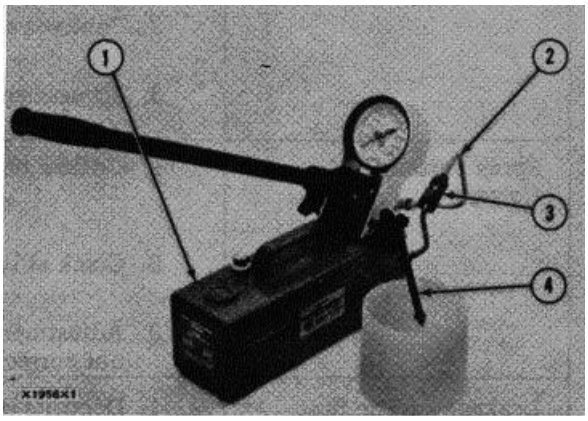
Before testing a fuel injection nozzle, remove any loose carbon from the tip of the nozzle with the 8S2258 Brass Wire Brush. Remove the carbon seal dam. Clean the groove for the carbon seal dam and the body of the nozzle below the groove with the 8S2258 Brass Wire Brush. A change in color in the area below the groove is normal and does not effect the body of the nozzle. Remove the carbon, but do not use the 8S2258 Brass Wire Brush to cause damage to the body of the nozzle. Do all tests before cleaning or making any adjustments to a nozzle. A test can show that the nozzle must not be used again.

WARNING: When testing a fuel injection nozzle, keep the tip of the nozzle pointed away from the operator and into the 8S2270 Fuel Collector. Fuel from the orifices in the tip of the nozzle is under high pressure and can cause injury to the operator.

Put the fuel injection nozzle (4) to the 8S2267 Nozzle Tester (1) using the 8S2268 Tube Assembly (2) and the 9S3093 Adapter (3). The nut on the fuel injection nozzle can be tightened by hand if the 1H1023 Seal does not have damage.

CAUTION: Be sure to use clean Kent-Moore J23300-585 or Shell 66631 calibration oil or equivalent when testing. Dirty test oil will damage components of the fuel injection nozzle.

NOTE: Kent-Moore J23300-585 calibration oil can be purchased from Kent-Moore Corporation 1501 South Jackson Street, Jackson, Michigan 49203. Shell 66631 calibration oil can be purchased from Shell Oil Company.



CONNECTING NOZZLE TO TESTER
1. 8S2267 Nozzle Tester. 2. 8S2268 Tube Assembly. 3. 9S3093 Adapter. 4. Fuel injection nozzle.

Opening Pressure Test

1. Close the gauge protector valve. Close the on-off valve. Open the pump isolator valve. Flush the fuel injection nozzle by operating the nozzle tester for 10 to 15 strokes at a rate of 60 strokes per minute.

2. Open the gauge protector valve. Make a slow increase to the pressure until the valve in the

reading of the pressure on the gauge to be almost constant when the valve in the fuel injection nozzle opens. The pressure needed to open the valve must be the same as shown in the chart. If the opening pressure is less than 2200 psi (154.7 kg/cm2), do not use the fuel injection nozzle again.

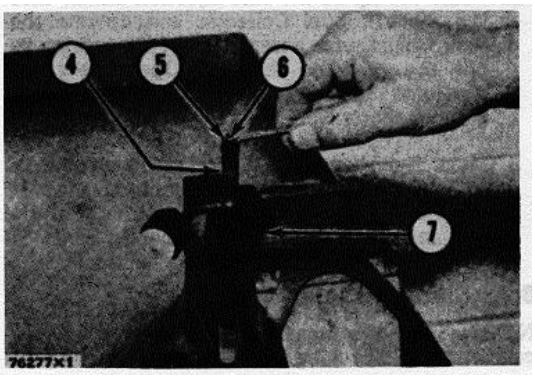
NOTE: The valve in the fuel injection nozzle can be good and still not make a noise (chatter), or not have a very fine vapor (spray) from the orifices in the tip of the fuel injection nozzle during Step 2.

VALVE NO.	OPENING PRESSURE	
	Used	New
9L7883	2400 to 2900 psi (168.7 to 203.9 kg/cm^2)	2750 to 2900 psi (193.3 to 203.9 kg/crn$^{2)}$

NOTE: The correct setting of the opening pressure for used nozzles that have been cleaned is 2700 to 2900 psi (189.8 to 203.9 kg/cm2).

3. To make an adjustment to the opening pressure, use the following procedure:

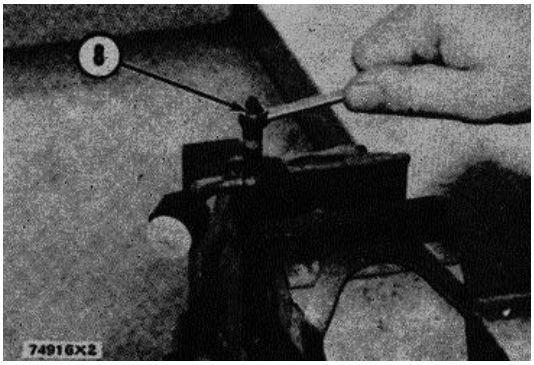
a. Remove the fuel injection nozzle (4) from the 8S2267 Nozzle Tester and put it in the 8S2250 Nozzle Holding Tool (7). Loosen Locknut (5). Turn lift adjustment screw (6) counterclockwise two or three turns.



LOOSENING LOCKNUT
4. Fuel injection nozzle. 5. Locknut. 6. Lift adjustment screw. 7. 8S2250 Nozzle Holding Tool.

CAUTION: If the lift adjustment screw (6) is not loosened, the valve can be bent or the seat for the valve can be damaged when the fuel injection nozzle is assembled in Step e.

b. Loosen the pressure screw (8). Remove the fuel injection nozzle from the 8S2250 Nozzle Holding Tool (7).

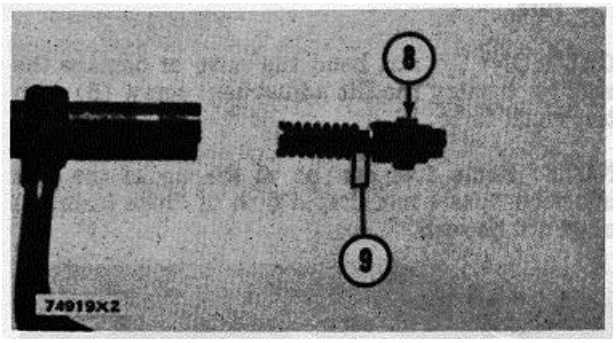


LOOSENING PRESSURE SCREW
8. Pressure screw.

c. Tilt the fuel injection nozzle down, a small amount, from the vertical position and remove pressure screw (8) and shims (9).

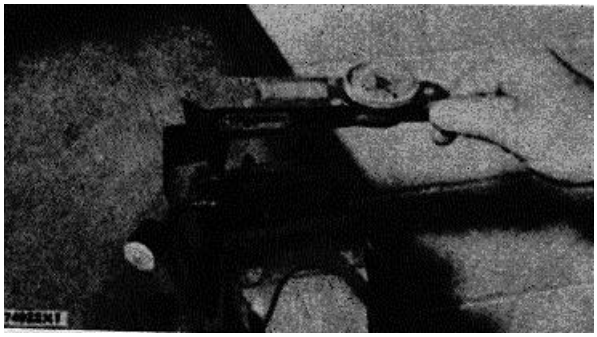
NOTE: If shims (9) do not come out of the fuel injection nozzle, turn the fuel injection nozzle over and let the shims, spring, and spring seat fall into your hand. The valve can come out of the body by its own weight and must be held carefully by the stem.

d. To make an increase in the opening pressure add a 4N5730 Shim. The 4N5730 Shim is .005 in. (0.13 mm) thick and will increase the opening pressure approximately 250 psi (17.8 kg/cm^2) maximum of two shims can be added to make an increase in the opening pressure.



PRESSURE SCREW AND SHIMS
8. Pressure screw. 9. Shims.

e. Assemble the fuel injection nozzle being sure the thicker shim is against the pressure screw as shown. Put the fuel injection nozzle in the 8S2250 Nozzle Holding Tool. Put the nozzle holding tool in a vise and tighten the pressure screw (8) to 75 to 80 lb. in. (86.5 to 92.2 cm. kg).



TIGHTENING PRESSURE SCREW

f. Remove the fuel injection nozzle from the 882250 Nozzle Holding Tool. Connect the fuel injection nozzle, to the 8S2267 Nozzle Tester. Make sure the tip of the fuel injection nozzle is in the down position. Point the tip of the fuel injection nozzle into the 862270 Fuel Collector. Check the opening pressure. If the opening pressure is not correct, do the complete procedure in Step 3 again.

Valve Lift Adjustment

1. With the opening pressure correct and while pumping test oil through the fuel injection nozzle, hold the locknut (5) and slowly turn the lift adjustment screw (6) clockwise until no fuel comes from the fuel injection nozzle.

2. Check to be sure the valve is on the seat by making the pressure 200 to 500 psi (14.06 to 83.15 kg/cm^2) more than the opening pressure.

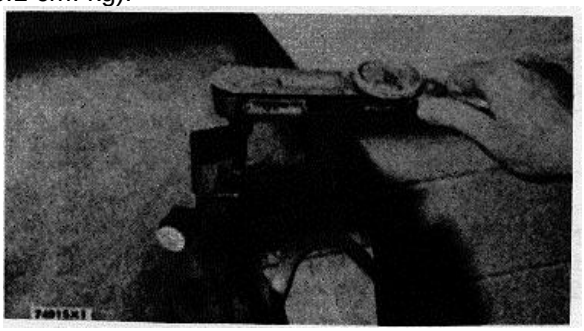
CAUTION: Do not bend the valve or damage the seat by turning the lift adjustment screw (6) with too much force.

NOTE: Some fuel can be at the tip of the fuel injection nozzle but a rapid flow of drops (dribble) must not be seen.



TIGHTENING LOCKNUT

3. Turn the lift adjustment screw (6) counterclockwise 3/4 ± 1/8 of a turn.
4. Hold the lift adjustment screw (6) with a screwdriver and tighten locknut (5) just enough so that the lift adjustment screw (6) will not turn.
5. Put the fuel injection nozzle in the 882250 Nozzle Holding Tool. Put the 8S2250 Nozzle Holding Tool in a vise and tighten locknut (5) to 356 to 40 lb. in. (40.4 to 46.1 cm. kg).



TIGHTENING LOCKNUT

Checking Seat Condition

1. Put a shop towel around the top of the body of the fuel injection nozzle (pressure screw end) to take in the leakage. Close the gauge protector valve.
2. Point the tip of the fuel injection nozzle into the 8S2270 Fuel Collector and operate the pump rapidly for a minimum of five strokes to put the valve on the seat. Open the gauge protector valve. Be sure the nozzle tip is completely dry.
3. Make the pressure 250 to 800 psi (17.6 to 21.1 kg/cm) less than the opening pressure. If more than 3 drops of fuel get on the tip of the fuel injection nozzle in 15 seconds, clean or make replacement to the fuel injection nozzle.

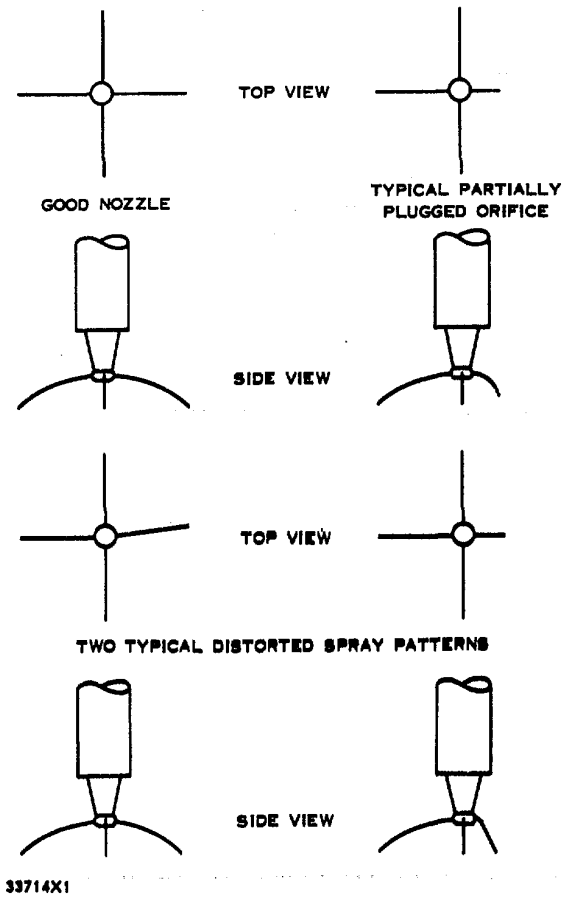
Spray Characteristic (Pattern)

NOTE: The adjustment for the valve lift must be correct before checking the spray pattern.

1. Close the gauge protector valve and the on-off valve. Open the pump isolator valve.

2. Point the tip of the fuel injection nozzle into the 8S2270 Fuel Collector.

3. Make a slow increase in pressure and look at the spray pattern when fluid begins to flow through the fuel injection nozzle. The spray must be the same through all four orifices. Any change, either vertically or horizontally, is an indication of a bad nozzle. See the ANALYSIS OF NOZZLE SPRAY PATTERN.



Return Leakage Test

1. Put the tip of the fuel injection nozzle a little above the horizontal position. Tighten the nuts that connect the fuel injection nozzle to the tester.

2. Operate the tester until the pressure is at 1400 to 1600 psi (98.4 to 112.5 kg/cm2).

3. Look at the leakage from the return at the top (pressure screw end) of the fuel injection nozzle. After the' first two drops fall, leakage is 1 to 10 drops in 15 seconds with Kent Moore J23300-585 or Shell 66631 calibration oil or equivalent, with the temperature of the calibration oil at 650 to 765 F (180 to 240 C). More than 10 drops in 15 seconds is an indication of parts with wear or bad parts, and replacement of the fuel injection nozzle is necessary.

NOZZLE ASSEMBLY TROUBLESHOOTING GUIDE

For the NOZZLE ASSEMBLY TROUBLESHOOTING GUIDE, See Page 49.

FUEL INJECTION LINES

Fuel from the fuel injection pumps is sent through the fuel injection lines to the fuel injection nozzles.

Each fuel injection line of an engine has a special design and must be installed in a certain location. When fuel injection lines are removed from an engine, put identification marks or tags on the fuel lines as they are removed, so they can be put in the correct location when they are installed.

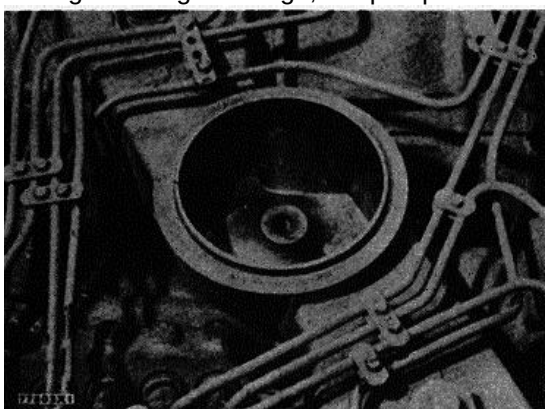
The nuts that hold a fuel injection line to an injection nozzle and injection pump must be kept tight. Use a torque wrench and the 5P144 Fuel Line Socket to tighten the fuel line nuts to 30 ± 5 lb. ft. (4.1 ± 0.7 mkg).

FUEL INJECTION PUMPS

When injection pumps, sleeves and lifters are removed from the injection pump housing, keep the parts of each pump together so they can be installed back in their original location.

Be careful when disassembling injection pumps. Do not damage the surface on the plunger. The plunger, sleeve and barrel for each pump are made as a set. Do not put the plunger of one pump in the barrel or sleeve of another pump. If one part is worn, install a complete new pump assembly. Be careful when putting the plunger in the bore of the barrel or sleeve.

When an injection pump is installed correctly, the plunger is through the sleeve and the adjustment lever is engaged with the groove on the sleeve. The bushing that holds the injection pump in the pump housing must be kept tight. Tighten the bushing to 70 ± 5 lb. ft. (9.7 ± 0.7 mkg). Damage to the housing will result if the bushing is too tight. If the bushing is not tight enough, the pump will leak.

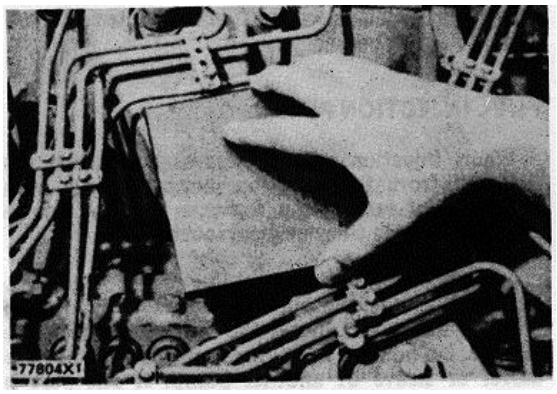


AIR INLET PIPE
(Typical Example)

WARNING: If the sleeves on one or more of the fuel injection pumps have been installed wrong, damage to the engine is possible if cautions are not taken at first starting. When the fuel injection pumps have been removed and installed with the fuel injection pump housing on engine, take the following cautions when first starting the engine.

a. Remove the air cleaner leaving the air inlet pipe open as shown.

b. If the sleeve on pump has been installed wrong and the engine starts to run too fast, put a steel plate over the air inlet opening as shown to stop the engine.

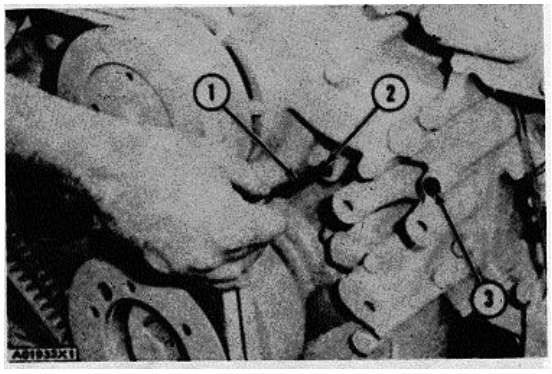


STOPPING THE ENGINE
(Typical Example)

FINDING TOP CENTER COMPRESSION POSITION FOR NO.1 PISTON

No.1 piston at top center (TDC) on the compression stroke is the starting point for all timing procedures.

1. Remove the plug from timing hole (2) in the front cover. Put bolt (1) in timing hole (2). The bolt from hole (3) can be used.



INSTALLING BOLT
1. 1D4539 Bolt, 5/16 in.-18NC, 25 in. (635 mm) long. 2. Timing hole. 3. Hole.

2. Turn the crankshaft CLOCKWISE (as seen from front of engine) until bolt (1) will go into the hole in the drive gear for the camshaft.

3. Remove the valve cover on the right side of the engine (as seen from rear of engine). The two valves at the right front of the engine are the intake and exhaust valves for No.1 cylinder.

4. The intake and exhaust valves for No.1 cylinder must now be closed and the timing pointer will be in alignment with the TDC-1 on the damper assembly. The No.1 piston is now at top center on the compression stroke.

FUEL SYSTEM ADJUSTMENTS

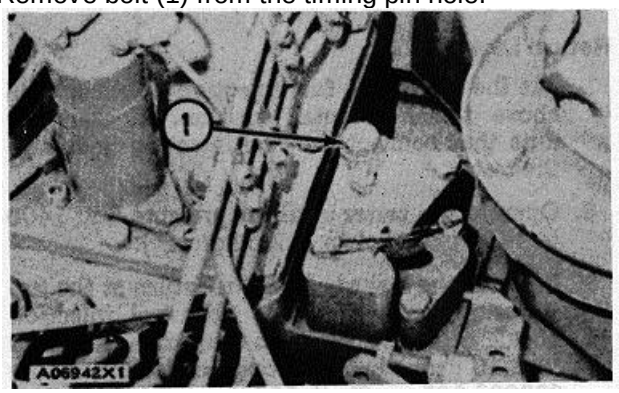
Checking Fuel Injection Pump Timing; On Engine

The timing of the fuel injection pump can be checked and changed if necessary, to make compensation for movement in the taper sleeve drive or worn timing gears. The timing can be checked and, if necessary, changed using the following method.

Checking Timing By Timing Pin Method

Tools Needed: 5P2371 Puller.
3P1544 Timing Pin.

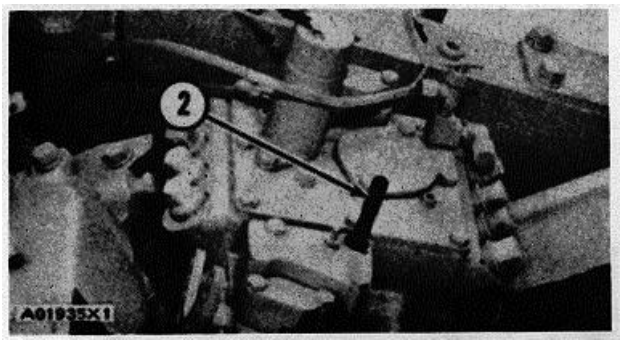
1. Remove bolt (1) from the timing pin hole.



TIMING HOLE BOLT
1. Bolt.

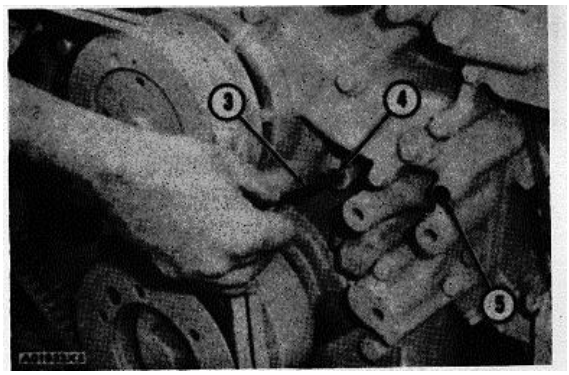
2. Turn the crankshaft CLOCKWISE (as seen from front of engine) until timing pin (2) goes into the notch in the camshaft for the fuel injection pumps.

3. Remove the plug from timing hole (4) in the front cover. Put bolt (3) through the front cover and into the hole with threads in the timing gear. The bolt from hole (5) can be used.



TIMING PIN INSTALLED
(Typical Example'

2. 3P1544 Timing Pin.

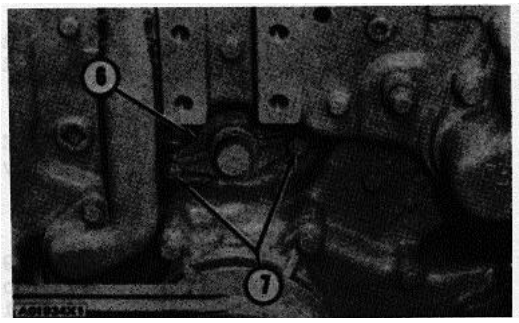


INSTALLING BOLT

3. lD4539 Bolt, 5/16 in.-18 NC, 2.5 in. (63.5 mm) long. 4. Timing hole. 5. Hole.

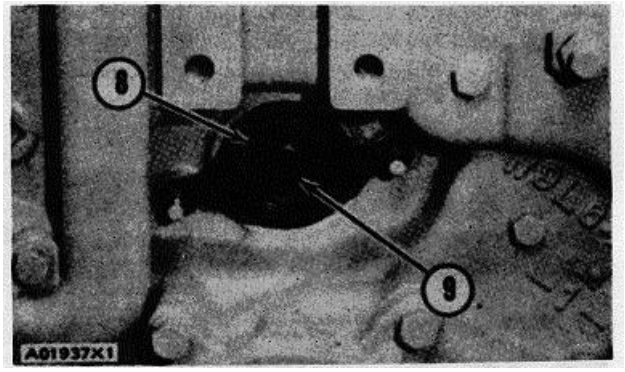
4. If the timing pin is in the notch in the camshaft for the fuel injection pumps, and bolt (3) goes into the hole in the timing gear through timing hole (4), the timing of the fuel injection pump is correct.

NOTE: If bolt (3) does not go in the hole in the timing gear with timing pin (2) in the notch in the camshaft, use the following procedure.



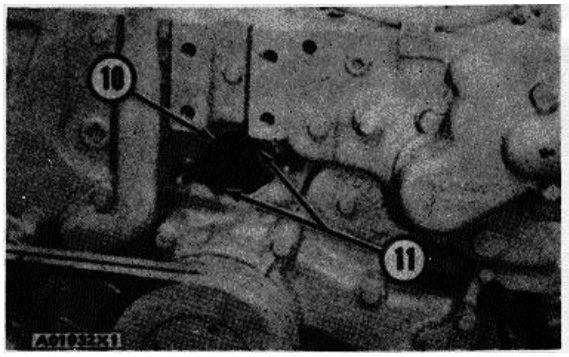
LOCATION OF COVER
6. Cover for the tachometer drive assembly. 7. Nuts.

a. Remove nuts (7) and the cover for the tachometer drive adapter (6).
b. Remove bolt (9) and washer (8) from the camshaft for the fuel injection pumps.



LOCATION OF BOLT
8. Washer. 9. Bolt.

c. Put 5P2371 Puller (10) on the camshaft for the fuel injection pumps. Tighten bolts (11) until the drive gear on the camshaft for the fuel injection pumps comes loose.



LOOSENING DRIVE GEAR
10. 5P2371 Puller. 11. Bolts.

d. Remove the 5P2371 Puller.

e. Turn the crankshaft CLOCKWISE (as seen from front of engine) until bolt (3) goes into the hole in the timing gear. With timing pin (2) in the notch in the camshaft for the fuel injection pumps; and bolt (3) in the hole in the timing gear, the timing for the engine is correct.

f. Install washer (8) and bolt (9). Tighten bolt (9) to 80 + 5 lb. ft. (11.1 ± 0.7 mkg). Remove timing pin (2).

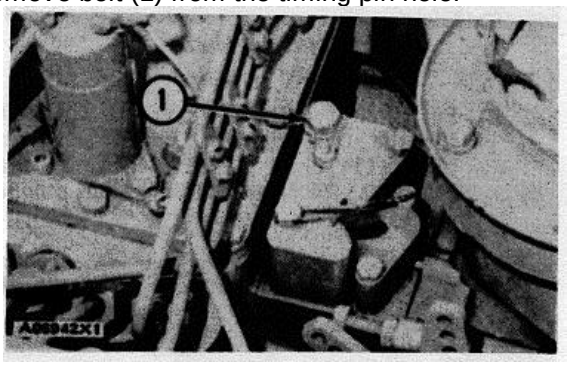
g. Turn the crankshaft two complete revolutions CLOCKWISE (as seen from front of engine) and put timing pin (2) and bolt (3) in again. If timing pin (2) and bolt (3) can not be installed do Steps a through f again.

h. Remove bolt (3) from the timing gear and install in hole (5). Install the plug in timing hole (4). Remove timing pin (2) and install bolt (1). Install cover for the tachometer drive assembly (6).

Checking Timing By Fuel Flow Method
Tools Needed: 3P1544 Timing Pin.
1P540 Flow Checking Tool Group.
9M9268 Dial Indicator.
Pan for holding the fuel.
5P2371 Puller.
8S2298 Adapter Group.

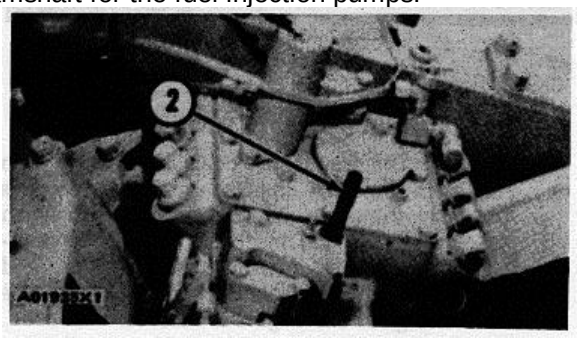
See Special Instruction (FM035709) for complete instructions for the fuel flow method of engine timing (injection sequence).

1. Remove bolt (1) from the timing pin hole.



TIMING HOLE BOLT
1. Bolt.

2. Turn the crankshaft CLOCKWISE (as seen from front of engine) until timing pin (2) goes into the notch in the camshaft for the fuel injection pumps.



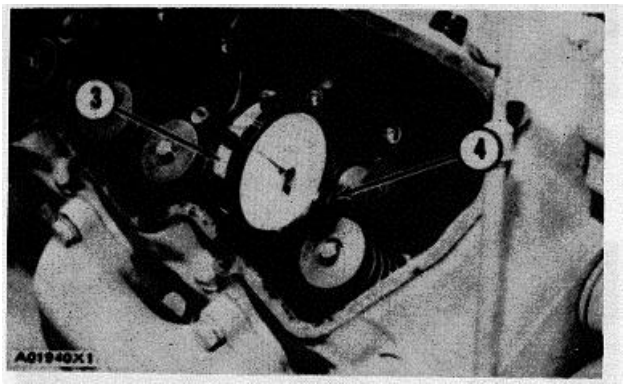
TIMING PIN INSTALLED
2. 3P1544 Timing Pin.

3. Remove timing pin (2).

4. Remove the valve cover from the right side of the engine. Remove the fuel return line, rocker arm assembly, and the fuel injection nozzle for No.1 cylinder.

5. Put 8S2298 Adapter Group (4) and 9M9268 Dial Indicator (3) in the No.1 cylinder. Adjust dial indicator (3) so both pointers are on "0" (zero).

6. Turn the crankshaft COUNTERCLOCKWISE (as seen from front of engine) a minimum of 45 decrees.



DIAL INDICATOR INSTALLED

3. 9M9268 Dial Indicator. 4. 8S2298 Adapter Group.

7. Turn the crankshaft CLOCKWISE (as seen from front of engine) until dial indicator (3) gives an indication of maximum travel of the piston. Make an adjustment to dial indicator (3), if necessary, to put both pointers of the dial indicator on "0" (zero).

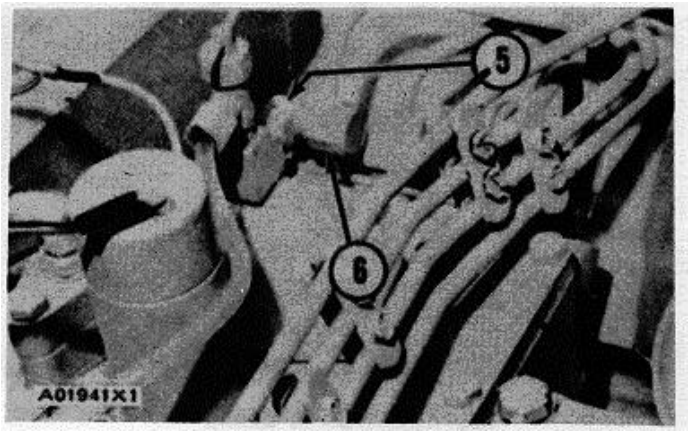
8. Disconnect the fuel line for No.1 fuel injection pump at the housing for the fuel injection pumps. Put 7M1999 Tube Assembly (8) on No.1 fuel injection pump and tighten the nut. The position of the end of tube assembly (8) must be a little above horizontal as shown.

9. Disconnect the line for the supply of fuel at the fuel filter. Use an adapter to connect 5J4634 Hose Assembly (9) to the fuel filter.

10. Disconnect the fuel return line from constant bleed valve (5). Put cap (6) on the constant bleed valve.

11. Turn the crankshaft COUNTERCLOCKWISE (as seen from front of engine) approximately 45 degrees.

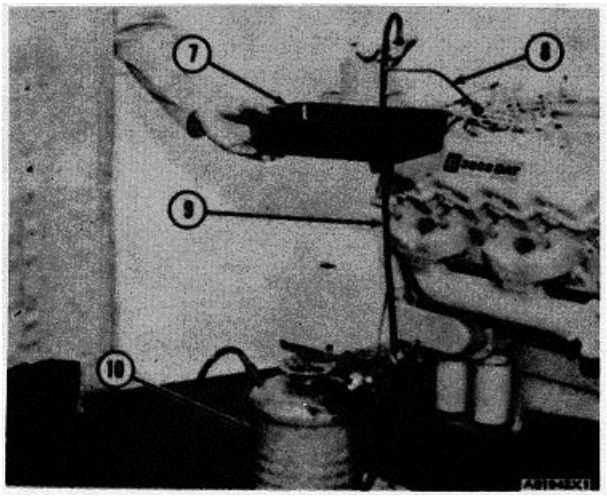
12. With 1 gal. (3.8 lit) of clean fuel in 1P539 Pressure tank (10), move the governor lever to full FUEL-ON position. Put 15 psi (1.1 kg/cm2) of air pressure in the tank by using the hand pump or shop air.



CONSTANT BLEED VALVE
5. Constant bleed valve. 6. Cap.

CAUTION: If shop air is used, be sure to adjust the regulator so there is no more than 15 psi (1.1 kg/cm^2) of air pressure in the tank.

13. Put pan (7) under the end of tube assembly (8) for the fuel that comes out of the tube.



FUEL FLOW CHECK OF TIMING
7. Pan. 8. 7M1999 Tube Assembly. 9. 5J4634 How Assembly. 10. 1P539 Pressure Tank.

14. Turn the crankshaft, slow, in the direction of normal rotation CLOCKWISE (as seen from front of engine). Do this until the flow of fuel from the end of tube assembly (8) is 6 to 12 drops per minute.

15. Stop rotation of the crankshaft when the flow of fuel is 6 to 12 drops per minute. Take a reading of the measurement on dial indicator (3).

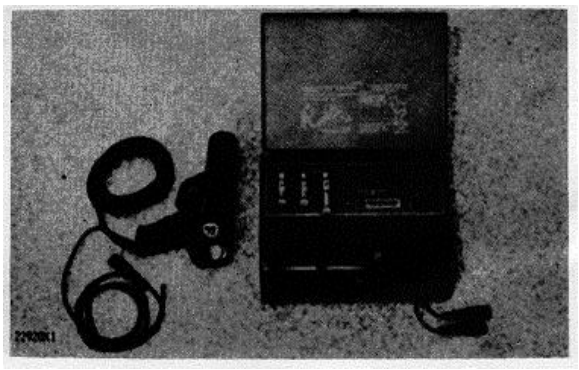
16. To check for correct timing of the fuel system, make a comparison of the reading on dial indicator (3) with the correct measurement in the chart.

TIMING ANGLE	INDICATOR READING	
15º	.112 in.	2.84 mm
*16º	.127 in.	3.23 mm
17º	.143 in.	3.63 mm
*Correct timing angle		

NOTE: If the timing of the fuel system is different than the correct timing dimension given in the chart, see the subject CHECKING TIMING BY TIMING PIN METHOD.

Checking Automatic Timing Advance Unit By Timing Light Method

Tools Needed: 1P3500 Injection Timing Group



1P3500 INJECTION TIMING GROUP

This group can be used to check the automatic timing advance. Special Instruction (GMG00501) is part of the group and has detailed instructions for its use.

FUEL SETTING

Tools Needed: 3P1550 Field Service Tool Group

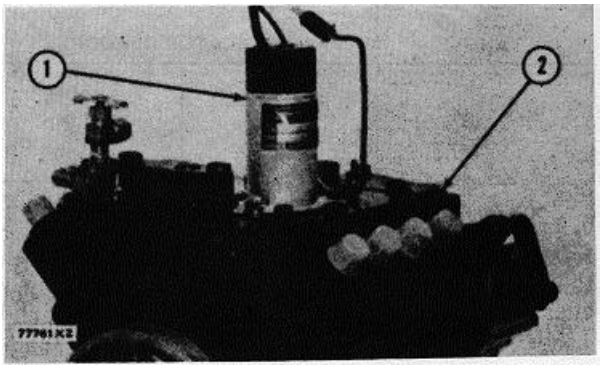
The following procedure for fuel setting can be done with the housing for-the fuel injection pumps either on or off the engine.

CAUTION: Before doing any service work on this fuel system, the outside of the housing for the fuel injection pumps and all parts connected to it must be especially clean.

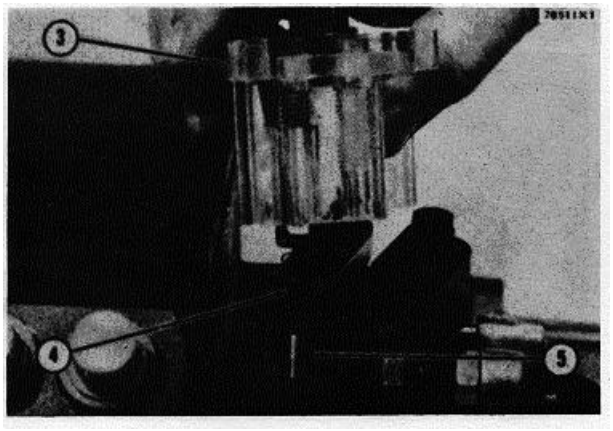
1. Remove shut-off solenoid (1) and cover (2).

2. Put the 5P298 Zero Set Pin (5), with 17.8507 on it, in the pump housing.

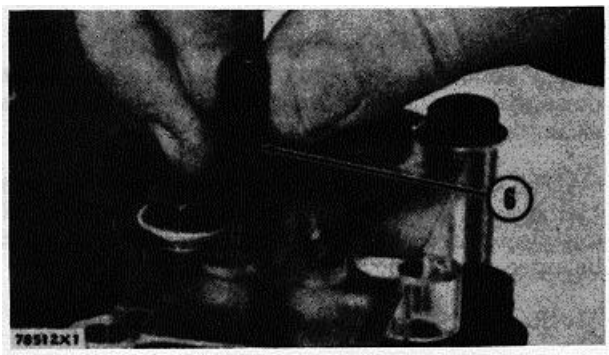
3. Put cover (3) and spring (4) over zero set pin (5). Do not put a gasket under cover (3). Use two 1D4533 Bolts with 4B4276 Washers and a 1D4538 Bolt to fasten cover (3) to the housing for the fuel injection pumps.



REMOVAL OF COVER
1. Shut-off solenoid. 2. Cover.



INSTALLATION OF COVER
3. 2P8331 Cover. 4. 3J6956 Spring. 5. 5P298 Zero Set Pin, with 17.8507 on it.

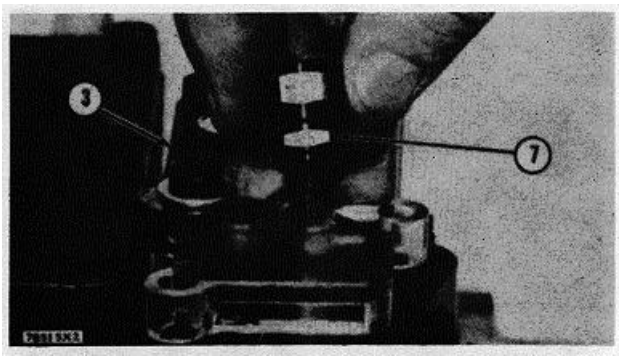


4. Put screw (6) in the hole over pin (5) and spring (4).

INSTALLATION OF SCREW
6. 8S7271 Screw.

5. Turn screw (6) clockwise until pin (5) is held against the housing for the fuel injection pumps. Do not tighten screw (6) too tight.

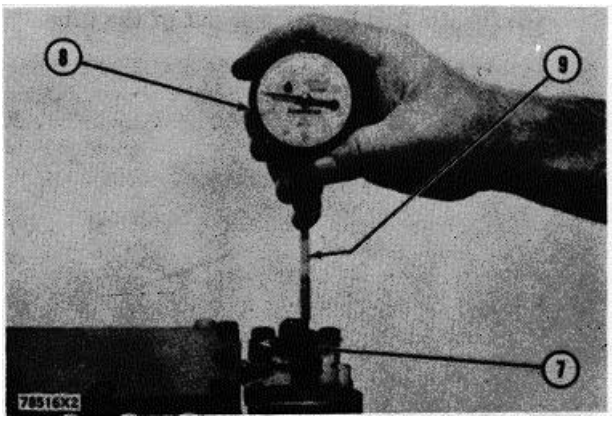
6. Put clamp (7) in cover (3).



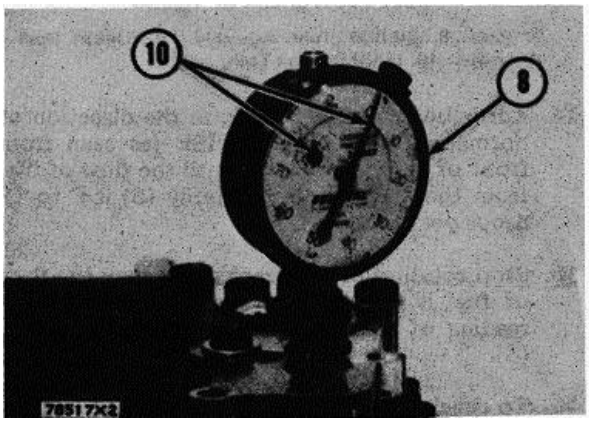
INSTALLATION OF CLAMP
3. Cover. 7. 3P1565 Collect Clamp.

7. Move the governor control lever to FULL LOAD position.

8. Put magnetic point (9) on dial indicator (8). Put the indicator assembly in clamp (7).



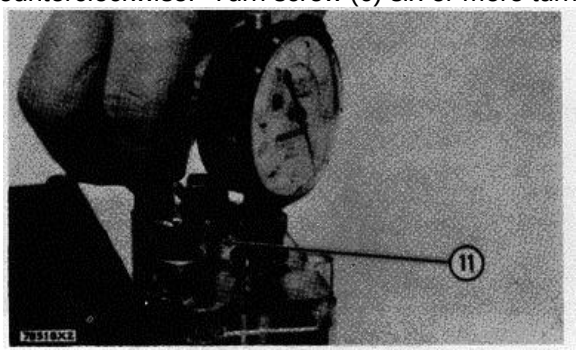
INSTALLATION OF DIAL INDICATOR
7. 3P1565 Collect Clamp. 8. 3P1567 Dial Indicator. 9. 3P1569 Magnetic Point.



INDICATOR SET ON ZERO
8. 3P1567 Dial Indictor. 10. Pointers.

9. Adjust dial indicator (8) so both pointers (10) are on "0" (Zero).

10. Using wrench (11) turn the 8S7271 Screw (6) counterclockwise. Turn screw (6) six or more turns.



LOOSENING SCREW (6)
11. 1S9836 Wrench.

11. Put the clip end of the 8S4627 Circuit Tester to a good ground. Put the other end of the 8S4627 Circuit Tester on the load stop contact. Put this end of the 8S4627 Circuit Tester through the large hole on top of cover (3).

12. Move the governor control lever to the LOW IDLE position.

13. Move the governor control lever slowly toward the HIGH IDLE position until the continuity light just comes on. Make a note of the reading on dial indicator (8). Do this step several times to make sure the reading is correct.

14. Make a comparison of this reading and the fuel setting in the RACK SETTING INFORMATION.

15. If the reading on dial indicator (8) is not correct, do the following.

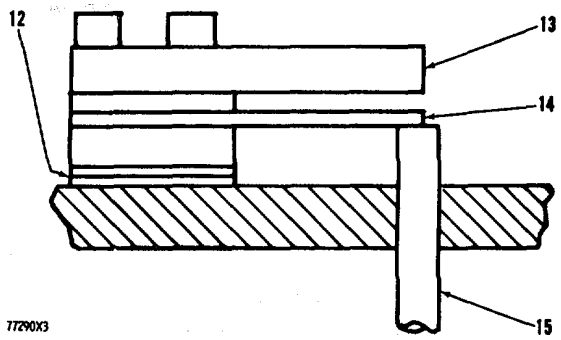
Leaf Type Torque Spring

a. Write down the dimension that is on dial indicator (8).

b. Write down the dimension given in the RACK SETTING INFORMATION.

c. Remove the test tools [cover (3), spring (4), and dial indicator (10)] from the housing for fuel injection pumps.

d. Install or remove shims at location (12) to get the correct dimension as given in the RACK SETTING INFORMATION. The difference between the dimensions in (a) and (b) is the thickness and amount of shims to remove or install to get the correct setting.



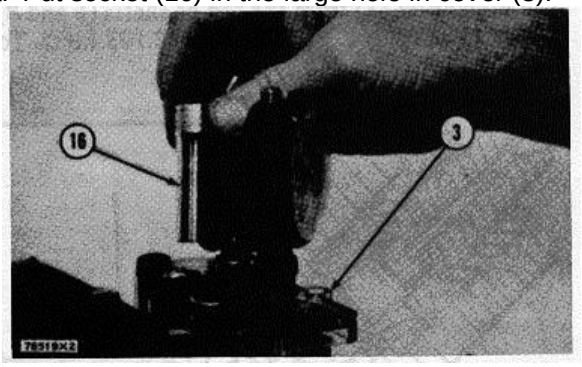
LEAF TYPE TORQUE SPRING
12. Location of shims. 13. Stop bar. 14. Leaf type torque spring. 15. Load stop pin.

e. Install the correct amount of shims (12) torque spring (14), and stop bar (13) on the housing for the fuel injection pumps.

f. Install the test tools and do the test procedure again. Do this until the dimension on the dial indicator is the same as the dimension given in the RACK SETTING INFORMATION. After the fuel setting is correct, remove the test tools. Install cover (2) and shut-off solenoid (1).

Load Stop Adjustment

a. Put socket (16) in the large hole in cover (3).

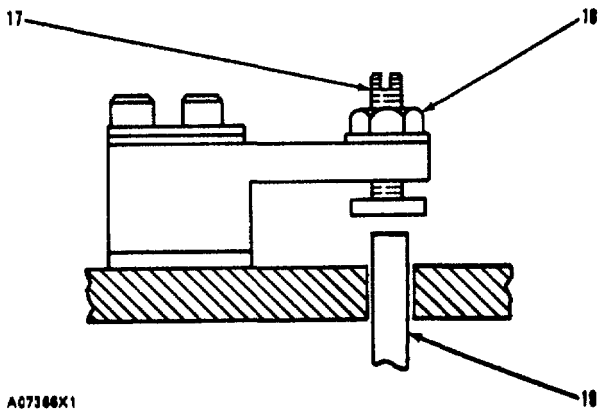


PUTTING SOCKET IN COVER
3. 2P331 Cover. 16. 3P221 Socket.

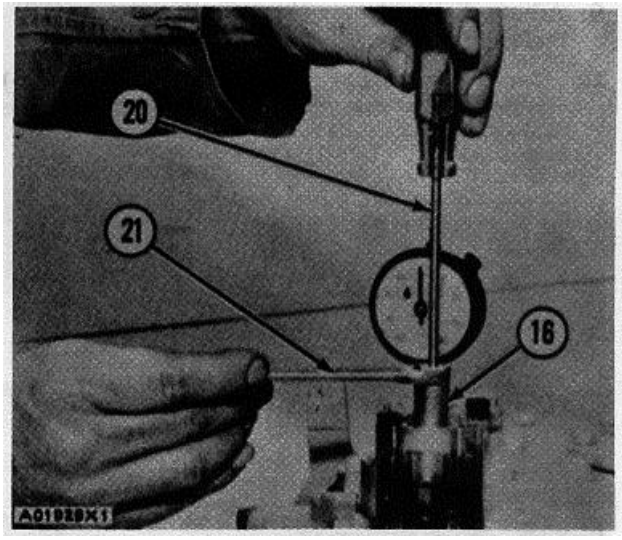
b. Use wrench (21) with socket (16) and loosen locknut (18).

c. Using screwdriver (20), turn adjustment screw (17) until the reading on dial indicator (8) is the same as the dimension given in the RACK SETTING INFORMATION.

d. When the adjustment is correct, tighten locknut (18). Check the adjustment again by doing Steps 11 through 15 again.



ADJUSTMENT SCREW FOR FUEL FITTING
17 Adjustment screw, 1S. Locknut. 19, Lock nut. 19. stop pin.



ADJUSTMENT OP FUEL SETTING
16. P2210locket, 20. screwdriver, 21.Wrenoh,

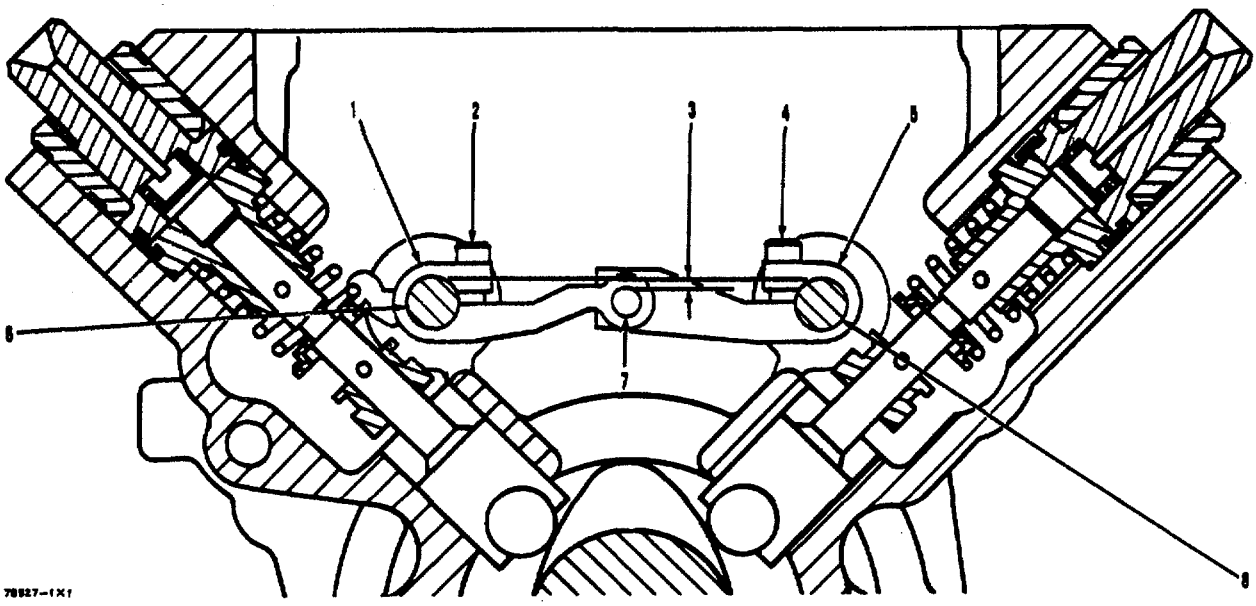
e. Remove the test tools. Install cover (2) and shut-off solenoid (1),

ADJUSTMENT OF CROSSOVER LEVERS

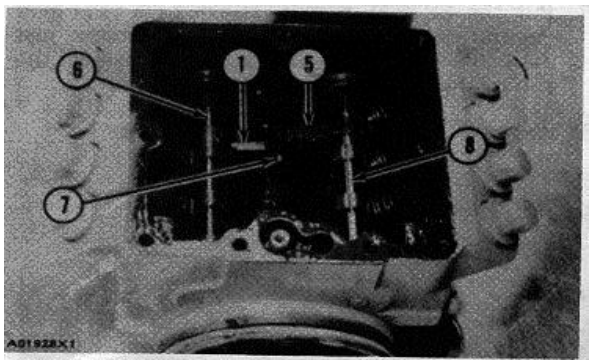
NOTE: The 3P1S46 Calibration Pin must be installed before checking the adjustment of the crossover levers.

To check the adjustment of crossover levers (1 and 5), put a straight edge across shafts (6 and 8). The dimension (3) from the top of shafts (6 and 8) to the top of pin (7) is .0828 in. (2.103 mm). To adjust, loosen screws (2 and 4) that hold levers (1 and 5), and make adjustment as necessary. Tighten screws (2 and 4) to 24 ± 2 lb. in. (27.7 ± 2.3 cm. kg).

NOTE: After the adjustment of the crossover levers is completed, the fuel injection pumps must be calibrated. See FUEL PUMP CALIBRATION.



CROSSOVER LEVERS
1. Crossover lever. 2. Screw. 3. Dimension for adjustment .0O28 in. 12.130 mm. 4. Screw. 5. Crossover lever. 6. Shaft. 7. Pin. 8. Shaft.



CROSSOVER LEVERS

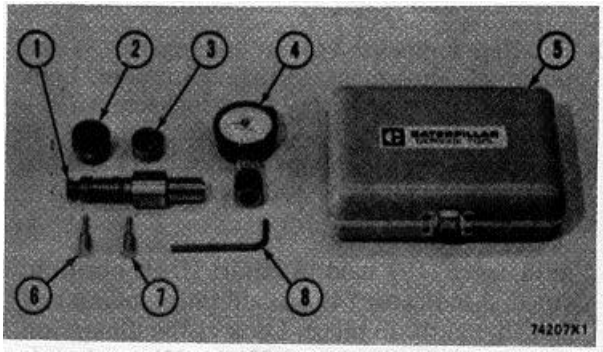
1. Crossover lever. 5. Crossover lever. 6. Shaft. 7. Pin. 8. Shaft.

FUEL PUMP CALIBRATION

Tools Needed: 3P2200 Tool Group.
The following tools from
3P1550 Tool Group are also needed:
882243 Wrench.
2P8331 Cover.
4B4276 Washer (two).
8S7271 Screw.
1D4633 Bolt (two).
1D4538 Bolt.
3K6896 Washer.
3J6956 Spring.
2H3740 Bolt.

The following procedure for fuel pump calibration can be done with the housing for the fuel injection pumps either on or off the engine.

CAUTION: Before doing any service work on this fuel system, the outside of the injection pump housing and all parts connected to it must be especially clean.



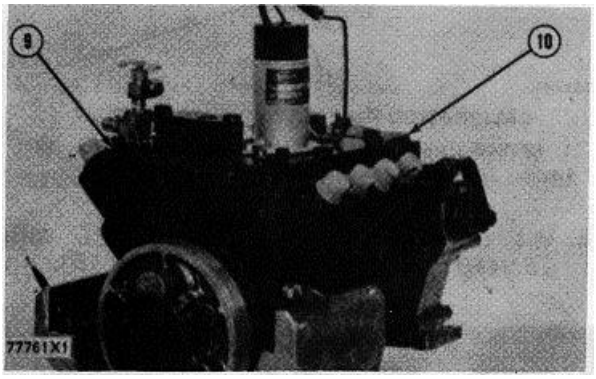
3P2200 TOOL GROUP

1. 3P1540 Calibration Pump. 2. 4N218 Bushing, 3. 1P7379 Microgage. 4. 3P1568 Dial Indicator with 3P2226 Base. 5. 2P5519 Box. 6. 3P1545 Calibration Pin (In. line engines). 7. 3P1546 Calibration Pin (Vee engines.). 8. 1S9838 Wrench.

NOTE: Be sure the adjustment for the crossover levers is correct before calibrating the pumps.

1. Remove the fuel that is in the injection pump housing and the governor housing.

2. Remove covers (9) and (10).

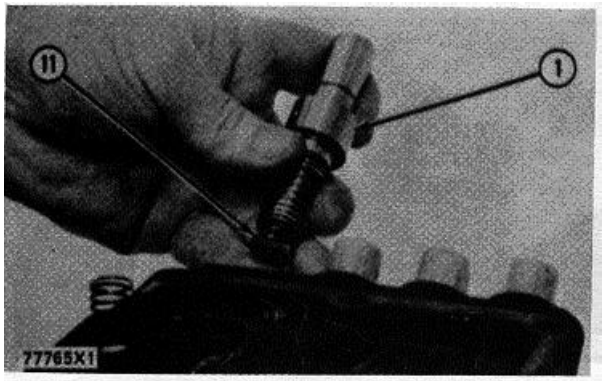


REMOVAL OF COVERS
9. Cover. 10. Cover.

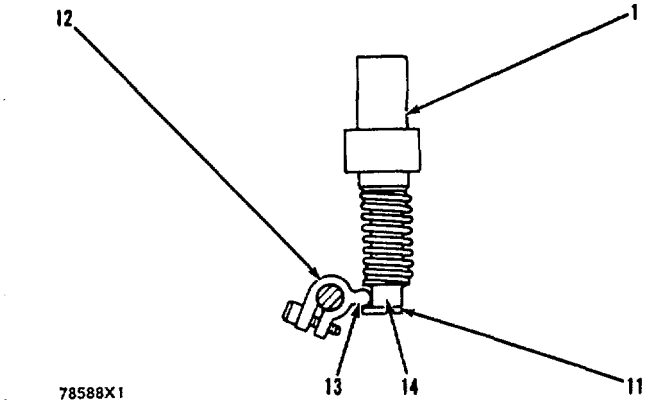
NOTE: There is a bypass valve and spring under cover (9) at the front of the injection pump housing.

3. Use the 882243 Wrench and remove the injection pump that is going to be calibrated.

4, Put calibration pump (1) in the injection pump housing with flat (11) on plunger of pump toward tang (13) on lever (12). When calibration pump (1) is all the way in the bore, turn the calibration pump approximately 456 so tang (13) on lever (12) fits in groove (14). Install 4N218 Bushing. Tighten bushing to 70 ± 5 lb. ft. (9.7 ± 0.7 mkg).

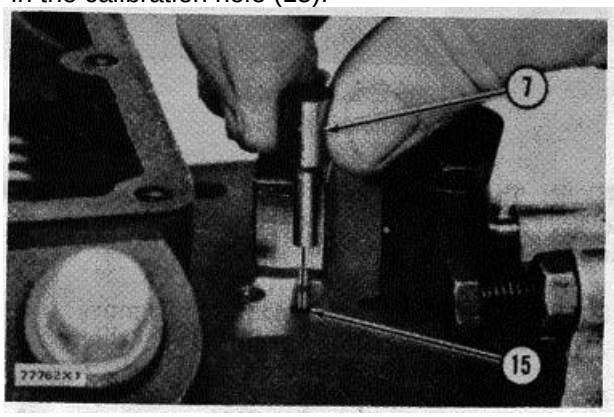


INSTALLING SP1540 CALIBRATION PUMP
1, 3P140 Calibration Pump. 11. Flat on plunger.



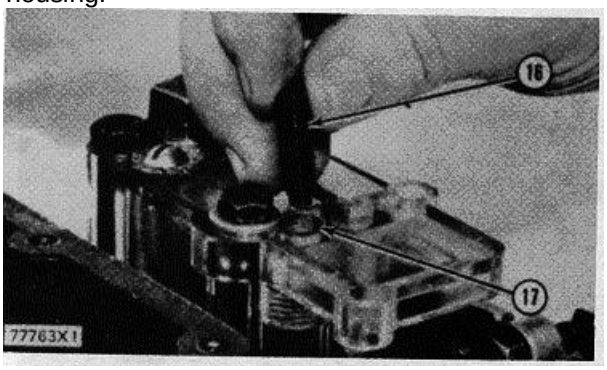
CALIBRATION PUMP INSTALLED CORRECTLY
1. 3P1540 Calibration Pump. 11. Flat on plunger. 12. Lever. 13. Tang on lever. 14. Groove of plunger.

5. Put the 3P1546 calibration pin (7), with 15.9410 on it, in the calibration hole (15).



INSTALLING CALIBRATION PIN
7.3P1546 Calibration Pin. 15. Calibration hole.

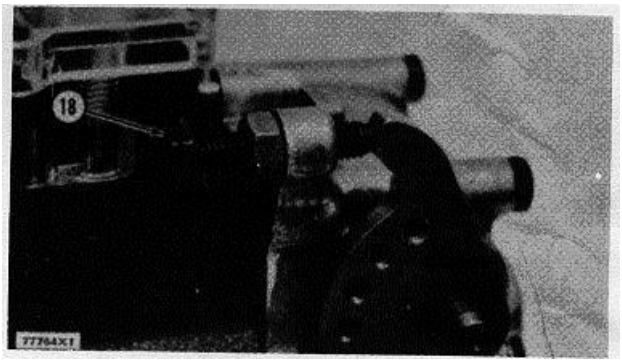
6. Put the 2P8331 Cover over the calibration pin. (Do not put a gasket under 2P8331 Cover). Use two 1D4533 bolts, two 4B4276 Washers and a 1D4538 bolt to hold 2P8331 Cover on the injection pump housing.



INSTALLING 8S7271 SCREW
16. 8S7271 Screw. 17. Hole for 8S7271 Screw.

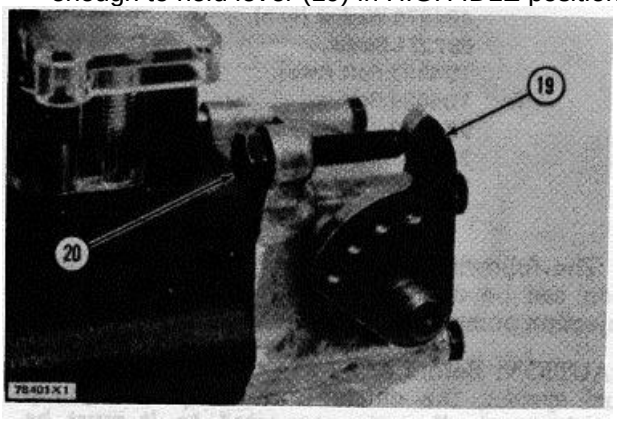
7. Put the 8S7271 Screw (16) in hole (17) over calibration pin (7). Tighten the screw just enough to hold the calibration pin against the top of the injection, pump housing.

8. Remove bolt (18), for idle adjustment.



REMOVAL OF BOLT
8. Bolt for low idle adjustment

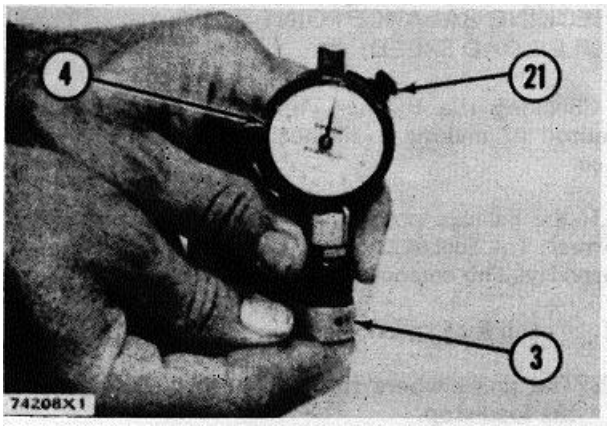
9. Move lever to HIGH IDLE. Put a longer bolt (20) through the hole for bolt (18). Bolt (20) must be long enough to hold lever (19) in HIGH IDLE position.



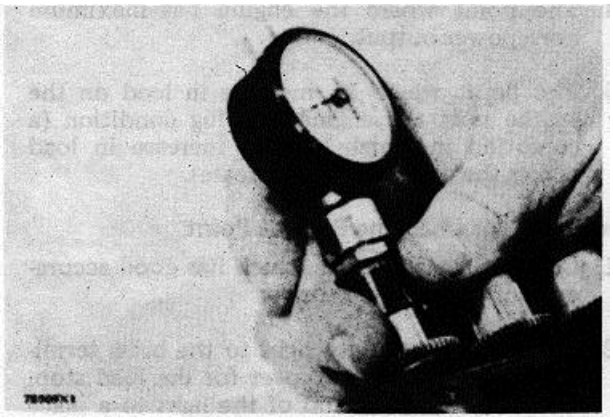
LEVER IN HIGH IDLE POSITION
19. Idle adjustment lever. 20. Bolt.

10. Put dial indicator (4) on microgage (3) and make an adjustment so dial is on zero. Lock the indicator on zero with lockscrew (21). Check the adjustment again and make sure the pointer on dial indicator is set correct and not one revolution off.

11. With lever (19) held in HIGH IDLE position, put dial indicator (4) on calibration pump and hold it tightly in place. Look at the dimension on the dial indicator. If the dimension is 0 ± 0.005 mm, lever (12) is calibrated correctly for that pump. If the dimension is not correct, check again by doing Steps 10 and 11 over.



PUTTING DIAL INDICATOR ON ZERO
3. 1P7379 Microgage. 4. 3P1568 Indicator with 3P2226 Base. 21. Lockscrew.

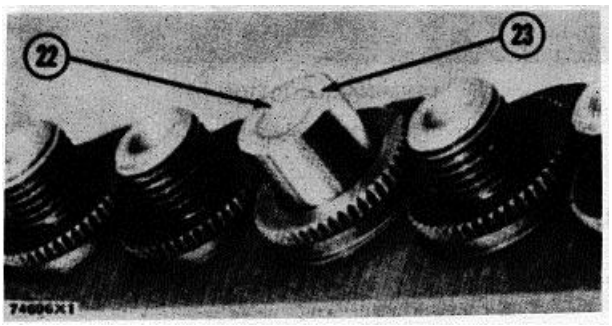


CHECKING PUMP CALIBRATION

12. If a pump needs to be calibrated, use the following procedure:

    a. Use wrench (8) to loosen the screw that holds lever (12) on shaft (24). Loosen the screw just enough so lever (12) can be moved (up or down) on shaft (24).

NOTE: Move the lever and put plunger (22) of the calibration pump almost flush with top surface (23) of the calibration pump.

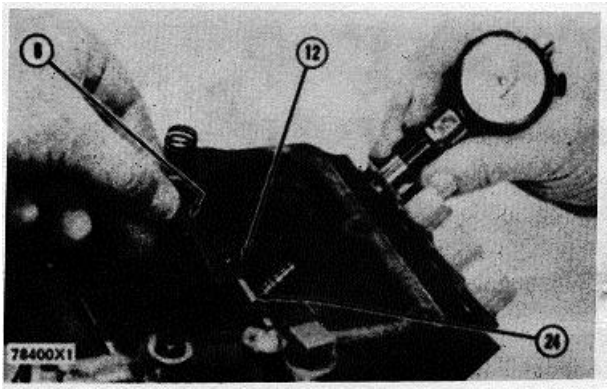


POSITION OF PLUNGER
22. Plunger. 23. Top surface of calibration pump.

    b. With wrench (8) in the screw for lever (12) and dial indicator held tightly on top of the calibration pump, use wrench (8) to move lever (12) up or down until the dimension on the dial indicator is zero. Tighten the screw to 24 ± 2 lb. in. (27.7 ± 2.3 cm. kg).

    c. After the screw is tightened, use the dial indicator to check the adjustment again.

13. The calibration of each pump can be checked using this same procedure. The 1P7379 Microgage is used to put the dial indicator on zero before the calibration dimension of each pump is checked.



CALIBRATION OF AN INJECTION PUMP
8. 1S9836 Wrench. 12. Lever. 24. Sleeve control shaft.

14. If a pump is checked and an adjustment is made, again check the dimension after the lever screw is tightened.

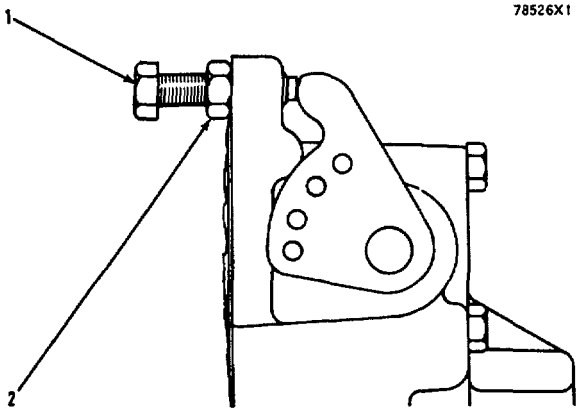
GOVERNOR ADJUSTMENTS

CAUTION: A mechanic that has the correct training is the only one to make the adjustment of low idle and high idle rpm. The correct low idle and high idle rpm, and the measurements for adjustment of fuel setting are given in the RACK SETTING INFORMATION.

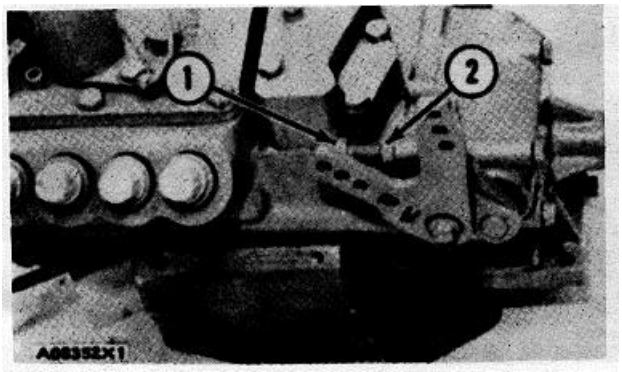
Check engine rpm with a tachometer that has good accuracy. If the low idle or high idle rpm needs an adjustment, use the following procedure:

1. For adjustment of low idle, loosen locknut (2) and turn adjustment bolt (1) to get as near as possible to the correct low idle rpm.

2. After the low idle adjustment is correct, tighten locknut (2).



ADJUSTMENT OF LOW IDLE RPM
1.Adjustement bolt for low idle. 2. Locknut.

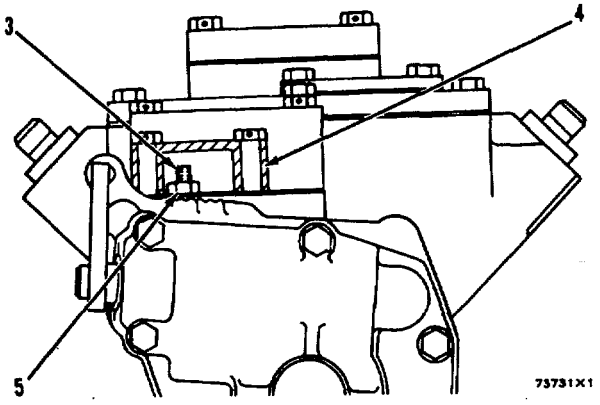


ADJUSTMENT OF LOW IDLE RPM
1.Adjustment bolt for low idle. 2. Locknut.

3. To make an adjustment to the high idle rpm, remove the small cover (4) at the top rear of the fuel system.

4. Loosen locknut (5) and turn adjustment screw (3) to get as near as possible to the correct high idle rpm.

5. After adjustment of high idle rpm is correct, tighten locknut (5) and install cover (4).



ADJUSTMENT OF HIGH IDLE RPM
3. Adjustment screw. 4. Cover. 5. Locknut.

CHECKING BALANCE POINT (FULL LOAD SPEED)

Checking the Balance Point of the engine is a method of making a diagnosis of engine performance.

If the balance point and the high idle speed are correct, the fuel system of the engine is operating correctly. The balance point for the engine is:

1. At full load speed.

2. The point where the load stop pin is against the load stop.

3. The point where the engine gets the maximum amount of fuel per stroke.

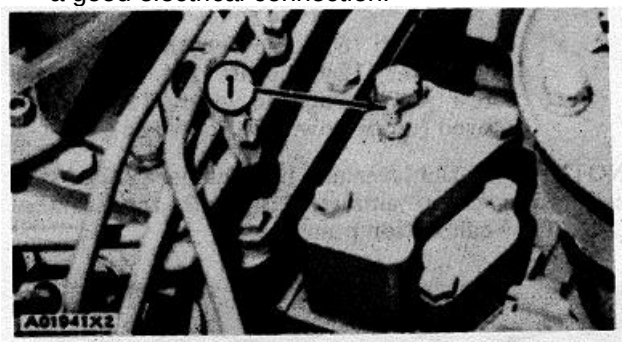
4. The point where the engine has maximum horsepower output.

5. The point where an increase in load on the engine puts the engine in a lug condition (a condition in which a small increase in load makes the engine speed decrease).

Procedure for Checking Balance Point

1. Connect a tachometer which has good accuracy to the tachometer drive.

2. Connect a continuity light to the brass terminal screw (1) on the cover for the load stop. Connect the other end of the light to a place on the fuel system which is a good electrical connection.



TERMINAL LOCATION
1. Brass terminal screw.

3. Start the engine.

4. With the engine at operating conditions, run the engine at high idle.

5. Make a record of the speed of the engine at high idle.

6. Add load on the engine slowly until the continuity light just comes on. This is the balance point.

7. Make a record of the speed at the balance point.

8. Repeat' Step 6 several times to make sure that the reading is correct.

9. Stop engine. Make a comparison of the records from Steps 5 and 7 with the information from the RACK SETTING INFORMATION.

10. If the balance point is correct, the fuel system is working correctly. If the balance point is not correct, adjust the, high idle rpm until you get the correct balance point.

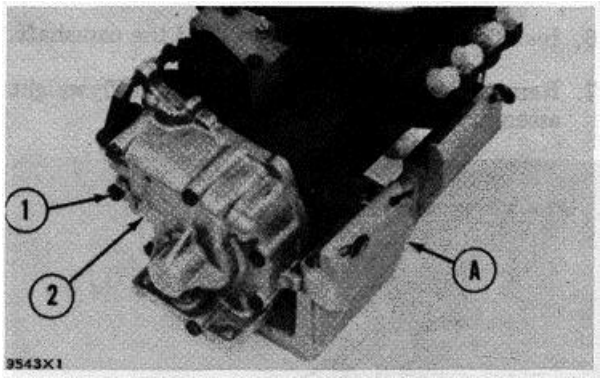
PROCEDURE FOR INSTALLATION OF DASHPOT GOVERNOR

Tools Needed: 2P8315 Bracket Assembly.
5P302 Bar.
3P1544 Timing Pin.
5P301 Driver.

Remove Governor

1. Install the fuel injection pump housing on the bracket assembly (A).

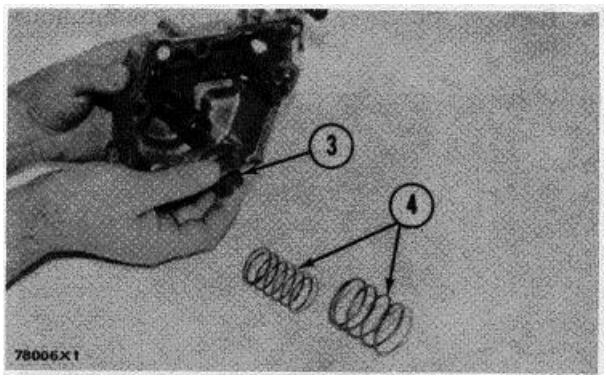
2. Remove the bolts (1) that hold the governor housing (2) to the fuel injection pump housing.



GOVERNOR HOUSING
1. Bolts. 2. Governor housing. A. 2P8315 Bracket Assembly.

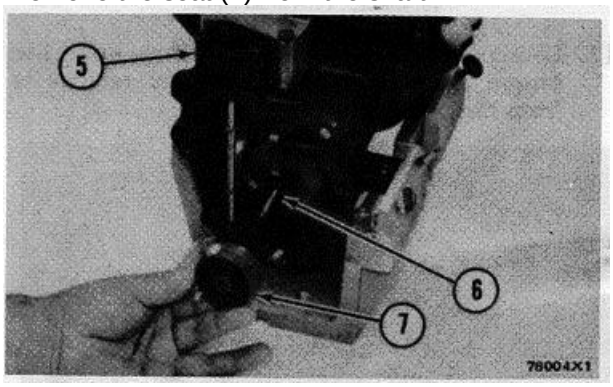
3. Remove the governor housing (2).

4. Remove two springs (4) and the seat (3) from the governor housing. Remove springs (4) from seat (3).



REMOVING SPRINGS AND SEAT
3. Seat. 4. Springs.

5. Remove the seat (7) from the shaft.

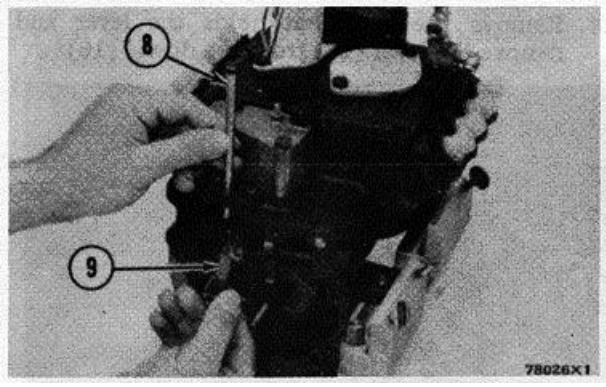


REMOVING GOVERNOR PARTS
5. Cover. . Spring. 7. Seat.

6. Remove the spring (6) from the shaft.

7. Remove the cover (5) from the pump housing.

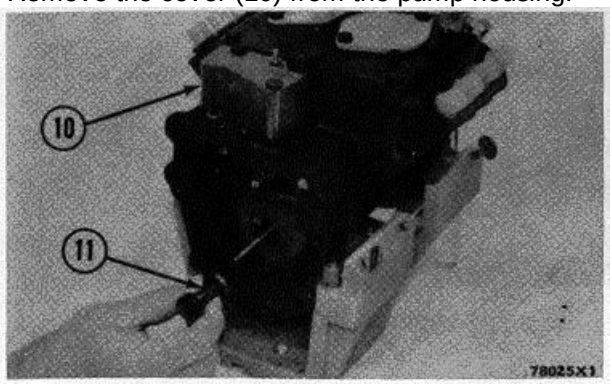
8. Remove the shaft (8) and the lever (9) from the pump housing.



REMOVING SHAFT AND LEVER
8. Shaft. 9. Lever.

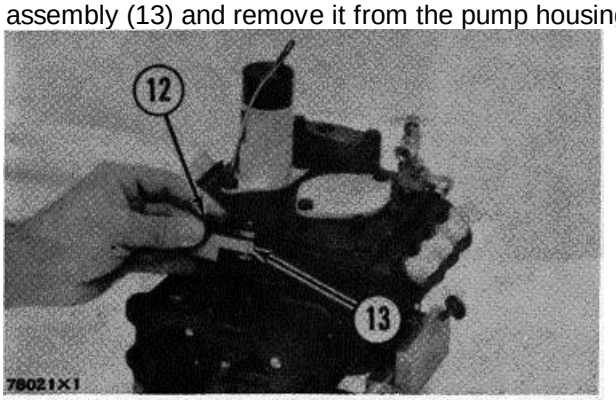
9. Remove the thrust collar (11) from the shaft. 65

10. Remove the cover (10) from the pump housing.



REMOVING COVER AND THRUST COLLAR
10. Cover. 11. Thrust collar.

11. Loosen the two bolts (12) that hold the torque spring assembly (13) and remove it from the pump housing.

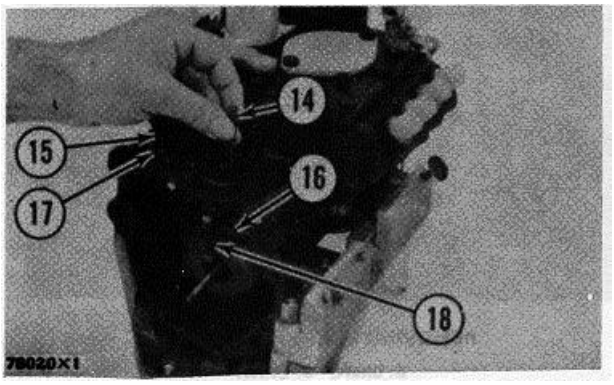


REMOVING TORQUE SPRING
12. Bolts (two). 13. Torque spring assembly.

12. Remove the pin (14) from the pump housing.

13. Remove the screw (15) and the nut (17) from the pump housing.

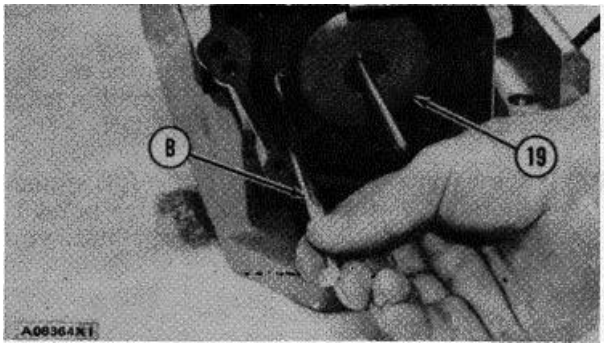
14. Remove the ring that holds the lever and remove the lever (18) from the dowel (16).



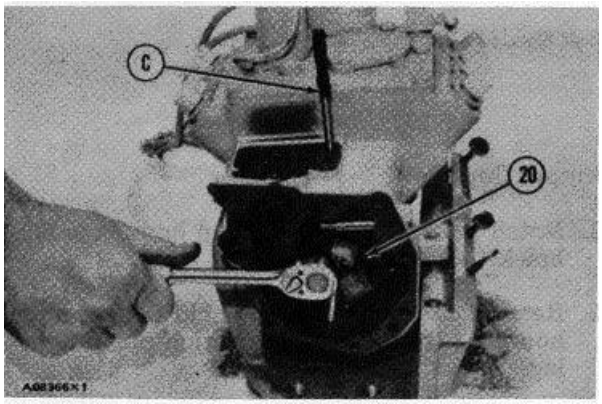
REMOVING GOVERNOR PARTS
14. Pin. 15.Screw. 16.Dowel. 17.Nut. 18.Lever.

15. Remove the shield (19) from the camshaft with bar (B).

CAUTION: Pull on the shield only a small amount in each location, so it will not have distortion or damage. The shield is staked in place and can be damaged when removed. If the shield is damaged it must be replaced.



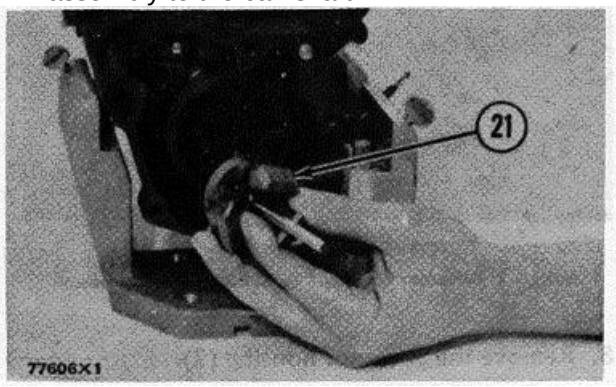
REMOVING SHIELD
19. Shield. B. 5P302 Bar.



REMOVING BOLTS
20. Bolts (three). C. 3P1544Timing Pin.

16. Install the timing pin (C) to hold the camshaft.

17. Remove the bolts (20) that hold the flyweight assembly to the camshaft.



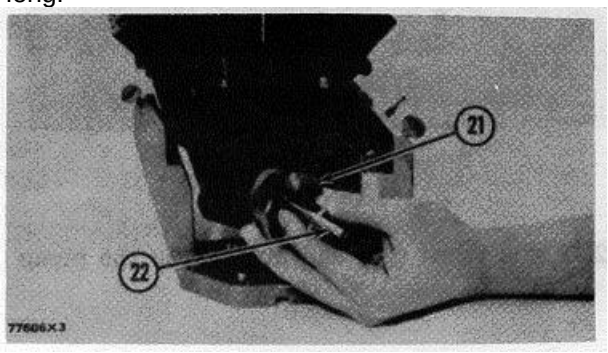
REMOVING FLYWEIGHT ASSEMBLY
(Typical Example)

21. Flyweight assembly.

18. Remove the flyweight assembly (21) from the camshaft.

Install Dashpot Governor

1. Put the new longer shaft (22) in flyweight assembly (21). The new longer shaft is 5.031 in. (127.80 mm) long.

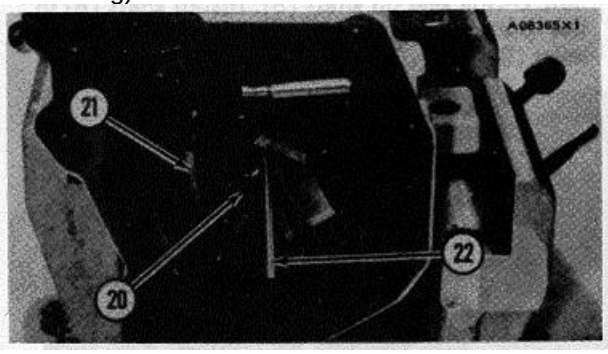


INSTALLING FLYWEIGHT ASSEMBLY
(Typical Example)
21. Flyweight assembly. 22. Shaft.

2. Put flyweight assembly (21) in position on the camshaft.

NOTE: Be sure the dowel that holds shaft (22) is in position on the back of the flyweight assembly.

3. Install the bolts (20) that hold flyweight assembly (21) to the camshaft. Tighten bolts (20) to 10 ± 2 lb. ft. (1.4 ± 0.3 mkg).

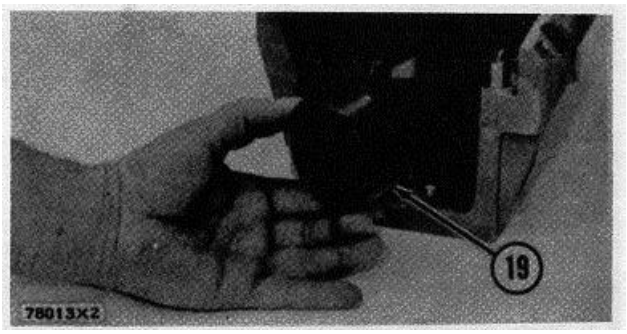


FLYWEIGHT ASSEMBLY INSTALLED
20. Bolts (three). 21. Flyweight assembly. 22. Shaft.

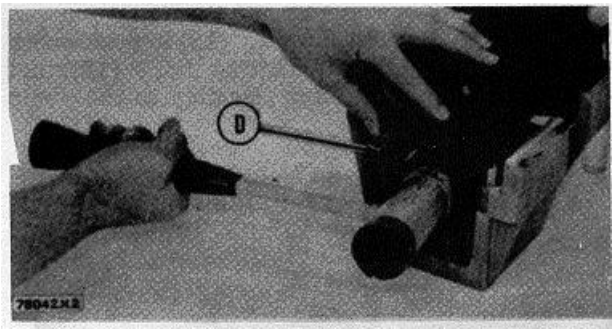
4. Remove timing pin (C).

5. Put shield (19) in position over the flyweights.

6. Use driver (D) to install shield (19) the remainder of the way on to the camshaft.



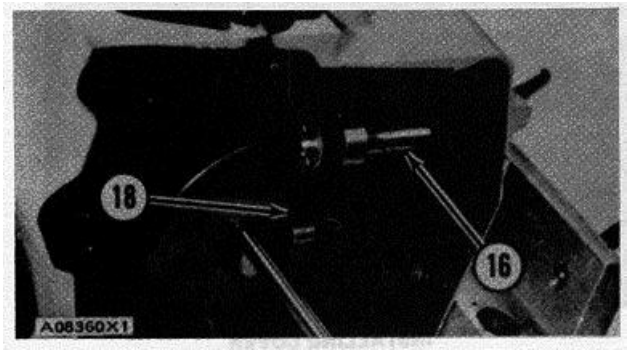
POSITIONING SHIELD
19. Shield.



INSTALLING SHIELD
(Typical Example)
D. 5P301 Driver.

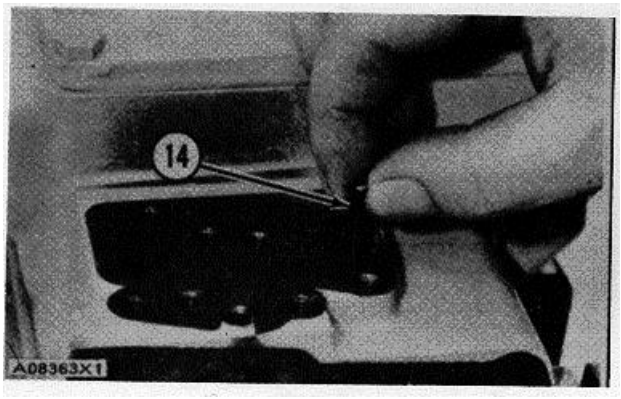
7. Install lever (18) on dowel (16) and install the ring that holds the lever on the dowel.

NOTE: Stake shield (19) in two places, 180 degrees apart, around the cover in alignment with the groove in the camshaft.



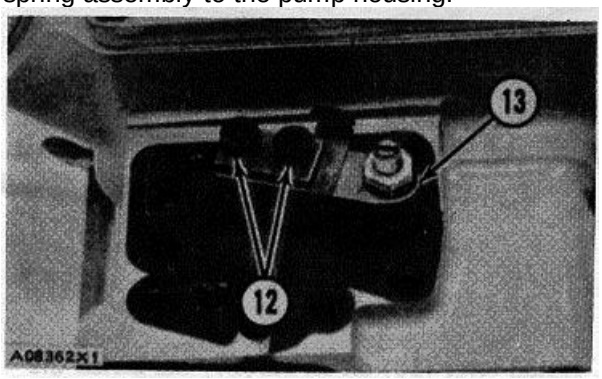
LEVER INSTALLED
16. Dowel. 18. Lever.

8. Install pin (14) in the pump housing.



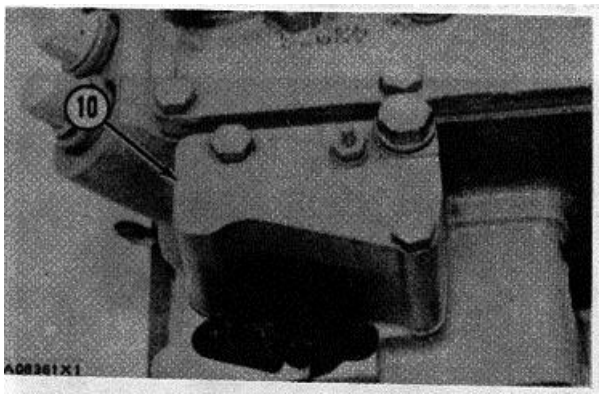
INSTALLING PIN 14. Pin.

9. Put torque spring assembly (13) in position on the pump housing.- Tighten bolts (12) that hold the torque spring assembly to the pump housing.



TORQUE SPRING INSTALLIED
12. Bolts. 13. Torque spring assembly.

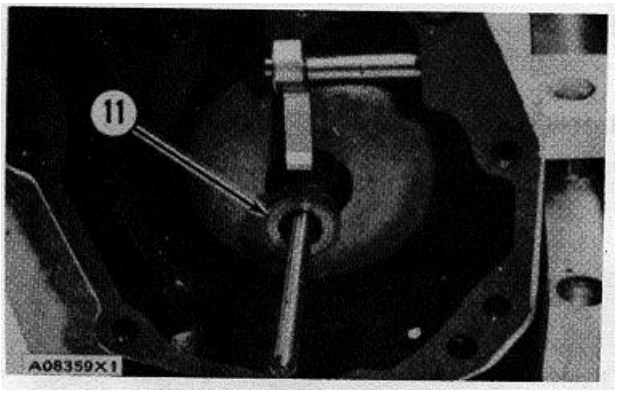
10. Install cover (10) on the pump housing.



INSTALLING COVER
10. Cover.

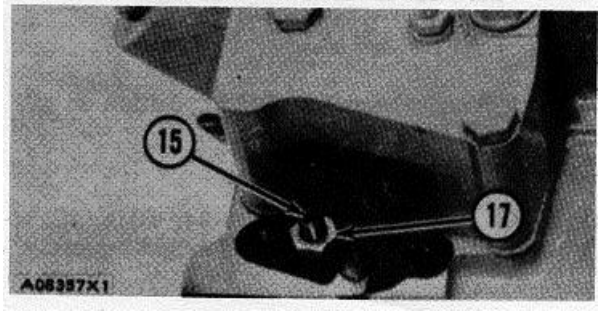
11. Put thrust collar (11) in position between the flyweights. Lift the flyweight and push thrust collar (11) forward.

12.



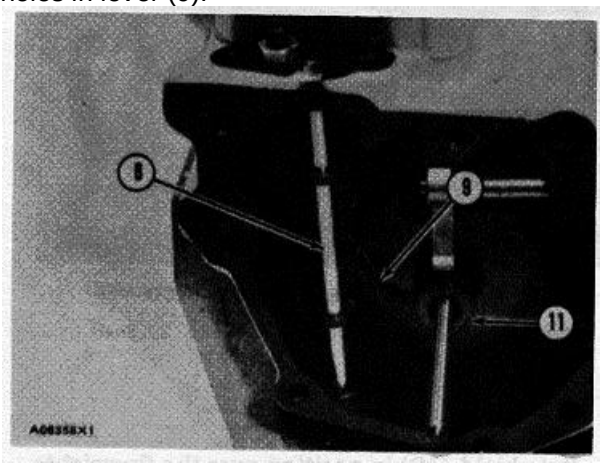
THRUST COLLAR IN POSITION
11. Thrust collar.

12. Install screw (15) and nut (17) in the pump housing.



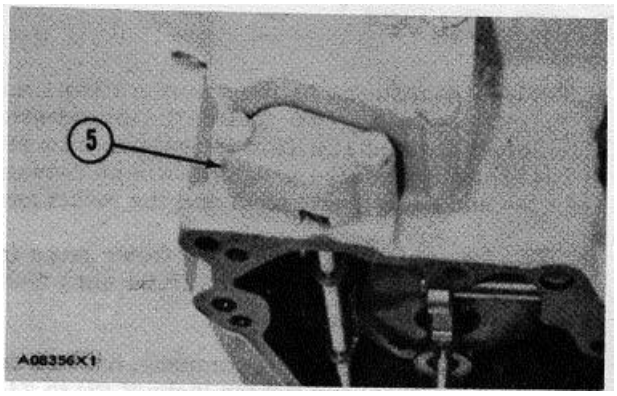
SCREW INSTALLED
15. Screw. 17. Nut.

13. Put lever (9) in position in the pump housing and in the groove in thrust collar (11). Put a new O-ring seal on shaft (8). Install shaft (8) in the pump housing and through the holes in lever (9).



LEVER INSTALLED
8.Shift. 9. Lever. 11.Thrust cotter.

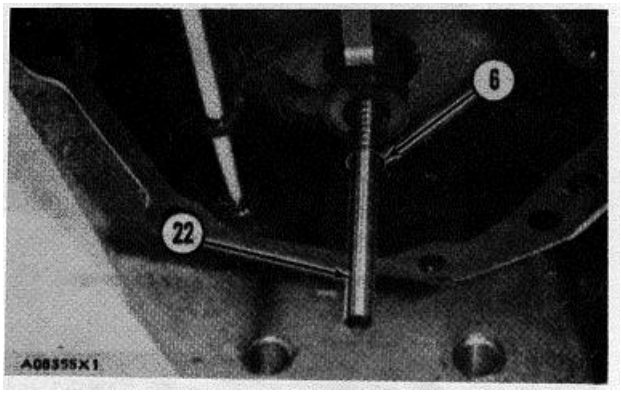
14. Install cover (5) on the pump housing.



COVER INSTALLED
5. Cover.

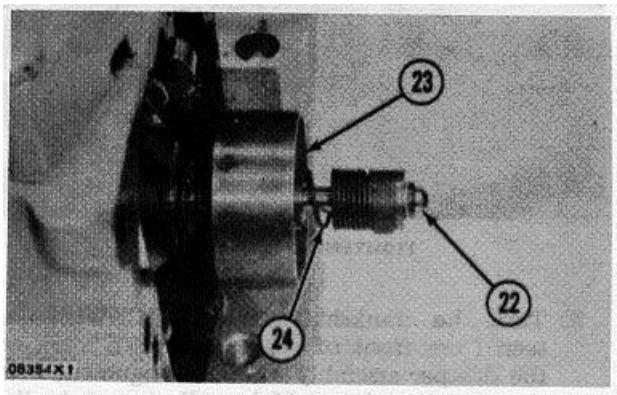
15. Install spring (6) on shaft (22).

16. Install seat and piston assembly (23) on shaft (22).



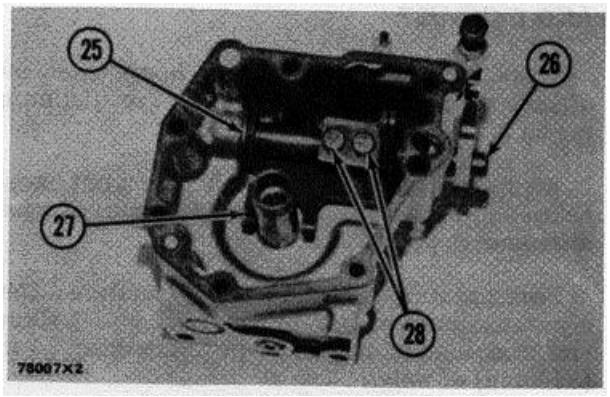
SPRING INSTALLED
6. Spring. 22. shaft,

NOTE: Turn spring (24) on the piston and seat, Turn spring (24) until it just contacts the shoulders on the piston and seat. The piston and seat must be alignment after spring (24) is installed. If not, remove the spring and install again.



SEAT AND PISTON ASSEMBLY INSTALLED
22. Shaft. 23. Seat and piston assembly. 24. Spring.

17. Remove bolts (28). Remove governor shaft (26), governor lever (27), and Shims (25) from the governor housing.



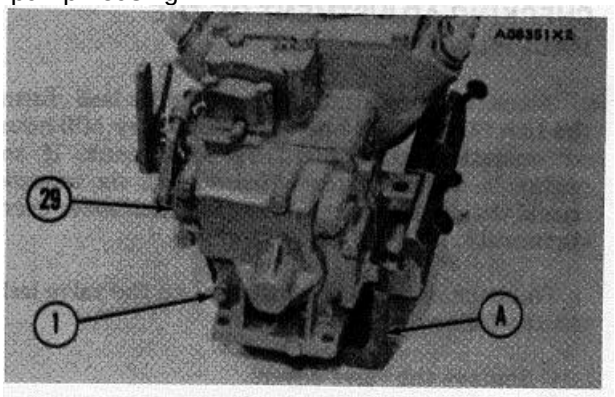
GOVERNOR HOUSING
25. Shims (two). 26. Governor shaft. 27. Governor lever. 28. Bolts,

18. Put governor shaft (26) and governor lever (27) in the governor housing for the dashpot governor. Be sure there is a shim (25) on each side of governor lever (27). Install bolts (28) that hold governor lever (27) to governor shaft (26).

19. Install springs (4) and seat (3) into governor housing (29).

NOTE: Be sure both springs are completely on seat (3) before installing in governor housing (29).

20. Position governor housing (29) on the pump housing. Install bolts (1) that hold governor housing (29) on the pump housing.



GOVERNOR HOUSING INSTALLED
1. Bolts. 29. Governor Housing. A, 2P8315 Bracket Assembly.

21. Remove bracket assembly (A).

CYLINDER HEAD AND VALVES

RESTRICTION OF AIR INLET AND EXHAUST

There will be a reduction of horsepower and efficiency of the engine if there is a restriction in the air inlet or exhaust system.

Air flow through the air cleaner must not have a restriction of more than 25 in. (635 mm) of water difference in pressure.

Back pressure from the exhaust (pressure difference measurement between exhaust outlet elbow and atmosphere) must not be more than 34 in. (864 mm) of water.

COMPRESSION

An engine that runs rough can have a leak at the valves, or valves that need adjustment. Run the engine at the speed that gives rough running. To find a cylinder that has low compression or does not have good fuel ignition, loosen a fuel line nut at a fuel injection pump. This will stop the flow of fuel to that cylinder. Do this for each cylinder until a loosened fuel line is found that makes no difference in engine rough running. Be sure to tighten each fuel line nut after the test before the next fuel line nut is loosened. This test can also be an indication that the fuel injection is wrong, so more checking of the cylinder will be needed. This test is just a fast method of finding the cause of compression loss in a cylinder. Removal of the head and inspection of the valves and valve seats is necessary to find those small defects that do not normally cause a problem. Repair of these problems is normally done when reconditioning (overhaul) the engine.

CHECKING ADJUSTMENT OF THE VALVE LASH

Check the adjustment of the valve lash during the first 80 hours of operation and every 500 hours of operation after the first adjustment. If the engine is not used for 500 hours in six months, check the adjustment of the valve lash after every six months.

To check and make adjustment to the valve lash, use the following procedure:

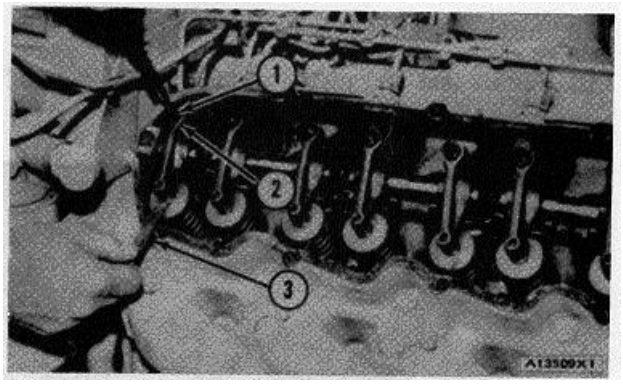
1. Remove the valve covers.

2. Turn the crankshaft CLOCKWISE (as seen from front of engine) until No.1 piston is at top center on the compression stroke. The TDC-1 mark on the damper assembly will be in alignment with the timing pointer.

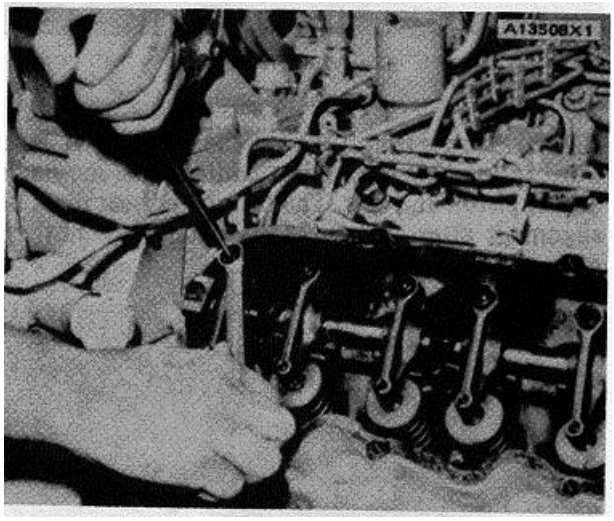
3. Make adjustment to the valves for No.1 and No.2 cylinders. To make the adjustment, loosen locknut (2). Turn the adjustment screw (1) until the feeler gauge (3) will go between the end of the valve stem and the rocker arm.

NOTE: Use a . 015 in. (0.38 mm) feeler gauge for the intake valves. Use a .025 in. (0.64 mm) feeler gauge for the exhaust valves.

4. After the adjustment is complete, hold adjustment screw (1) and tighten locknut (2) to 24 ± 5 lb. ft. (3.3 ± 0.7 mkg). After the locknut is tightened, check the adjustment again.



VALVE LASH ADJUSTMENT
1. Adjustment screw. 2. Locknut. 3. Feeler gauge.

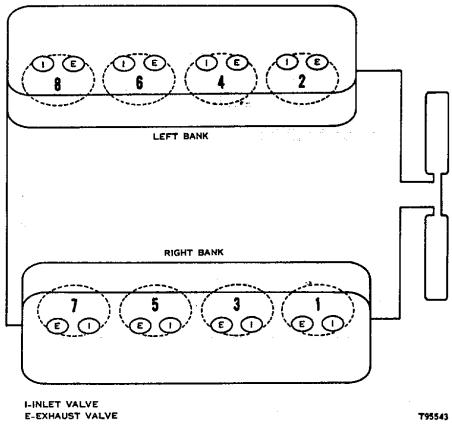


TIGHTENING LOCKNUT

5. Turn he crankshaft 180 CLOCKWISE (as seen from. front of engine). The VS mark on the damper assembly will be in alignment with the tighting pointer. Make adjustment to the valves for No.3 and N.7 cylinders.

6. Turn the crankshaft 180° CLOCKWISE (as seen from front of engine). The TDC-1 mark on the damper assembly will be in alignment with the timing pointer. Make adjustment to the valves for No.4 and No.5 cylinders.

7. Turn the crankshaft 180° CLOCKWISE (as seen from front of engine). The VS mark on damper assembly will be in alignment with the timing pointer. Make adjustment to the valves for No.6 and No.8 cylinders.



CYLINDER AND VALVE LOCATION

When the adjustment of the valve lash needs to be done several times in a short period of time, it can be an indication of wear in a different part of the engine. Find the problem and make any necessary repairs to prevent more damage to the engine.

Not enough valve lash, if not corrected, can be the cause of rapid wear of the camshaft and cam followers. Not enough valve lash can also be. an indication of the seats for the valves being bad. Some reasons for the seats for the valves becoming bad are fuel injection nozzles with defects, restriction to the inlet air or dirty air filters, wrong fuel setting, or using the engine on loads that are too large for the engine.

Too much valve lash, if not corrected, can be the cause for broken valve stems, push rods, or spring retainers. A fast increase in valve lash can be an indication of any of the following:

a. Camshaft and cam followers with wear.

b. Rocker arms with wear.

a. c. Push rods that are bent.

d. Loose adjustment screw for the valve lash.

e. Broken socket on the upper end of a push rod.

If the camshaft and cam followers show signs of rapid wear, look for fuel in the lubrication oil or dirty lubrication oil as a possible cause when making the necessary repairs.

PROCEDURE FOR MEASURING CAMSHAFT LOBES

To measure height (B) of camshaft lobes, use the following procedures:

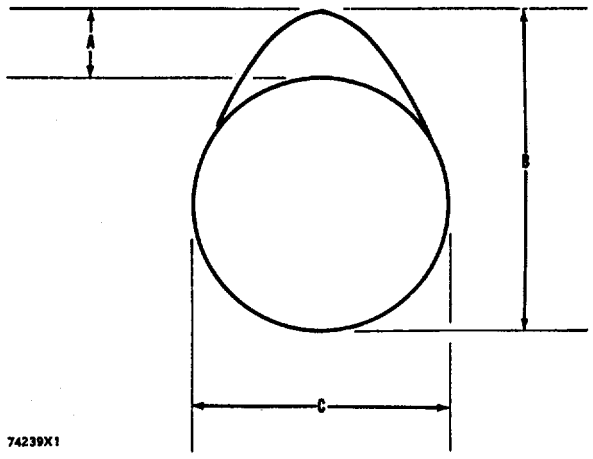
1. Measure base circle (C) of one exhaust and one intake lobe. Make a record of each dimension.

2. Add lobe lift dimension (A) to each base circle measurement. The lobe lift dimension (A) is .3071 in. (7.800 mm) for the exhaust lobe and .3077 in. (7.816 mm) for the intake lobe.

3. The minimum height of lobe (B) is .025 in. (0.64 mm) less than the dimension found in Step 2.

Example of finding the height of a lobe:

Base circle (C)	1.8200 in. (46.228 mm)
Add lobe lift (A)	.3077 in. (7.816 mm)
Lobe height (B)	2.1277 in. (54.044 mm)
Maximum wear of lobe	.025 in. (0.64 mm)
Minimum height of lobe	2.1027 in. (53.409 mm)



CAMSHAFT LOBE
A. Lobe lift. B. Lobe height. C. Base circle.

LUBRICATION SYSTEM

One of the problems in the following list will generally be an indication of a problem in the lubrication system for the engine.

TOO MUCH OIL CONSUMPTION

OIL PRESSURE IS LOW

OIL PRESSURE IS HIGH

TOO MUCH COMPONENT WEAR

TOO MUCH OIL CONSUMPTION

Oil Leakage on Outside of Engine

Check for leakage at the seals at each end of the crankshaft. Look for leakage at the oil pan gasket and all lubrication system connections. Check to see if oil is coming out of the crankcase breather. This can be caused by combustion gas leakage around the pistons. A dirty crankcase breather will cause high pressure in the crankcase, and this will cause gasket and seal leakage.

Oil Leakage Into Combustion Area of Cylinders

Oil leakage into the combustion area of the cylinders can be the cause of blue smoke. There are three possible ways for oil leakage into the combustion area of the cylinders:

1. Oil leakage between worn valve guides and valve stems.

2. Worn or damaged piston rings or dirty oil return holes.

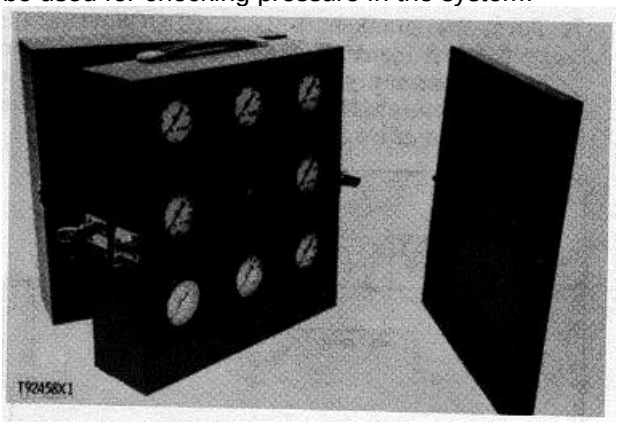
3. Compression ring not installed correctly.

Too much oil consumption can also be the result of using oil with the wrong viscosity. Oil with a thin (low) viscosity can be caused from dirt or fuel getting in the crankcase, or by the engine getting too hot.

OIL PRESSURE IS LOW

An oil pressure gauge that has a defect may give an indication of low oil pressure.
When the engine is running at rated speed with SAE 30 oil at operating temperature, the oil pressure measured at the clean side of the oil filter at the oil filter base will be 55 to 85 psi (3.9 to 6.0 kg/cm2).

A minimum low pressure reading of 15 psi (1.1 kg/cm2) is normal at low idle rpm. If there is no oil pressure, stop the engine immediately. An 8M2744 Gauge, which is part of 7S8875 Hydraulic Test Box, can be used for checking pressure in the system.



7S8875 HYDRAULIC TEST BOX

Crankcase Oil Level

Check the level of the oil in the crankcase. Add oil if needed. It is possible for the oil level to be too far below the oil pump supply tube. This will result in the oil pump not having the ability to supply enough lubrication to the engine components.

Oil Pump Does Not Work Correctly

The inlet screen of the supply tube for the oil pump can have a restriction. This will result in cavitation and a loss of oil pressure. Air leakage in the supply side of the oil pump will also cause cavitation and loss of oil pressure. If the pressure regulating valve for the system is held in the open (unseated) position, the lubrication system can not get to maximum pressure. Oil pump gears that have too much wear will cause a reduction in oil pressure.

Oil Filter and Oil Cooler Bypass Valves

If the bypass valve for the oil filter is held in the open position (unseated) and the oil filter has a restriction, a reduction in oil pressure can result.

The bypass valve is in the oil filter base. The bypass valve will cause the flow of oil to go around the filter elements when there is a reduction to the flow through the elements.

If the oil cooler has a restriction:, the oil cooler bypass valve in the oil filter base will open. This will cause the flow of oil to go around the oil cooler.

Too Much Clearance at Engine Bearings or Open, Broken or Disconnected Oil Line or Passage in Lubrication System

Components that are worn and have too much bearing clearance can cause oil pressure to be low. Low oil pressure can also be caused by an oil line or oil passage that is open, broken, or disconnected.

Oil Cooler

Look for a restriction in the oil passages of the oil cooler.

If the oil cooler has a restriction the oil temperature will be higher than normal when the engine is running. The oil pressure of the engine will become low if the oil cooler has a restriction

OIL PRESSURE IS HIGH

Oil pressure will be high if the bypass valve for the oil pump can not move from the closed position.

TOO MUCH COMPONENT WEAR

When some components of the engine show bearing wear in a short time, the cause can be a restriction in an oil passage. A broken oil passage can also be the cause.

If the gauge for oil pressure shows the correct oil pressure, but a component is worn because it is not getting enough lubrication, look at the passage for oil supply to that component. A restriction in a supply passage will not let enough lubrication get to a component and this will cause early wear.

COOLING SYSTEM

The cooling system is a pressure type with regulators at the outlet, the cooling system is equipped with a shunt line.

A pressure type cooling system gives two advantages. The first advantage is that the cooling system can have safe operation at a temperature that is higher than the normal boiling (steam) point of water. The second advantage is that this type system prevents cavitation (the sudden making of low pressure bubbles in liquids by mechanical forces) in the water pump. With this type system, it is more difficult for an air or steam pocket to be made in the cooling system.

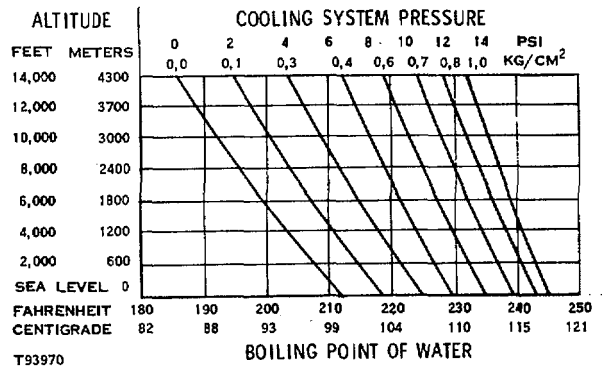
The cause for an engine getting too hot is generally because regular inspections of the cooling system were not made. Make a visual inspection of the cooling system before testing with testing equipment.

VISUAL INSPECTION OF THE COOLING SYSTEM

1. Check coolant level in the cooling system.
2. Look for leaks in the system.
3. Look for bent radiator fins. Be sure that air flow through the radiator does not have a restriction.
4. Inspect the drive belt for the fan.
5. Check for damage to the fan blades.
6. Look for air or combustion gas in the cooling system.
7. Inspect the pressure cap and the sealing surface for the cap. The sealing surface must be clean.

TESTING THE COOLING SYSTEM

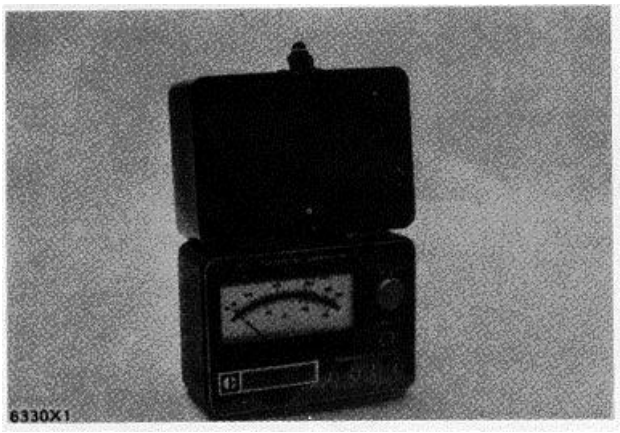
Remember that temperature and pressure work together. When making a diagnosis of a cooling system problem, temperature and pressure must both be checked. Cooling system pressure will have an effect on cooling system temperatures. For an example, look at the chart to see the effect of pressure and height above sea level on the boiling (steam) point of water.



Test Tools for Cooling System

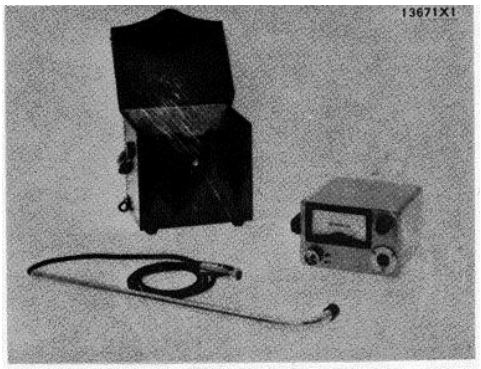
Tools Needed: 9S9102 Thermistor Thermometer Group.
9S7373 Air Meter Group.
1P5500 Portable Phototach Group.
9S8140 Cooling System Pressurizing Pump Group.

The 9S9102 Thermistor Thermometer Group is used in the diagnosis of overheating (engine running too hot) or overcooling (engine runs too cool) problems. This group can be used to check temperatures in several different parts of the cooling system. The testing procedure is in Special Instruction (GMG00450).



9S9102 THERMISTOR THERMOMETER GROUP

The 9S7373 Air Meter Group is used to check the air flow through the radiator core. The testing procedure is in Special Instruction (GMG00203).



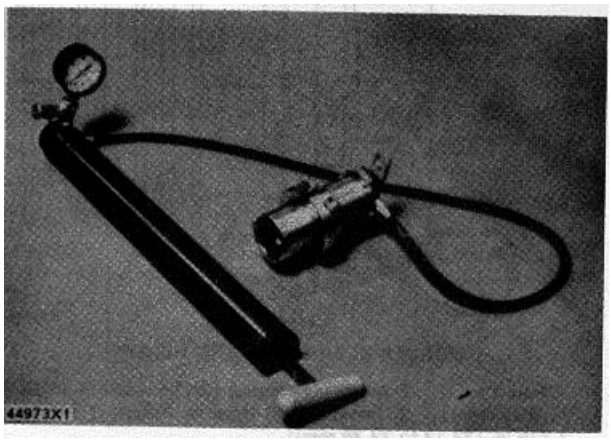
9S7373 AIR METER GROUP

The 1P5500 Portable Phototach Group is used to check the fan speed. The testing procedure is in Special Instruction (GMG00819).



1P5500 PORTABLE PHOTOTACH GROUP

The 9S8140 Cooling System Pressurizing Pump Group is used to test pressure caps and pressure relief valves, and to pressure check the cooling system for leaks. The pressure needed to make the relief valve in the pressure cap open is approximately 7 psi (0.49 kg/cm2).



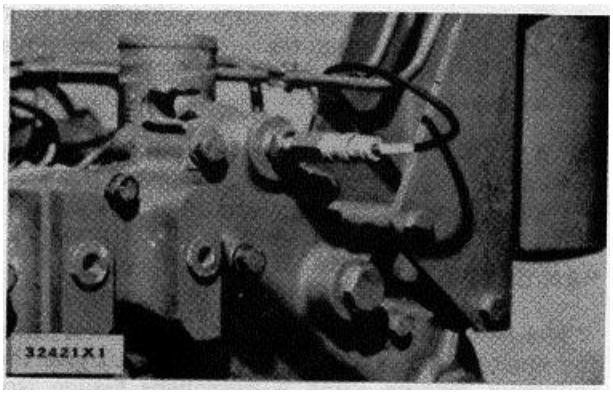
9S8140 COOLING SYSTEM PRESSURIZING PUMP GROUP

Gauge For Water Temperature

Tools Needed: 9S9102 Thermistor Thermometer Group.

If the engine gets too hot and a loss of coolant is a problem, a pressure loss in the cooling system can be the cause. If the gauge for water temperature shows that the engine is getting too hot, look for coolant leakage. If a place can not be found where there is coolant leakage, check the accuracy of the gauge for water temperature. Use the 9S9102 Thermistor Thermometer Group.

CAUTION: Be 'careful when working around an engine if it is running.

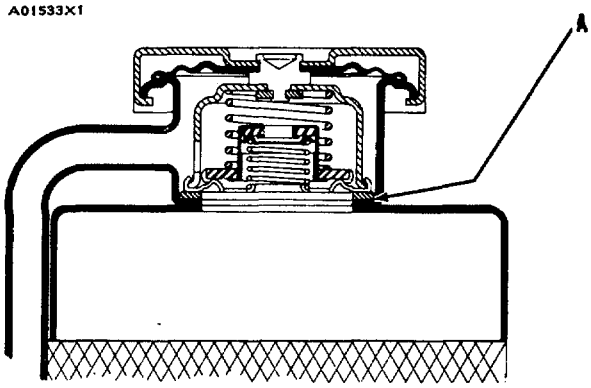


9S9102 THERMISTOR THERMOMETER GROUP INSTALLED (Typical Example)

Start the engine. Put a cover over part of the radiator. The reading on the gauge for water temperature must be the same as the reading on the thermistor thermometer.

Pressure Cap For Radiator

One cause for a pressure loss in the cooling system can be a bad seal on the pressure cap of the radiator. Inspect the pressure cap carefully. Look for damage to the seal or the sealing surface. Any foreign material or deposits on the cap, seal or fill neck of the radiator must be removed.



SCHEMATIC OF PRESSURE CAP
A. Sealing surface of cap and radiator.

Temperature Regulator

Test procedure for water temperature regulators:

1. Remove the regulator from the engine.

2. Put heat to a pan of water. Get the temperature of the water to 197° F (92° C).

3. Hang the regulator in the pan of hot water. Put the regulator completely under the water. Do not let the regulator make contact with the pan.

4. Keep the temperature of the water at 1970 F (92 C) for ten minutes. Make the water move around. This keeps all of the water at the same temperature.

5. After ten minutes, remove the regulator and immediately measure the distance the regulator is opened. The distance must be a mini- mum of .380 in. (9.65 mm).

FAN BELT ADJUSTMENT

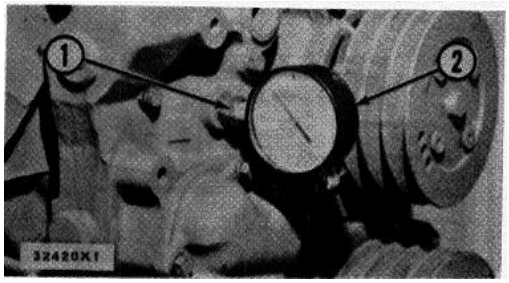
Make an adjustment to the belt farthest from the engine. Correct belt adjustment must give the following reading using a Burroughs Gauge No, BT-33-96-4-15 or a similar gauge:

New belt .... 120 ± 5 Gauge reading.
Belt with a minimum of 30 minutes
of operation time ..... 90 ± 10 Gauge reading.

WATER PUMP PRESSURE CHECK

Tools Needed: 9S8138 Pressure Gauge.
3B7722 Bushing.

The pressure at the outlet for the water pump tells if the shunt system and water pump are operating correctly. To check the pump pressure, install pressure gauge (2) in the front cover. The pressure must be a minimum of 15 psi (1.05 kg/cm2) at 2800 rpm.



GAUGE INSTALLED
(Typical Example)
1, 3B7722 Bushing. 2.9S8138 Pressure Gauge.

If the pump pressure is less than the minimum pressure: First, check the vent tube between the radiator top tank and the surge tank; it must have an inside diameter of approximately .19 in. (4.8 mm).

Second, check to see that the shunt line has a minimum inside diameter of .75 in. (19.1 mm).

INSPECT REBUILT WATER PUMPS

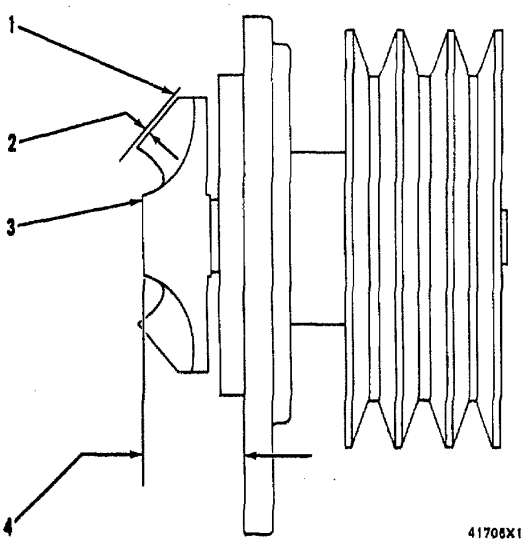
The water pump is serviced only as a complete unit and separate parts for the water pump are not available. Some others can be reconditioning these water pumps, using a different impeller, or an impeller they have machined on the face for the seal or on the vanes.

Unless the same impeller or one like it is used and positioned on the shaft correctly, it is possible for a rebuilt water pump not to give enough flow of coolant to cool the engine. If the one who rebuilt the water pump used an impeller with a design different from the original equipment water pump, be sure the output of his rebuilt water pump is as good as the original equipment water pump.

Here is how to check a rebuilt water pump:

1. Bearing end clearance must be .001 to .025 in. (0.03 to 0.64 mm).

2. The clearance (2) between the face of the impeller and the front cover is .011 to .035 in. (0.28 to 0.89 mm).



IMPELLER CLEARANCE AND HEIGHT
1. Front cover, 2. Impeller clearance [.011 to .035 In, (0.28 to 0,B mm)]. 3, Impeller. 4, Impeller height [1.286 to 1,275 in. (32,12 to 32.39 mm)].

Clearance (2) is an indication of the condition of the impeller and of the location of the impeller on the shaft. It can also be an indication of the condition of the bearing and front cover. Check the clearance of the impeller in the following way.

a. Put a small amount of wax or a soft material on two vanes of the impeller directly opposite of each other.

b. Using a new gasket, install the water purity and tighten the bolts holding the water pump. DO NOT turn the pulley.

c. Push in on the pulley with a force of about 15 lbs. (7 kg). This will remove the end clearance.

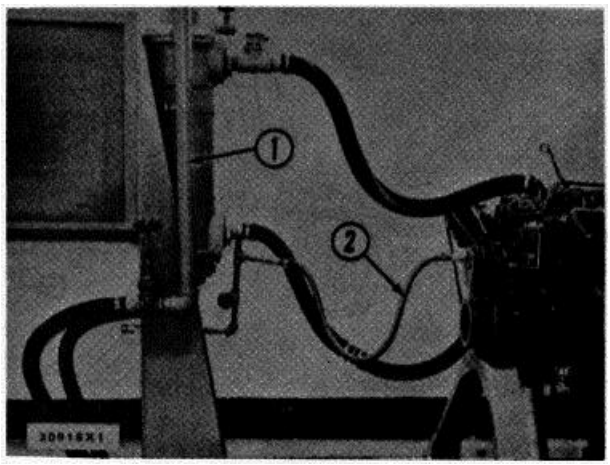


REMOVING END CLEARANCE

d. Remove the water pump. Measure the thickness of the wax that is between the vanes and the front Rover. When the last bolts are removed, be careful not to hit the clay or wax. The impeller clearance (2) is .011 to .035 in. (0.28 to 0.89 mm).

DYNAMOMETER TEST CAUTION
(Industrial Engines)

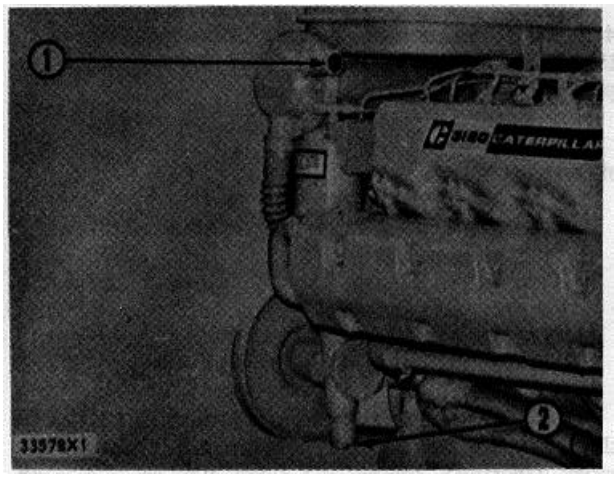
To prevent possible damage to an engine while testing on a dynamometer, the water temperature connected as shown.



SHUNT LINE CONNECTED TO ENGINE
(Typical Example)
1. FT790 Cooling Tower Group. 2. Shunt line,

DYNAMOMETER TEST CAUTION
(Marine Engines)

To prevent possible damage to an engine while testing on a dynamometer, the water temperature regulators must be installed and coolant connections made as shown.



COOLANT CONNECTIONS
(Typical Example)

1. See water outlet (connect cooling tower return line to this connection). 2. See water pump Inlet (connect cooling tower outlet to this connection).

BASIC BLOCK

CONNECTING RODS AND PISTONS

Use the 5F9059 Piston Ring Expander to remove or install piston rings.

Use the IY7426 Piston Ring Compressor or the 4S9450 Compressor and the 4S9446 Clamp from the 4S9458 Teflon Seal Tool Group to install pistons into cylinder block.

Tighten the connecting rod nuts in the following step sequence:

1. Put crankcase oil on bolt threads and seating faces of cap and nut.
2. Tighten both nuts to 30 ± 3 lb.ft. (4.1 ± 0.4 mkg).
3. Put a mark on each nut and cap.
4. Tighten each nut 60° from the mark.

The connecting rod bearings should fit tightly in the bore in the rod. If bearing joints or backs are worn (fretted), check for bore size as this is an indication of wear because of looseness.

5P3519 PISTON RING GROOVE GAUGE

A 5P3519 Piston Ring Groove Gauge is available for checking ring grooves with straight sides. For instructions on the use of the gauge, See the GUIDELINE FOR REUSABLE PARTS; PISTONS AND CYLINDER LINERS, Form No. REG01660.



PISTON RING GROOVE GAUGE

CONNECTING ROD AND MAIN BEARINGS

Bearings are available with a smaller inside diameter than the original size bearings. These bearings are for crankshafts that have been "ground" (made smaller than the original size).

Main bearings are available with a larger outside diameter than the original size bearings These bearings are for cylinder blocks that have had the bore for the main

bearings "bored" (made larger than the original size).

FLYWHEEL AND FLYWHEEL HOUSING

Tools Needed- 8S2328 Dial Indicator Group.

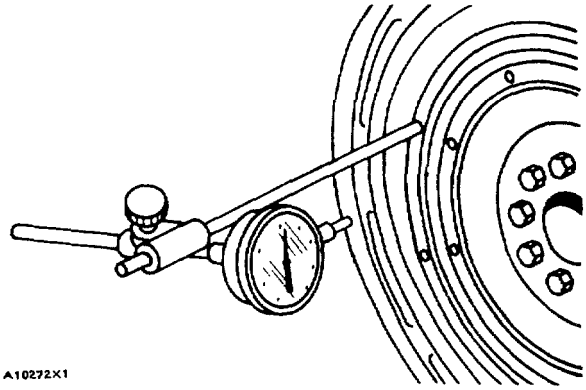
Heat the rind gear to install it. Do not heat to more than 400° F (204° C). Install the ring gear so the chamfer on the gear teeth is next to the starter pinion when the flywheel is installed.

Face Runout (axial eccentricity) of the Flywheel Housing

If any method other than given here is used, always remember bearing clearances must be removed to get correct measurements.

1. Fasten a dial indicator to the crankshaft flange so the anvil of the indicator will touch the face of the flywheel housing.

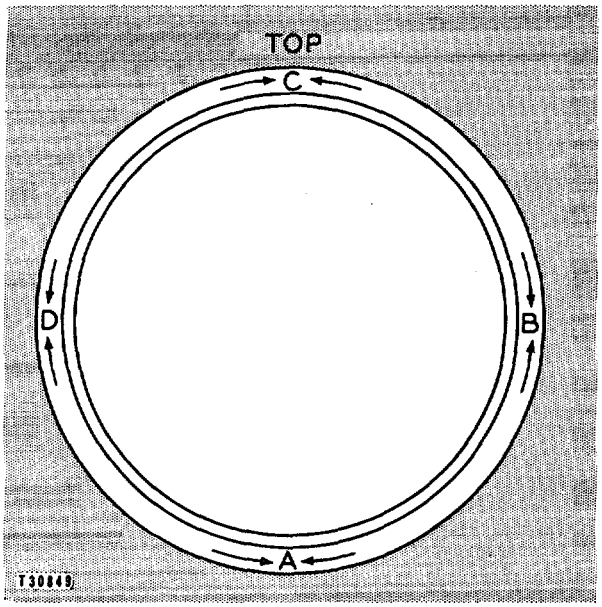
2. Force the crankshaft to the rear before reading the indication at each point.



8S2328 DIAL INDICATOR GROUP INSTALLED

3. With dial indicator set at .000 in. (0.0 mm) at location (A), turn the crankshaft and read the indicator at locations (B), (C) and (D).

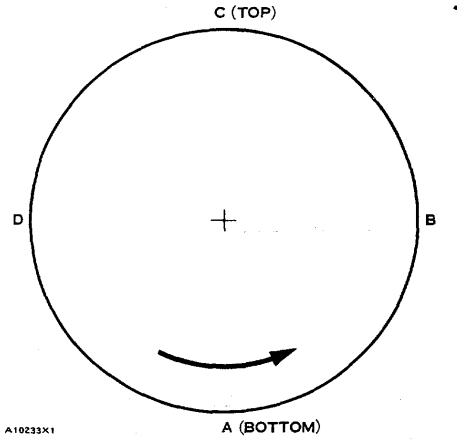
4. The difference between lower and higher measurements taken at all four points must not be more than .012 in. (0.30 mm), which is the maximum permissible face runout (axial eccentricity) of the flywheel housing.



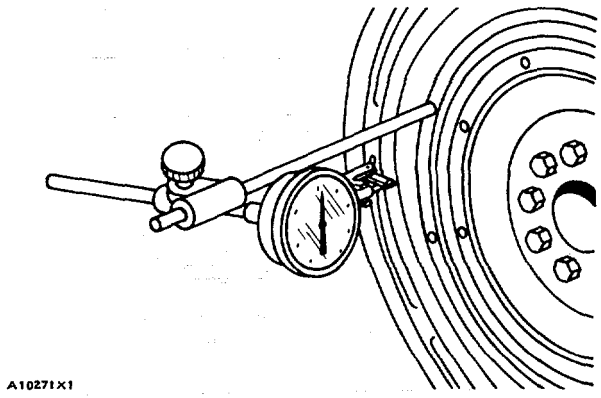
CHECKING FACE RUNOUT OF THE FLYWHEEL HOUSING
A. Bottom. B. Right side. C. Top. D. Left side.

Bore Runout (radial eccentricity) of the Flywheel Housing

1. With the dial indicator in position at (C), ad- just the dial indicator to "0" (zero). Push the crankshaft up against the top bearing. Write the measurement for bearing clearance on line 1 in column (C).



CHECKING BORE RUNOUT OF THE FLYWHEEL HOUSING



8S2328 DIAL INDICATOR GROUP INSTALLED

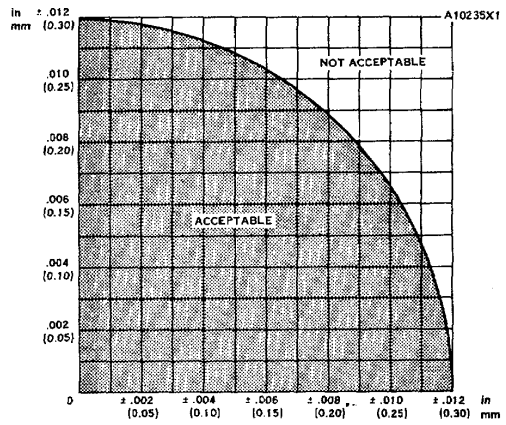
2. Divide the measurement from Step 1 by 2. Write this number on line I in columns (B) & (D).
3. Turn the crankshaft to put the dial indicator at (A). Adjust the dial indicator to "0" (zero).
4. Turn the crankshaft counterclockwise to put the dial indicator at (B). Write the measurement in the chart.
5. Turn the crankshaft counterclockwise to put the dial indicator at (C). Write the measurement in the chart.
6. Turn the crankshaft counterclockwise to put the dial indicator at (D). Write the measurement in the chart.
7. Add lines I & II by columns.
8. Subtract the smaller number from the larger number in line III in columns (B) & (D). The result is the horizontal "eccentricity" (out of round). Line III, column (C) is the vertical eccentricity.

CHART FOR DIAL INDICATOR MEASUREMENTS

	Position of dial indicator				
	Line No	A	B	C	D
Correction for bearing clearance	I	0			
Dial Indicator Reading	II	0			
Total of Line 1 & 2	III	0	**	*	* *

*Total Vertical eccentricity (out of round). ·
**Subtract the smaller No. from the larger No. The difference is the total horizontal eccentricity. A0234X1

9. On the graph for total eccentricity find the point of intersection of the lines for vertical eccentricity and horizontal eccentricity.



GRAPH FOR TOTAL ECCENTRICITY

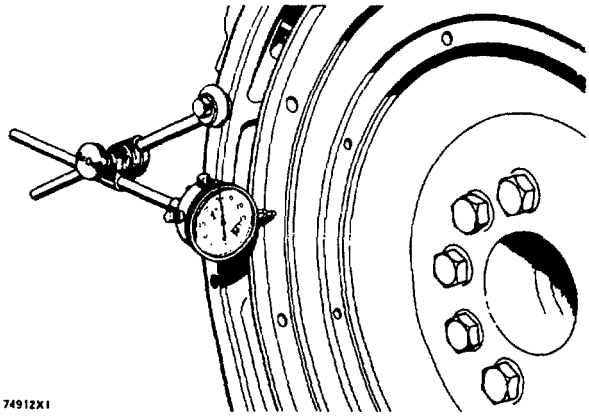
10. If the point of intersection is in the range marked "Acceptable" the bore is in alignment. If the point of intersection is in the range marked "Not Acceptable" do Step 11.

II. Loosen the bolts holding the flywheel housing to the cylinder block. Hit the flywheel housing lightly with a hammer to put it in the correct position. Tighten the bolts holding the flywheel housing to the cylinder block and do Steps 1 through 10 again.

Face Runout (axial eccentricity) of the Flywheel

1. Install the dial indicator as shown. Force the crankshaft the same way before the indicator is read so the crankshaft end clearance (movement) is always removed.

2. Set the dial indicator to read .000 in. (0.0 mm).



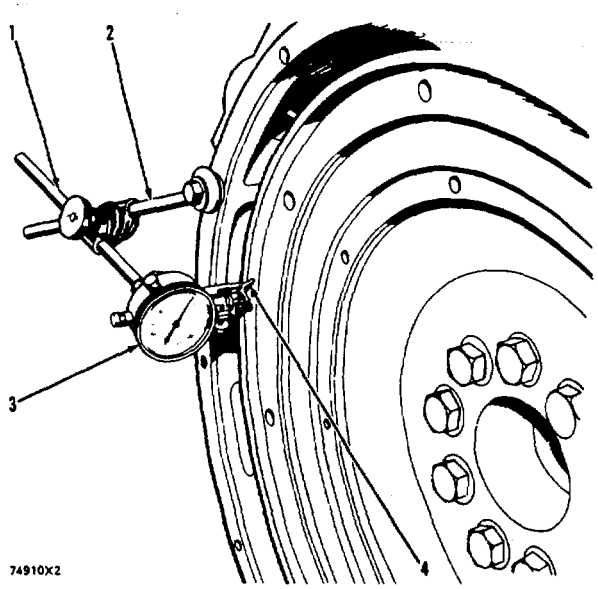
CHECKING FACE RUNOUT OF THE FLYWHEEL

3. Turn the flywheel and read the indicator every 90°.

4. The difference between the lower and higher measurements taken at all four points must not be more than .006 in. (0.15 mm), which is the maximum permissible face runout (axial eccentricity) of the flywheel.

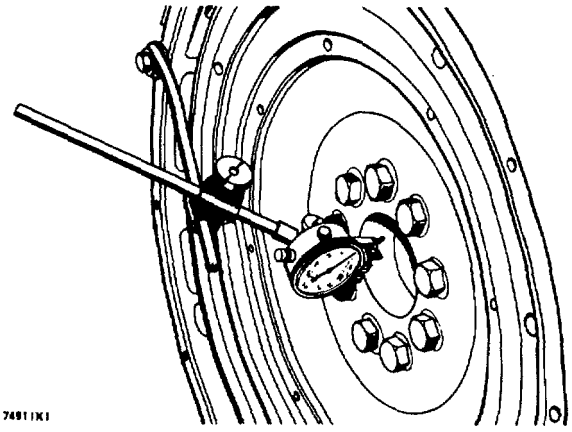
Bore Runout (radial eccentricity) of the Flywheel

1. Install the dial indicator (3) and make an adjustment of the universal attachment (4) so it makes contact as shown.



CHECKING BORE RUNOUT OF THE FLYWHEEL

1. 7H1945 Holding Rod. 2. 7H1645 Holding Rod. 3, 7H1942 Indicator. 4. 7H1940 Universal Attachment.



CHECKING FLYWHEEL CLUTCH PILOT BEARING BORE

2. Set the dial indicator to read .000 in. (0.0 mm).

3. Turn the flywheel and read the indicator every 90°.

4. The difference between the lower and higher measurements taken at all four points must not be more than .006 in. (0.15 mm), which is the maximum permissible bore runout (radial eccentricity) of the flywheel.

5. Runout (eccentricity) of the bore for the pilot bearing for the flywheel clutch, must not exceed .005 in. (0.13 mm.).

ELECTRICAL SYSTEM

Most of the testing of the electrical system can be done on the engine. The wiring insulation must be in good condition, the wire and cable connections clean and tight and the battery fully charged. If on the engine test shows a defect in a component, remove the component for more testing.

BATTERY

Tools Needed: 5P300 Electrical Tester.
9S1990 or 1P7470 Battery Charger Tester.
5P957 or 5P3414 Coolant and Battery Tester.

NOTE: Make reference to Special Instruction (GEG02276) and to the instructions inside of the cover of the tester, when testing with the 5P300 Electrical Tester.

The battery circuit is an electrical load on the charging unit. The load is variable because of the condition of the charge in the battery. Damage to the charging unit will result, if the connections, (either positive or negative) between the battery and charging unit are broken while the charging unit is charging. This is because the battery load is lost and there is an increase in charging voltage.

High voltage will damage, not only the charging unit but also the regulator and other electrical components.



9S1990 BATTERY CHARGER TESTER

CAUTION: Never disconnect any charging unit circuit or battery circuit cable from battery when the charging unit is charging.

Load test a battery that does not hold a charge when in use. To do this, put a resistance, across the battery main connections (terminals). For a 6 volt battery, put a resistance of two times the ampere/hour rating of the battery. For a 12 'volt battery, put a resistance of three times the ampere/hour rating. Let the resistance remove the charge (discharge the battery) for 15 seconds. Immediately test the battery voltage. A 6 volt battery in good condition will test 4.5 volts; a 12 volt battery in good condition will test 9 volts.

The Special Instruction (GEG00058) with the 9S1990 Charger Tester gives the battery testing procedure.

CHARGING SYSTEM

Tools Needed: 5P300 Electrical Tester.

NOTE: Make reference to Special Instruction (GEG02276) and to the instructions inside of the cover of the tester, when testing with the 5P300 Electrical Tester.

The condition of charge in the battery at each regular inspection will show if the charging system is operating correctly. An adjustment is necessary when the battery is always in a low condition of charge or a large amount of water is needed (one ounce per cell per week or every 50 service hours). Test the charging units and voltage regulators on the engine, when possible, using wiring and components that are a permanent part of the system. Off the engine (bench) testing will give an operational test of the charging unit and voltage regulator. This testing will give an indication of needed repair. Final testing will give proof that the units are repaired to their original operating condition.

Before starting on the engine testing, the charging system and battery must be checked. See the following Steps.

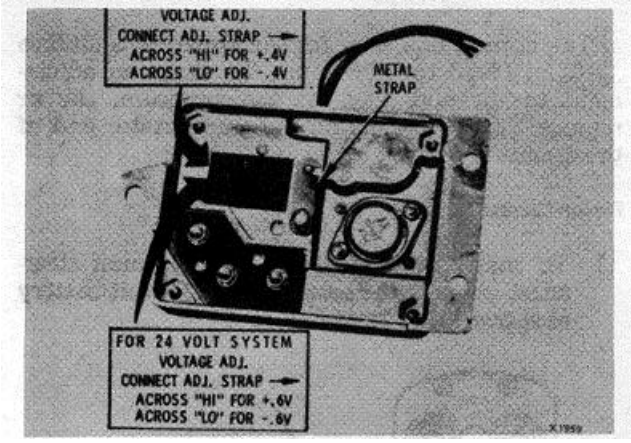
1. Battery must be at least 75% (1.240 Sp. Gr.) full charged and held tightly in place. The battery holder must not put too much stress on the battery.

2. Cables between the battery, starter and engine ground must be the correct size. Wires and cables must be free of corrosion and have cable support clamps to prevent stress on battery connections (terminals).

3. Leads, junctions, switches and panel instruments that have direct relation to the charging circuit must give proper circuit control.

4. Inspect the drive components for the charging unit to be sure they are free of grease and oil and are able to drive the load of the charging unit.

Alternator Regulator (Motorola)

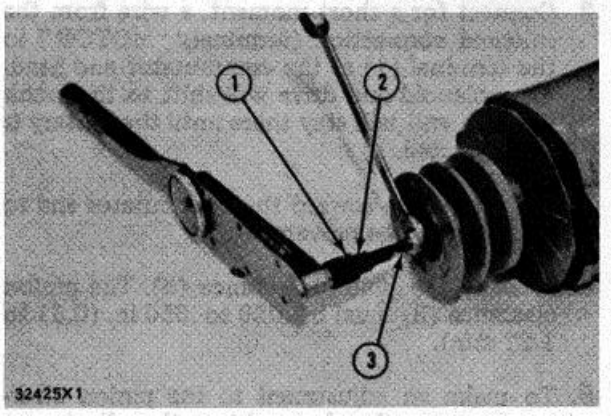


REGULATOR ADJUSTMENT

To make an increase to the voltage (approximately .4 volt on a 12 volt system or .6 volt on a 24 volt system) remove the locknuts from the two terminals that are nearer the word "HI" than the other terminals. Put the metal strap over these terminals, put the locknuts on the terminals and tighten the locknuts.

To make the voltage lower (approximately .4 volt on a 12 volt system and .6 volt on a 24 volt system) put the metal strap on the two terminals nearer the word "LO".

Alternator: Pulley Nut Tightening (Delco-Remy)



ALTERNATOR PULLEY INSTALLATION

1. 8S1588 Adapter (1/2" female to 3/8" male). 2. 8S1590 Socket (5/16"-3/8" drive). 3. 1P2977 Tool Group. 8H8555 Socket (15/16"-1/2" drive) not shown.

Tighten nut holding the pulley to a torque of 60 ± 5 lb. ft. (8.3 ± 0.7 mkg) with the tools shown.

STARTING SYSTEM

Tools Needed: 5P300 Electrical Tester.

NOTE: Make reference to Special Instruction (GEG02276) and to the instructions inside of the cover of the tester, when testing with the 5P300 Electrical Tester.

Use a D. C. Voltmeter to find starting system components which do not function.

Move the starting control switch to activate the starter solenoid. Starter solenoid operation can be heard as the pinion of the starter motor is engaged with the ring gear on the engine flywheel. The solenoid operation also closes the electric circuit to the motor. Connect one lead of the voltmeter to the solenoid connection (terminal) that is fastened to the motor. Put the other lead to a good ground. Activate the starter solenoid and look at the voltmeter. A reading of battery voltage shows the problem is in the motor. The motor must be removed for further testing. No reading on the voltmeter shows that the solenoid contacts do not close. This is an indication of the need for repair to the solenoid or an adjustment to be made to the starter pinion clearance. Pinion clearance for Delco-Remy starters is .36 in. (9.1 mm). Pinion clearance for the Prestolite starter is .020 to .050 in. (0.51 to 1.27 mm).

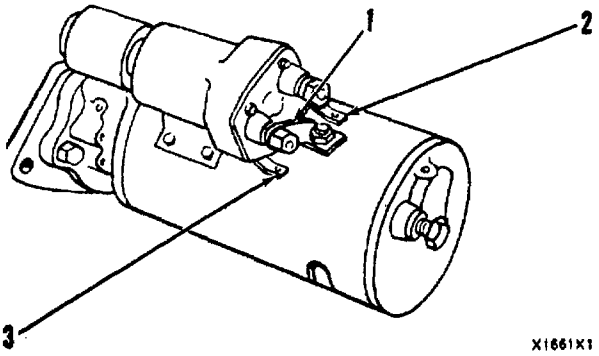
If the solenoid for the starting motor will not operate, it is possible that the current from the battery is not getting to the solenoid. Fasten one lead of the voltmeter to the connection (terminal) for the battery cable on the solenoid. Put the other lead to a good ground. No voltmeter reading shows there is a broken circuit from the battery. Further testing is necessary when there is a reading on the voltmeter.

Further test by fastening one voltmeter lead to the connection (terminal) for the small wire at the solenoid and the other lead to the ground. Look at the voltmeter and activate the starter solenoid. A voltmeter reading shows that the problem is in the solenoid. No voltmeter reading shows that the problem is in the starter switch or wiring. Fasten one lead of the voltmeter to the battery wire connection of the starter switch and put the other lead to a good ground. A voltmeter reading indicates a failure in the switch.

A starting motor that operates too slow can have an overload because of too much friction in the engine being started. Slow operation of the starting motor can also be caused by shorts, loose connections, and/or dirt in the motor.

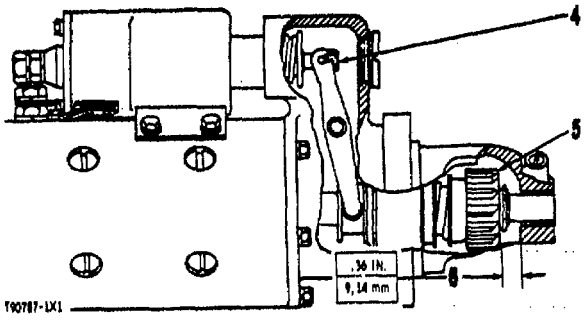
Pinion Clearance Adjustment (Delco-Remy)

Whenever the solenoid is installed, make an adjustment of the pinion clearance. The adjustment can be made with the starting motor removed.



CONNECTION FOR CHECKING PINION CLEARANCE
1. Connector from MOTOR terminal on solenoid to motor, 2. SW terminal. 3. Ground terminal.

1. Install the solenoid without connector (1) from the MOTOR connection (terminal) on solenoid to the motor.
2. Connect a battery, of the same voltage as the solenoid, to the terminal (2), "SW".
3. Connect the other side of battery to. Ground terminal (3).



PINION CLEARANCE ADJUSTMENT
4. Shaft nut. 5. Pinion. 6. Pinion clearance.

4. Connect for a moment, a wire from the solenoid connection (terminal) "MOTOR" to the ground connection (terminal). The pinion will shift to crank position and will stay there until the battery is disconnected.
5. Push the pinion toward commutator end to remove free movement.
6. Pinion clearance (6) must be .36 in. (9.1 mm).
7. Pinion clearance adjustment is made by removing plug and turning nut (4).

Pinion Clearance Adjustment (Prestolite)

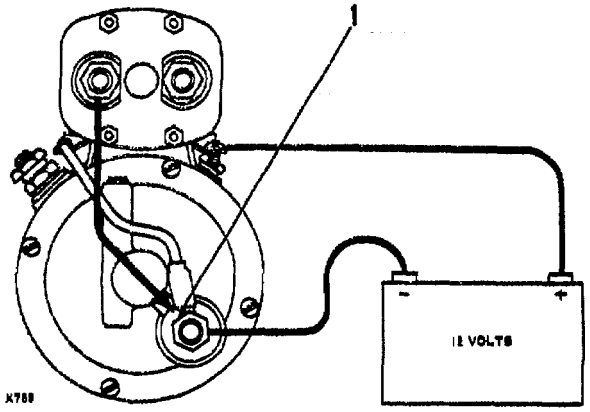
There are two adjustments for this type starting motors. They are end play for the armature and pinion clearance.

End Play for the Armature

The correct end play for the armature is .005 to .030 in. (0.13 to 0.76 mm). To make an adjustment to the end play for the armature, add or remove thrust washers on the commutator end of the armature shaft.

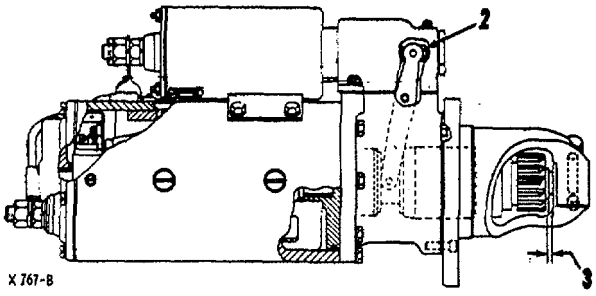
Pinion Clearance

1. To make an adjustment to the pinion clearance, connect the solenoid to a 12 volt battery as shown,

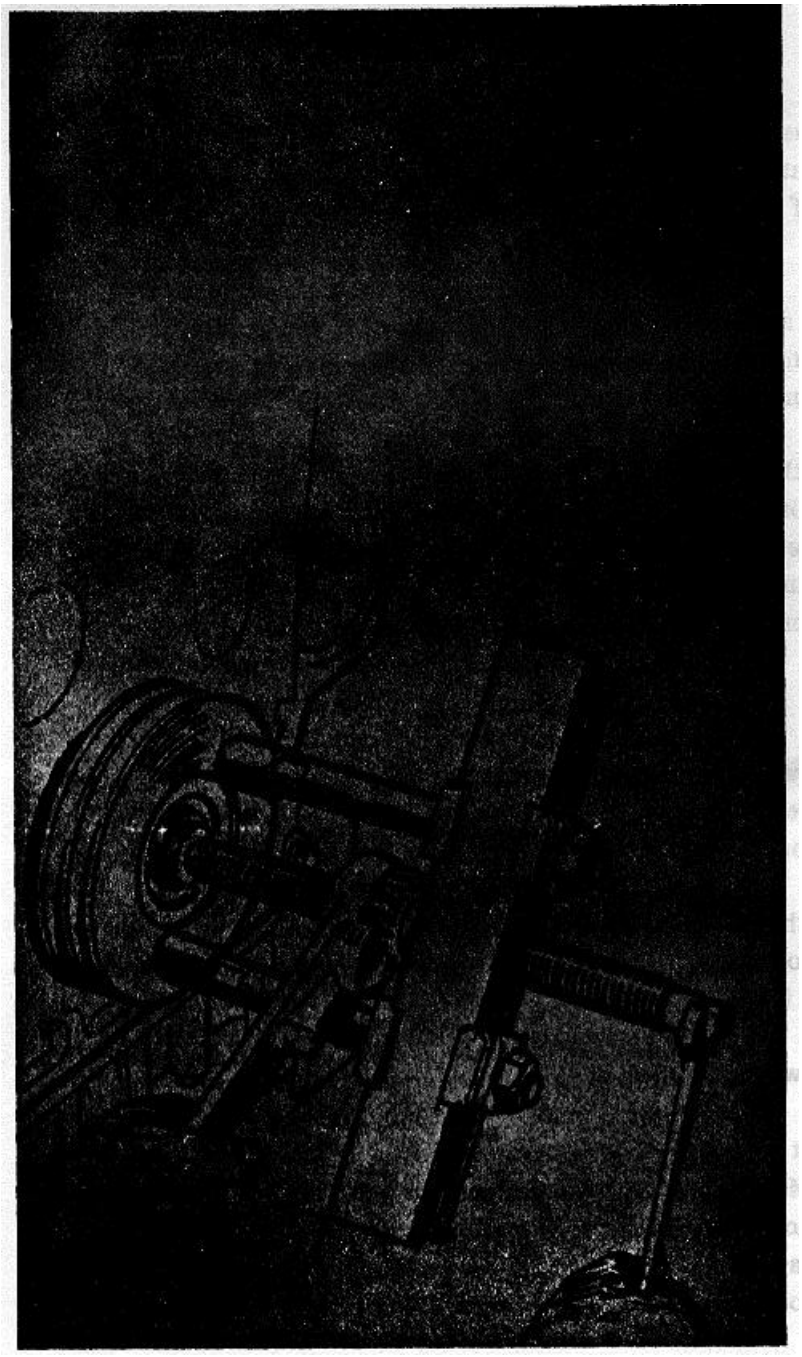


CONNECTIONS FOR ADJUSTMENT OF THE PINION CLEARANCE
1. Terminal.

2. Connect for a short moment, a wire from the solenoid connection (terminal) "MOTOR" to the terminal (1) at the commutator end head. The solenoid and drive will shift to the crank position and will stay there until the battery is disconnected.
3. Push the drive toward the commutator end to remove any free movement.
4. Measure the pinion clearance (3). The pinion clearance (3) must be .020 to .050 in. (0.51 to 1.27 mm).
5. To make an adjustment to the pinion clearance, remove the plug and turn the adjustment nut (2) as necessary.



PINION CLEARANCE ADJUSTMENT
2. Adjustment nut 3. Pinion clearance.



FORM NO. SENR7106

FOR USE IN SERVICE MANUALS:
3208 ENGINE, REG01658
V160 THRU V300 LIFT
TRUCKS, REG01275

DISASSEMBLY AND ASSEMBLY

3208 INDUSTRIAL & MARINE ENGINES

SERIAL NUMBERS
75V1- UP
90N1-UP

INTRODUCTION

This publication has instructions and procedures for the subject on the front cover. The information, specifications, and illustrations in this publication are on the basis of information that was current at the time this issue was written.

The "Alphabetical and Service Index" is a list of all components and service operations found in this manual. It gives page numbers and also an operation number for each component.

All operations in the column "Component Operation" are removal and installation instructions, unless other descriptions are given for the operations. The numbers under the column "Operation" are numbers given to each operation for use under the column "Other Needed Operations" which gives all other component operations by number that are necessary to do the respective job.

Correct operation, maintenance, test and repair procedures will give this product a long service life. Before starting a test, repair or rebuild job, the serviceman must read the respective sections of the Service Manual, and know all the components he will work on.

Your safety, and the safety of others, is at all times very important. When you see this symbol ⊕ or this  bol in the manual, you must know that caution is needed for the procedure next to it. The symbols are warnings. To work safely, you must understand the job you do. Read all instructions to know what is safe and what is not safe.

It is very important to know the weight of parts. Do not lift heavy parts by hand. Use a hoist. Make sure heavy parts have a good stability on the ground. A sudden tall can cause an accident. When lifting part of a machine, make sure the machine has blocks at front and rear. Never let the machine hang on a hoist, put blocks or stands under the weight.

When using a hoist, follow the recommendation in the manual. Use correct lift tools as shown in illustrations to get the correct balance of the component you lift. This makes your work safer at all times.
44300x3

GENERAL TIGHTENING TORQUE FOR BOLTS, NUTS AND TAPERLOCK STUDS



The following charts give the standard torque values for bolts, nuts and taperlock studs of SAE Grade 5 or better quality. Exceptions are given in the component Disassembly and Assembly.

THREAD DIAMETER		STANDARD TORQUE	
inches	millimeter	lb. ft.	mkg
Standard thread		**Use these torques for bolts and nuts with standard threads.**	
1/4	6.35	9 ± 3	1.24 ± 0.4
5/16	7.94	18 ± 5	2.5 ± 0.7
318	9.53	32 ± 5	4.4 ± 0.7
7/16	11.11	50 ± 10	6.9 ± 1.4
1/2	12.70	75 ± 10	10.4 ± 1.4
9/16	14.29	110±15	15 ± 2.0
5/8	15.88	150 ± 20	20.7 ± 2.8
3/4	19.05	265 ± 35	36.6 ± 4.8
7/8	22.23	420 ± 60	58.1 ± 8.3
1	25.40	640 ± 80	88.5 ± 11.1
1 1/8	28.58	800 ± 100	110.6 + 13.8
1 1/4	31.75	1000 ± 120	138 ± 16.6
1 3/8	34.93	1200 ± 150	166 + 20.7
1 1/2	38.10	1500 ± 200	207 ± 27.7
		Use these torques for bolts and nuts on hydraulic valve bodies.	
5/16	7.94	13 ± 2	1.8 ± 0.3
3/8	9.53	24 ± 2	3.3 ± 0.3
7/16	11.11	39 ± 2	5.4 ± 0.3
1/2	12.70	60 ± 3	8.3 ± 0.4
5/8	15.88	118 ± 4	16.3 ± 0.5
Taperlock stud		**Use these torques for studs with Taperlock threads.**	
1/4	6.35	5 ± 2	0.69 ± 0.3
5/16	7.94	10 ± 3	1.4 ± 0.4
318	9.53	20 ± 3	2.8 ± 0.4
7/16	11.11	30 ± 5	4.1 ± 0.7
1/2	12.70	40 ± 5	5.5 ± 0.7
9/16	14.29	60 ± 10	8.3 ± 1.4
5/8	15.88	75 ± 10	10.4 ± 1.4
3/4	19.05	110 ± 15	15.2 ± 2.0
7/8	22.23	170 ± 20	23.5 ± 2.8
1	25.40	260 ± 30	35.9 ± 4.1
1 1/8	28.58	320 ± 30	44.2 ± 4.1
1 1/4	31.75	400 ± 40	55 ± 5.5
1 3/8	34.93	480 ± 40	66 ± 5.5
1 1/2	38.10	550 ± 50	76 ±7

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ALPHABETICAL AND SERVICE INDEX

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AIR CLEANER, FUEL INJECTION LINES

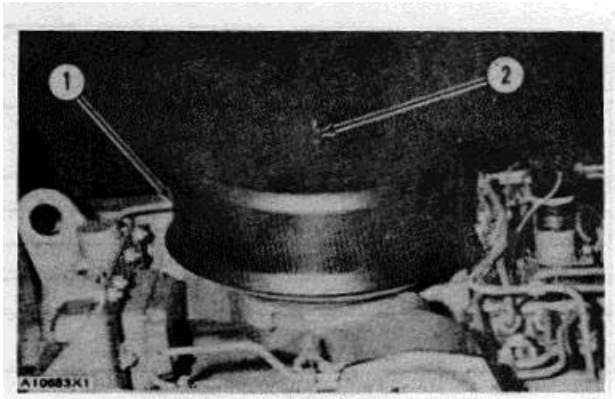
REMOVE AND INSTALL AIR CLEANER (MARINE ENGINE) 10-1051

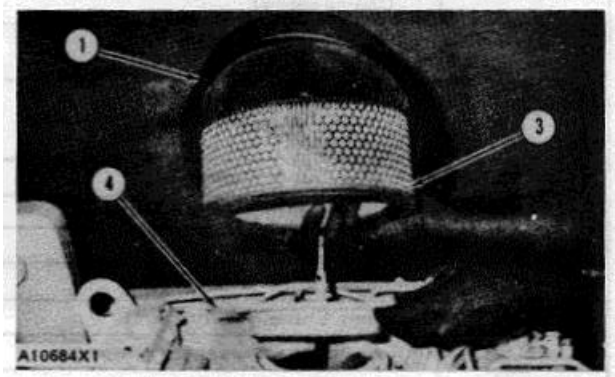
1. Remove wing nut (2). Remove element cover (1).

2. Remove element (3) and adapter (4).

3. Install adapter (4) and element (3).

4. Install element cover (1) and wing nut (2).





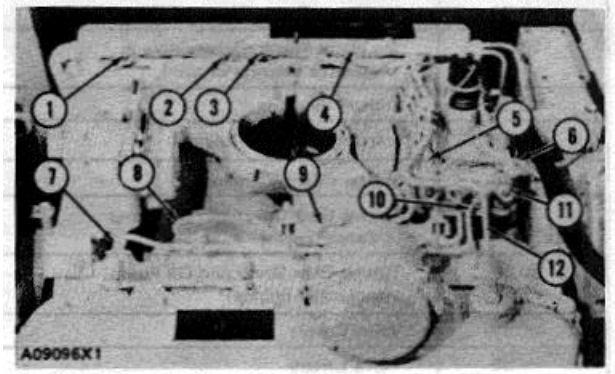
REMOVE AND INSTALL FUEL INJECTION LINES (MARINE ENGINE) 10-1252

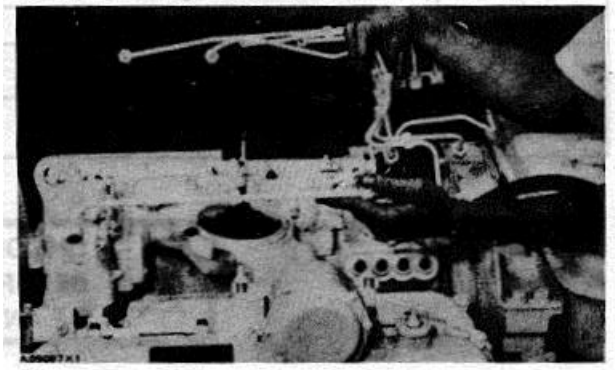
1. Thoroughly clean the area around each fuel line connection before removing any fuel lines.

2. Remove fuel lines (1), (2), (3) and (4) as a unit. Remove fuel lines (7), (8), (9) and (10) as a unit. Remove fuel lines (5), (6), (11) and (12) as a unit.

3. Put caps on all openings and plugs in all fuel lines to prevent dirt or foreign material from getting into the fuel system.

4. Remove the plugs and caps and install the fuel lines in their respective positions. Tighten fuel line nuts to a torque of 30 ± 5 lb.ft. (4.1 ± 0.7 mkg).





AIR INLET MANIFOLD

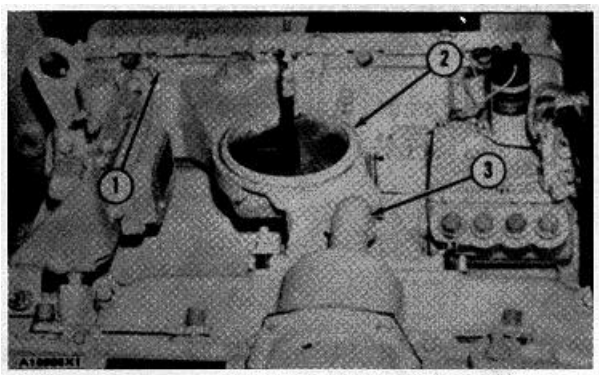
REMOVE AIR INLET MANIFOLD (MARINE ENGINE) 1.1-1058

start by:
a) remove air cleaner
b) remove fuel injection lines

1. Remove the bolts (1) that hold the manifold to the cylinder heads. Disconnect hose (3) from crankcase ventilator valve.

2. Remove air inlet manifold (2).

3. Put tape over the openings in the cylinder heads to prevent dirt or foreign material from getting into the engine.

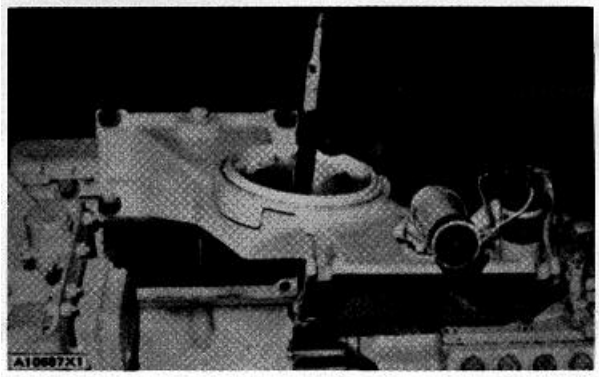


INSTALL AIR INLET MANIFOLD (MARINE ENGINE) 12-1058

1. Remove the tape from the openings in the cylinder heads.

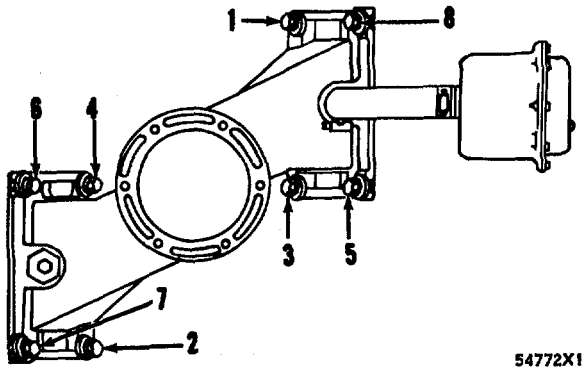
2. Inspect the gaskets for the air inlet manifold. Install new gaskets if necessary.

3. Put the air inlet manifold in position on the engine and install the bolts that hold the manifold in place.



4. Tighten the bolts for the manifold as follows:
   a) Tighten bolts (3) and (4) to a torque of 15 ± 5 lb.ft. (2.1 ± 0.7 mkg).
   b) Tighten bolts 1 through 8 in number sequence to a torque of 32 ± 5 lb.ft. (4.4 ± 0.7 mkg).

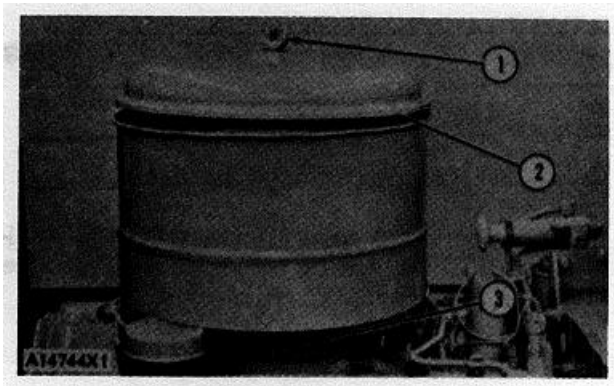
5. Connect the hose from the crankcase ventilator valve to the inlet manifold.
   end by:
   a) install fuel injection lines
   b) install air cleaner



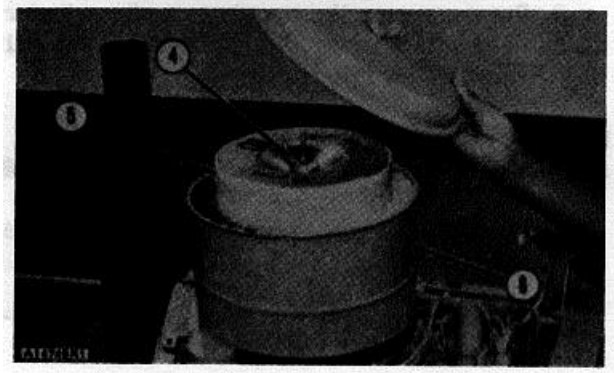
AIR CLEANER

REMOVE AIR CLEANER (INDUSTRIAL ENGINE) 11-1051

1. Loosen nut (l) and remove cover (2).



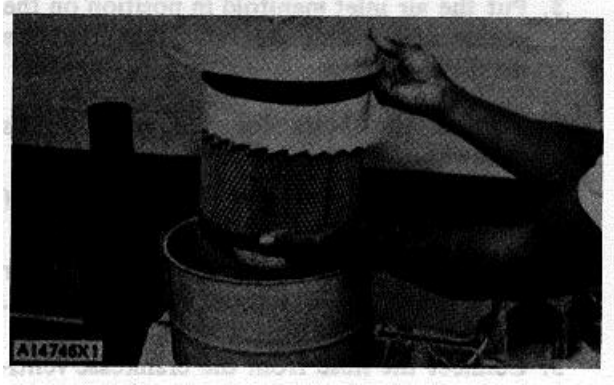
2. Remove nut (4) and lift air cleaner element (5) out of housing.



3. Remove bolts (3) to remove air cleaner housing (6).

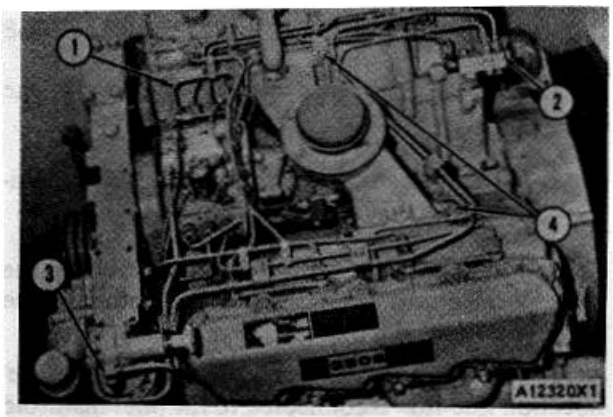
INSTALL AIR CLEANER (INDUSTRIAL ENGINE) 12-1051

1. Put air cleaner housing in position on air inlet manifold and install the bolts that hold it.
2. Install air cleaner element in housing. Install and tighten nut that hold it.
3. Install cover and tighten nut.



FUEL INJECTION LINES, AIR INLET MANIFOLD

REMOVE AND INSTALL FUEL INJECTION LINES (INDUSTRIAL ENGINE) 10-1262



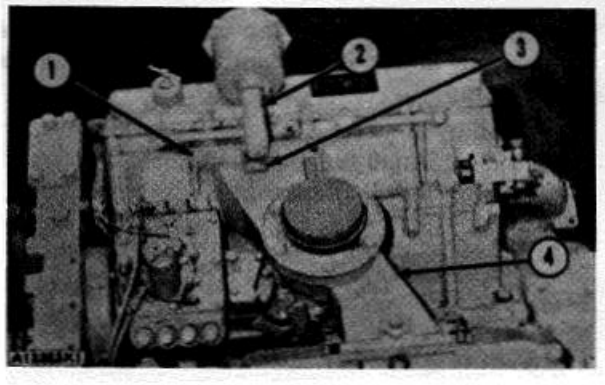
1. Thoroughly clean the area around each fuel line connection before removing any fuel lines.

2. Disconnect fuel lines (1) at the fuel injection pumps and at the cylinder heads. Disconnect fuel lines at block (2) and at the fuel filter base (3). Remove the two bolts (4) from the inlet manifold that hold the fuel lines. Remove fuel lines (1).

3. Put caps on all openings and plugs in all fuel lines to prevent dirt or foreign material from getting into the fuel system.

4. Remove the plugs and caps and install the fuel lines in their respective positions. Tighten fuel line nuts to a torque of 30 ± 5 lb.ft. (4.1 ± 0.7 mkg).

REMOVE AIR INLET MANIFOLD (INDUSTRIAL ENGINE) 11-1058



start by:
- a) remove air cleaner
- b) remove fuel injection lines

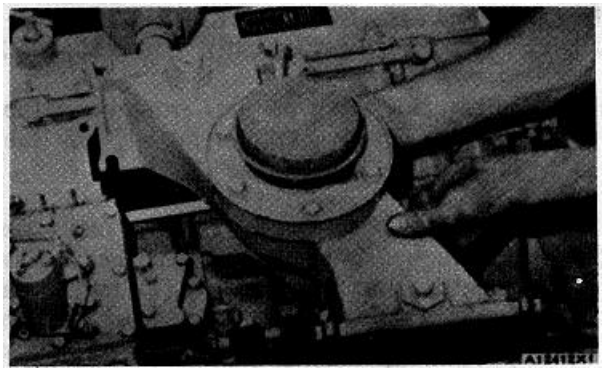
1. Remove the six bolts (1) that hold the inlet manifold (4) to the cylinder heads.

2. Loosen clamp (3) and push crankcase ventilator valve hose (2) away from inlet manifold. Remove inlet manifold (4).

3. Put tape over the openings in the cylinder heads to prevent dirt or foreign material from getting into the engine.

AIR INLET MANIFOLD

INSTALL AIR INLET MANIFOLD (INDUSTRIAL ENGINE) 12-1058

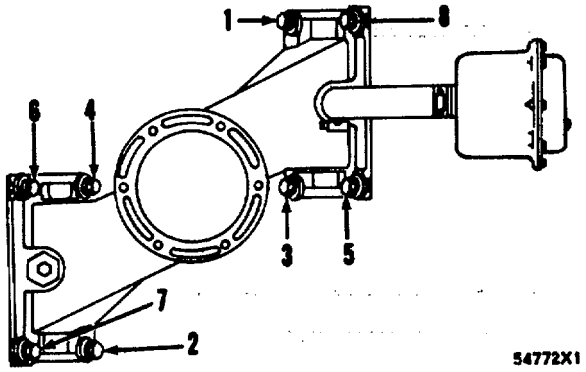


1. Remove the tape from the openings in the cylinder heads.

2. Inspect the gaskets for the air inlet manifold. Install new gaskets if needed.

3. Put the air inlet manifold in position on the engine and install the bolts that hold the manifold in place.

NOTE: It will be necessary to install the one fuel injection line that is connected to the inlet manifold.



4. Tighten the bolts for the manifold as follows:
   a) Tighten bolts (3) and (4) to a torque of 15 ± 5 lb.ft. (2.1 ± 0.7 mkg).
   b) Tighten bolts I through 8 in number sequence to a torque of 32 ± 5 lb.ft. (4.4 ± 0.7 mkg).

5. Connect hose for the crankcase ventilator valve to the inlet manifold and tighten the clamp.
   end by:
   a) install fuel injection lines
   b) install air cleaner

FUEL INJECTION PUMP HOUSING AND GOVERNOR

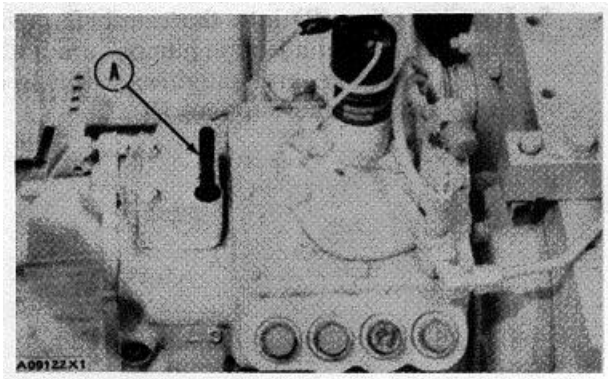
REMOVE FUEL INJECTION PUMP HOUSING AND GOVERNOR (MARINE ENGINE) 11-1286

Tools Needed		A	B
3P1544	Timing Pin	1	
5P2371	Plate		1
0S1616	Bolt 1/4"-20 NC x 1" long		2

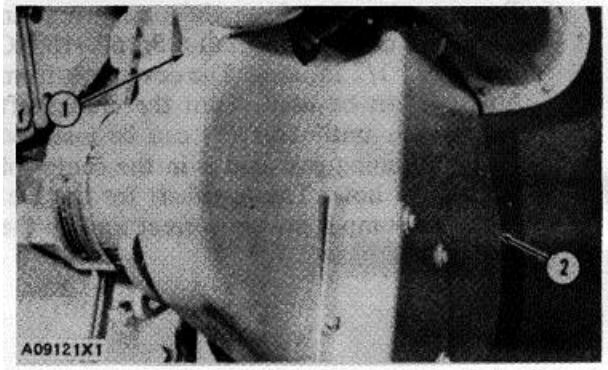
start by:

a) remove air cleaner
b) remove fuel injection lines
c) remove air inlet manifold

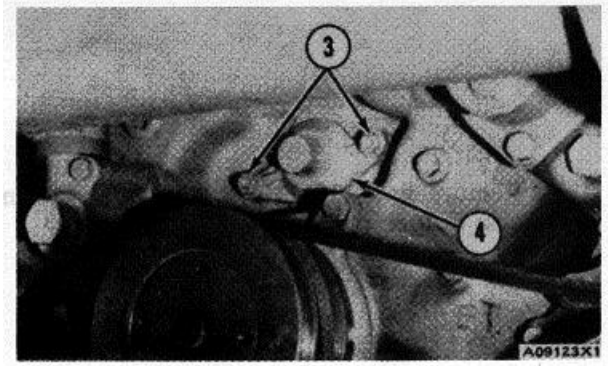
1. Remove plug from' cover and install tool (A).



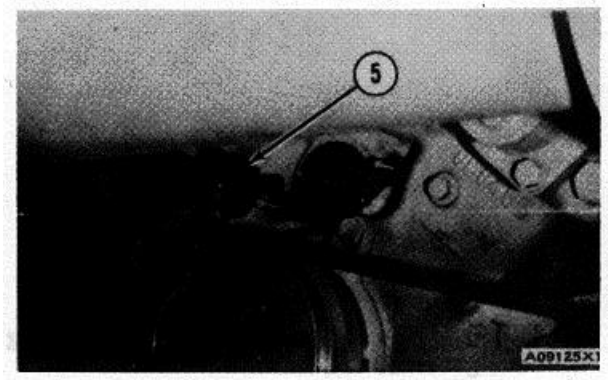
2. Remove four bolts (I) and pulley guard (2). Turn the crankshaft (clockwise) until the timing pin drops into the groove (slot) in the fuel injection pump camshaft.



3. Remove two nuts (3) and tachometer drive cover (4).

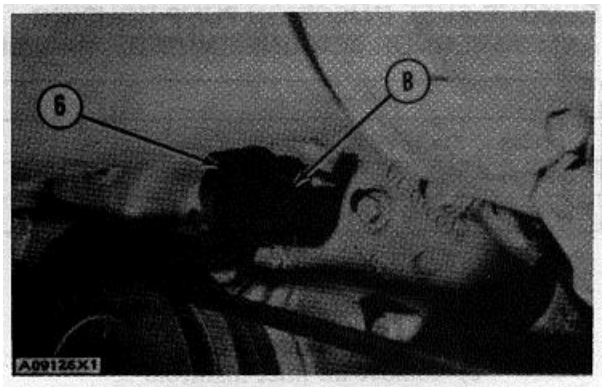


4. Remove the tachometer drive shaft (5).

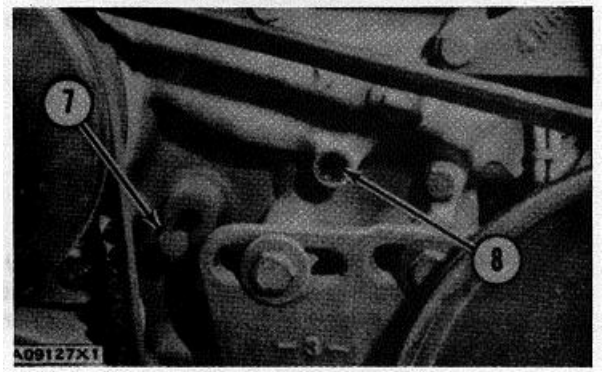


FUEL INJECTION PUMP HOUSIG AND GOVERNOR

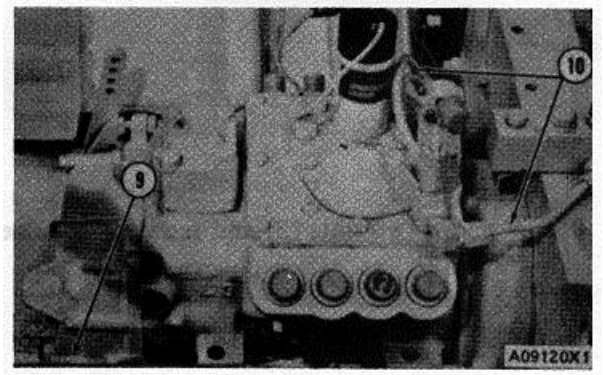
5. Install tooling (B) into the camshaft drive gear for the fuel injection pump. Turn both bolts (6) evenly until the drive gear is free of the shaft. Remove tooling (B).



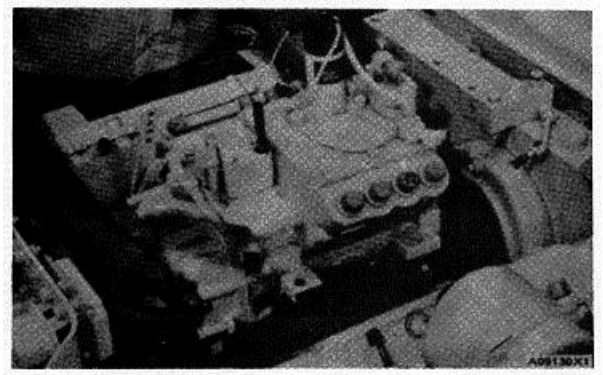
6. Remove the plug from the timing hole in the front cover and install a 5/16"-18 NC bolt (7) 2 1/2 in. long. The cover bolt from hole (8) can be used. Turn the crankshaft (clockwise) until bolt (7) can be installed into the timing gear and is in the center of the timing hole. The camshaft for the fuel injection pump is now in correct time to the engine.



7. Remove lines (10). Remove bolts (9) from base of fuel injection pump housing.



8. Remove the fuel injection pump housing and governor as a unit.



FUEL INJECTION PUMP HOUSING AND GOVERNOR

INSTALL FUEL INJECTION PUMP HOUSING AND GOVERNOR (MARINE ENGINE) 12-1286

1. Put the fuel injection pump housing and governor in position on the engine. Install the bolts and lines.

2. Install the tachometer drive shaft and tighten it to a torque of 80 ± 5 lb. ft. (11.1 ± 0.7 mkg).

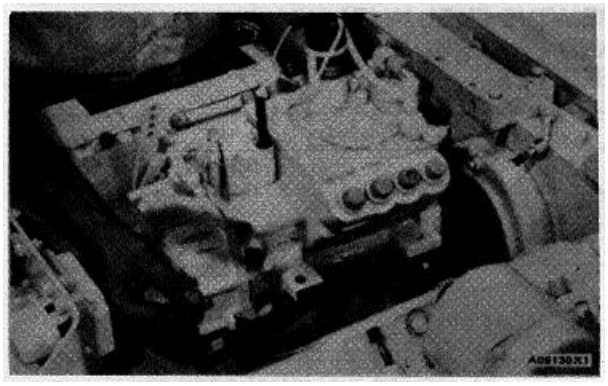
NOTE: Illustration A23394X1 shows earlier tachometer drive shaft that must be tightened to a torque of 80 ± 5 lb. ft. (11.5 ± 0.7 mkg). Illustration A23857X1 shows a later tachometer drive shaft. When the engine is equipped with this type of drive shaft, tighten it to a torque of 110 ± 10 lb. ft. (15.2 ± 1.4 mkg).

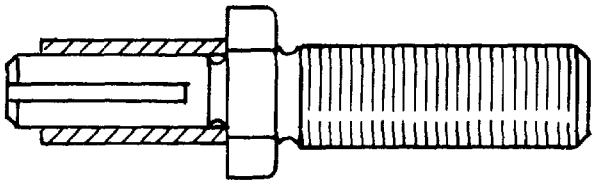
3. To check the timing, remove the timing pin and the bolt. Turn the crankshaft (clockwise) two revolutions and install the timing pin and bolt back in place. If the timing pin or bolt can not be installed, the fuel injection pump camshaft must be put in time again before doing Step 4.

4. Remove the bolt from the timing gear. Install the plug into the timing hole.

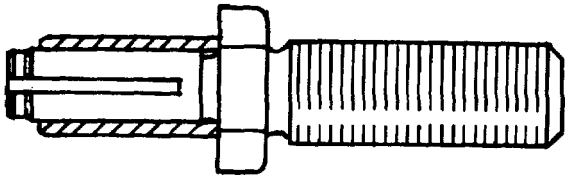
5. Remove the timing pin from the timing groove (slot) in the fuel injection pump camshaft.

6. Install the tachometer drive housing.
   end by:
   a) install air inlet manifold
   b) install fuel injection lines
   c) install air cleaner





A23394X1
EARLIER TACHOMETER DRIVE SHAFT



A23857X1
LATER TACHOMETER DRIVE SHAFT

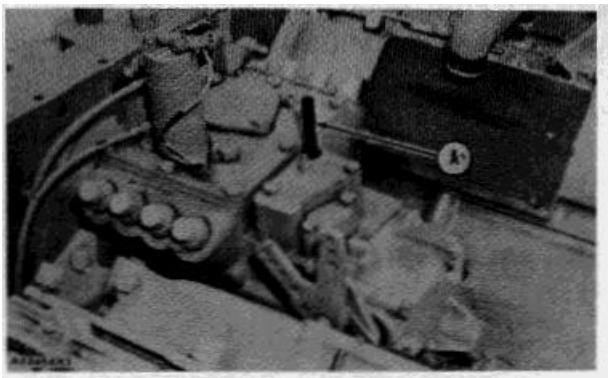
REMOVE FUEL INJECTION PUMP HOUSING AND GOVERNOR (INDUSTRIAL ENGINE) 11-1286

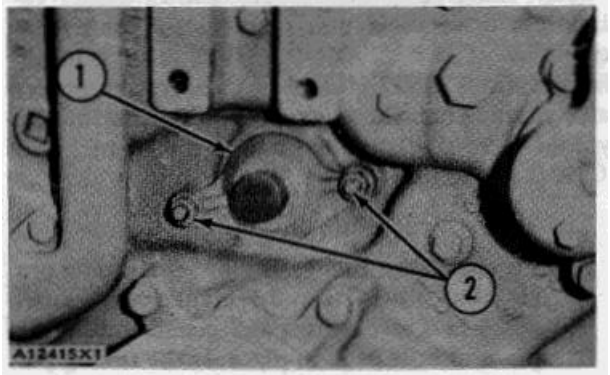
Tools Needed		A	B
3P1544	Timing Pin	1	
5P2371	Plate		1
0S1616	Bolt 1/4"-20 NC x 1" long		2

start by:

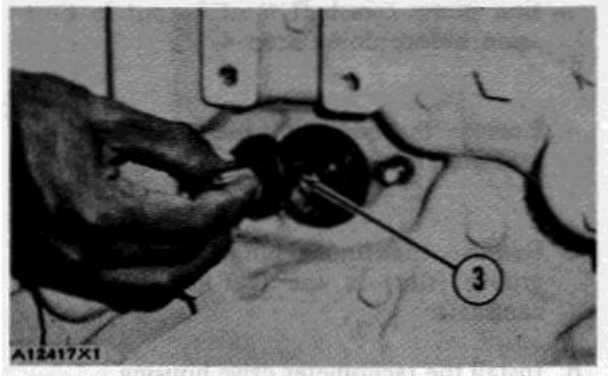
a) remove air cleaner
b) remove fuel injection lines
c) Remove air inlet manifold

1. Remove plug from cover in fuel injection pump housing and install tool (A). Turn the crankshaft (clockwise) until the timing pin drops into the groove (slot) in the fuel injection pump camshaft.



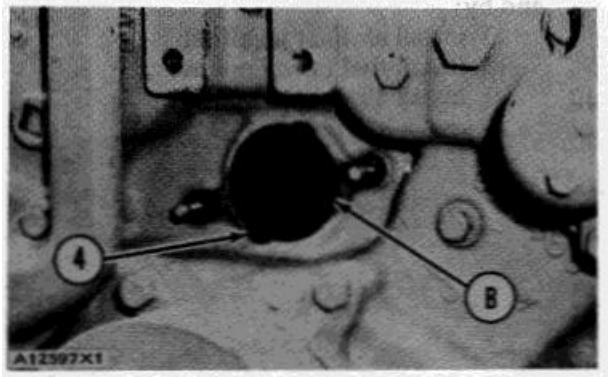


2. Remove two nuts (2) and the tachometer drive housing (1).



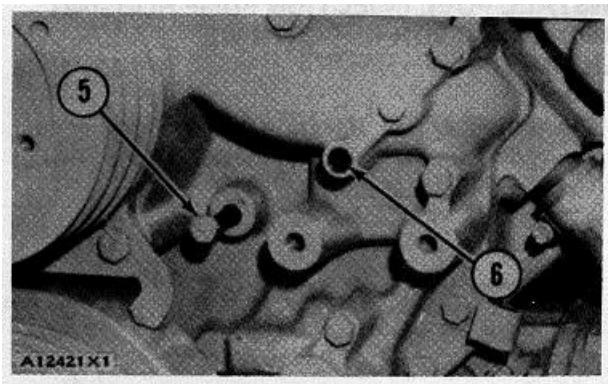
3. Remove the tachometer drive shaft (3).

4. Install tooling (B) into the camshaft drive gear for the fuel injection pump. Turn bolts (4) evenly until the drive gear is free of the shaft. Remove tooling (B).

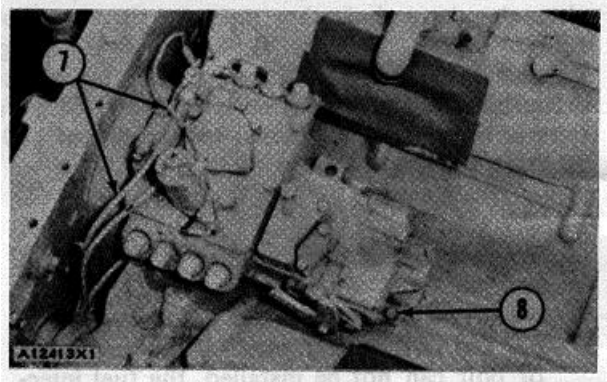


FUEL INJECTION PUMP HOUSING AND GOVERNOR

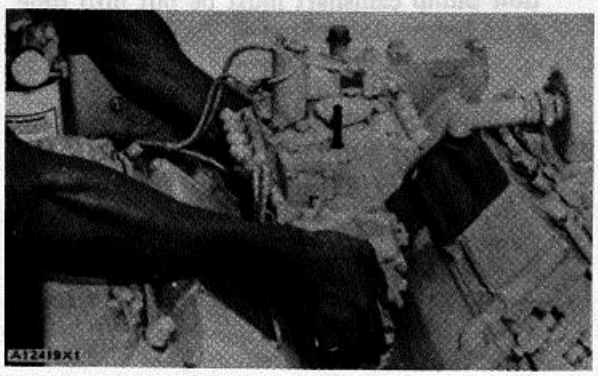
5. Remove the plug from the timing hole in the front cover and install a 5/16"-18 NC bolt (5) 2 1/2 in. long. The cover bolt from hole (6) can be used. Turn the crankshaft (clockwise) until bolt can be installed into the timing gear and is in the center of the timing hole. The camshaft for the fuel injection pump is now in correct time to the engine.



6. Remove line (7). Remove bolts (8) from base of the fuel injection pump housing.



7. Remove the fuel injection pump housing and governor as a unit.



FUEL INJECTION PUMP HOUSING AND GOVERNOR

INSTALL FUEL INJECTION PUMP HOUSING AND GOVERNOR (MARINE ENGINE) 12-1286

1. Put the fuel injection pump housing and governor in position on the engine. Install the bolts and lines.

2. Install the tachometer drive shaft and tighten it to a torque of 80 ± 5 lb. ft. (11.1 ± 0.7 mkg).

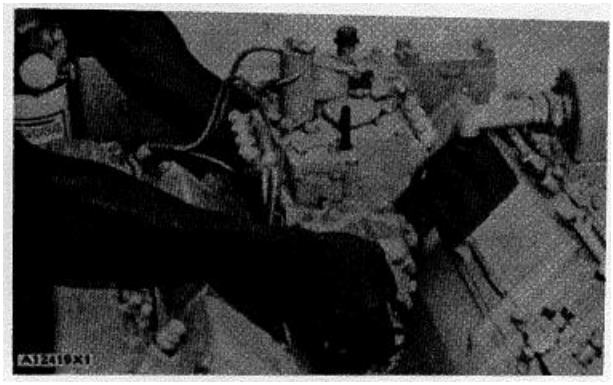
NOTE: Illustration A23394X1 shows earlier tachometer drive shaft that must be tightened to a torque of 80 ± 5 lb. ft. (11.1 ± 0.7 mkg). Illustration A23857X1 shows a later tachometer drive shaft. When the engine is equipped with this type of drive shaft, tighten it to a torque of 110 ± 10 lb. ft. (15.2 ± 1.4 mkg).

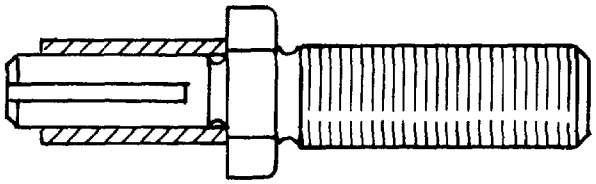
3. To check the timing, remove the timing pin and the bolt. Turn the crankshaft (clockwise) two revolutions and install the timing pin and bolt back in place. If the timing pin or bolt can not be installed, the fuel injection pump camshaft must be put in time again before doing Step 4.

4. Remove the bolt from the timing gear. Install the plug into the timing hole.

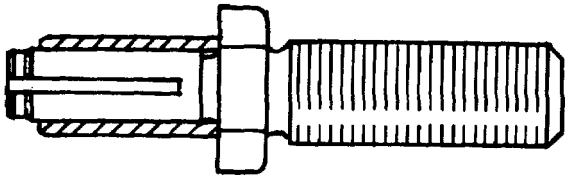
5. Remove the timing pin from the timing groove (slot) in the fuel injection pump camshaft.

6. Install the tachometer drive housing.
   end by:
   a) install air inlet manifold
   b) install fuel injection lines
   c) install air cleaner





A23394X1
EARLIER TACHOMETER DRIVE SHAFT



A23857X1
LATER TACHOMETER DRIVE SHAFT

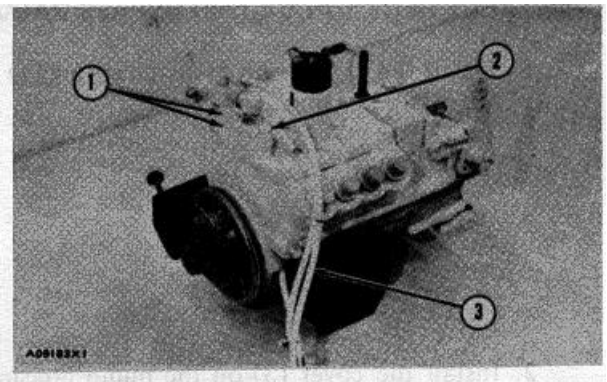
CHECK VALVE AND BYPASS VALVE

REMOVE CHECK VALVE AND BYPASS VALVE

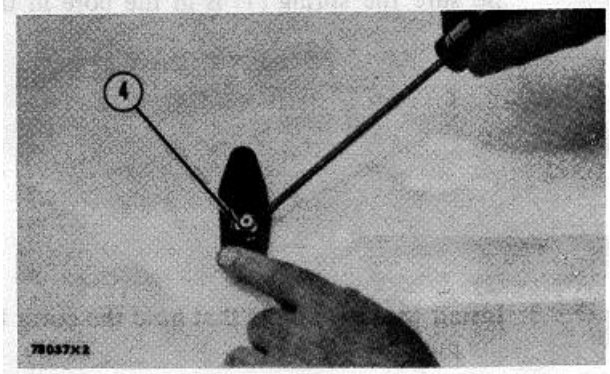
start by:
a) remove fuel injector pump housing and governor

CAUTION: Before any service work is done on this fuel system, the outer surface of the injection pump housing must be clean.

1. Remove fuel lines (3). Remove two bolts (2) and remove flange and flange assembly (1).

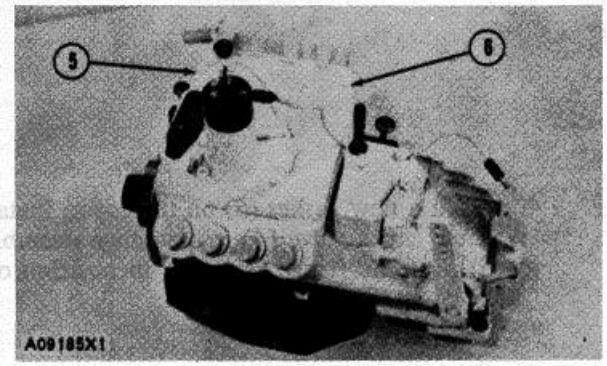


2. Remove the check valve (4) from the flange assembly.

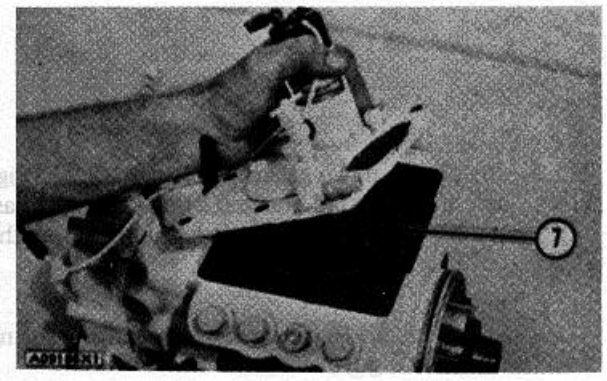


3. Remove the seven bolts (6) that hold the cover (5) to the pump housing.

4. Remove the cover (5) from the pump housing.



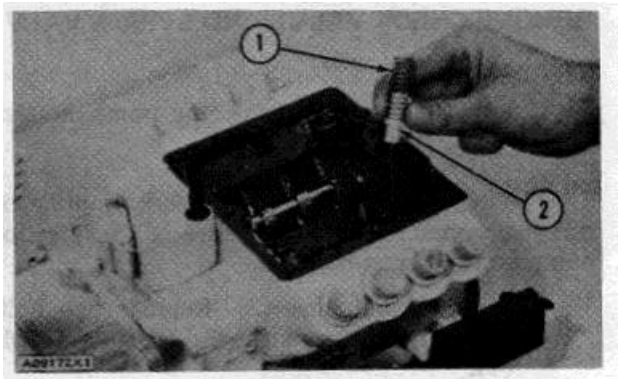
5. Remove the spring (7) and the bypass valve from the pump housing.



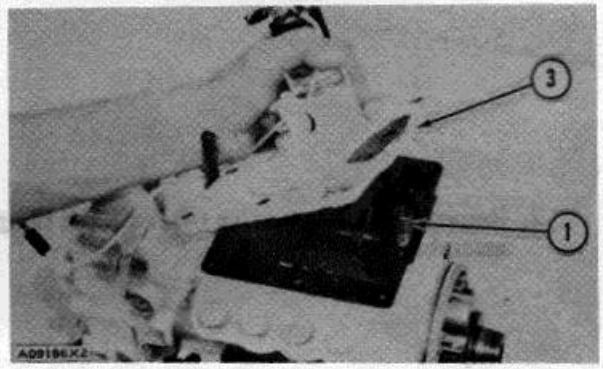
CHECK VALVE AND BYPASS VALVE

INSTALL CHECK VALVE AND BYPASS VALVE

1. Install the bypass valve (2) and spring (1) in the pump housing.

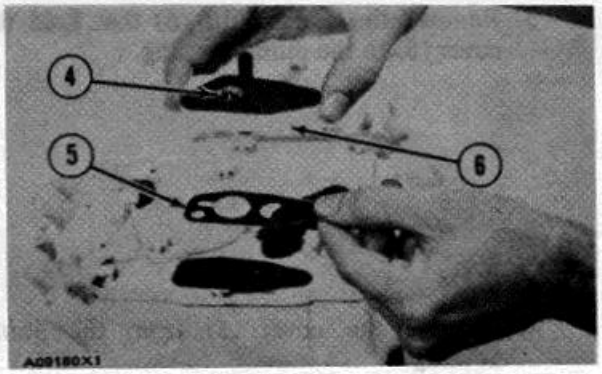


2. Install the cover (3) on the pump housing. Be sure the spring (I) is in the bore in the lever.

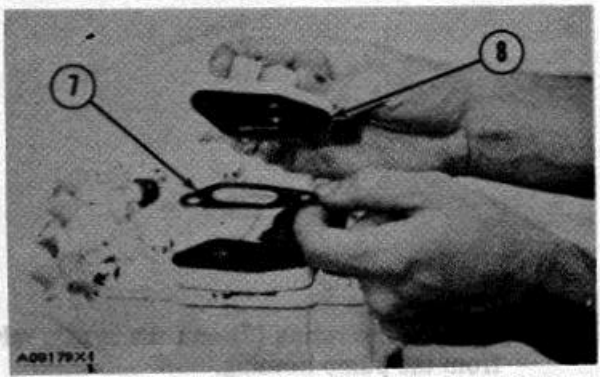


3. Install the seven bolts that hold the cover to the pump housing.

4. Install a new gasket (5) on the cover. Install a new check valve (4) in the flange assembly (6). Put the flange assembly in position on the cover.



5. Install a new gasket (7) on the flange assembly. Install flange (8) on the flange assembly with the bolts that hold them to the cover.



end by:

a) install fuel injection pump housing and governor

SHUTOFF HOUSING

REMOVE SHUTOFF HOUSING 11-1259

CAUTION: Before any service work is to be done on the fuel system, the outer surface of the injection pump housing must be clean.

NOTE: Illustrations show fuel injection pump housing and governor removed from engines. Service work can be done with it installed on engine.

1. Remove the flange (1) and flange assembly (2) from the cover (3).

2. Remove the cover from the pump housing by removing seven bolts.

3. Remove the solenoid (4) from the cover.

4. Remove cover (6).

5. Remove two bolts (5) that hold the cover to the shutoff housing.

6. Remove the cover from the shutoff housing (7).

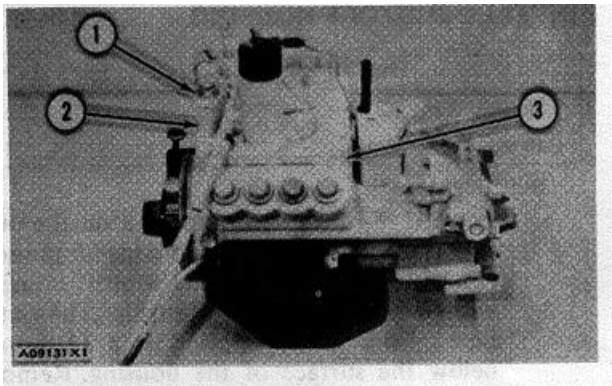
7. Remove the lever (10) from the shaft (11).

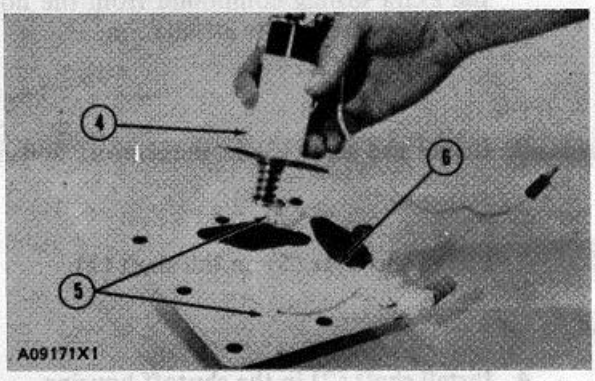
8. Remove the shaft (9) from the shutoff housing.

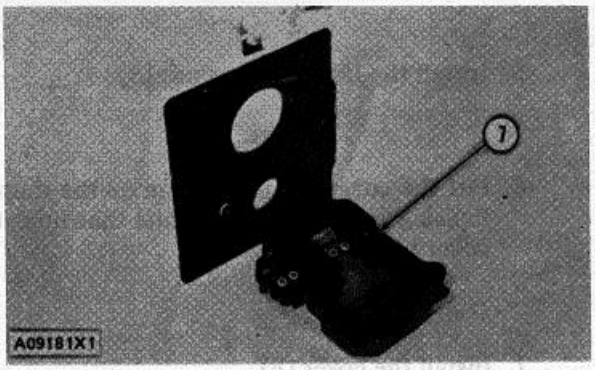
9. Remove the lever (8) from the shaft (11).

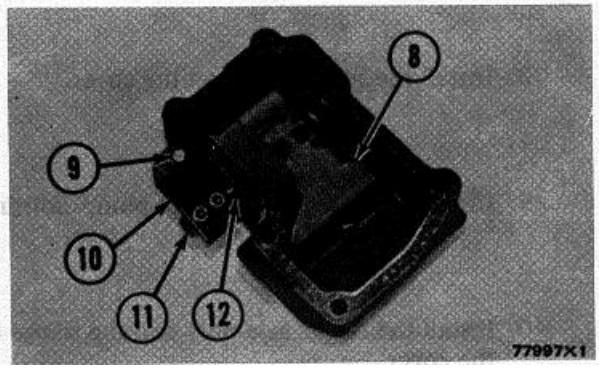
10. Remove the shaft (11) from the shutoff housing.

11. Remove the seal (12) from the shutoff housing.





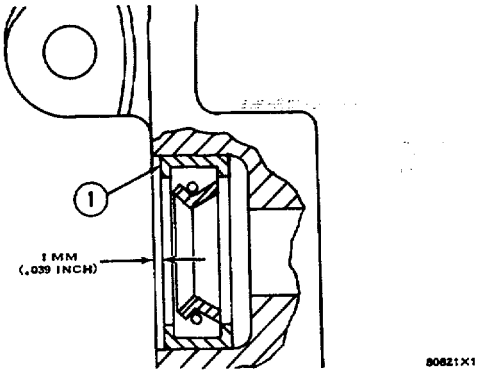




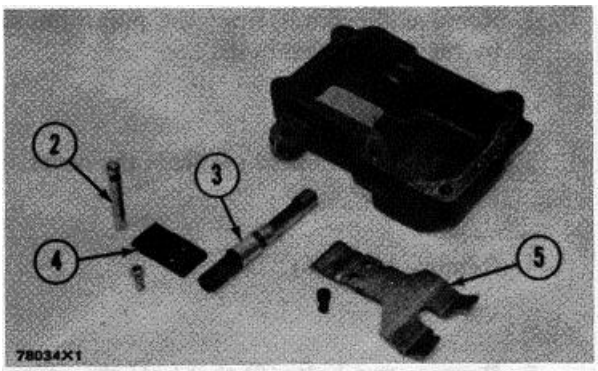
SHUTOFF HOUSING

INSTALL SHUTOFF HOUSING 12-1259

Tools Needed		A
1 P529	Handle	1
1 P460	Plate	1



1. Put 5S1454 Sealing Compound on the outside diameter of the seal and install the seal (1) with tooling (A) in the shutoff housing with the lip toward the outside. The outer face of the seal must be .039 in. (1.0 mm) below the surface of the housing. Remove the extra sealing compound from the housing and the seal after installation.

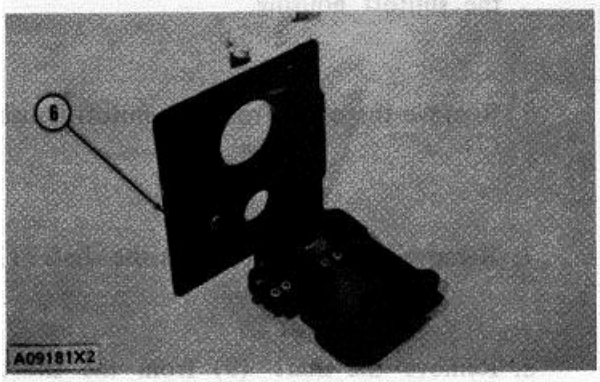


2. Install the shaft (3) in the shutoff housing.

3. Install the lever (5) on the shaft (3).

4. Install shaft (2) in the shutoff housing.

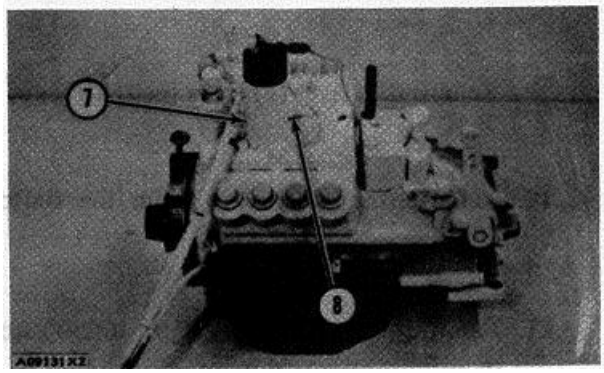
5. Install the lever (4) on shaft (3).



6. Put the cover (6) in position on the shutoff housing and install two bolts that hold the cover to the housing.

7. Install the cover (8).

8. Install the solenoid (7) on the cover.



9. Install the cover (6) on the pump housing.

10. Install the flange assembly and the flange on the cover.

FUEL INJECTION PUMPS

REMOVE FUEL INJECTION PUMPS 11-1251

Tools Needed		A
8S2243	Wrench	1
8S2244	Extractor	1

CAUTION: Before any service work is to be done on this fuel system, the outer surface of the injection pump housing must be clean.

NOTE: The fuel injection pump housing and governor has been removed from the engine for illustration purposes.

1. Remove the flange (1) and the flange assembly from the cover.

2. Remove the cover (2) from the pump housing.

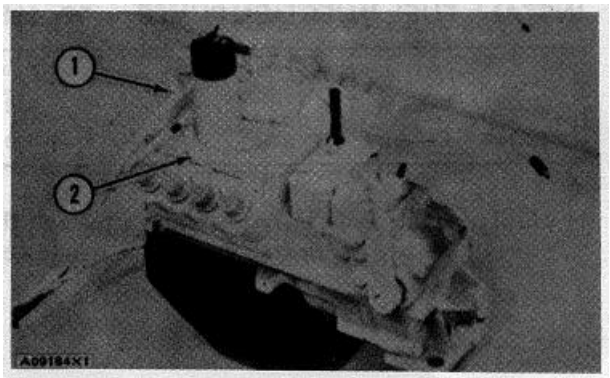
3. Remove the bypass valve (3) and springs from the pump housing.

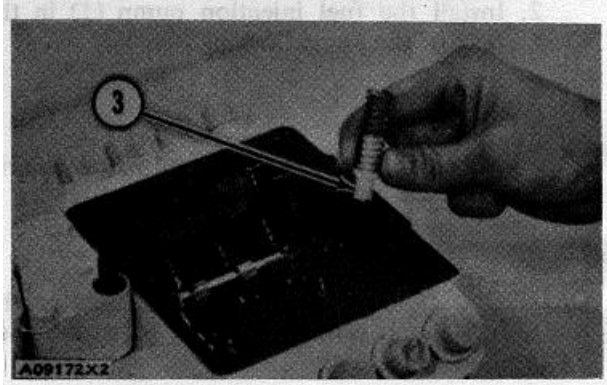
4. Install tooling (A) on the fuel injection pump and loosen the bushing from the pump housing.

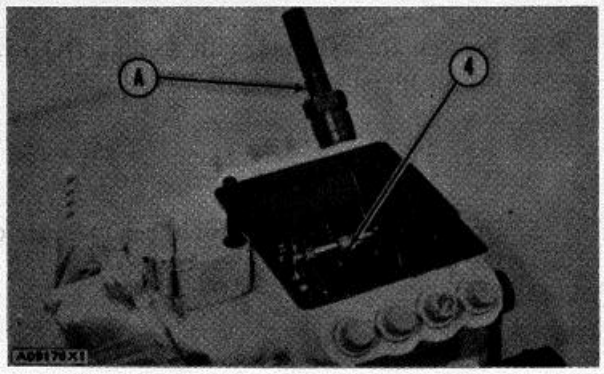
NOTE: Do not loosen the screws (4) that hold the levers to the shaft when removing or installing pumps. If the levers are moved, fuel pump. calibration will be changed.

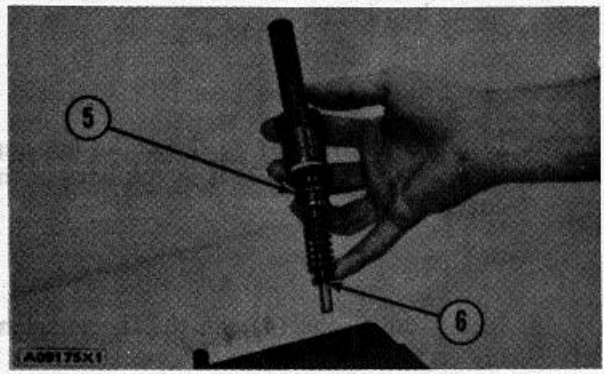
5. Remove the fuel injection pump (5) from the pump housing. The sleeve (6) on the plunger will slide off the lever as the pump is removed.

6. Do Steps 4 and 5 for the remainder of the pumps.







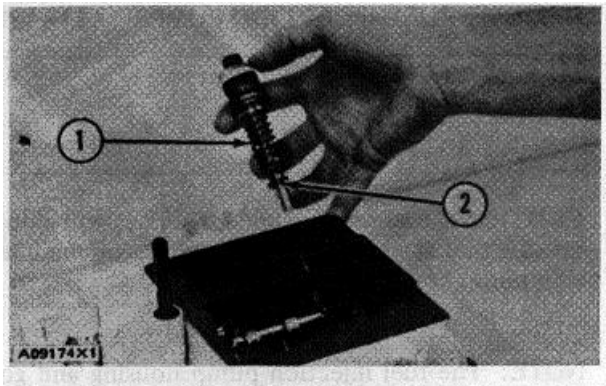


FUEL INJECTION PUMPS

INSTALL FUEL INJECTION PUMPS 12-1251

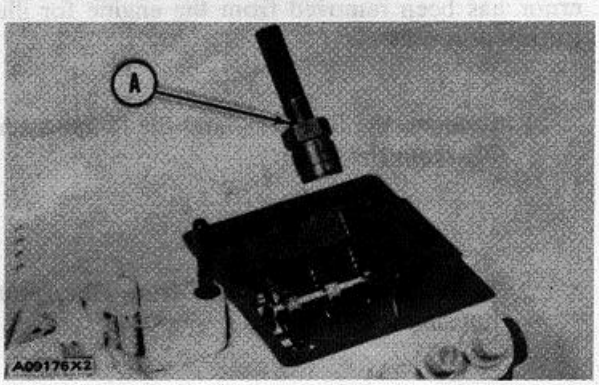
Tools Needed		A
8S2243	Wrench	1
8S2244	Extractor	1

1. Turn the camshaft until the lifter for the pump to be installed is at its lowest position.



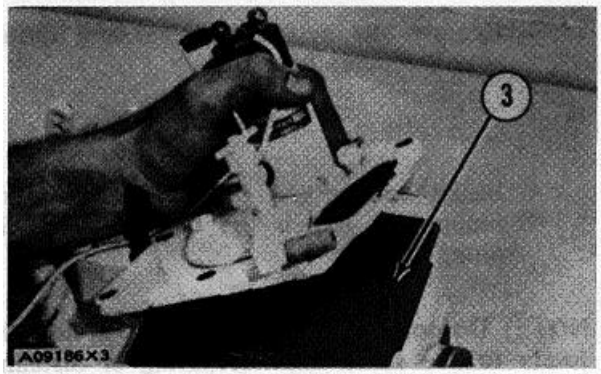
2. Install the fuel injection pump (1) in the bore of the pump housing.

3. The sleeve (2) will be engaged with the lever when the pump is installed correctly.



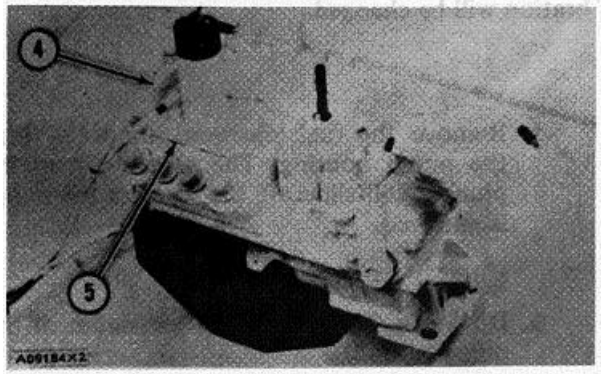
CAUTION: If the levers have been moved on the shaft, fuel pump calibration must be made. (See Testing and Adjusting).

4. Tighten the bushing with tooling (A) to a torque of 70 ± 5 lb. ft. (9.7 ± 0.7 mkg).



5. Do Steps I through 4 for the remainder of the pumps.

6. Install the bypass valve and spring (3) in the pump housing.

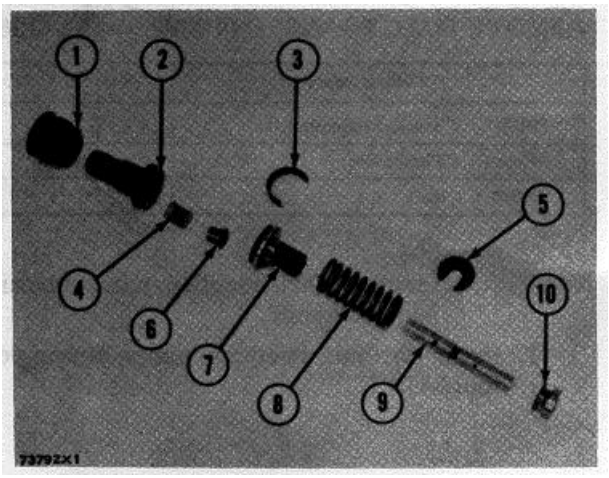


7. Install the cover (5) on the pump housing. Be sure the spring (3) is in the bore in the cover.

8. Install the flange (4) and the flange assembly on the cover.

FUEL INJECTION PUMPS

DISASSEMBLE FUEL INJECTION PUMPS 15-1251



start by:

a) remove fuel injection pumps

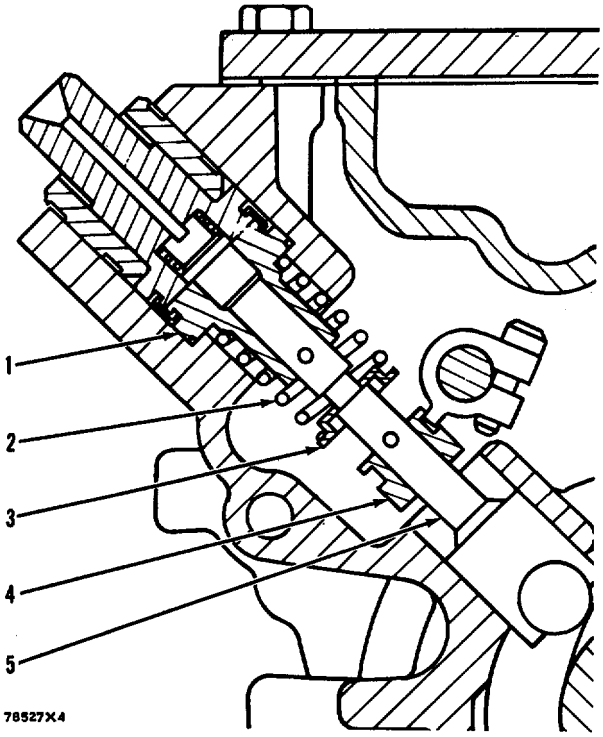
1. Remove the bushing (1) and seal from the bonnet (2).

2. Remove the ring (3) from the bonnet and barrel (7). Remove the check valve (6) and spring (4) from the bonnet.

3. Remove the spring (8) and washer (5). Remove the plunger (9) and sleeve (10).

NOTE: Keep the plunger and sleeve with their respective barrel for installation. Do not use plungers, sleeves and barrels with other plungers, sleeves and barrels.

ASSEMBLE FUEL INJECTION PUMPS 16-1251



1. Install the sleeve (4), plunger (5), spring (2) and washer (3) on the barrel (1).

NOTE: Be sure the sleeve and plunger are installed in their original barrel and the large hole in the plunger is up. The sleeve must be installed with the thin flange up.

2. Install the check valve and spring in the bonnet. Connect the barrel and bonnet and install the ring. Install the seal and bushing on the bonnet.

end by:

a) install fuel injection pumps

FUEL TRANSFER PUMPS

REMOVE FUEL TRANSFER PUMP 11-1256

Tools Needed		A	B	C
2P8316	Bracket Assembly	1		
3P1544	Timing Pin		1	
2H3740	Bolt			1

start by:

a) remove fuel injection pump housing and governor

1. Install the fuel injection pump housing on tool (A).

2. Remove a bolt from cover (1). Turn the injection pump camshaft until tool (B) can be installed in the camshaft.

3. Install tool (C) In the threads of the sleeve (3). Tighten the bolt until the sleeve can be removed.

4. Remove the four bolts (4) that hold the body to the housing,

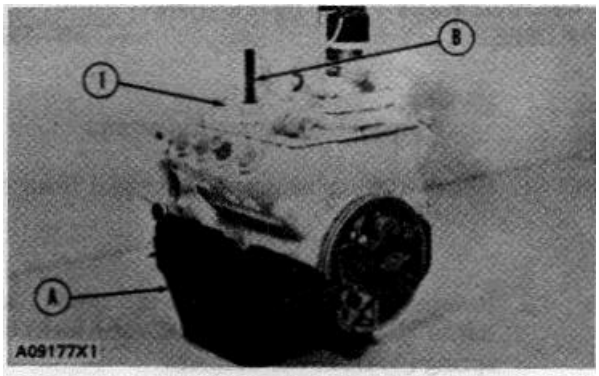
5. Remove the body (2) from the housing.

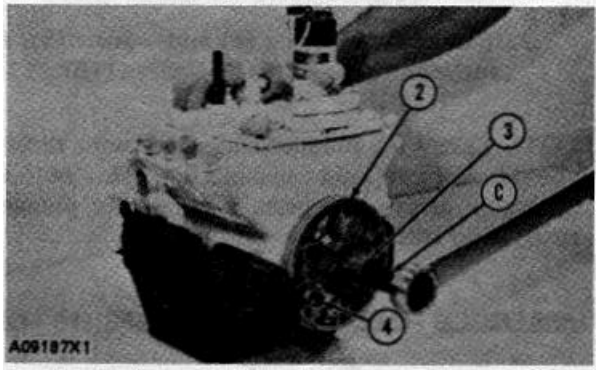
6. Remove the idler gear (5) from the body.

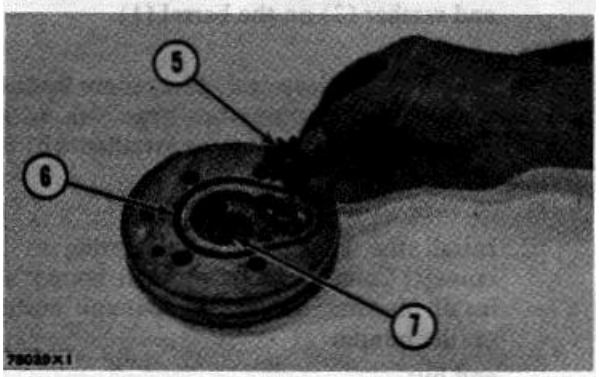
7. Remove the O-ring seal (6) from the body. Remove the two lip type seals (7) from the body.

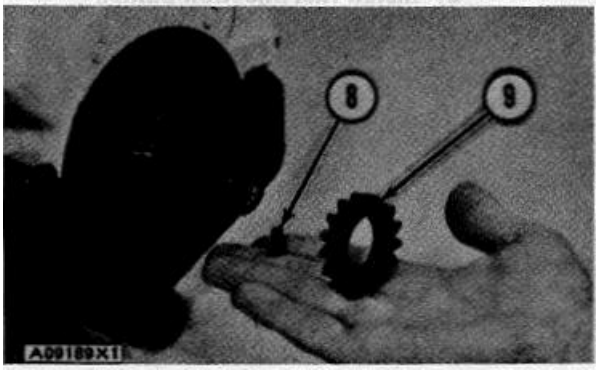
8. Remove the drive gear (9) from the shaft.

9. Remove the key (8) from the shaft.









FUEL TRANSFER PUMPS

INSTALL FUEL TRANSFER PUMP 12-1256

	Tools Needed	A	B	C	D
1P629	Handle	1	1		
1P463	Drive Plate	1			
5P318	Drive Plate	1			
5P319	Drive Plate		1		
S1603	Bolt			1	
4B4280	Washer			1	
3P1544	Timing Pin				1

1. Install the key (1) and the drive gear (2) on the shaft.

2. Put 55S1454 Sealing Compound on the outside of the seals.

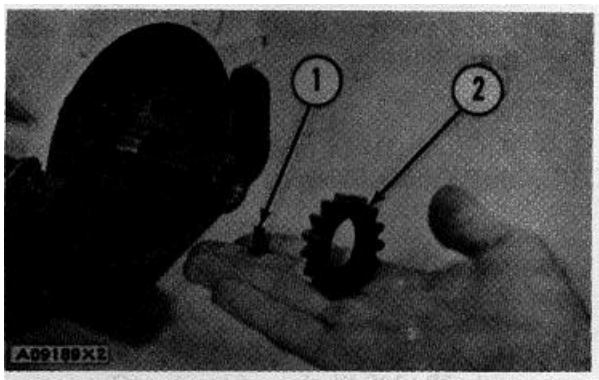
3. Install the inner seal in the body with the lip of the seal toward the inside with tooling (A).

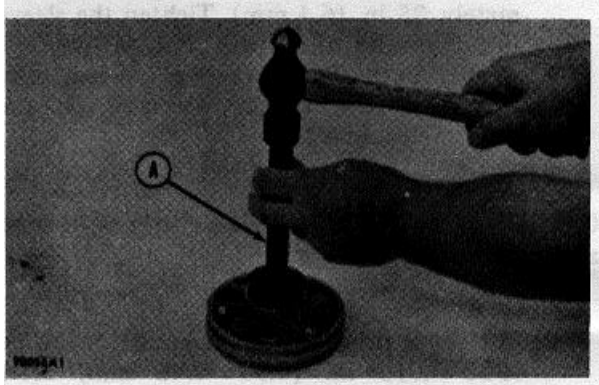
4. Install the outer seal in the body with the lip of the seal toward the outside with tooling (B).

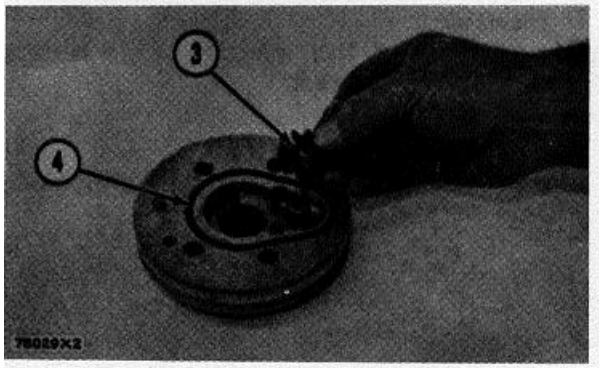
5. Remove the extra sealing compound from the body and the seals after installation.

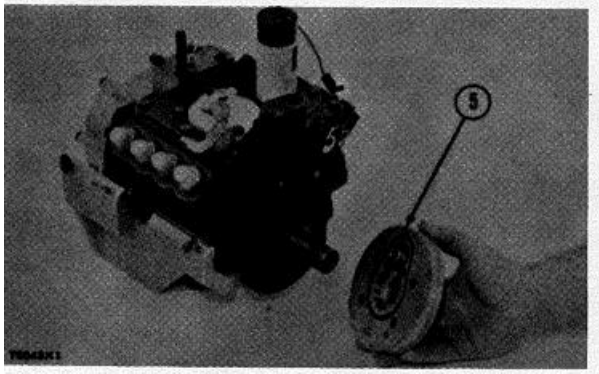
6. Install the O-ring seal (4) and the idler gear (3) in the body.

7. Install the body (5) on the housing.









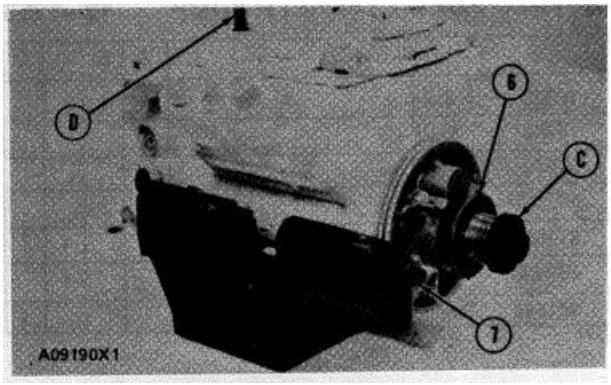
FUEL TRANSFER PUMPS

8. Install the four bolts (7) that hold the body to the housing.

9. Put tool (D) in position to keep the camshaft from turning.

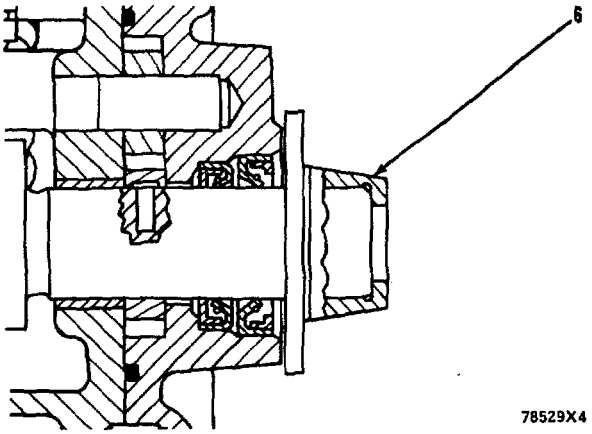
10. Put the sleeve (6) on the camshaft.

11. Tighten the sleeve into position on the shaft with 4B4280 Washer of tooling (C) approximately 25 in. (6.4 mm). Tighten the sleeve the remainder of the way with the 4N3371 Washer until the sleeve is at bottom. The washer is the washer which is on the tachometer drive bolt.



CAUTION: Do not hit the sleeve to install. Damage to governor will result.

12. The end play of the camshaft must be .023 ± .018 in. (0.58 ± 0.46 mm) after sleeve (6) is installed.



end by:

a) install fuel injection pump housing and governor

FUEL INJECTION PUMP HOUSING AND GOVERNOR

SEPARATION OF GOVERNOR FROM FUEL INJECTION PUMP HOUSING

	Tools Needed	A	B	C
2P8315	Bracket Assembly	1		
5P302	Bar		1	
3P1544	Timing Pin			1

start by:

a) remove fuel injection pump housing and governor

1. Install the fuel injection pump housing on tool (A).

2. Remove the bolts (1) that hold the governor housing (2) to the fuel injection pump housing.

3. Remove the governor housing (2).

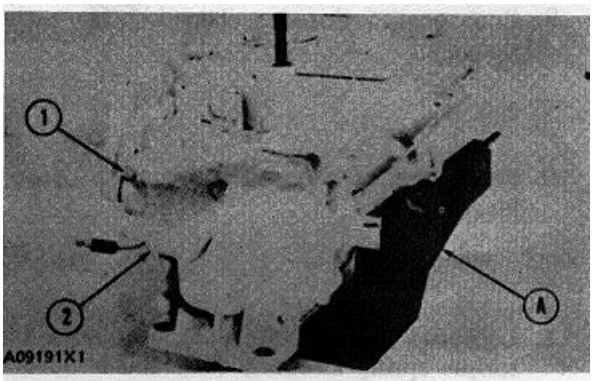
4. Remove two springs (4) and the seat (5) from the governor housing.

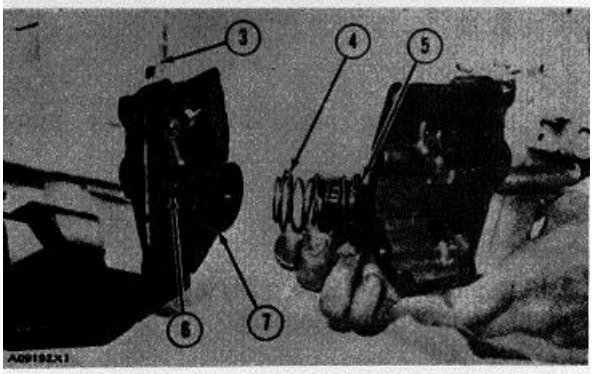
5. Remove the seat (7) from the shaft.

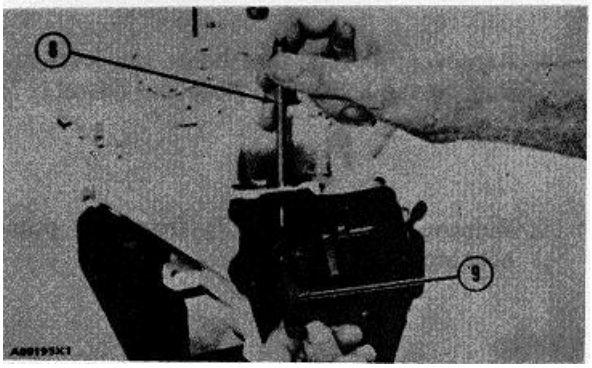
6. Remove the spring (6) from the shaft.

7. Remove the cover (3) from the pump housing.

8. Remove the shaft (8) and the lever (9) from the pump housing.

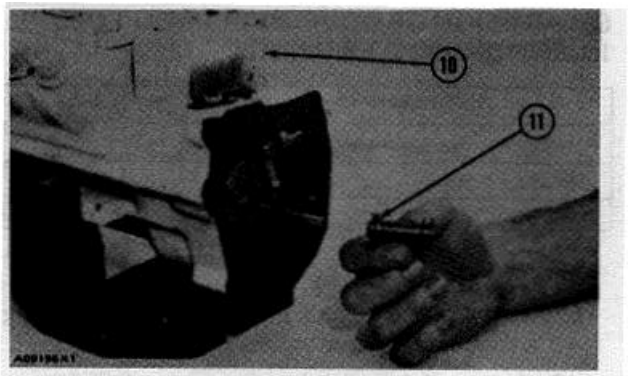






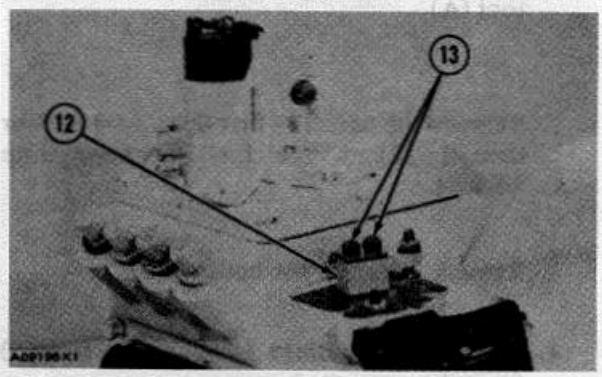
FUEL INJECTION PUMP HOUSING AND GOVERNOR

9. Remove the thrust collar (11) from the shaft.



10. Remove the cover (10) from the pump housing.

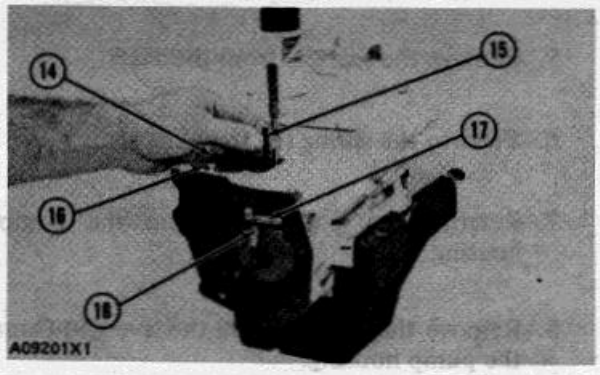
11. Loosen the two bolts (13) that hold the torque spring assembly (12) and remove it from the pump-housing.



12. Remove the pin (15) from the pump housing.

13. Remove the screw (14) and the nut (16) from the pump housing.

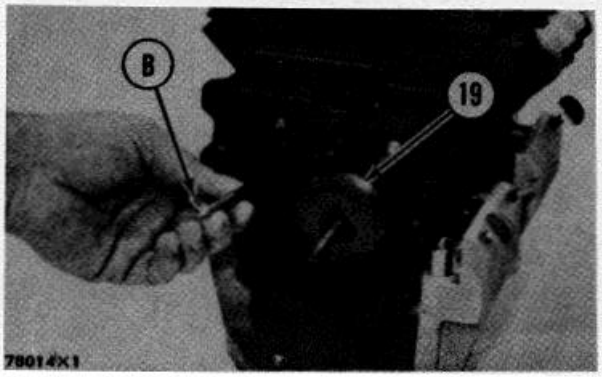
14. Remove the ring that holds the lever and remove the lever (18) from the dowel (17).



15. Remove the dowel (17) from the pump housing.

NOTE: Dowel does not need to be removed unless camshaft is to be removed.

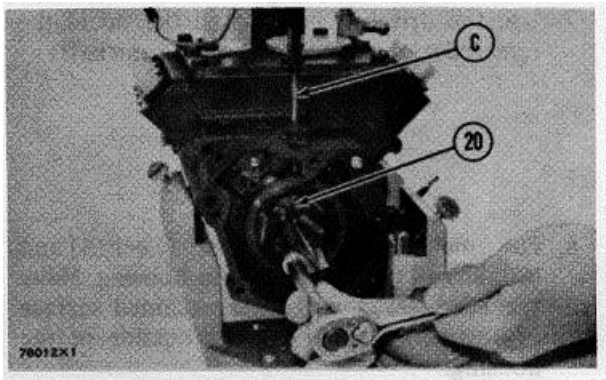
CAUTION: Pull on the shield only a small amount in each location so it will not have distortion or damage. A damaged shield must be replaced.



16. Remove the shield (19) from the camshaft with tool (B).

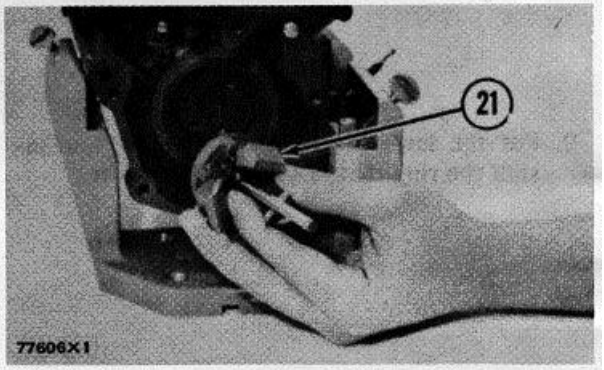
FUEL INJECTION PUMP HOUSING AND GOVERNOR

17. Install the timing pin (C) to hold the camshaft.



18. Remove the bolts (20) that hold the fly-weight assembly to the camshaft.

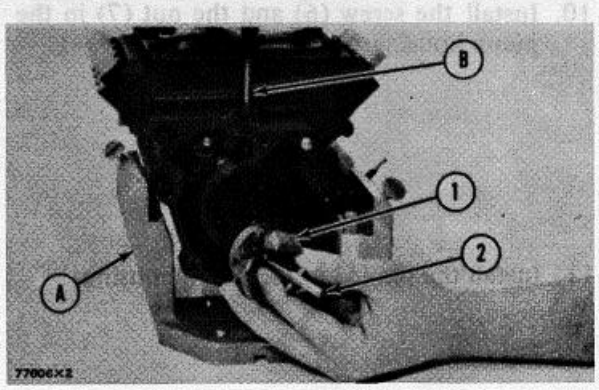
19. Remove the flyweight assembly (21) from the camshaft.



20. Remove the timing pin (C) from the pump housing.

CONNECTION OF GOVERNOR TO FUEL INJECTION PUMP HOUSING

	Tools Needed	A	B	C
2P8315	Bracket Assembly	1		
3P1544	Timing Pin		1	
5P301	Driver			1



1. Put the fuel injection pump housing on the bracket assembly (A).

2. Install the timing pin (B) to hold the camshaft.

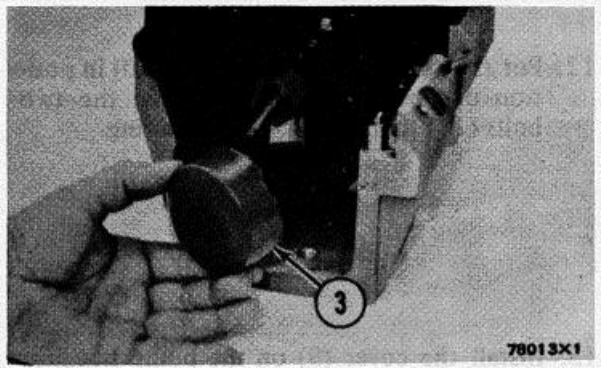
3. Put the flyweight assembly (1) in position on the camshaft.

NOTE: Be sure the pin that holds the shaft (2) is in position on the back of the flyweight assembly.

4. Install the bolts that hold the flyweight assembly to the camshaft and tighten to a torque of 10 ± 2 lb. ft. (1.38 ± 0.28 mkg).

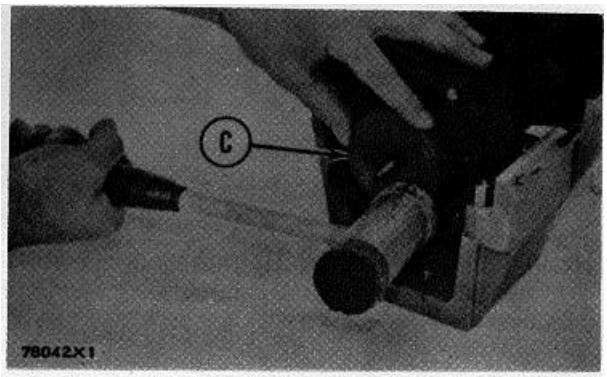
5. Remove the timing pin (B).

6. Put the shield (3) in position over the flyweights.



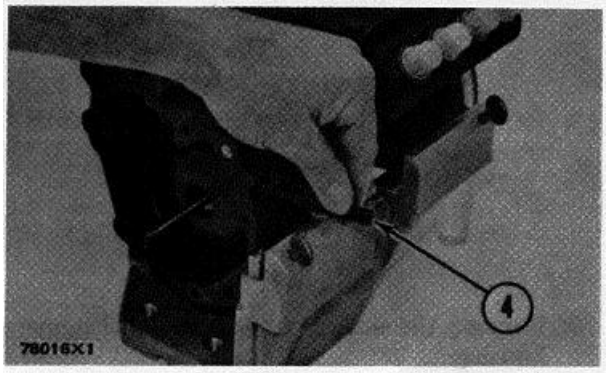
FUEL INJECTION PUMP HOUSING AND GOVERNOR

7. Use the driver (C) to install the shield the remainder of the way on to the camshaft.



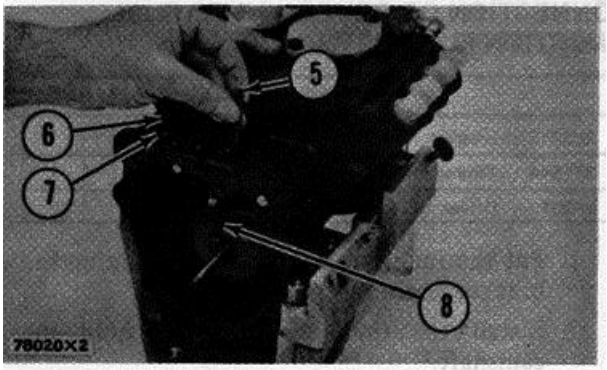
8. Put a new O-ring seal on the dowel (4) and install the dowel in the pump housing. Make the dowel even with the machined surface of the counterbore on the outside of the housing.

9. Put the lever (8) on the dowel (4) and install the ring that holds it on the dowel.



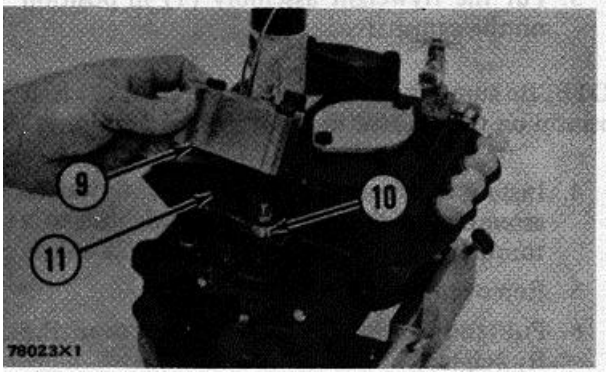
10. Install the screw (6) and the nut (7) in the pump housing.

11. Install the pin (5) in the pump housing.



12: Put the torque spring assembly (10) in position on the housing and tighten the two bolts (11) that hold it to the housing.

13. Install the cover (9) on the pump housing.



FUEL INJECTION PUMP HOUSING AND GOVERNOR

14. Put the thrust collar (13) in position between the flyweights. Lift the flyweights up with a piece of wire and push the thrust collar (13) forward.

15. Put the lever (14) in position in the housing and in the groove of the thrust collar (13). Put a new O-ring seal on the shaft and install the shaft (12) down through the housing and into the holes in lever (14).

16. Install the cover (15) on the pump housing.
17. Install the spring (16) on the shaft.
18. Install the seat (17) on the shaft.
19. Install the seat (18) and two springs (19) in the governor housing.

CAUTION: Both springs must make a full seat on seat (18) before installing in governor housing. If springs do not make a full seat, high idle speed will not be correct. Low idle governor surge can be caused by springs not making a full seat. It can also prevent getting a low idle setting with stability.

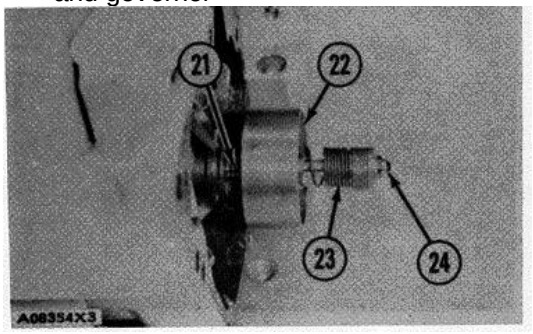
20. Install the governor housing (20) on the pump housing.

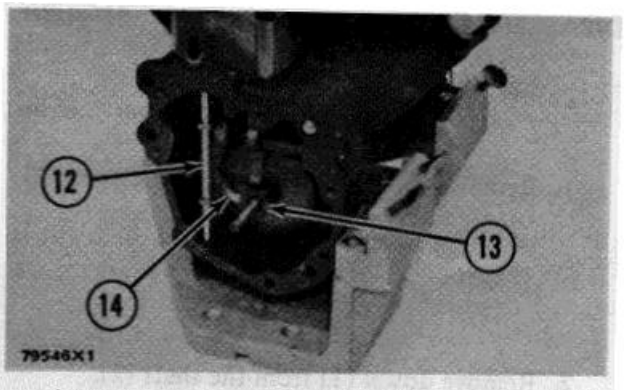
21. For fuel systems equipped with a dashpot governor, install spring (21) on shaft (24). Install seat and piston assembly (22) on shaft (24). Turn spring (23) on the piston and seat until it just contacts the shoulders on the piston and seat.

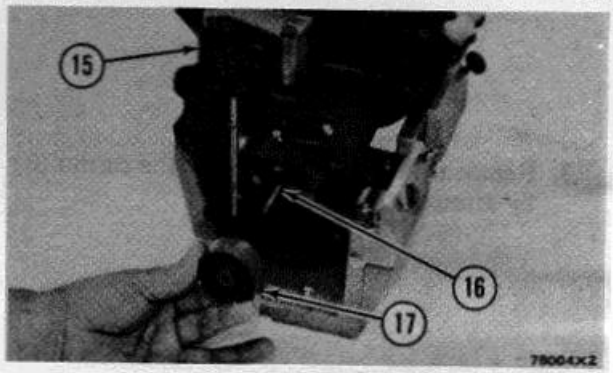
end by:

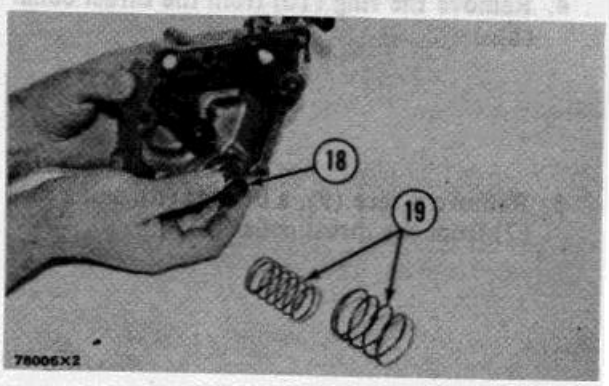
a) make an adjustment of the fuel system setting (See FUEL SYSTEM in TESTING AND ADJUSTING)

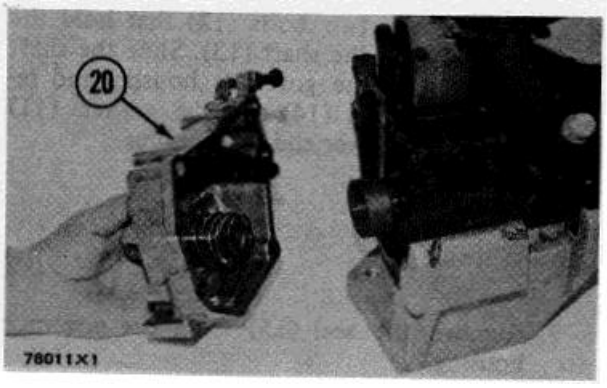
b) install fuel injection pump housing and governor











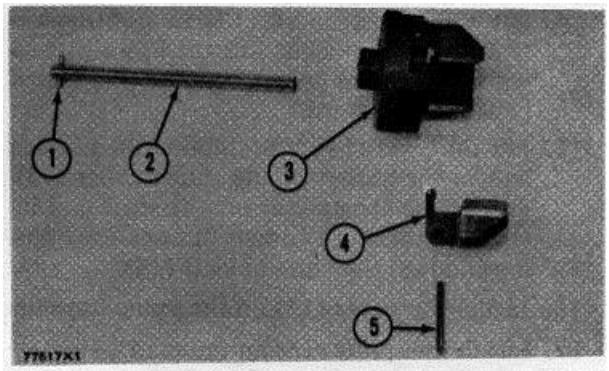
GOVERNOR

DISASSEMBLE GOVERNOR 15-1264

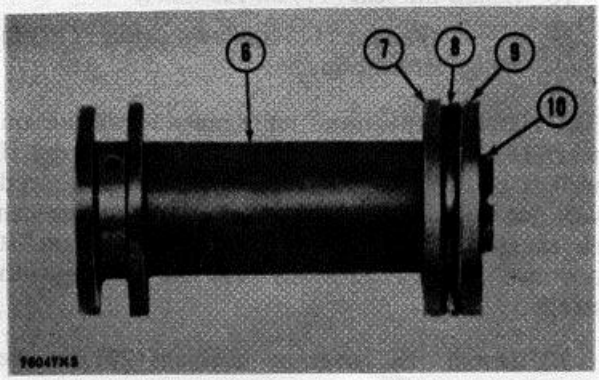
start by:

a) separation of governor from fuel injection pump housing

1. Remove the shaft (2) from the carrier (3).

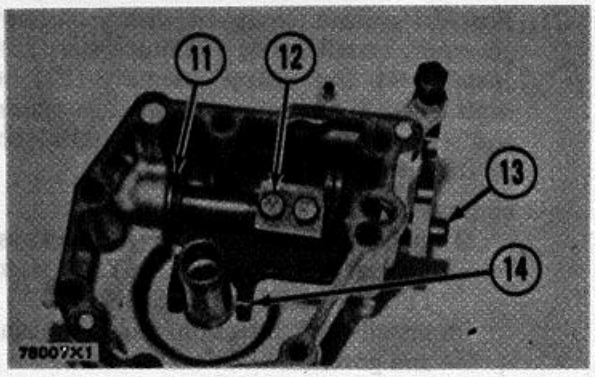


2. Remove dowel (1) from the shaft (2).



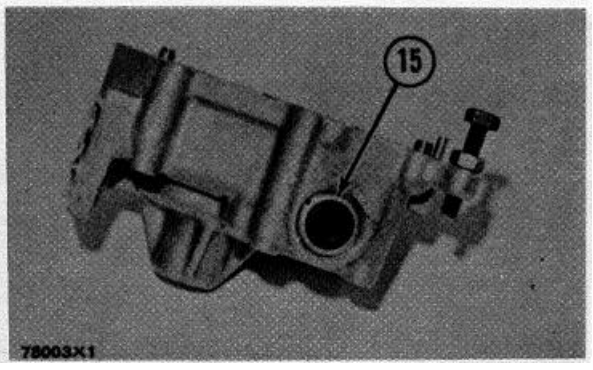
3. Remove the weights (4) from the carrier (3) by removing the dowels (5).

4. Remove the ring (10) from the thrust collar (6)1



5. Remove a race (9), a bearing (8), and a race (7) from the thrust collar (6).

6. Remove the two bolts (12) that hold the lever (14) to the shaft (13). Slide the shaft (13) out of the governor housing and remove the lever (14) and the washers (11) between the lever and the housing.

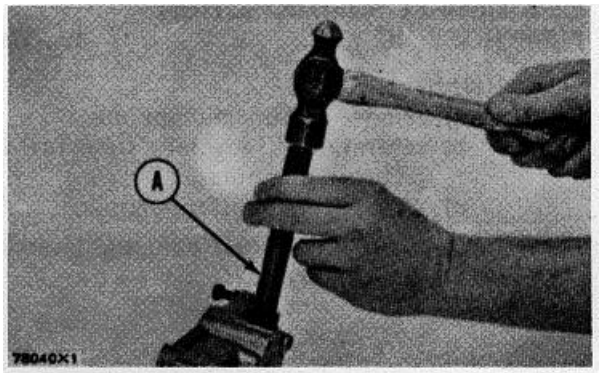


7. Remove the seal (15) from the governor housing.

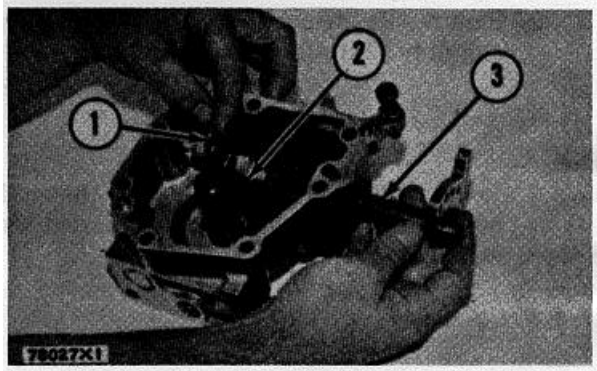
GOVERNOR

ASSEMBLE GOVERNOR 16-1264

Tools Needed		A
1P529	Handle	1
1P456	Drive Plate	1
1P463	Drive Plate	1

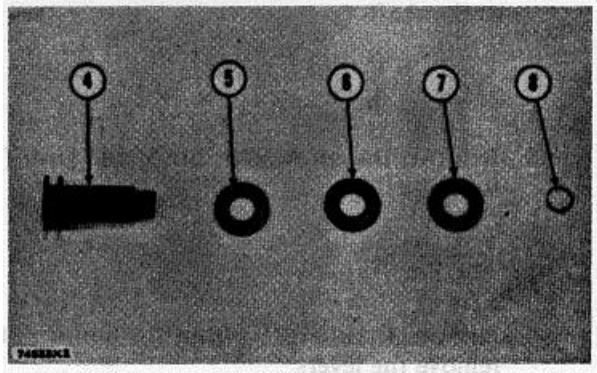


1. Use tooling (A) to install the seal in the governor housing with the lip of the seal toward the inside of the housing.



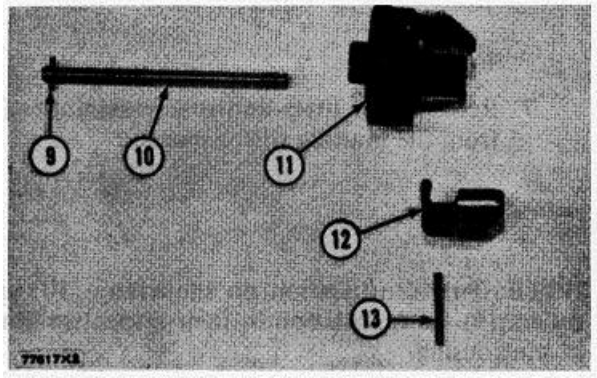
2. Put the lever (2) in position in the governor housing with a washer (1) between the lever (2) and the housing at each side.

3. Slide the shaft (3) into position and install the two bolts that hold the lever (2) to the shaft (3).



4. Install a race (5), a bearing (6), a race (7), and a ring (8) on the thrust collar (4).

5. Install the weights (12) on the carrier (11) with the dowels (13).



6. Install dowel (9) in the shaft (10).

7. Install the shaft (10) in the carrier (11).

end by:

a) connection of governor to fuel injection pump housing

FUEL INJECTION PUMP HOUSING

DISASSEMBLE FUEL INJECTION PUMP HOUSING 15-1253

start by:

a) remove fuel injection pumps

b) separation of governor from fuel injection pump housing

c) remove fuel transfer pump

1. Loosen the screws that hold the levers to the shaft assembly.

2. Remove the screw (1) that holds the lever assembly (2) to the shaft assembly.

3. Remove the shaft assembly (5) from the housing and remove the levers (3) and lever assembly (2).

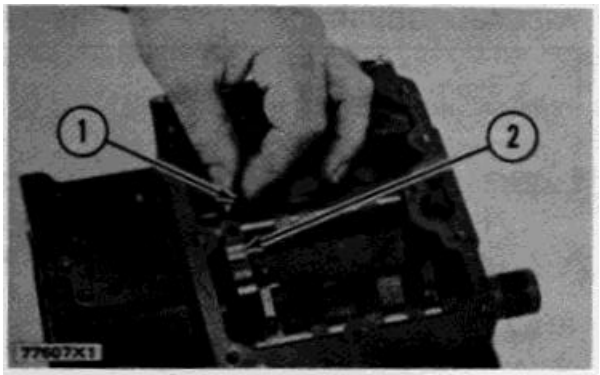
4. Loosen the screws that hold the levers (6) to the shaft.

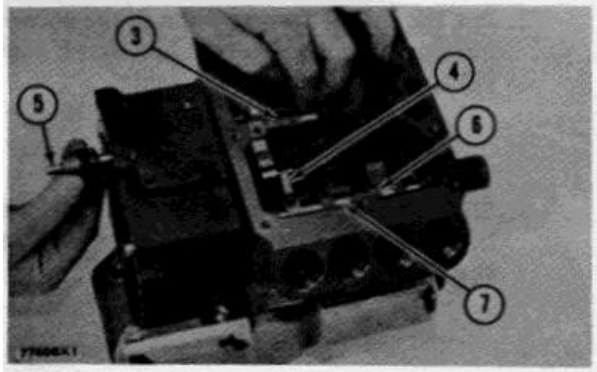
5. Remove the screw that holds the lever (4) to the shaft.

6. Remove the shaft (7) from the housing and remove the levers.

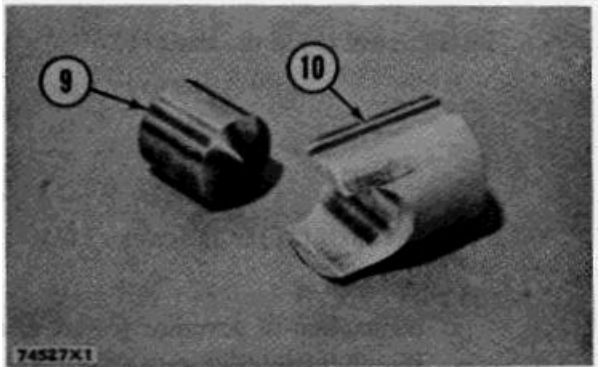
7. Remove the lifter and roller assemblies (8) from the housing with a magnet.

NOTE: Put identification on the lifters (10) and rollers (9) for installation in their respective bores in the housing.



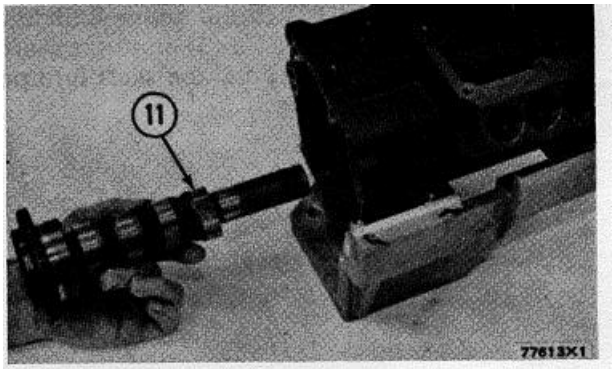




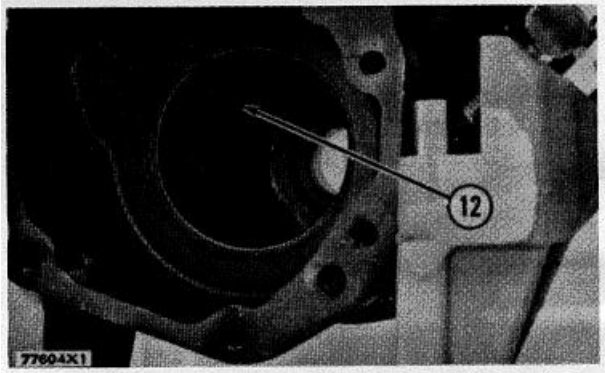


FUEL INJECTION PUMP HOUSING

8. Remove the camshaft (11) from the housing.

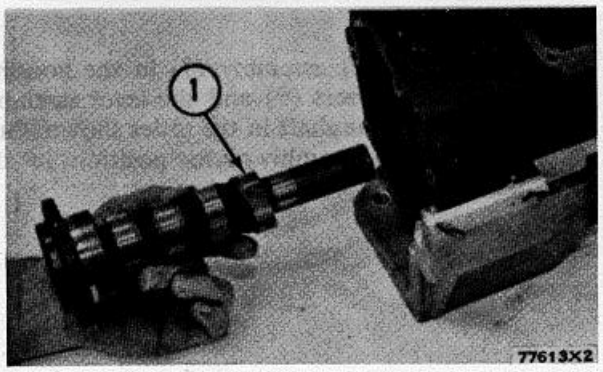


CAUTION: Do not use a force to remove the camshaft. Turn the camshaft to permit the free passage of the camshaft by the bosses (12) in the.



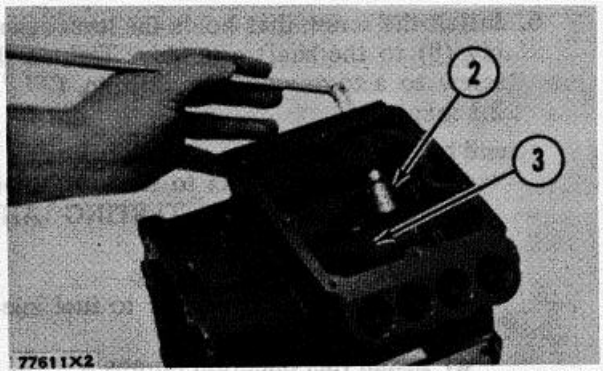
ASSEMBLE FUEL INJECTION PUMP HOUSING 16-1253

1. Install the camshaft (1) in the housing.



CAUTION: Do not use a force to install the camshaft. Turn the camshaft to permit the free passage of the camshaft by the bosses in the housing.

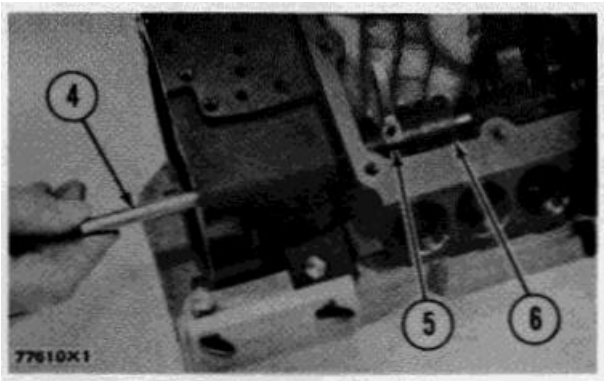
2. Install the lifter and roller assemblies (2) in their respective bores in the housing with a magnet.



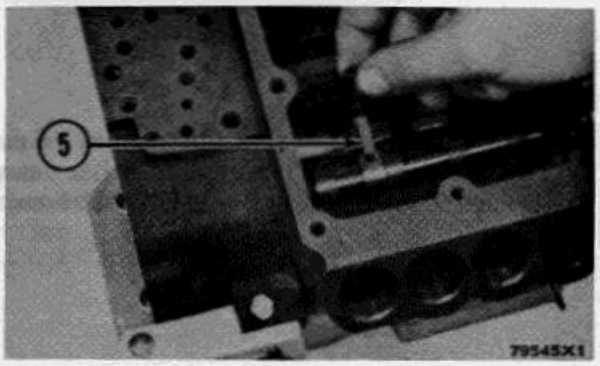
NOTE: Install the lifters with their grooves in alignment with the pins (3) in the housing.

FUEL INJECTION PUMP HOUSING

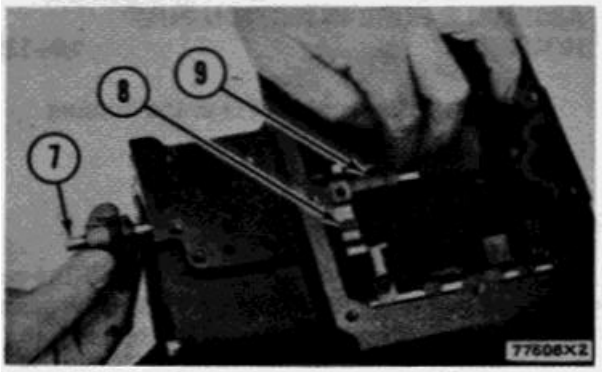
3. Put the shaft (4) in the housing. Slide the levers (6) and the lever (5) on to the shaft in the order shown. Push the shaft into position in the housing.



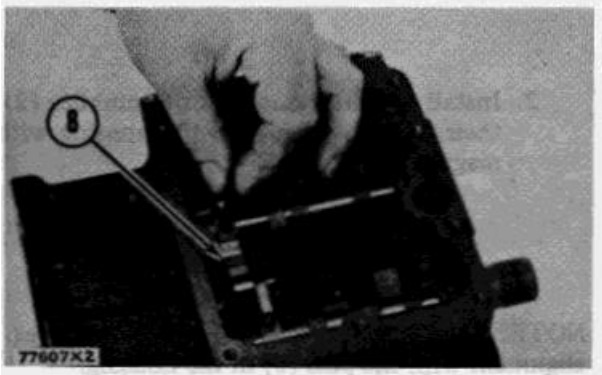
4. Install the screw that holds the lever (5) to the shaft. Tighten the screw to a torque of 24 ± 2 lb.in. (27.7 ± 2.3 cm.kg).



5. Put the shaft assembly (7) in the housing. Slide the levers (9) and the lever assembly (8) on to the shaft in the order shown. Push the shaft assembly into position in the housing.



6. Install the screw that holds the lever assembly (8) to the shaft assembly. Tighten the screw to a torque of 24 ± 2 lb. in. (27.7 ± 2.3 mkg).



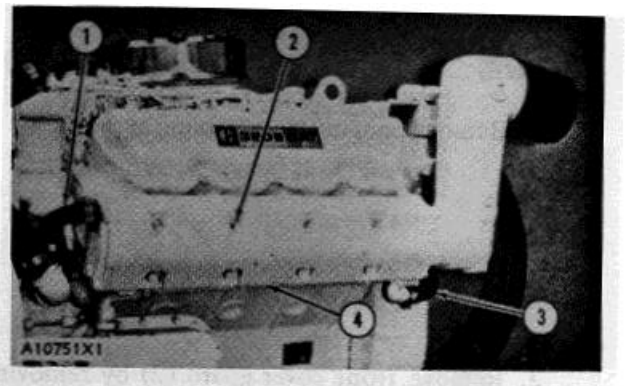
end by:

a) make adjustments to the sleeve control shafts (see TESTING AND ADJUSTING)
b) install fuel transfer pump
c) connection of governor to fuel injection pump housing
d) install fuel injection pumps

EXHAUST MANIFOLDS

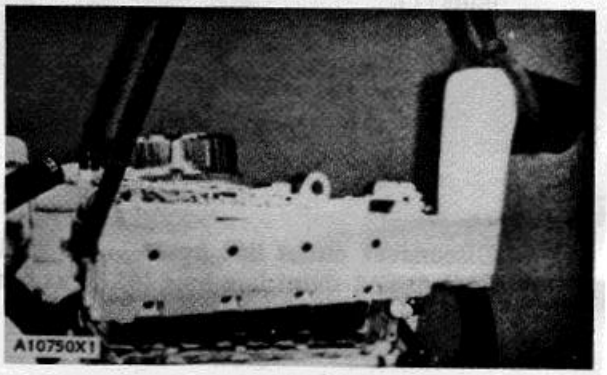
REMOVE EXHAUST MANIFOLD (MARINE ENGINE) 11-1059

1. Disconnect inlet water line (1) and outlet line (3).
2. Remove the bolts (2) that hold the manifold in place.
3. Fasten a hoist and remove the exhaust manifold (4). Weight of the exhaust manifold is 80 lb. (36 kg).



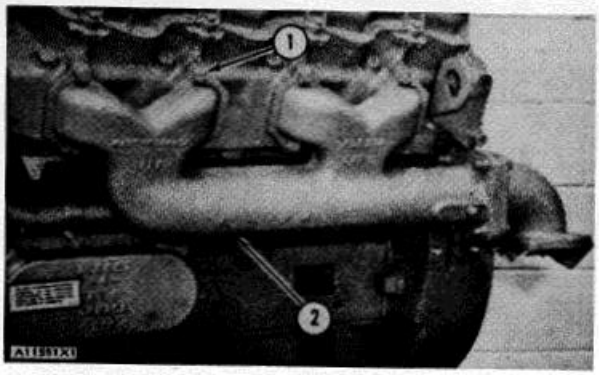
INSTALL EXHAUST MANIFOLD (MARINE ENGINE) 12-1059

1. Put gaskets and manifold in position on the cylinder block.
2. Put 9M3710 Anti-Seize Compound on the bolt threads and install them. Tighten the bolts to a torque of 32 ± 5 lb.ft. (4.4 ± 0.7 mkg).
3. Connect the inlet and outlet water lines.



REMOVE EXHAUST MANIFOLD (INDUSTRIAL ENGINE) 11-1059

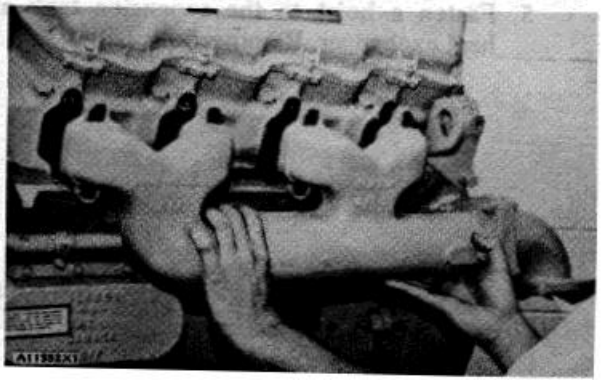
1. Remove bolts (1) and remove exhaust manifold (2).



INSTALL EXHAUST MANIFOLD (INDUSTRIAL ENGINE) 12-1059

1. Put gaskets and manifold in position on the cylinder block.
2. Put 9M3710 Anti-Seize Compound on the bolt threads and install them. Tighten the bolts to a torque of 32 + 5 lb.ft. (4.4 ± 0.7 mkg).

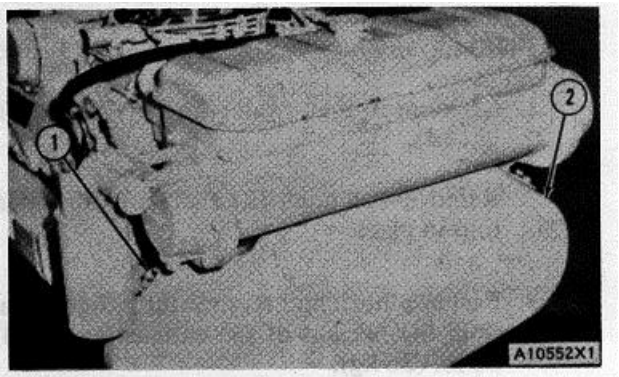
NOTE: Locks must be bent on a flat side of the bolt head. Bolts must be turned no more than 300 of a turn for the alignment of the locks with a flat side of the bolt head.



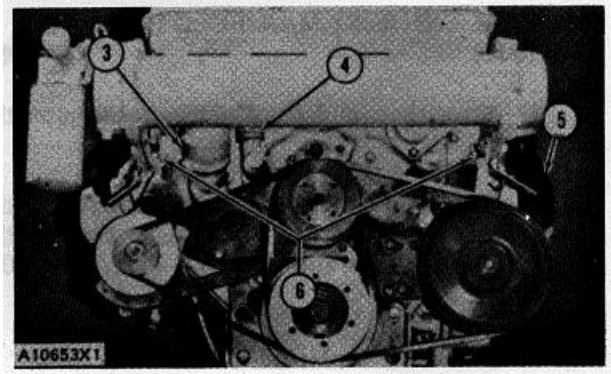
EXPANSION TANK AND HEAT EXCHANGER

REMOVE EXPANSION TANK AND HEAT EXCHANGER (MARINE ENGINE) 11-1354 & 1379

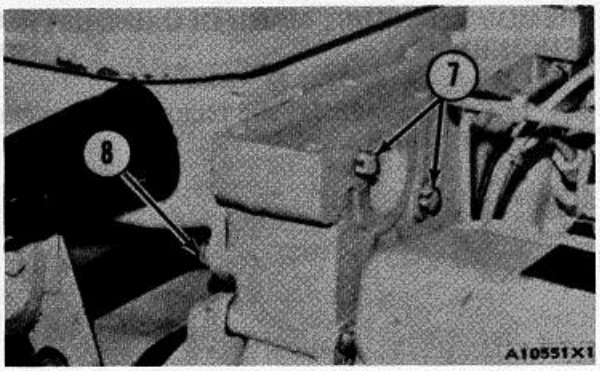
1. Remove coolant from cooling system.



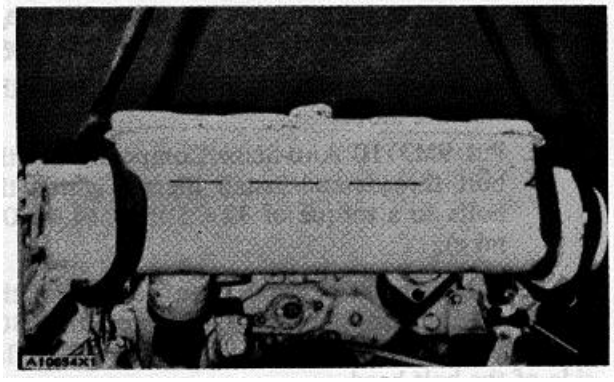
2. Remove front cover guard (2) by removing bolts (1).



3. Disconnect outlet line hose (3) for engine coolant and shunt line hose (4). Disconnect hose (5).



4. Remove rear bolts (7) and (8).



5. Fasten a hoist to the expansion tank and heat exchanger. Remove bolts (6).

6. Remove expansion tank and heat exchanger as a unit. Weight of the unit is 78 lb. (35 kg).

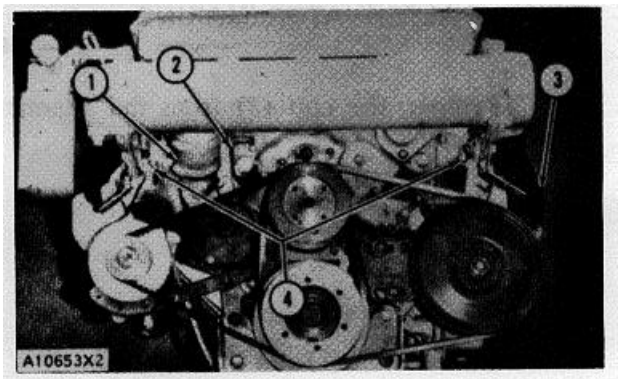
EXPANSION TANK AND HEAT EXCHANGER, STARTER

INSTALL EXPANSION TANK AND HEAT EXCHANGER (MARINE ENGINE) 12-1354 & 1374

1. Fasten a hoist to the expansion tank and heat exchanger and put the unit in position on the engine. Install bolts (4).

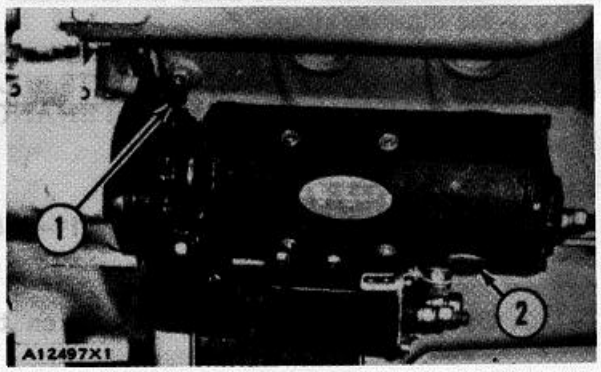
NOTE: Inspect and put oil on the engine coolant inlet seal before installing the expansion tank and heat exchanger.

2. Install the rear bolts.
3. Connect hose (3).
4. Connect outlet line hose (1) for engine coolant and shunt line hose (2).
5. Install the front cover guard.
6. Fill the cooling system with coolant to the correct level.



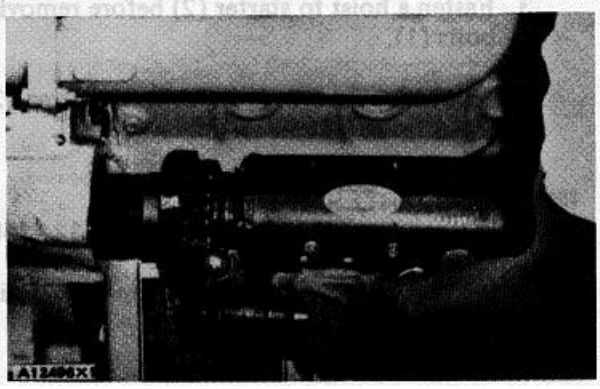
REMOVE STARTER (INDUSTRIAL ENGINE) 11-1453

1. Disconnect the battery cables.
2. Disconnect and put identification on the wiring.
3. Remove bolts (1) and starter (2).



INSTALL STARTER (INDUSTRIAL ENGINE) 12-1453

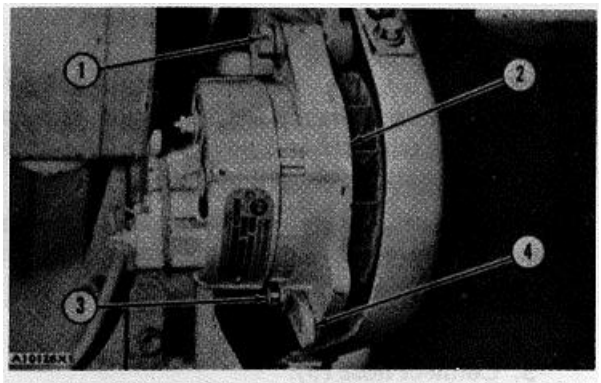
1. Put the starter in position on the engine.
2. Install the bolts.
3. Connect the wiring and battery cables.



ALTERNATOR, STARTER

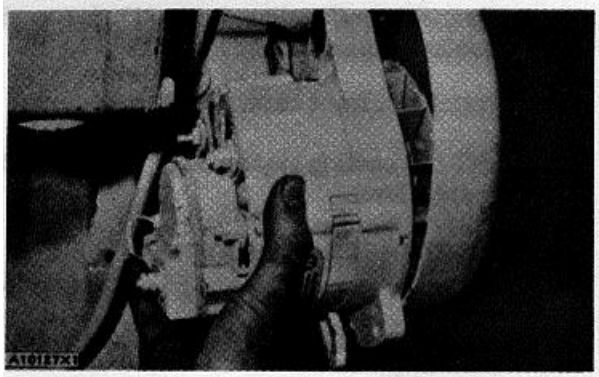
REMOVE ALTERNATOR (MARINE ENGINE) 11-1405

1. Remove the bolt (3) from the alternator strap (4).
2. Remove the alternator belt.
3. Remove bolt (1) and alternator (2).



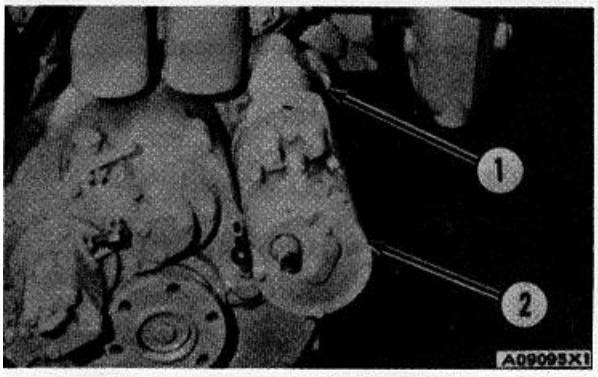
INSTALL ALTERNATOR (MARINE ENGINE) 12-1405

1. Put the alternator in position on the engine.
2. Install alternator belt.
3. Install the bolt that holds the alternator to the engine.
4. Install the bolt that holds the alternator to the adjusting strap.
5. Make an adjustment to the belt tension. See FAN AND ALTERNATOR BELTS in LUBRICATION AND MAINTENANCE GUIDE.



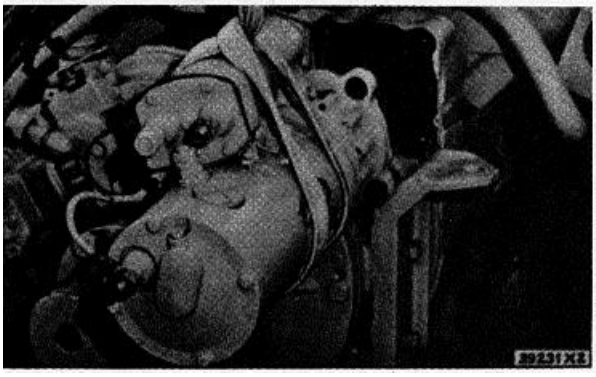
REMOVE STARTER (MARINE ENGINE) 11-1453

1. Disconnect the battery cables.
2. Disconnect and put identification on the wiring.
3. Fasten a hoist to starter (2) before removing bolts (1).
4. Remove bolts (1) and remove starter (2). Weight of the starter is 68 lb. (31 kg).



INSTALL STARTER (MARINE ENGINE) 12-1453

1. Put the starter in position on the engine with a hoist.
2. Install the bolts.
3. Connect the wiring and battery cables.

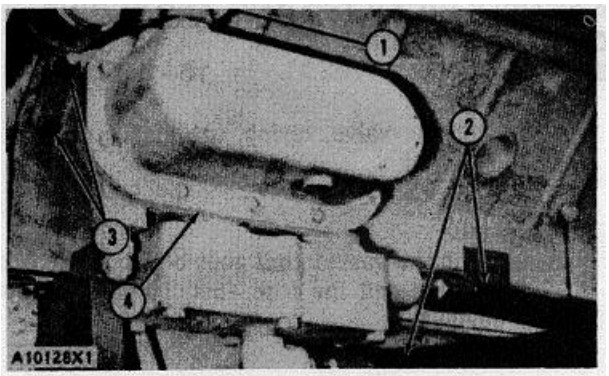


OIL FILTER BASE AND ENGINE OIL COOLER

REMOVE OIL FILTER BASE AND ENGINE OIL COOLER (MARINE ENGINE) 11-1306& 1378

1. Remove the coolant from the cooling system.

2. Remove hoses (2) from cover and base of the oil cooler. Loosen clamps (1). Remove two bolts (3) and two bolts from behind the oil cooler. Remove oil cooler (4).

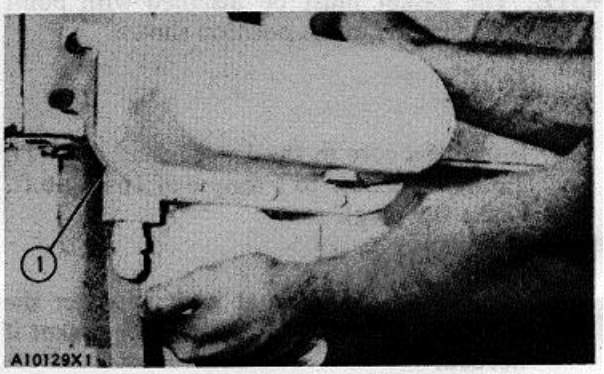


INSTALL OIL FILTER BASE AND ENGINE OIL COOLER (MARINE ENGINE) 12-1306 & 1375

1. Put the oil cooler (1) in position on the engine block and install the four bolts that hold it. Slide the two rubber elbows on the oil cooler and tighten the clamps.

2. Install the two hoses on the cover and base.

3. Fill the cooling system with coolant to the correct level.

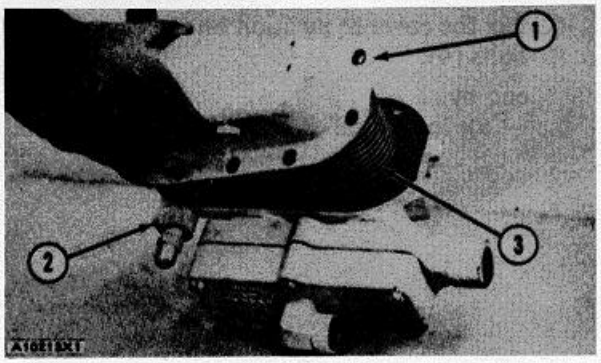


DISASSEMBLE OIL FILTER BASE AND ENGINE OIL COOLER (MARINE ENGINE) 15-1306 & 1378

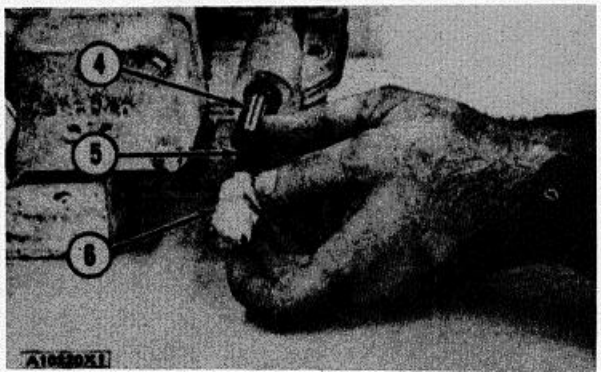
start by:

a) remove oil filter base and engine oil cooler

1. Remove the bolts that hold cover (1) to base (2). Remove the cover.



2. Remove the three nuts that hold core (3) to the base. Remove the core.



3. Remove the cap and fitting (6), spring (5) and valve (4) from the base.

OIL FILTER BASE AND ENGINE OIL COOLER

ASSEMBLE OIL FILTER BASE AND ENGINE OIL COOLER (MARINE ENGINE) 16-1306 & 1378

1. Install the valve, spring, cap and fitting (3) in base (2).

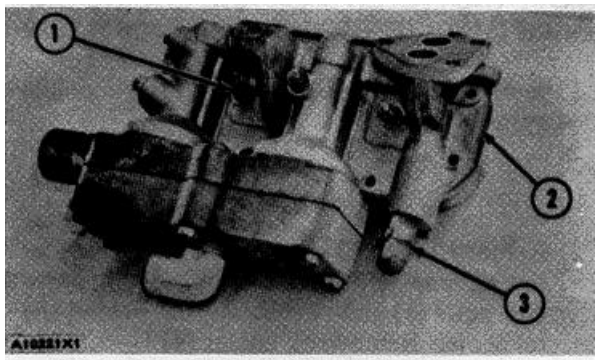
2. Inspect the gasket that goes between the oil filter base and the core. Install a new gasket if needed.

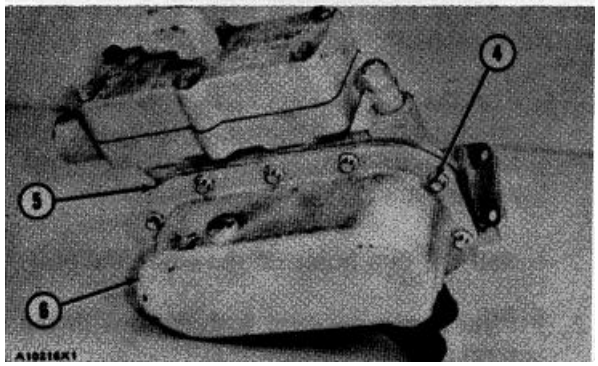
NOTE: The gasket must be installed with point (5) (indexing point) in the position shown.

3. Install the core in the base. Install nuts (1). Tighten the nuts to a torque of 16 ± 2 lb.ft. (2.2 ± 0.3 mkg).

4. Inspect the gasket that goes between the core and cover (6). Install a new gasket if needed.

5. Put the cover in position on the base. Install bolts (4).
   end by:
   a) install oil filter base and engine oil cooler

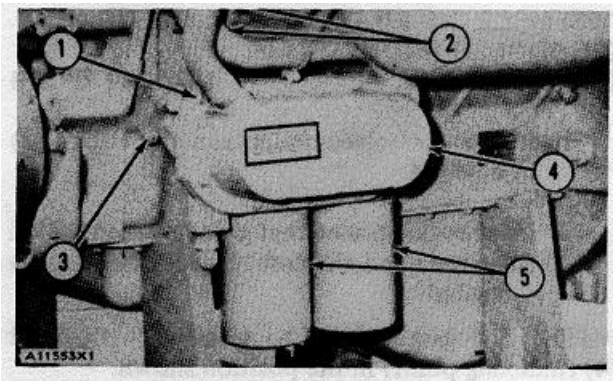


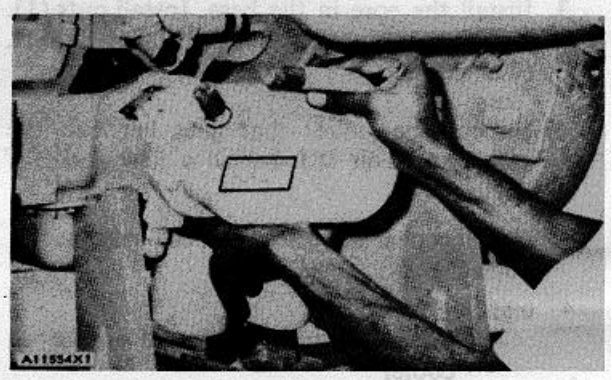


OIL FILTER BASE AND ENGINE OIL COOLER

REMOVE OIL FILTER BASE AND ENGINE OIL COOLER (INDUSTRIAL ENGINE) 11-1306 & 1378

1. Remove the coolant from the cooling system.
2. Loosen clamps (1) and disconnect hoses (2) from engine oil cooler (4). Remove oil filters (5).
3. Remove two bolts (3) and two bolts from behind the oil cooler.
4. Remove oil filter base and engine oil cooler as a unit.





INSTALL OIL FILTER.BASE AND ENGINE OIL COOLER (INDUSTRIAL ENGINE) 12-1306& 1378

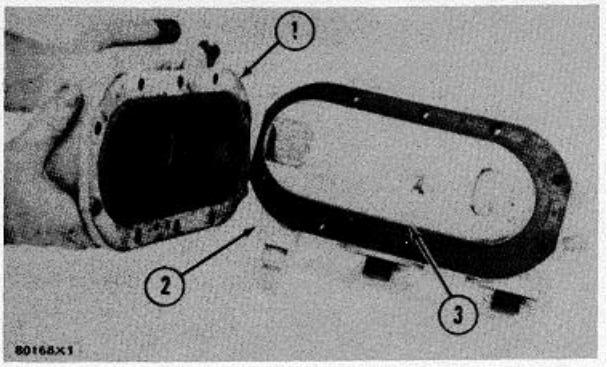
1. Inspect the O-ring seals in the oil filter base. Install new seals if needed. Put oil on the seals.
2. Put oil filter base and oil cooler in position on the engine. Install the four bolts that hold it in place.
3. Install two oil filters. Connect two hoses.
4. Fill the cooling system to the correct level.

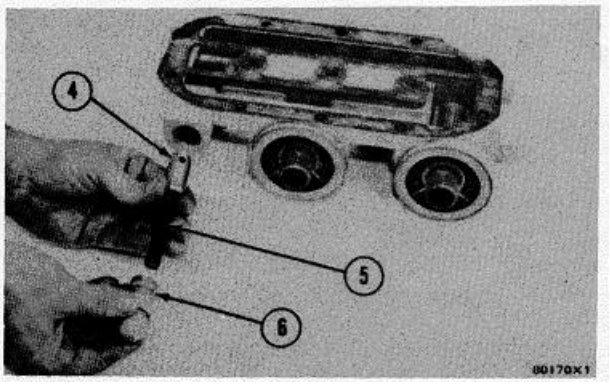
DISASSEMBLE OIL FILTER BASE AND ENGINE OIL COOLER (INDUSTRIAL ENGINE) 15-1306 & 1378

start by:

a) remove oil filter base and engine oil cooler

1. Remove the bolts that hold cover (1) to base (2). Remove the cover.
2. Remove the three nuts that hold core (3) to the base. Remove the core.
3. Remove the cap and fitting (6), spring (5), and valve (4) from the base.





OIL FILTER BASE ABD ENGINE COOLER

ASSEMBLE OIL FILTER BASE AND ENGINE OIL COOLER (INDUSTRIAL ENGINE) 16-1306& 1378

1. Install the valve, spring, cap and fitting (3) in base (2).

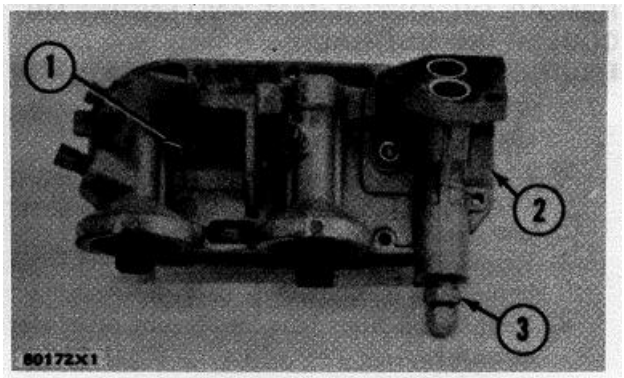
2. Inspect the gasket that goes between the oil filter base and the core. Install a new gasket if needed.

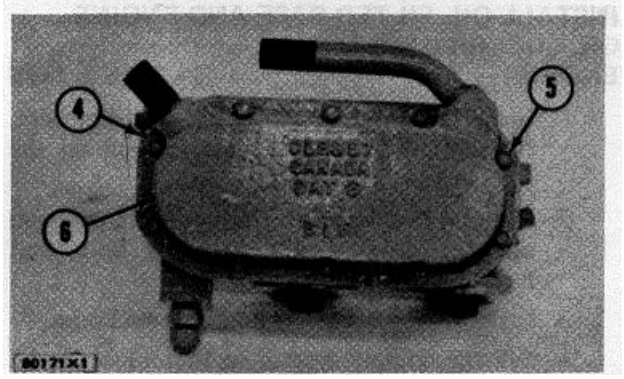
NOTE: The gasket must be installed with point (4) (indexing point) in the position shown.

3. Install the core in the base. Install nuts (1). Tighten the nuts to a torque of 16 ± 2 lb.ft. (2.2 ± 0.3 mkg).

4. Inspect the gasket that goes between the core and cover (6). Install a new gasket if needed.

5. Put the cover in position on the base. Install bolts (5).
   end by:
   a) install oil filter base and engine oil cooler

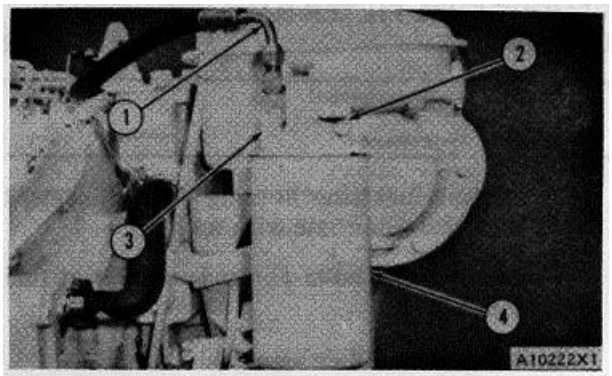




FUEL FILTER BASE, OIL PAN

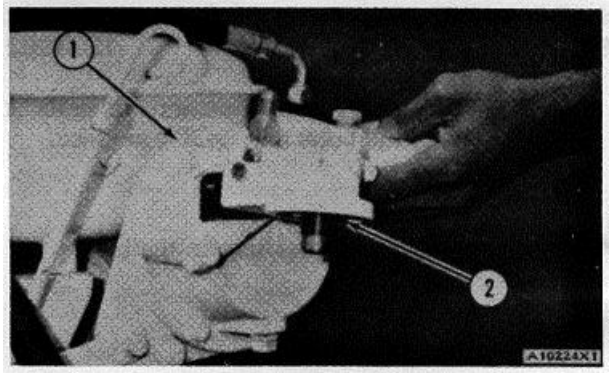
REMOVE FUEL FILTER BASE (MARINE ENGINE) 11-1262

1. Remove fuel filter housing (4).
2. Disconnect fuel line (1) from the fuel filter base.
3. Remove bolts (2) and remove fuel filter base (3).



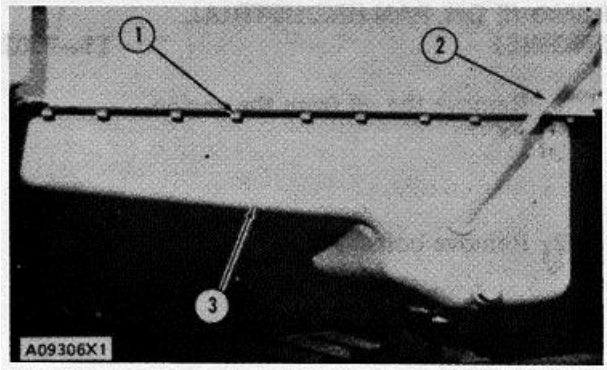
INSTALL FUEL FILTER BASE (MARINE ENGINE) 12-1262

1. Put fuel filter base (2) in position on bracket (1). Install the bolts that hold the base in place.
2. Connect the two fuel lines to the base.
3. Install the fuel filter housing.



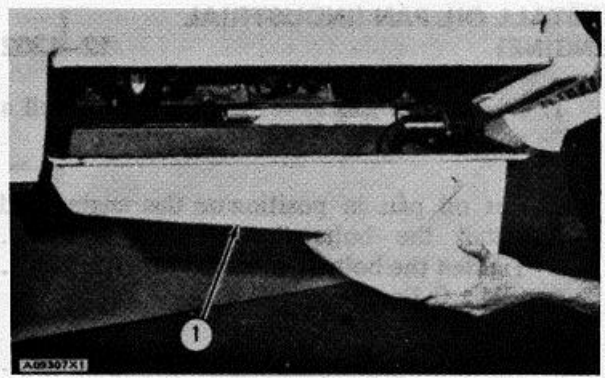
REMOVE OIL PAN (MARINE ENGINE) 11-1302

1. Remove the oil from the engine.
2. Remove the oil level gauge.
3. Disconnect oil level gauge guide (2) from the oil pan.
4. Remove bolts (1) and remove oil pan (3).



INSTALL OIL PAN (MARINE ENGINE) 12-1302

1. Inspect the gasket for the oil pan. Install a new gasket if needed.
2. Put oil pan (1) in position on the engine and install the bolts that hold it in place. Tighten the bolts to a torque of 17 + 3 lb.ft. (2.4 + 0.4 mkg).
3. Connect the oil level gauge guide to the oil pan. Install the oil level gauge.
4. Fill the engine with oil to the correct level.

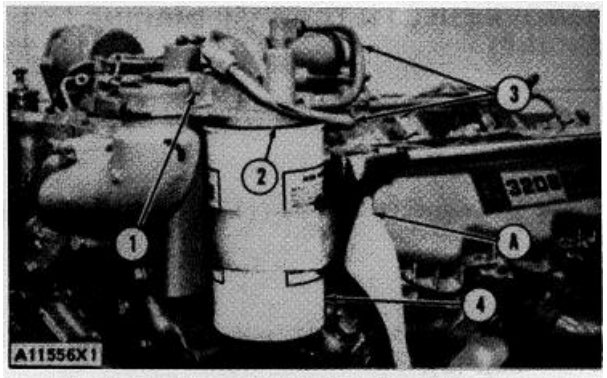


FUEL FILTER BASE, OIL PAN

REMOVE FUEL FILTER BASE (INDUSTRIAL ENGINE) 11-1262

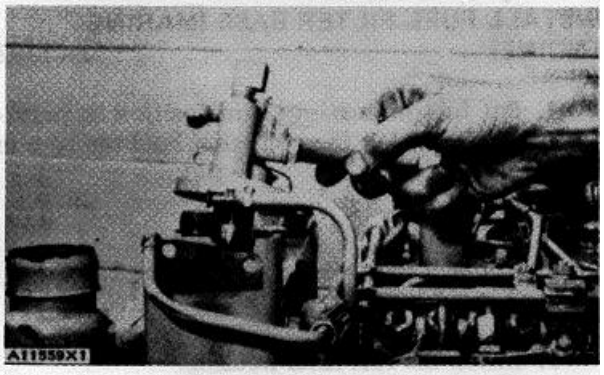
	Tools Needed	A
2P8250	Strap Wrench	1

1. Remove fuel filter housing (4) and element from fuel filter base with tool (A).
2. Remove two bolts (1) and disconnect fuel lines (3).
3. Remove fuel filter base (2).



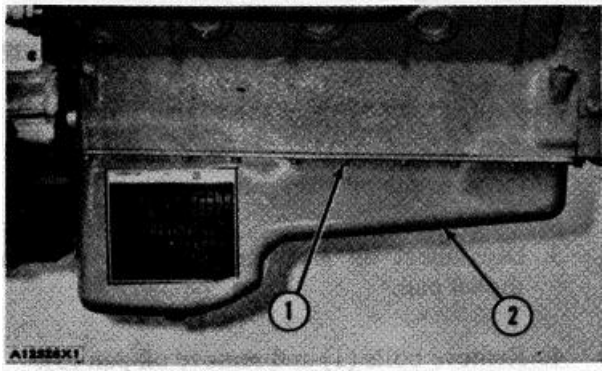
INSTALL FUEL FILTER BASE (INDUSTRIAL ENGINE) 12-1262

1. Put fuel filter base in position on bracket and install the bolts that hold it in place.
2. Connect the two fuel lines to the base.
3. Install fuel filter housing.



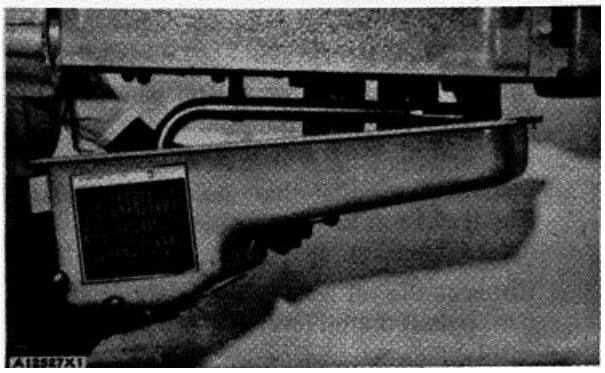
REMOVE OIL PAN (INDUSTRIAL ENGINE) 11-1302

1. Remove the oil from the engine.
2. Remove bolts (1) and remove oil pan (2).



INSTALL OIL PAN (INDUSTRIAL ENGINE) 12-1302

1. Inspect the gasket for the oil pan. Install a new gasket if needed.
2. Put oil pan in position on the engine and install the bolts that hold it in place. Tighten the bolts to a torque of 17 ± 3 lb.ft. (2.4 ± 0.4 mkg).
3. Fill the engine with oil to the correct level.



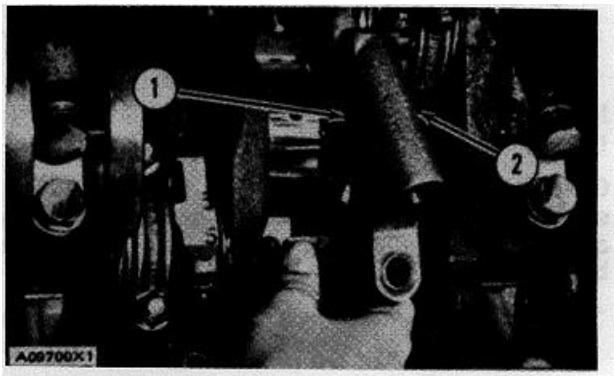
CRANKSHAFT MAIN BEARINGS

REMOVE AND INSTALL CRANKSHAFT MAIN BEARINGS 10-1203

Tools Needed		A	B	C	D
2P5518	Bearing Tool	1			
581161	Wire		*		
8S5131	Adapter			1	
8S2328	Dial Test Indicator Group				1

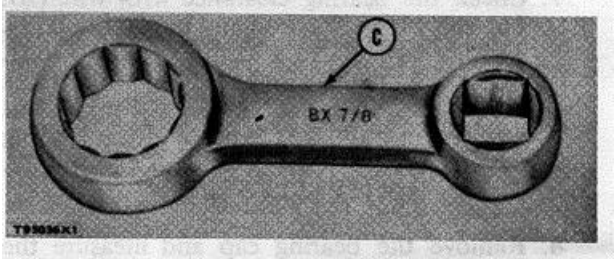
start by:

a) remove oil pan



1. Remove the bolts and washers that hold main bearing cap (2) in place. Remove the bearing cap and the lower half of the main bearing.

2. Remove bearing (1) from the bearing cap.



NOTE: When removing and installing the No. 1 main bearing cap use tool (C) to remove and install the bolts that hold the bearing cap in place.

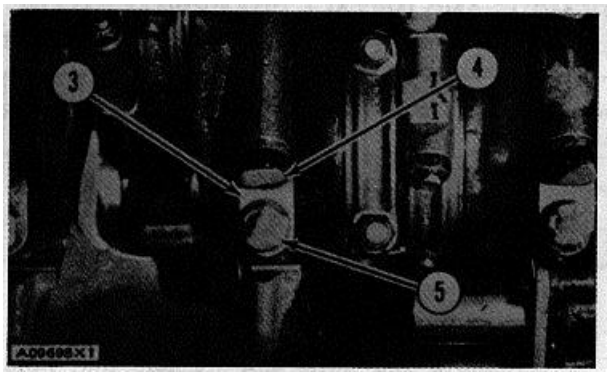
3. Turn the crankshaft until tool (A) can be installed in the oil hole in the crankshaft journal. Install tool (A).

4. Remove the upper half of the main bearing by turning the crankshaft and moving the bearing out of the cylinder block with tool (A).



CRANKSHAFT MAIN BEARINGS

5. Put clean SAE 30 oil on the upper half of the new main bearing. Install the upper half of the main bearing with tool (A).

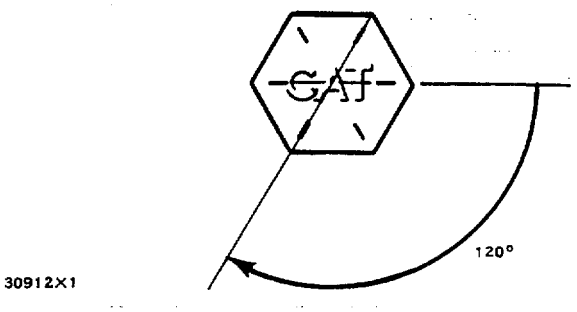


NOTE: The main bearing half with a hole in it is the upper bearing.

CAUTION: When installing bearing caps make sure the number on the side of the cap is next to and respective with the number on the engine block.

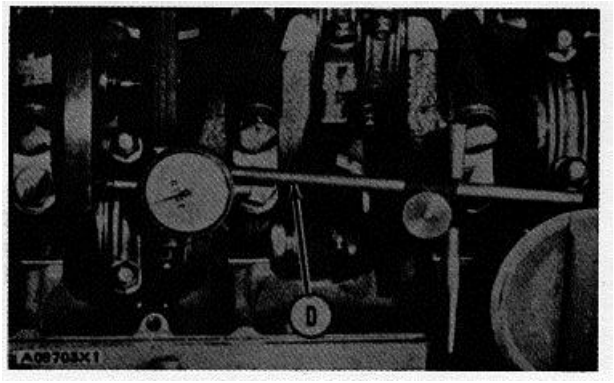
6. Clean the main bearing cap and install the lower half of the new bearing in the cap.

7. Check the bearing clearance with wire (B). Put cap (3) in position and install the bolts. Tighten-bolt (5) to a torque of 30 ± 3 lb.ft. (4.1 ± 0.4 mkg). Tighten bolt (4) to a torque of 30 ± 3 lb.ft. (4.1 ± 0.4 mkg). Put a mark on both bolt heads and the bearing cap. Tighten bolt (4) 120± 5° more. Tighten bolt (5) 120 ± 50 more.



8. Remove the bearing cap and measure the thickness of the wire. The main bearing clearance must be .002 to .005 in. (0.05 to 0.13 mm). The maximum permissible clearance is .006 in. (0.15 mm).

9. Put clean SAE 30 oil on the bolt threads, washer faces and lower half of the main bearing. Put the bearing cap and lower half of the main bearing in position on the engine. Install the bolts. Tighten bolt (5) to a torque of 3Qa: 3 lb.ft. (4.1 ± 0.4 mkg). Tighten bolt (4) to a torque of 30 ± 3 lb.ft. (4.1 ± 0.4 mkg). Put a mark on both bolt heads and the cap. Tighten bolt (4) 120± 5° more. Tighten bolt (5) 120 5° more.



10. Do Steps 2 through 8 for the remainder of the bearings.

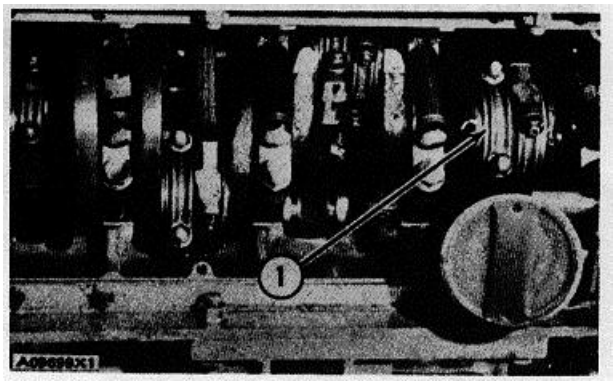
11. Check the crankshaft end play with tooling (D). The end play is controlled by the thrust bearing on No. 4 main bearing. The end play with new bearings must be .006 ± .003 in. (0.15 ± 0.08 mm). The maximum permissible end play with used bearings is .014 in. (0.36 mm).
end by:
    a) install oil pan.

CONNECTING ROD BEARINGS

REMOVE AND INSTALL CONNECTING ROD BEARINGS 10-1219

	Tools Needed	A
5B1161	Wire	*

start by:
a) remove oil pan

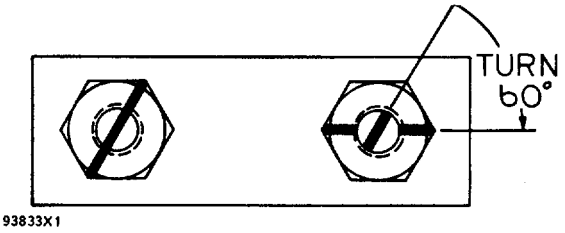


1. Turn the crankshaft until two pistons are at bottom center. Remove connecting rod caps (1) from the two-connecting rods. Remove the lower half of the bearings from the caps.

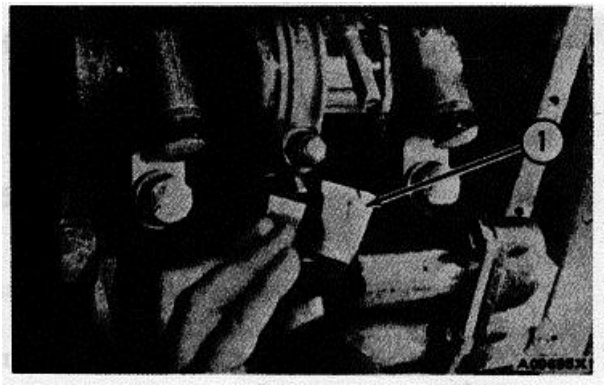
2. Push the connecting rods away from the crankshaft and remove the upper half of the bearings.

3. Clean the surfaces where the bearings fit. Install the upper half of the new bearings in the rods. Put clean SAE 30 oil on the bearings and crankshaft journals. Put the connecting rods in position on the crankshaft.

4. Clean the surfaces where the bearings fit. Install the lower half of the new bearings in the caps. Put clean SAE 30 oil on the bearings, bolt threads and contact surfaces of the nuts.



CAUTION: When installing connecting rod caps make sure that the numbers on the side of the cap is next to and respective with the number on the side of the connecting rod.



5. Check the bearing clearance with wire (A). Put the caps (1) in position on the connecting rods and install the nuts. Tighten the nuts to a torque of 30 ± 3 lb.ft. (4.1 ± 0.4 mkg). Put a mark on each nut and the end of each bolt. Tighten the nuts 60 ± 5° more.

6. Remove the cap. Measure the thickness of the wire. The rod bearing clearance must be .0030 ± .0015 in. (0.076 ± 0.038 mm). The maximum permissible clearance is .007 in. (0.18 mm).

7. Put the caps in position on the connecting rods and install the nuts. Tighten the nuts to a torque of 30 ± 3 lb.ft. (4.1 ± 0.4 mkg). Put a mark on each nut and the end of each bolt. Tighten the nuts 60 ± 5° more.

8. Do Steps 1 through 7 again for other bearings.
end by:
a) install oil pan

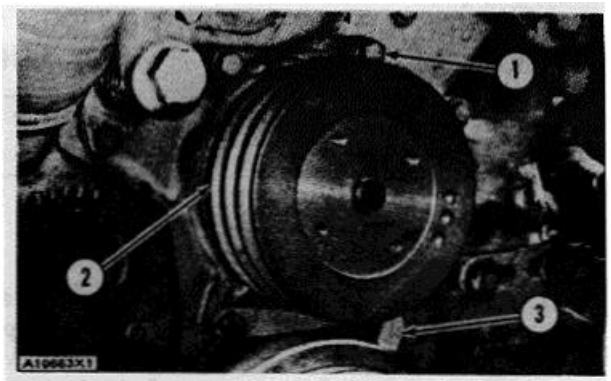
WATER PUMP, WATER TEMPERATURE REGULATORS

REMOVE WATER PUMP (MARINE ENGINE) 11-1361

1. Remove coolant from the cooling system.

2. Remove alternator belts.

3. Remove bolts (1) and pointer (3). Remove pump (2) from the timing gear cover.

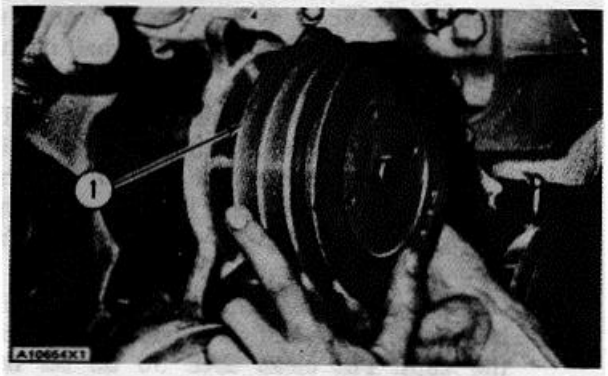


INSTALL WATER PUMP (MARINE ENGINE) 12-1361

1. Inspect the gasket for the water pump. Install a new gasket if necessary.

2. Put pump (1) in position on the timing gear cover. Install the bolts and pointer.

3. Fill the cooling system with coolant to the correct level.



REMOVE AND INSTALL WATER TEMPERATURE REGULATORS (MARINE ENGINE) 10-1355

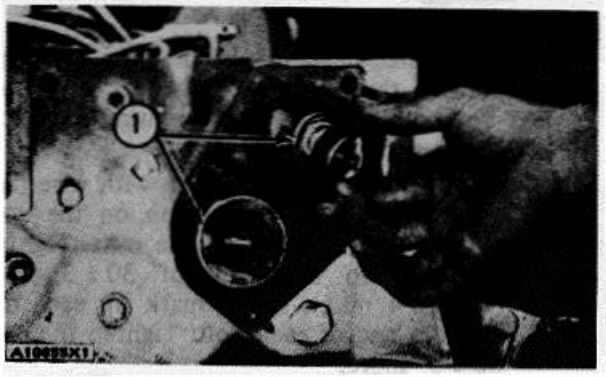
start by:
   a) remove expansion tank and heat exchanger

1. Remove the coolant from the cooling system.

2. Remove water temperature regulators (1).

3. Install water temperature regulators (1).

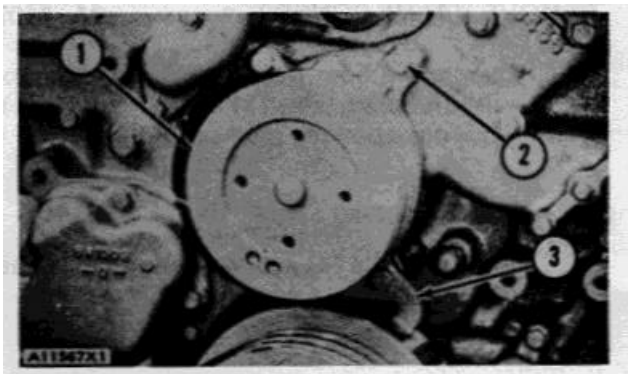
end by:
   a) install expansion tank and heat exchanger



WATER PUMP, WATER PUMP REGULATORS

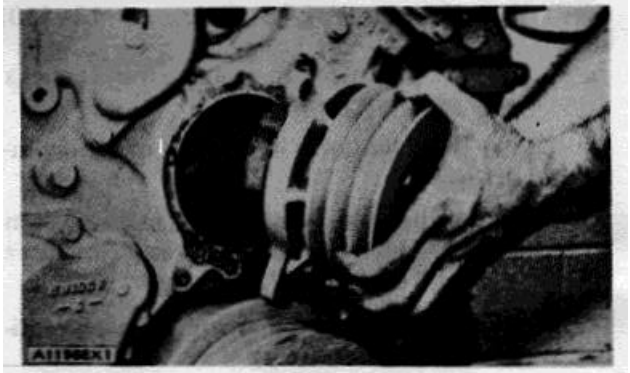
REMOVE WATER PUMP (INDUSTRIAL ENGINE) 11-1361

1. Remove coolant from the cooling system.
2. Remove four bolts (2).
3. Remove water pump (1) and pointer (3).



INSTALL WATER PUMP (INDUSTRIAL ENGINE) 12-1361

1. Inspect the gasket for the water pump. Install a new gasket if necessary.
2. Put pump in position on the timing gear cover. Install the bolts and pointer.
3. Fill the cooling system with coolant to the correct level.



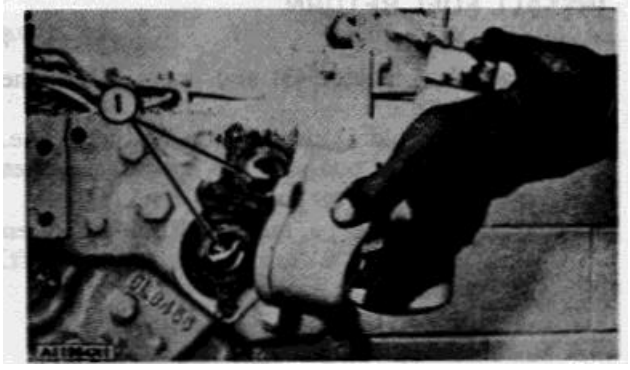
REMOVE WATER TEMPERATURE REGULATORS (INDUSTRIAL ENGINE) 11-1355

1. Remove coolant from the cooling system.
2. Remove bolts (1) that hold water temperature regulator housing (2) in place.
3. Remove water temperature regulators from timing gear cover.



INSTALL WATER TEMPERATURE REGULATORS (INDUSTRIAL ENGINE) 12-1355

1. Install water temperature regulators (l) into timing gear cover.
2. Put housing into position on the timing gear cover and install the bolts that hold it.
3. Fill the cooling system with coolant to the correct level.

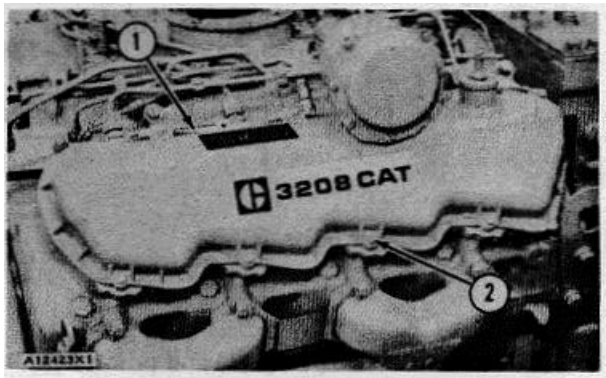


VALVE COVERS, FUEL RETURN MANIFOLDS

REMOVE VALVE COVERS 11-1107

1. Disconnect hose frown crankcase ventilator valve. Remove bolts (2) and valve cover (1). (This operation for right side only).

2. Remove bolts (2) and valve cover (1). (This operation for left side only).



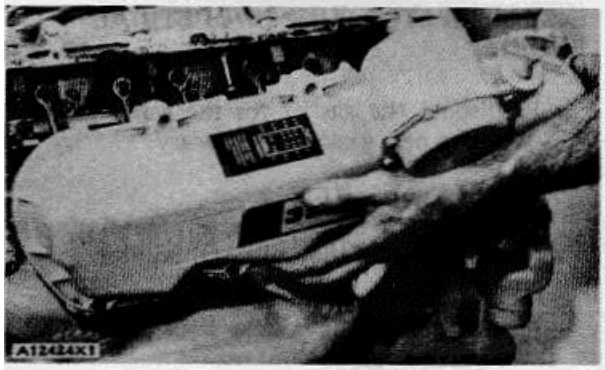
INSTALL VALVE COVERS 12-1107

1. Inspect gasket for the valve cover. Install a new gasket if needed.

2. Put the valve cover in position on the cylinder head.

3. Install the bolts that hold the valve cover in place. Tighten the bolts to a torque of 120 + 24 lb. in. (138.4 + 27.7 cm. kg.)

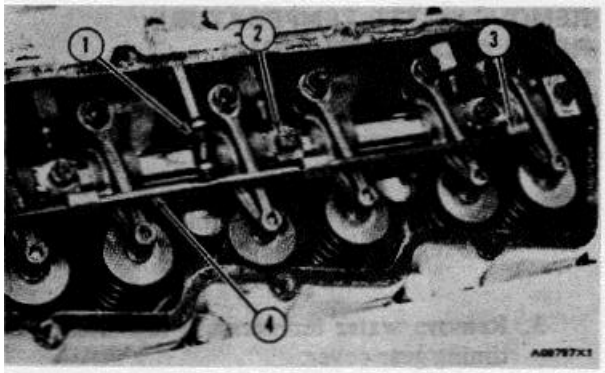
4. Connect the hose to the crankcase ventilator (right side only).



REMOVE FUEL RETURN MANIFOLDS 11-1274

start by:
a) remove valve covers

1. Disconnect boot (1). Remove bolts (2), locks, clamps (3) and fuel return manifold (4).

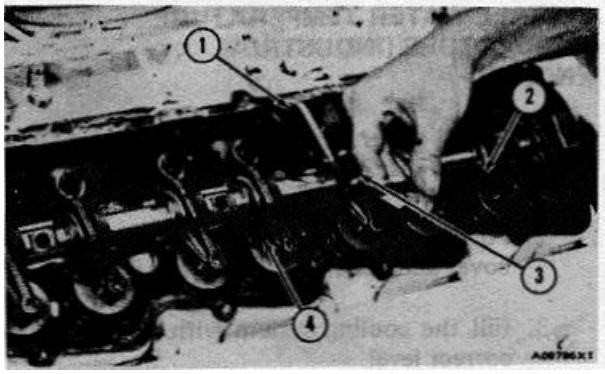


INSTALL FUEL RETURN MANIFOLDS 12-1274

1. Install connector (3) and boots (4) on the manifold.

2. Put manifold (2) in position on the engine. Connect the boots to the injection nozzles and the connector to line (1).

3. Install the clamps, locks and bolts. Tighten the bolts to a torque of 18 ± 5 lb.ft. (2.5 ± 0.7 mkg). end by:
a) install valve cover.

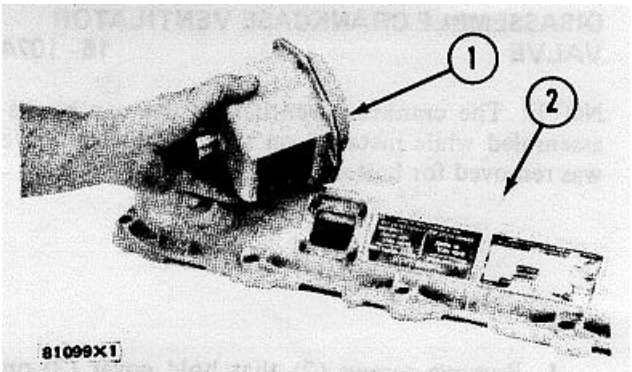


CRANKCASE VENTILATOR VALVE

REMOVE CRANKCASE VENTILATOR VALVE 11-1074

start by:
a) remove valve cover (right side)

1. Remove the bolts and locks that hold valve (1) to valve cover (2). Remove the valve from the valve cover.

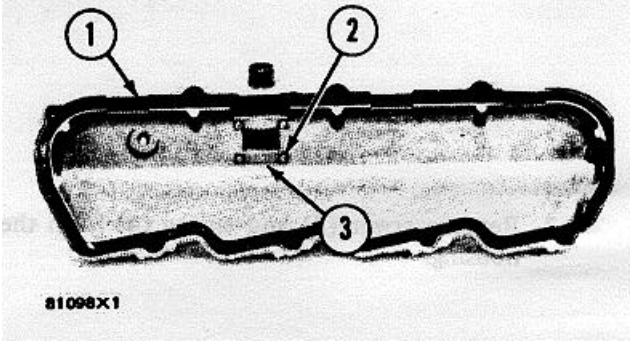


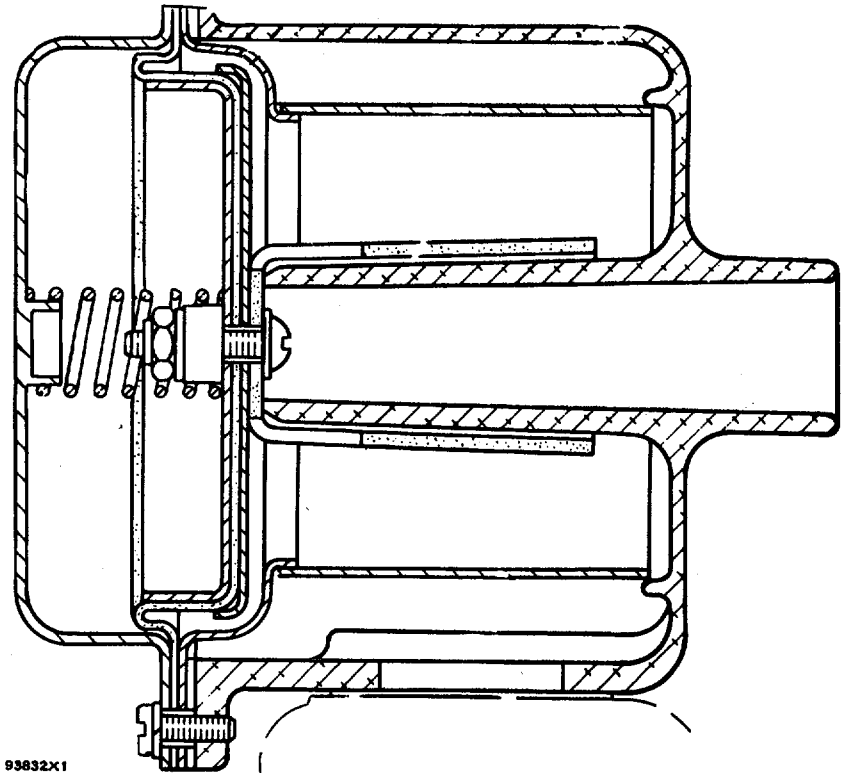
INSTALL CRANKCASE VENTILATOR VALVE 12-1074

1. Put the valve in position on valve cover (1).

2. Install locks (3) and bolts (2). Bend the locks against the bolts.

end by:
a) install valve cover (right side)

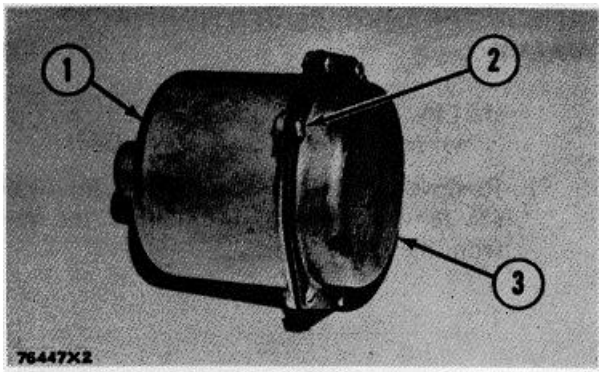




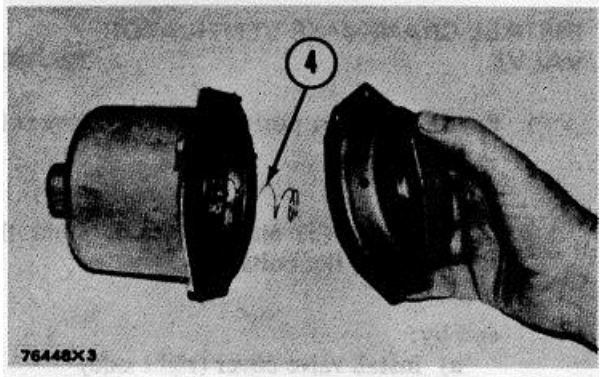
CRANKCASE VENTILATOR VALVE

DISASSEMBLE CRANKCASE VENTILATOR VALVE 15-1074

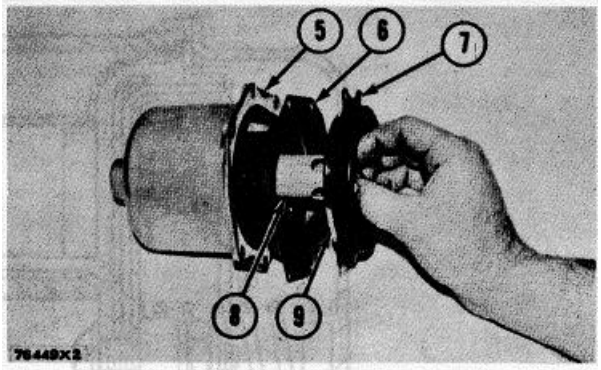
NOTE: The crankcase ventilator valve can be disassembled while installed on the engine. The valve was removed for better photo illustration.



1. Remove screws (2) that hold cover (3) on housing (1).

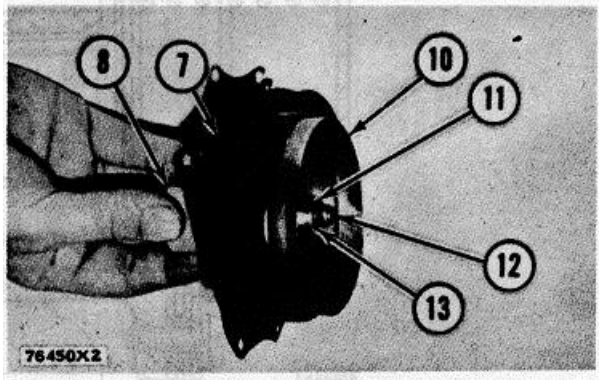


2. Remove cover (3) and spring (4) from the housing.



3. Remove the piston, sleeve (8), retainer (9), and diaphragm (7) from the housing as a unit.

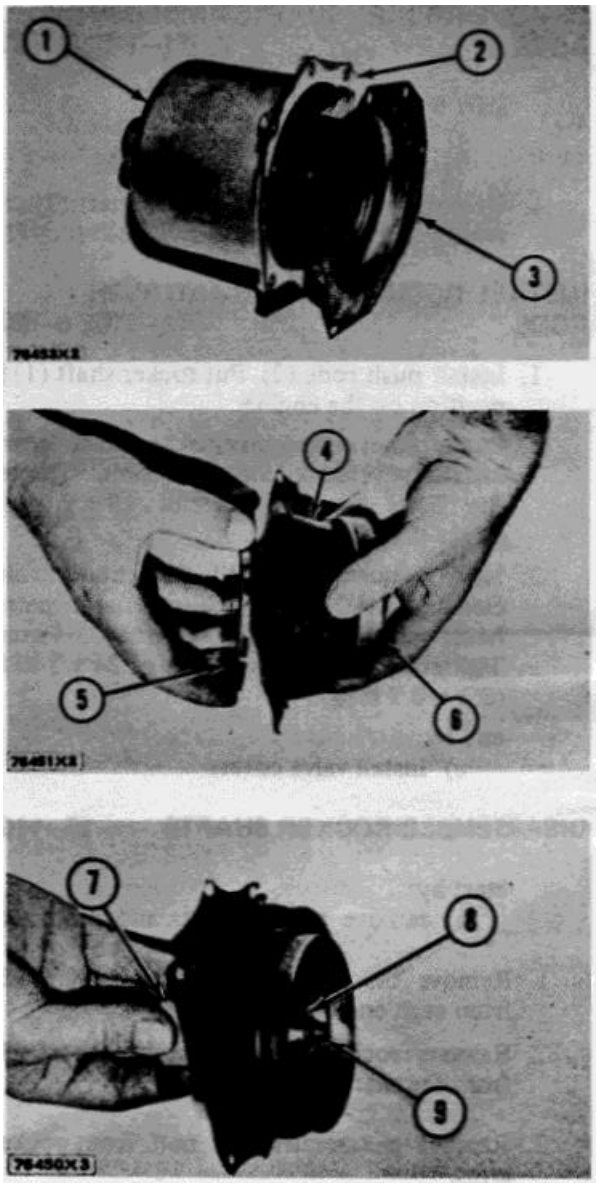
4. Remove inner sleeve (6) and gasket (5) from the housing.



5. Remove nut (12), washer (13), spacer (11), piston (10), diaphragm (7), and the retainer from sleeve (8).

CRANKCASE VENTILATOR VALVE

ASSEMBLE CRANKCASE VENTILATOR VALVE 15-1074



1. Put 5H2471 Gasket Cement on both sides of gasket (2). Install the gasket on housing (1).

2. Install inner sleeve (3) in the housing.

3. Put piston (6) in position next to the side of diaphragm (4) that has identification "PISTON SIDE".

4. Put retainer (5) in the diaphragm.

5. Put the screw through sleeve (7), retainer, diaphragm, and the piston.

6. Install spacer (8), washer, and nut (9) on the screw.

7. Put 5H2471 Gasket Cement on the contact surfaces of the diaphragm. Install the sleeve, retainer, diaphragm, and piston in the inner sleeve and housing.

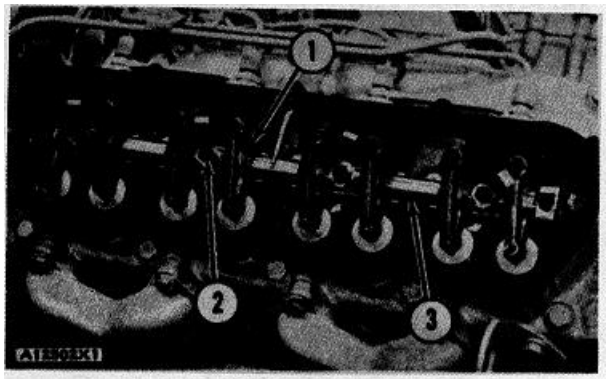
8. Put the spring and cover in position on the housing and install the screws that hold the cover in place.

ROCKER SHAFTS ABD PUSH RODS, ROCKER SHAFTS

REMOVE ROCKER SHAFTS AND PUSH RODS 11-1102 & 1208

start by:
a) remove valve covers
b) remove fuel return manifold

1. Remove bolts (2) from rocker shaft (3) and remove rocker shaft. Remove push rods (1).

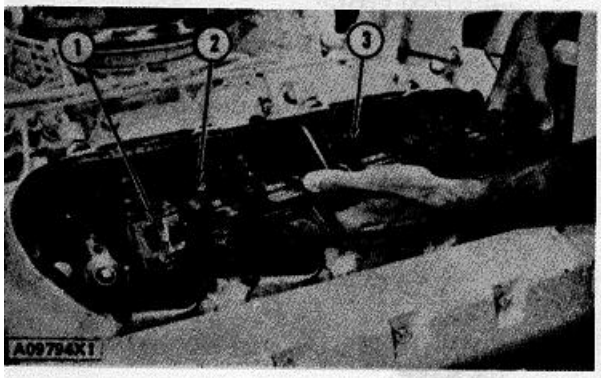


INSTALL ROCKER SHAFTS AND PUSH RODS 12-1102 & 1208

1. Install push rods (2). Put rocker shaft (1) in position on the engine.

2. Put the fuel return manifold in position and install the clamps, locks and bolts. Tighten the bolts to a torque of 18 ± 5 lb.ft. (2.5 ± 0.7 mkg).

3. Make adjustment until the intake valve clearance is .015 in. (0.38 mm) and the exhaust valve clearance is .025 in. (0.64 mm). Tighten nuts (3) to a torque of 24 ± 5 lb.ft. (3.3 ± 0.7 mkg).
end by:
a) install valve covers



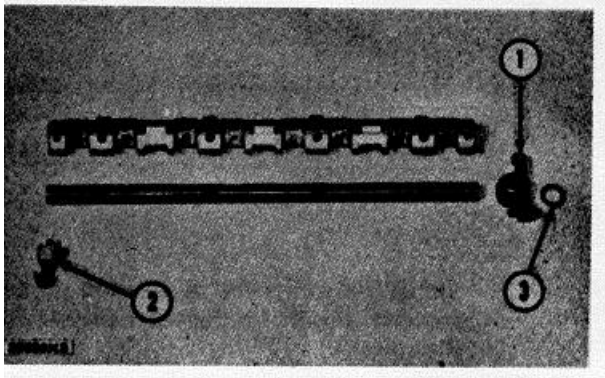
DISASSEMBLE ROCKER SHAFTS 15-1102

start by:
a) remove rocker shafts and push rods

1. Remove the bolts, locks, and washers (2) from each end of the rocker shaft.

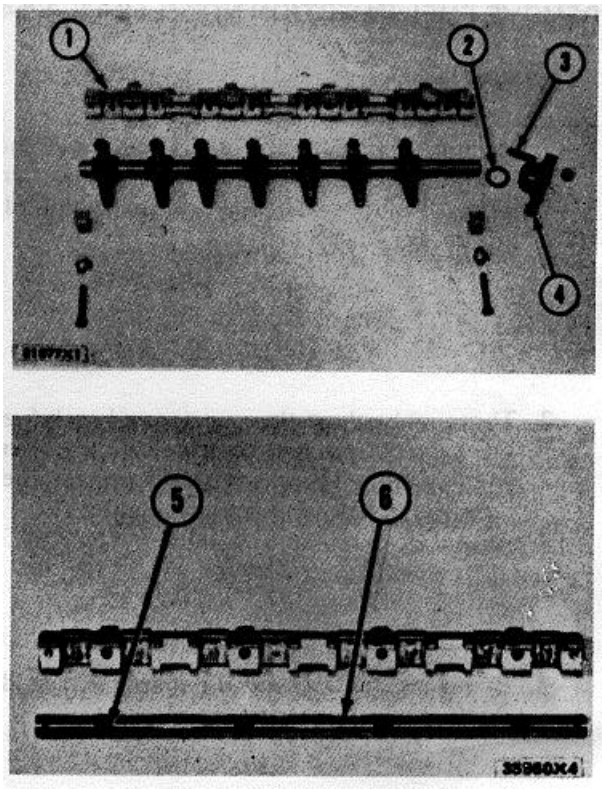
2. Remove rocker arms (1) and washers (3) from the shaft.

3. Remove the screws and nuts from rocker arms.



ROCKER SHAFTS

ASSEMBLE ROCKER SHAFTS 16-1102



1. Make sure the oil hole, in the rocker arms, rocker shaft, and bracket are clean and free of all dirt and foreign material.

2. Measure the bore of the bushing in each of the rocker arms. The bore must be .8603 : .0008 in. (21.852 ± 0.020 mm), The maximum permissible bore is .8630 in. (21.920 mm).

NOTE: Make a replacement of the arm and bushing as a unit if the bore is not correct. The arms and bushings can not be ordered separately.

3. Measure the diameter of the shaft at each of the rocker arm locations. The diameter must be .8580 to .8588 in. (21.793 to 21.814 mm). The minimum permissible diameter is .8570 in. (21.768 mm).

4. Install screws (3) into rocker arms (4). Turn the screws until they are .44 in. (11.2 mm) below the bottom of the rocker arms.

5. Install the rocker arms and washers (2) on the shaft as shown.

6. Put the shaft and rocker arms in position on bracket (1) with screws (3) on the same side as the oil hole on the bottom of the bracket.

7. Make sure the flat surfaces (5) on the shaft (6) are turned up. Install the washers, locks, and bolts. Tighten the bolts to a torque of 18 ± 5 lb. ft. (2.5 ± 0.7 mkg),
   end by:
   a) install rocker shafts and push rods

FUEL INJECTION NOZZLES

REMOVE FUEL INJECTION NOZZLES 11-1254

start by:

a) remove valve covers

1. Remove the bolts and locks that hold the fuel return manifold and rocker shafts in place. Remove the fuel return manifolds and rocker shafts(1).

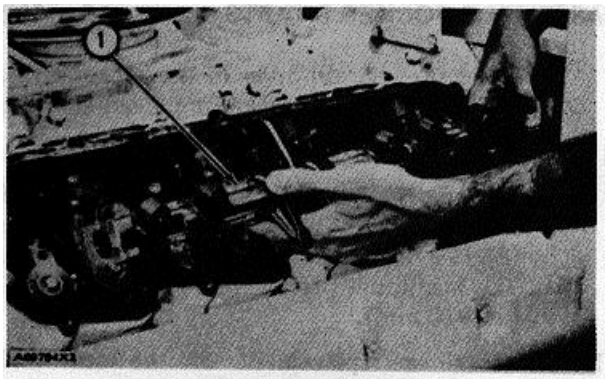
2. Thoroughly clean the area around each fuel line connection. Disconnect fuel injection line (2) from the adapter. Disconnect fuel injection nozzle (3) from the adapter.

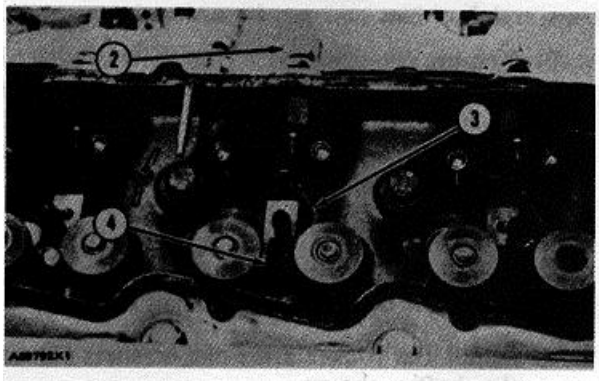
3. Remove clamp (4) and the spacer that holds the fuel injection nozzle in place.

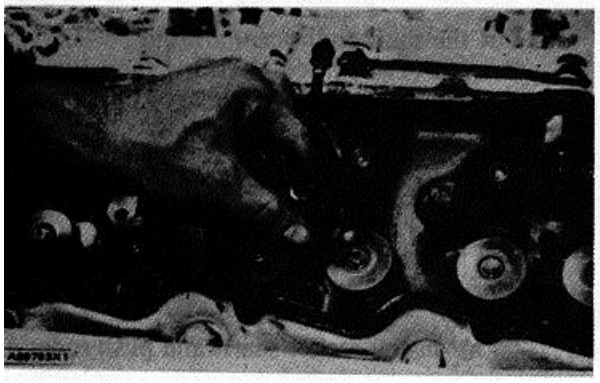
CAUTION: Never use force to remove the fuel injection nozzles. If necessary, use a twisting motion to pull the fuel injection nozzle out of the cylinder head.

4. Remove the adapter from the cylinder head. Remove the fuel injection nozzle.

5.







FUEL INJECTION NOZZLE

INSTALL FUEL INJECTION NOZZLES 12-1254

Tools Needed		A	B
8S2242	Nozzle Test Group	1	
8S2252	Carbon Seal Installation Tool		1

CAUTION: Always check the fuel injection nozzles for leakage, opening pressure and the shape and amount of fuel (spray pattern) coming out of the nozzles with tool (A) before installing the nozzles in the cylinder head. See TESTING FUEL INJECTION NOZZLES in TESTING AND ADJUSTING.

1. Remove carbon seal dam (2) with pliers. Remove compression seal (1).

2. Install a new compression seal on the nozzle. Install a new carbon seal dam with tool (B).

3. Make sure the bore in the cylinder head and the fuel inlet fittings are clean.

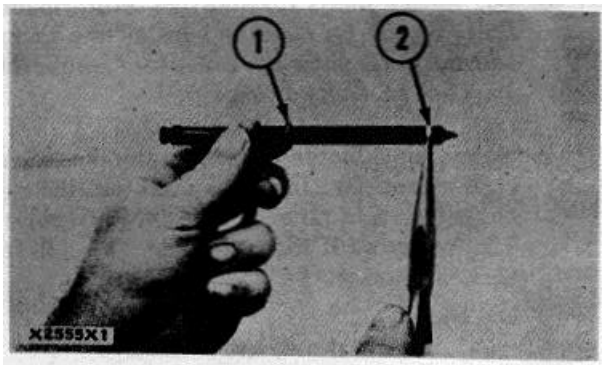
4. Install new O-ring seals on adapter (3) and fuel injection nozzle (4).

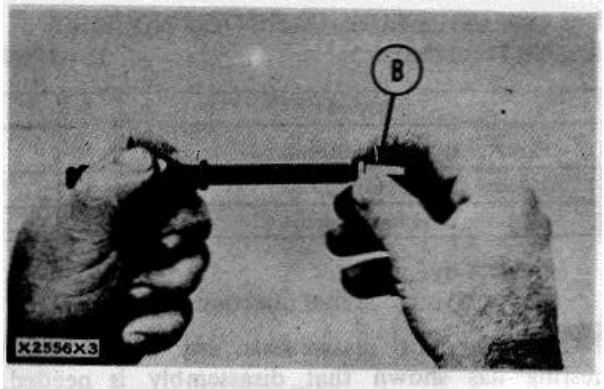
5. Install the fuel injection nozzle in the head. Use a twisting motion to push the nozzle into its correct position. Never put lubricant on the nozzle or bore in the cylinder head.

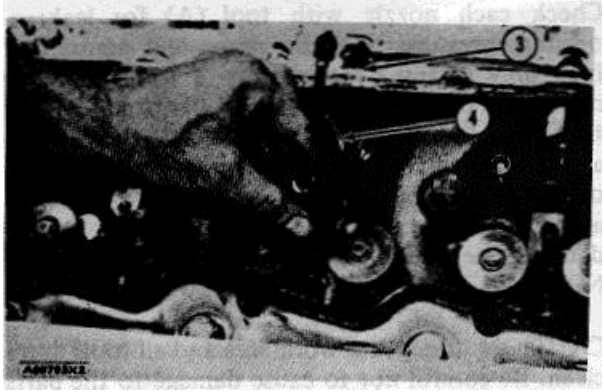
6. Install the adapter in the head. Connect the nozzle and fuel injection line to the adapter. Tighten the nuts to a torque of 30 ± 5 lb. ft. (4.1 ± 0.7 mkg).

7. Install the spacer and clamp that holds the nozzle to the cylinder head.

8.



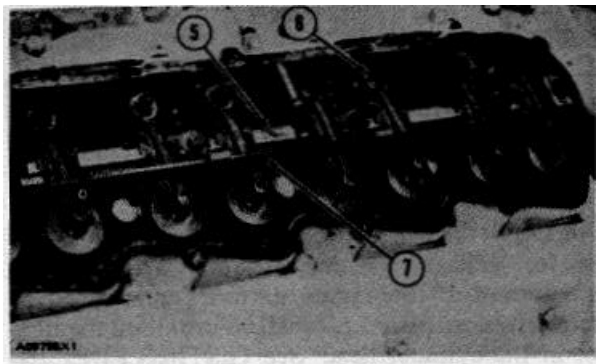




FUEL INJECTION NOZZLES

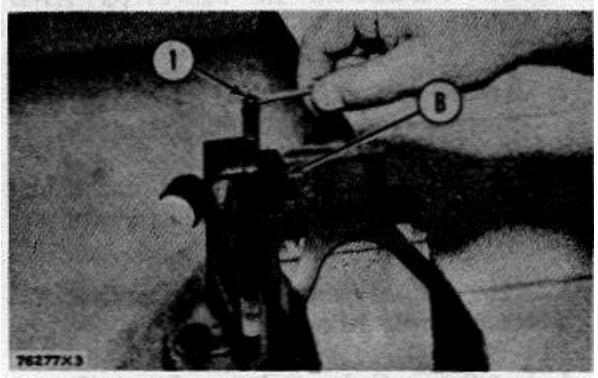
8. Put rocker shafts (5) and fuel return manifolds (7) in position and install the locks and bolts. Tighten the bolts to a torque of 18 ± 5 lb.ft. (2.5 ± 0.7 mkg).

9. Make adjustments until the intake valve clearance is .01-5 in. (0.38 mm) and the exhaust valve clearance is .025 in. (0.64 mm). Tighten nuts (6) to a torque of 24 ± 5 lb.ft. (3.3 ± 0.7 mkg).
   end by:
   a) install valve covers

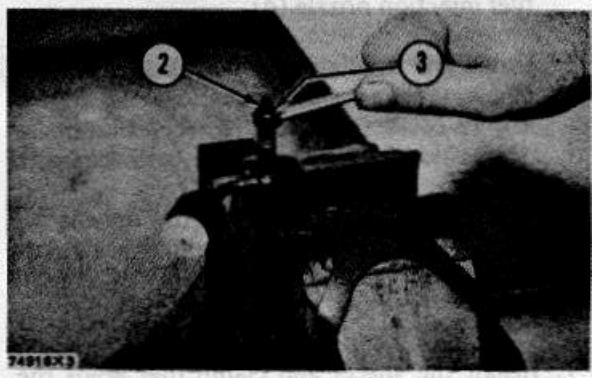


DISASSEMBLE FUEL INJECTION NOZZLES (9L7883 Nozzles) 15-1254

Tools Needed		A	B	C
8S2242	Nozzle Test Group	1		
8S2250	Nozzle Holding Tool		1	
5P958	Valve Retractor			1



start by:
a) remove fuel injection nozzles



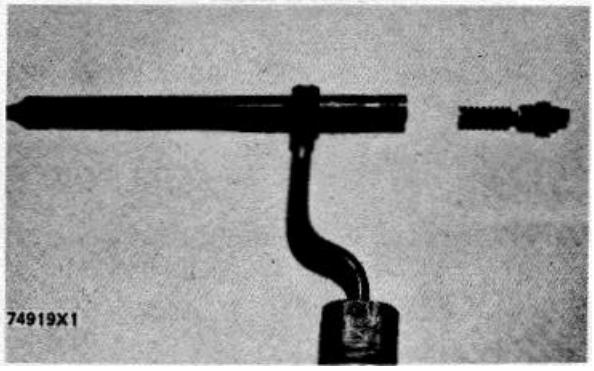
NOTE: Do not disassemble any nozzle until testing has shown that disassembly is needed. Check each nozzle with tool (A) for leakage, opening pressure, and the shape and amount of fuel(spray pattern) coming out of the nozzle. Do not clean or make an adjustment to any nozzle that has a large (excessive) amount of return leakage. Excessive return leakage can be an indication of nozzle failures that can not be corrected with an adjustment or cleaning and can cause engine damage. See TESTING 9L7883 FUEL INJECTION NOZZLES in TESING AND ADJUSTING.

CAUTION: Keep the work area and all tools extra clean. Be careful not to cause damage to the parts during disassembly and assembly of the nozzles.

1. Put the nozzle in tool (B). Put tool (B) and the nozzle in a vise. Do not put any part of a nozzle directly in a vise. Loosen locknut (1).

2. Loosen adjusting screw (2) approximately three turns. Loosen pressure screw (3).

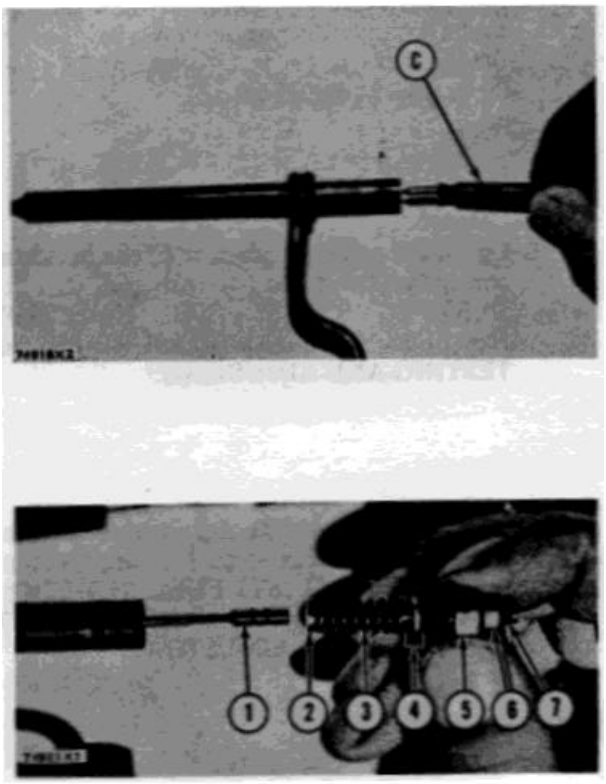
3. While holding the nozzle in one hand, tilt the nozzle and remove the pressure adjusting screw and locknut, shims, spring, seat, and valve.



FUEL INJECTION NOZZLES

4. If the valve does not slide out of the nozzle, install tool (C) and remove valve as follows:
   a) Push valve into nozzle with tool (C) until valve is against bottom of nozzle.
   b) Push down on body of tool (C) to engage collet on valve with tool (C).
   c) Turn nut counterclockwise and remove valve from the nozzle body.

5. Put the parts in solvent to loosen carbon and deposits of foreign material. The body is assembled with an epoxy material and must not be in contact with the solvent for more than one to two hours. See SPECIAL INSTRUCTION FORM NO. FM055225 for the correct method of cleaning the nozzle.



ASSEMBLE FUEL INJECTION NOZZLES (9L7883 Nozzles) 16-1254

Tools Needed		A	B
8S2250	Nozzle Holding Tool	1	
8S2242	Nozzle Test Group		1

NOTE: Make sure all of the parts have been thoroughly cleaned before assembling the nozzles. Flush the body to remove any debris or lapping compound.

1. Put clean fuel on all of the parts.

2. Put valve (1) in position in the body as shown.

3. Install adjusting screw (7) into pressure screw (5). Turn the adjusting screw two or three turns and install locknut (6). Do not tighten the locknut.

4. Put shims (4), spring (3), and seat (2) in position on the adjusting screw. The thicker shim of shims (4) must be against the screw.

5. Put seat (2) in contact with the valve and push the valve into position in the body. Tighten the pressure screw by hand.

FUEL INJECTION NOZZLES

6. Put the nozzle in position in tool (A). Put tool (A) and the nozzle in a vise. Tighten the pressure screw to a torque of 75 to 80 lb. in. (86.5 to 92.2 cm. kg).

7. Check the opening pressure of the nozzle as controlled by shims (4) with tool (B). See TESTING 9L7883 FUEL INJECTION NOZZLES, OPENING PRESSURE TEST in TESTING AND ADJUSTING.

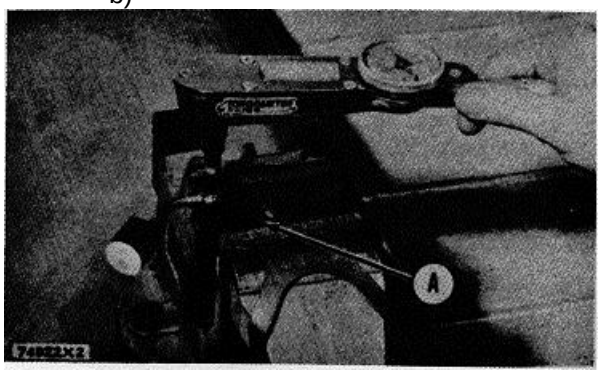
8. Check the valve lift adjustment as controlled by adjusting screw (7) with tool (B). See TESTING 9L7883 FUEL INJECTION NOZZLES, VALVE LIFT ADJUSTMENT in TESTING AND ADJUSTING.

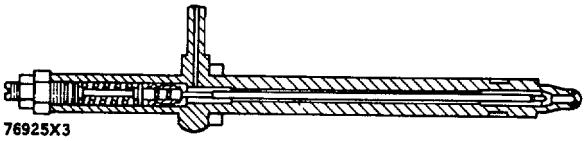
9. Hold the adjusting screw with a screwdriver and tighten the locknut until the adjusting screw will not turn.

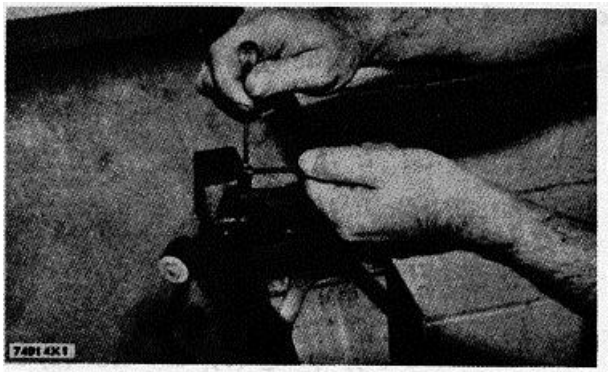
10 Tighten the locknut to a torque of 35 to 40 lb. in. (40.4 to 46.1 cm. kg).
end by:
   a) install fuel injection nozzles

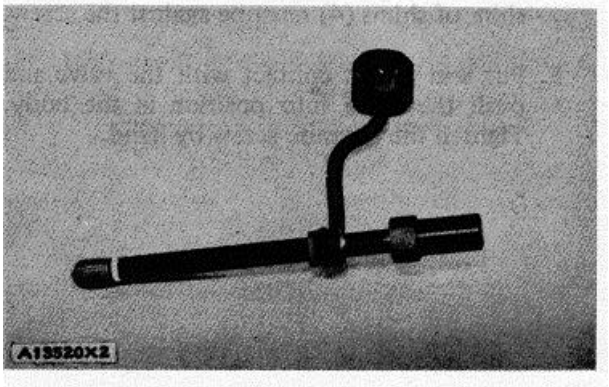
11. Illustration A13520X2 shows the later 9L6969 Fuel Injection Nozzle. Disassembly and Assembly is basically the same as the 9L7883 Nozzle. See testing and adjusting procedures of the 9L6969 Fuel Injection Nozzle in 3208 INDUSTRIAL AND MARINE ENGINE, TESTING AND ADJUSTING.
end by:
   a) install fuel injection nozzles

b)









CYLINDER HEADS

REMOVE CYLINDER HEADS 11-A & B-1101

	Tools Needed	A
8S6692	Water Sleeve Tool	1

start by:
- a) remove exhaust manifold
- b) remove air inlet manifold
- c) remove valve covers
- d) remove rocker shafts and push rods
- e) remove fuel injection nozzles

1. Remove the coolant from the cooling system.

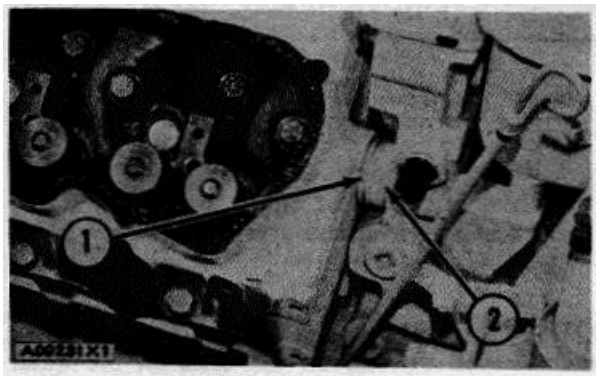
2. Remove clamp (2) from the water sleeves (1) in each cylinder head. Push water sleeves into timing gear cover with tool (A).

3. Remove bolts (3) and (4) that hold cylinder heads to cylinder block.

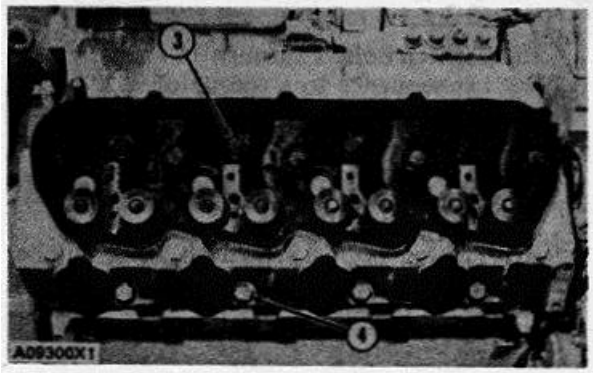
CAUTION: Make sure the fuel injection nozzles are removed before removing the cylinder head. The fuel injection nozzles go through the cylinder head and the nozzle tips can be broken off if the nozzles are not removed from the heads.

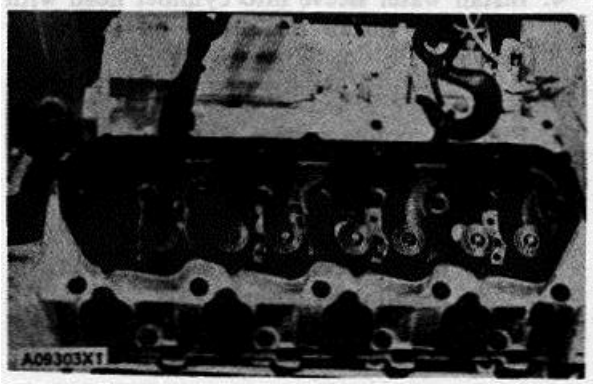
4. Install two 5/16"-18 NC forged eyebolts in the cylinder head. Fasten a hoist and remove cylinder head. Weight of the cylinder head is 85 lb. (39 kg).

5.





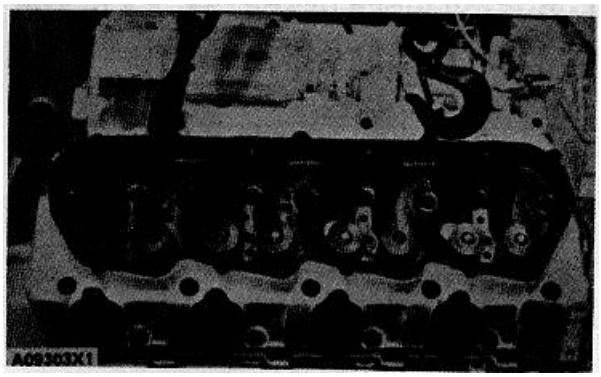




CYLINDER HEADS

INSTALL CYLINDER HEADS 12-A & B-1101

	Tools Needed	A
8S8692	Water Sleeve Tool	1



1. Clean the contact surfaces of the cylinder head and cylinder block. Make sure the surfaces are clean and dry. Install a new cylinder head gasket.

NOTE: Clean the bore in the cylinder head for the water sleeves. Put oil on the seals on the water sleeves.

2. Install two 5/16"-18 NC forged eyebolts in the cylinder head. Fasten a hoist and put the cylinder head in position on the cylinder block.

3. Put 9M3710 Anti-Seize Compound on the bolt threads and install the bolts that hold the cylinder head in place. Tighten the bolts in the cylinder head as follows:
   a) Tighten bolts I through 18 in number sequence to a torque of 60 10 lb.ft. (8.3 ± 1.4 mkg).
   b) Tighten bolts 1 through 18 again in number sequence to a torque of 95 ± 5 lb.ft. (13.1 ± 0.7 mkg).
   c) Tighten bolts 1 through 18 again in number sequence to a torque of 95 ± 5 lb.ft. (13.1 ± 0.7 mkg).
   d) Tighten bolts 19 through 22 in number sequence to a torque of 32 ± 5 lb.ft. (4.4 ± 0.7 mkg).

4. Install water sleeve into cylinder head with tool (A). Install the clamp on the water sleeves.

5. Fill the cooling system with coolant to the correct level.
   end by:
   a) install fuel injection nozzles
   b) install rockershafts and push rods
   c) install valve covers
   d) install air inlet manifold
   e) install exhaust manifold

CYLINDER HEADS

DISASSEMBLE CYLINDER HEADS 15-1101

Tools Needed	A	B	C	D
FT806 Cylinder Head Stand	1			
FT967 Adapter Plate	2			
8S2263 Valve Spring Tester		1		
551330 Valve Spring Compressor			1	
8S7170 Valve Seat Insert Puller Group				1

start by:

a) remove cylinder heads

1. Fasten a hoist and put the cylinder head in position on tool (A). Use adapter plates (1) from tooling (A) to hold the head in place.

2. Put tension on the valve springs with tool (C) and remove the locks.

NOTE: Later engines have only one valve spring and a spacer instead of the inner spring.

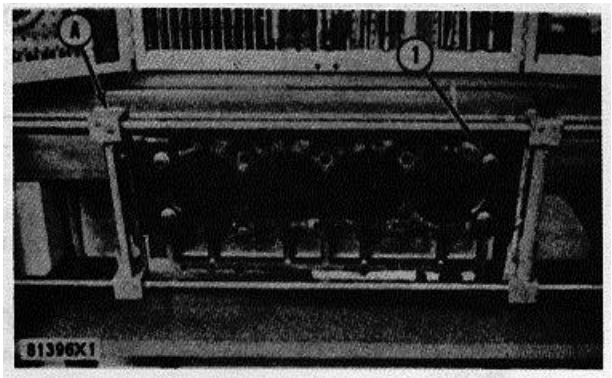
3. Remove tool (C), retainer, springs, washer, and valve from the cylinder head. Put identification on the valve as to its location in the cylinder head.

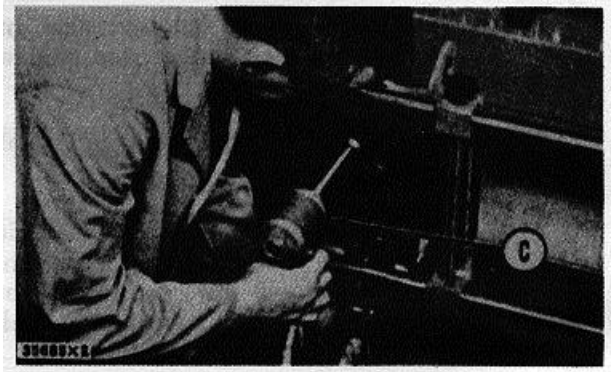
4. Check the spring force with tool (B). The spring force for the outer spring is 35 ± 5 lb. (15.9 ± 2.3 kg) when the length of the spring under the test force is 1.715 in. (43.56 mm). The spring force for the inner spring (if so equipped) is 16.5 ± 4 lb. (7.4 ± 1.8 kg) when the length of the spring under the test force is 1.715 in. (43.56 mm).

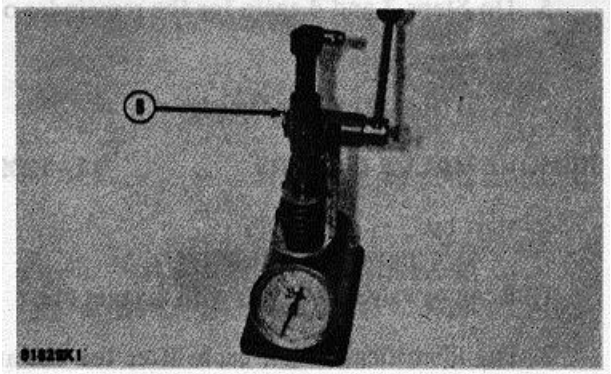
5. Do Steps 2 through 4 again for the remainder of the valves.

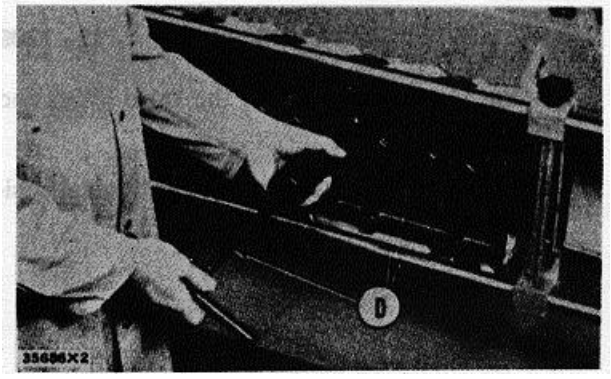
6. Remove the exhaust valve seat inserts with tooling (D).

NOTE: The valve guides are part of the cylinder head. Measure the bore in each valve guide .75 in. (19.0 mm) from the outside edge on both ends of each valve guide. The bore must be .3745 ± .0005 in. (9.512 ± 0.013 mm). The maximum permissible bore is .3760 in. (9.550 mm). Valve guides worn more than the maximum specification can be made to the original size by knurling.









CYLINDER HEADS, VALVE LIFTERS

ASSEMBLE CYLINDER HEADS 16-1101

Tools Needed		A	B
5S1330	Valve Spring Compressor	1	
8S7170	Valve Seat Insert Puller Group		1

1. Clean and remove all foreign material from the exhaust valve seat insert bores. Install new exhaust valve seat inserts with tooling (B).

2. Grind the valve inserts according to specifications given in ENGINE SPECIFICATIONS.

3. Put clean engine oil on the valve stem. Install the valve, washer, springs, and retainer in the cylinder head.

4. Put tool (A) on the valve springs and install the locks. -

WARNING: Make sure the locks are in their correct position on the valve. The locks can be thrown from the valve when tool (A) is released if the locks are not in their correct position on the valve.

5. Do Steps 3 and 4 again for the remainder of the valves.
   end by:
   a) install cylinder heads

REMOVE VALVE LIFTERS 11-1209

start by:
a) remove cylinder heads

1. Remove valve lifters (2) with magnet (1).

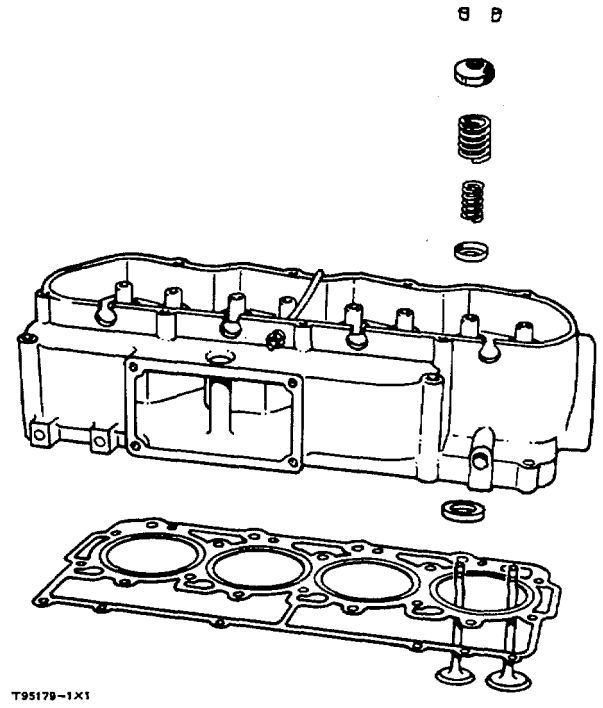
2. Put identification on each lifter for use at installation of the valve lifters.

INSTALL VALVE LIFTERS 12-1209

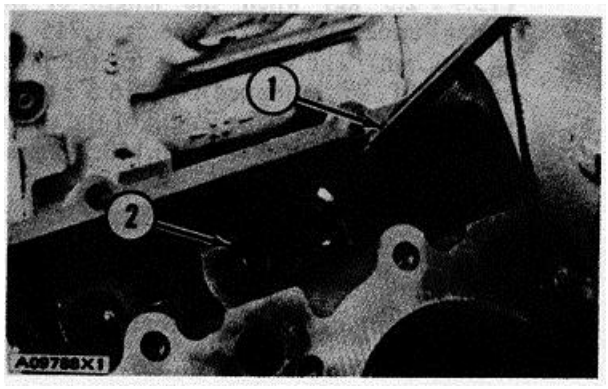
1. Put clean engine oil on the valve lifters and camshaft lobes.

2. Install the valve lifters in their original positions in the cylinder block.
   end by:
   a) install cylinder heads

b)



EARLIER CYLINDER HEAD ILLUSTRATED



PISTONS

REMOVE PISTONS 11-1214

	Tools Needed	A
8S2269	Ridge Reamer	1

start by:
a) remove cylinder heads
b) remove oil pan

1. Remove the ring of carbon from the top inner surface of the cylinders with tool (A).

2. Turn the crankshaft until two pistons are at bottom center.

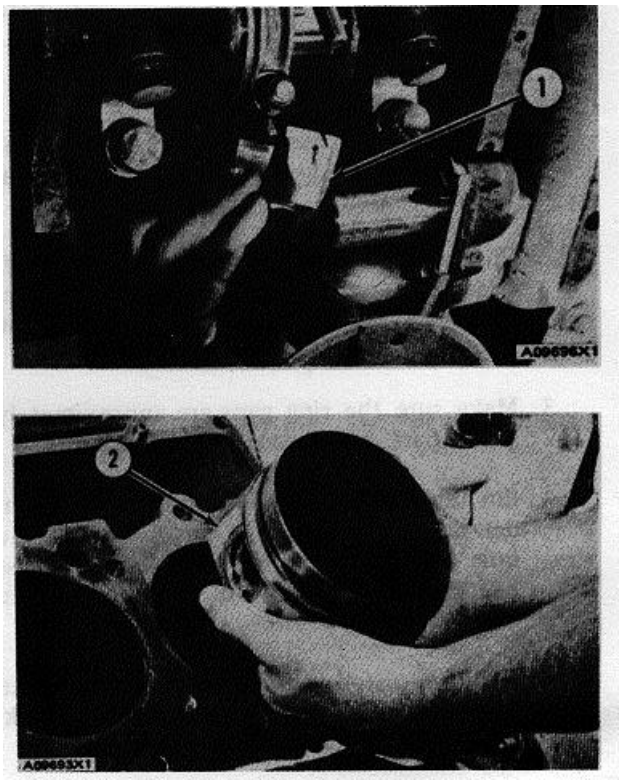
3. Remove connecting rod caps (1) from the two connecting rods.

CAUTION: Do not let the connecting rods hit the bottom edge of the cylinder bores or the crankshaft during removal and installation of the pistons.

4. Push the piston and connecting rod away from the crankshaft until the piston rings are above the cylinder block.

5. Remove the two pistons (2) and the connecting rods. Keep each connecting rod cap with its respective connecting rod and piston. Put identification on each connecting rod as to its location for use at installation.

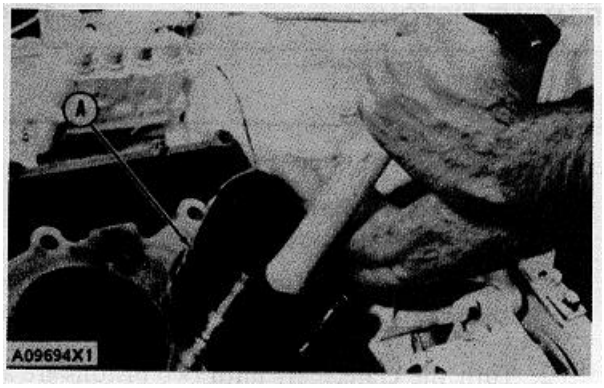
6. Do Steps 3 through 6 for the remainder of the pistons.



PISTONS

INSTALL PISTONS 12-1214

Tools Needed		A
1Y7426	Compressor	1



1. Turn the crankshaft until the bearing journal for the pistons to be installed is at bottom center.

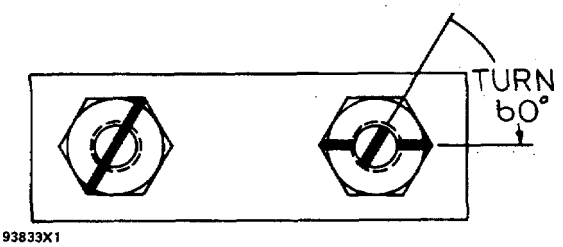
2. Put clean engine oil on the crankshaft bearing journal and inside of the cylinder walls. Put clean engine oil on the piston rings and connecting rod bearings.

3. Make sure the ring gaps are approximately 120° apart. Install tool (A) on the piston.

4. Put the piston in position in the same cylinder bore from which it was removed. The hole (crater) in the top of the piston must be toward (nearest) the center of the engine.

5. Push the piston into place while putting the connecting rod into position on the crankshaft.

6. Put clean engine oil on the threads of the bolts and contact surfaces of the nuts for the connecting rod caps.



CAUTION: When installing connecting rod caps, make sure that the numbers on the side of the cap is next to and respective with the number on the side of the connecting rod.

7. Put the cap in position on the connecting rod and install the nuts. Tighten the nuts to a torque of 30 ± 3 lb.ft. (4.1 ± 0.4 mkg). Put a mark on each nut and the end of each bolt. Tighten the nuts 60 ± 5° more.

8. Follow the same above procedure for installation of the remainder of the pistons.

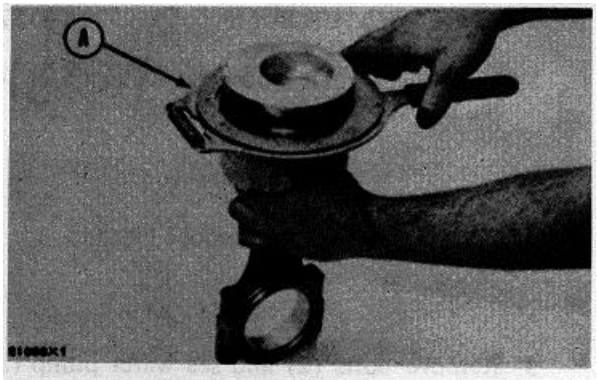
PISTONS

DISASSEMBLE PISTONS 15-1214

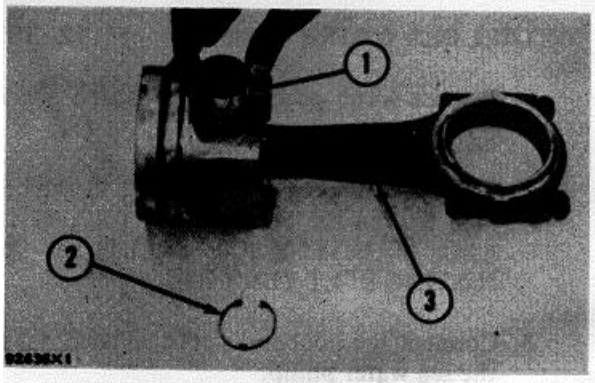
Tools Needed		A
5F9059	Ring Expander	1

start by:
a) remove pistons

1. Remove the rings from the piston with tool (A).



2. Remove snap ring (2), pin (1), and connecting rod (3) from the piston.

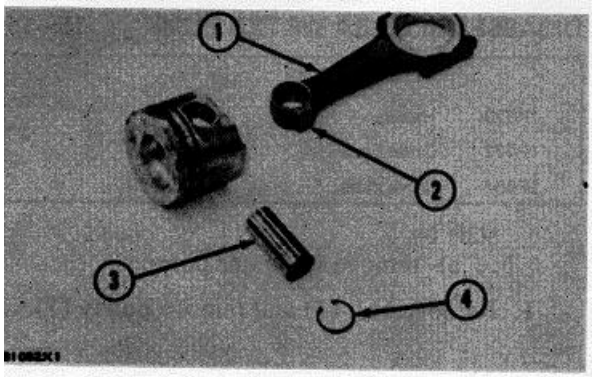


ASSEMBLE PISTONS 16-1214

Tools Needed		A	B
SS2304	Piston Ring Groove Cleaner	1	
5F9059	Ring Expander		1

1. Install connecting rod (1) in the piston with boss (2) on the same side as the hole (crater) in the top of the piston.

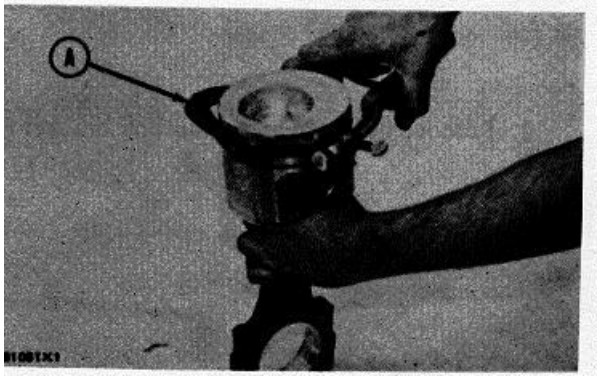
2. Install piston pin (3) and snap ring (4).



3. When old pistons are to be used, clean the piston grooves with tool (A).

4. Install the spring for the oil ring. Install the oil ring with tool (B). The gap in the ring must be approximately 180° from the oil ring spring connection.

5. Install the compression ring using tool (B). The side of the ring having identification "TOP" must be toward top of piston. The gaps in the rings must be approximately 120° apart.



NOTE: Compression rings not having identification must be installed with the edge having a bevel toward the top of the piston.

end by:
a) install pistons

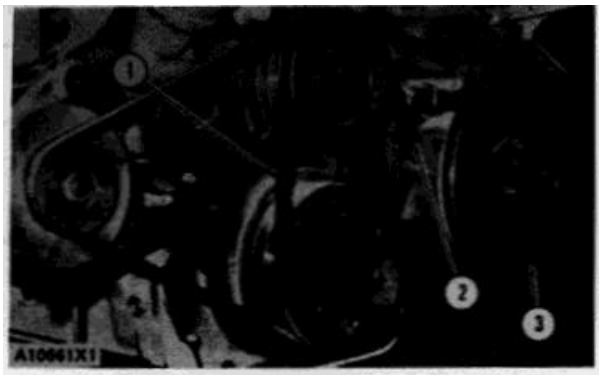
SEA WATER PUMP

REMOVE SEA WATER PUMP 11-1371

1. Disconnect inlet and outlet water hoses for the sea water pump.

2. Loosen bolts (2) and remove belt (1).

3. Remove bolts (2) and sea water pump (3).



INSTALL.SEA WATER PUMP 12-1371

1. Put sea water pump (I) in position and install the pump bolts hand tight.

2. Install and make an adjustment to the belt, then tighten the bolts. See LUBRICATION AND MAINTENANCE GUIDE for ADJUSTING BELT TENSION.

3. Connect the inlet and outlet water hoses for the sea water pump.

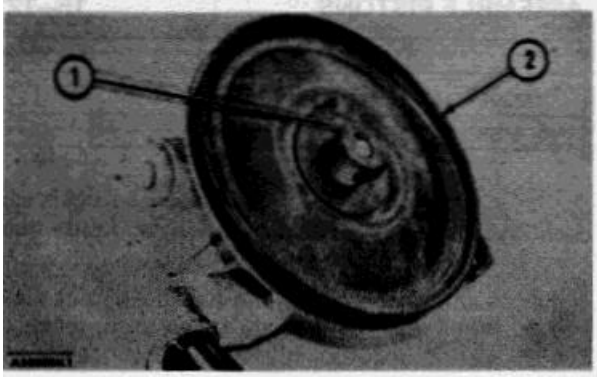


DISASSEMBLE SEA WATER PUMP 15-1371

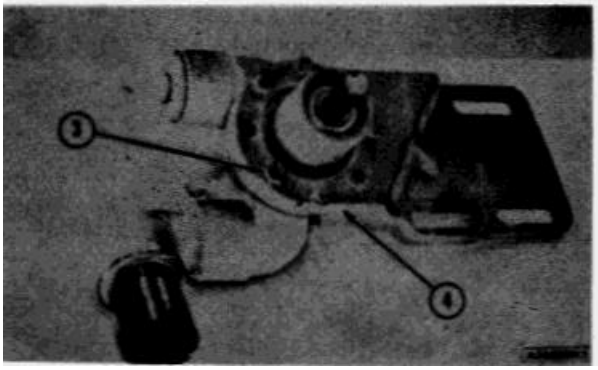
	Tools Needed	A
1P529	Handle	1
1P472	Drive Plate	1
1P464	Drive Plate	1

start by:
a) remove sea water pump

1. Remove -bolt (I) and remove pulley (2).

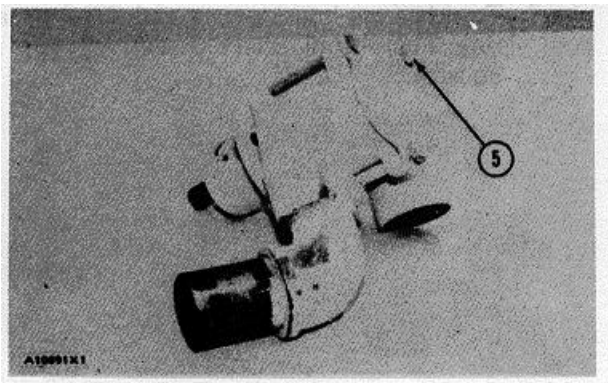


2. Remove bolts (3) and mounting bracket (4).

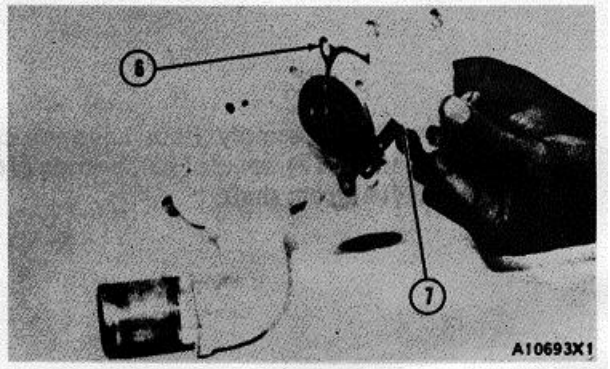


SEA WATER PUMP

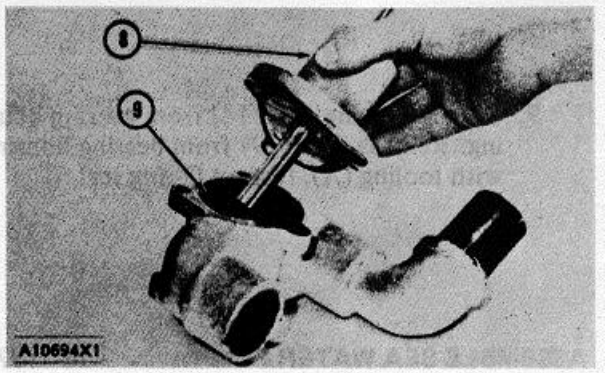
3. Turn pump assembly over and remove bolts (5) from the impeller housing.



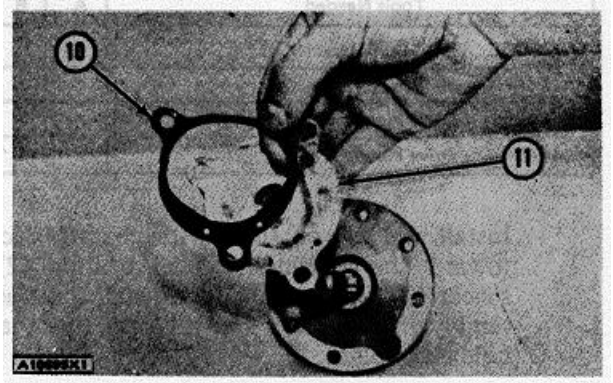
4. Remove cover (7) and gasket (6). Inspect gasket.



5. Turn pump assembly over again and remove bearing housing (8). Remove impeller (9).

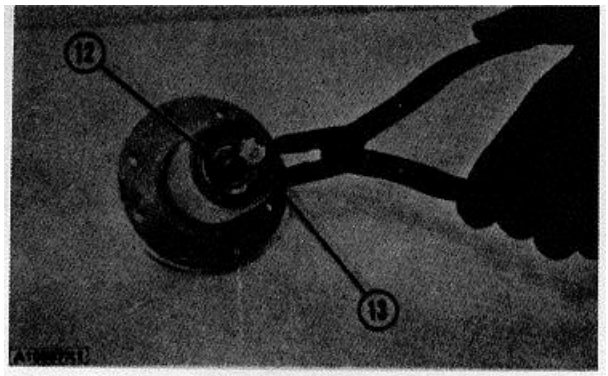


6. Remove gasket (10) and wear plate (11) from bearing housing. Inspect gasket.

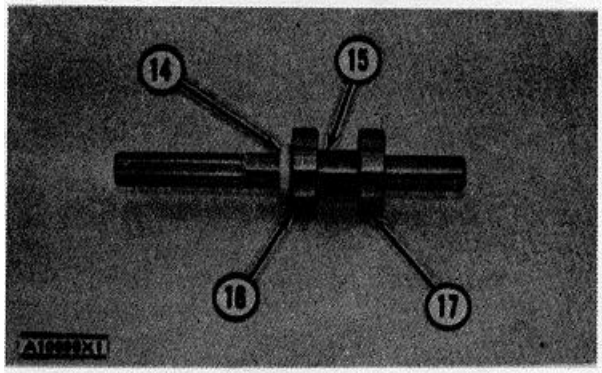


SEA WATER PUMP

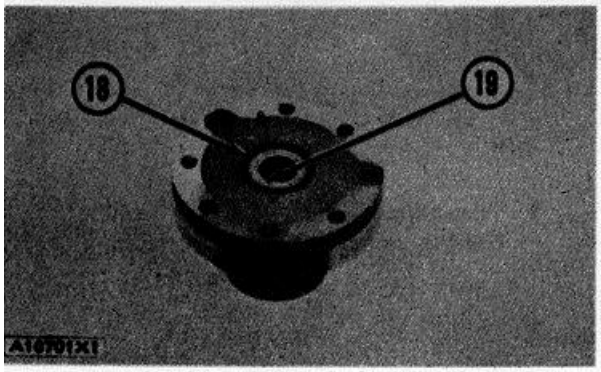
7. Turn bearing housing over and remove snap ring (12) from shaft assembly (13) in housing.



8. Remove shaft assembly from housing. Remove bearing (17), spacer (15), bearing (16) and seal (14) from shaft.



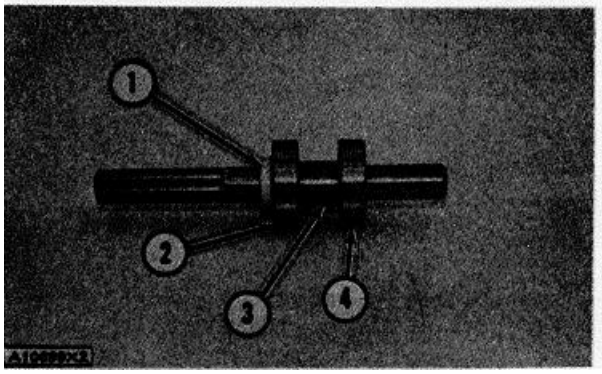
9. Remove O-ring seal (18) from bearing housing. Remove seal (19) from bearing housing with tooling (A). Inspect O-ring seal.



ASSEMBLE SEA WATER PUMP 16-1371

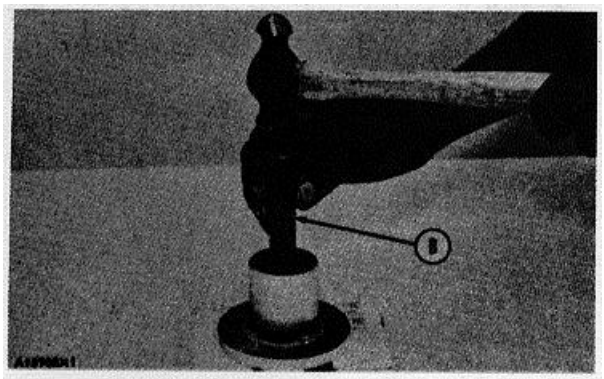
Tools Needed		A	B
1Y7426	Ring Compressor	1	
1P529	Handle		1
1P472	Drive Plate		1
1P464	Drive Plate		1

1. Install seal (1) on shaft with chamfer face toward the bearings. Install bearing (2), spacer (3) and bearing (4). Install shaft assembly into housing and the snap ring that holds it in place.

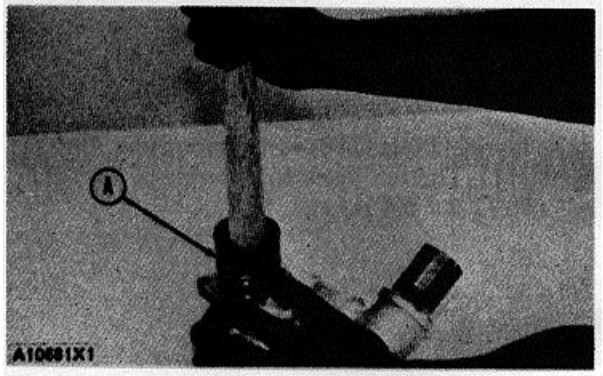


SEA WATER PUMP

2. Install seal in bearing housing with tooling (B) with the lip of the seal toward the bearings. Install new O-ring seal in housing.

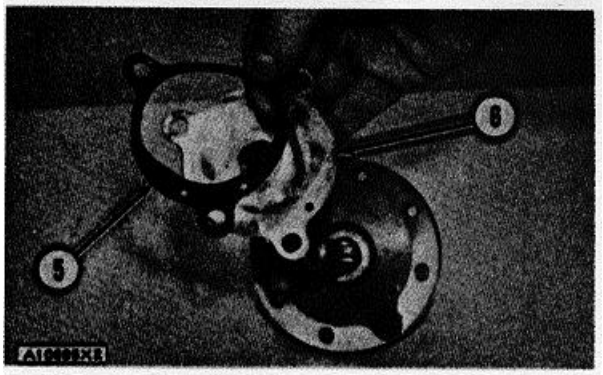


3. Install impeller into housing with tool (A). Use a hammer to push the impeller into the housing.



CAUTION: Be careful not to cut edges of the inlet and outlet ports when installing.

4. Install wear plate (6) and a new gasket (5) on bearing housing.



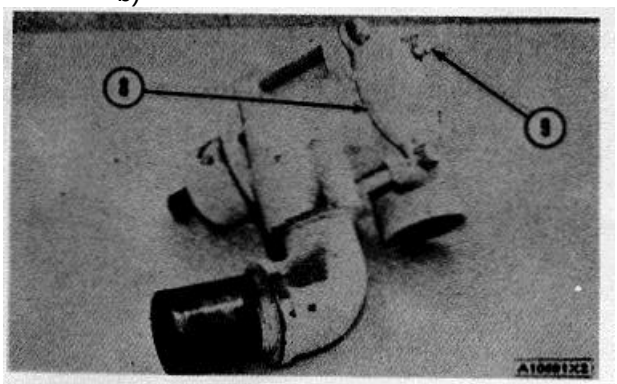
5. Install bearing housing (7) into impeller housing.



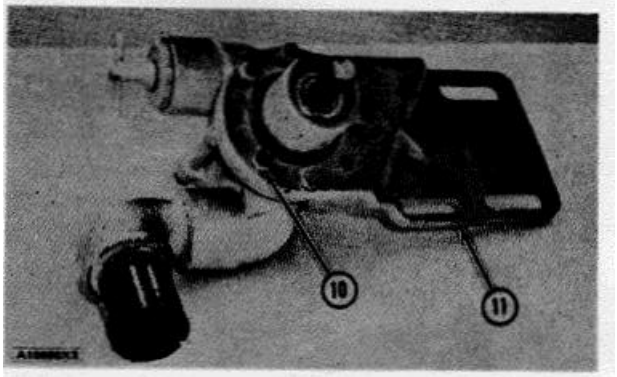
SEA WATER PUMP

6. Install gasket and cover (8) on impeller housing. Install bolts (9) that hold cover (8).

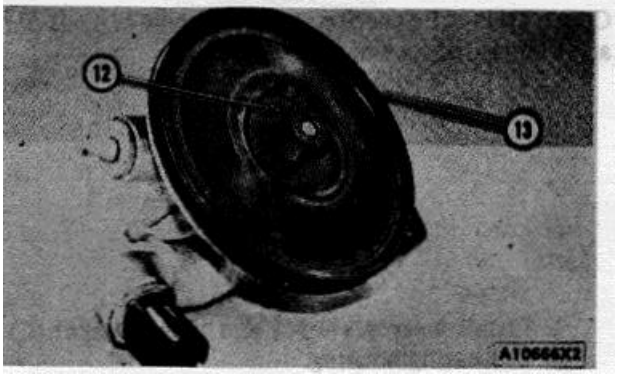
b)



7. Install bolts (10) and mounting bracket (11). Tighten bolts to a torque of 17 ± 3 lb. ft. (2.4 ± 0.4 mkg).



8. Install pulley (13) and bolt (12). Tighten bolt to a torque of 10 ± 2 lb. ft. (1.4 ± 0.3 m kg).
   a) install sea water pump



CRANKSHAFT PULLEY

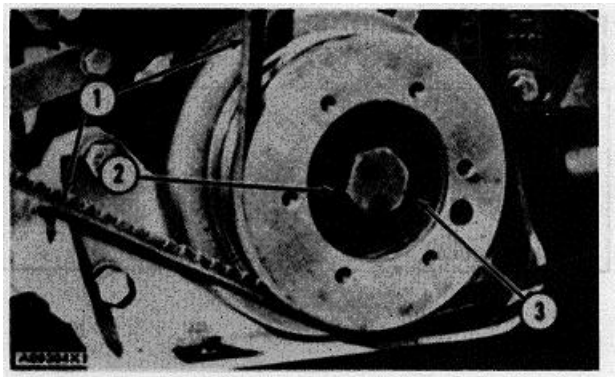
REMOVE CRANKSHAFT PULLEY (MARINE ENGINE) 11-1205

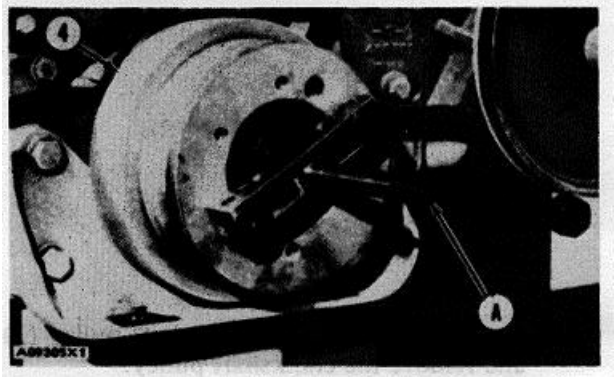
	Tools Needed	A
5F7465	Puller Assembly	1
8B7560	Step Plate	1
5M2894	Washer	1
S1590	Bolt	1

1. Remove drive belts (I).

2. Remove bolt (2) and washer (3).

3. Install tooling (A) on crankshaft pulley (4) and remove the crankshaft pulley.





INSTALL CRANKSHAFT PULLEY (MARINE ENGINE) 12-1205

	Tools Needed	**A**
1F7464	Bolt 1 "-14 NF x 4" long	1

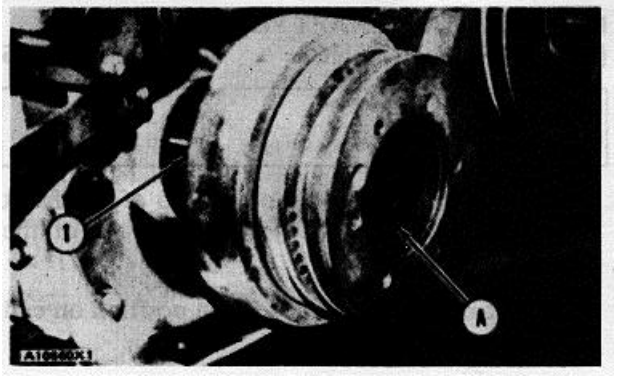
1. Put clean engine oil on the lip of the front crankshaft seal and sealing surface of the crankshaft pulley.

2. Put crankshaft pulley (1) in position on end of crankshaft.

3. Install a standard washer and tool (A) in pulley and tighten bolt until the pulley makes contact with the crankshaft gear. Remove tool (A) and the standard washer.

4. Install the original washer and bolt in the end of the crankshaft. Tighten the bolt to a torque of 460 ± 60 lb. ft. (63.6 ± 8.3 mkg).

5. Install the drive belts. Make an adjustment to the belt tension. See FAN AND ALTERNATOR BELTS in LUBRICATION AND MAINTENANCE GUIDE.



REMOVE CRANKSHAFT PULLEY (INDUSTRIAL ENGINE) 11-1205

	Tools Needed	A
5F7465	Puller Assembly	1
8B7560	Step Plate	1
5M2894	Washer	1
S1590	Bolt	1

1. Remove alternator belts.

2. Remove bolt (1) and washer (2).

3. Install tooling (A) on crankshaft pulley (3) and remove the crankshaft pulley.

INSTALL CRANKSHAFT PULLEY (INDUSTRIAL ENGINE) 12-1205

	Tools Needed	A
1F7464	Bolt 1"-14 NF x 4" long	1

1. Put clean engine oil on the lip of the front crankshaft seal and sealing surface of the crankshaft pulley.

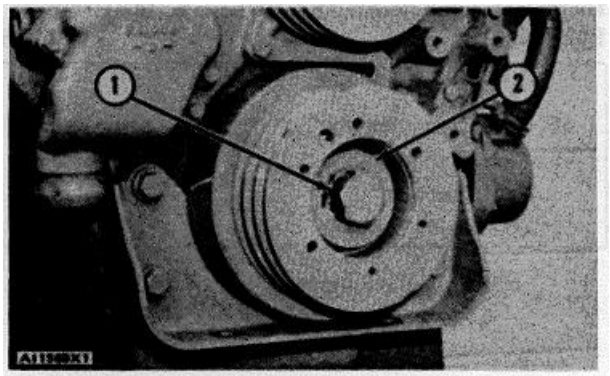
2. Put crankshaft pulley (1) in position on end of crankshaft.

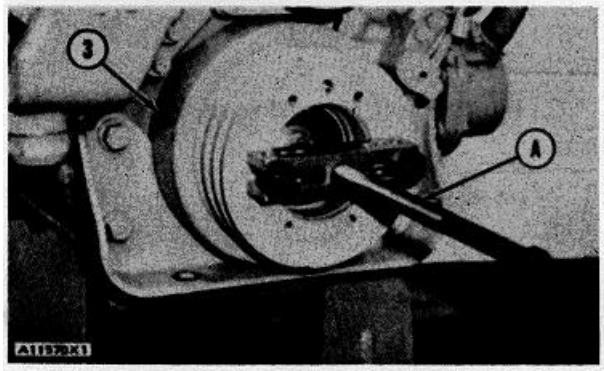
3. Install a standard washer and tool (A) in pulley and tighten bolt until the pulley makes contact with the crankshaft gear. Remove tool (A) and the standard washer.

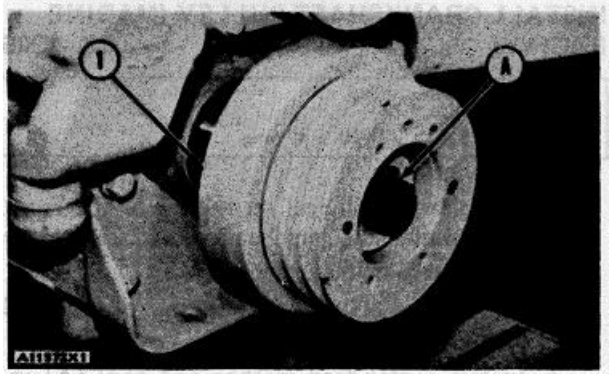
4. Install the original washer and bolt in the end of the crankshaft. Tighten the bolt to a torque of 460 ± 60 lb. ft. (63.6 ± 8.3 mkg).

5. Install the alternator belts. Make an adjustment to the belt tension. See FAN AND ALTERNATOR BELTS in LUBRICATION AND MAINTENANCE GUIDE.

6.







CRANKSHAFT FRONT SEAL

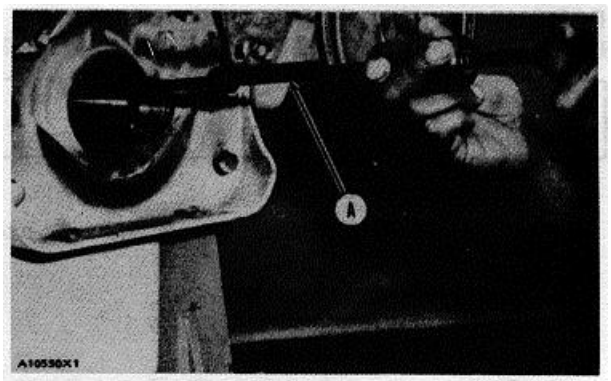
REMOVE CRANKSHAFT FRONT SEAL 11 -1160

Tools Needed		A
1P3075	Puller Group	1

start by:

a) remove crankshaft pulley

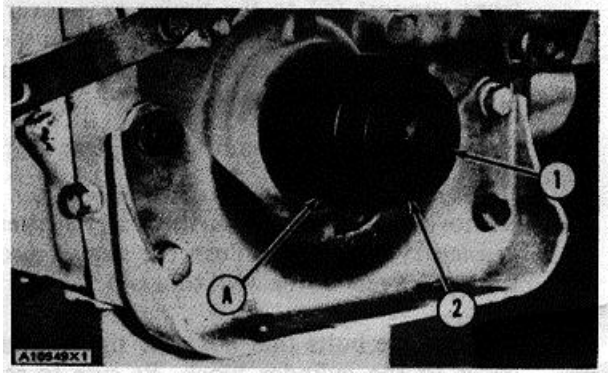
1. Remove the front seal with tool group (A).



INSTALL CRANKSHAFT FRONT SEAL 12-1160

Tools Needed		A
5P4194	Installer Assembly	1

1. Put 7F2770 Cement on the outer metal surface of the front seal. Put the seal in position on the short end of the installer assembly (A). The lip of the seal must be toward the inside of the engine.

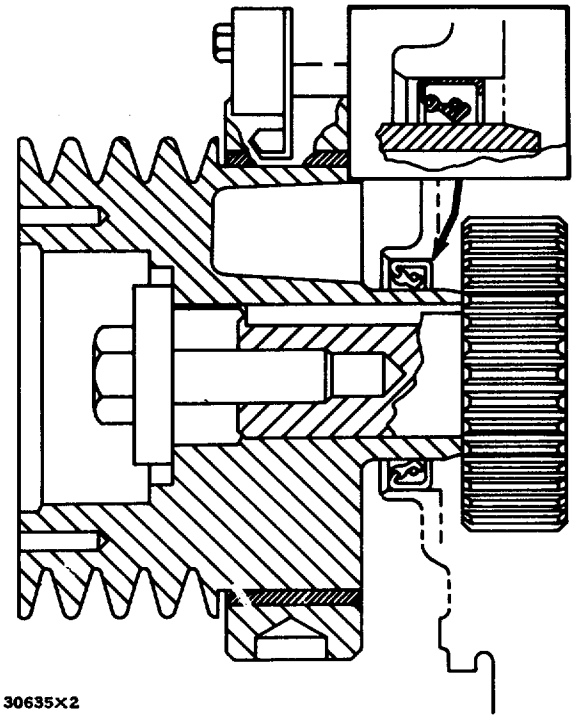


NOTE: If a new wear surface for the front seal is needed, put the spacer from tooling (A) between the seal and flange of the installer assembly.

2. Put the seal and installer assembly in position on the end of the crankshaft. Install bolt (1) and washer (2) that hold the crankshaft pulley in place. Tighten the bolt until the installer assembly makes contact with the crankshaft gear. Remove the bolt, washer and tool (A).

end by:

a) install crankshaft pulley



TIMING GEAR COVER AND OIL PUMP

REMOVE TIMING GEAR COVER AND OIL PUMP (MARINE ENGINE) 11-1166 & 1304

Tools Needed		A
8S6692	Water Sleeve Tool	1

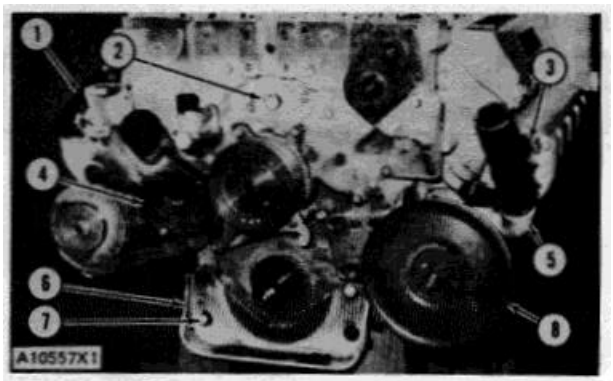
start by:

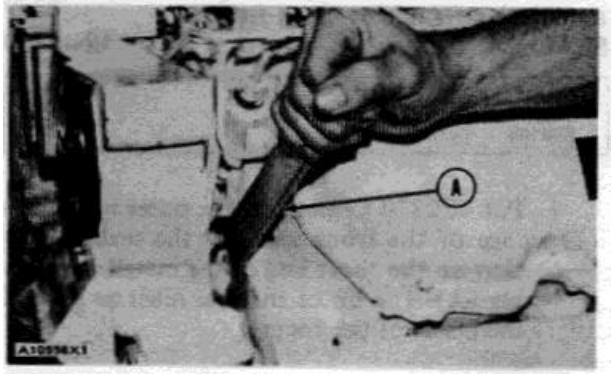
a) remove expansion tank and heat exchanger
b) remove sea water pump
c) remove crankshaft pulley
d) remove oil pan

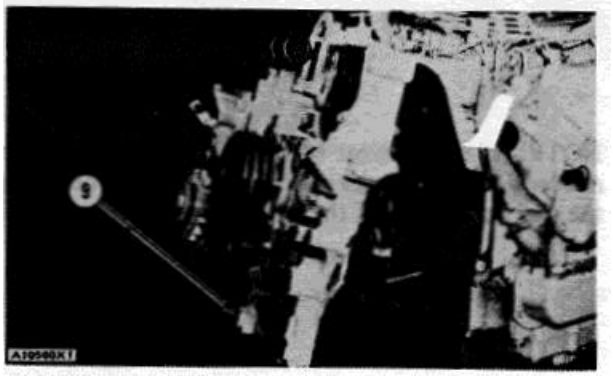
1. Remove the four bolts (7) that hold the front support (6) to the timing gear cover. Remove the water lines (1) and (3) from the exhaust manifold. Remove the tachometer drive adapter (2). Remove elbow (4).
2. Remove elbow (5). Remove sea water pump (8).
3. Remove the clamps from the water sleeves in each cylinder head. Push the sleeves into the timing gear cover with tool (A).
4. Remove the bolts that hold the timing gear cover to the cylinder block. Be sure to remove the bolt that is behind elbow (4). Put identification of the bolts as to their location for use at installation.

CAUTION: Be extra careful not to cause damage to the crankshaft front seal during removal and installation of the timing gear cover.

5. Install two 7/16"-14 NC forged eyebolts in the timing gear cover. Fasten a hoist and remove timing gear cover (9) and the oil pump from the dowels on the cylinder block. The weight of the cover and pump is 136 lb. (62 kg).







TIMING GEAR COVER AND OIL PUMP

INSTALL TIMING GEAR COVER AND OIL PUMP (MARINE ENGINE) 12-1166 & 1304

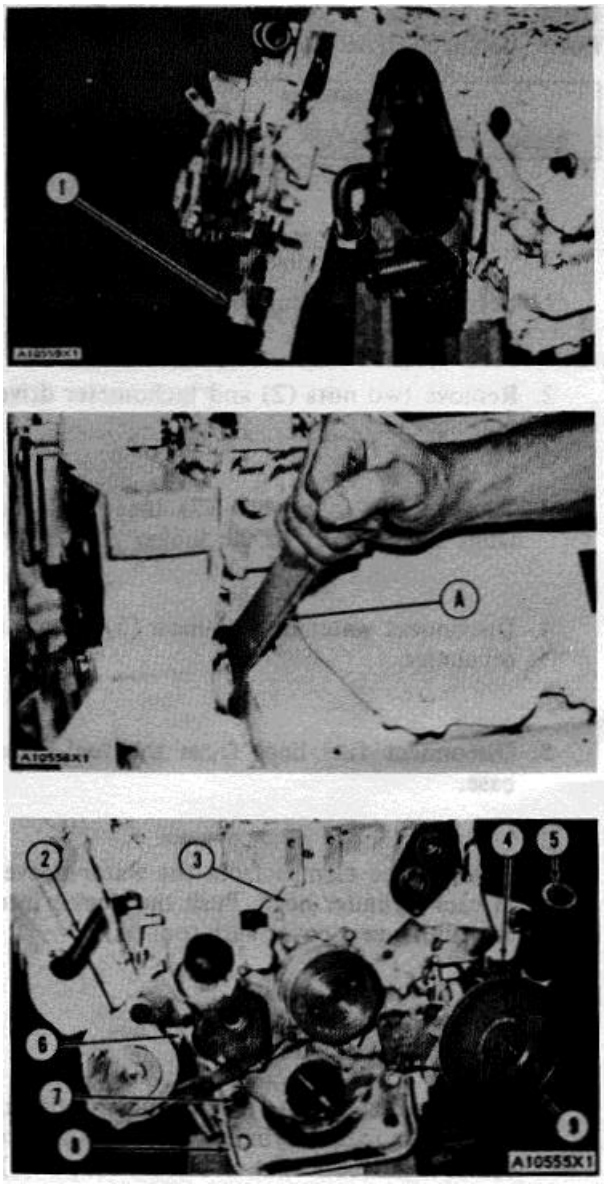
Tools Needed		A
8S6692	Water Sleeve Tool	1

1. Clean the contact surfaces of the cylinder block and timing gear cover. Install the timing gear cover gasket on the cylinder block.

NOTE: Make sure the water sleeves are installed in the timing gear cover. Put oil on the seals.

2. Install two 7/16"- 14 NC forged eyebolts in the timing gear cover. Fasten a hoist and put the timing gear cover (1) and the oil pump in position on the engine. Make sure the oil pump gear and crankshaft gear are in alignment.
3. Install the bolts that hold the cover in place.
4. Push the water sleeves into the cylinder heads with tool (A). Install clamps.
5. Put the engine front support (8) in position and install the bolts (7) that hold it in place.
6. Install elbow (6) and bolts that hold it to the timing gear cover. Connect water lines (2) and (4) to the exhaust manifolds.
7. Install tachometer drive adapter (3) and the bolts that hold it.
8. Install elbow (5) and sea water pump (9).

end by:
a) install oil pan
b) install crankshaft pulley
c) install sea water pump
d) install expansion tank and heat exchanger



TIMING GEAR COVER AND OIL PUMP

REMOVE TIMING GEAR COVER AND OIL PUMP (INDUSTRIAL ENGINE) 11-1166 & 1304

Tools Needed		A
8S6692	Water Sleeve Tool	1

start by:
a) remove oil pan
b) remove crankshaft pulley

1. Remove oil pump suction pipe.

2. Remove two nuts (2) and tachometer drive housing (I).

3. Remove the four bolts (7) that hold the front support (8) to the timing gear cover.

4. Disconnect water outlet elbow (5) from the oil cooler.

5. Disconnect fuel lines from the fuel filter base.

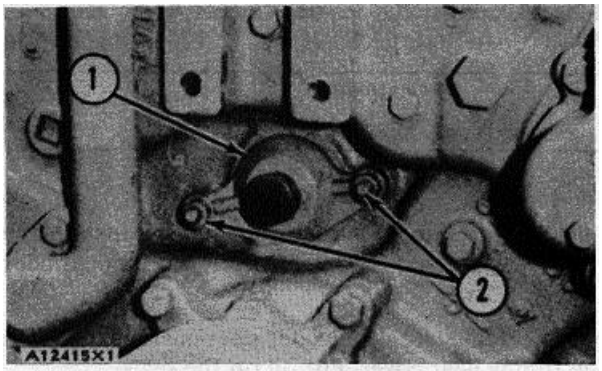
6. Remove the clamps from the water sleeves in each cylinder head. Push the sleeves into the timing gear cover with tool (A).

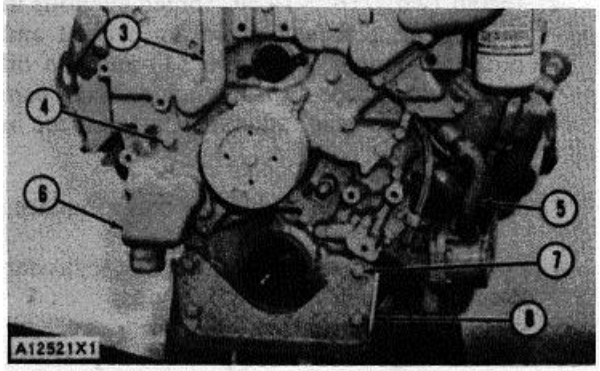
7. Remove connector (3).

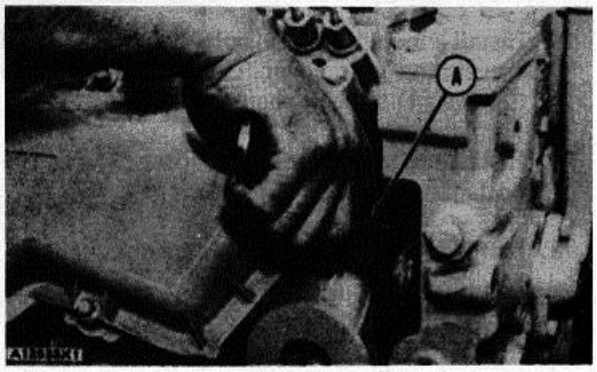
8. Remove the bolts (4) that hold the timing gear cover to the cylinder block. Be sure to remove the bolt that is behind elbow (6). Put identification of the bolts as to their location for use at assembly.

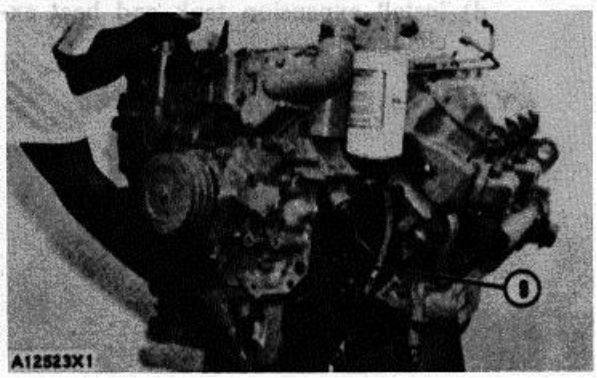
CAUTION: Be extra careful not to cause damage to the crankshaft front seal during removal and installation of the timing gear cover.

9. Install two 7/16"-14 NC forged eyebolts in the timing gear cover. Fasten a hoist and remove timing gear cover (9) and the oil pump from the dowels on the cylinder block. The weight of the timing gear cover and oil pump is 136 lb. (62 kg).



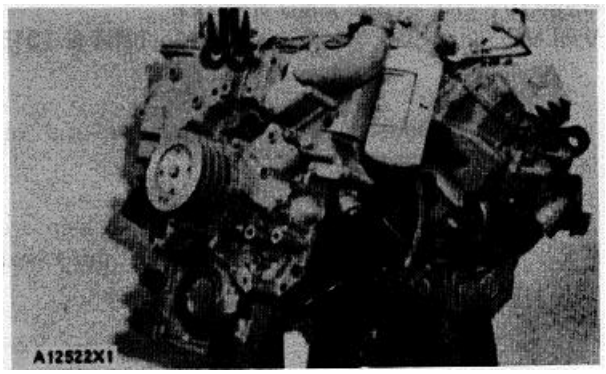






TIMING GEAR COVER AND OIL PUMP

INSTALL TIMING GEAR COVER AND OIL PUMP (INDUSTRIAL ENGINE) 11-1166 & 1304



Tools Needed		A
8S6692	Water Sleeve Tool	1

1. Clean the contact surfaces of the cylinder block and timing gear cover. Install the timing gear cover gasket on the cylinder block.

NOTE: Make sure the water sleeves are installed in the timing gear cover. Put oil on the seals.

2. Install two 7/16"- 14 NC forged eyebolts in the timing gear cover. Fasten a hoist and put timing gear cover and the oil pump in position on the engine. Make sure the oil pump gear and crankshaft gear are in alignment.

3. Install the bolts that hold the cover in place.

4. Install the connector.

5. Push the water sleeves into the cylinder heads with tool (A). Install clamps.

6. Put the engine front support in position and install the bolts that hold it in place. Install the tachometer drive housing.

7. Connect the fuel lines to the fuel filter base.

8. Connect water outlet elbow to the timing gear cover,

9. Install oil pump suction pipe.

end by:
a) install crankshaft pulley
b) install oil pan

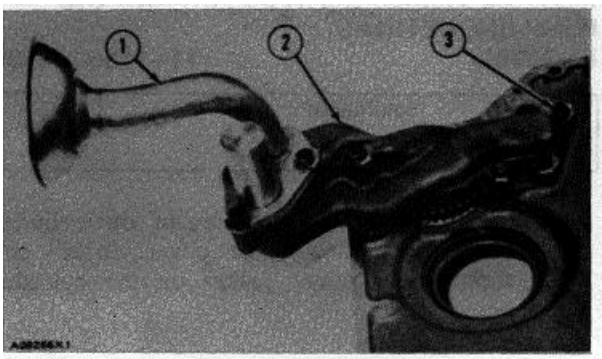
OIL PUMP AND RELIEF VALVE

REMOVE OIL PUMP AND RELIEF VALVE 11-1304 & 1315

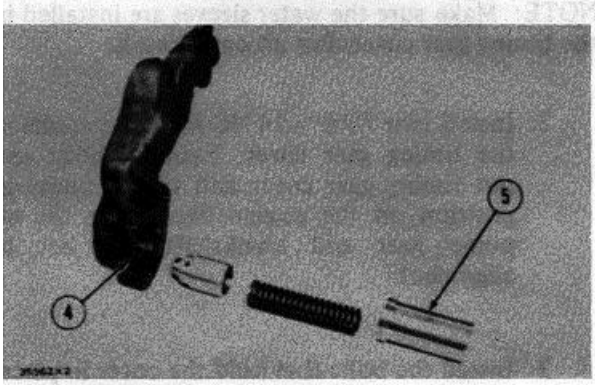
start by:

a) remove timing gear cover and oil pump

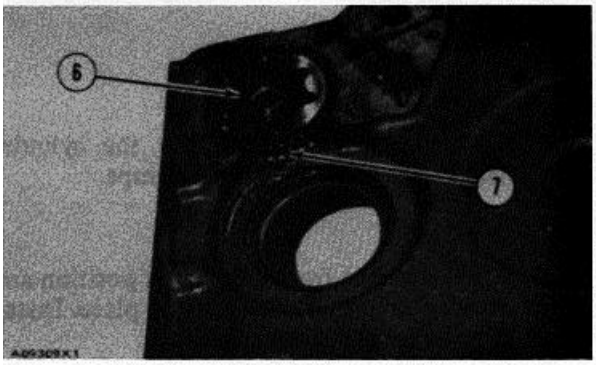
1. Remove oil pump suction pipe (1). Remove bolts (3) and cover (2) from the timing gear cover.



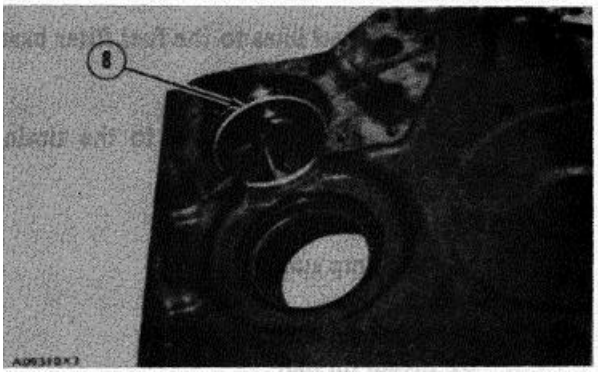
2. Loosen setscrew (4) and remove guide (5), relief valve spring and plunger.



3. Remove inner rotor (6) and outer rotor (7) from the timing gear cover.



4. Measure the inside diameter of bearing (8). The inside diameter must be 2.804 ± .002 in. (71.22 ± 0.05 mm). Remove the bearing as needed.



OIL PUMP AND RELIEF VALVE

INSTALL OIL PUMP AND RELIEF VALVE 12-1304 & 1315

Tools Needed		A
8S2285	Drive Assembly	1

1. Thoroughly clean all of the parts. Put oil on all of the parts.

2. If the bearing was removed from the timing gear cover, install a/new bearing with tool (A).

3. Install inner rotor (2) and outer rotor (1) in the timing gear cover.

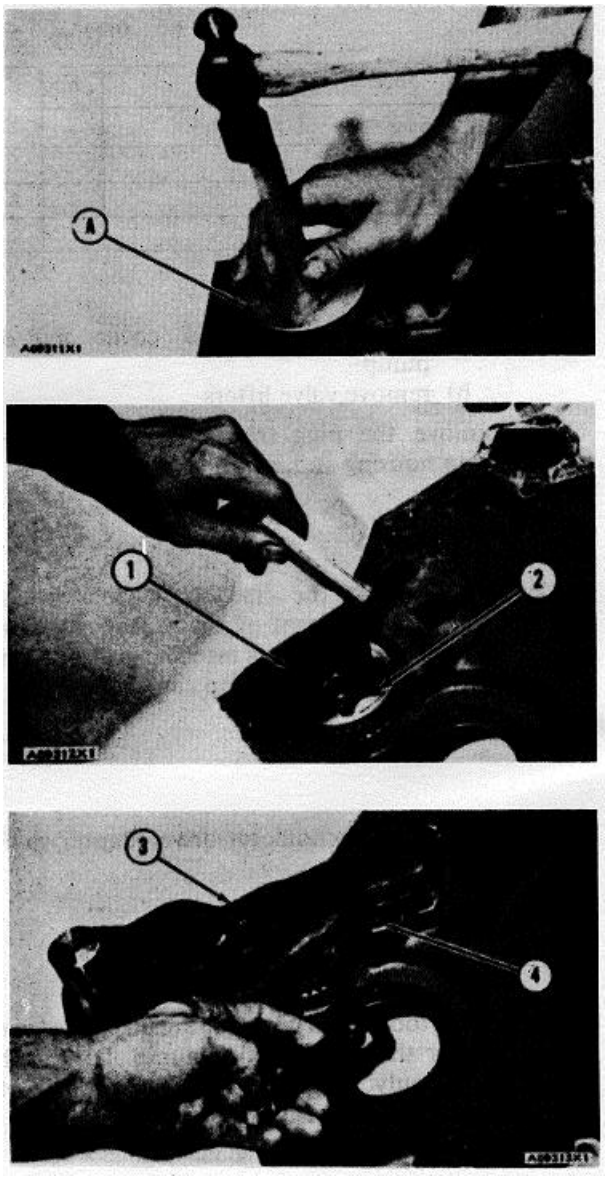
4. Measure the clearance between the rotors with a feeler gauge. The clearance must be .002 to .006 in. (0.05 to 0.15 mm). The maximum permissible clearance is .009 in. (0.23 mm).

NOTE: Make a replacement of both rotors if the clearance is not correct. The rotors can not be ordered separately.

5. Put the plunger and spring in position and push the guide into the cover with a press until the lip on the guide is even with the finished surface on the cover. Make sure the flat surface on the guide is in alignment with the setscrew. Tighten the setscrew.

6. Put cover (3) in position on the timing gear cover. Install the locks and bolts (4).

end by:
a) install timing gear cover and oil pump



CAMSHAFT AND GEARS

REMOVE CAMSHAFT AND GEARS

11-1210 & 1212

Tools Needed	A	B
3P1544 Timing Pin	1	
5P2371 Puller Plate		1
Bolt 1/4"-20 NC x 1" long		2
Flat Washer 1/4"		2

start by:

a) remove timing gear cover and oil pump
b) remove valve lifters

1. Remove the plug from the fuel injection pump housing and install timing pin (A).

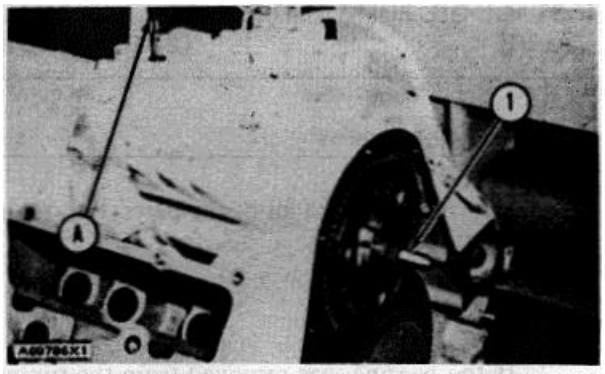
2. While turning the crankshaft clockwise as seen from the front of the engine, push on tool (A) until it slides into the groove (slot) in the fuel injection pump camshaft.

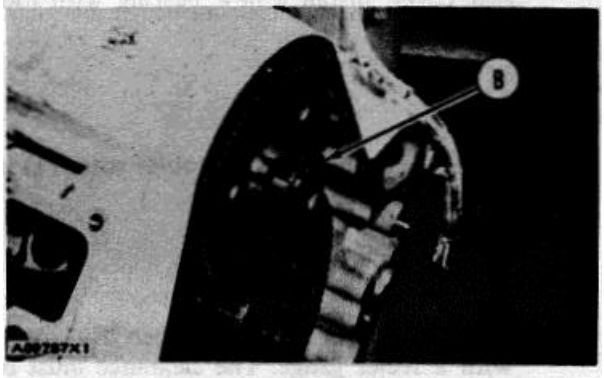
3. Remove the tachometer drive adapter shaft (1).

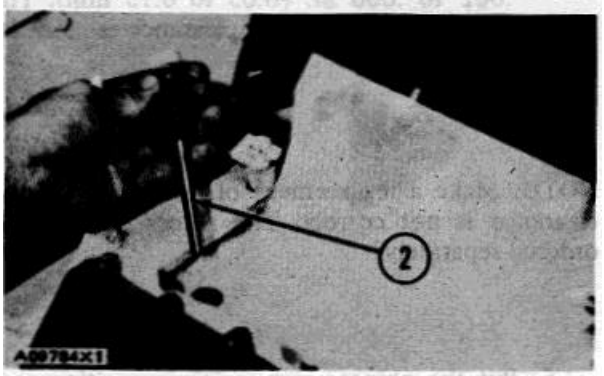
4. Install tooling (B) into the camshaft drive gear for the fuel injection pump. Turn both bolts evenly until the drive gear is free of the shaft. Remove tooling (B).

5. Remove thrust pin (2) that holds the camshaft in place from the rear of the cylinder block.

6. Remove the camshaft (3) and gears from the cylinder block as a unit. Be careful not to cause damage to the camshaft bearing or journals.









CAMSHAFT AND GEARS

INSTALL CAMSHAFT AND GEARS

12-1210 & 1212

Tools Needed		A
3P1544	Timing Pin	1

1. Put clean engine oil on the camshaft lobes and journals. Install camshaft (1) and the gears as a unit. Make sure the timing marks on the crankshaft gear and camshaft gear are in alignment.

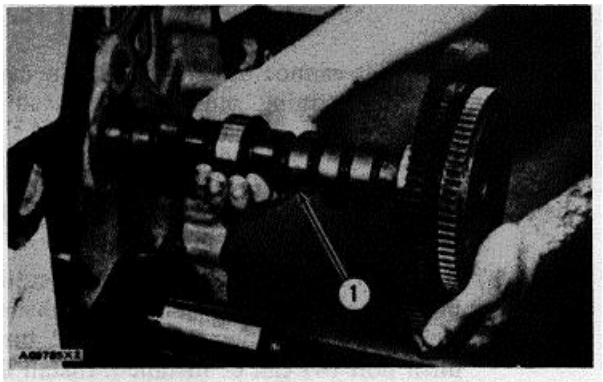
2. Install the thrust pin. Tighten the pin to a torque of 35 ± 5 lb. ft. (4.8 ± 0.7 mkg).

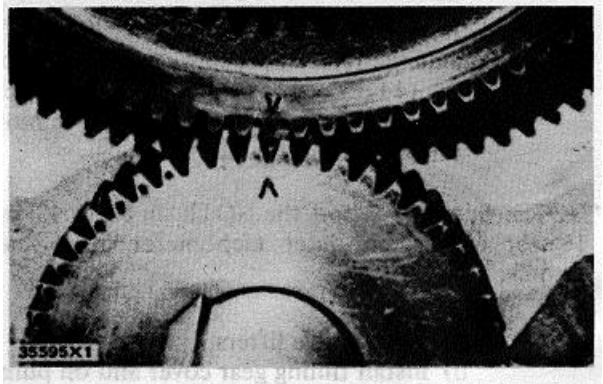
3. Put gear (3) in position and install tachometer drive adapter shaft (2). Tighten the shaft to a torque of 80 ± 5 lb. ft. (11.1 ± 0.7 mkg).

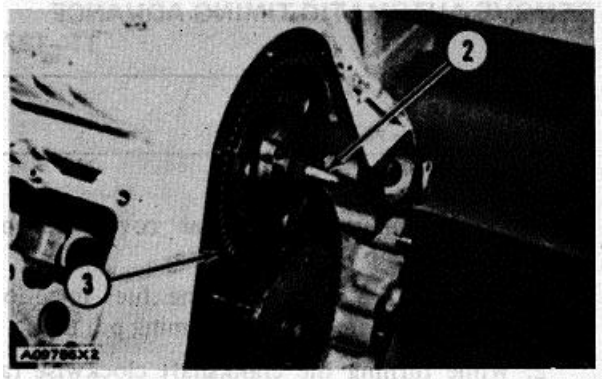
NOTE: See Step 2 and NOTE on Pages 13 and 16 for earlier and later tachometer drive shaft torques.

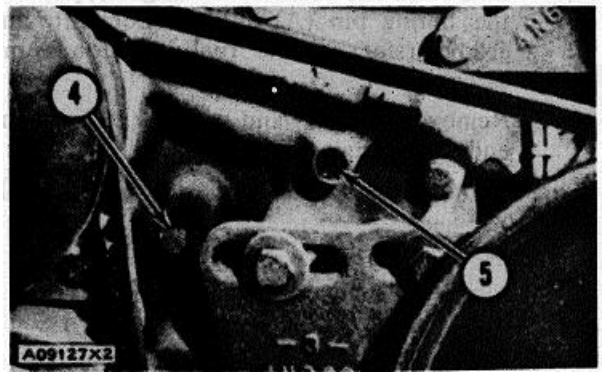
4. After valve lifters and timing gear cover have been installed, check the timing as follows:

   a) Remove timing pin (A).
   b) Turn the crankshaft clockwise as seen from the front of the engine approximately 1/2 turn. Install timing pin (A) again.
   c) While turning the crankshaft clockwise, push on timing pin (A) until it slides into the groove (slot) in the fuel injection pump camshaft.
   d) Remove the plug from the timing hole in the front cover and install a 5/16"-18 NC bolt (4) 2 1/2 in. long. The cover bolt from hole (5) can be used. Turn the crankshaft clockwise until bolt (4) can be installed into the timing gear and is in the center of the timing hole. The camshaft for the fuel injection pump is now in correct time with the engine.
   e) Remove the bolt and install the plug. Remove timing pin (A) and install the plug.









CAMSHAFT AND GEARS,

AUTOMATIC TIMING ADVANCE

NOTE: If the bolt cannot be installed in the camshaft of gear, the timing must be corrected as follows:

a) With timing pin (A) installed, remove the tachometer drive adapter housing and shaft.
b) Loosen the gear from the fuel injection pump camshaft. Turn the crankshaft clockwise approximately two full turns until bolt (4) can be installed. Install the bolt.
c) Install tachometer drive adapter shaft and tighten it to a torque of 80 ± 5 lb. ft. (11.1 ± 0.7 mkg). Install adapter housing. Remove the bolt and timing pin and install the plugs.

•NOTE: See Step 2 and the NOTE on Pages 13 and 16 for earlier and later tachometer drive shaft torques.

end by:

a) install valve lifters
b) install timing gear cover and oil pump

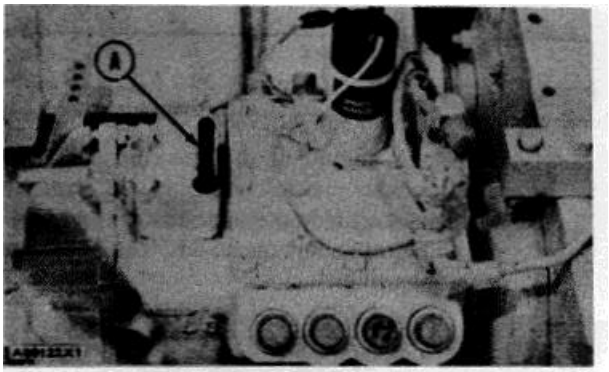
REMOVE AUTOMATIC TIMING ADVANCE 11-1272

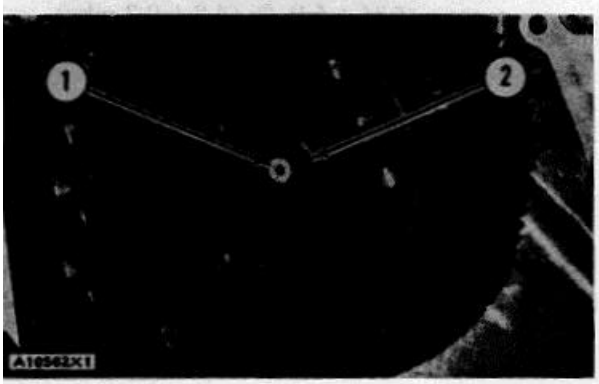
Tools Needed		A
3P1544	Timing Pin	1

start by:

a) remove timing gear cover and oil pump

1. Remove the plug from the fuel injection pump housing and install timing pin (A).
2. While turning the crankshaft clockwise (as seen from the front of the engine), push on the timing pin (A) until it slides into the groove (slot) in the fuel injection pump camshaft.
3. Remove screw (I) and washer (2) from the end of the engine camshaft.
4. Remove the automatic timing advance (3).







AUTOMATIC TIMING ADVANCE

INSTALL AUTOMATIC TIMING ADVANCE
12-1272

1. If the timing mark on the crankshaft and the timing mark on the camshaft gear are not in alignment, turn the crankshaft clockwise (as seen from the front of the engine) until the marks are in alignment.

2. Put the dowels in the gear in alignment with the holes in the weights and install the automatic timing advance.

3. Put pin (2) in washer in alignment with hole (3) in the camshaft and install washer (1).

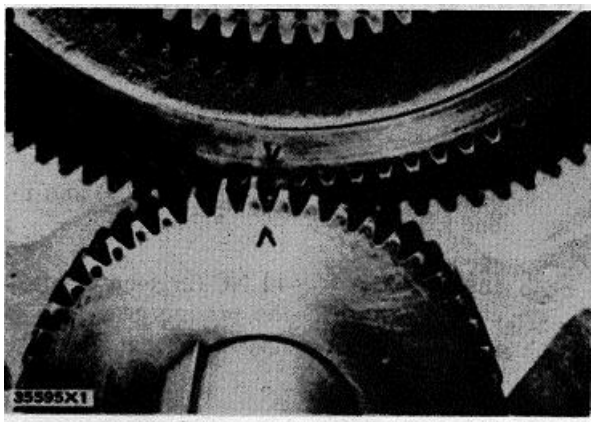
4. Install screw (4) and tighten it to a torque of 108 ± 36 lb. in. (124.5 ± 41.5 cm. kg). Put marks (stake) on the screw in two places with a hammer and punch.

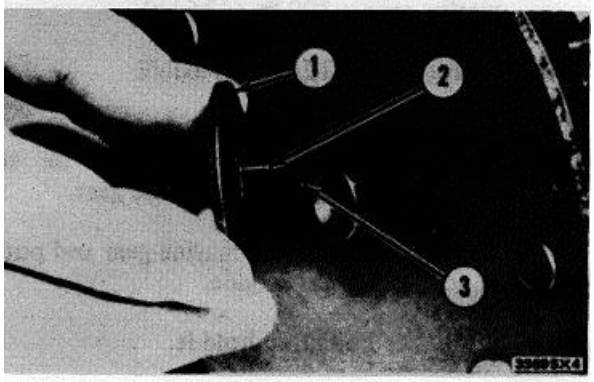
CAUTION: Put marks (stake) on screw (4) carefully. Too much force pushes the shaft extension into the camshaft and takes away all end clearance.

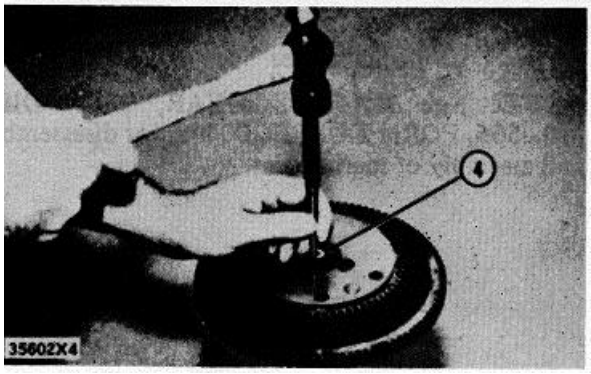
5. After putting marks (stake) on the screw (4), the end clearance for the gear and weight assembly must be .003 to .037 in. (0.08 to 0.94 mm). This end clearance will prevent binding against the washer, camshaft end, or camshaft gear.

end by:

a) install timing gear cover and oil pump







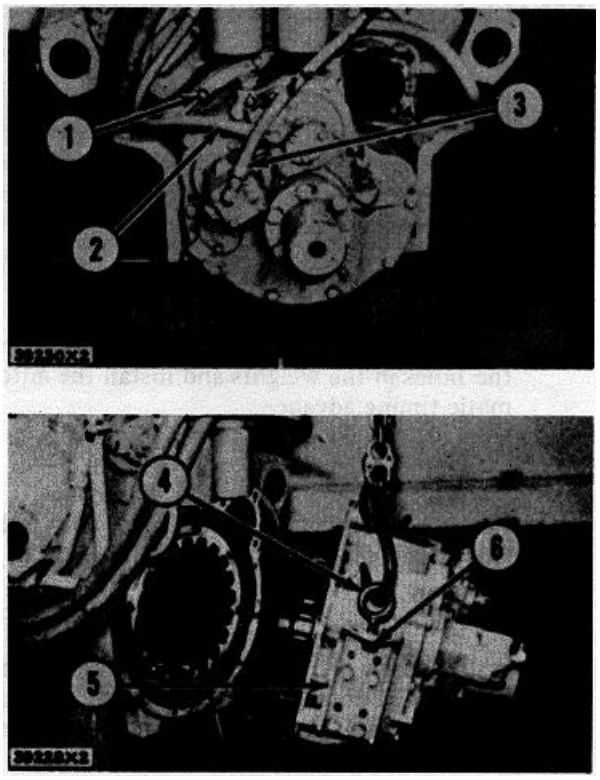
MARINE GEAR

REMOVE MARINE GEAR (MARINE ENGINE) 11-3300

start by:

a) remove starter

1. Disconnect the oil outlet line (2) and inlet line (3).
2. Install two 5/8"- 11 NC forged eyebolts (4) and nuts (6) in the marine gear side supports (5) if so equipped. Fasten a hoist and remove bolts (1).
3. Remove the marine gear. Weight of the marine gear is 300 lb. (136 kg).



INSTALL MARINE GEAR (MARINE ENGINE) 12-3300

1. Put 7M7260 Liquid Gasket on the mounting surface of the marine gear.
2. Fasten a hoist to the marine gear and put it in position on the engine.
3. Install the bolts that hold it.
4. Connect the oil outlet line and inlet line.

end by:

a) install starter

NOTE: See MARINE GEAR, TWIN DISC MG-506, FORM NO. REG00498, for disassembly and assembly of marine gear.

FLYWHEEL

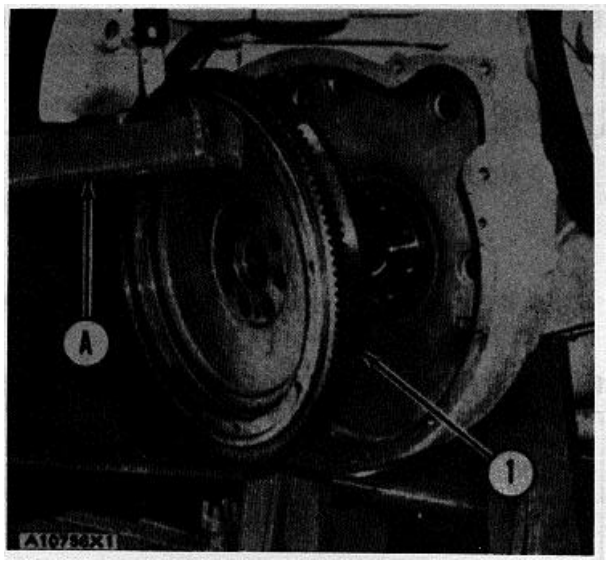
REMOVE FLYWHEEL 11-1156

Tools Needed		A
FT120	Lifting Bracket	1
S609	Bolt	1

start by:

a) remove marine gear (marine engine only)

1. Install tooling (A) on the flywheel. Fasten a hoist to tooling (A).
2. Remove the bolts that hold the flywheel in place. Remove flywheel (1). The weight of the flywheel is 68 lb. (31 kg).

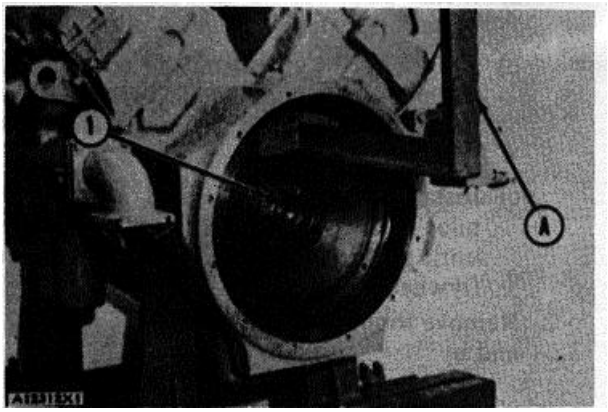


MARINE ENGINE SHOWN

INSTALL FLYWHEEL 12-1156

Tools Needed		A
FT120	Lifting Bracket	1
S509	Bolt	1

1. Install tooling (A) on the flywheel, Fasten a hoist and put the flywheel in position on the crankshaft. Make sure the marks on the flywheel and crankshaft are in alignment.
2. Put 8H5137 Gasket Sealer on the bolt threads and install bolts (1). Tighten the bolts to a torque of 55 ± 5 lb. ft. (7.6 ± 0.7 mkg).



INDUSTRIAL ENGINE SHOWN

NOTE: Make sure that the correct sealant is put on the bolt threads. The holes for the bolts in the crankshaft flange are drilled through making the holes open to the oil in the engine. Leaking along the bolt threads can be the result if the correct sealant is not used.

CAUTION: When installing a new flywheel, check the thickness of the new flywheel at the bolt holes in relation to the thickness of the old flywheel. Install the correct length bolts so they will be fully engaged in the crankshaft flange. Bolts that are too long will make contact with the block on back side of the crankshaft flange and pull crankshaft back. This will cause the crankshaft thrust bearing to fail.

end by:

a) install marine gear (marine engine only)

CRANKSHAFT REAR SEAL, CRANKSHAFT REAR SEAL WEAR SLEEVE

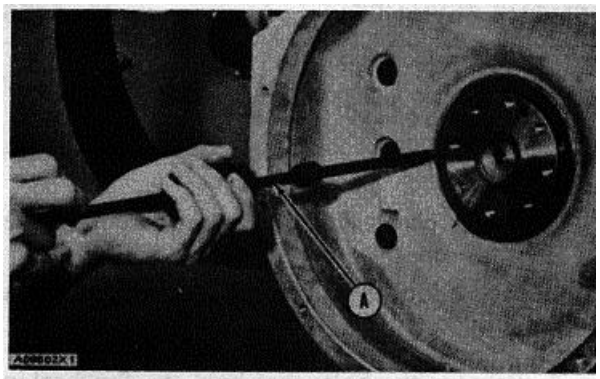
REMOVE CRANKSHAFT REAR SEAL 11-1161

Tools Needed		A
1P3075	Puller Group	1

start by:

a) remove marine gear (marine engine only)
b) remove flywheel

1. Remove the crankshaft rear seal with tooling (A).

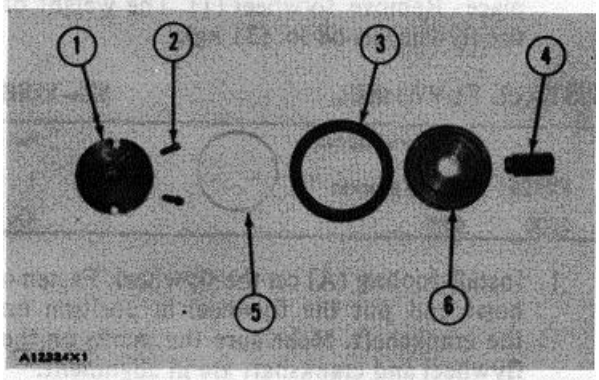


INSTALL CRANKSHAFT REAR SEAL 12-1161

Tools Needed		A
5P290	Pilot	1
1P5515	Bolt	2
5P285	Ring	1
9S8864	Pusher Plate	1
9S8858	Nut	1
5P288	Ring	1

1. Install tooling (A) as follows:

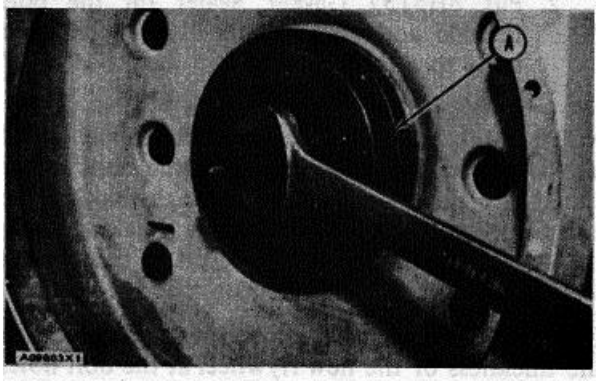
   a) Install pilot (1) on the crankshaft with bolts (2). Install ring (5) on pilot (i).
   b) Put 7F2770 Cement on the outer metal surface of the seal. Install the seal on the pilot with the lip of the seal toward the front of the engine.
   c) Install pusher plate (6) and ring (3) over pilot (1). Install nut (4). Tighten the nut until the ring (5) makes contact with the flywheel housing.



2. Remove tooling (A).

end by:

a) install flywheel
b) install marine gear (marine engine only)



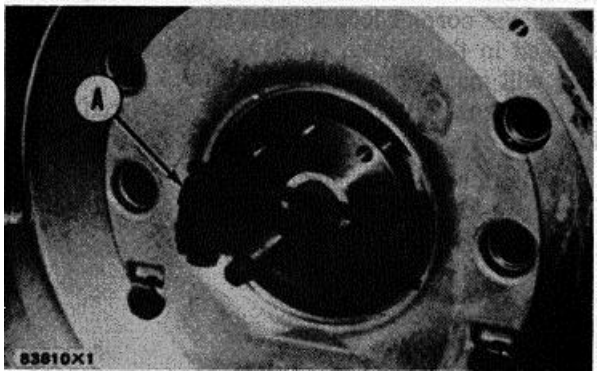
REMOVE CRANKSHAFT REAR SEAL WEAR SLEEVE

Tools Needed		A
8S7164	Puller Group	1

start by:

a) remove flywheel
b) remove crankshaft rear seal

1. Install tooling (A) and remove the wear sleeve from the crankshaft.



CRANKSHAFT REAR SEAL WEAR SLEEVE, FLYWHEEL HOUSING

INSTALL CRANKSHAFT REAR SEAL WEAR SLEEVE

Tools Needed		A
5P290	Pilot	1
1P5515	Bolt	2
5P286	Ring	1
9S8864	Pusher Plate	1
9S8858	Nut	1

1. Install tooling (A) as follows:

   a) Install pilot (1) on the end of the crankshaft. Install .bolts (4) and tighten enough to hold the pilot (1). Put wear sleeve on pilot (1) with the outside angle toward the rear of the engine. Push the sleeve on the crankshaft to put pilot (1) in the center, then tighten bolts (4).

   b) Put ring (2) on plate (5) and put this assembly on to the stud of pilot (1). Put on nut (3) and push the sleeve on to the crankshaft. Remove tooling (A).

end by:
   a) install crankshaft rear seal
   b) install flywheel

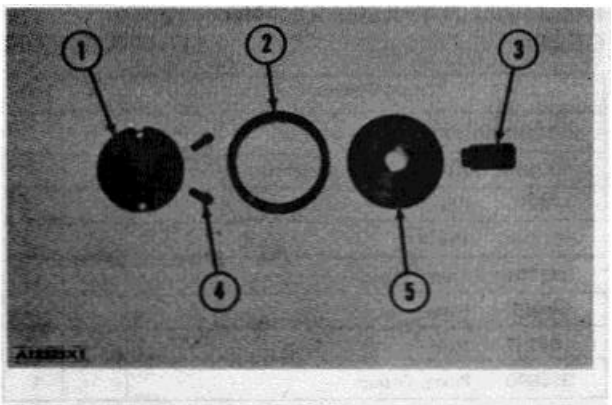
REMOVE FLYWHEEL HOUSING 11-1157

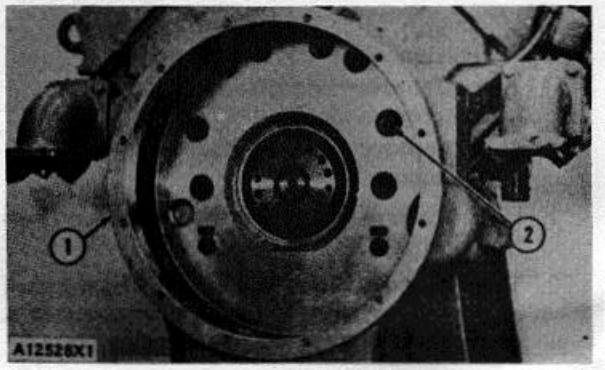
start by:
   a) remove starter
   b) remove marine gear (marine engine only)
   c) remove flywheel

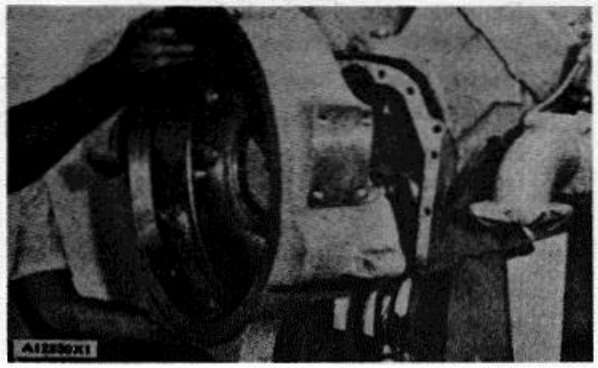
1. Loosen the bolts that hold the oil pan to the cylinder block. Remove the bolts that hold the oil pan to the flywheel housing. Fasten a hoist to the rear of the engine. Lift the rear of the engine and install shims on each side of the cylinder block.
2. Remove the bolts (2) and locks that hold the flywheel housing in place. Remove flywheel housing (1).

INSTALL FLYWHEEL HOUSING 12-1157

1. Clean the contact surfaces of the flywheel housing and cylinder block. Install a new gasket.
2. Put oil on the lip of the rear seal. Put flywheel housing in position and install the locks and bolts.







3. Cut the gasket so it is even with the bottom of the block and flywheel housing. Remove the shims from each side of the block and tighten the bolts for the oil pan. Install remainder of bolts in oil pan.
4. Install the starter.

end by:
   a) install marine gear (marine engine only)
   b) install flywheel

CRANKSHAFT AND GEAR

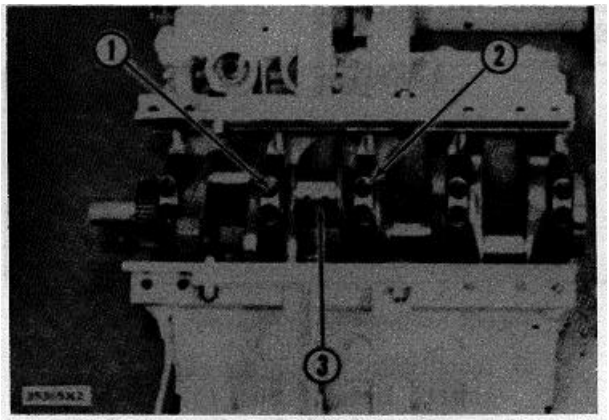
REMOVE CRANKSHAFT AND GEAR 11-1202 & 1204

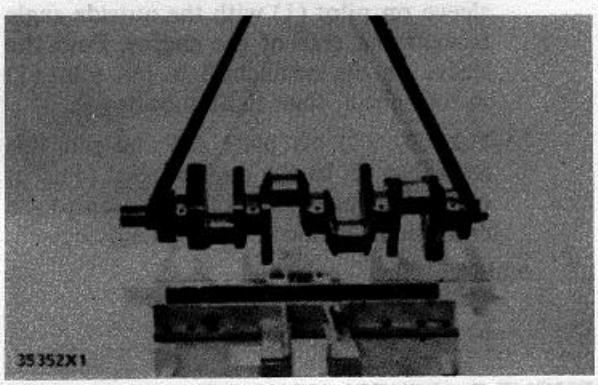
Tools Needed		A	B
OTC Model 1730-A Engine Stand		1	
8B7551	Bearing Puller Attachment		1
1P820	Puller Group		1
8B7549	Leg		2
8B7561	Step Plate		1
3H465	Plate		4
184207	Nut		2
9S5800	Pump Group		1

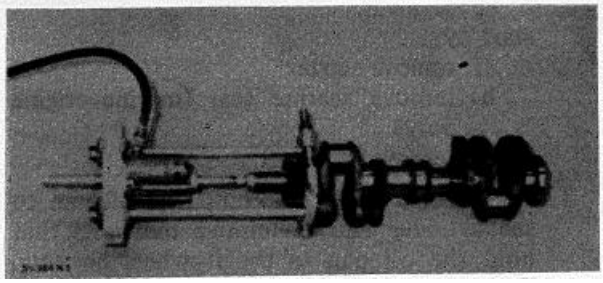
start by:

a) remove flywheel housing
b) remove valve lifters
c) remove pistons
d) remove timing gear cover and oil pump

1. Fasten a hoist and put the engine in position on tool (A).
2. Turn the crankshaft until the timing mark on the crankshaft gear is in alignment with the timing mark on the camshaft gear.
3. Remove bolts (1) and main bearing caps (2). Remove the lower halves of the main bearings from the caps.
4. Install two of the bolts that hold the flywheel in place in the end of crankshaft.
5. Fasten a hoist and remove crankshaft (3) from the engine. The weight of the crankshaft is 120 lb. (54 kg).
6. Remove the upper halves of the main bearings from the cylinder block.
7. Install tooling (B) and remove the gear from the crankshaft.







CRANKSHAFT AND GEAR

INSTALL CRANKSHAFT AND GEAR 12-1202 & 1204

Tools Needed		A	B
8S2328	Dial Test Indicator Group		1
5B1161	Wire		1

1. Install the key for the crankshaft gear on the crankshaft.
2. Heat the gear for the crankshaft in oil to a maximum temperature of 300°F (149°C). Install the gear on the crankshaft gear toward the crankshaft pulley end of the crankshaft.
3. Thoroughly clean the area where the upper halves of the main bearings fit. Install the upper halves of the main bearings in the cylinder block.

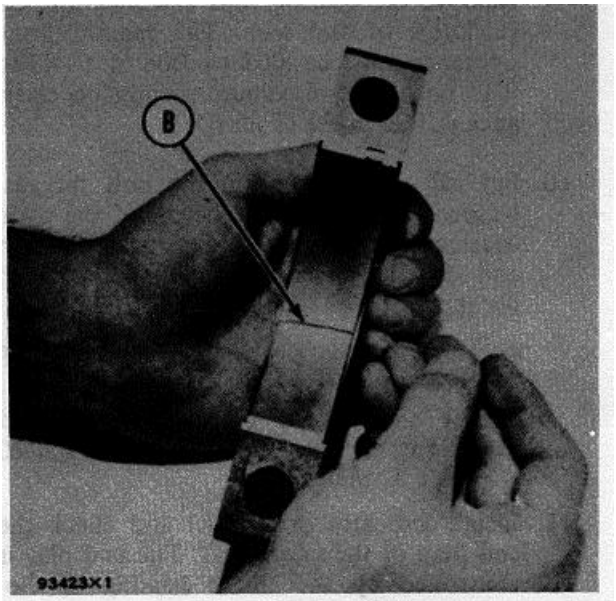
NOTE: The main bearing half with a hole in it is the upper bearing.

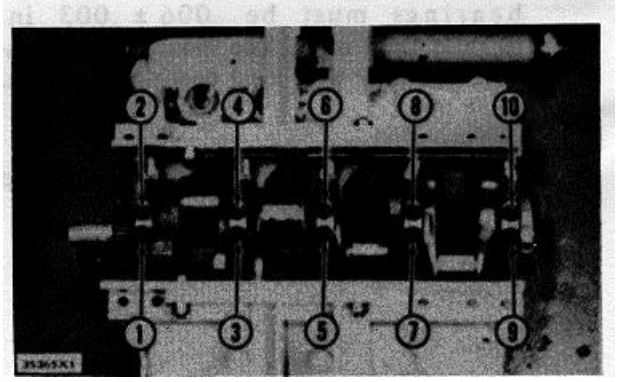
4. Install the thrust bearing for the No. 4 main.
5. Put clean engine oil on the bearings and journals of the crankshaft.
6. Install two of the bolts that hold the flywheel in place in the end of the crankshaft. Fasten a hoist and put the crankshaft in position in the block. Make sure the timing mark on the crankshaft gear is in alignment with the timing mark on the camshaft gear.
7. Clean the main bearing caps and install the lower halves of the main bearings in the caps.

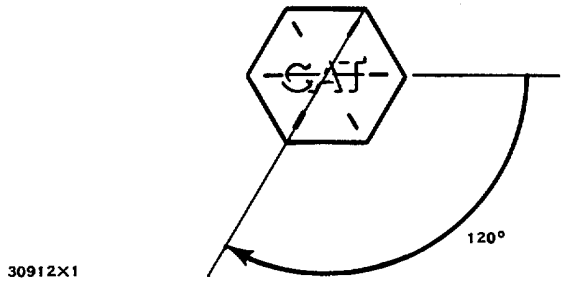
CAUTION: When installing bearing caps, make sure the number on the side of the cap is next to and respective with the number on the engine block.

8. Check the bearing clearance with wire (B). Put the caps in position and install the bolts. Tighten the bolts in number order as follows:

   a) Tighten bolts 1 through 10 to a torque of 30 ± 3 lb. ft. (4.1 ± 0.4 mkg).







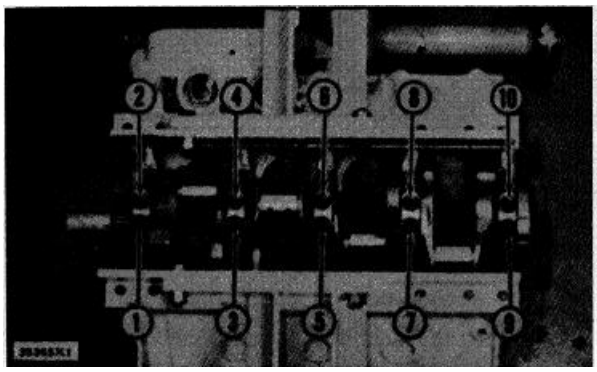
   b) Put a mark on each bolt head and bearing cap. Tighten bolts I through 10 120 + 5° more.

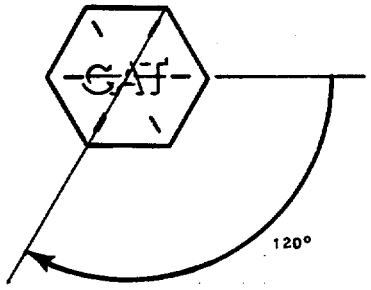
CRANKSHAFT AND GEAR

9. Remove the bearing caps and measure the thickness of the wire. The main bearing clearance must be .002 to .005 in. (0.05 to 0.13 mm). The maximum permissible clearance is .006 in. (0.15 mm).

10. Put clean engine oil on the bolt threads, washer faces and lower halves of the main bearings. Put the bearing caps in position and install the bolts. Tighten the bolts in number order as follows:

    a) Tighten bolts 1 through 10 to a torque of 30 ± 3 lb. ft. (4.1 ± 0.4 mkg).
    b) Put a mark on each bolt head and bearing cap. Tighten bolts I through 10 120 ± 5° more.





30912X1

11. Install indicator group (A) and check the end play of the crankshaft. The end play is controlled by the thrust bearing on No. 4 main bearing. The end play with new bearings must be .006 ± .003 in. (0.15 ± 0.08 mm). The maximum permissible end play with used bearings is .014 in. (0.36 mm).

end by:
a) install timing gear cover and oil pump
b) install pistons
c) install valve lifters
d) install flywheel housing

CAMSHAFT BEARINGS

REMOVE CAMSHAFT BEARINGS 11-1211

Tools Needed		A	B
1P5545	Adapter Group	1	
8S2241	Camshaft Bearing Installation & Removal Group		1
8H684	Ratchet Box Wrench		1

start by:

a) remove crankshaft and gear
b) remove camshaft and gears

NOTE: The crankshaft does not have to be removed for removal and installation of the camshaft bearings, but must be removed to correctly clean the oil passages in the cylinder block.

1. Install tooling (B) through the flywheel housing end of the cylinder block.
2. Install washer (1) and bolt (2) from tool group (A) in the end of the shaft of tooling (B). Remove the bearings from the cylinder block starting with the front bearing.
3. Thoroughly clean the oil passages and surfaces where the camshaft and bearings fit.

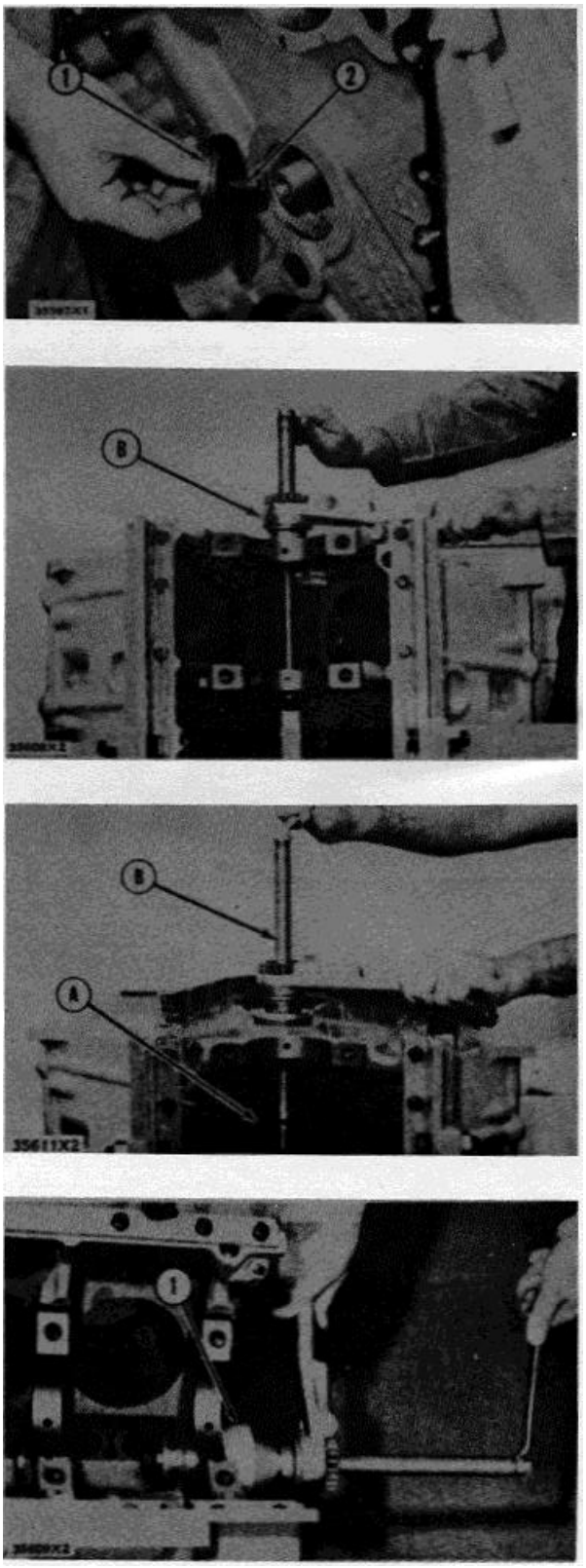
INSTALL CAMSHAFT BEARINGS 12-1211

Tools Needed		A	B
1P5645	Adapter Group	1	
8S2241	Camshaft Bearing Installation & Removal Group		1
8H684	Ratchet Box Wrench		1

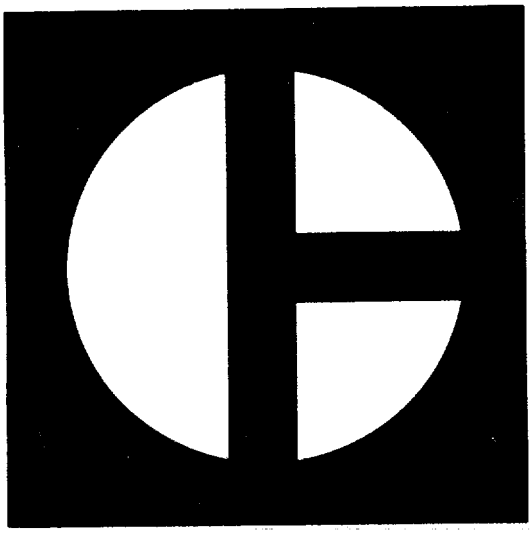
1. Start with the rear camshaft bearing and install the bearings in the cylinder block with tooling (A) and (B). Make sure the oil holes in the bearing are in alignment with the oil holes in the cylinder block.
2. To install the front camshaft bearing, put tube (1) from tool group (B) in position shown with the tube over the boss on the front of the cylinder block and pull the bearing into place. Make sure the oil holes in the bearings are in alignment with the oil holes in the cylinder block.

end by:

a) install camshaft and gears
b) install crankshaft and gear



FORM NO. REG01684-01
FOR USE IN SERVICE MANUALS:
3208 ENGINE, REG01658
V160 THRU V300 LIFT TRUCKS, REG01275
VOLUME I SPECIFICATIONS, REG01312



SPECIFICATIONS
FOR

3208 INDUSTRIAL a MARINE ENGINES

SERIAL NUMBERS
75V1 - UP
90N1-UP

INTRODUCTION

The specifications given in this book are on the basis of information available at the time the book was written. These specifications give the torques, operating pressure, measurements of new parts, adjustments and other items that will affect the service of the product.

When the words "use again" are in the description, the specification given can be used to determine if a part can be used again. If the part is equal to or within the specification given, use the part again.

When the word "permissible" is in the description, the specification given is the "maximum or mini- mum" tolerance permitted before adjustment, repair and/or new parts are needed.

A comparison can be made between the measurements of a worn part, and the specifications of a new part to find the amount of wear. A part that is worn can be safe to use if an estimate of the remainder of its service life is good. If a short service life is expected, replace the part.

NOTE: The specifications given for "use again" and "permissible" are in- tended for guidance only and Caterpillar Tractor Co. hereby expressly denies and excludes any representation, warranty or implied warranty of the reuse of any component. 77200X1

NOTE: For Systems Operation and Testing and Adjusting, make reference to 3208 INDUSTRIAL & MARINE ENGINES, Form No. REG01683.

ENGINE DESIGN

.Bore	4.5 in. (114.3 mm)
Stroke	5.0 in. (127.0 mm)
Number of Cylinders	8
Cylinder Arrangement	90°V
Firing Order (Injection Sequence)	1.2, 7, 3, 4, 5, 6, 8
Direction of Rotation (As Seen From Flywheel End)	Counterclockwise

Air Inlet Manifold....17
Alternators 28
Alternator Regulators 29
Automatic Timing Advance Unit 9
....
Camshaft 16
Connecting Rod 23
Cooling System Pressure Cap 20
Crankshaft 24
Cylinder Block....22
Cylinder Head 16

Drive Gear for the Injection Pump 8
Starter Magnetic Switch 30
Flywheel Housing Bore 27
Flywheel 25
Flywheel Housing Face (Industrial Engines) ...26
Flywheel Housing Face (Marine Engines)....26
Fuel Injection Pump 4
Fuel Transfer Pump 8
Fuel Filter Base 8

Governor 5-6

Injection Nozzle 7

Lubrication System (Industrial Engines) 18

Manifold and Ventilation Valve (Industrial Engines) 17
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Piston 23
Pulley and Damper.... 25

Shutoff Solenoid.... 9

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Valve Rocker Arms and Cam Followers.... 15

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Water Pump 20
Water Temperature Regulator 20

3208 INDUSTRIAL & MARINE ENGINES SPECIFICATIONS

GENERAL TIGHTENING TORQUE FOR BOLTS, NUTS AND TAPERLOCK STUDS

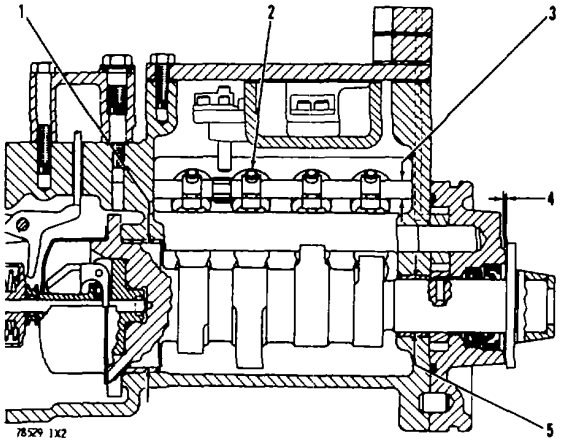


The following charts give the standard torque values for bolts, nuts and taperlock studs of SAE Grade 5 or better quality. Exceptions are given in the Specifications.

THREAD DIAMETER		STANDARD TORQUE	
inches	millimeters	lb. ft.	mkg
Standard thread 		Use these torques for bolts and nuts with standard threads.	
1/4	6.35	9 ± 3	1.24 ± 0.4
5/16	7.94	18 ± 5	2.5 ± 0.7
3/8	9.53	32 ± 5	4.4 ± 0.7
7/16	11.11	50 ± 10	6.9 ± 1.4
1/2	12.70	75 ± 10	10.4 ± 1.4
9/16	14.29	110 ± 15	15.2 ± 2.0
5/8	15.88	150 ± 20	20.7 ± 2.8
3/4	19.05	265 ± 35	36.6 ± 4.8
7/8	22.23	420 ± 60	58.1 ± 8.3
1	25.40	640 ± 80	88.5 ± 11.1
1 1/8	28.58	800 ± 100	110.6 ± 13.8
1 1/4	31.75	1000 ± 120	138 ± 16.6
1 3/8	34.93	1200 ± 150	166 ± 20.7
1 1/2	38.10	1500 ± 200	207 ± 27.7
		Use these torques for bolts and nuts on hydraulic valve bodies.	
5/16	7.94	13 ± 2	1.8 ± 0.3
3/8	9.53	24 ± 2	3.3 ± 0.3
7/16	11.11	39 ± 2	5.4 ± 0.3
1/2	12.70	60 ± 3	8.3 ± 0.4
5/8	15.88	118 ± 4	16.3 ± 0.5
Taperlock stud 		Use these torques for studs with Taperlock threads.	
1/4	6.35	5 ± 2	0.69 ± 0.3
5/16	7.94	10 ± 3	1.4 ± 0.4
3/8	9.53	20 ± 3	2.8 ± 0.4
7/16	11.11	30 ± 5	4.1 ± 0.7
1/2	12.70	40 ± 5	5.5 ± 0.7
9/16	14.29	60 ± 10	8.3 ± 1.4
5/8	15.88	75 ± 10	10.4 ± 1.4
3/4	19.05	110 ± 15	15.2 ± 2.0
7/8	22.23	170 ± 20	23.5 ± 2.8
1	25.40	260 ± 30	35.9 ± 4.1
1 1/8	28.58	320 ± 30	44.2 ± 4.1
1 1/4	31.75	400 ± 40	55 ± 5.5
1 3/8	34.93	480 ± 40	66 ± 5.5
1 1/2	38.10	550 ± 50	76 ± 7

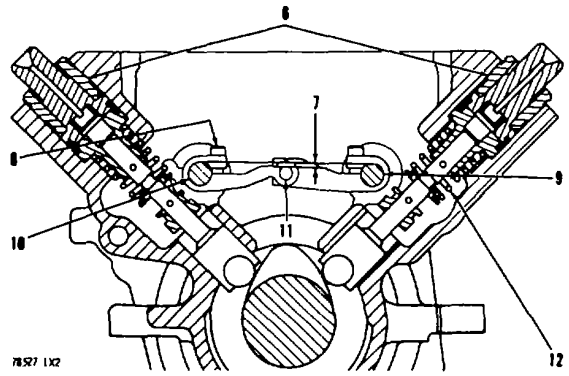
T95416-5

FUEL INJECTION PUMP



	Firing order (injection sequence)	1, 2, 7, 3, 4, 5, 6, 8
	Injection timing before TC (top center)	16°
	Torque for the nuts that hold the fuel lines (Use 5P144 Fuel Line Socket)	30 ± 5 lb ft (4 1 ± 0 7 mkg)
	4N605 Spring for bypass valve	
	Length under test force	1 231 in (31 27 mm)
	Test force	1 41 ± 0 14 lb (0 639 ± 0 006 kg)
	Free length after test	1 504 in (38 21 mm)
	Outside diameter	531 in (13 49 mm)
(1)	Bore in the rear bearing for the camshaft (new)	2 3750 ± 0005 in (60 325 ± 0 013 mm)
	Diameter of rear bearing surface (journal) of the camshaft (new)	2 3720 ± 0005 in (60 249 ± 0 013 mm)
	Maximum permissible clearance between the bearing and the camshaft bearing surface (journal) (worn)	006 in (0 15 mm)
(2)	Torque for screws that hold sleeve control levers	24 ± 2 lb in (27 7 ± 2 3 cm kg)
(3)	Bore in the housing for the fuel control shaft (new)	3543 ± 0005 in (8 999 ± 0 013 mm)
	Diameter of sleeve control shaft (new)	3530 ± 0003 in (8 966 ± 0 008 mm)
	Maximum permissible clearance between the bore in the housing and the sleeve control shaft (worn)	003 in (0 07 mm)
(4)	End play for camshaft with sleeve installed (new)	023 ± 018 in (0 58 ± 0 46 mm)

NOTE When installing sleeve on end of camshaft, support the camshaft to prevent damage to parts inside of injection pump and governor housing

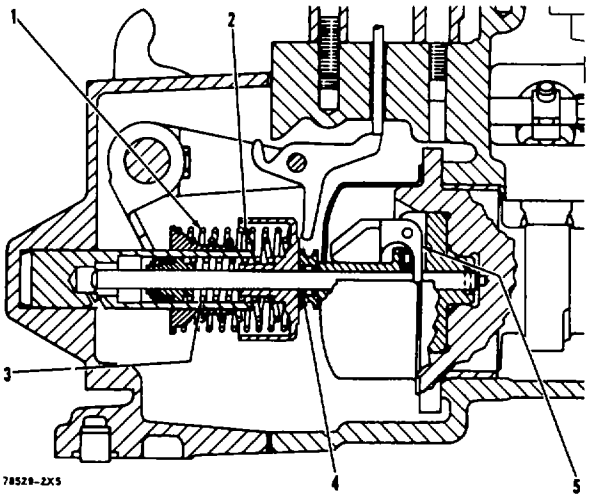


(5)	Bore in the front bearing for the camshaft (new)	1 0005 ± 0005 in (25 413 ± 0 013 mm)
	Diameter of front bearing surface (journal) of the camshaft (new)	9990 ± 0005 in (25 375 ± 0 013 mm)
	Maximum permissible clearance between the bearing and the camshaft bearing surface (journal) (worn)	004 in (0 10 mm)
(6)	Torque for bushing	70 ± 5 lb ft (9 7 ± 0 7 mkg)
(7)	Distance from top of pin (11) to top of shafts (9 and 10) with 3P1546 Calibration Pin installed	0828 in (2 103 mm)
(8)	Torque for screws that hold crossover levers	24 ± 2 lb in (27 7 ± 2 3 cm kg)
(12)	4N4318 Spring for injection pump	
	Length under test force	1 348 in (34 24 mm)
	Test force	12 5 ± 1 3 lb (5 67 ± 0 58 kg)
	Free length after test	1 566 in (39 78 mm)
	Outside diameter	728 ± 010 in (18 49 ± 0 25 mm)

NOTE: FOR TORQUE VALUES NOT GIVEN, SEE THE FIRST PAGE OF SPECIFICATIONS FOR GENERAL TIGHTENING TORQUES

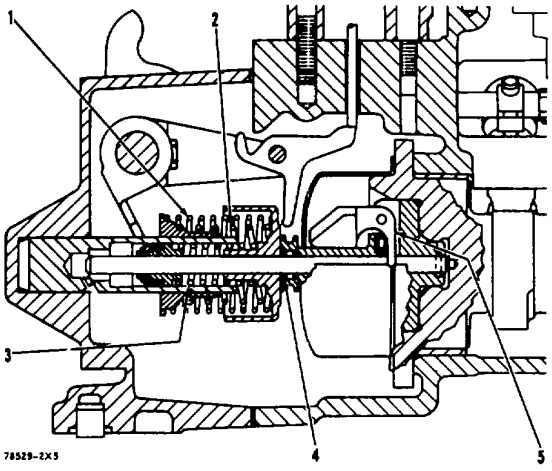
GOVERNOR

(1) 6N2127 Spring for governor (outer)	
Color code is	one pink stripe
Put force on spring of .	2 0 lb (0 9 kg)
Then add more force to make spring shorter by	600 in (15 24 mm)
Total test force	6 20 ± 12 lb (2 81 ± 0 05 kg)
Free length after test	1 740 in (44 20 mm)
Outside diameter	1 518 in (38 56 mm)
(1) 4N9226 Spring for governor (outer)	
Color code is	two green stripes
Put force on spring of	3 5 lbs (1 6 kg)
Then add more force to make spring shorter by	700 in (17 78 mm)
Total test force	14 69 ± 34 lbs (6 7 ± 0 15 kg)
Free length after test	1 741 in (44 22 mm)
Outside diameter	1 518 in (38 56 mm)
(1) 9L6508 Spring for governor (outer)	
Color code is	one yellow stripe
Put force on spring of	5 0 lbs (2 3 kg)
Then add more force to make spring shorter by	354 in (9 00 mm)
Total test force	12 43 ± 27 lbs (5 6 ± 0 12 kg)
Free length after test	1 740 in (44 20 mm)
Outside diameter	1 518 in (38 56 mm)
(1) 6N2129 Spring for governor (outer)	
Color code is	two pink stripes
Put force on spring of	2 0 lb (0 9 kg)
Then add more force to make spring shorter by	700 in (17 78 mm)
Total test force	8 30 ± 20 lb (3 76 ± 0 09 kg)
Free length after test	1 740 in (44.20 mm)
Outside diameter	1 490 in (37 85 mm)
(1) 4N5661 Spring for governor (outer)	
Color code is	two white stripes
Put force on spring of	3 0 lb (1 4 kg)
Then add more force to make spring shorter by	700 in (17 78 mm)
Total test force	12 80 ± 34 lb (5 81 ± 0 15 kg)
Free length after test	1 740 in (44 20 mm)
Outside diameter	1 506 in (38 25 mm)



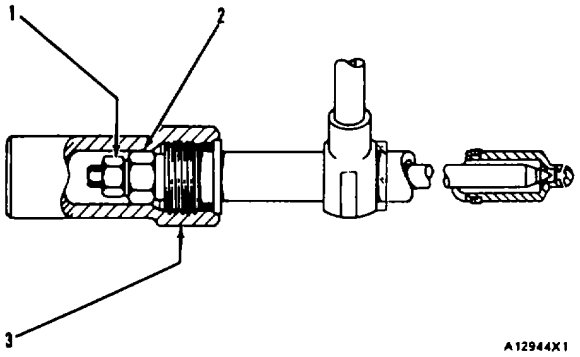
Governor (Cont.)

(1)	6N2130 Spring for governor (outer)	
	Color code is	one pink and one yellow stripe
	Put force on spring of	3 0 lb. (1 4 kg)
	Then add more force to make spring shorter by	700 in (17 78 mm)
	Total test force	11 40 ± 26 lb (5 17 ± 0 12 kg)
	Free length after test	1 740 in (44 20 mm)
	Outside diameter	1 506 in (38 25 mm)
(1)	6N2132 Spring for governor (outer)	
	Color code is	one green stripe
	Put force on spring of	6 0 lb (2 7 kg)
	Then add more force to make spring shorter by	600 in (15 24 mm)
	Total test force	21 00 ± 51 lb (9 53 ± 0 23 kg)
	Free length after test	1 740 in (44 20 mm)
	Outside diameter	1 544 in (39 22 mm)
(2)	4N5663 Spring for governor (inner)	
	Color code is	one pink stripe
	Put force on spring of	1 2 lb (0 54 kg)
	Then add more force to make spring shorter by	663 in (16 84 mm)
	Total test force	4 54 ± 34 lb (2 1 ± 0 15 kg)
	Free length after test	1 690 in (42 93 mm)
	Outside diameter	1 144 in (29 06 mm)
(3)	6N2517 Spring for dashpot	
	Put force on spring of	2 0 lb (0 9 kg)
	Then add more force to make spring shorter by	200 in (5 08 mm)
	Total test force	5 60 ± 18 lb (2 5 ± 0 08 kg)
	Free length after test	1 230 in (31 24 mm)
	Outside diameter	584 in (14 83 mm)
(4)	4N527 Spring for over fueling	
	Length under test force	343 in (8 71 mm)
	Test force	0 19 ± 0 02 lb (0 09 ± 0 01 kg)
	Free length after test	720 in (18.29 mm)
	Outside diameter	360 in (9 14 mm)
(5)	Torque for bolts that hold governor weight carrier to camshaft . .	10 ± 2 lb ft (1 4 ± 0 3 mkg)



NOTE: FOR TORQUE VALUES NOT GIVEN, SEE THE FIRST PAGE OF SPECIFICATIONS FOR GENERAL TIGHTENING TORQUES

INJECTION NOZZLE
(9L6969)



Bench test nozzles using SAE J967b oil or Kent Moore J23300-585 or Shell 66631 calibration oil with the oil at a temperature of 65° to 70°F (18° to 20°C)

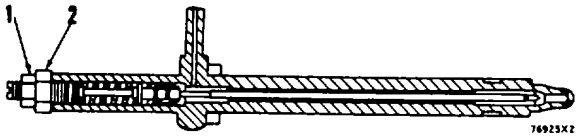
Nozzle setting pressures (valve lift adjustment screw turned 3/4 ± 1/8 turn from closed position)

New nozzle	2750 to 2900 psi (193 3 to 203 9 kg/cm²)
Used nozzle	2400 to 2900 psi (168 7 to 203 9 kg/cm²)
Used, adjusted nozzle	2700 to 2900 psi (189.8 to 203 9 kg/cm²)
Return oil leakage test pressure	1400 to 1600 psi (98 4 to 112 5 kg/cm²)
Leakage in 15 seconds	1 to 10 drops

Maximum tip leakage is 3 drops in 15 seconds with pressure 250 to 300 psi (17 6 to 21 1 kg/cm²) less than opening pressure

(1)	Torque for valve lift locknut	35 to 45 lb in (40 4 to 51 9 cm.kg)
(2)	Torque for pressure screw locknut	70 to 80 lb in (80 7 to 92 2 cm kg)
(3)	Torque for cap	110 to 120 lb in (126.8 to 138 4 cm kg)

INJECTION NOZZLE
(9L7883)



Bench test nozzles using Kent Moore J23300-585 or Shell 66631 calibration oil or equivalent at 65° to 70° F (18° to 20° C)

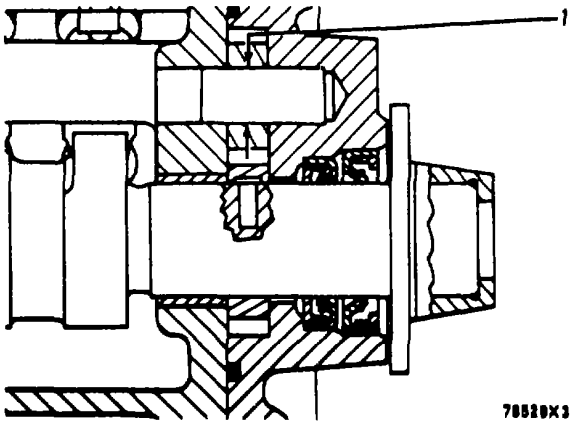
Nozzle setting pressures (valve lift adjustment screw turned 3/4 ± 1/8 turn from closed position)

New nozzle	2750 to 2900 psi (193 3 to 203 9 kg/cm³)
Used nozzle	2400 to 2900 psi (168 7 to 203 9 kg/cm³)
Used, adjusted nozzle	2700 to 2900 psi (189 8 to 203 9 kg/cm³)
Return oil leakage test pressure	1400 to 1600 psi (98 4 to 112 5 kg/cm³)
Leakage in 15 seconds	1 to 10 drops

Maximum tip leakage is 3 drops in 15 seconds with pressure 250 to 300 psi (17 6 to 21 1 kg/cm³) less than opening pressure

(1)	Torque for locknut	35 to 40 lb in (40 4 to 46 1 cm kg)
(2)	Torque for pressure screw	75 to 80 lb in (86 5 to 92 2 cm kg)

FUEL TRANSFER PUMP

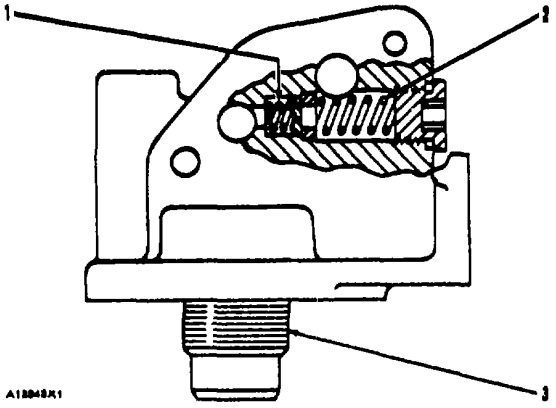


Fuel pressure at FULL LOAD . . . . 30 ± 5 psi (2.1 ± 0.4 kg/cm²)

(1) Diameter of shaft for idler gear ..... .4914 ± .0003 in. (12.481 ± 0.008 mm)

Bore in idler gear ..... .4926 ± .0003 in. (12.512 ± 0.008 mm)

FUEL FILTER BASE



(1) 4N3296 Spring:

Length under test force ..... .275 in. (7.0 mm)

Test force ..... .875 lb. (0.40 kg)

Free length after test ..... .510 in. (13.0 mm)

Outside diameter ..... .273 in. (6.9 mm)

(2) 8F2621 Spring:

Length under test force .... 1.25 in. (31.8 mm)

Test force .. .. 2.84 to 3.34 lb. (1.3 to 1.5 kg)

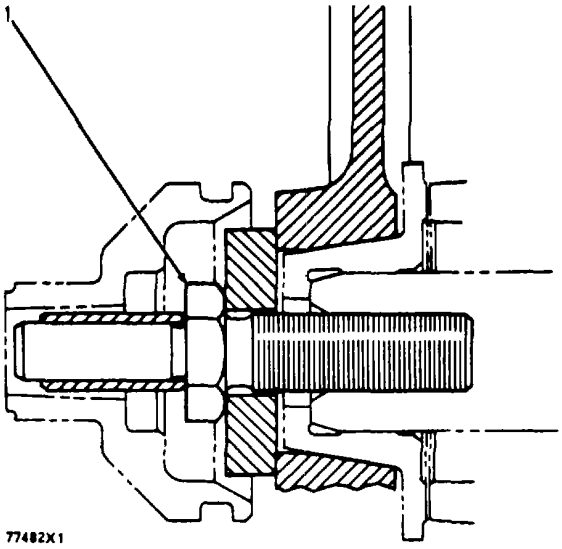
Free length after test . ... 1.68 in. (42.7 mm)

Outside diameter ... . .41 in. (10.4 mm)

(3) Torque for stud:

Put 9S3263 Thread Lock Compound on threads of the stud and tighten the stud to .... 50 ± 10 lb.ft. (6.9 ± 1.4 mkg)

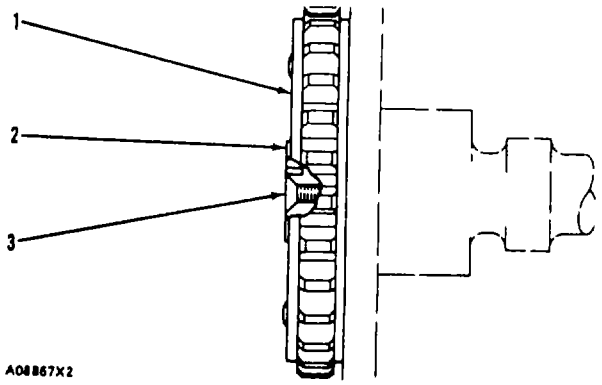
DRIVE GEAR FOR THE INJECTION PUMP



(1) Torque for the bolt that holds the drive gear to the camshaft of the injection pump 80 ± 5 lb. ft (11.1 ± 0.7 mkg)

NOTE: FOR TORQUE VALUES NOT GIVEN, SEE THE FIRST PAGE OF SPECIFICATIONS FOR GENERAL TIGHTENING TORQUES

AUTOMATIC TIMING ADVANCE UNIT



End play between washer (2) and timing advance unit (1) . . .003 to .037 in. (0.08 to 0.84 mm)

(3) Torque for screw 108 ± 36 lb in (124.5 ± 41.5 cm kg)

Stake screw (3) in two places

SHUTOFF SOLENOID

(Activated to Run)

4N4316 24V (Synchro Start Number Series 1500)

9N1067 12V (Synchro Start Number Series 1500)

(1) 4N7218 Spring for solenoid

Length under test force . . . . . .59 in. (14.9 mm)

Test force . . . . . 6.17 lb. (2.8 kg)

Free length after test . . . . . 1.10 in. (27.9 mm)

Outside diameter . . . . . .639 in. (16.2 mm)

9N1068 12V (John W. Hobbs Number 21844)

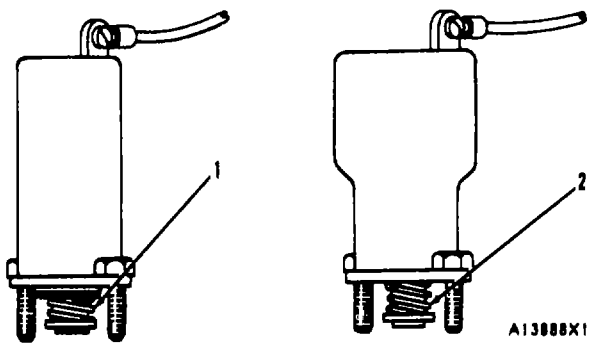
(2) 9L6479 Spring for solenoid:

Length under test force . . . . . .720 in. (18.29 mm)

Test force . . . . . 5.5 ± .30 lb. (2.5 ± 0.14 kg)

Free length after test . . . . . 1.08 in. (27.4 mm)

Outside diameter . . . . . .79 in. (20.1 mm)



VALVES

(Engines with Serial Numbers 90N1-90N6120, 75V1-75V1446)

(1) 9L9190 Spring (outer)

Length under test force	1 715 in (43 56 mm)
Test force	35 ± 5 lb (15 9 ± 2 3 kg)
Free length after test	1 855 in (47 12 mm)
Outside diameter	1 440 in (36 58 mm)

(2) 9L9172 Spring (inner)

Length under test force	1 715 in (43 56 mm)
Test force	16 5 ± 4 lb (7 4 ± 1 8 kg)
Free length after test	1 855 in (47 12 mm)
Outside diameter	998 in (25 35 mm)

(3) Diameter of valve stem

9L7682 Intake Valve	3725 ± 0005 in (9 462 ± 0 013 mm)
Minimum permissible diameter of the valve stem (worn)	3710 in (9 423 mm)

(9L7683 Exhaust Valve (tapered stem)

Head end of valve stem	3705 ± 0005 in (9 411 ± 0 013 mm)
Lock end of valve stem	3715 ± 0005 in (9 436 ± 0 013 mm)
Minimum permissible diameter of the valve stem (worn)	3690 in (9 373 mm)
Bore in the valve guides (intake and exhaust)	3745 ± 0005 in (9 512 ± 0 013 mm)

Maximum permissible bore in the valve guides (worn)

Measure 75 in (19 0 mm) deep in valve guide bore from both ends of the valve guide	3760 in (9 550 mm)

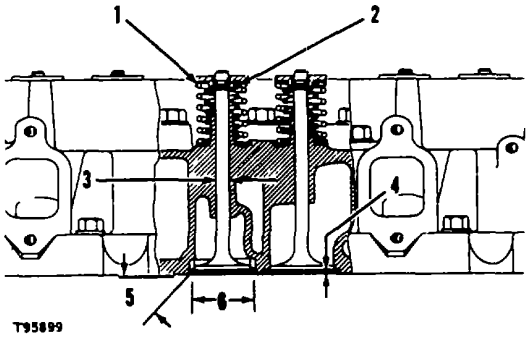
(4) Thickness of valve lip

Intake valve	091 in (2 31 mm)
Minimum permissible valve lip	076 in (1 93 mm)
Exhaust valve	063 in (1 60 mm)
Minimum permissible valve lip	048 in (1 22 mm)

(5) Angle of valve face

Intake valve	30° ± 15'
Exhaust valve	45° ± 15'

(6) Diameter of valve head (intake valve)	2 094 ± 005 in (53 19 ± 0 13 mm)
Diameter of valve head (exhaust valve)	1 804 ± 005 in (45 82 ± 0 13 mm)

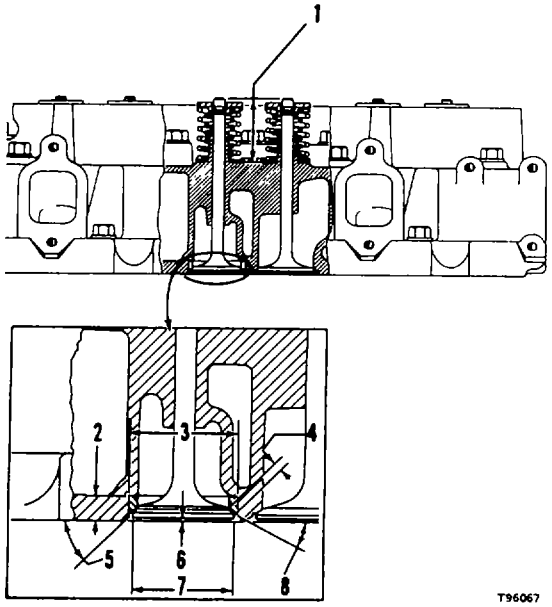


NOTE: FOR TORQUE VALUES NOT GIVEN, SEE THE FIRST PAGE OF SPECIFICATIONS FOR GENERAL TIGHTENING TORQUES

VALVE SEATS AND INSERTS

(Engines with Serial Numbers 90N1-90N6120, 75V1-75V1446)

EXHAUST VALVE



(1) Distance from the end of the valve to the valve spring washer seat — 2 063 ± 015 in (52 40 ± 0 38 mm)

(2) Depth of bore in head for valve seat insert — 442 ± 002 in (11 23 ± 0 05 mm)

(3) Diameter of valve seat insert — 1 9120 ± 0005 in (48 565 ± 0 013 mm)

Bore in head for valve seat insert — 1 9090 ± 0005 in (44 489 ± 0 013 mm)

(4) Maximum permissible width of the face of the valve seat insert — 105 in (2 67 mm)

(5) Angle of the face of the valve seat insert — 45¼° ± ½°

(6) Distance from head of valve to cylinder head face

Maximum permissible (valve closed) — 085 in (2 16 mm)

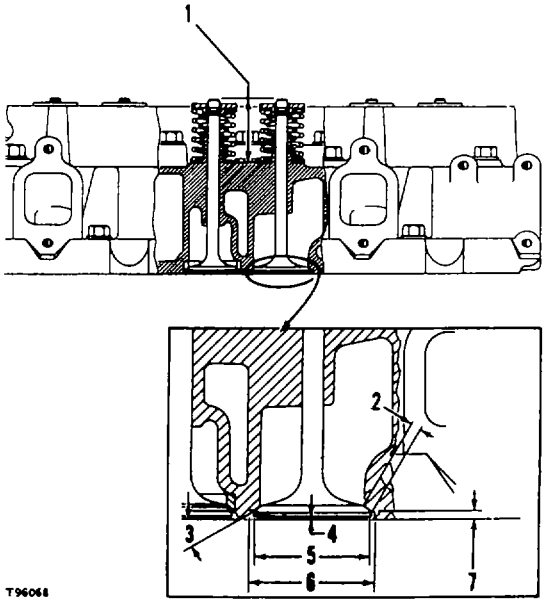
Minimum permissible (valve closed) — 050 in (1 27 mm)

(7) Outside diameter of the face of the valve seat insert — 1 735 ± 005 in (44 07 ± 0 13 mm)

Maximum permissible — 1 760 in (44 70 mm)

(8) Angle to grind face of seat insert (to get a reduction of maximum seat diameter) — 15°

INTAKE VALVE (without valve seat insert)



(1) Distance from the end of the valve to the valve spring washer seat — 2 063 ± 015 in (52 40 ± 0 38 mm)

(2) Maximum permissible width of the face of the valve seat — 120 in (3 05 mm)

(3) Angle of the face of the valve seat — 30¼° ± ½°

(4) Distance from head of valve to cylinder head face

Maximum permissible (valve closed) — 068 in (1 73 mm)

Minimum permissible (valve closed) — 036 in (0 91 mm)

(5) Outside diameter of the valve seat — 2 045 ± 005 in (52 23 ± 0 13 mm)

Maximum permissible — 2 065 in (52 45 mm)

(6) Diameter of the bore — 2 150 in (54 61 mm)

(7) Maximum permissible depth of the bore to make the face of the valve seat smaller — 170 in (4 32 mm)

Valve Seats and Inserts (Cont.)

(Engines with Serial Numbers 90N1-90N6120, 75V1-75V1446)

INTAKE VALVE (with valve seat insert)

(1) Distance from the end of the valve to the valve spring washer seat 2 063 ± 015 in (52 40 ± 0 38 mm)

(2) Depth of bore in head for valve seat insert 442 ± 002 in (11 23 ± 0 05 mm)

(3) Diameter of valve seat insert 2 1500 ± 0005 in (54 610 ± 0.013 mm)

Bore in head for valve seat insert 2 1470 ± 0005 in (54 534 ± 0 013 mm)

(4) Maximum permissible width of the face of the valve seat insert 120 in (3 05 mm)

(5) Angle of the face of the valve seat insert . 30¼° ± ½°

(6) Distance from head of valve to cylinder head face

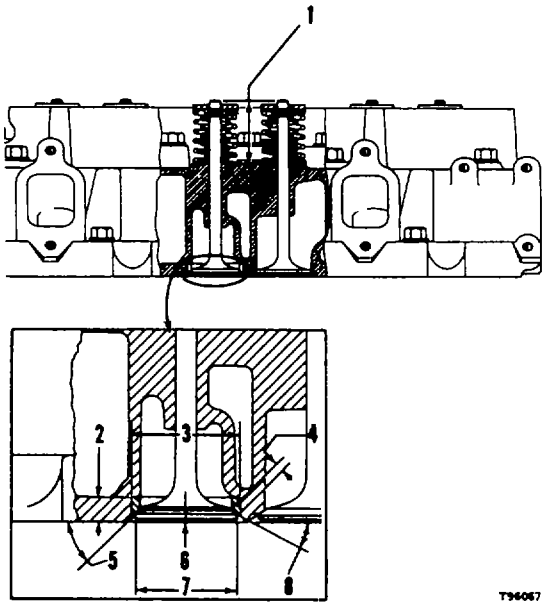
Maximum permissible (valve closed) . 068 in (1 73 mm)

Minimum permissible (valve closed) . 036 in (0 91 mm)

(7) Outside diameter of the face of the valve seat insert 2 045 ± 005 in (52.23 ± 0 13 mm)

Maximum permissible 2 065 in (52 45 mm)

(8) Angle to grind face of seat insert (to get a reduction of maximum seat diameter) 15°



TYPICAL ILLUSTRATION

NOTE: FOR TORQUE VALUES NOT GIVEN, SEE THE FIRST PAGE OF SPECIFICATIONS FOR GENERAL TIGHTENING TORQUES

VALVES

(Engines with Serial Numbers 90N6121-Up, 75V1447-Up)

(1) 9L9190 Spring

Length under test force	1 715 in (43 56 mm)
Test force	35 ± 5 lb (15 9 ± 2 3 kg)
Free length after test	1 855 in (47 12 mm)
Outside diameter	1 440 in (36 58 mm)

(2) Distance from the end of the valve to the valve spring spacer seat 2 063 ± 015 in (52 40 ± 0 38 mm)

(3) Diameter of valve stem

9L7682 Intake Valve	3725 ± 0005 in (9 462 ± 0 013 mm)
Minimum permissible diameter of the valve stem (worn)	3710 in (9 423 mm)

9L7683 Exhaust Valve (tapered stem)

Head end of valve stem	3705 ± 0005 in (9 411 ± 0 013 mm)
Lock end of valve stem	3715 ± 0005 in (9 436 ± 0 013 mm)
Minimum permissible diameter of the valve stem (worn)	3690 in (9 373 mm)
Bore in the valve guides (intake and exhaust)	3745 ± 0005 in (9 512 ± 0 013 mm)

Maximum permissible bore in the valve guides (worn)

Measure 75 in (19 0 mm) deep in valve guide bore from both ends of the valve guide	3760 in (9 550 mm)

(4) Angle of valve face

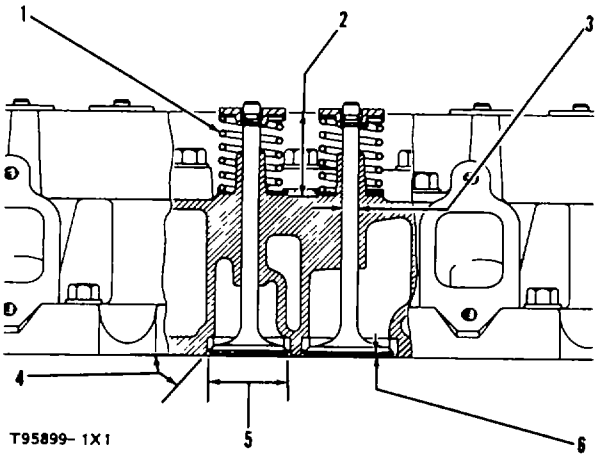
Intake valve	30° ± 15'
Exhaust valve	45° ± 15'

(5) Diameter of valve head

(intake valve)	2 094 ± 005 in (53 19 ± 0 13 mm)
Diameter of valve head (exhaust valve)	1 804 ± 005 in (45 82 ± 0 13 mm)

(6) Thickness of valve lip

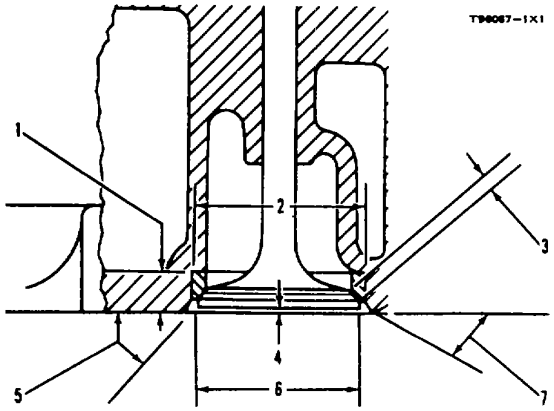
Intake valve	091 in (2 31 mm)
Minimum permissible valve lip	076 in (1 93 mm)
Exhaust valve	063 in (1 60 mm)
Minimum permissible valve lip	048 in (1 22 mm)



VALVE SEATS AND INSERTS

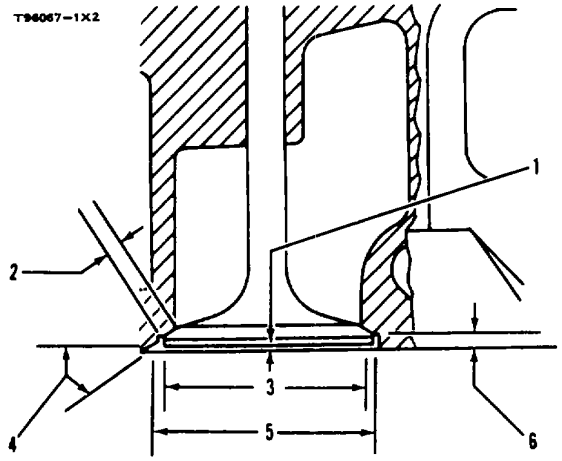
(Engines with Serial Numbers 90N6121-Up, 751447-Up)

EXHAUST VALVE



(1)	Depth of bore in head for valve seat insert	442 ± 002 in (11 23 ± 0 05 mm)
(2)	Diameter of valve seat insert	1 9120 ± 0005 in (48 565 ± 0 013 mm)
(3)	Bore in head for valve seat insert	1 9090 ± 0005 In (44 489 ± 0 013 mm)
	Maximum permissible width of the face of the valve seat insert	105 in. (2 67 mm)
(4)	Distance from head of valve to cylinder head face	
	Maximum permissible (valve closed)	085 in (2 16 mm)
	Minimum permissible (valve closed)	050 in (1 27 mm)
(5)	Angle of the face of the valve seat insert	45¼° ± ½°
(6)	Outside diameter of the face of the valve seat insert	1 735 ± 005 in (44 07 ± 0 13 mm)
	Maximum permissible	1 760 in (44 70 mm)
(7)	Angle to grind face of seat insert (to get a reduction of maximum seat diameter)	15°

INTAKE VALVE (without valve seat insert)

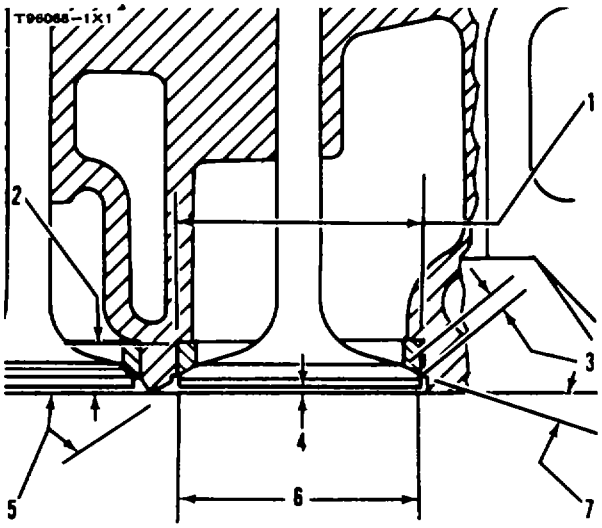


(1)	Distance from head of valve to cylinder head face	
	Maximum permissible (valve closed)	068 in (1 73 mm)
	Minimum permissible (valve closed)	036 in (0 91 mm)
(2)	Maximum permissible width of the face of the valve seat	120 in (3 05 mm)
(3)	Outside diameter of the valve seat	2 045 ± .005 in (52 23 ± 0 13 mm)
	Maximum permissible	2 065 in (52 45 mm)
(4)	Angle of the face of the valve seat	30¼° ± ½°
(5)	Diameter of the bore	2 150 in (54 61 mm)
(6)	Maximum permissible depth of the bore to make the face of the valve seat smaller	170 in (4 32 mm)

NOTE: FOR TORQUE VALUES NOT GIVEN, SEE THE FIRST PAGE OF SPECIFICATIONS FOR GENERAL TIGHTENING TORQUES

Valve Seats and Inserts (Cont.)

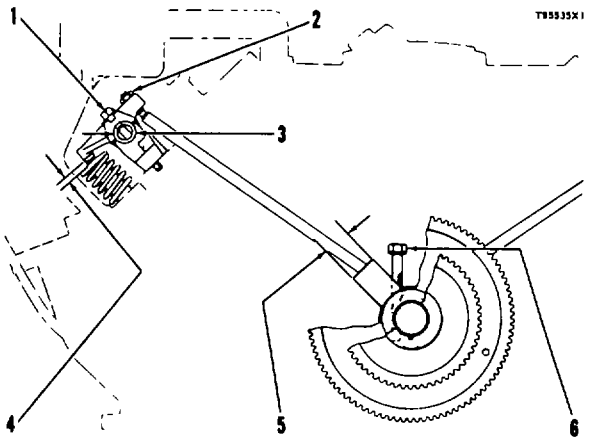
(Engines with Serial Numbers 90N6121-Up, 75V1447-Up)



INTAKE VALVE (with valve seat insert)

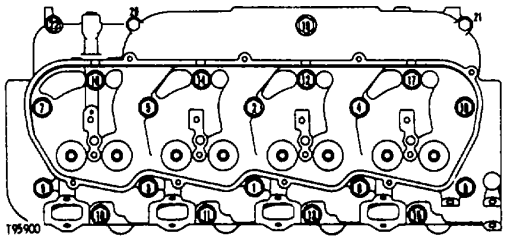
(1)	Diameter of the valve seat insert	2 1500 ± 0005 in (54 610 ± 0 013 mm)
(2)	Bore in head for valve seat insert	2 1470 ± 0005 in (54 534 ± 0 013 mm)
(2)	Depth of bore in head for valve seat insert	442 ± 002 in (11 23 ± 0 05 mm)
(3)	Maximum permissible width of the face of the valve seat insert	120 in (3 05 mm)
(4)	Distance from head of valve to cylinder head face	
	Maximum permissible (valve closed)	068 in (1 73 mm)
	Minimum permissible (valve closed)	036 in (0 91 mm)
(5)	Angle of the face of the valve seat insert	30¼° ± ½°
(6)	Outside diameter of the face of the valve seat insert	2 045 ± 005 in (52 23 ± 0 13 mm)
	Maximum permissible	2 065 in (52 45 mm)
(7)	Angle to grind face of seat insert (to get a reduction of maximum seat diameter)	15°

VALVE ROCKER ARMS AND CAM FOLLOWERS



(1)	Torque for bolts holding rocker arms	18 ± 5 lb ft (2 5 ± 0 7 mkg)
(2)	Torque for lock nut for valve adjustment screw	24 ± 5 lb ft (3 3 ± 0 7 mkg)
(3)	Diameter of the shaft for the rocker arms	8580 to 8586 in (21 793 to 21 814 mm)
	Minimum permissible diameter (worn)	8570 in (21 768 mm)
	Bore in bearings for the rocker arms (new)	8603 ± 0008 in (21 852 ± 0 020 mm)
	Maximum permissible bore (worn)	8630 in (21 920 mm)
	Maximum permissible clearance between bore in bearing and shaft (worn)	005 in (0 13 mm)
(4)	Clearance for valves (intake valve)	015 in (0 38 mm)
	Clearance for valves (exhaust valve)	025 in (0 64 mm)
(5)	Diameter of cam follower	1 1589 ± 0004 in (29 436 ± 0 010 mm)
	Minimum permissible (worn)	1 1575 in (29 401 mm)
	Bore in block for cam follower	1 1624 ± 0006 in (29 525 ± 0 015 mm)
	Maximum permissible bore (worn)	1 1650 in (29 591 mm)
(6)	Torque for the thrust pin for the camshaft	35 ± 5 lb ft (4 8 ± 0 7 mkg)

CYLINDER HEAD



Torque for bolts holding the valve cover . 120 ± 24 lb in. (138.4 ± 27 7 cm.kg)

Put 4S9416 Anti-Seize Compound on bolt threads and tighten bolts in the following Step sequence

Torque for head bolts 1 thru 18

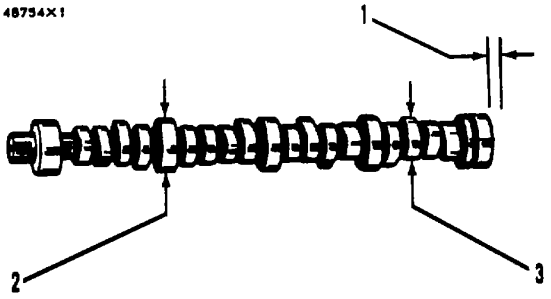
Step 1. Tighten all bolts in number sequence to .. .. 60 ± 10 lb ft. (8.3 ± 1.4 mkg)

Step 2 Again tighten all bolts in number sequence to . 95 ± 5 lb. ft. (13.1 ± 0 7 mkg)

Step 3 Again tighten all bolts in number sequence to 95 ± 5 lb. ft (13.1 ± 0 7 mkg)

Torque for head bolts 19 thru 22 (tighten all bolts in number sequence to) 32 ± 5 lb ft (4 4 ± 0 7 mkg)

CAMSHAFT



Heat gear to install. Do not heat to a temperature of more than 600° F (316° C). Do not heat with a torch.

(1) End play for the camshaft .... .007 ± .003 in. (0.18 ± 0.08 mm)

Maximum permissible end play (worn) ..... .020 in. (0.51 mm)

(2) Diameter of bearing surfaces (journals) of the camshaft . . .. 2 5000 ± .0005 in. (63 500 ± 0 013 mm)

Bore in bearing for camshaft . . 2 5035 ± 0015 in (63 599 ± 0 038 mm)

Maximum permissible clearance between bearing and bearing surface (journal) (worn) 007 in (0 18 mm)

(3) Height of the lobes of camshaft.

To get height (3), use the following procedure

A Measure base circle (5).

B Add lobe lift (4) to base circle measurement

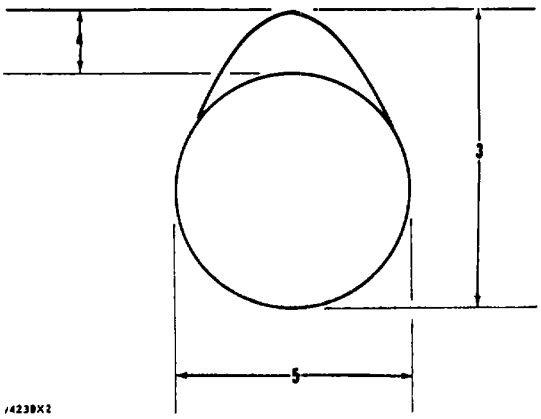
Total is camshaft lobe height

NOTE. Camshaft lobe lift (4) is

a Exhaust lobe . . . 3071 in (7 800 mm)

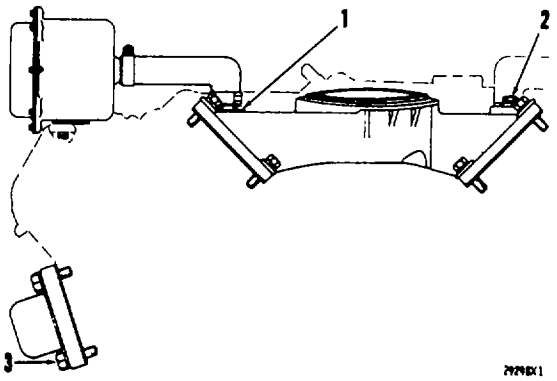
b Intake lobe . 3077 in (7 816 mm)

Minimum permissible height of lobes is 025 in. (0 64 mm) less than measurement in step (B).



NOTE: FOR TORQUE VALUES NOT GIVEN, SEE THE FIRST PAGE OF SPECIFICATIONS FOR GENERAL TIGHTENING TORQUES

MANIFOLD AND VENTILATION VALVE
(Industrial Engines)



Put 8H5137 Form A Gasket on threads of adapter and plug

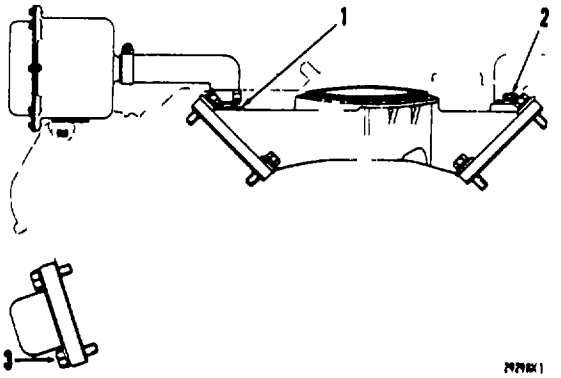
(1) Torque for adapter . 108 ± 36 lb in (125 ± 44 cm.kg)

(2) Torque for plug .. ... 108 ± 36 lb in (125 ± 44 cm kg)

(3) Torque for bolts holding the exhaust manifold 32 ± 5 lb ft (4.4 ± 0 7 mkg)

Locks must be bent on a flat side of the bolt head Bolts must be turned no more than 30° of a turn for the alignment of locks with a flat side of the bolt head

MANIFOLD AND VENTILATION VALVE
(Marine Engines)



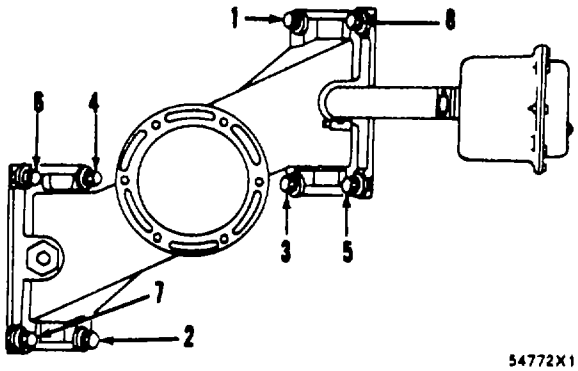
Put 8H5137 Form A Gasket on threads of adapter and plug.

(1) Torque for adapter ..... 108 ± 36 lb. in. (125 ± 44 cm.kg)

(2) Torque for plug ..... 108 ± 36 lb. in. (125 ± 44 cm.kg)

(3) Torque for bolts holding the exhaust manifold ..... 32 ± 5 lb. ft. (4.4 ± 0.7 mkg)

AIR INLET MANIFOLD

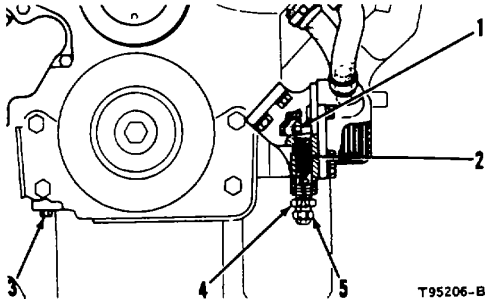


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Tighten bolts (3) and (4) to . . . 15 ± 5 lb. ft (2.0 ± 0.7 mkg)

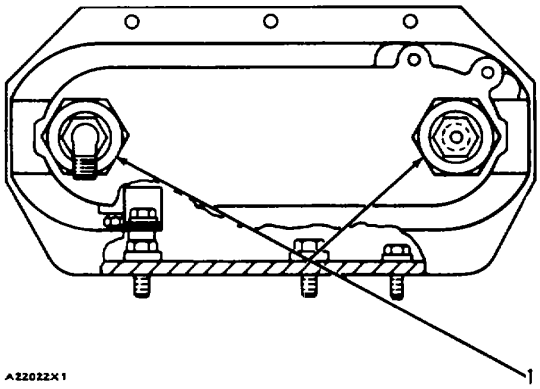
Tighten all bolts in number sequence to . .. . 32 ± 5 lb. ft (4 4 ± 0 7 mkg)

LUBRICATION SYSTEM



Oil pressure that makes the oil filter bypass valve open	20 ± 2 psi (1.41 ± 0 14 kg/cm²)
Oil pressure that makes the oil cooler bypass valve open	18 ± 4 psi (1 27 ± 0.28 kg/cm²)
(1) Torque for nuts holding oil cooler core to oil cooler base	16 ± 2 lb ft (2 2 ± 0 3 mkg)
(2) 9L9188 Spring (oil cooler bypass valve)	
Length under test force	1 70 in (43 2 mm)
Test force	3 5 lbs (1 59 kg)
Free length after test	2 28 in (57 9 mm)
Outside diameter	440 in (11 18 mm)
(3) Torque for bolts holding the oil pan	17 ± 3 lb ft (2 4 ± 0 4 mkg)
(4) Torque for fitting	19 ± 4 lb ft. (2.6 ± 0 55 mkg)
(5) Torque for cap	16 ± 4 lb ft (2 0 ± 0 55 mkg)

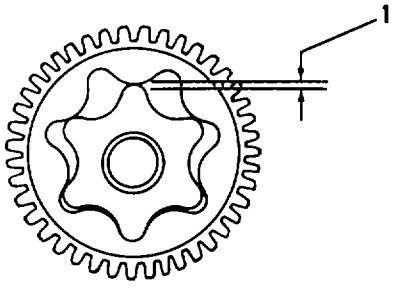
MARINE GEAR OIL COOLER



(1) Torque for nuts holding the oil cooler core for the marine gear . . . . 45 ± 5 lb. ft (6 2 ± 0 7 mkg)

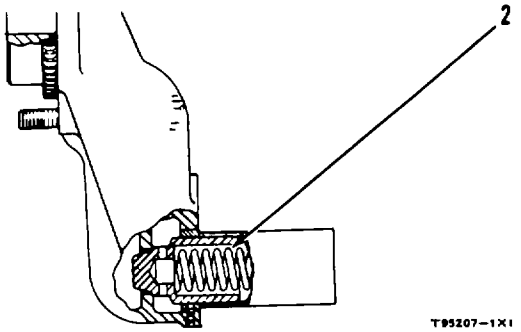
NOTE: FOR TORQUE VALUES NOT GIVEN, SEE THE FIRST PAGE OF SPECIFICATIONS FOR GENERAL TIGHTENING TORQUES

OIL PUMP



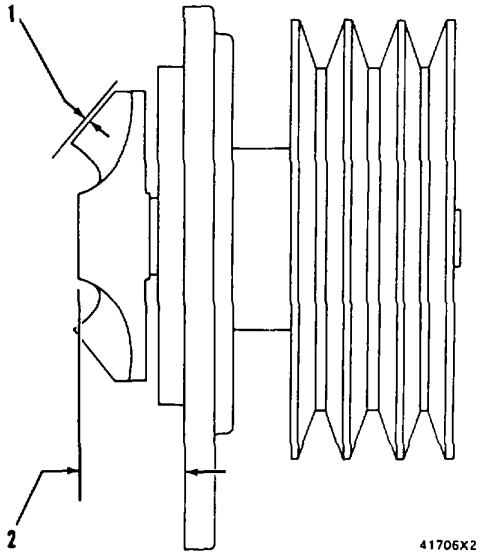
28774X1

Pressure of oil when measured at oil filter base (warm oil)	
High idle rpm	55 to 85 psi (3 9 to 6 0 kg/cm²)
Low idle rpm	minimum oil pressure of 15 psi (1 1 kg/cm²)
Maximum permissible end clearance of oil pump gears when measured with oil pump installed to front cover	006 in (0 15 mm)
(1) Clearance of oil pump gear rotor tip	002 to 006 in (0 05 to 0 15 mm)
Maximum permissible clearance of oil pump gear rotor tip	009 in (0 23 mm)
(2) 9L9243 Spring (pump pressure relief valve)	
Length under test force	2 579 in (65 51 mm)
Test force	37 3 ± 1 9 lbs (16 9 ± 0 9 kg)
Free length after test	3 50 in (88 9 mm)
Outside diameter	875 in (22 23 mm)



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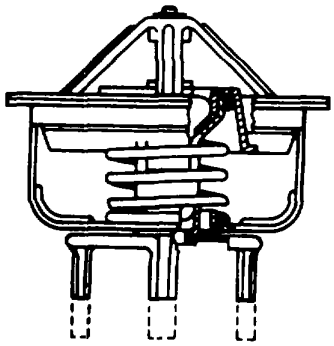
WATER PUMP



(1) Clearance between the water pump impeller face and the front cover 011 to 035 in (0 28 to 0 89 mm)

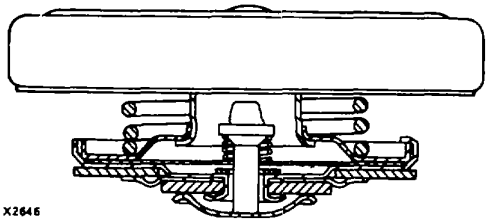
(2) Distance from mounting face of the water pump to the end of the impeller 1 265 to 1 275 (32 12 to 32 39 mm)

WATER TEMPERATURE REGULATOR
(9L6756)



Temperature when completely open	197° F (92° C)
Minimum opening distance	380 in (9 65 mm)

COOLING SYSTEM PRESSURE CAP



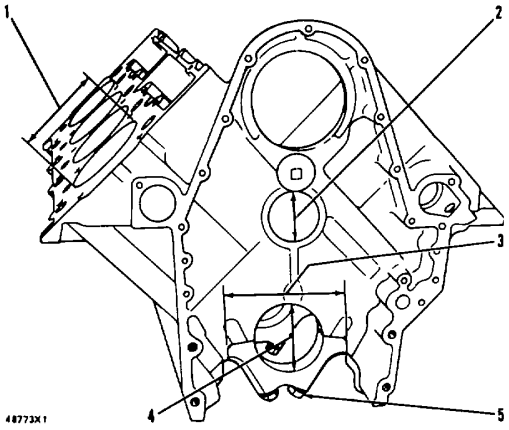
TYPICAL ILLUSTRATION

689505 Pressure Relief Cap:	
Pressure that makes the relief valve open	13 to 15 psi (0 9 to 1 0 kg/cm²)
2N3402 Pressure Relief Cap:	
Pressure that makes the relief valve open	6 4 to 7 7 psi (0 45 to 0 54 kg/cm²)
6L8617 Pressure Relief Cap:	
Pressure that makes the relief valve open	6 5 to 8 psi (0 46 to 0 56 kg/cm²)

NOTE: FOR TORQUE VALUES NOT GIVEN, SEE THE FIRST PAGE OF SPECIFICATIONS FOR GENERAL TIGHTENING TORQUES

V-BELT TENSION CHART							
	WIDTH		WIDTH TOP OF PULLEY		BELT TENSION	BELT TENSION	BORROUGHS
BELT SIZE	BELT TOP		GROOVE		"INITIAL"*	"USED"**	GAGE NO.
	in.	mm	mm	in	GAGE READING	GAGE READING	
3/8	.422	25.82	.380	9.65	100 + 5	45 + 5	BT-33-73F
1/2	.547	13.89	.500	12.70	120+5	90+10	BT-33-96-4-16
5V	.625	15.88	.600	15.24	120+5	90+10	BT-33-72-4-15
11/16	.688	17.48	.625	15.88	120-+5	90 +10	BT-33-72-4-15
3/4	.750	19.05	.690	41.34	120+5	90+10	BT-33-72-4-15
15/16	.938	23.83	.878	22.30	120+5	90 +10	BT-33-72-4-15
MEASURE TENSION OF BELT FARTHEST FROM THE ENGINE							
*"INITIAL" BELT TENSION is for a new belt. *,"USED" BELT TENSION is for a belt which has more than 30 minutes of operation at rated speed of engine. A 023ZX							

CYLINDER BLOCK



Measure wear of the cylinder bore at the top and bottom of piston ring travel

(1) Cylinder bore [standard, original size] 4 5005 ± 0005 in (114 313 ± 0 013 mm)

The recommendation is made to make the cylinder bore the next size larger when the size of the bore is 4 5060 in (114 452 mm)

Cylinder bore must be made the next size larger when the size of the bore is 4 5090 in (114 529 mm)

Cylinder bore [020 in (0 51 mm) larger than the original size] 4 5205 ± 0005 in (114 821 ± 0 013 mm)

The recommendation is made to make the cylinder bore the next size larger when the size of the bore is 4 5260 in (114 960 mm)

Cylinder bore must be made the next size larger when the size of the bore is 4 5290 in (115 037 mm)

Cylinder bore [040 in (1 02 mm) larger than the original size] 4 5405 ± 0005 in (115 329 ± 0 013 mm)

Maximum permissible wear of cylinder bores (replacement of the cylinder block is necessary) 4 5490 in (115 545 mm)

(2) Bore in block for camshaft bearing 2 6525 ± 0005 in (67 374 ± 0 013 mm)

(3) Width of main bearing cap 6 5600 ± 0007 in (116 624 ± 0 018 mm)

Minimum permissible width of main bearing cap 6 5580 in (116 573 mm)

Width of main bearing cap guide (in cylinder block) 6 5590 ± 0005 in (116 599 ± 0 013 mm)

(4) Bore in block for main bearing 3 7075 ± 0005 in (94 171 ± 0 013 mm)

Permissible amount of distortion in bore 3 706 to 3 709 in (94 13 to 94 21 mm)

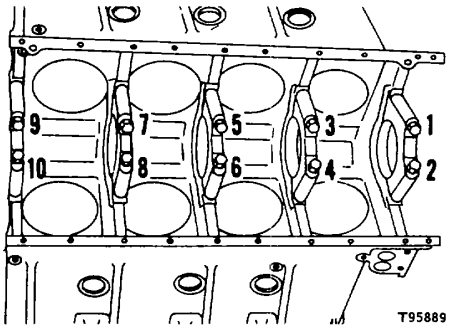
(5) Torque for bolts holding caps for main bearings

1 Put crankcase oil on bolt threads and washer face

2 Tighten all bolts in number sequence to 30 ± 3 lb ft (4 1 ± 0 4 mkg)

3 Put a mark on each bolt and cap

4 Tighten all bolts in number sequence from mark 120° ± 5°



NOTE: FOR TORQUE VALUES NOT GIVEN, SEE THE FIRST PAGE OF SPECIFICATIONS FOR GENERAL TIGHTENING TORQUES

CONNECTING ROD

(1) Bore in bearing for piston pin 1 5010 ± 0003 in (38 125 ± 0 007 mm)

(2) Bore in connecting rod for bearing 2 9418 ± 0005 in (74 721 ± 0 013 mm)

(3) Distance between center of bearing for piston pin and center of bearing for crankshaft journal 7 900 ± 001 in (200 66 ± 0 03 mm)

(4) Diameter of piston pin 1 4999 ± 0002 in (38 097 ± 0 005 mm)

Maximum permissible clearance between bearing and piston pin 003 in (0 08 mm)

(5) Bore in bearing for crankshaft bearing surfaces (journal) 2 753 ± 001 in (69 93 ± 0 03 mm)

Clearance between bearing and crankshaft bearing surface (journal) 0030 ± 0015 in (0 076 ± 0 038 mm)

Maximum permissible clearance between bearing and crankshaft bearing surface (journal) 007 in (0 18 mm)

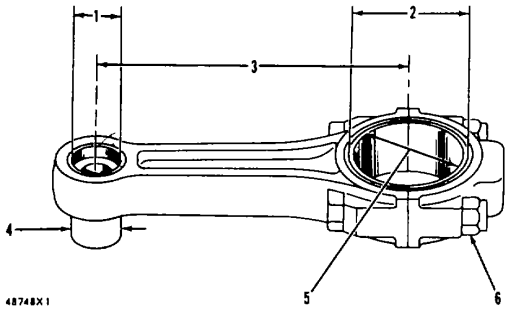
(6) Torque for nuts

A Put crankcase oil on bolt threads and seating faces of cap and nut

B Tighten both nuts to 30 ± 3 lb ft (4 1 ± 0 4 mkg)

C Put a mark on each nut and cap

D Tighten each nut from mark 60° ± 5°



PISTON

(1) Clearance between top ring and groove 0030 to 0055 in (0 076 to 0 140 mm)

Replacement needed at 011 in (0 28 mm)

Maximum permissible clearance 014 in (0 36 mm)

(2) Clearance between oil ring and groove 0015 to 0035 in (0 038 to 0 089 mm)

Replacement needed at 006 in (0 15 mm)

Maximum permissible clearance 008 in (0 20 mm)

(3) Bore in piston for pin 1 5006 to 1 5009 in (38 115 to 38 123 mm)

Maximum permissible clearance between piston pin and bore in piston 003 in (0 08 mm)

Clearance between ends of piston ring, installed in the part of the cylinder bore that has no wear

(4) Top ring

Clearance between ends of piston ring 0225 ± 0075 in (0 572 ± 0 191 mm)

Ring needs replacement when clearance is 045 in (1 14 mm)

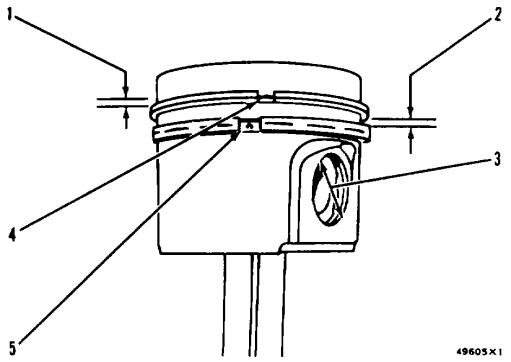
Maximum permissible clearance (replacement of ring necessary) 055 in (1 40 mm)

(5) Oil ring

Clearance between ends of piston ring 0175 ± 0075 in (0 445 ± 0 191 mm)

Ring needs replacement when clearance is 038 in (0 97 mm)

Maximum permissible clearance (replacement of ring necessary) 045 in (1 14 mm)



CRANKSHAFT

(1) End play for the crankshaft . . 006 ± .003 in. (0.15 ± 0 08 mm)

Maximum permissible end play for the crankshaft (worn) . . . .012 in (0 30 mm)

(2) Diameter of pulley end of crankshaft . 2 1256 ± 0005 in (53 990 ± 0.013 mm)

(3) Heat gear to install Do not heat to a temperature of more than . 500° F (260° C)

(4) Diameter of bearing surfaces (journals) for the connecting rods (standard, original size) . . . . . 2.7500 ± .0004 in. (69.850 ± 0.010 mm)

Minimum permissible diameter (worn) . 2.7486 in. (69.814 mm)

Diameter of bearing surfaces (journals) for the connecting rods [.010 in. (0.25 mm) smaller than the original size] . . . . . 2.7400 ± .0004 in. (69.596 ± 0.010 mm)

Minimum permissible diameter (worn) . . 2.7386 in. (69.560 mm)

Diameter of bearing surfaces (journals) for the connecting rods [.020 in. (0.51 mm) smaller than the original size) . . . . . 2.7300 ± .0004 in. (69.342 ± 0.010 mm)

Minimum permissible diameter (worn) . . 2.7286 in. (69.306 mm)

(5) Diameter of bearing surfaces (journals) for the main bearings (standard, original size] . . . . . 3.4995 ± .0005 in. (88.887 ± 0.013 mm)

Minimum permissible diameter (worn) . . 3.4980 in. (88.749 mm)

Diameter of bearing surfaces (journals) for the main bearings [.010 in. (0.25 mm) smaller than the original size] . . . . . 3.4895 ± .0005 in. (88.633 ± 0.013 mm)

Minimum permissible diameter (worn) . 3.4880 in. (88.595 mm)

Diameter of bearing surfaces (journals) for the main bearings [020 in. (0.51 mm) smaller than the original size] . 3.4795 ± 0005 in (88 379 ± 0 013 mm)

Minimum permissible diameter (worn) 3 4780 in (88 341 mm)

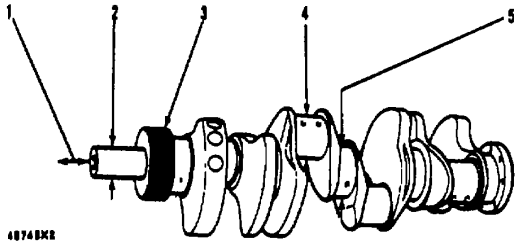
Bore in main bearing 3 5030 ± 0010 in (88 976 ± 0 025 mm)

Clearance between main bearing and crankshaft bearing surface (journal) . 0020 to 0060 in (0.051 to 0.127 mm)

Maximum permissible clearance between main bearing and crankshaft bearing surface (journal) .006 in. (0 15 mm)

Maximum permissible run out (axial eccentricity) of the crankshaft, measured at the center main bearing surface (journal) . . . 006 in. (0.15 mm)

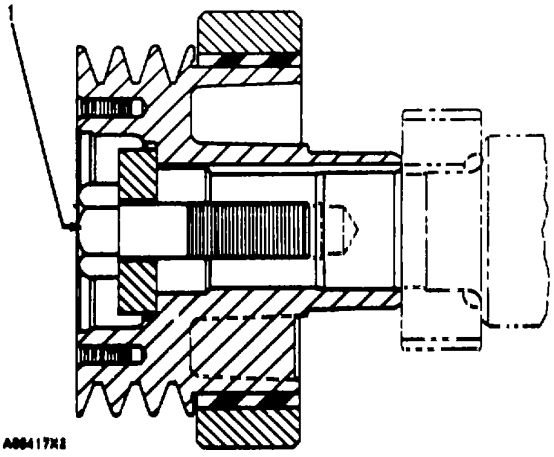
Maximum permissible run out (axial eccentricity) of the crankshaft, measured at No 2 and No 4 main bearing surfaces (journal) . . . . .003 in (0 08 mm)



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NOTE: FOR TORQUE VALUES NOT GIVEN, SEE THE FIRST PAGE OF SPECIFICATIONS FOR GENERAL TIGHTENING TORQUES

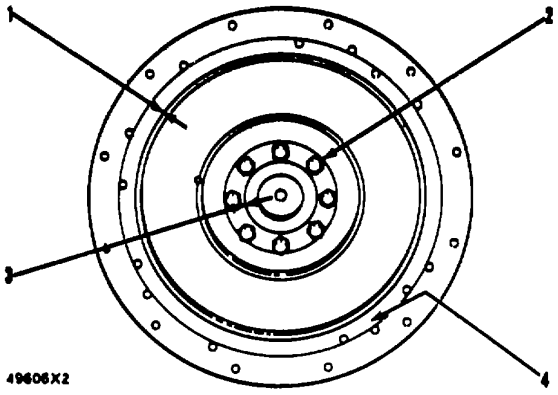
PULLEY AND DAMPER



Install the damper assembly on the crankshaft until the hub of the damper assembly comes in contact with the gear on the crankshaft. DO NOT use the bolt and washer that holds the damper assembly on the crankshaft to install the damper assembly.

(1) Torque for bolt holding the pulley ..... 460 ± 60 lb. ft. (63.6 ± 8.3 mkg)

FLYWHEEL



Put 8H5137 Form A Gasket on threads of flywheel bolts.

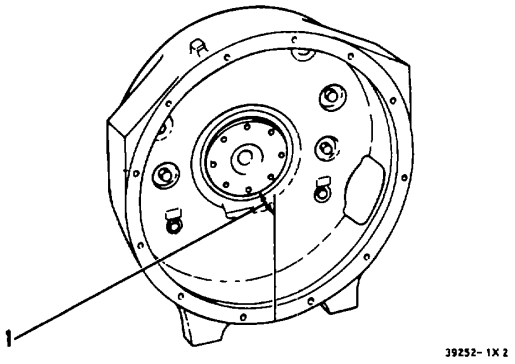
(1) Maximum permissible "run out" (radial eccentricity) off center of bore (total indicator reading) ..... .006 in. (0.15 mm)

(2) Torque for bolts holding flywheel to crankshaft ..... 55 ± 5 lb. ft. (7.6 ± 0.7 mkg)

(3) Maximum permissible "run out" (radial eccentricity) off center of pilot bore (total indicator reading) ..... .005 in. (0.13 mm)

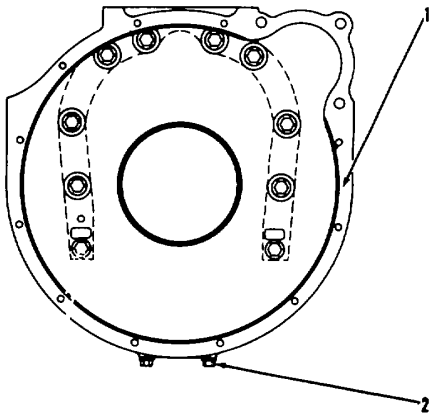
(4) Maximum permissible "run out" (axial eccentricity) of face (total indicator reading) ..... .006 in. (0.15 mm)

FLYWHEEL HOUSING FACE
(Industrial Engines)



(1) Maximum permissible "run out" (axial eccentricity) of face total indicator reading . . . . . .008 in (0.20 mm)

FLYWHEEL HOUSING FACE
(Marine Engines)



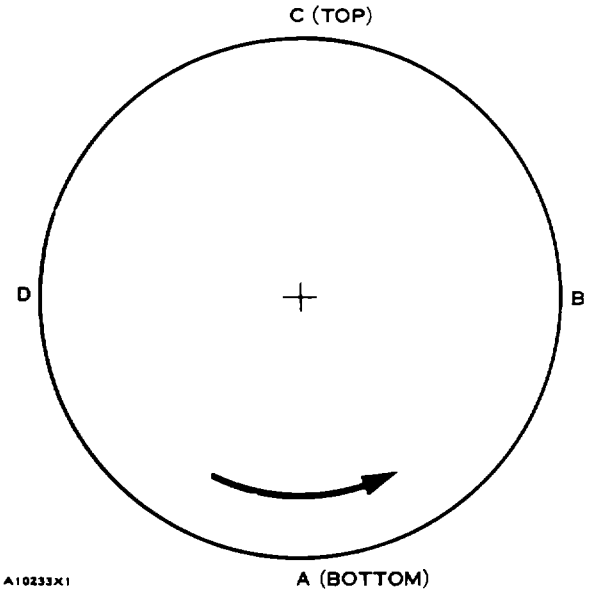
(1) Maximum permissible "run out" (axial eccentricity) of face (total indicator reading) . . . . . 008 in (0 20 mm)

(2) Torque for bolts . . . . . 20 ± 5 lb ft (2.8 ± 0 7 mkg)

NOTE Put 9S3264 Pipe Sealant on threads

NOTE: FOR TORQUE VALUES NOT GIVEN, SEE THE FIRST PAGE OF SPECIFICATIONS FOR GENERAL TIGHTENING TORQUES

FLYWHEEL HOUSING BORE



1 With the dial indicator in position at (C), adjust the dial indicator to "0" (zero) Push the crankshaft up against the top bearing. Write the measurement for bearing clearance on line 1 in column (C)

2 Divide the measurement from Step 1 by 2 Write this number on line 1 in columns (B) & (D)

3 Turn the crankshaft to put the dial indicator at (A) Adjust the dial indicator to "0" (zero)

4 Turn the crankshaft counterclockwise to put the dial indicator at (B) Write the measurement in the chart

5 Turn the crankshaft counterclockwise to put the dial indicator at (C) Write the measurement in the chart

6 Turn the crankshaft counterclockwise to put the dial indicator at (D) Write the measurement in the chart

7 Add lines I & II by columns

8 Subtract the smaller number from the larger number in line III in columns (B) & (D) The result is the horizontal "eccentricity" (out of round) Line III, column (C) is the vertical eccentricity.

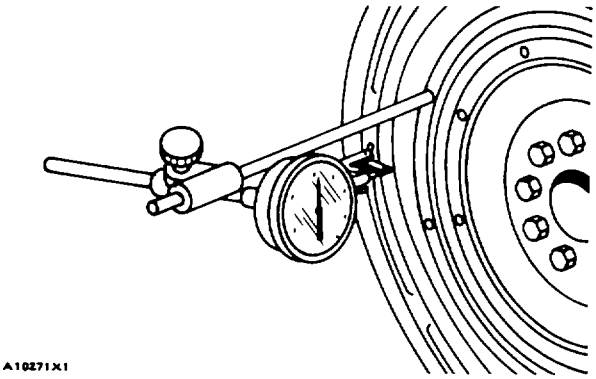
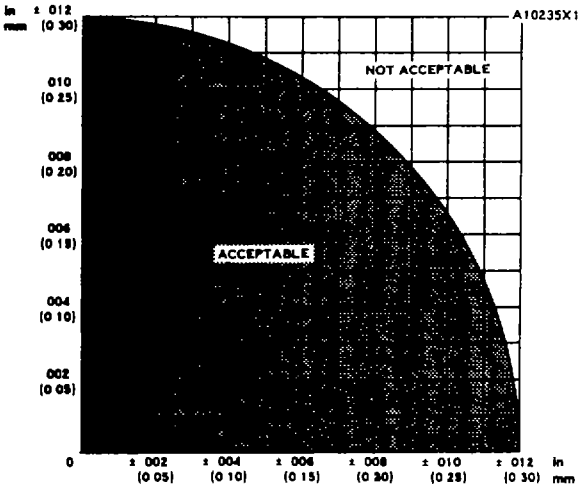


CHART FOR DIAL INDICATOR MEASUREMENTS					
		Position of dial indicator			
	Line No	A	B	C	D
Correction for bearing clearance	I	0			
Dial Indicator Reading	II	0			
Total of Line 1 & 2	III	0	**	*	**

*Total Vertical eccentricity (out of round)
**Subtract the smaller No from the larger No The difference is the total horizontal eccentricity

A10234X1



9 On the graph for total eccentricity find the point of intersection of the lines for vertical eccentricity and horizontal eccentricity.

10 If the point of intersection is in the range marked "Acceptable" the bore is in alignment If the point of intersection is in the range marked "Not Acceptable" do Step 11.

11 Loosen the bolts holding the flywheel housing to the cylinder block Hit the flywheel housing lightly with a hammer to put it in the correct position Tighten the bolts holding the flywheel housing to the cylinder block and do Steps 1 through 10 again

ALTERNATORS

2N7759 12V (Motorola Number 8MH-2003K)

Rotation can be either direction

Output at 5000 rpm and 14 V (cold) put a load on the battery with a carbon pile to get maximum of . . . . 50 A

Rated output (hot) in air temperature of 77° F (25° C)

Speed at 5000 rpm and when temperature and output are not changing . . 50 A

Field current at 12 V and 75° F (24° C) . . Maximum of 3 0 A

(1) Torque for nut . 45 ± 5 lb ft (6 2 ± 0 7 mkg)

(2) Tension of brush spring . 5 5 to 7 oz (0.16 to 0 20 kg)

2N6398 24V (Motorola Number 8MH3005F)

Rotation can be either direction

Output at 5000 rpm and 28 V (cold) put a load on the battery with a carbon pile to get maximum of . 32 A

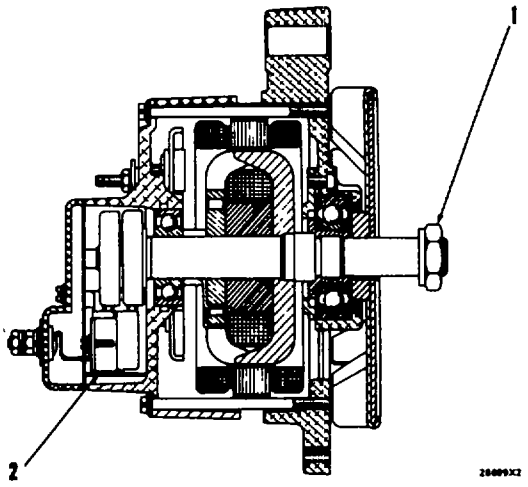
Rated output (hot) in air temperature of 77° F (25° C)

Speed at 5000 rpm and when temperature and output are not changing . 32 A

Field current at 24 V and 75° F (24° C) Maximum of 3 0 A

(1) Torque for nut 45 ± 5 lb ft (6 2 ± 0 7 mkg)

(2) Tension of brush spring . 5 5 to 7 oz. (0 16 to 0 20 kg)



3P77 24V (Delco-Remy Number 1102398)

Polarity is negative ground.

Rotation can be either direction.

Output at 26V and 2600 rpm (cold) . . . . . 25 A

Output at 26V and 7000 rpm (cold) . . . . . 41 A

Rated output (hot) . . . . . 40 A

(1) Torque for stud nut for battery connection . . . . . 25 to 40 lb. in (29 to 46 cm.kg)

(2) Torque for pulley nut . . . . . 60 ± 5 lb ft. (8.3 ± 0 7 mkg)

9L6298 12V (Delco-Remy Number 1102396)

Polarity is negative ground

Rotation can be either direction

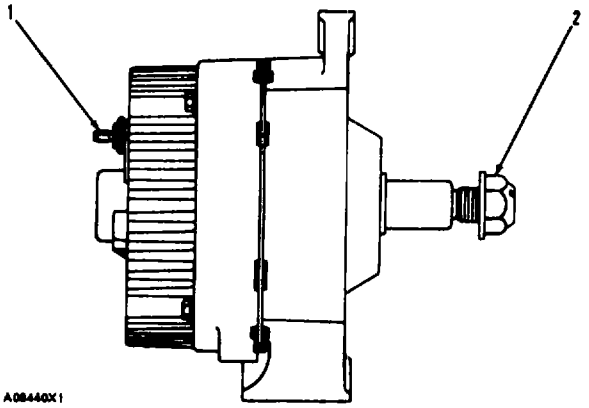
Output at 14V and 2000 rpm (cold) . . . . . 33 A

Output at 14V and 7000 rpm (cold) . . . . . 54 A

Rated output (hot) . . . . . 55 A

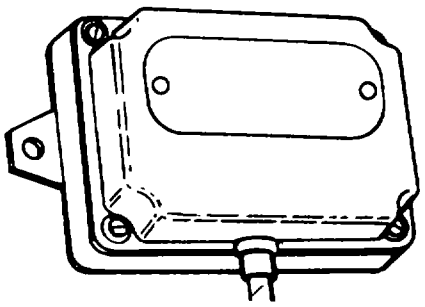
(1) Torque for stud nut for battery connection . . . . 25 to 40 lb. in. (29 to 46 cm.kg)

(2) Torque for pulley nut . . . . 60 ± 5 lb. ft. (8.3 ± 0.7 mkg)



ALTERNATOR REGULATORS

2N7278 12V (Motorola Number TVR12-33C)	
Polarity is negative ground or insulated	
Voltage setting range	13 to 16 V
Make adjustment of voltage setting to	14 4 V
2N7279 24V (Motorola Number TVR24-29C)	
Polarity is negative ground or insulated	
Voltage regulator setting range	27 to 35 V
Make adjustment of voltage setting to	28 4 V


48739X1

STARTER SOLENOIDS

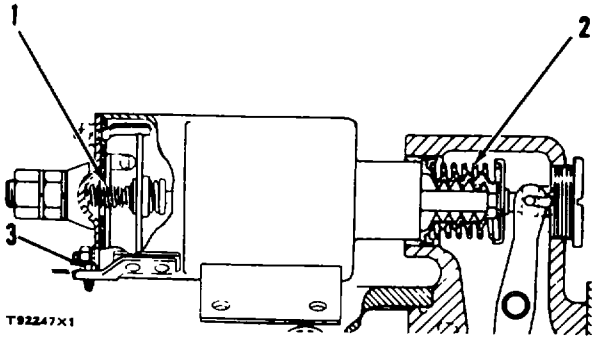
5L8735 12V (Delco Remy Number 1119862)

7L6586 12V (Delco-Remy Number 1119879)

Current consumption (draw)	
Pull in windings at 5 V	21 3 to 35 7 A
Pull in windings at 10 to 12 V	62 6 to 85 7 A
Hold in windings at 10 V	14 3 to 15 4 A
Hold in windings at 10 to 12 V	14 3 to 18 5 A
(1) 4M1815 Spring for contact release	
Length under test force	42 in (10 7 mm)
Test force	8 5 to 9 5 lb (3 9 to 4 3 kg)
Free length after test	83 ± 015 in (21 1 ± 0 38 mm)
Outside diameter	875 ± 010 in (22 23 ± 0 25 mm)
(2) 9M7609 or 4M1856 Spring to return the clutch lever	
Length under test force	1 56 in (39 6 mm)
Test force	14 ± 5 lb (6 35 ± 0 23 kg)
Free length after test	2 79 in (70 9 mm)
Outside diameter	1 393 ± 015 in (35 38 ± 0 38 mm)
(3) Torque for terminal screws	16 to 30 lb in (18 4 to 35 0 cm kg)

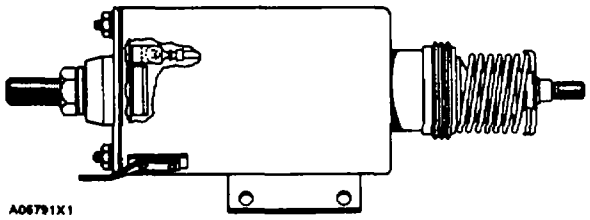
4M1812 24V (Delco-Remy Number 1119832)

Current consumption (draw)	
Pull in windings at 5 V	10 to 11 5 A
Pull in windings at 20 to 24 V	40 to 55 2 A
Hold in windings at 20 to 24 V	8 2 A
(1) 4M1815 Spring for contact release	
Length under test force	42 in (10 7 mm)
Test force	8 5 to 9 5 lb (3 9 to 4 3 kg)
Free length after test	83 ± 015 in (21 1 ± 0 38 mm)
Outside diameter	875 ± 010 in (22 23 ± 0 25 mm)
(2) 9M7609 or 4M1856 Spring to return the clutch lever	
Length under test force	1 56 in (39 6 mm)
Test force	14 ± 5 lb (6 35 ± 0 23 kg)
Free length after test	2 79 in (70 9 mm)
Outside diameter	1 393 ± 015 in (35 38 ± 0 38 mm)
(3) Torque for terminal screws	16 to 30 lb in (18 4 to 35 0 cm kg)



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Starter Solenoids (Cont.)

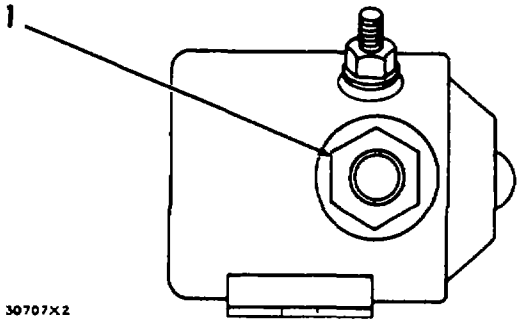

A06791X1

9S7976 24V (Prestolite Number SAT-4103)

Current consumption (draw) at 70° F (21° C).

Pull in windings at 12V	23 2 to 26 6 A
Pull in windings at 20 to 24V	38 6 to 52 4 A
Hold in windings at 12V	4 1 to 4 8 A
Hold in windings at 20 to 24V	6 8 to 9 6 A

STARTER MAGNETIC SWITCH



30707X2

9N964 12V (Delco-Remy Number 1119828)

Current consumption (draw) both windings at 8V 2 1 to 2 4 A

(1) Torque for nuts for larger terminal 35 ± 5 lb in (40 4 ± 5.8 cm kg)

STARTING MOTORS

4N8253 12V (Delco-Remy Number 1114733)

9L3597 12V (Delco-Remy Number 1114708)

Rotation is clockwise when seen from drive end

Minimum no load speed	4000 rpm
Maximum no load speed	7000 rpm
Current consumption (draw) at no load	
Minimum with solenoid at 9 V	140 A
Maximum with solenoid at 9 V	190 A
Clearance between pinion and housing (pinion clearance)	36 in (9 1 mm)
(1) Tension of brush spring	80 oz (2 3 kg)
(2) Torque for screws holding nose housing to lever housing	13 to 17 lb ft (1 8 to 2.4 mkg)
(3) Torque for terminal nuts	20 to 25 lb ft (2.8 to 3 5 mkg)

4N9253 12V (Delco-Remy Number 1114731)

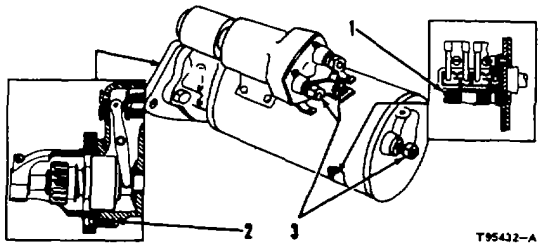
Rotation is counterclockwise when seen from drive end

Minimum no load speed	4000 rpm
Maximum no load speed	7000 rpm
Current consumption (draw) at no load	
Minimum with solenoid at 9 V	140 A
Maximum with solenoid at 9 V	190 A
Clearance between pinion and housing (pinion clearance)	,36 in (9.1 mm)
(1) Tension of brush spring	80 oz. (2 3 kg)
(2) Torque for screws holding nose housing to lever housing	13 to 17 lb ft (1 8 to 2 4 mkg)
(3) Torque for terminal nuts	20 to 25 lb ft (2.8 to 3 5 mkg)

2S900 24V (Delco-Remy Number 1113942)

Rotation is clockwise when seen from drive end

Minimum speed with no load	5500 rpm
Maximum speed with no load	7500 rpm
Current consumption (draw) at no load	
Minimum with solenoid at 20 V	75 A
Maximum with solenoid at 20 V	95 A
Clearance between pinion and housing (pinion clearance)	36 in (9 1 mm)
(1) Tension of brush spring	80 oz (2.27 kg)
(2) Torque for screws holding nose housing to lever housing	13 to 17 lb ft (1 8 to 2 4 mkg)
(3) Torque for terminal nuts	20 to 25 lb ft (2 8 to 3 5 mkg)



Starting Motors (Cont.)

4N7153 24V (Prestolite Number MFY 6402)

Rotation is counterclockwise when seen from drive end.

Minimum speed with no load ..... 5000 rpm

Current consumption (draw) with no load:

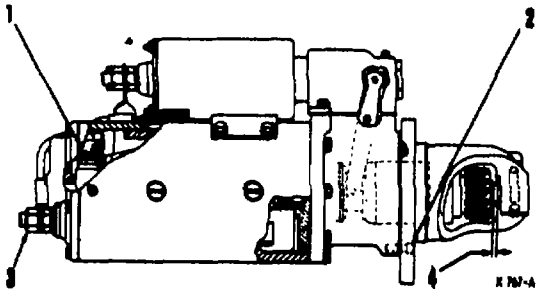
Maximum at 20V ..... 65 A

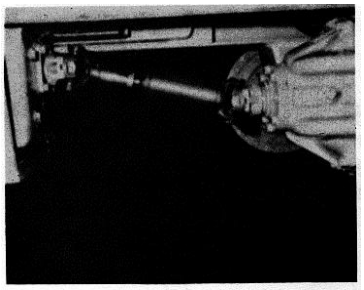
(1) Tension of brush spring ..... 80 to 90 oz. (2.27 to 2.55 kg)

(2) Torque for housing bolts ..... 100 lb. in. (115.2 cm.kg)

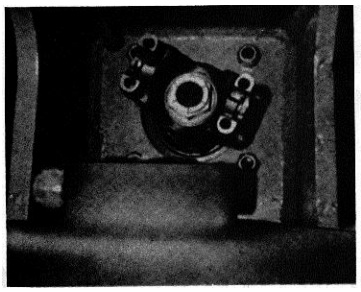
(3) Torque for terminal nuts ..... 20 to 25 lb. ft. (2.8 to 3.5 mkg)

(4) Clearance between pinion and housing (pinion clearance) ..... .020 to .050 in. (0.51 to 1.27 mm)





Transmission to Rear Axle Drive Shaft

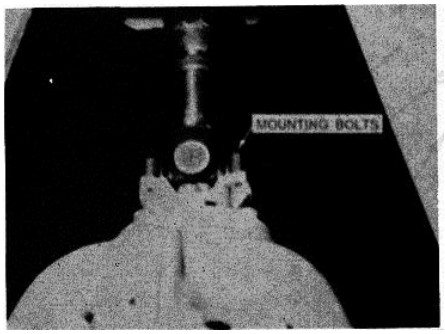


Center Bearing to Front Axle Drive Shaft

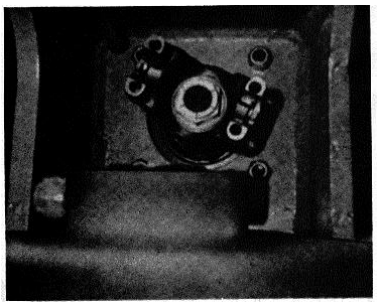
DRIVE SHAFT REMOVAL:

1. Park machine on level ground, lower blade, set parking brake and securely block machine.

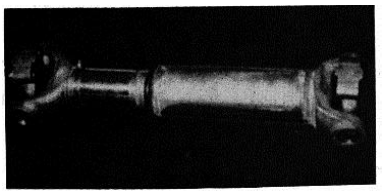
2. Remove journal cross mount bolts from axle companion flange and remove drive shaft assembly.



3. To remove front drive shaft from center bearing, the yoke nut and yoke end must be removed first.

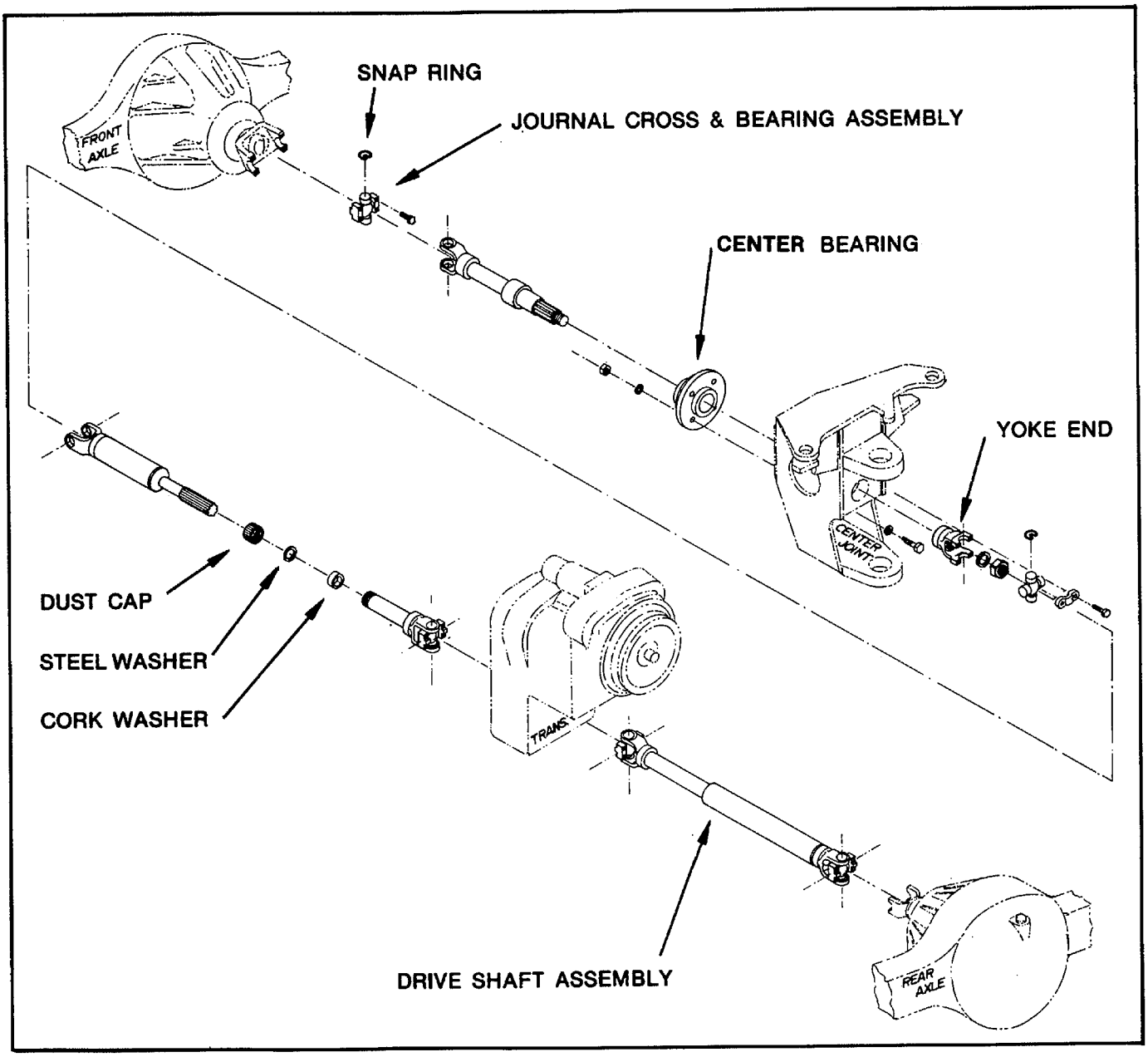


Drive Shaft Yoke Nut and Yoke End



Drive Shaft Assembly

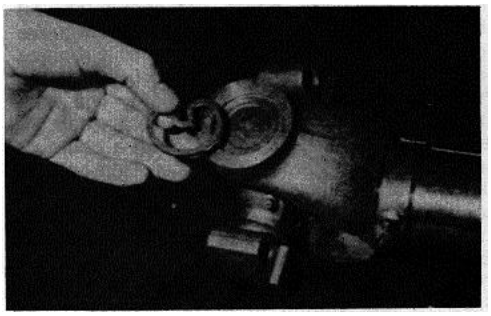
DRIVE SHAFTS:



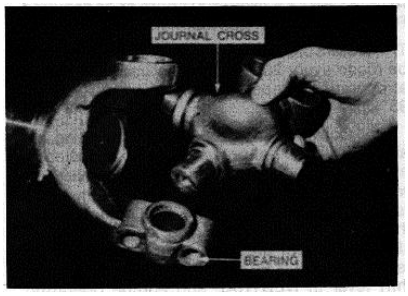
DRIVE SHAFT GROUP

DRIVE SHAFT DISASSEMBLY:

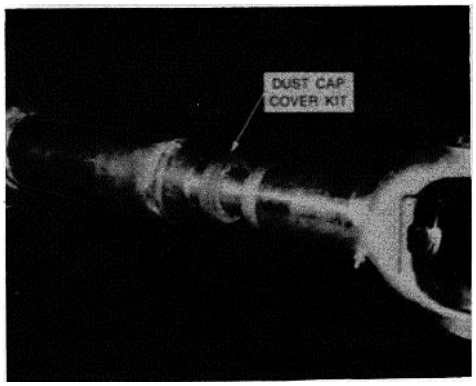
1. To remove journal assembly, remove the bearing retainer snap rings from the yoke.



2. Press bearings from the yoke and remove the journal assembly.

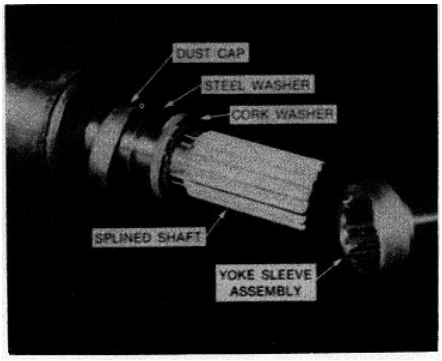


Journal Cross and Bearing

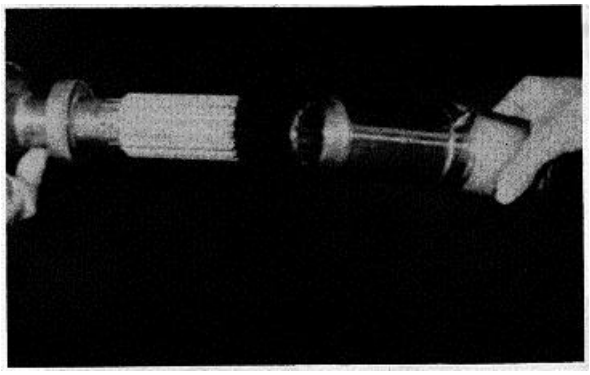


Dust Cover Kit

3. To remove yoke sleeve remove dust cap and separate the shaft assembly.

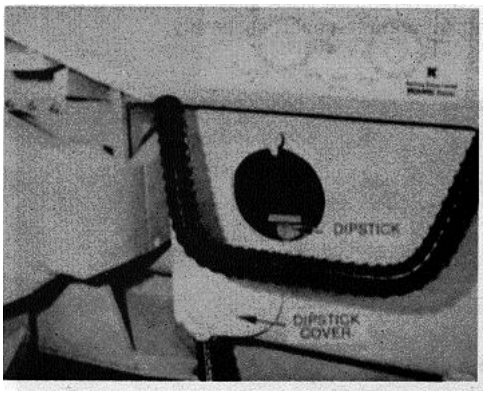


4. When reassembling the unit, check for proper yoke alignment if the drive shaft yoke sleeve has been removed.



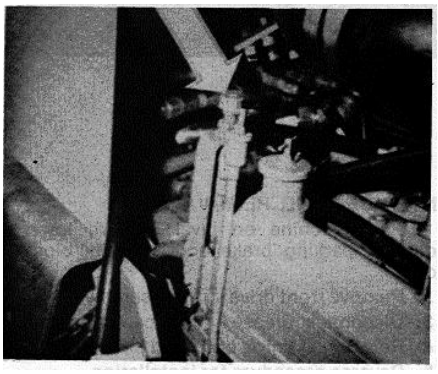
CENTER BEARING REMOVAL:

1. Park machine on level ground, lower blade, set parking brake and securely block machine.
2. Remove front drive shaft assembly.
3. Disconnect grease lines at center bearing.
4. Remove retaining bolts and bearing.
5. Reverse proceEdure.for installation.



Transmission Oil Dipstick and Cover

MAINTENANCE:
CHECK OIL LEVEL daily on transmission oil dipstick with engine idling and transmission oil at 180 to 200°F (82 to 93°C). Maintain oil level between dipstick markings, adding fluid as necessary (refer to LUBRICANTS SPECIFICATION CHART) through transmission fill plug.



Transmission Oil Filler-Breather Cap

OIL AND FILTER CHANGE should be made after initial 50 hours of operation and thereafter filter change every 200 hours and oil and filter change every 400 hours. Transmission oil should be at operating temperature. Remove sump screen, cleaning thoroughly and replace using new gaskets. Access to the filter can be made by removing rear floor plate. The seat mounting base, complete with seat, may be removed to aid accessibility. Using a chain or belt filter wrench, remove canister. Remove old element and check for foreign material deposits. Install new element and O ring. Install filter canister and torque to 20 to 25 ft-lbs (2,8 to 3,5 m-kg). Refill transmission to FULL mark (refer to LUBRICANTS -SPECIFICATION CHART). Idle engine to prime converter and lines and recheck level, topping to FULL mark as required. When oil temperature is at operating temperature of 180 to 200°F (82 to 93°C) make final oil level check.

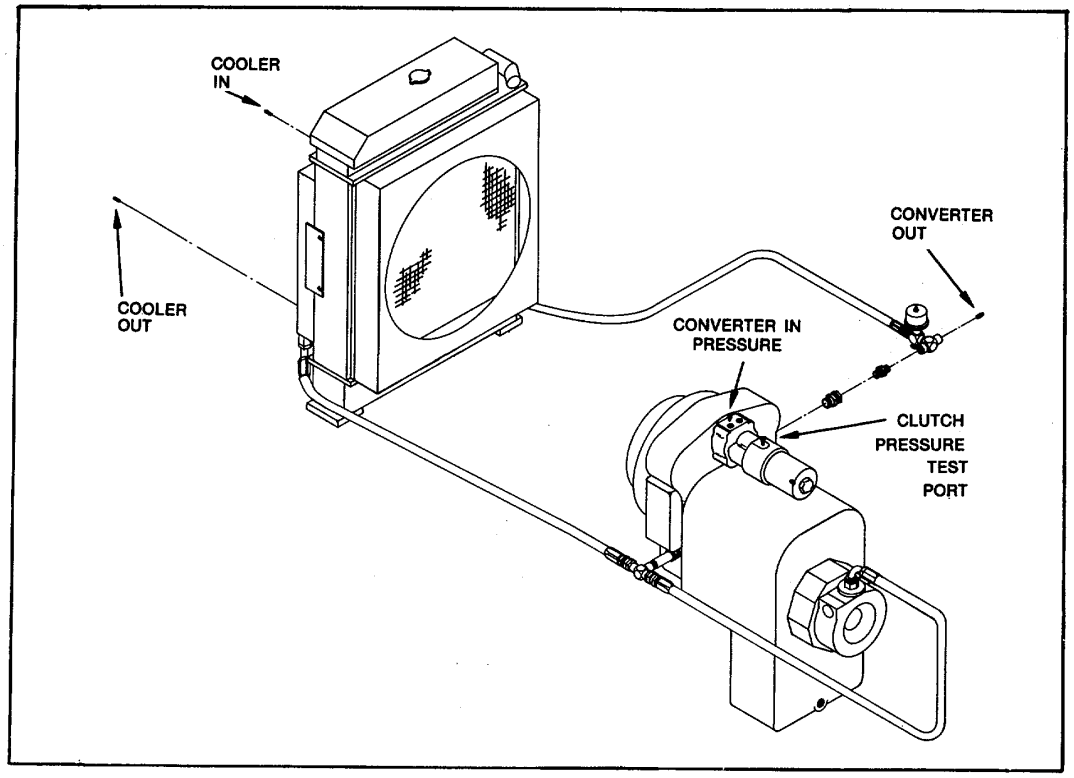
ADJUST BRAKE every 800 hours or as required. Refer to vendor service manual.

TRANSMISSION OIL PRESSURE TESTS should be made every 200 hours with transmission oil at operating temperature of 180 to 2000F (82 to 93°C).

1. "Converter Out" pressure reading is taken with a 150 psi pressure gauge installed in test port on tee fitting at transmission. Pressure reacing should be a minimum of 25 psi (173 kPa 11,8 kglsq cm) with transmission shift lever in NEUTRAL and engine at 2000 RPM. Maximum pressure is not to exceed 70 psi (483 kPal4,9 kglsq cm) with transmission shift lever in NEUTRAL and engine operating with no load at governed speed (2800 RPM).

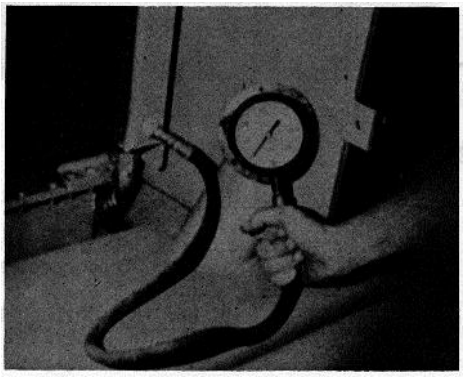


"Converter Out" Pressure Test

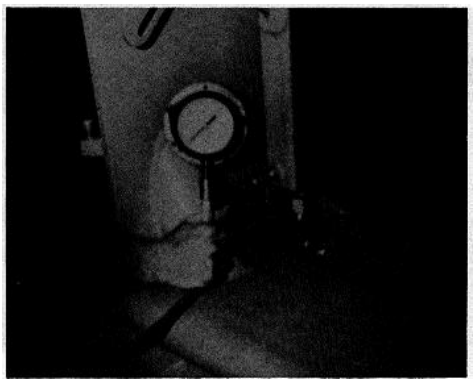


Transmission Oil System Pressure Testing

2. "Cooler **Out"** pressure reading is taken with a 150 psi pressure gauge at right hand test port at back of air-oil cooler. Reading should be 10 to 14 psi (69 to 96 kPa/0,7 to 1,0 kg/sq. cm) less than "Converter Out" pressure with trans- mission shift lever in NEUTRAL and engine at 2000 RPM. If the pressure does not fall within the prescribed limits, a further check to localize the problem can be made at the left hand Cooler In" test port at the back of the air-oil cooler.

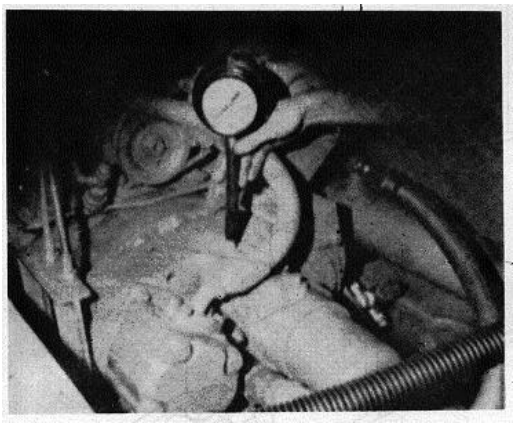


Cooler In Pressure Test



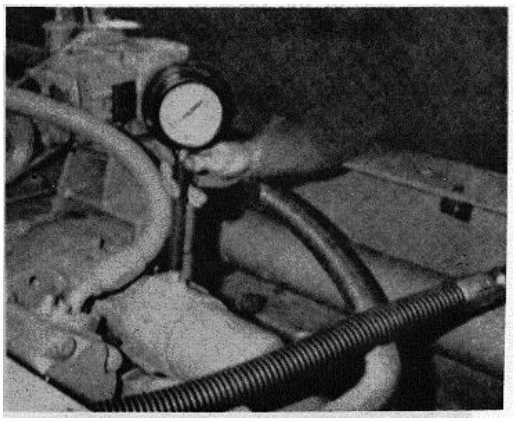
Cooler In Pressure Test

3. "Co**nverter** In" pressure tested with a 150 **psi pressure** gauge should register 40 to 90 psi (276 to 620 kPa /2,8 to 6,3 kg/ sq cm) at test port on pump valve body. Pressure is checked with transmission shift lever in NEUTRAL and engine at 2000 RPM.



"Converter In" Pressure Tesl

4. To test the "Clutch" pressure, the transmission oil should be at operating temperature of 180 to 200°F (82 to 930C) and engine at idle (600 RPM). Shift through all direction and speed clutches with brake applied. With a 300 psi pressure gauge installed in the test port on the filter housing. the clutch pressure should register 240 to 280 psi (1654 to 1930 kPa 16,9 to 19,6 kg sq cm). All clutch pressures must be equal within 5 psi (35 kPa/0,4 kg Isq cm). If clutch pressure varies in any one clutch more than 5 psi, clutch requires repair.



"Clutch" Pressure Test

FLOW TEST:
With a flow gauge installed in the "Converter Out" line near the air-oil cooler, it should register 17 to 18 Imp. gpm (20 to 22 US gpm/77 to 82 lit Imin).

REMOVAL:
On the machine, the engine and transmission are mounted in such a manner that in order to remove the transmission, the engine and transmission must be removed as a complete unit.

1. Park machine on a level surface, lower the blade and securely block the machine.

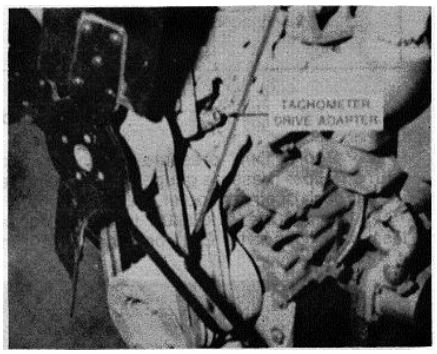
2. Remove hydraulic tank.

3. Remove rear fenders and engine side plates.

4. Remove radiator (refer to COOLING SYSTEM).

5. Close fuel shut off valve at fuel tank and disconnect and cap fuel supply and fuel return hoses at engine.

6. Disconnect and label all electrical connections at engine. Remove engine temperature sending unit from the engine.



Engine Tachometer Cable Drive Adapter

7. Disconnect throttle and tachometer cables at engine.

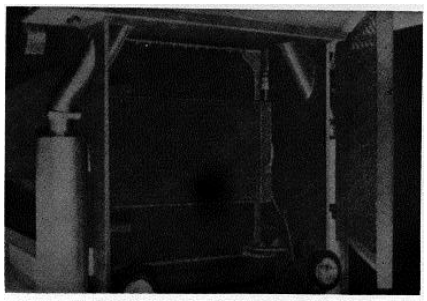
8. Disconnect and cap air intake hose and remove air cleaner assembly. Disconnect exhaust pipes at the manifolds.

9.- Disconnect front and rear drive shafts from transmission output shafts.

TRANSMISSION

10. Remove front and rear steering cylinder pins and move both steering cylinders against the side of the frame.

11. Disconnect and cap the transmission cooler hoses at the transmission swivel fittings.



Transmission Oil Cooler Connections

12. Disconnect and cap hydraulic brake line at the transmission.

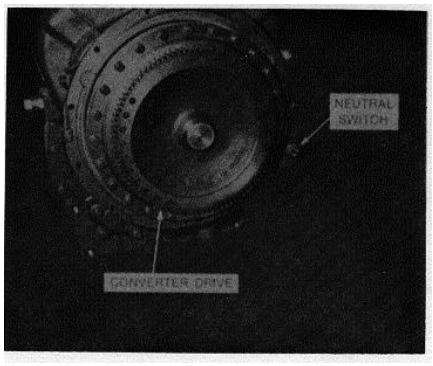
13. Drain the transmission fluid and remove dipstick assembly.

14. Install a suitable lifting device on the engine and transmission and support the weight.

15. Remove front and rear mounting bolts and lift engine-transmission assembly. When assembly has been lifted, it must be moved approximately 3" (8 cm) toward the rear of the frame to allow rear mounting brackets to clear frame when it is lifted out.

16. After removing assembly from the frame, it must be positioned on a stand. The transmission can be separated from the engine by removing the right and left side mount plates and bolts securing the transmission to the engine flywheel housing.

Caution: *When engine and transmission are being separated, both units must be supported securely.*



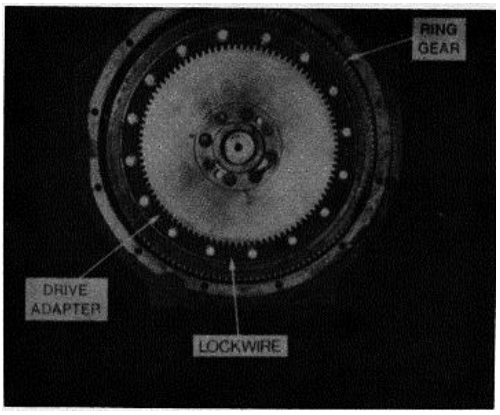
Transmission

INSTALLATION:

1. Reverse procedure for installation. Care must be taken when coupling the engine to the transmission, not to damage the fibre ring gear on engine flywheel.

2. If installing a new ring gear on the engine flywheel, check to see that it fits on the converter drive ring before mounting.

3. Mount the fibre ring gear on engine flywheel, install bolts and torque evenly to 21 ft-lbs (3 m-kg).



Engine

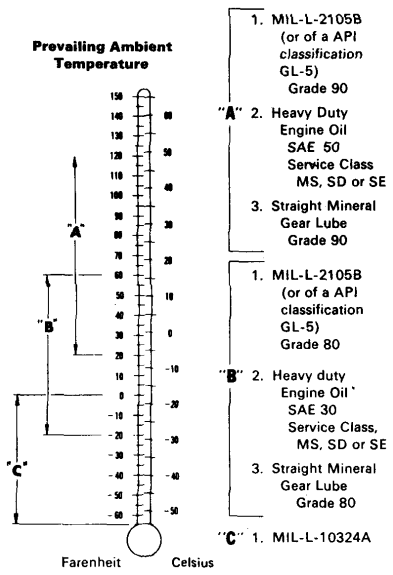


***MIL-L-2105B Extreme -Pressure Lubricant** (or API *classification* GL-5) of the SAE viscosity recommended in the chart at the right is preferred. All lubricants should be backed by the reputation of a well known supplier. It is im- portant to specify EP lubricants of the MIL-L- 2105B type only, or of a API classification GL-5.

Heavy Duty Engine Oil of the proper SAE viscosity and backed by the reputation of a well known supplier will provide satisfactory operation. It is important to specify the heavy duty type, with the old API service designation MS - new SAE service designation SD or SE.

Straight Mineral Gear Oil of the SAE viscosity recommended in the chart and backed by the reputation of a well known supplier of petroleum products is satisfactory.

***Do not use extreme pressure lubricants other than MIL-L-2105B or of a API classification GL-5.** Many EP lubricants contain highly-active chemical compounds that have been formulated to perform satisfactorily in specific types of applications. Severe corrosion, residual deposits, and inadequate lubrication may result from Improper application. Use of EP lubricants other than MIL-L-2105B or of a API classification GL-5 may result In failure and/or impaired operation



DRAINING ECONOMY --The object in draining the transmission oil periodically is to eliminate possible bearing surface abrasion and attendant wear. Minute particles of metal, the product of normal wear in service, are deposited in and circulate with the transmission oil. The oil change chemically, due to its repeated heating and cooling, also the terrific *churning it undergoes in* the *presence* of air. It Is desirable to drain out this used oil at least every 24,000 vehicle miles or 500 hours of service - more frequently when operating in a dusty or dirty environment. Do this only when the transmission is thoroughly warm.

FLUSHING - After draining, flushing is desirable. Replace the drain plug and fill the transmission to the proper level with a light flushing oil. Drive the transmission for a short period at fast idle In such a manner that the gears in the transmission are rotating without **load.** This washes out the old oil clinging to the interior of the gear case, covers and shifter rails. **Be sure to drain out all** of the flushing oil before attempting to refill with new oil.

REFILL-- First, remove all dirt around the filler plug. Then refill with new oil of a grade recom- mended for the existing season and prevailing service. Fill to the bottom of the level testing plug positioned on the side of the transmission. **Do Not *overfill,*** *as the excess quantity will serve no* useful purpose. If the oil level is too high, it will cause excessive oil churning and attendantly high oil temperature and possible leakage.

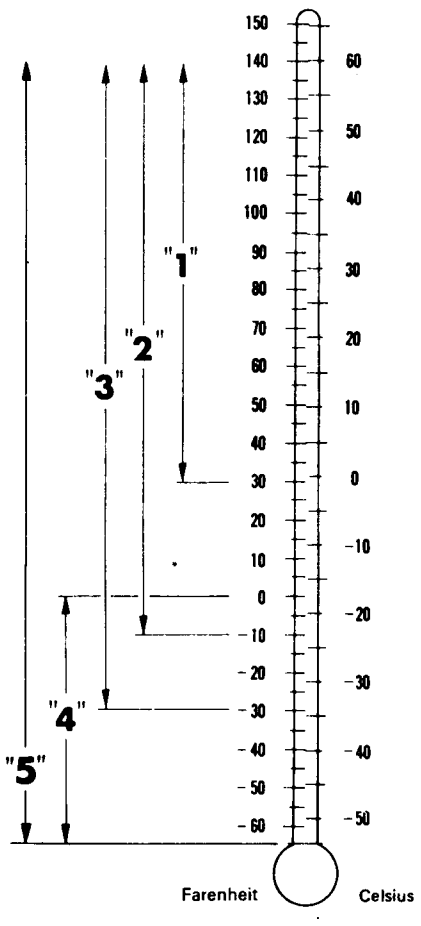
INSPECTION -*Oil0* level inspection should be made every 1,000 miles. Always clean around filler plug before inspection. Add sufficient oil to maintain correct level.

a satisfactory transmission oil must have the following characteristics:

(1) It must follow, coat and cushion the gear teeth. (2) It must be adequately fluid at prevailing temperatures to distribute to all gear and bearing surfaces. (3) It must not foam excessively nor materially increase in volume under severe service operation. (4) It should be chemically stable and not thicken up in service, even though it be used for a reasonably long time at elevated temperatures. (5) It must not contain admixtures nor compounds which produce wear of the parts or metal erosion. (6) It should not possess any material or compounds that will settle out in storage or separate out in service. (7) It must not contain fillers, such as asbestos, mica, talc, earth or other solids, and shall be free from sediment and water.

RECOMMENDED LUBRICANTS FOR CLARK POWER SHIFTED TRANSMISSION AND TORQUE CONVERTERS

Prevailing Ambient Temperature



"1" ENGINE OIL
Grade 30
(API-MS or DG)
(SAE-SD or SE)

"2" (1) MIL-L-2104B or 2104C
Grade 10
(2) C-2
(3) ENGINE OIL
Grade 10
(API-MS or DG)
(SAE-SD or SE)

"3" (1) DEXRON*
(2) Type "A" Suffix "A"

"4" MIL-L-10295B

"5" CONOCO Polor Start
DN – 600 Fluid

NOTE:
Oil groups 2 & 3 may be used to lower ambient temperatures when sump preheaters are used.

Oil group 4 should be used only up to ambient temperature shown.

*Dexron is a registered trademark of General Motors Corporation.

RECOMMENDED POWER SHIFT TRANSMISSION & TORQUE CONVERTER OIL CHANGE

CHECK PERIOD--Check oil level DAILY with engine running at 500-600 RPM and oil at 180 degrees F. to 200 degrees F. Maintain oil level to FULL mark.

DRAIN PERIOD - Transmissions & Converters: Change oil filter element every 250 hours. Drain and refill system every 500 hours.

(a) Drain transmission and remove sump screen. Clean screen thoroughly and replace using new gaskets.

(b) Drain oil filters, remove and discard filter elements. Clean filter shells and install new elements.

(c) Refill transmission to FULL mark.

(d) Run engine at 500-600 RPM to prime converter and lines.

(e) Recheck level with engine running at 500-600 RPM and add oil to bring level to FULL mark. When oil temperature is hot (180 degrees to 200 degrees) make final oil level check.

RECOMMENDED TORQUE CONVERTER OIL CHANGE (When not used with a Clark Power Shift Transmission)

OIL IN A TORQUE CONVERTER is used primarily as means of transmitting power as well as providing adequate lubrication. Such oil must have the following properties:

1. It must remain fluid at all prevailing temperatures.

2. It must not foam excessively nor materially increase in volume.

3. It must be chemically stable at elevated temperatures.

4. It must be free from additives and impurities which would centrifuge out during operation.

5. **IT MUST BE CLEAN.** Dirt in the converter hydraulic circuit will cause wear and shorten life. Also it will cause malfunction by damaging the hydraulic pump, pressure regulating valves and oil seals within the unit.

RECOMMENDED CONVERTER OIL CHANGE - Converter oil should be renewed at least every 750 hours operation - more frequently when the unit is subject to dusty or dirty environment.

WHEN DRAINING THE CONVERTER, it is important that all parts of the system be emptied of oil. Drain the converter oil cooler and filter as well as the sump. Some units provide drain plugs in the converter impeller. Remove these plugs and rotate the converter so that one hole is at the bottom. This will allow the oil inside the elements to drain.

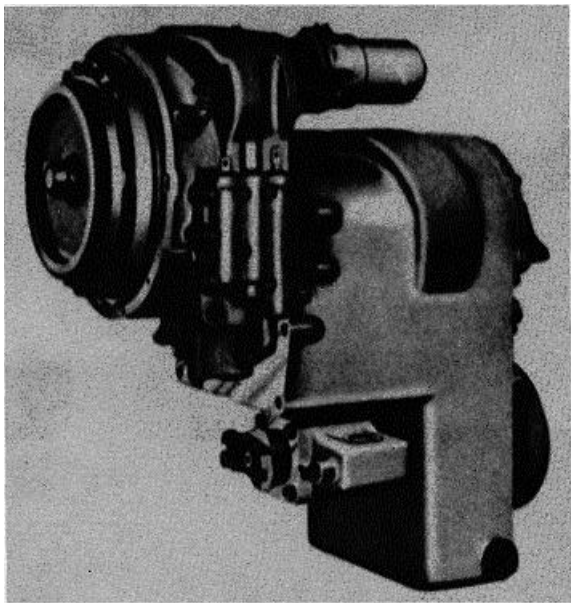
DO NOT USE FLUSHING OIL. Some units cannot be completely drained and a considerable amount of oil remains trapped in the converter elements. Entrapped flushing oil will contaminate the refill.

WHEN REFILLING cleanliness is extremely important. Use clean containers. Fill the sump to the full mark on the dipstick with the recommended oil. Start and operate the converter at slow speed and continue to fill until the oil remains at the full mark on the dipstick. Converter oil level is always measured with the converter in operation at engine idle.

INSPECTION of oil level should be made every shift or daily. Always clean around inspection plug before inspection. Add sufficient oil to maintain correct level.

TRANSMISSION

MAINTENANCE
&
SERVICE MANUAL



HR 28000 - SERIES - 3 SPEED

FOREWORD

✣

This manual has been prepared to provide the customer and the maintenance personnel with information and instructions on the maintenance and repair of the **CLARK** Power Shift Transmission.

Extreme care has been exercised in the design, selection of materials and manufacturing of these units. The slight outlay in personal atten- tion and cost required to provide regular and proper lubrication, in- spection at stated intervals, and such adjustments as may be indicated will be reimbursed many times in low cost operation and trouble free service.

In order to become familiar with the various parts of the transmiss- ion, its principal of operation, trouble shooting and adjustments, it is urged that the mechanic study the instructions in this manual carefully and use it as a reference when performing maintenance and repair operations.

Whenever repair or replacement of component parts is required, only Clark-approved parts as listed in the applicable parts manual should be used. Use of "will-fit" or non-approved parts may endanger proper operation and performance of the equipment. The Clark Equipment Company does not warrant repair or replacement parts, nor failures resulting from the use thereof, which are not supplied by or approved by the Clark Equipment Company. IMPORTANT: **Always furnish the Distributor with the transmission serial and model number when order- ing parts.**

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NOTE: Metric Dimensions Shown in Brackets [ ].

TRANSMISSION ASSEMBLY

The transmission and hydraulic torque portion of the power train enacts an important role in transmitting engine power to the driving wheels. In order to properly maintain and service these units it is important to first understand their function and how they operate.

The transmission and torque converter function together and operate through a common hydraulic system. It is necessary to consider both units in the study of their function and operation.

To supplement the text below, and for reference use therewith, the following illustrations are provided:

Basic Design Silhouette	Fig. A
Converter Assembly	Fig. B
Converter and Transmission Case Group	Fig. C
Three Speed Case and Clutch Group	Fig. D
Clutch Group	Fig. E.
Regulating Valve, Charging Pump and Filter Group	Fig. F
Control Valve	Fig. G
Axle Disconnect and Mechanical Parking Brake	Fig. H
Typical 28000 Cross Section	Fig. I
External Plumbing Diagram	Fig. J
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Ring Gear Installation	Fig. M
Shielded Bearing Installation	Fig. N

The R, HR, and MHR Model Transmissions are of three basic designs.

The R Model consists of a separate torque converter, mounted to the engine with the powershift transmission remotely mounted and connected to the torque converter with a drive shaft.

The HR Model consists of a torque converter and powershifted transmission in one package mounted directly to the engine.

The MHR version Is a mid-mount torque converter and transmission assembly connected to the engine by means of a drive shaft. (See Fig. A for basic design silhouette.)

The shift control valve assembly may be mounted directly on the side of the converter housing or front transmission cover, or remote mounted and connected to the transmission by means of flexible hoses. The function of the control valve assembly is to direct oil under pressure to the desired directional and speed clutch. A provision is made on certain models to neutralize the transmission when the brakes are applied. This is accomplished through use of a brake actuated shutoff valve. The speed and direction clutch assemblies are mounted inside the transmission case and are connected to the output shaft of the converter either by direct gearing or drive shaft. The purpose of the speed or directional clutches is to direct the power flow through the gear train to provide the desired speed range and direction.

An axle disconnect is optional and is located on the output shaft. The drive to the front or rear axle can be disconnected or connected by manual shifting.

HOW THE UNITS OPERATE

With the engine running, the converter charging pump draws oil from the transmission sump through the removable oil suction screen and directs it through the pressure regulating valve and oil filter.

The pressure regulating valve maintains pressure to the transmission control cover for actuating the direction and speed clutches. This requires a small portion of the total volume of oil used in the system. The remaining volume of oil is directed through the torque converter circuit to the oil cooler and returns to the transmission for positive lubrication. This regulator valve consists of a hardened valve spool operating in a closely fitted bore. The valve spool is spring loaded to hold the valve in a closed position. When a specific pressure is achieved, the valve spool works against the spring until a port is exposed along the side of the bore. This sequence of events provides the proper system pressure.

After entering the converter housing the oil is directed through the stator support to the converter blade cavity and exits in the passage between the turbine shaft and converter support. The oil then flows out of the converter to the oil cooler. After leaving the cooler, the oil is directed to a fitting on the transmission. Then through a series of tubes and passages lubricates the transmission bearings and clutches. The oil then gravity drains to the transmission sump.

The hydraulic torque converter consists basically of three elements and their related parts to multiply engine torque. The engine power is transmitted from the engine flywheel to the impeller element through the impeller cover. This element is the pump portion of the hydraulic torque converter and is the primary component which starts the oil flowing to the other components which results in torque multiplication. This element can be compared to a centrifugal pump in that it picks up fluid at its center and discharges at its outer diameter.

The torque converter turbine is mounted opposite the impeller and is connected to the output shaft of the torque converter. This element receives fluid at its outer diameter and discharges at its center. Fluid directed by the impeller out into the particular design of blading in the turbine and reaction member is the means by which the hydraulic torque converter multiplies torque.

The reaction member of the torque converter is located between and at the center or inner diameters of the impeller and turbine elements. Its function is to take the fluid which is exhausting from the inner portion of the turbine and change its direction to allow correct entry for recirculation into the impeller element.

The torque converter will multiply engine torque to its designed maximum multiplication ratio when the out- put shaft is at zero RPM. Therefore, we can say that as the output shaft is decreasing in speed the torque multiplication is increasing.

The shift control valve assembly consists of a valve body with selector valve spools. A detent ball and spring in the selector spool provides one position for each speed range. A detent ball and spring in the direction spool provides three positions, one each for forward, neutral and reverse.

With the engine running and the directional control lever in neutral position, oil pressure from the regulating valve is blocked at the control valve, and the transmission is in neutral. Movement of the forward and reverse spool will direct oil, under pressure to either the forward or reverse direction clutch as desired.

When either directional clutch is selected the opposite clutch is relieved of pressure and vents back through the direction selector spool. The same procedure is used in the speed selector.

The direction or speed clutch assembly consists of a drum with internal splines and a bore to receive a hydraulically actuated piston. The piston is "oil tight" by the use of sealing rings. A steel disc with external splines is inserted into the drum and rests against the piston. Next, a friction disc with splines at the inner diameter is inserted. Discs are alternated until the required total is achieved. A heavy back-up plate is then inserted and secured with a snap ring. A Hub with O.D. splines is inserted into the splines of discs with teeth on the inner diameter The discs and hub are free to increase in speed or rotate in the opposite direction as long as no pressure is present in that specific clutch.

To engage the clutch, as previously stated, the control valve is placed in the desired position. This allows oil under pressure to flow from the control valve, through a tube, to a chosen clutch shaft. This shaft has a drilled passageway for oil under pressure to enter the shaft. Oil pressure sealing rings are located on the clutch shaft. These rings direct oil under pressure to a desired clutch. Pressure of the oil forces the piston and discs against the heavy back-up plate. The discs, with teeth on the outer diameter, clamping against discs with teeth on the inner diameter, enables the hub and clutch shaft to be locked together and allows them to drive as a unit.

There are bleed balls in the clutch piston which allow quick escape for oil when the pressure to the piston is released.



R-28000 HR-28000 MHR-28000

FIG. A

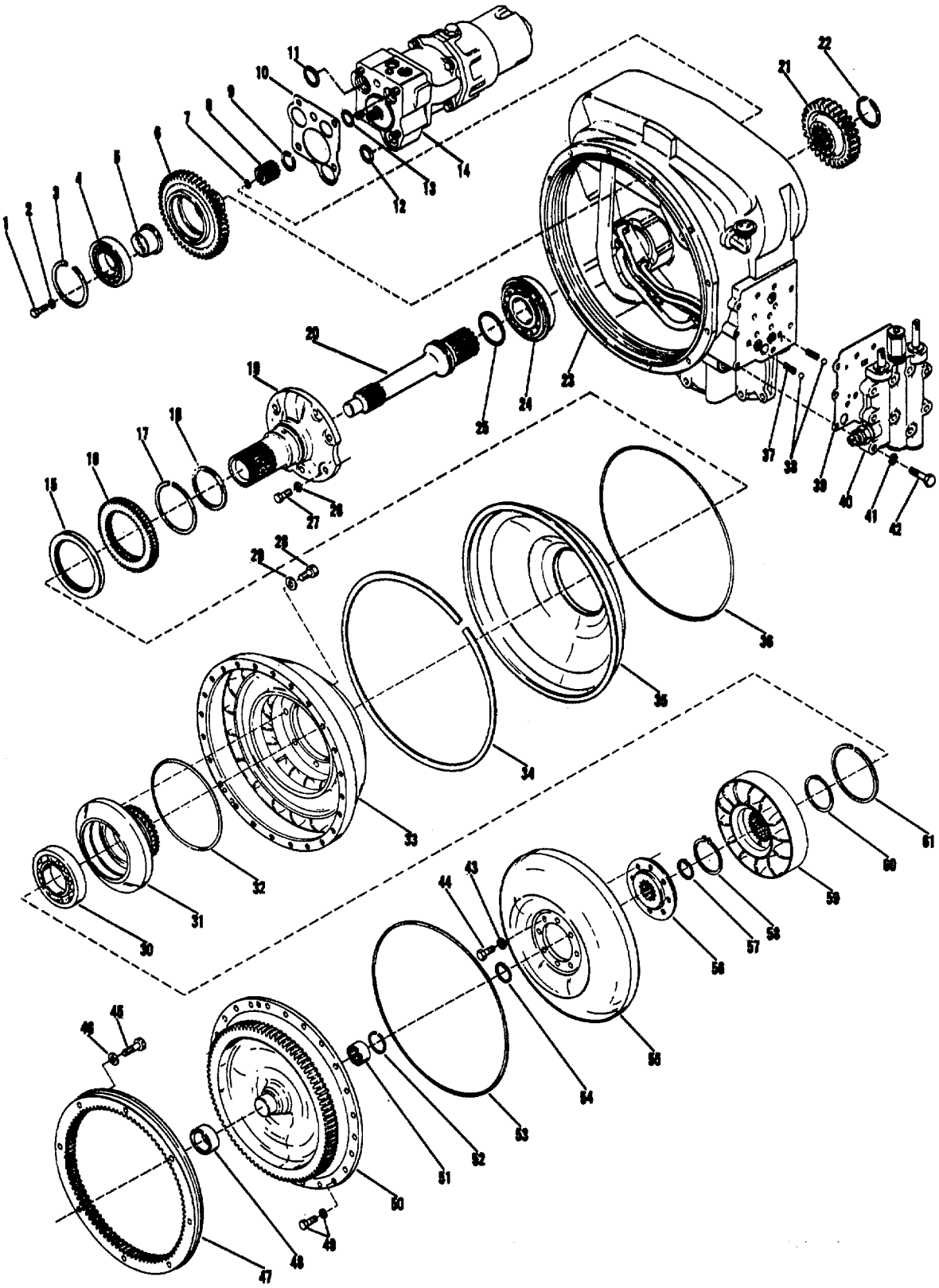


Figure B

HR 28000 CONVERTER GROUP

ITEM	DESCRIPTION	QTY.
1	Bearing Support Screw	6
2	Bearing Support Screw Lockwasher	6
3	Driving Gear Snap Ring	3
4	Drive Gear Bearing	3
5	Drive Gear Bearing Support	3
6	Drive Gear	3
7	Snap Ring (Internal-See item 8	1
8	Drive Gear Hub Sleeve and Snap Ring..... Assembly - Inc. items 7 and 9	1
9	Snap Ring (External) - See item 8	1
10	Valve Body to Converter Housing..... Gasket	1
11	Valve Body to Converter Housing..... "O" Ring.	1
12	Valve Body to Converter Housing..... "O" Ring	1
13	Valve Body to Converter Housing "O"4 Ring	1
14	Regulator Valve, Charging Pump and Filter Assembly	1
15	Oil Seal	1
16	Impeller Hub Gear	1
17	Impeller Hub Gear Snap Ring	1
18	Stator Support Oil Sealing Ring	1
19	Stator Support Oil Sealing Ring	1
20	Turbine Shaft	1
21	Turbine Shaft Gear	1
22	Turbine Shaft Gear Retainer Ring	1
23	Converter Housing and Tube Assembly	1
24	Turbine Shaft Bearing	1
25	Turbine Shaft Oil Sealing Ring.	1
26	Stator Support Screw Lockwasher	6
27	Stator Support Screw	6
28	Hub to Impeller Screw	8
29	Hub to Impeller Screw Washer	8
30	Impeller Hub Bearing	1
31	Impeller Hub	1
32	Impeller Hub "O" Ring	1
33	Impeller	1
34	Oil Baffle Retainer Ring	1
35	Oil Baffle	1
36	Oil Baffle Seal Ring	1
37	Detent Spring	2
38	Detent Ball	2
39	Valve to Converter Gasket	1
40	Control Valve Housing Assembly	1
41	Valve to Converter Housing Screw..... Lockwasher	9
42	Valve to Converter Housing Screw	9
43	Turbine Hub Screw Washer	8
44	Turbine Hub Screw	8
45	Ring Gear Screw	8
46	Ring Gear Screw Plain Washer	8
47	Flywheel Ring Gear	1
48	impeller Cover Sleeve	1
49	Impeller Cover to Impeller Screw and Lockwasher	24
50	Impeller Cover	1
51	Impeller Cover Bearing	
52	Impeller Cover Bearing Retainer Ring	1
53	Impeller Cover "0" Ring.	1
54	Turbine Retainer Ring.	1
55	Turbine	1
56	Turbine Hub	1
57	Turbine Locating Ring	1
58	Reaction Member Retainer Ring	1
59	Reaction Member	1
60	Reaction Member Spacer.	8
61	Impeller Hub Bearing Retainer Ring	1

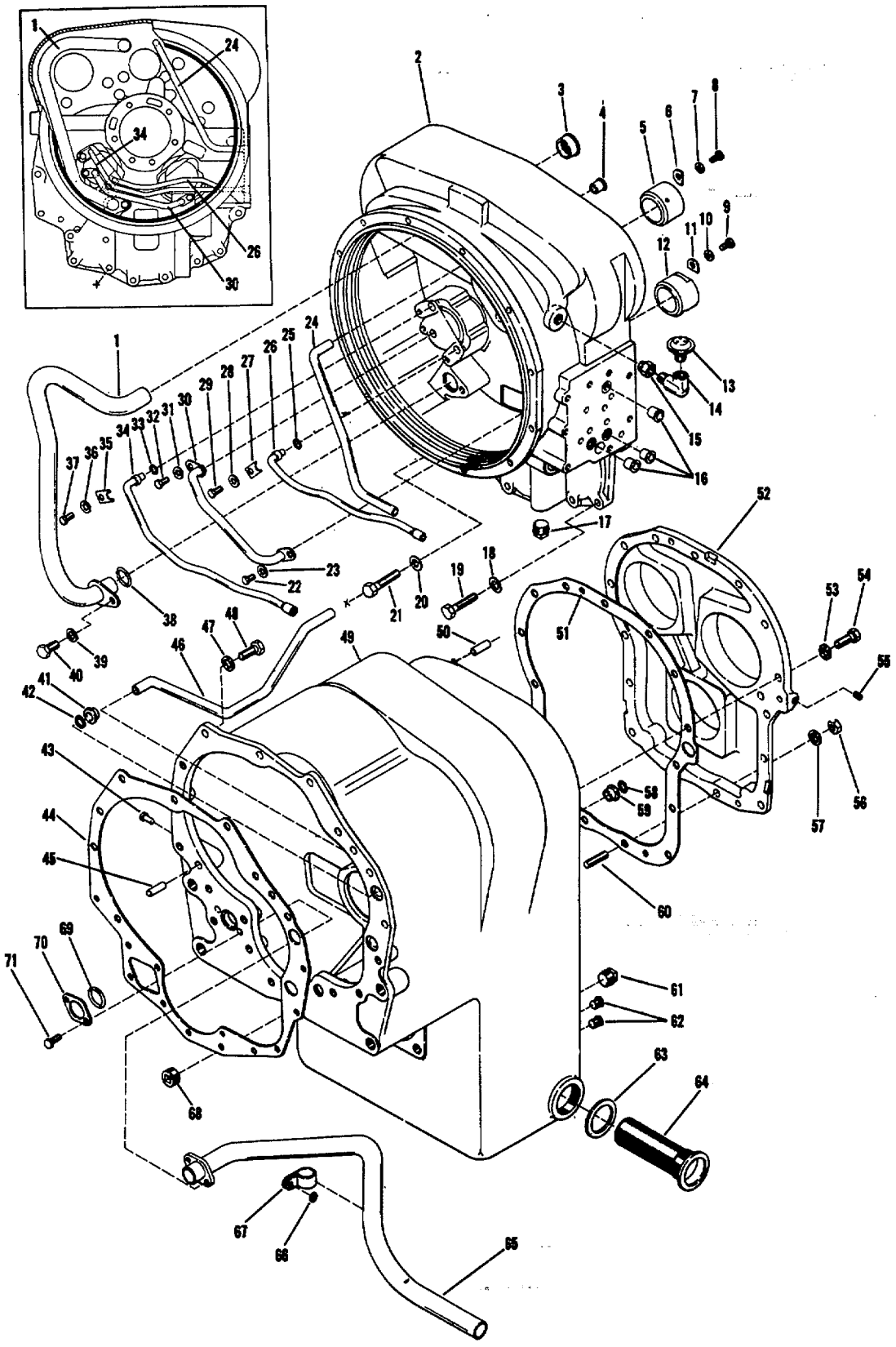


Figure C

HR 28000 CONVERTER AND TRANSMISSION CASE GROUP

ITEM	DESCRIPTION	QTY.
1	Suction Tube Assembly..	1
2	Converter Housing and Tube Assembly.	1
3	Tube Sleeve	1
4	Tube Sleeve.	1
5	Converter Housing Sleeve.	1
6	Converter Housing Sleeve Lock	1
7	Converter Housing Sleeve Screw ..... Lockwasher	1
8	Converter Housing Sleeve Screw..	1
9	Converter Housing Sleeve Screw	1
10	Converter Housing Sleeve Screw Lockwasher	1
11	Converter Housing Sleeve Lock	1
12	Converter Housing Sleeve	1
13	Breather	1
14	Street Ell	1
15	Street Ell Reducing Bushing	1
16	Tube Sleeve	3
17	Pipe Plug..	1
17,	Pipe Plug	1
18	Converter Housing to Transmission Housing Screw Lockwasher.....	
19	Converter Housing to Transmission Housing Screw	4
20	Converter Housing to Transmission Housing Lockwasher	4
21	Converter Housing to Transmission Housing Screw	4
22	Lube Tube Retaining Screw..1	8
23	Lube Tube Retaining Screw Lockwasher...	1
24	Valve Oil Supply Tuba-e	1
25	3rd Speed Tube “O" Ring.	1
26	3rd Speed Tube Assembly	2
27	Tube Clip	1
28	Tube Clip Screw Lockwasher	1
29	Tube Clip Screw.	1
30	Lube Tube Assembly	1
31	Lube Tube Retainer Screw Lockwasher	1
32	Lube Tube Retainer Screw	1
33	Reverse Tube "O” Ring.	1
34	Reverse Tube Assembly	1
35	Tube Clip	1
36	Tube Clip Screw Lockwasher	1
37	Tube Clip Screw	1
38	Suction Tube "O" Ring.	1
39	Lockwasher	1
40	Suction Tube Retainer Screw	1
41	Tube Sleeve	1
42	Pressure Tube "O" Ring	1
43	Suction Line Tube Clip Rivet.	1
44	Converter Housing to Transmission Case Gasket	1
45	Converter Housing to Transmission Case Dowel Pin..	2
46	Low Speed Clutch Pressure Tube .	1
47	Transmission Case to Converter Housing Screw Lockwasher	10
48	Transmission Case to Converter Housing Screw	10
49	Transmission Case Assembly..	1
50	Transmission Case to Rear Cover Dowel Pin	2
51	Transmission Case to Rear Cover Gasket..	1
52	Transmission Case Rear Cover	1
53	Rear Cover to Case Screw Lockwasher	13
54	Rear Cover to Case Screw.	13
55	Rear Cover Pipe Plug	1
56	Rear Cover to Transmission Case Stud Nut.	2
57	Rear Cover to Transmission Case Lockwasher	2
58	Pressure Tube "O” Ring	.1
59	Tube Sleeve..	1
60	Transmission Case to Rear Cover Stud..	2
61	Drain Plug	1
62	Oil Level Plug	2
63	Screen Assembly Gasket	1
64	Screen Assembly	1
65	Suction Tube Assembly	1
66	Suction Tube Clip Was her	1
67	Suction Tube Clip	1
68	Pipe Plug	2
69	Suction Tube "O” Ring..	1
70	Suction Tube Retainer Washer	1
71	Suction Tube Retainer Washer Screw	2

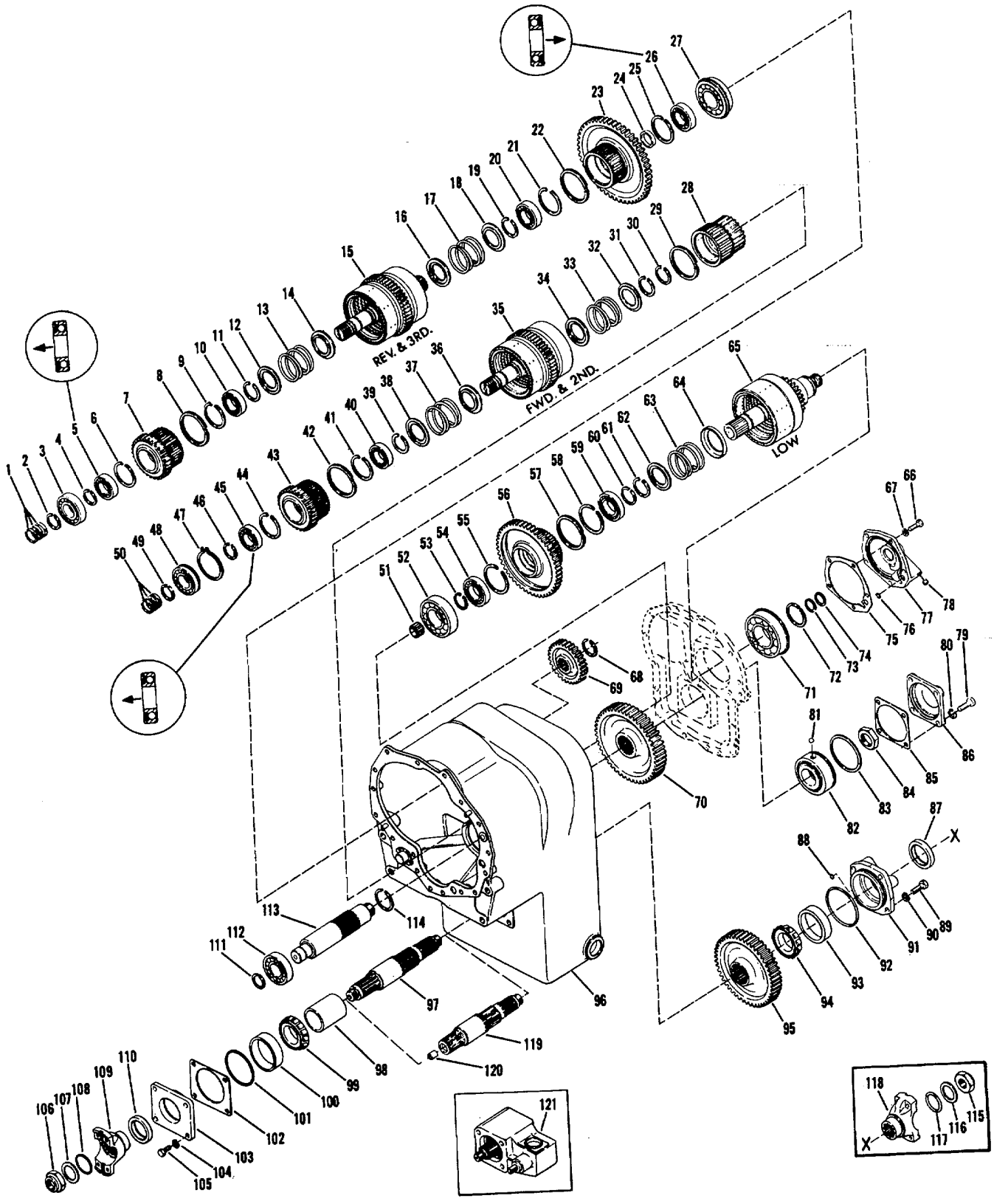
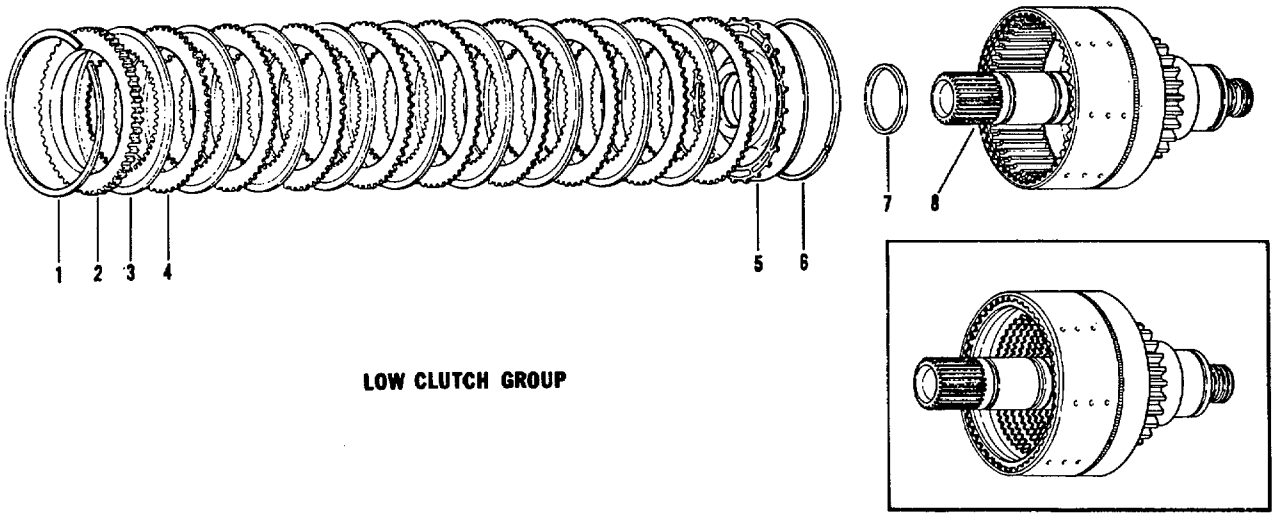


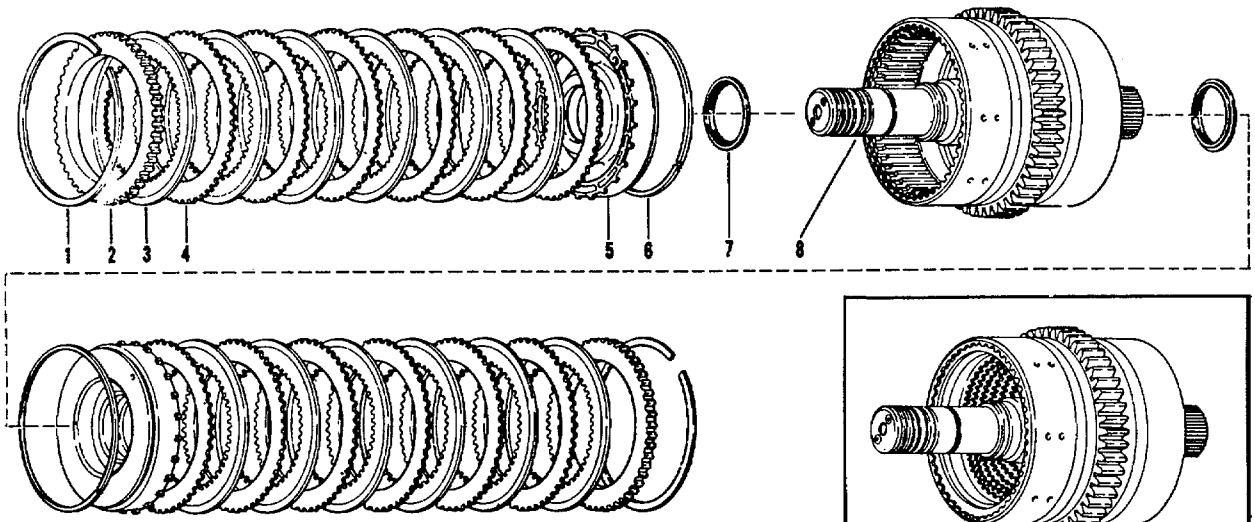
Figure D

28000 THREE SPEED CASE AND CLUTCH GROUP

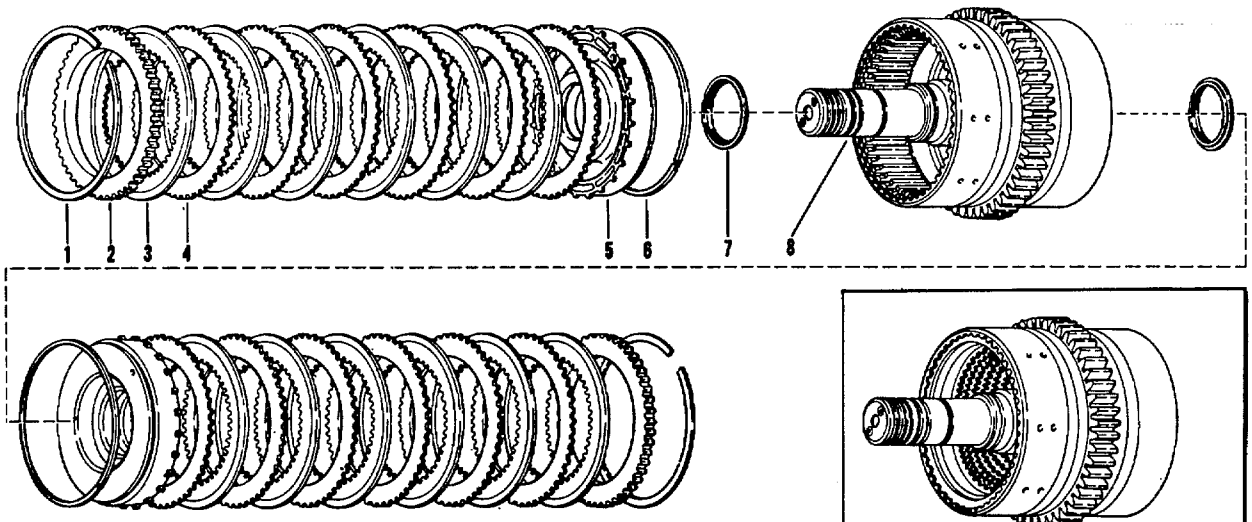
Item No.	Description	No. Req'd
1	Reverse and 3rd Clutch Shaft Piston Ring	3
2	Front Bearing Retainer Ring	1
3	Reverse and 3rd Shaft Front Bearing	1
4	Front Bearing Retainer Ring	1
5	Clutch Driven Gear Bearing	
6	Clutch Driven Gear Bearing Snap Ring	1
7	Clutch Driven Gear	1
8	Clutch Hub Oil Baffle Ring	1
9	Clutch Driven Gear Bearing Snap Ring	1
10	Clutch Driven Gear Bearing	1
11	Return Spring Retainer Snap Ring	1
12	Spring Retainer	1
13	Piston Return Spring	1
14	Spring Retainer	1
15	Reverse and 3rd Clutch Shaft and Drum	1
16	Spring Retainer	1
17	Piston Return Spring	1
18	Spring Retainer	1
19	Return Spring Retainer Snap Ring	1
20	3rd Gear Bearing	1
21	3rd Gear Bearing Snap Ring	1
22	Clutch Hub Oil Baffle Ring	1
23	3rd Gear	1
24	3rd Gear Bearing Spacer	1
25	3rd Gear Bearing Snap Ring	1
26	3rd Gear Bearing	1
27	Reverse and 3rd Shaft Rear Bearing	1
28	2nd Gear	1
29	Clutch Hub Oil Baffle Ring	1
30	2nd Gear Retainer Ring	1
31	Return Spring Retainer Snap Ring -	1
32	Spring Retainer	1
33	Piston Return Spring	1
34	Spring Retainer	1
35	Forward and 2nd Clutch Shaft and Drum	1
36	Spring Retainer	1
37	Piston Return Spring	1
38	Spring Retainer	1
39	Return Spring Retainer Snap Ring	1
40	Clutch Driven Gear Bearing	1
41	Clutch Driven Gear Searing Snap Ring	1
42	Clutch Hub Oil Baffle Ring	1
43	Clutch Driven Gear	1
44	Clutch Driven Gear Bearing Snap Ring	1
45	Clutch Driven Gear Bearing	1
46	Front ring Retainer Ring	1
47	Front Bearing Locating Ring	1
48	Forward and 2nd Shaft Front Bearings	1
49	Front Bearing Retainer Ring	1
50	Forward and 2nd Shaft Piston Ring	3
51	Low Speed Clutch Shaft Pilot Bearing	1
52	2nd Gear Bearing	1
53	Low Gear Bearing Retainer Ring	1
54	low Gear Bearing	1
55	Low Gear Bearing Locating Ring	1
56	Low Gear	1
57	Low Gear Oil	1
58	Low Gear Bearing Locating Ring	1
59	Low Gear Bearing	1
60	Low Gear Bearing Retaining Ring	1
62	Return Spring Retainer	1
63	Return Spring	1
64	Return Spring Retainer	1
65	Low Speed Clutch Shaft end Drum	1
66	Bearing Cap Screw	5
67	Bearing Cap Screw Lockwasher	5
68	Drive Gear Retainer Ring	1
69	Low Speed Drive Gear	1
70	Idler Shaft Gear	1
71	Low Shaft Rear Bearing	1
72	Low Shaft Rear Bearing Retainer Ring	1
73	Low Shaft Piston Ring	1
74	Low Shaft Piston Ring	1
75	Rear Bearing Cap Gasket	1
76	Rear Bearing Cap 'O" Ring	1
77	Low Shaft Rear Bearing Cap	1
78	Low Shaft Rear Bearing Cap Plug	1
79	Idler Shaft Bearing Cap Screw	4
80	Idle Shaft Bearing Cap Screw Lockwasher	4
81	Idler Shaft Rear Bearing Lock Ball	1
82	Idler Shaft Rear Bearing	1
83	Rear Bearing Locating Ring	1
84	Idler Shaft Nut	1
85	Idler Shaft Bearing Cap Gasket	1
86	Idler Shaft Bearing Cap	1
87	Rear Bearing Cap Oil Seal	1
88	Rear Bearing Cap "O" Ring	
89	Rear Bearing Cap Screw	4
90	Rear Bearing Cap Screw lockwasher	4
91	Output Shaft Rear Searing Cap	1
92	Bearing Cap “O” Ring	1
93	Rear Bearing Cup	1
94	Rear Bearing Cone	1
95	Output Shaft	1
96	Transmission Case and Tube Assembly;	1
97	Output Shaft	1
98	Output Shaft Gear Spacer	1
99	Output Shaft Bearing Cone	1
100	Output Shaft Bearing Cup	1
101	Front Bearing Cap "O" Ring	1
102	Front Bearing Cap Shim	AR
103	Front Bearing Cap	1
104	Front Bearing Cap Screw Lockwasher	4
105	Front Bearing Cap Screw	4
106	Flange Nut	1
107	Flange Nut Washer	1
108	Flange Nut “O” Ring	1
109	Output Flange	1
110	Front Bearing Cop Oil Seal	1
111	Bearing Retaining Ring	1
112	Idler Shaft Front	1
113	Idler Shaft	1
114	Idler shaft Gear Ring	1
115	Flange Nut	1
116	Flange Nut Washer	1
117	Flange Nut “O” Ring	1
118	Companion Flange	1
119	Output Shaft (Used with Disconnect only)	1
120	Bushing (Used with Disconnect only)	1
121	Disconnect (Optional)	1



LOW CLUTCH GROUP



REVERSE & 3RD CLUTCH GROUP



FORWARD & 2ND CLUTCH GROUP

Figure E'

LOW CLUTCH GROUP

ITEM	DESCRIPTION	QTY.	ITEM	DESCRIPTION	QTY.
1	End Plate Retainer Ring	1	5	Clutch Piston	1
2	End Plate	1	6	Clutch Piston Outer Seal Ring	1
3	Clutch Inner Disc	9	7	Clutch Piston Inner Seal Ring	1
4	Clutch Outer Disc	9	8	Low Speed Clutch Drum and Shaft	1

REVERSE AND 3rd CLUTCH GROUP

ITEM	DESCRIPTION	QTY.	ITEM	DESCRIPTION	QTY.
1	End Plate Retainer Ring	2	5	Clutch Piston	2
2	End Plate	2	6	Clutch Piston Outer Seal Ring	2
3	Clutch inner Disc	12	7	Clutch Piston Inner Seal Ring	2
4	Clutch Outer Disc	12	8	Reverse and 3rd Clutch Drum and Shaft	1

FORWARD AND 2nd CLUTCH GROUP

ITEM	DESCRIPTION	QTY.	ITEM	DESCRIPTION	QTY.
1	End Plate Retainer Ring	2	5	Clutch Piston	2
2	End Plate	2	6	Clutch Piston Outer Seal Ring	2
3	Clutch Inner Disc	12	7	Clutch Piston Inner Seal Ring	2
4	Clutch Outer Disc	12	8	Forward and 2nd Clutch Drum and Shaft	1

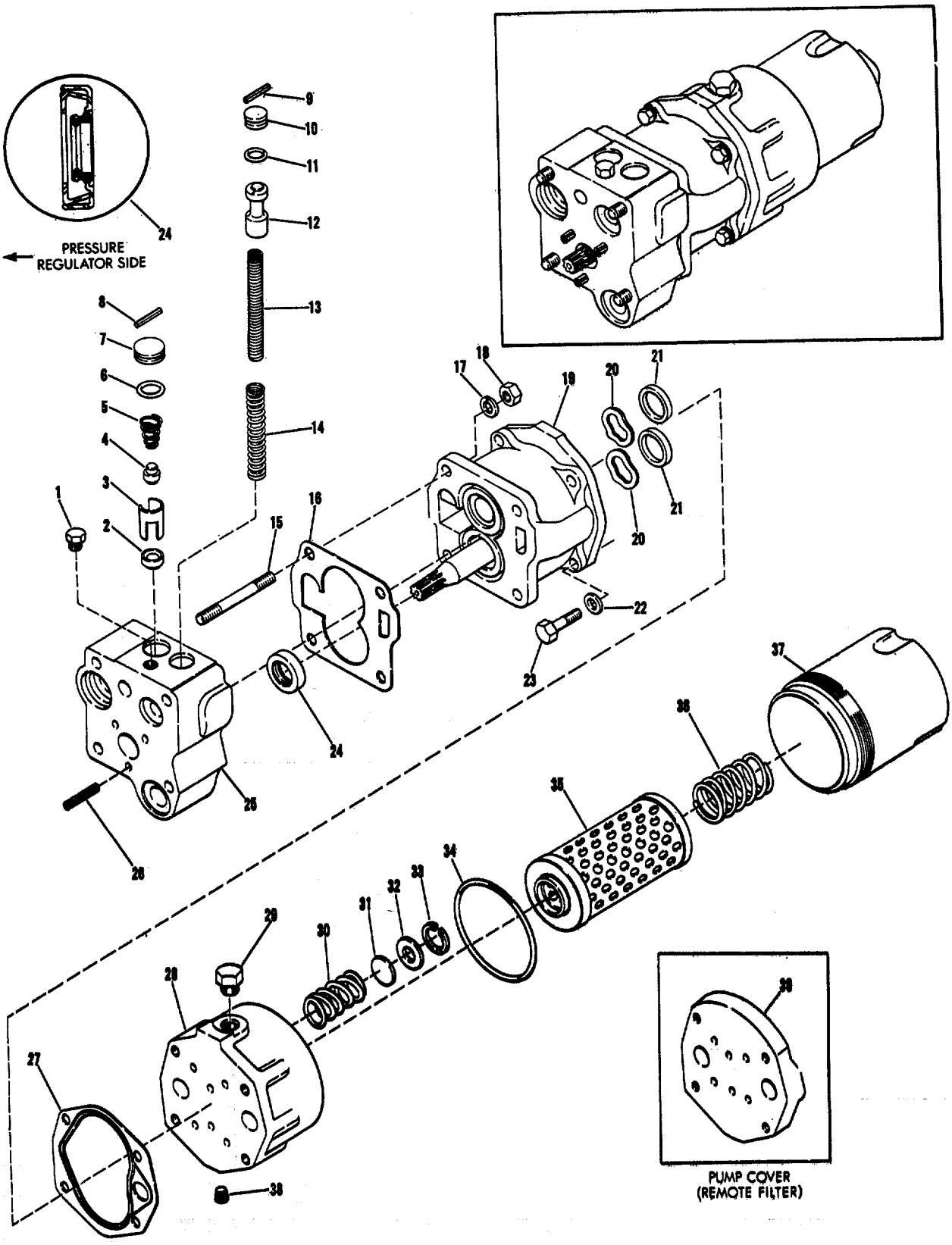
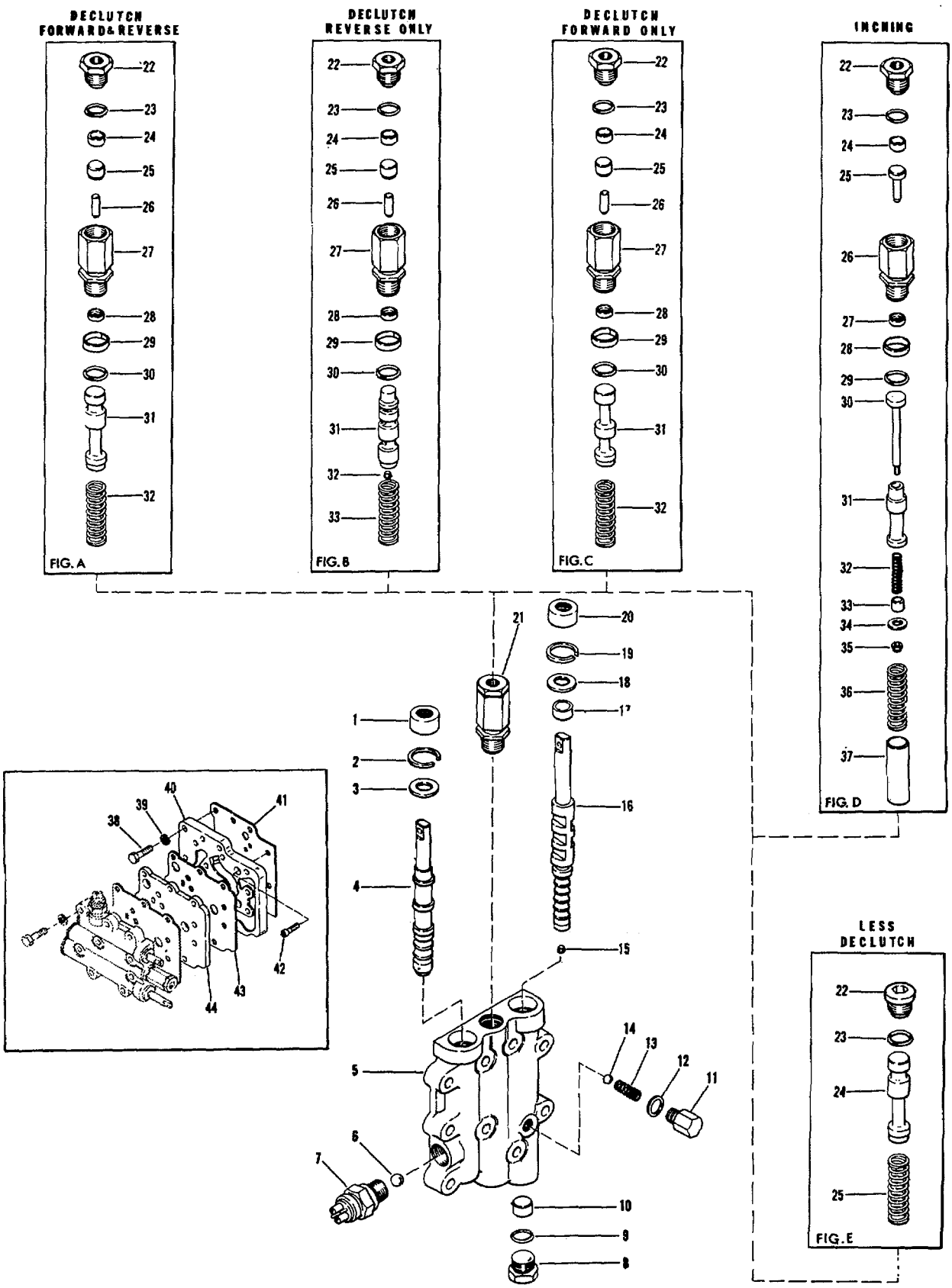


Figure F

PRESSURE REGULATOR, CHARGING PUMP AND OIL FILTER GROUP

ITEM	DESCRIPTION	QTY.
1	Pipe Plug	1
2	Safety Valve Seat	1
3	Safety Valve Spacer	1
4	Safety Valve Plunger	1
5	Safety Valve Spring	1
6	Valve Stop "O" Ring	1
7	Valve Stop	1
8	Valve Stop Roll Pin	1
9	Valve Stop Roll Pin	1
10	Valve Stop	1
11	Valve Stop "O" Ring ...	1
12	Valve Piston	1
13	Valve Spring - Inner	1
14	Valve Spring - Outer	1
15	Valve to Converter Housing Stud	4
16	Valve Body to Pump Gasket	1
17	Stud to Pump Nut Lockwasher	4
18	Stud to Pump Nut	4
19	Charging Pump Assembly..	1
20	Wave Spring ..	2
21	Pump Shaft Seal	2
22	Pump to Filter Adaptor Lockwasher	4
23	Pump to Filter Adaptor Capscrew	4
24	Pump Drive Shaft Oil Seal	1
25	Pressure Regulator Valve Assembly- Incl. items 1 thru 14 and 24, 26	1
26	Valve Body Roll Pin	3
27	Pump to Filter Gasket	1
28	Filter Adaptor	1
29	Filter Adaptor Plug	1
30	By-Pass Filter Disc Spring	1
31	By-Pass Filter Disc	1
32	By-Pass Filter Disc Seat	1
33	Filter Seat Retainer Ring	1
34	Filter Housing "O" Ring	1
35	Oil Filter Element Assembly	1
36	Oil Filter Element Spring	1
37	Filter Housing	1
38	Pipe Plug	1
39	Pump Cover (Optional Adaptor for Remote Filter only) .	1

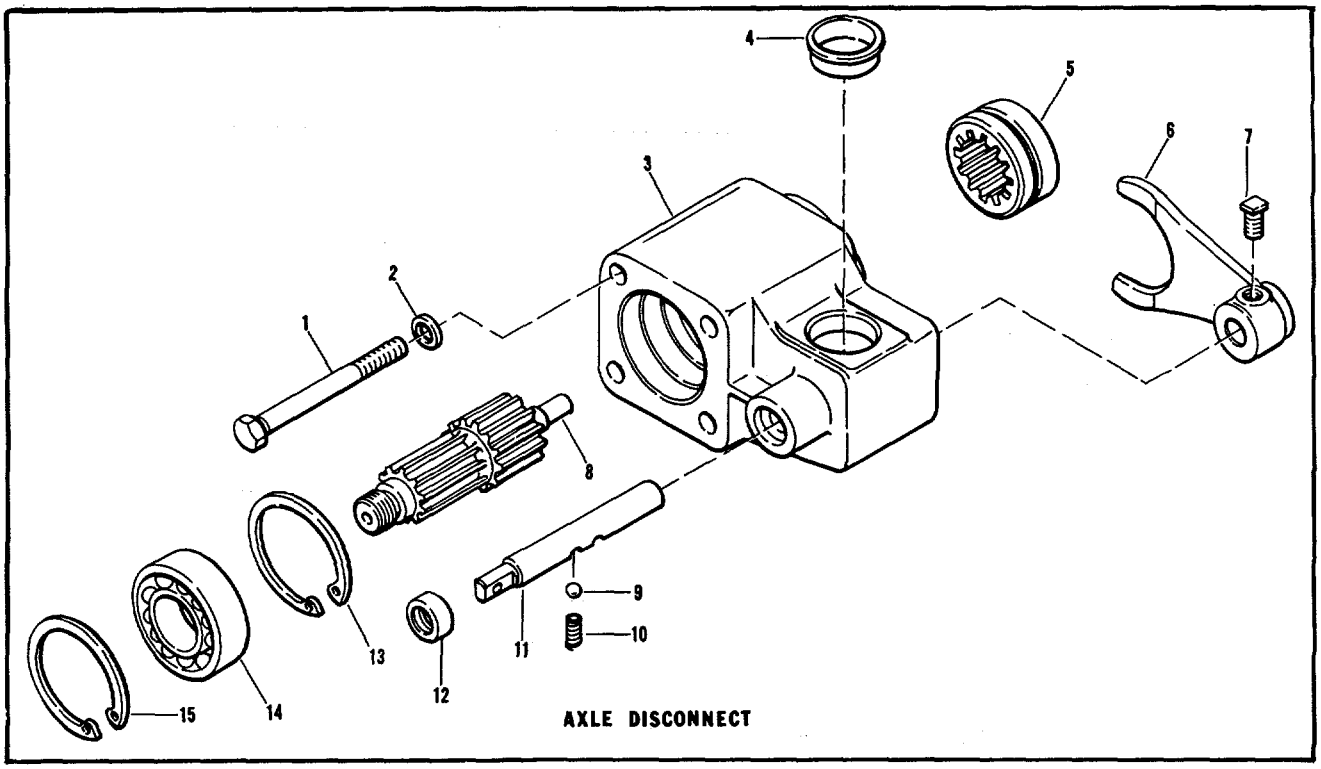


HYDRAULICALLY OPERATED CONTROL VALVE

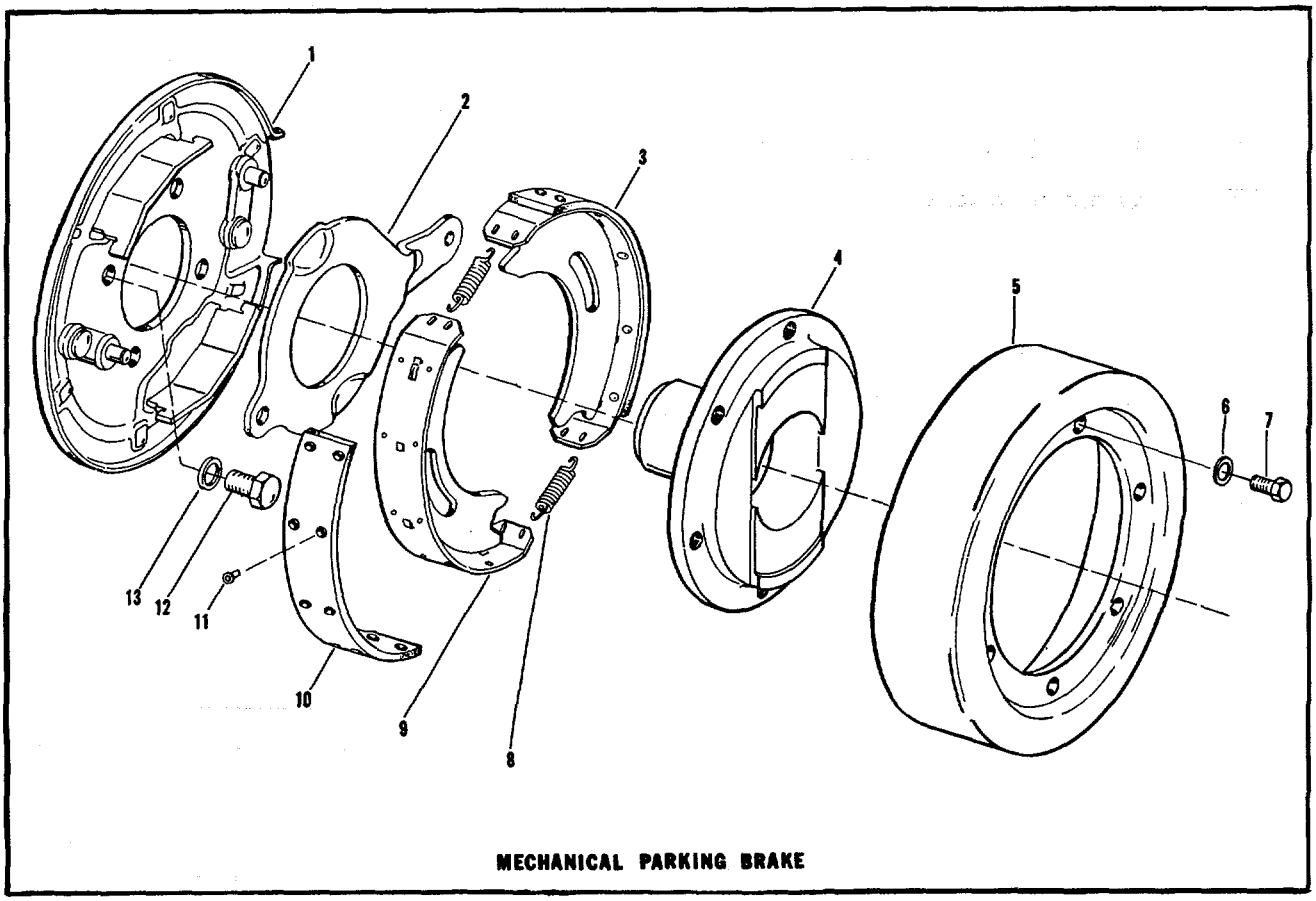
Figure G

CONTROL VALVE ASSEMBLY

ITEM	DESCRIPTION	QTY
1	Valve Spool Oil Seal	1
2	Valve Spool Oil Seal Retainer Ring	1
3	Valve Spool Oil Seal Washer	1
4	Forward and Reverse Valve Spool	1
5	Control Valve Assembly -Incl items 1 thru 9, 15, 16 and 18 thru 20	1
6	Neutral Switch Detent Ball	1
7	Neutral Switch	1
8	Valve Housing Plug	1
9	Valve Housing Plug "O" Ring	1
10	Overshift Spacer	1
11	Detent Spring Plug	1
12	Detent Spring Plug Washer	1
13	Detent Spring	1
14	Detent Ball	1
15	Speed Selector Spool Pipe Plug	1
16	Speed Selector	1
17	Overshift Spacer	1
18	Valve Spool Oil Seal Washer	1
19	Valve Spool Oil Seal Retainer Ring	1
20	Valve Spool Oil Seal	1
21	Hydraulic Piston Housing Assembly	1
	NOTE: Items 22 thru 25, 32, 33 and 37 are various declutch options	
38	Adaptor to Converter Housing Screw	4
39	Adaptor to Converter Housing Screw Lockwasher	4
40	Valve Adaptor Housing	1
41	Converter Housing to Valve Adaptor Housing Gasket	1
42	Adaptor Housing to Converter Housing Screw	5
43	Adaptor Housing to Adaptor Plate Gasket	1
44	Valve Adaptor Plate	1



AXLE DISCONNECT



MECHANICAL PARKING BRAKE

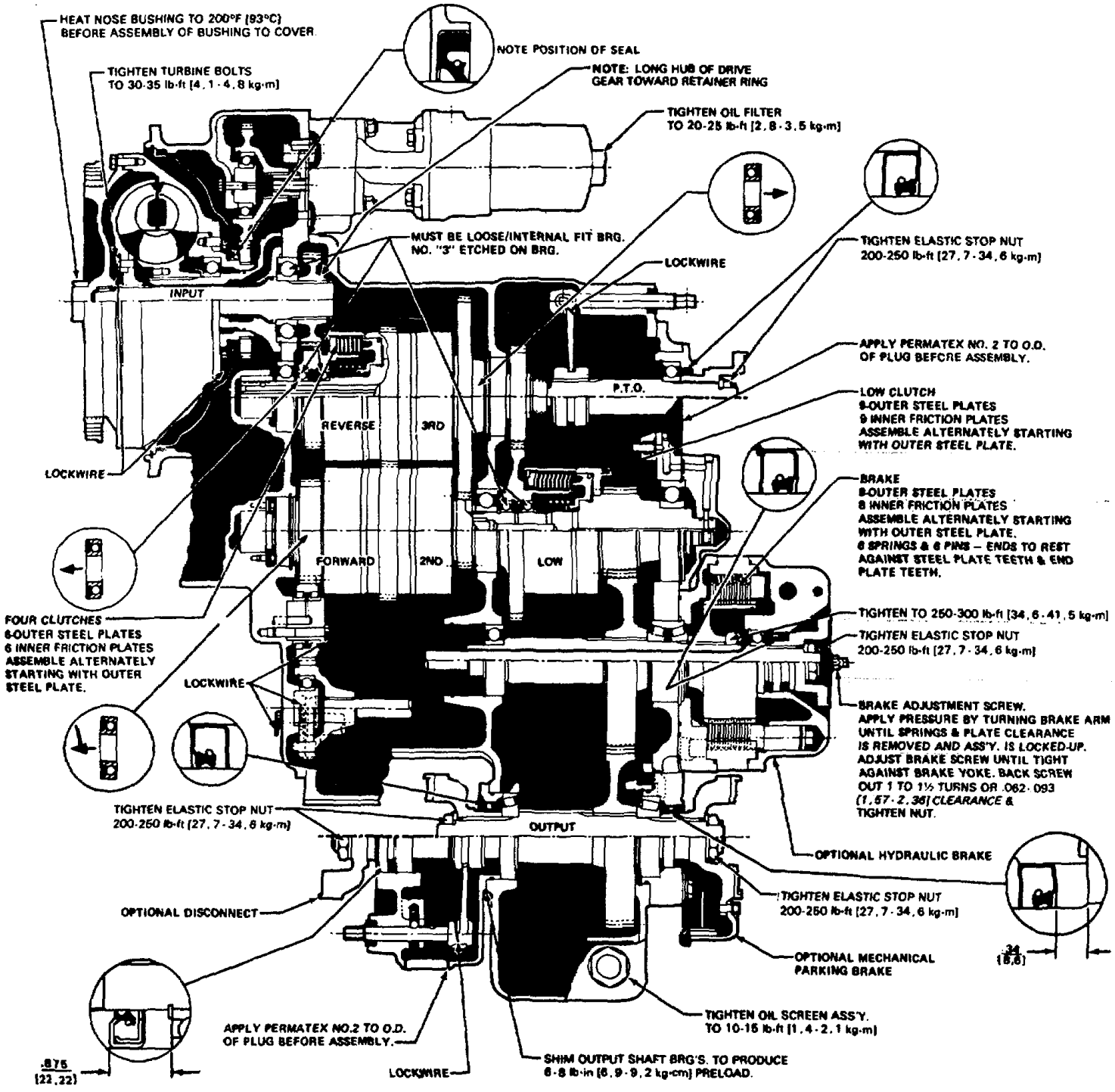
Figure H

AXLE DISCONNECT

ITEM	DESCRIPTION	QTY.	ITEM	DESCRIPTION	QTY.
1	Disconnect Housing Capscrew	4	8	Disconnect Shaft	1
2	Disconnect Housing Capscrew		9	Detent Ball	1
	Lockwasher	4	10	Detent Spring	1
3	Disconnect Housing	1	11	Shift Rail	
4	Disconnect Housing Plug	1	12	Shift Rail Oil Seal	1
5	Shift Hub	1	13	Bearing Retainer Ring	1
6	Shift Fork	1	14	Bearing	1
7	Shift Fork Lockscrew	1	15	Bearing Retainer Ring	1

MECHANICAL PARKING BRAKE

ITEM	DESCRIPTION	QTY.	ITEM	DESCRIPTION	QTY.
1	Backing Plate Assembly	1	8	Return Spring	2
2	Actuating Lever	1	9	Brake Shoe (see item 3)	
3	Brake Shoe and Lining	2	10	Brake Lining	2
4	Brake Flange	1	11	Rivet	20
5	Brake Drum .	1	12	Backing Plate Screw	4
6	Brake Drum to Flange Screw Lockwasher	6	13	Backing Plate Screw Lockwasher	4
7	Brake Drum to Flange Screw	6			



2320 SERIES POWER SHIFT TRANSMISSION WITH VARIOUS OPTIONS

Figure 1

MAINTENANCE AND SERVICE

The instructions contained herein cover the disassembly and reassembly of the transmission in a sequence that would normally be followed after the unit has been removed from the machine and is to be completely overhauled. It must also be understood that this is a basic 28000 transmission with many options. Companion flanges and output shafts with and without disconnect assemblies may vary on specific models. The units are very similar to trouble shoot, disassemble, repair, and reassemble.

CAUTION: Cleanliness is of extreme importance and an absolute must in the repair and overhaul of this unit. Before attempting any repairs, the exterior of the unit must be thoroughly cleaned to prevent the possibility of dirt and foreign matter entering the mechanism.

DISASSEMBLY

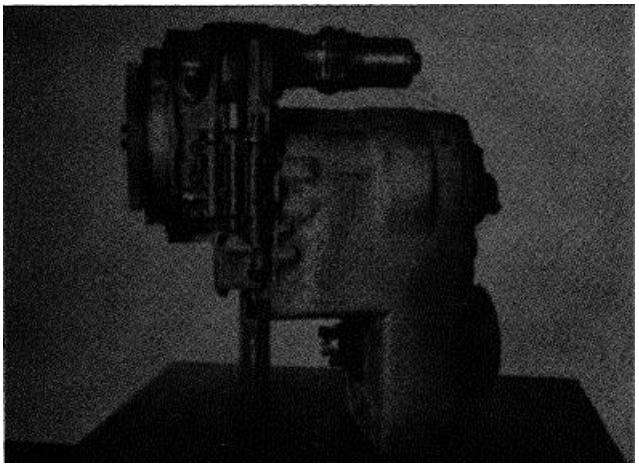


Figure 1
Side view of 3-speed transmission.

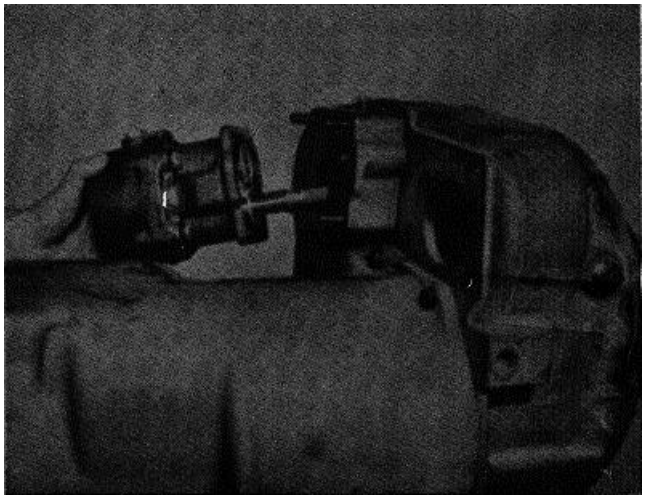


Figure 2
Remove charging pump to regulating valve stud nuts. Remove pump and filter adapter.



Figure 2
Remove filter housing and filter element.

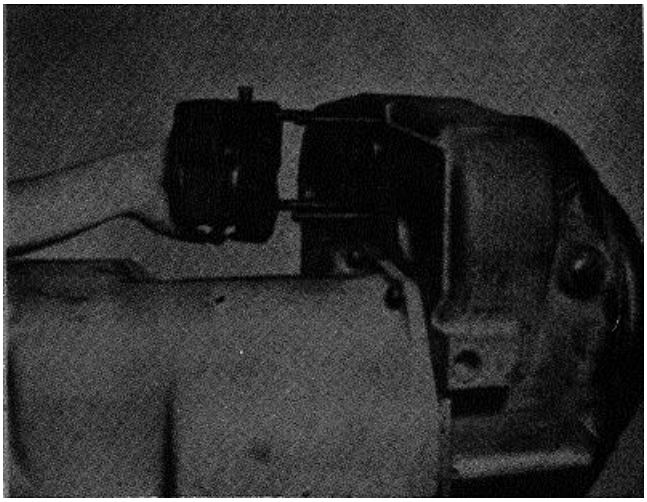


Figure 4
Remove pressure regulating valve assembly.

NOTE: On HR models (torque converter and transmission in one unit) filter element must be changed every 250 operating hours.

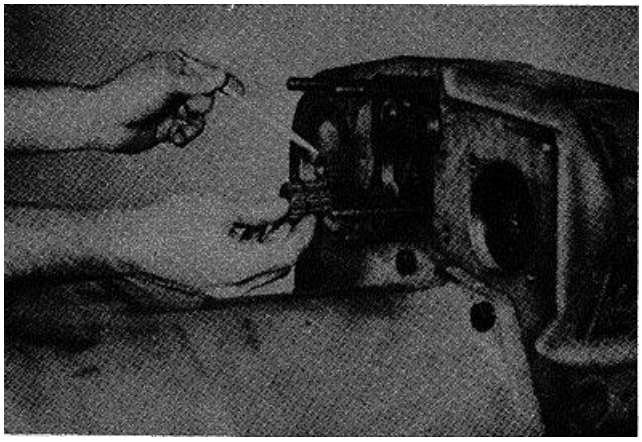


Figure 5
Remove pump drive sleeves.

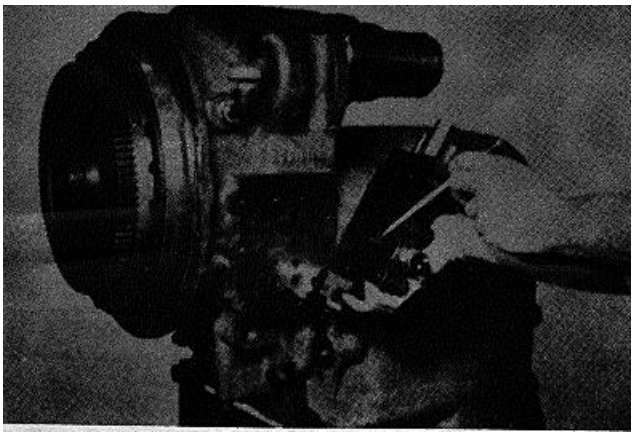


Figure 6
Remove control valve bolts and washers. Remove control valve. Use caution as not to lose detent springs and balls.

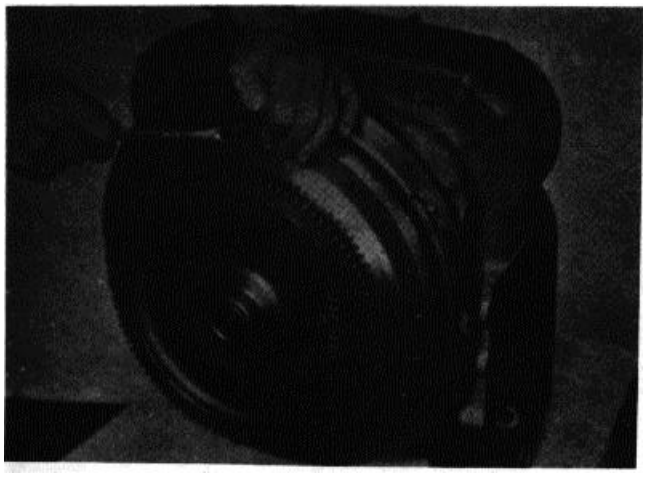


Figure 7
Remove impeller cover bolts.

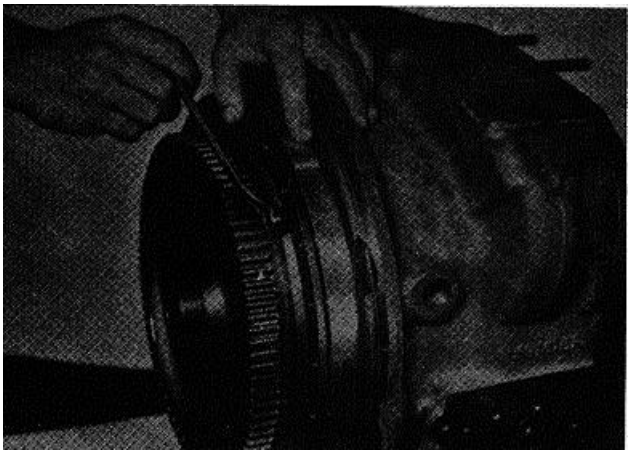


Figure 8
Install two bolts in threaded holes 180° apart to remove cover from impeller. **NOTE**: Some units may have pry slots instead of threaded holes.

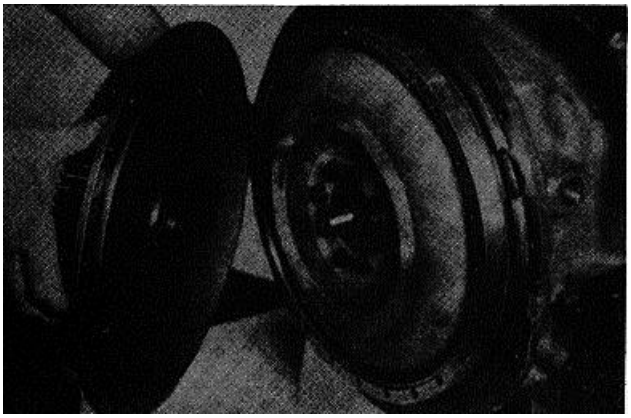


Figure 9
Remove impeller cover.

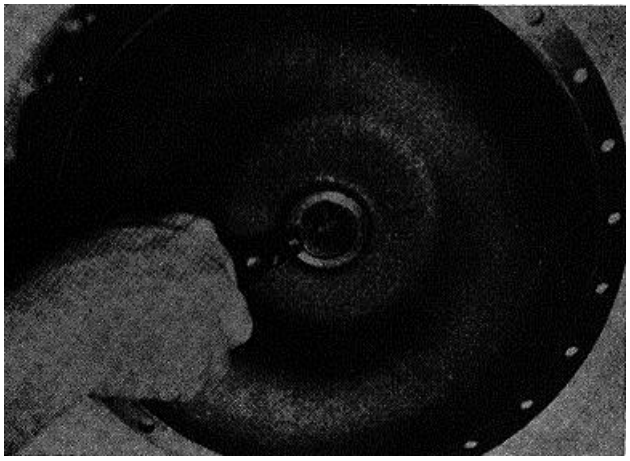


Figure 10
If impeller cover bearing is to be replaced remove trainer ring. Pry bearing from pocket.

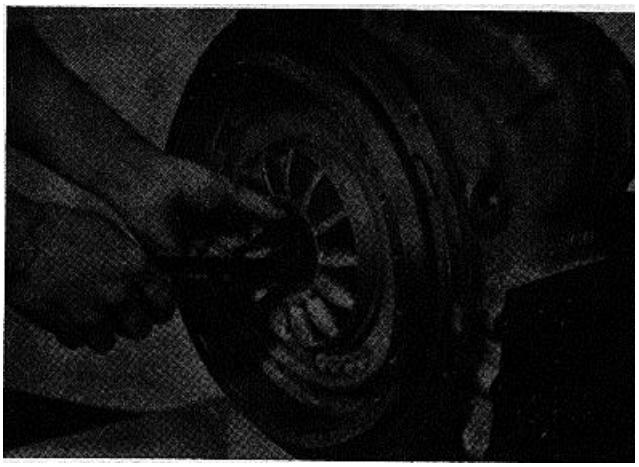


Figure 11
Remove turbine retaining ring.

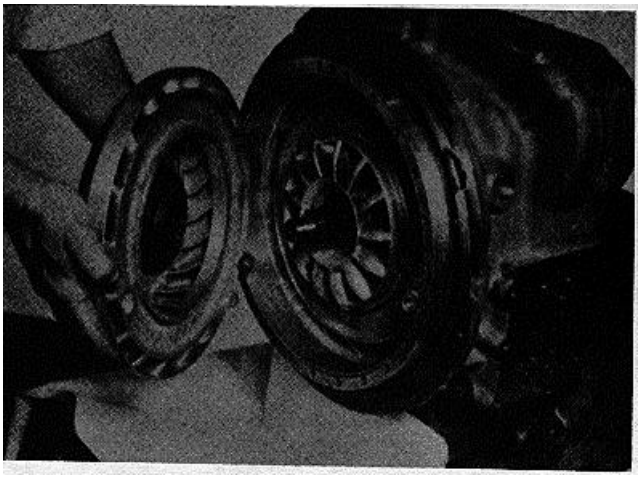


Figure 12
Remove turbine and hub assembly.

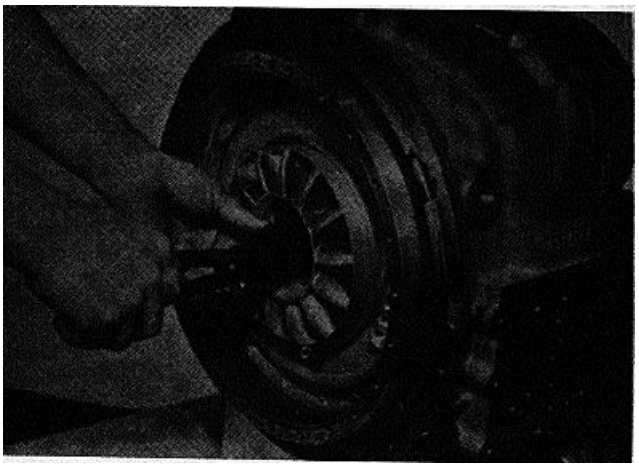


Figure 13
Remove turbine locating ring.

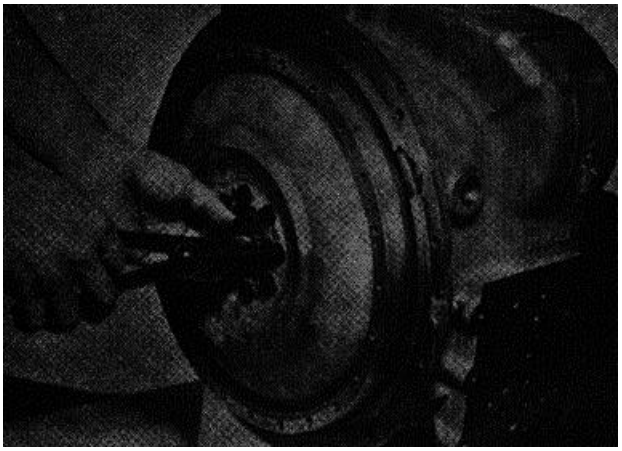


Figure 14
Remove reaction member retainer ring.

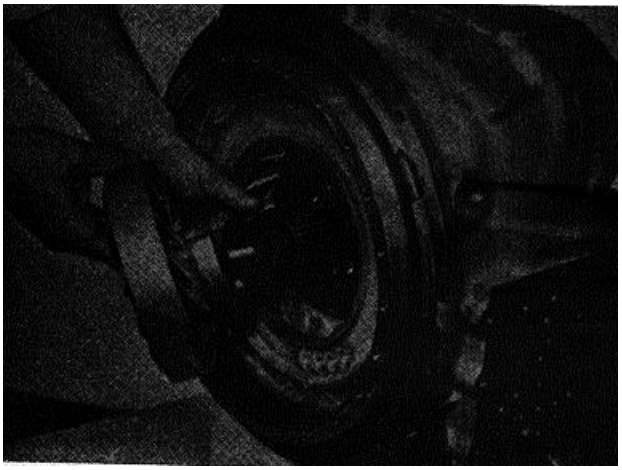


Figure 15
Remove reaction member and spacer.

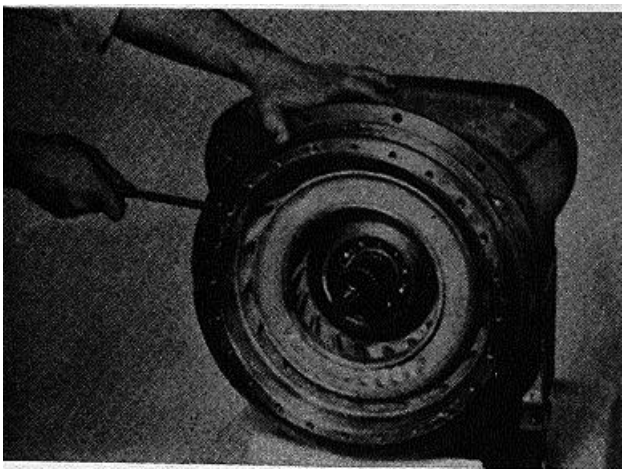


Figure 16
Remove oil baffle retainer ring.

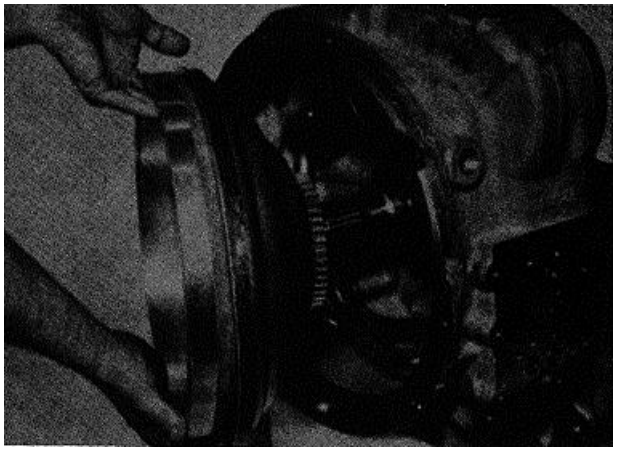


Figure 17

Using pry slots in converter housing, pry oil baffle and impeller from housing. **NOTE**: Impeller, oil baffle and impeller hub gear are removed as an assembly.

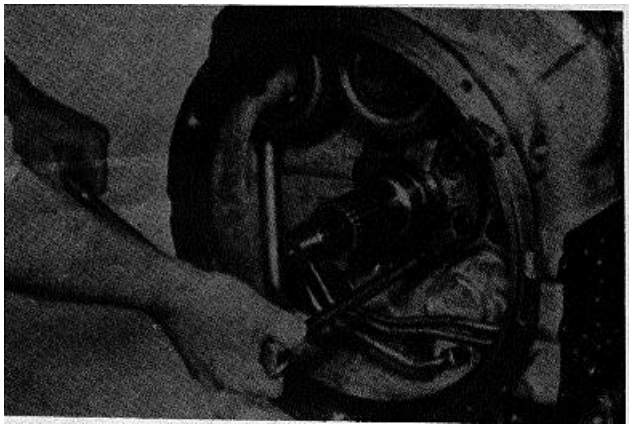


Figure 18

Remove stator support to housing bolts.

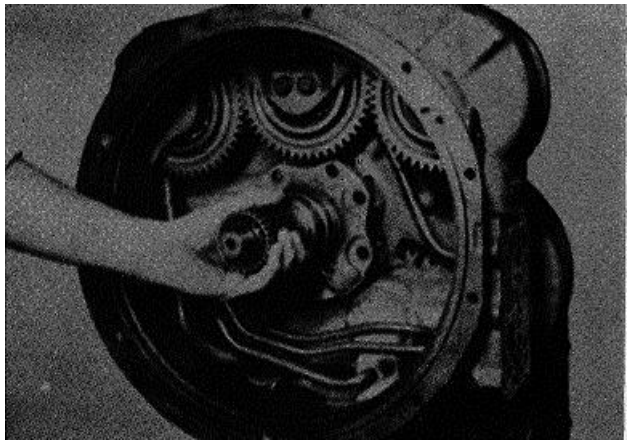


Figure 19

Remove stator support. **NOTE**: Support must be turned to clear pump drive gear.

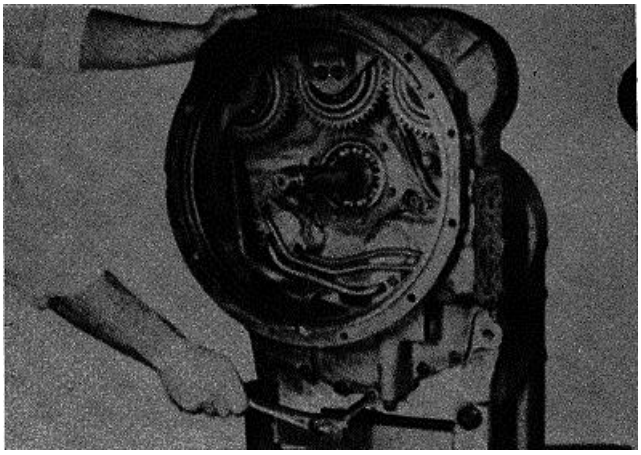


Figure 20

Remove bolts securing converter housing to transmission housing.

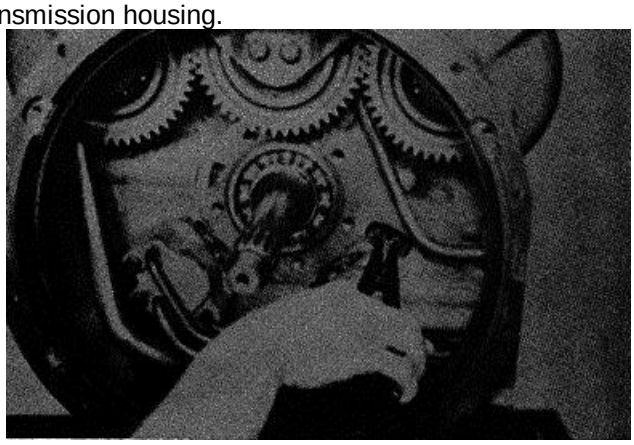


Figure 21

Support converter housing with a chain fall. Using spreading type snap ring pliers, spread ears on forward clutch front bearing retaining ring. Holding snap ring open tap converter housing from transmission housing.

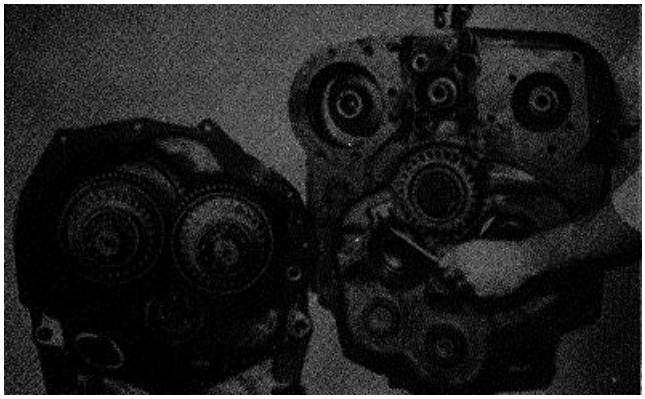


Figure 22

Converter housing removed. Note front bearing retaining ring relieved of front bearing.

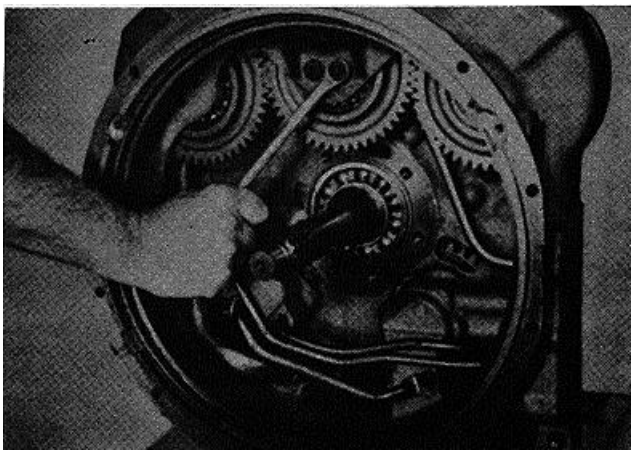


Figure 23
Remove pump drive gear bearing support bolts.

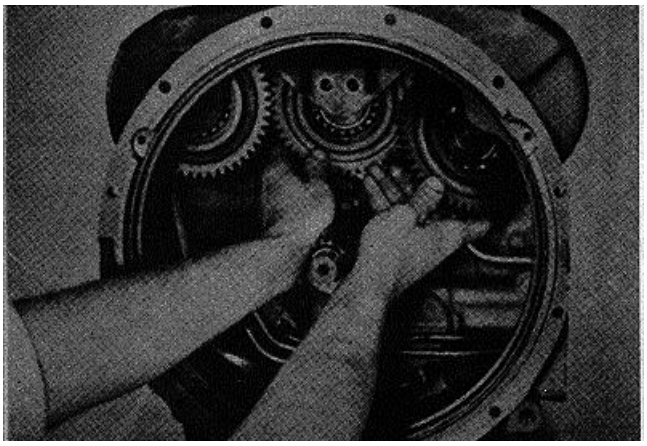


Figure 24
Move center gear toward the rear of converter housing. Remove pump drive gear on the right.

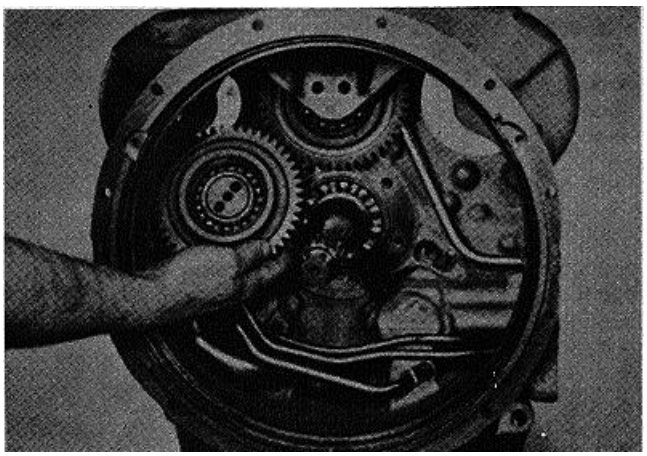


Figure 25
Remove pump drive gear on the left.

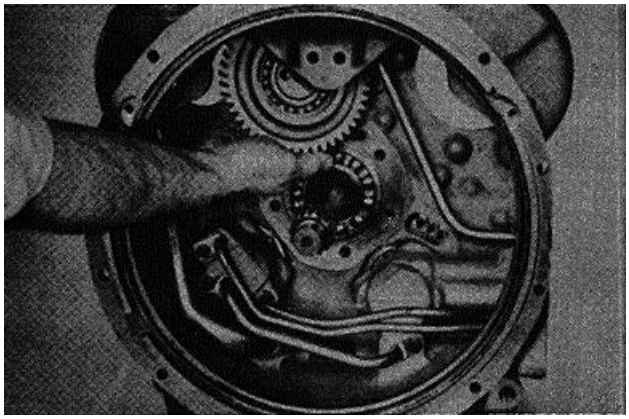


Figure 26
Remove center pump drive gear.

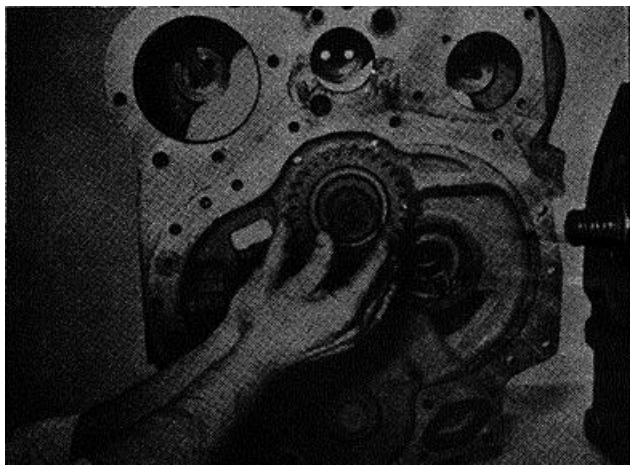


Figure 27
Remove turbine shaft gear retainer ring and gear.

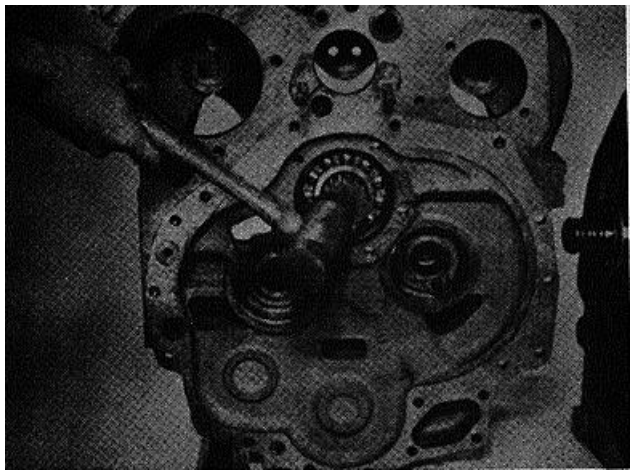


Figure 28
From rear of converter housing tap turbine shaft ad bearing from housing.

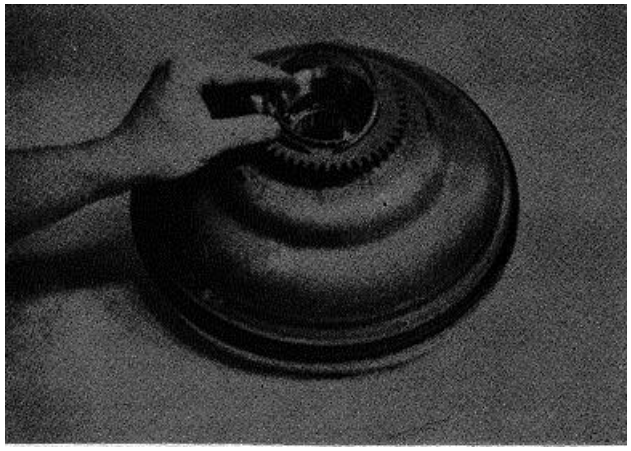


Figure 29
Remove impeller hub gear retainer ring.

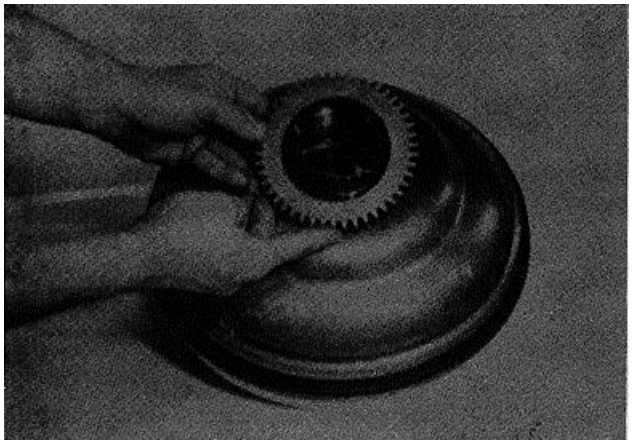


Figure 30
Remove impeller hub gear.

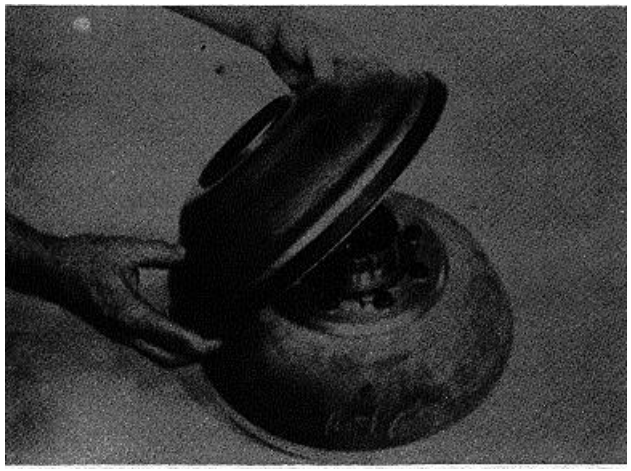


Figure 31
Lift oil baffle and oil seal assembly from impeller.

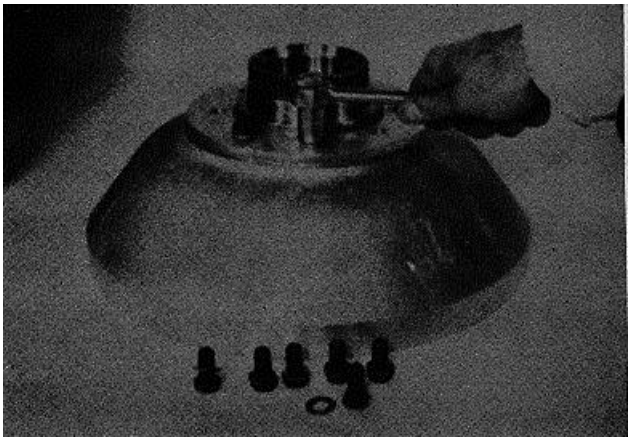


Figure 32
Remove impeller to hub bolts.

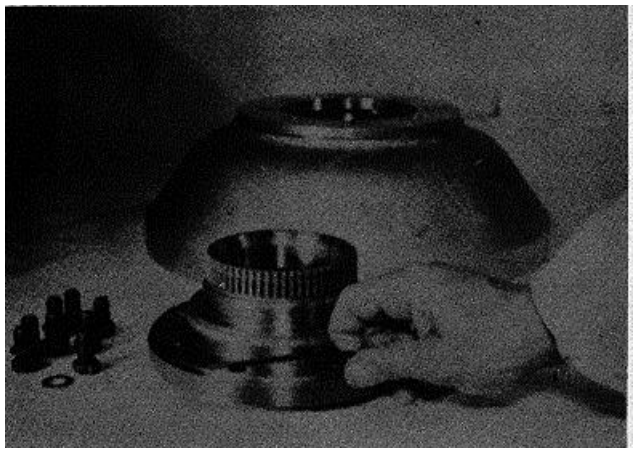


Figure 33
Remove impeller hub “O” ring.

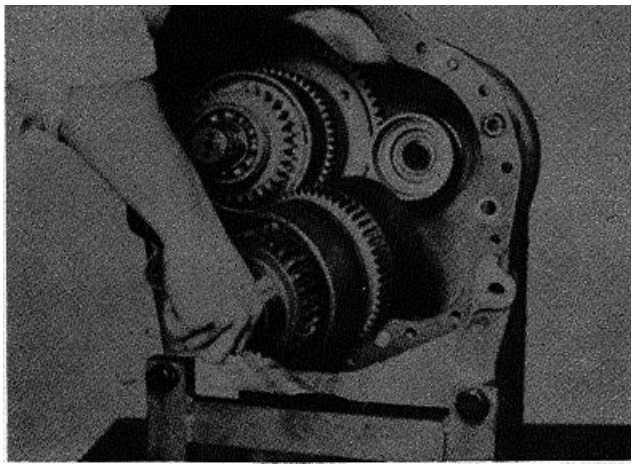


Figure 34
Remove forward and 2nd clutch assembly.

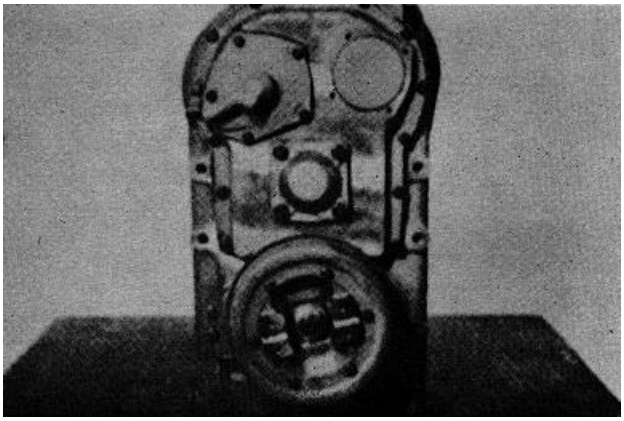


Figure 35

Rear view of transmission utilizing a mechanical parking brake option.

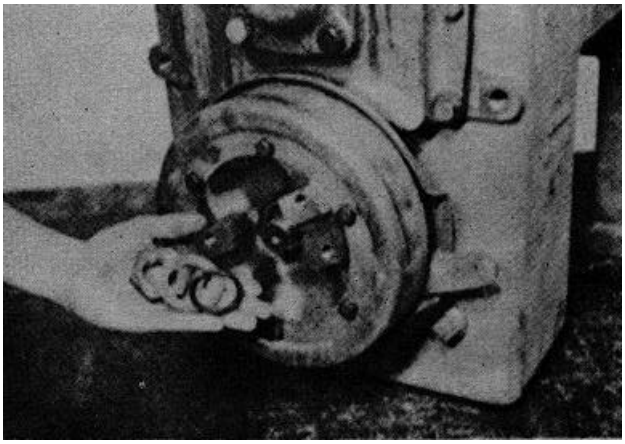


Figure 38

Remove upper and lower brake shoe return springs.

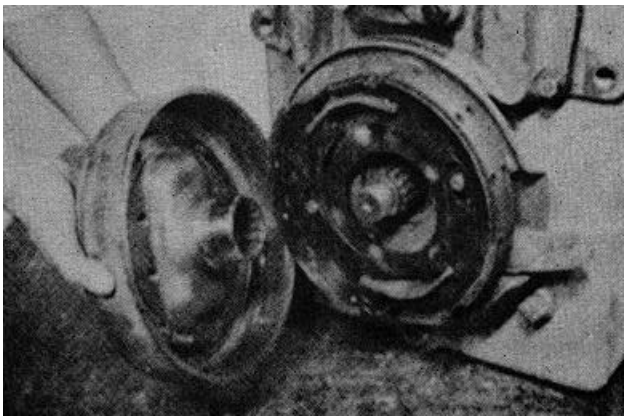


Figure 36

Remove output flange nut, washer and "0" ring. If parking brake is not used, remove companion flange and proceed to Figure 42.

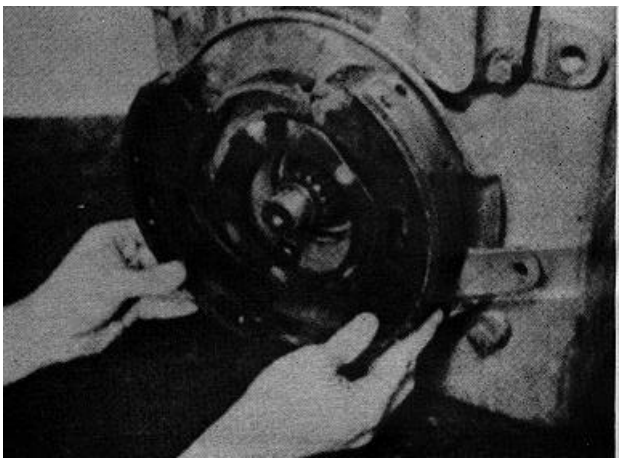
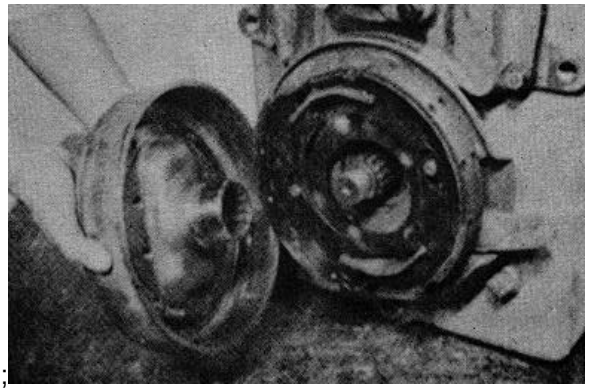


Figure 39

Remove brake shoes



;

Figure 37

Remove parking brake drum and flange.

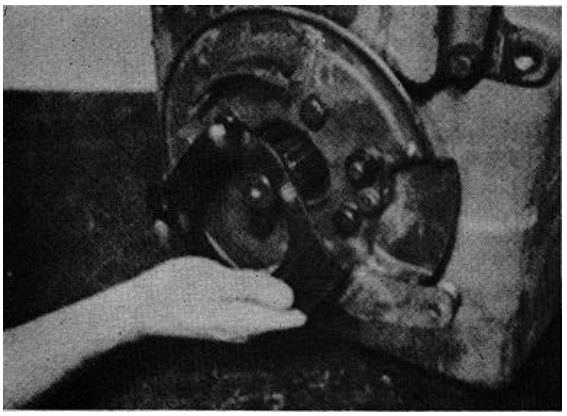


Figure 40

Remove brake actuator arm.

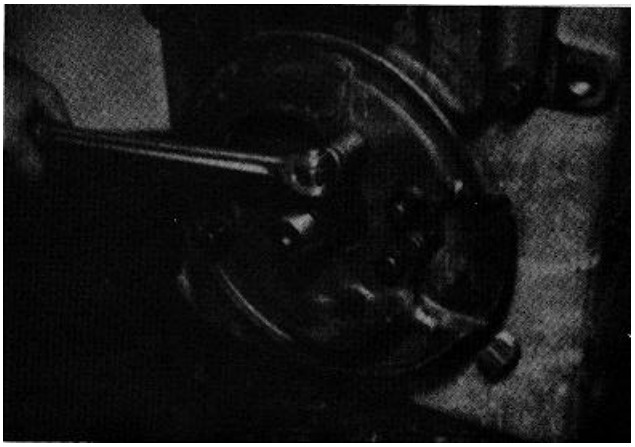


Figure 41
Remove brake backing plate bolts.

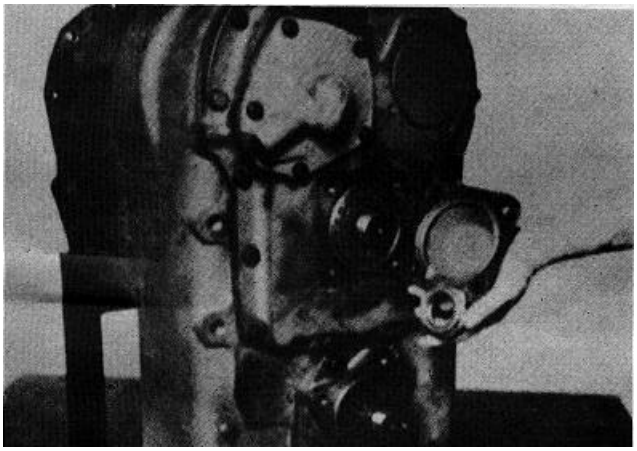


Figure 42
Remove idler shaft bearing cap bolts, bearing cap and idler shaft nut.

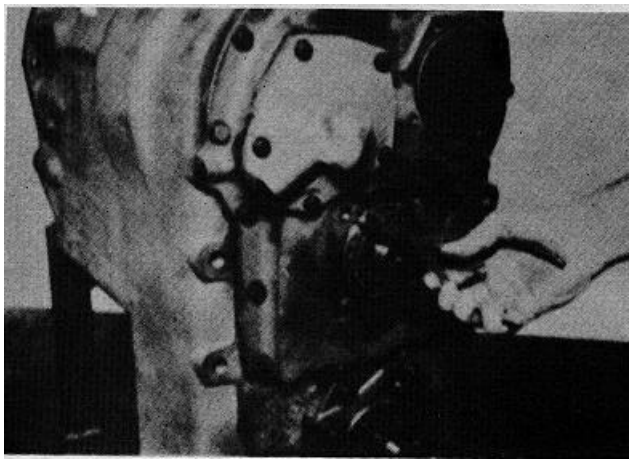


Figure 43
Remove idler shaft rear bearing locating ring.

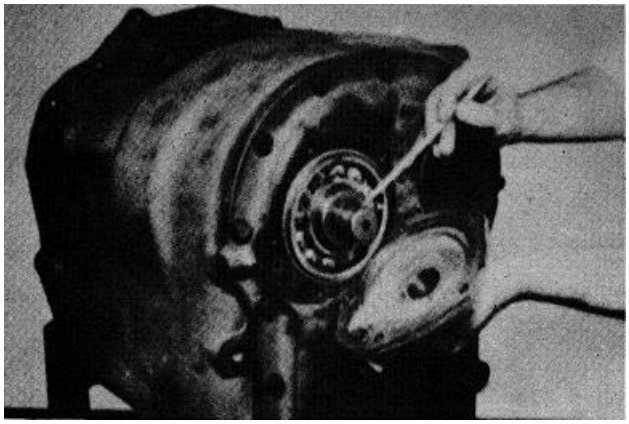


Figure 44
Remove low clutch rear bearing cap.

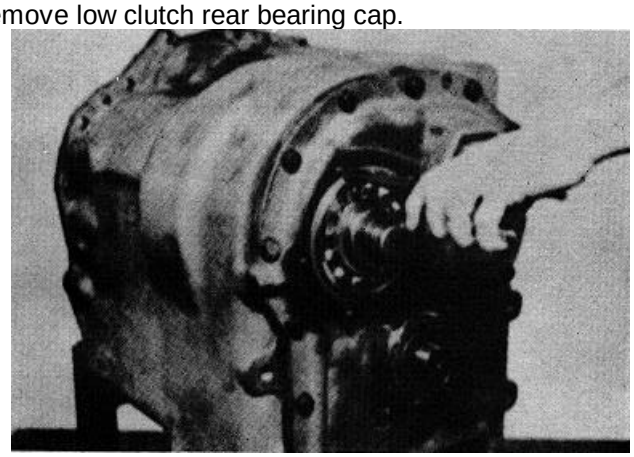


Figure 45
Remove low clutch rear bearing locating ring.

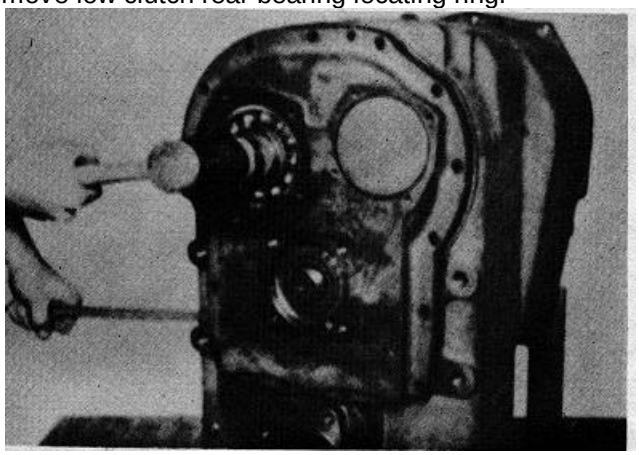


Figure 46
Remove rear cover bolts. Using pry slots provided, pry cover from transmission housing tapping on low clutch and idler shaft to allow cover to be removed without shaft binding.

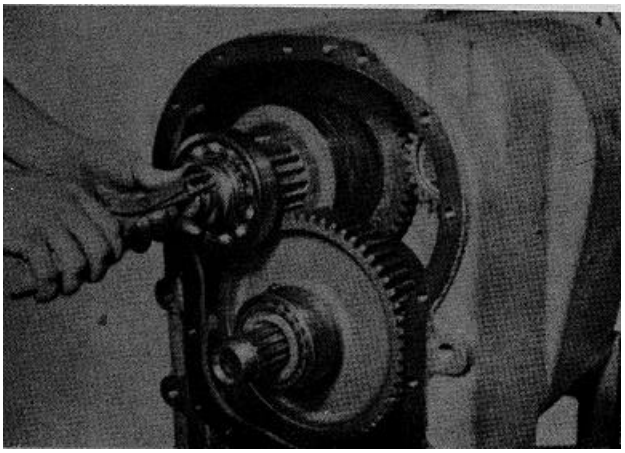


Figure 47
Remove low clutch rear bearing retaining ring.

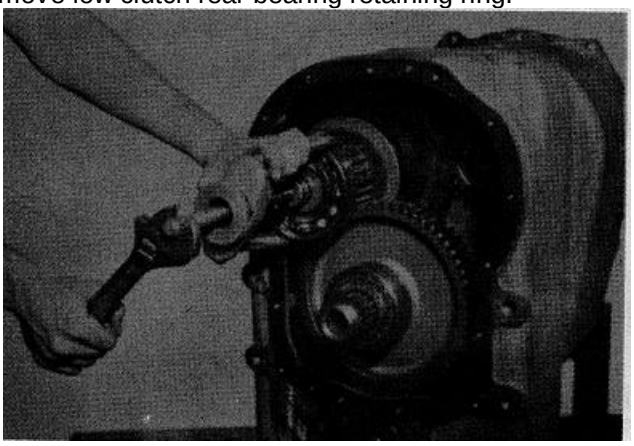


Figure 48
Remove low clutch rear bearing.

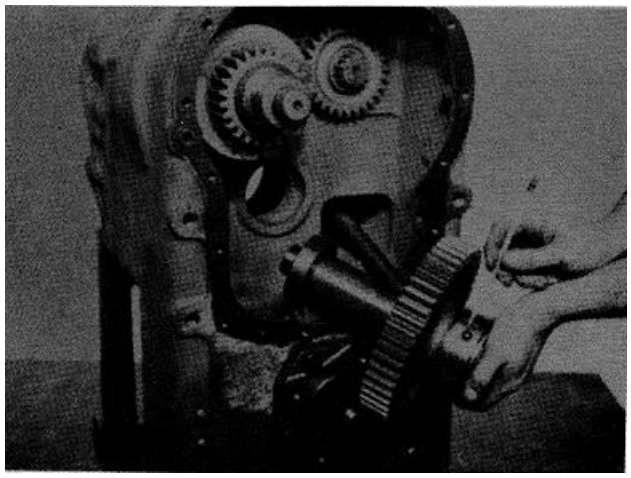


Figure 49
Tap idler shaft from housing. NOTE: Do not lose rear bearing lock ball.

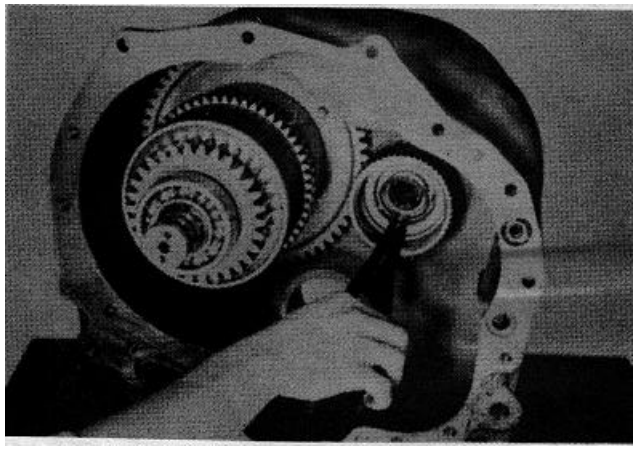


Figure 50
Remove low speed drive gear retainer ring and drive gear.

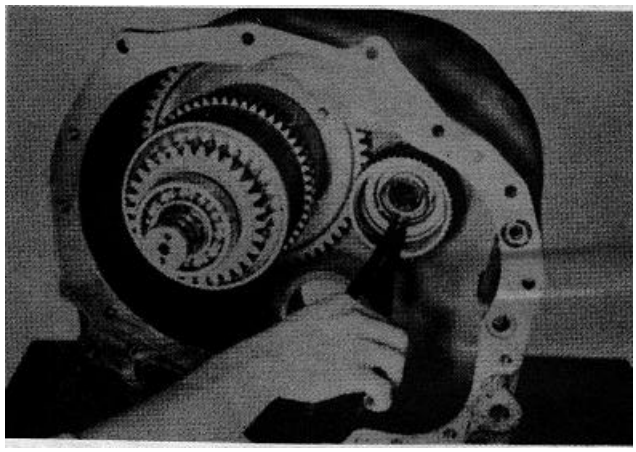


Figure 51
Remove 2nd gear retaining ring.

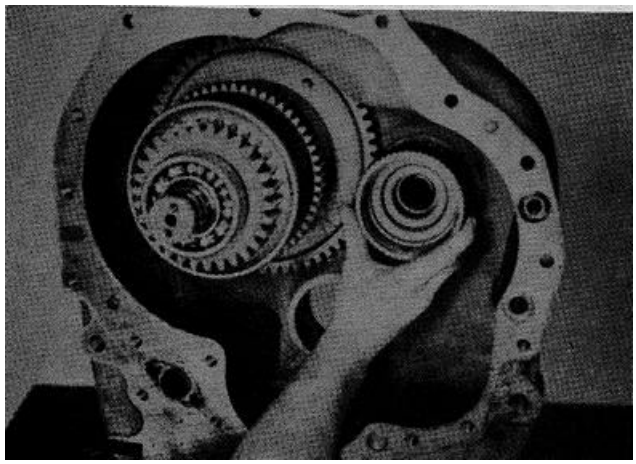


Figure 52
Remove 2nd gear.

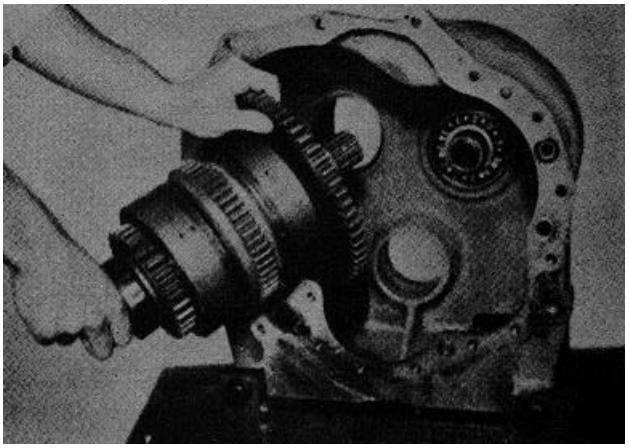


Figure 53
Remove reverse and 3rd clutch assembly.



Figure 54
Remove low clutch assembly.

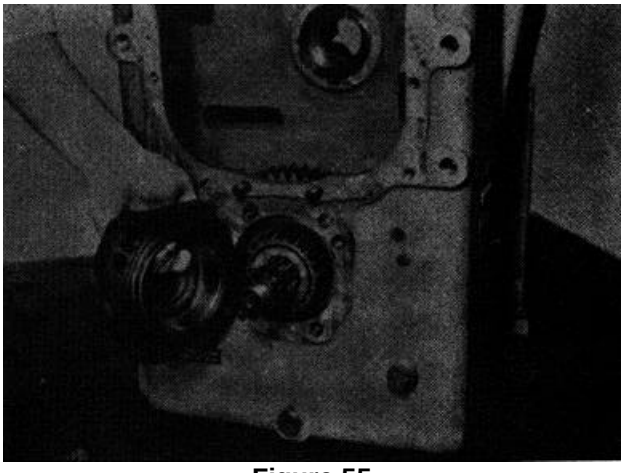


Figure 55
Remove rear output shaft bearing cap bolts and cap.

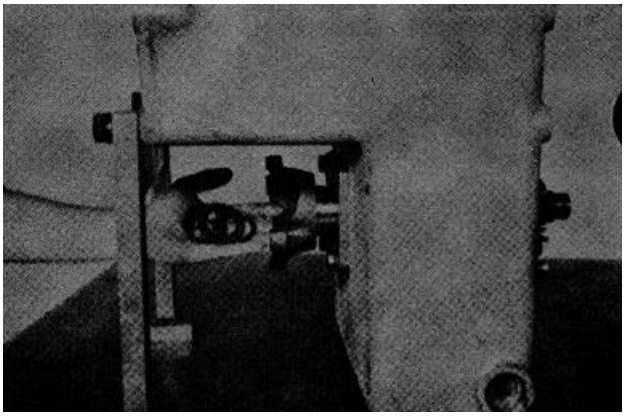


Figure 56
Remove front output flange nut, washer, "0" ring and companion flange.

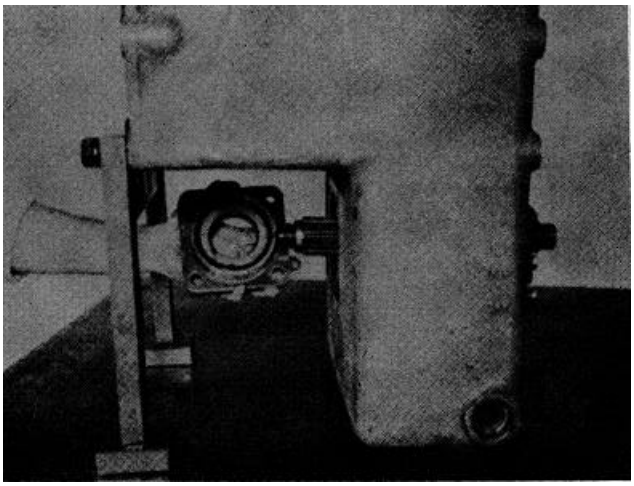


Figure 57
Remove output shaft front bearing cap bolts and cap.

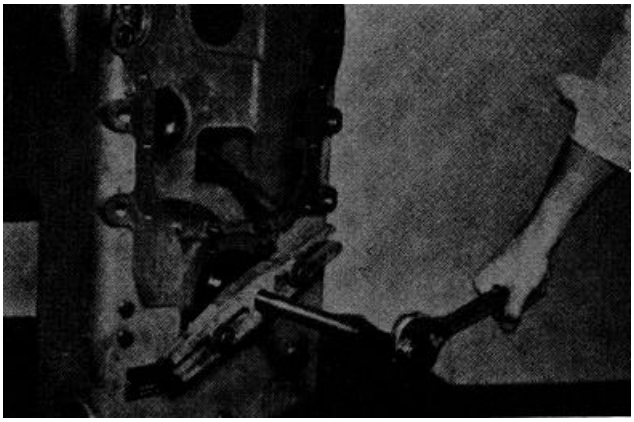


Figure 58
Block output gear. Push output shaft from rear through bearing and gear.

Clutch Disassembly

NOTE: Two clutches are shown being disassembled. The low clutch, and the forward and second. All clutches are disassembled in a similar manner. The quantity of clutch discs will differ between the low clutch and the forward, reverse, second and third. Do **n**ot mix the friction discs In the low clutch with the friction discs of any of the other clutches. (See note, **Figure 9**3).

Low Clutch Disassembly

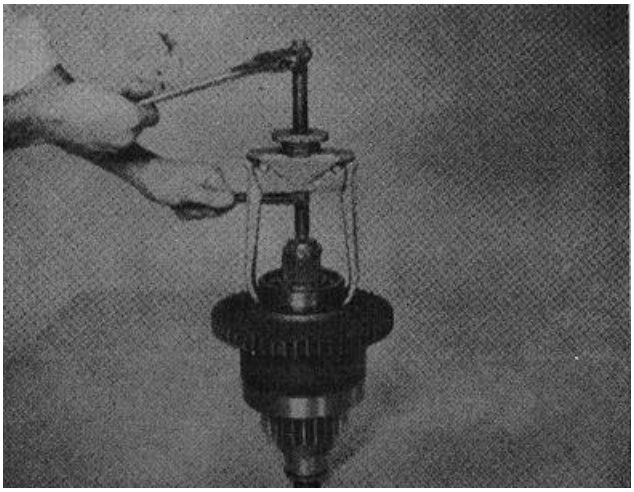


Figure 59
Remove low clutch shaft rear bearing.

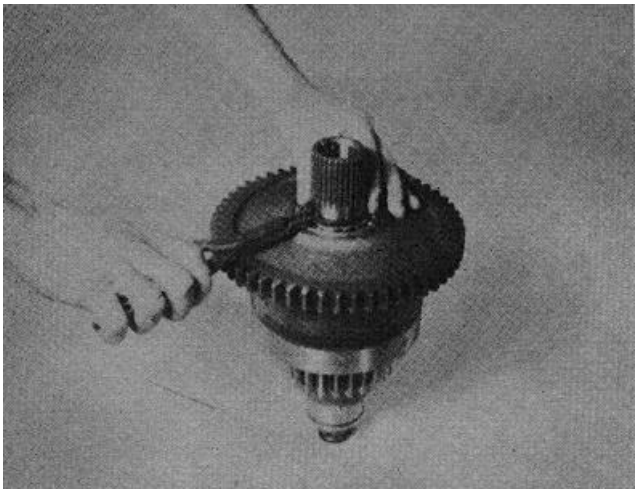


Figure 60
Remove low speed gear retainer ring.

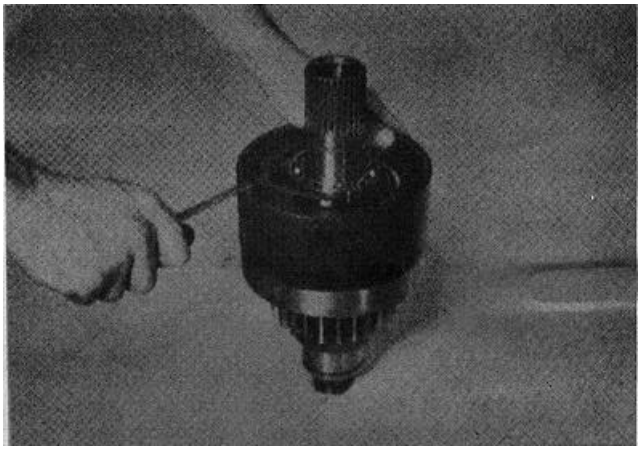


Figure 61
Remove low speed gear and outer bearing.

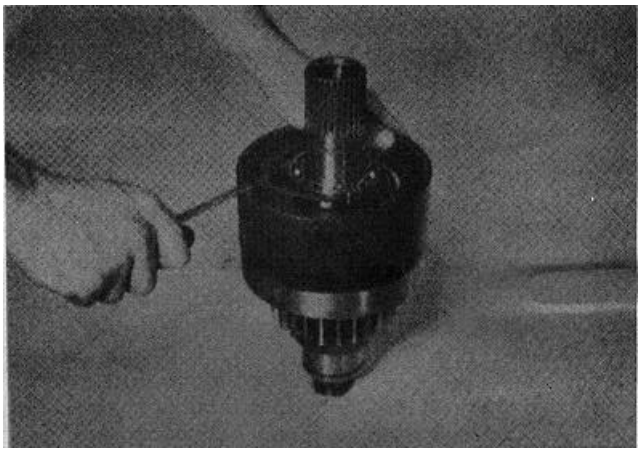


Figure 62
Remove clutch end plate retainer ring.

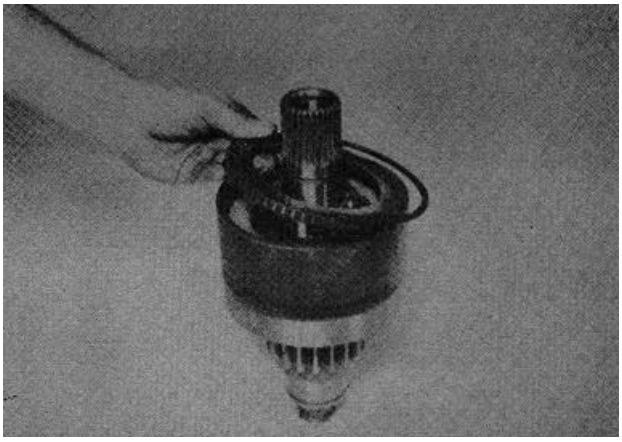


Figure 63
Remove clutch end plate and inner and outer clutch discs.

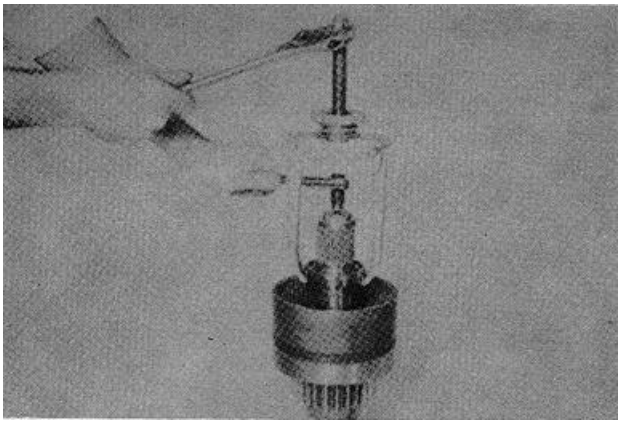


Figure 64
Remove low gear inner bearing.

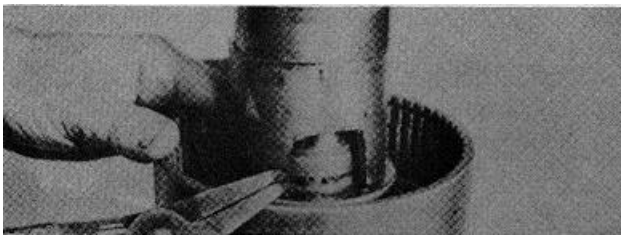


Figure 65
Remove clutch piston return spring. A sleeve with a portion removed is recommended for removing the clutch piston return spring, washer, and retainer ring. Sleeve shown is a common pipe, with a 1-1/2 x 1 [39,0x26,0mm] opening. The pipe is 6x3-1/4x2-3/4 [155,0x85,0x78,0mm]. Compress spring retainer washer. Through opening remove spring retainer snap ring. Release tension on spring retainer. Remove spring retainer and spring. Turn clutch over and tap clutch shaft on a block of wood to remove clutch piston.

Forward and 2nd Clutch Disassembly

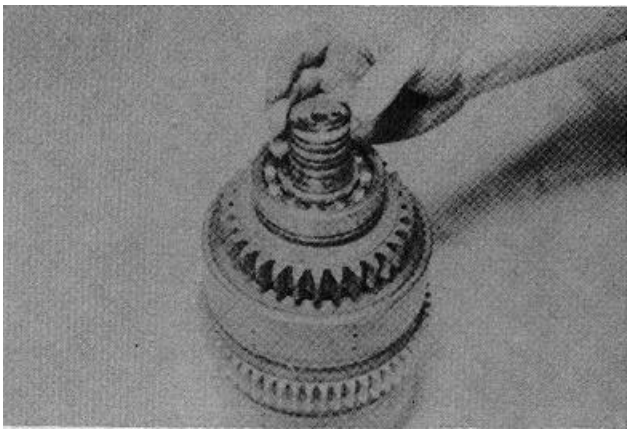


Figure 66
Remove clutch shaft piston rings.

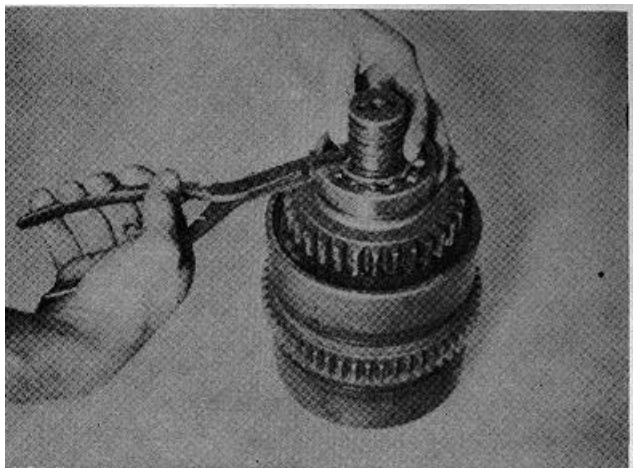


Figure 67
Remove front bearing retainer ring

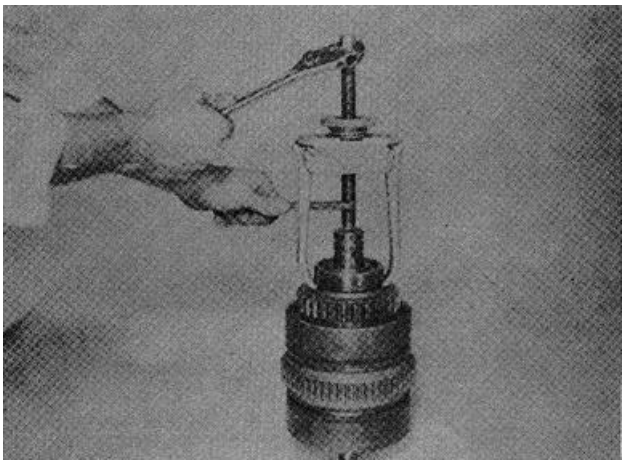


Figure 68
Remove front bearing.

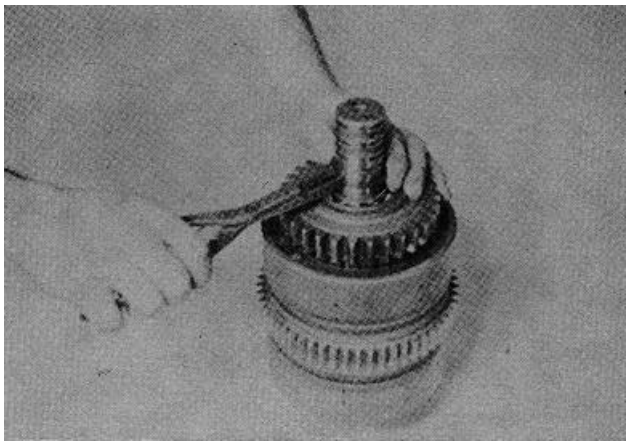


Figure 69
Remove front bearing locating ring.

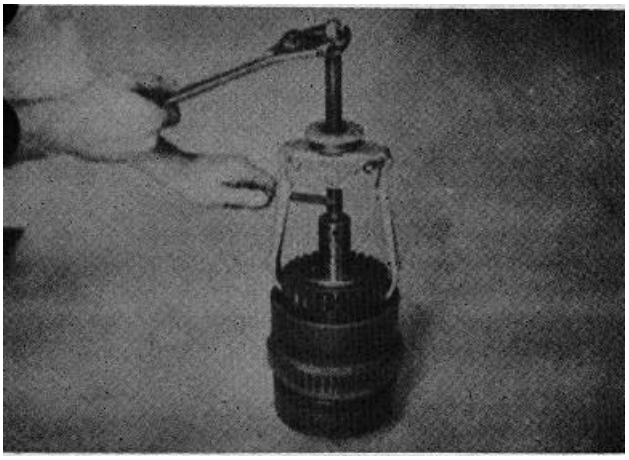


Figure 70

Remove clutch driven gear and outer bearing.

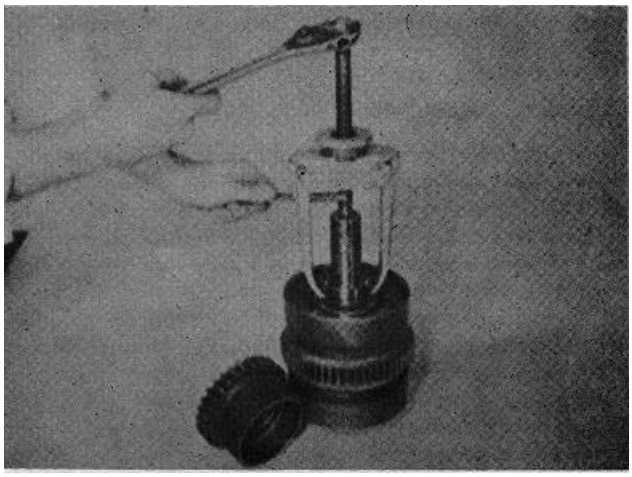


Figure 71
Remove inner bearing.

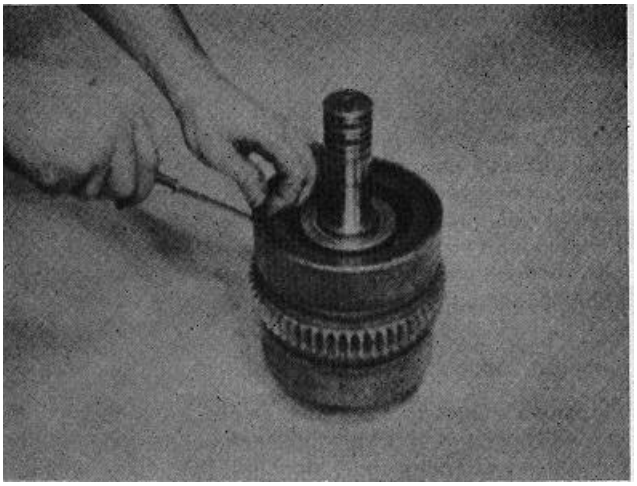


Figure 72

Remove end plate retainer ring.

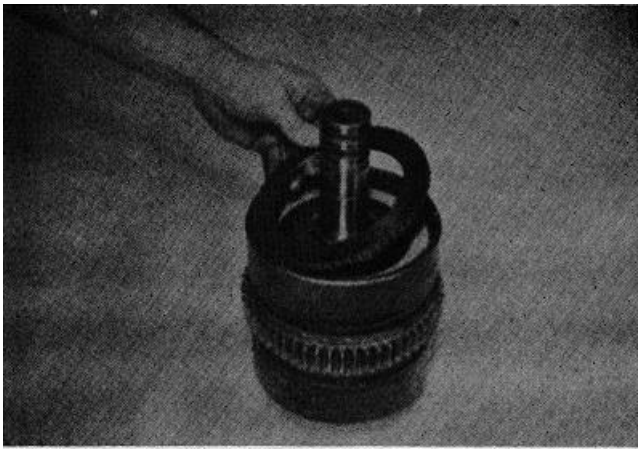


Figure 73

Remove end plate

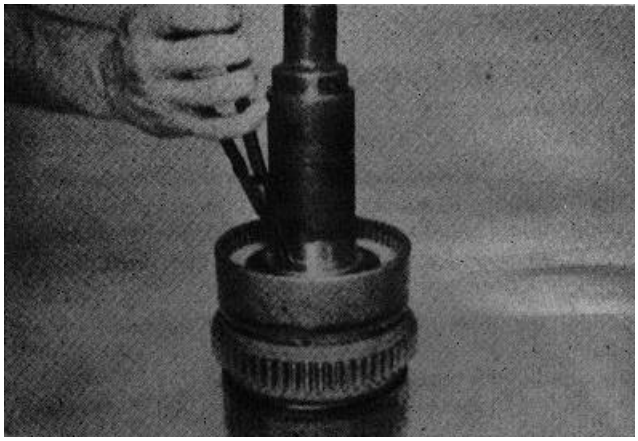


Figure 74

Compress return spring retainer. Remove retainer ring from groove.



Figure 75

Relieve spring compression. Remove retainer ring, retainer and spring.

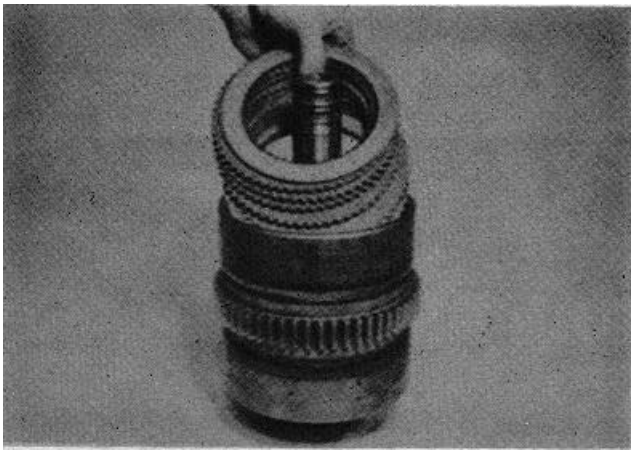


Figure 76

Remove inner and outer clutch discs. Turn clutch over and tap clutch shaft on a block of wood to re- move clutch piston.

CLEANING AND INSPECTION

CLEANING

Clean all parts thoroughly using solvent type -lean- ing fluid. It is recommended that parts be immersed in cleaning fluid and moved up and down slowly until all old lubricant and foreign material is dissolved and parts are thoroughly cleaned.

CAUTION: Care should be exercised to avoid skin rashes, fire hazards and inhalation of vapors when using solvent type cleaners.

Bearings

Remove bearings from cleaning fluid and strike flat against a block of wood to dislodge solidified particles of lubricant. Immerse again in cleaning fluid to flush out particles. Repeat above operation until bearings are thoroughly clean. Dry bearings using moisture- free compressed air. Be careful to direct air stream across bearing to avoid spinning. Do not spin bearings when drying. Bearings may be rotated slowly by hand to facilitate drying process.

Housings

Clean interior and exterior of housings, bearing caps, etc., thoroughly. Cast parts may be cleaned in hot solution tanks with mild alkali solutions providing these parts do not have ground or polished surfaces. Parts should remain in solution long enough to be thoroughly cleaned and heated. This will aid the evaporation of the cleaning solution and rinse water. Parts cleaned in solution tanks must be thoroughly rinsed with clean water to remove all traces of alkali. Cast parts may also be cleaned with steam cleaner.
CAUTION: Care should be exercised to avoid in- halation of vapors and skin rashes when using alkali cleaners.

All parts cleaned must be thoroughly dried immediately by using moisture-free compressed air or soft, lintless absorbent wiping rags free of abrasive materials such as metal filings, contaminated oil or lapping compound.

INSPECTION

The importance of careful and thorough inspection of all parts cannot be overstressed. Replacement of all parts showing indication of wear or stress will eliminate costly and avoidable failures at a later date.

Bearings

Carefully inspect all rollers, cages and cups for wear, chipping or nicks to determine fitness of bearings for further use. Do not replace a bearing cone or cup individually without replacing the mating cup or cone at the same time. After inspection, dip bearings in Automatic Transmission Fluid and wrap in clean lint- less cloth or paper to protect them until installed.

Oil Seals, Gaskets, Etc.

Replacement of spring load oil seals, "0" rings, metal sealing rings, gaskets and snap rings is more economical when unit is disassembled than premature overhaul to replace these parts at a future time. Further loss of lubricant through a worn seal may result in failure of other more expensive parts of the assem- bly. Sealing members should be handled carefully, particularly when being installed. Cutting, scratching, or curling under of lip of seal seriously impairs its efficiency. Apply a thin coat of Permatex No. 2 on the outer diameter of the oil seal to assure an oil tight fit into the retainer. When assembling new metal type sealing rings, same should be lubricated with coat of chassis grease to stabilize rings in their grooves for ease of assembly of mating members. Lubricate all "O" rings and seals with recommended type Automatic Transmission Fluid before assembly.

Gears and Shafts

If magna-flux process is available, use process to check parts. Examine teeth on all gears carefully for wear, pitting, chipping, nicks, cracks or scores. If gear teeth show spots where case hardening is worn through or cracked, replace with new gear. Small nicks may be removed with suitable hone. Inspect shafts and quills to make certain they are not sprung, bent, or splines twisted, and that shafts are true.

Housing, Covers, etc.

Inspect housings, covers and bearing caps to be certain they are thoroughly cleaned and that mating surfaces, bearing bores, etc., are free from nicks or burrs. Check all parts carefully for evidence, of cracks or condition which would cause subsequent oil leaks or failures.

REASSEMBLY

Forward and 2nd Clutch Reassembly

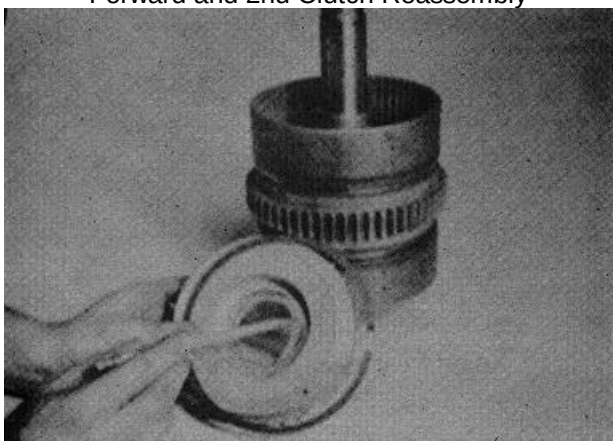


Figure 77

Install new clutch piston inner and outer sealing rings.

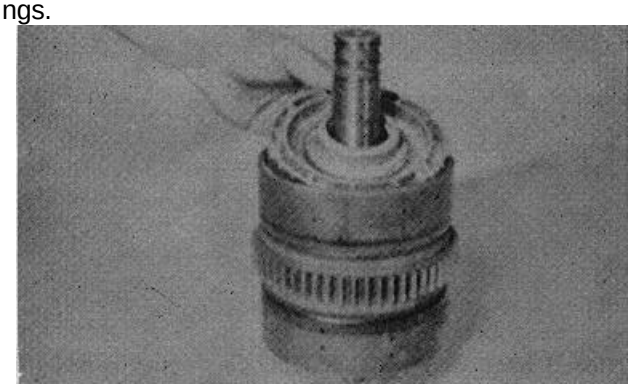


Figure 78

Insert clutch piston in clutch drum. Use caution as not to damage sealing rings.

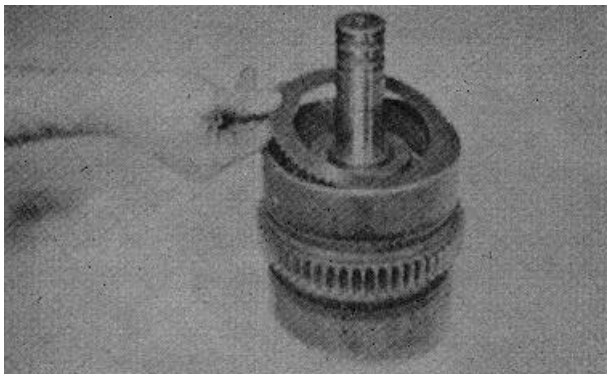


Figure 79

Install clutch piston return spring, spring retainer and retainer snap ring. Insert one steel disc.

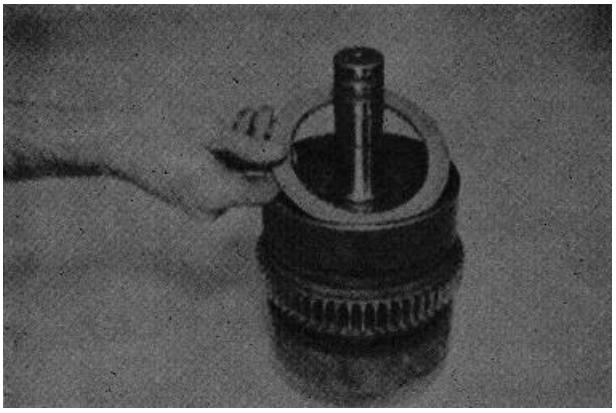


Figure 80

Install one friction disc. Alternate steel and friction discs until the proper amount of discs are installed. First disc next to the piston is steel, last disc installed is friction.

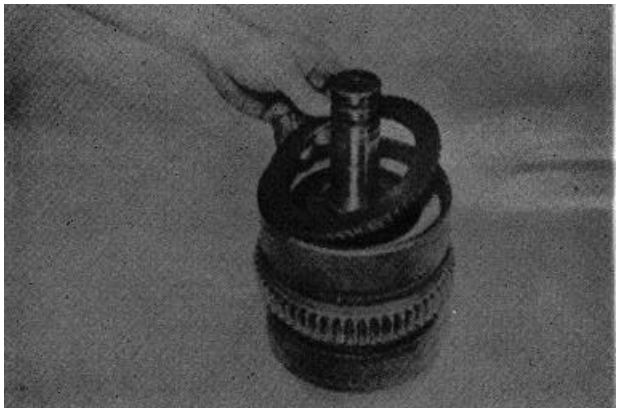


Figure 81

Install end plate.

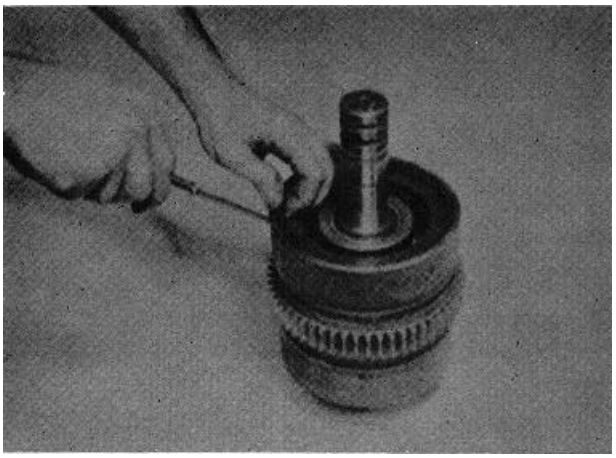


Figure 82

Install end plate retainer ring.

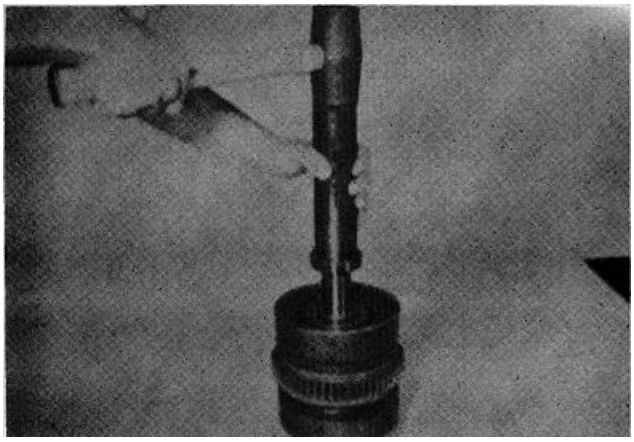


Figure 83
Install clutch driven gear inner bearing.

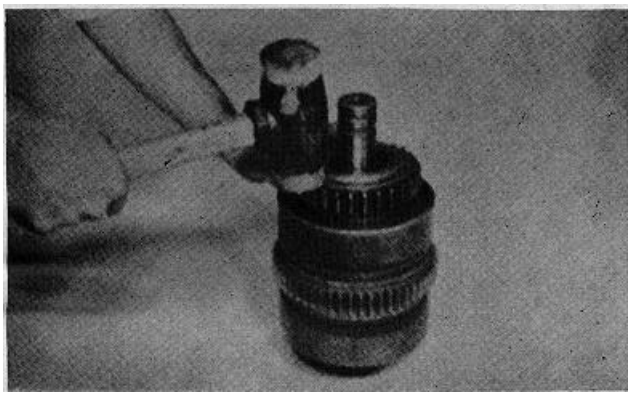


Figure 84
Install clutch driven gear into clutch drum. Align splines on clutch gear with internal teeth of friction discs. Tap gear into position. Do not force this operation. Gear splines must be in full position with internal teeth of all friction discs.

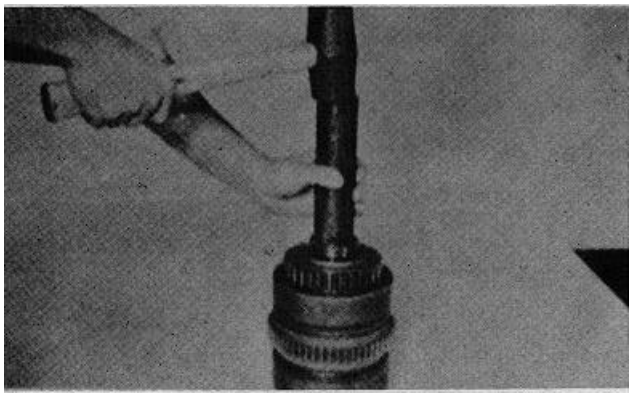


Figure 85
Install driven gear outer bearing.

SEE FIG. N FOR PROPER

SHIELDED BEARING INSTALLATION

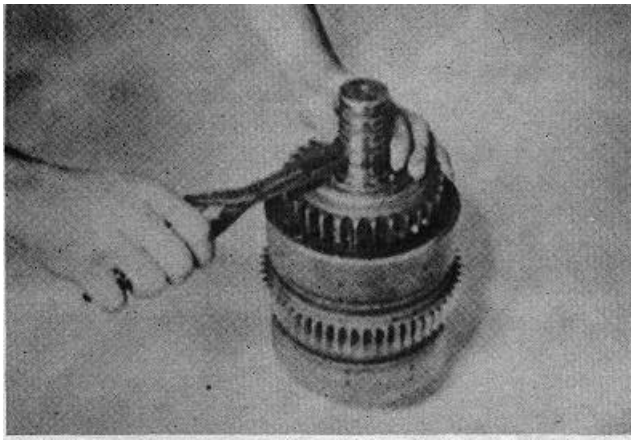


Figure 86
Install front bearing locating ring.

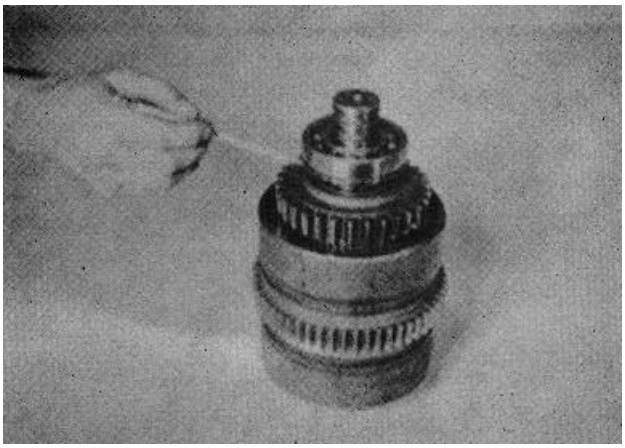


Figure 87
Install front bearing. NOTE: Snap ring groove In front bearing must be down.

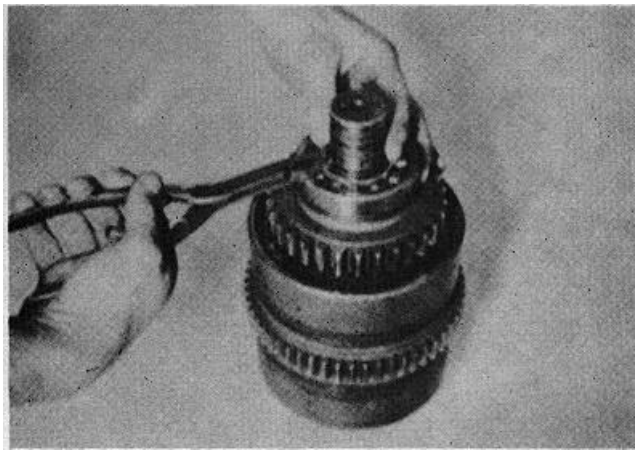


Figure 88
Install front bearing retaining ring.

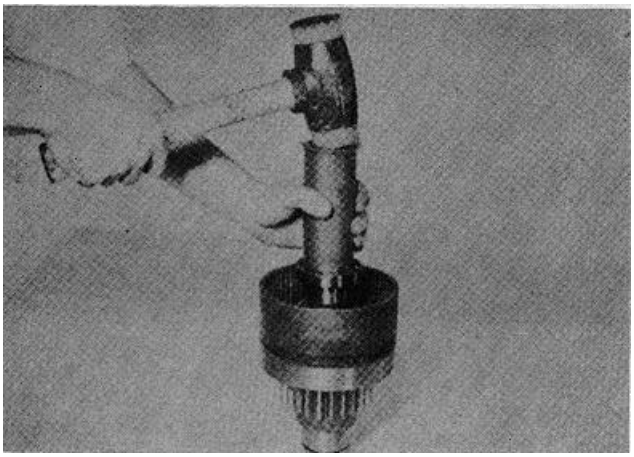


Figure 89
Install clutch shaft oil sealing rings. Grease rings to facilitate reassembly into front housings.

Low Clutch Reassembly

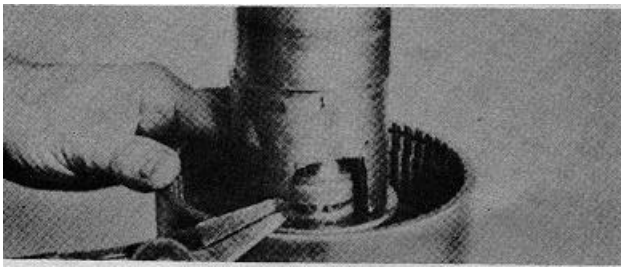


Figure 90

Install new clutch piston inner and outer sealing ring. Insert piston into clutch drum using caution as not to damage seals. Position piston return spring, spring retainer and retainer snap ring. Compress spring and retainer and install snap ring.

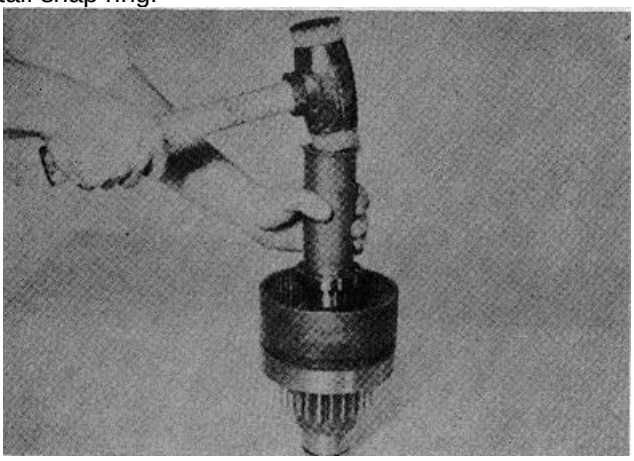


Figure 91
Install low gear inner bearing.

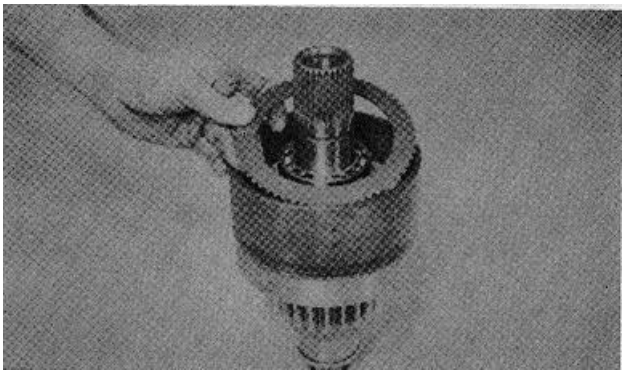


Figure 92
Install one steel disc.

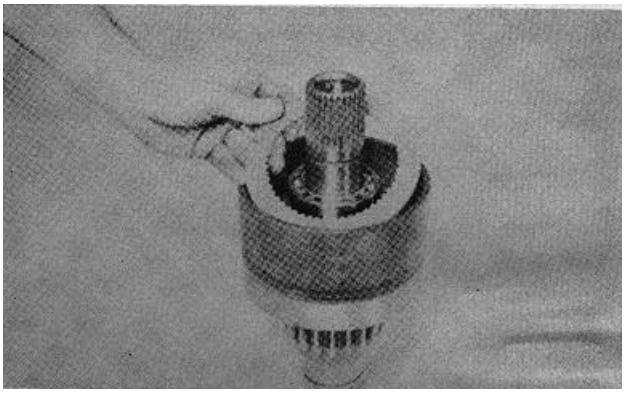


Figure 93

Install one friction disc. **NOTE: The friction discs in the low clutch has a higher co-efficient rating than the friction discs in the other clutches, therefore the discs must not be mixed. The low clutch inner disc can be identified by an "X" stamped on one side of the inner teeth. The low clutch inner disc also has a strip of non soluble yellow paint sprayed on the outer edge of the disc.** Alternate steel and friction discs until the proper amount of discs are installed. First disc next to the piston is steel, last disc installed is friction.

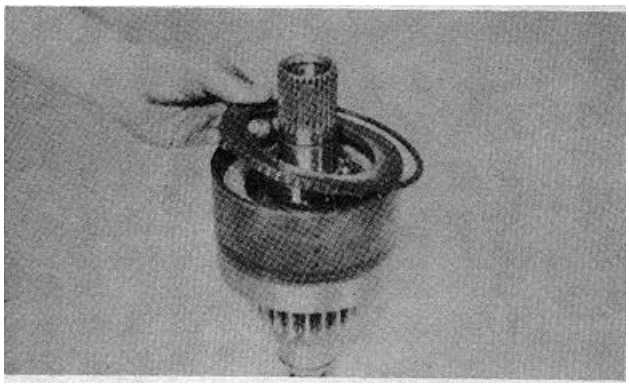


Figure 94
Install end plate and retainer ring.

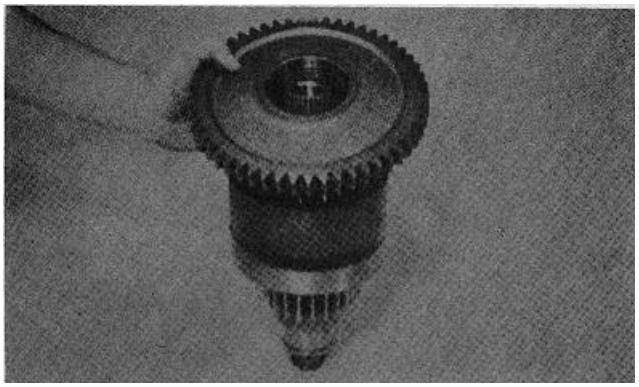


Figure 95

Install low gear Into clutch drum. Align splines on low gear with Internal teeth of friction discs. Tap gear Into position. Do not force this operation, Gear splines must be In full position with Internal teeth of all friction discs.

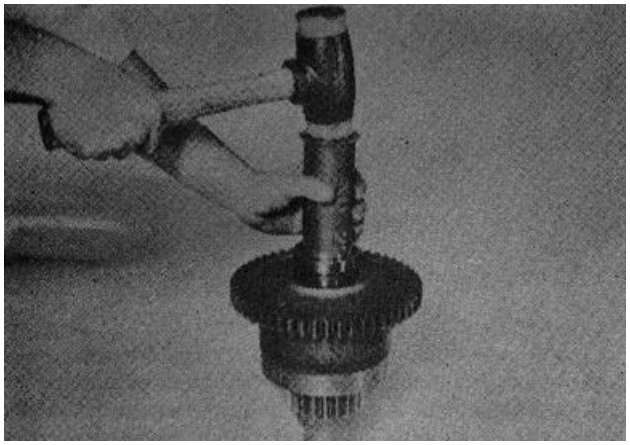


Figure 96

Install low gear outer bearing. **NOTE: When in- stalling the 3rd gear In the 3rd speed clutch a bearing spacer is used between the Inner and outer 3rd gear bearing.**

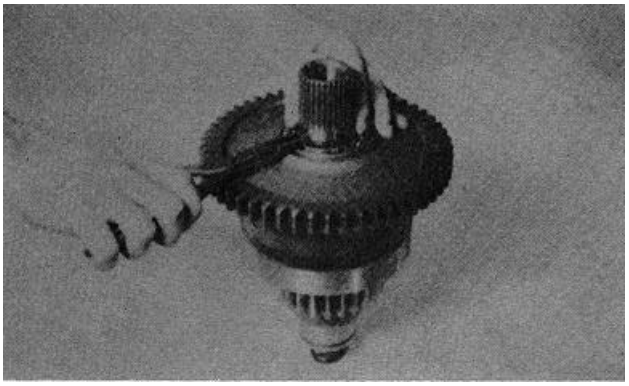


Figure 97

Install low gear retainer ring.

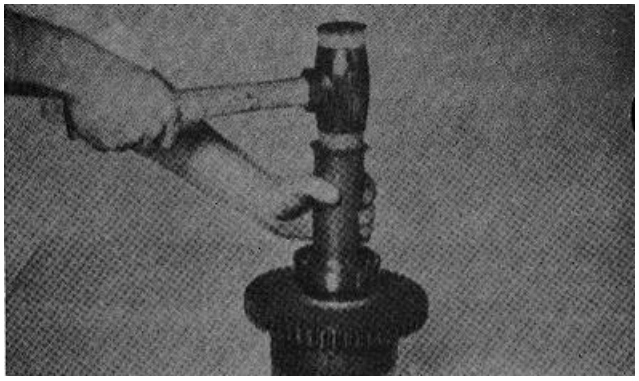


Figure 98

Install low clutch shaft rear bearing.

Reassembly of the Output Shaft

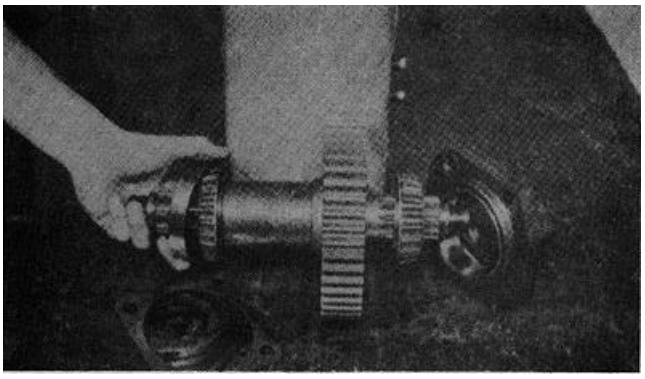


Figure 99

View of output shaft as it would be positioned in transmission cace. Note front cone bearing shouldered on shaft with large diameter of bearing in.

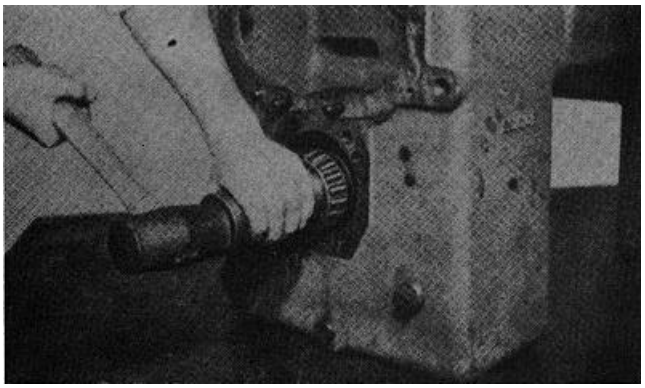


Figure 100

Position output gear in transmission case with protruding hub toward front of case. See Fig. 99. Insert output shaft, gear spacer and taper bearing from front of case and through output gear. Install front taper bearing cup. Block output shaft and install rear taper bearing with large diameter in.

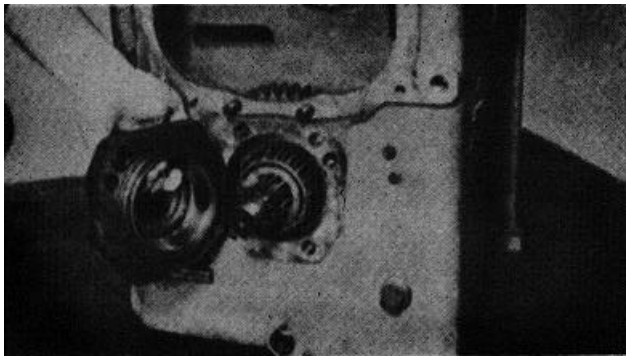


Figure 101

Using new "O" rings install rear output' bearing cap and taper bearing cup on transmission case. Lube opening in bearing cap must be aligned with lube opening in case. Tighten bearing cap bolts to specified torque. (See torque chart).

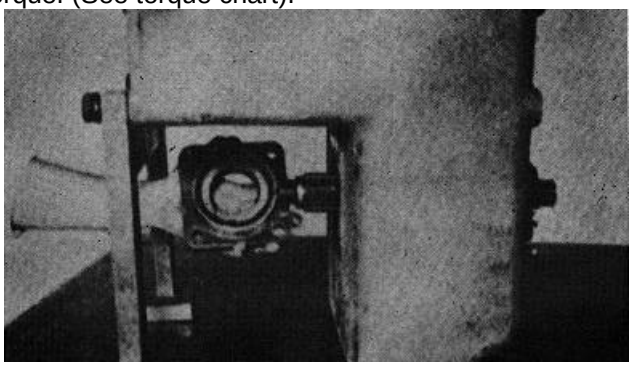


Figure 102

Install front bearing cap and shims. Tighten bolts to specified torque. Tap output shaft front and rear to seat taper bearings. Loosen front bearing cap bolts.

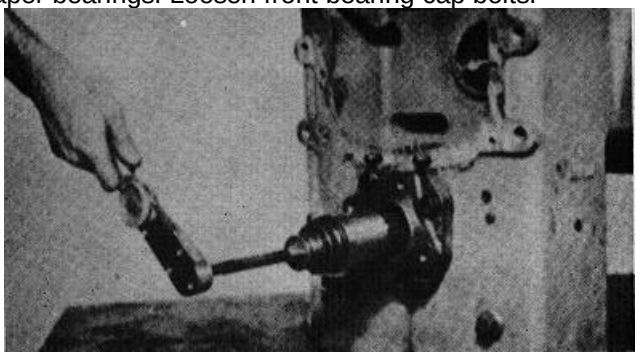


Figure 103

Using an inch lb. torque wrench, determine the rolling torque of the output shaft and record. Tighten front bearing cap bolts to specified torque. Check rolling torque with bolts tight. Torque must be 6 to 8 inch lbs. [0,07-0,09 m.kg] more than when bearing cap bolts were loose. Add or omit shims on the front bearing cap to achieve the proper preload.

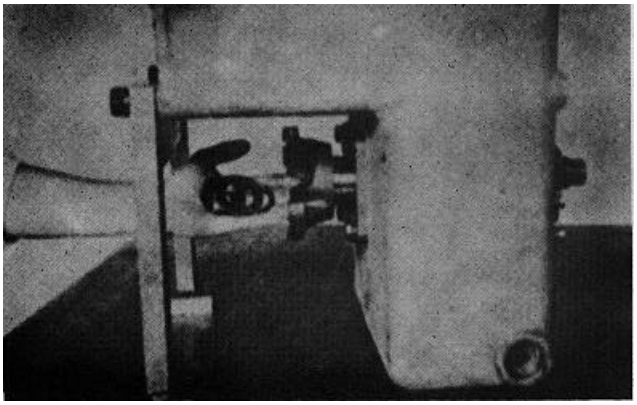


Figure 104

Install output shaft front companion flange, flange "O" ring, washer and flange nut. Block output gear. Tighten nut 200 to 250 ft. lbs. torque [27,7-34,5 m.kg].

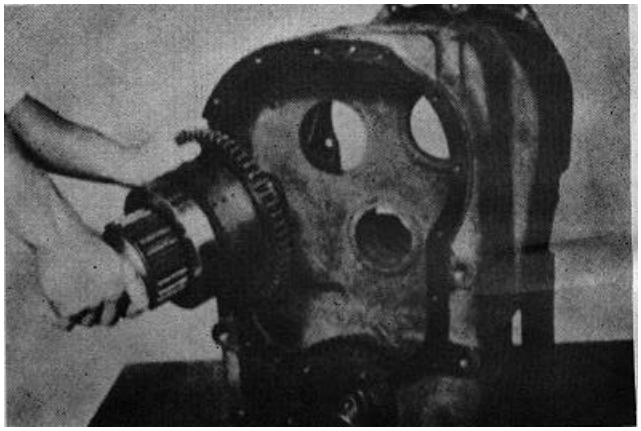


Figure 105

From the rear of the transmission case Install the low clutch assembly.

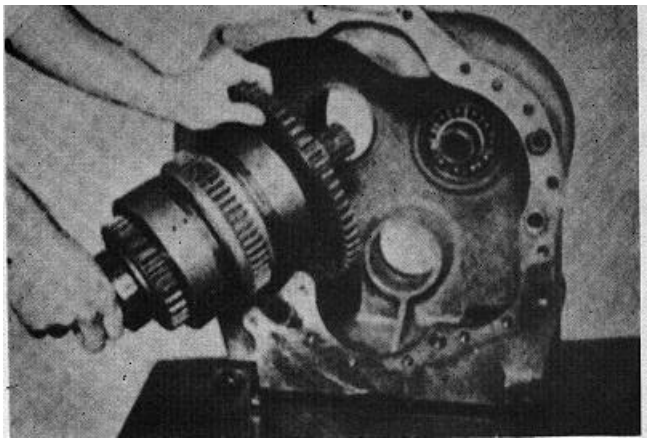


Figure 106

From the front of the transmission case Install the reverse and 3rd clutch assembly.



Figure 107

Install 2nd speed gear on low clutch shaft.

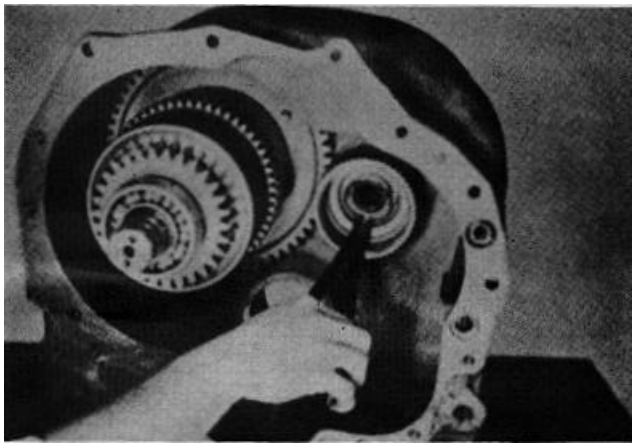


Figure 108

Install 2nd speed gear retainer ring.

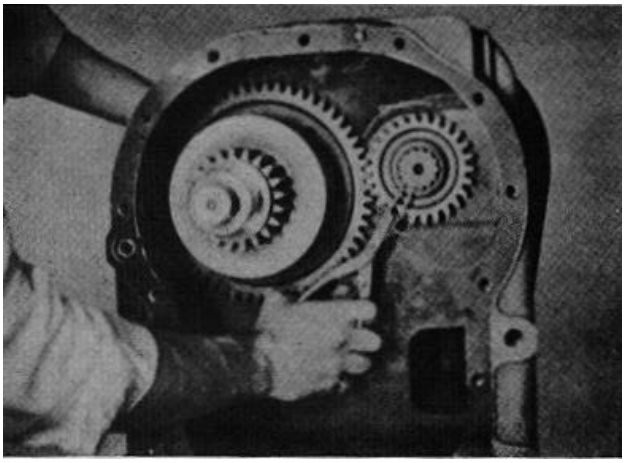


Figure 109

Install low speed drive gear and retainer ring

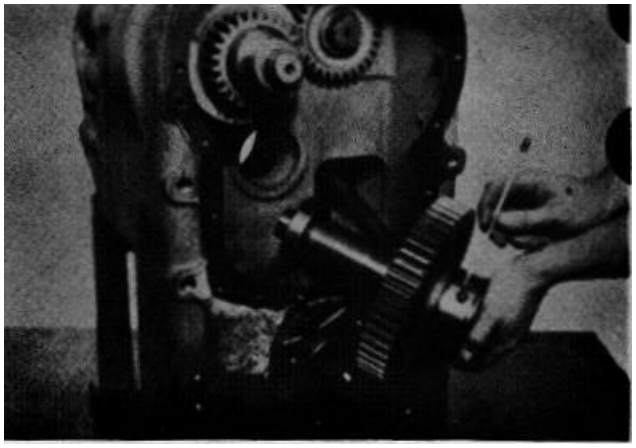


Figure 110

Install idler shaft and bearing assembly.

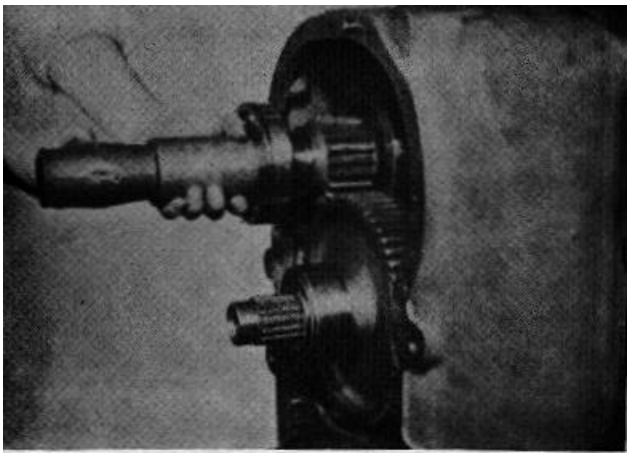


Figure 111

Install low clutch rear bearing with bearing ring groove to the rear.

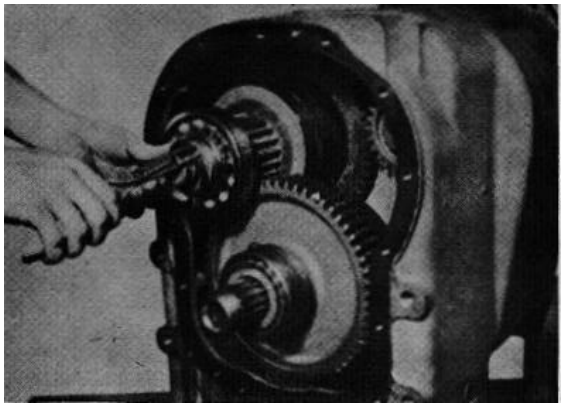


Figure 112

Install low clutch rear bearing retainer ring.

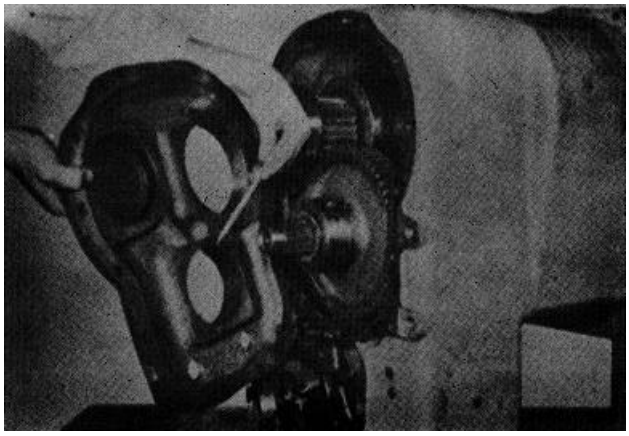


Figure 113

Position a new gasket on rear transmission case. Align lock ball in idler shaft rear bearing with notch in rear transmission cover. Tap cover in place and secure with bolts and lockwashers.

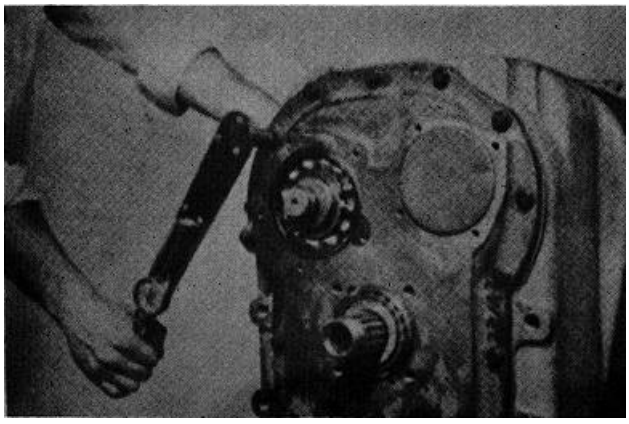


Figure 114

Torque rear cover bolts to specified torque.

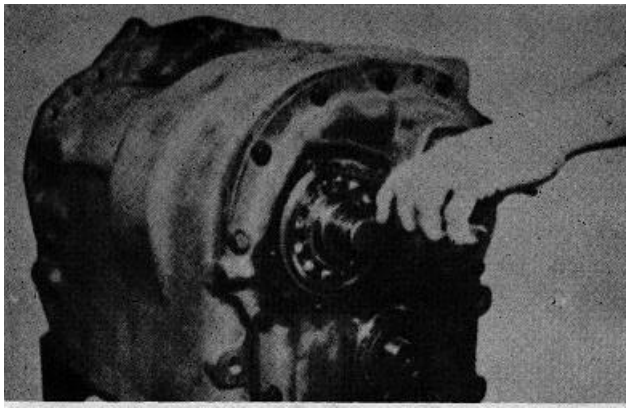


Figure 115

From front of transmission case tap low clutch and idler shaft to rear. This will allow clearance to install rear bearing snap ring.

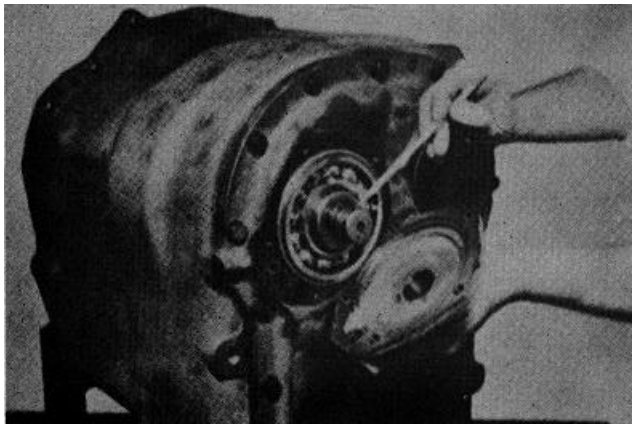


Figure 116

Install low clutch shaft piston rings. Install new gasket and "0" ring on low shaft bearing cap.

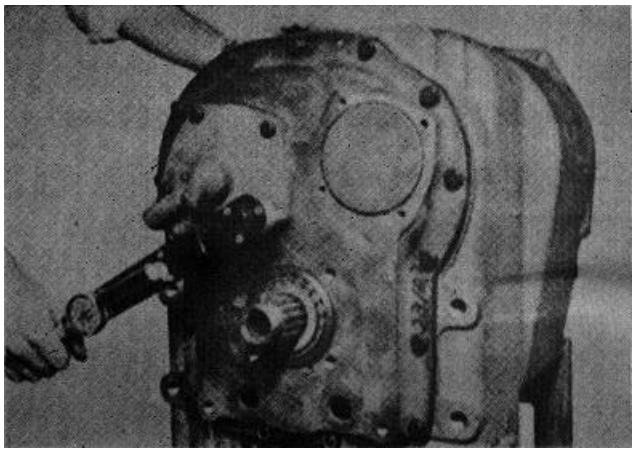


Figure 117

Install bearing cap and secure with lockwashers and bolts. Tighten to specified torque.

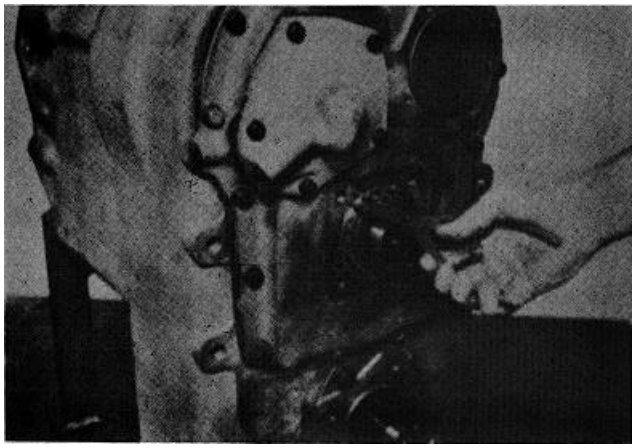


Figure 118

Install idler shaft rear bearing locating ring.

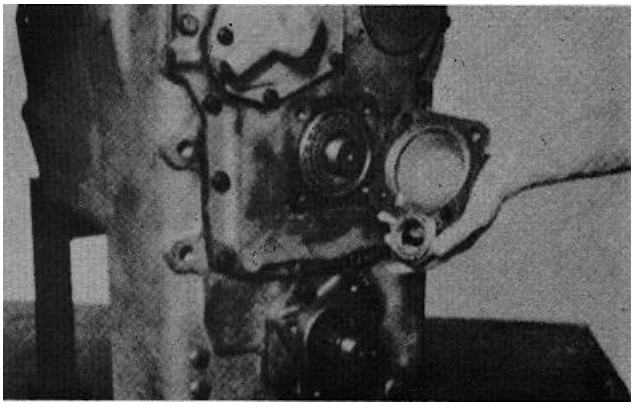


Figure 119

Install idler shaft nut. Block idler gear, tighten nut 250 to 300 ft. lbs. torque [34,6-41,4 m.kg]. With a new gasket in position install idler shaft bearing cap. Tighten bolts to specified torque. If a mechanical parking brake is not used proceed to figure 125.

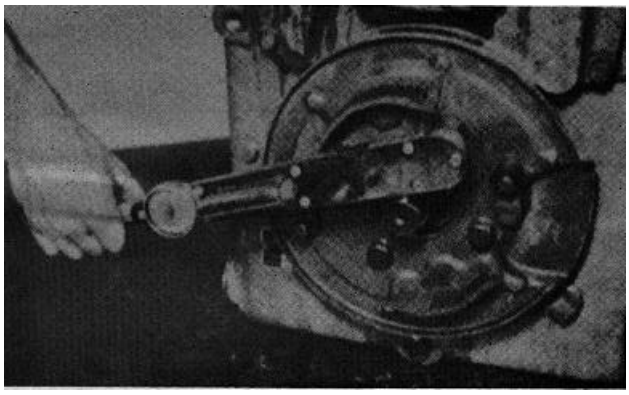


Figure 120

Install brake backing plate assembly. Tighten bolts to specified torque.

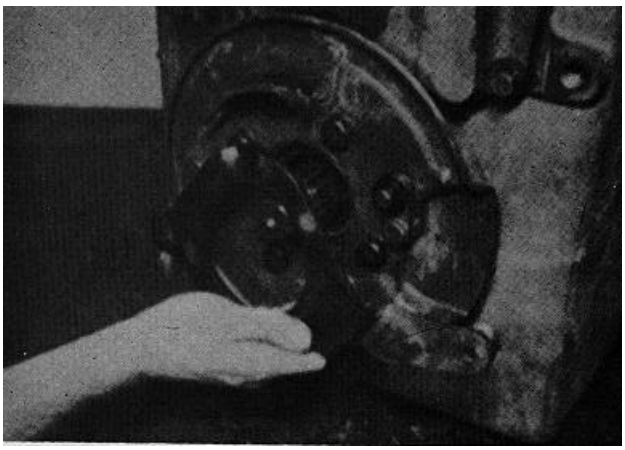


Figure 121

Position brake actuating arm.

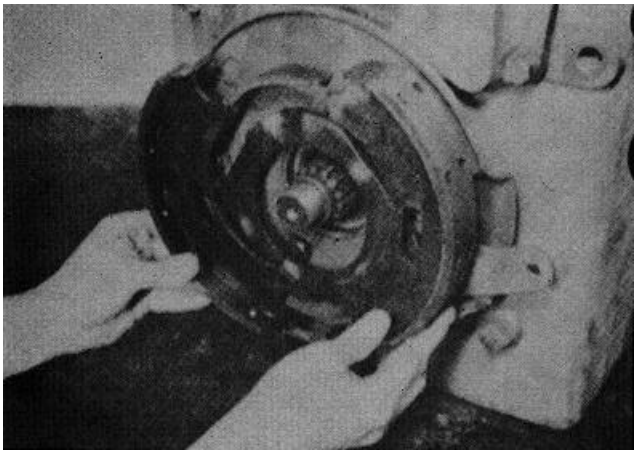


Figure 122

Locate brake shoes.

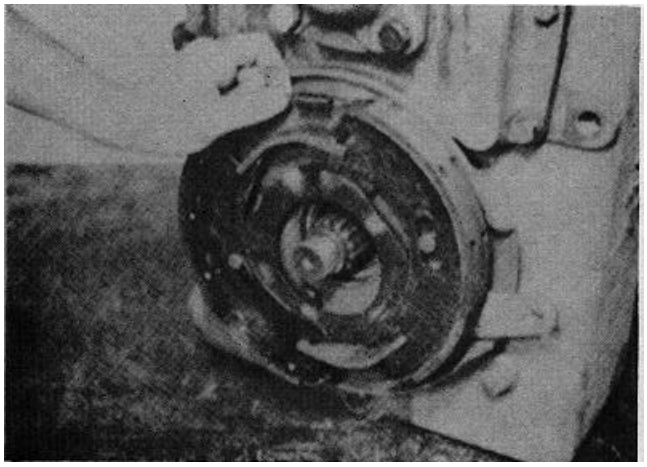


Figure 123

Install upper and lower brake shoe return springs.

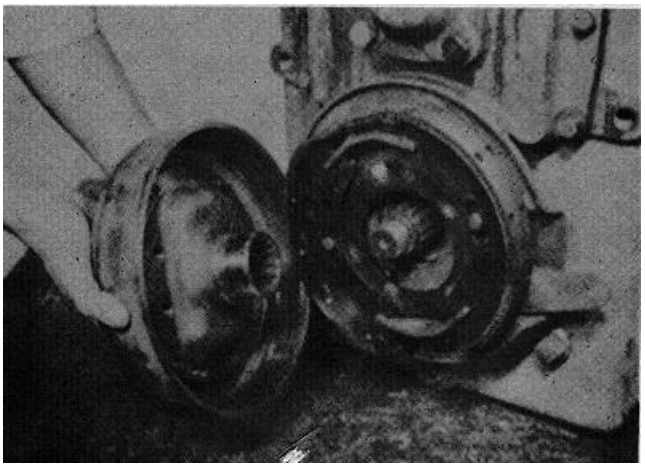


Figure 124

Install brake drum and flange assembly.

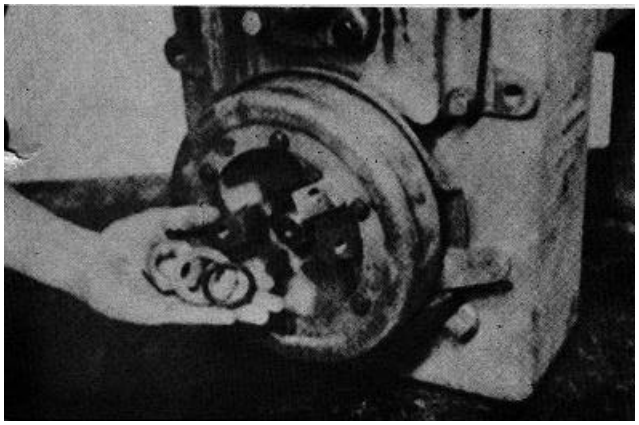


Figure 125

Secure flange with a new "O" ring, washer and flange nut. Block output shaft and tighten nut 200 to 250 ft. lbs. torque [27,7-34,5 m.kg].

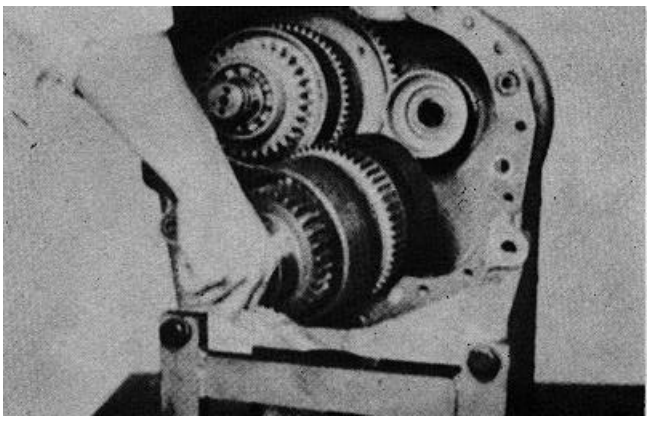


Figure 126

From the front of the transmission case install the forward and 2nd clutch assembly.



Figure 127

Install new "O" ring on impeller hub. Align holes in impeller hub with holes in impeller. Install bolts and tighten to specified torque. Lockwire in pairs to prevent loosening.

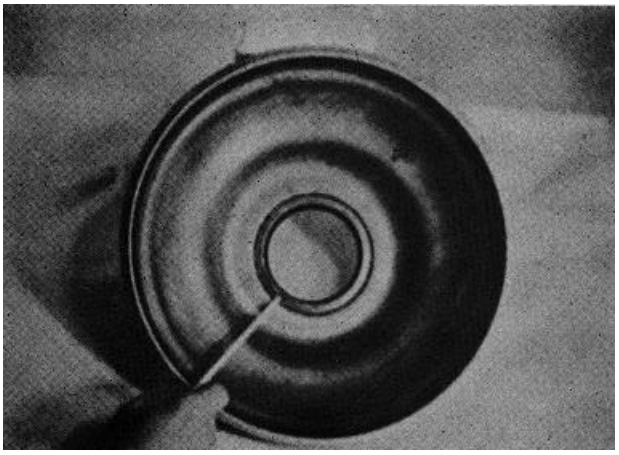


Figure 128

Apply a light coat of Permatex No. 2 on the outer diameter of the oil baffle seal. Press seal in oil baffle with lip of seal down.

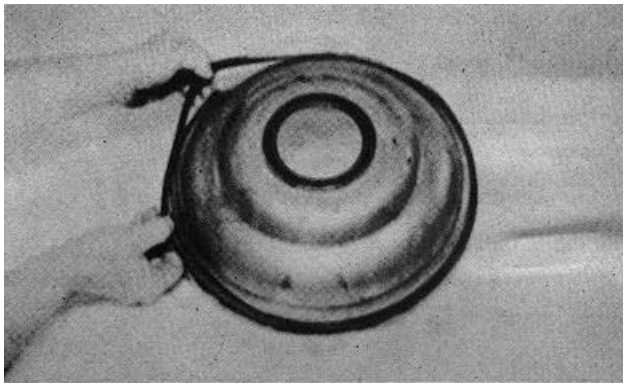


Figure 129

Install a new oil baffle seal ring.

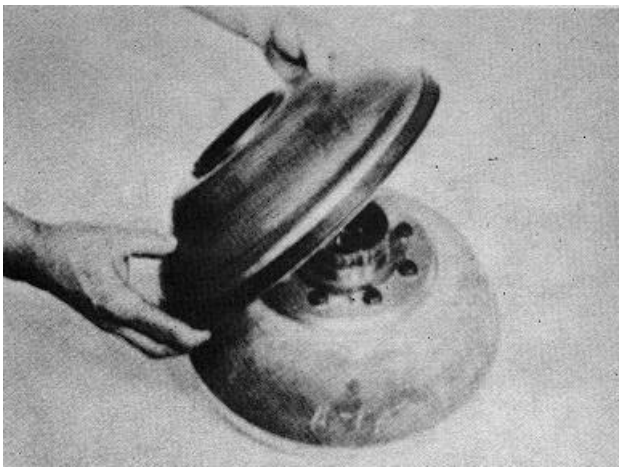


Figure 130

Install oil baffle on impeller assembly.

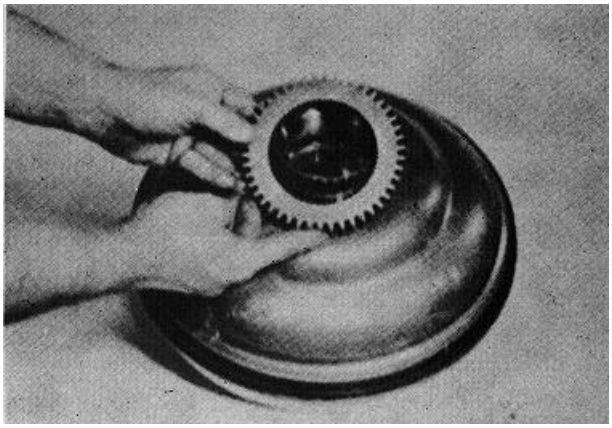


Figure 131

Install impeller hub gear.

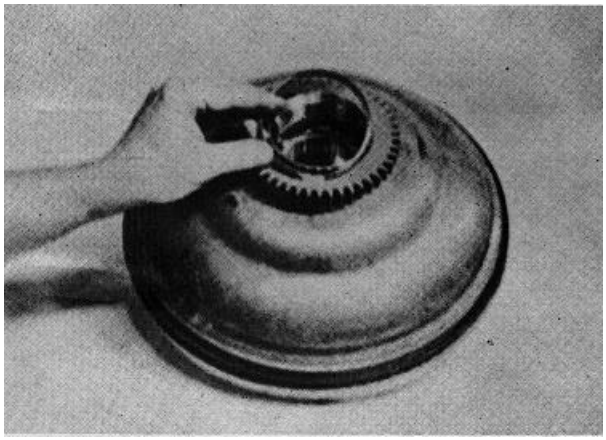


Figure 132

Secure impeller hub gear with retainer ring.

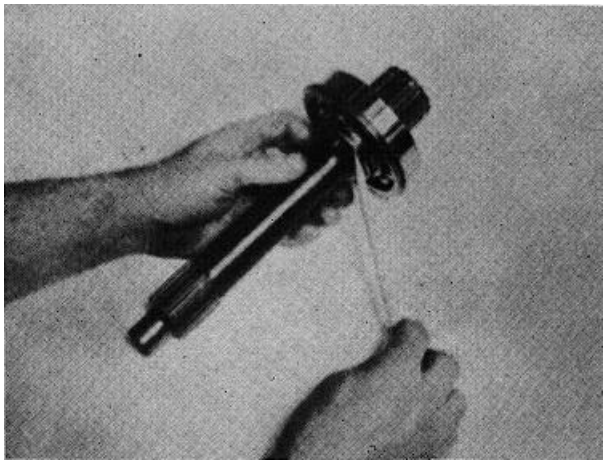


Figure 133

Install new turbine shaft piston ring.

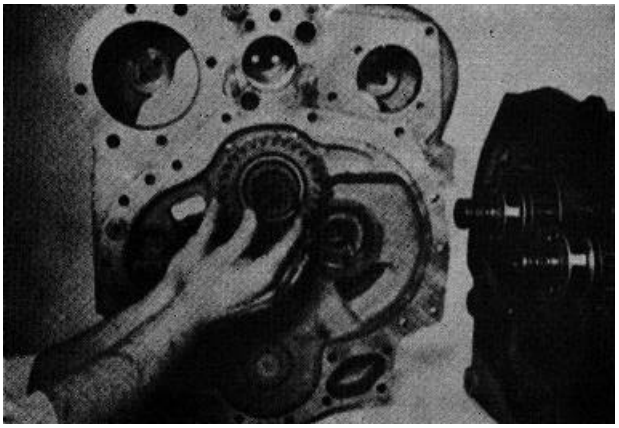


Figure 134

Tap turbine shaft into converter housing from front. At the rear of the converter housing install turbine shaft gear and retainer ring.

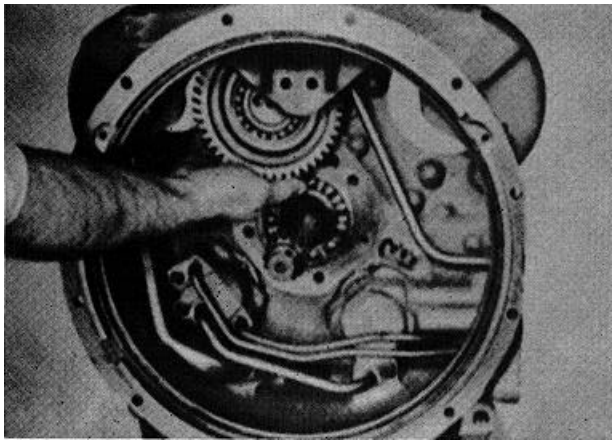


Figure 135

Position center pump drive gear.

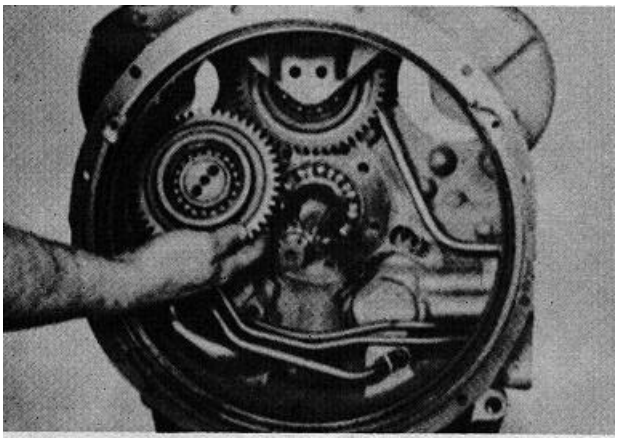


Figure 136

Install left pump drive gear.

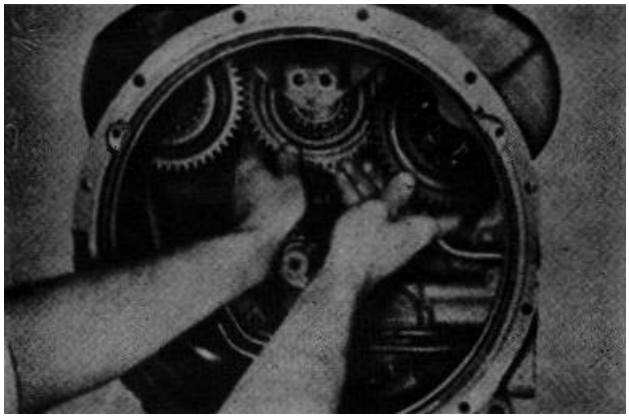


Figure 137

Install right pump drive gear.

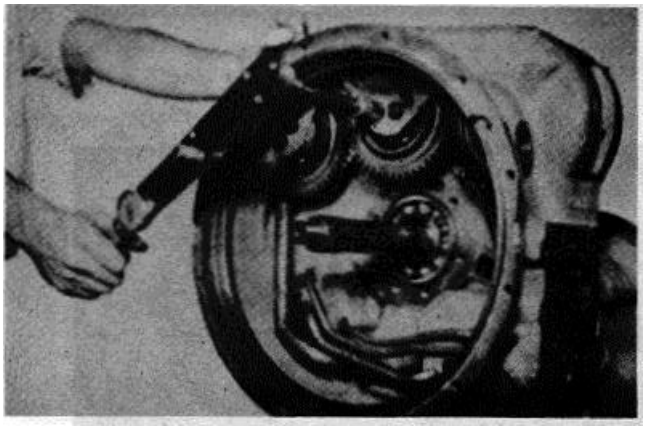


Figure 138

Align holes in pump drive gear bearing supports with holes in converter housing. Install bolts and washers and tighten to specified torque.

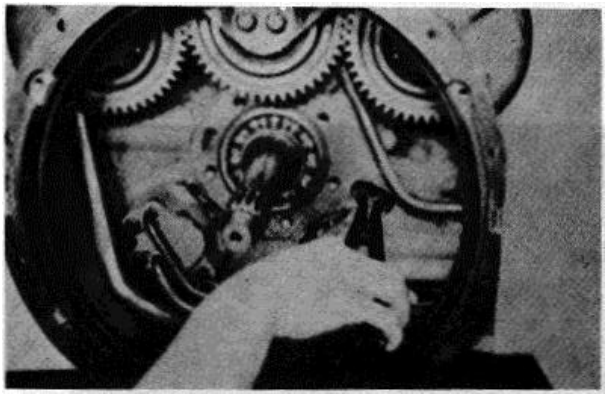


Figure 139

Support converter housing with a chain fall. Spread forward clutch front bearing retainer ring. Position converter housing to transmission case assembly. Tap housing into place using caution as not to damage any of the clutch shaft piston rings.

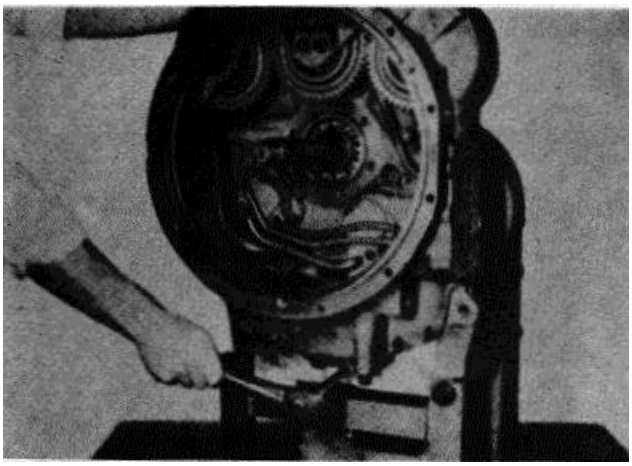


Figure 140

Secure converter housing to transmission case with bolts and washers. Tighten to specified torque.

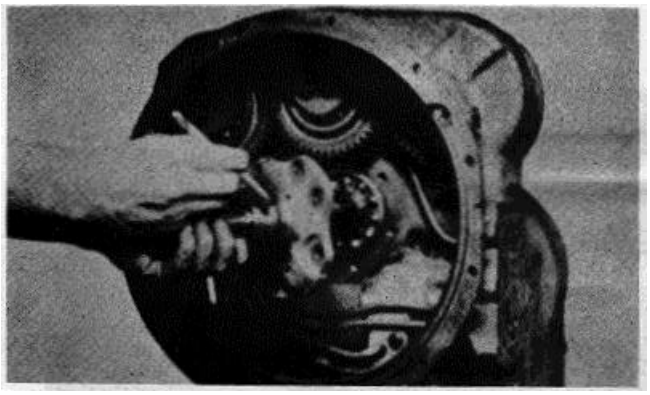


Figure 141

Install new piston ring on stator support. Position support on turbine shaft to clear pump drive gear. Align support holes with converter housing.

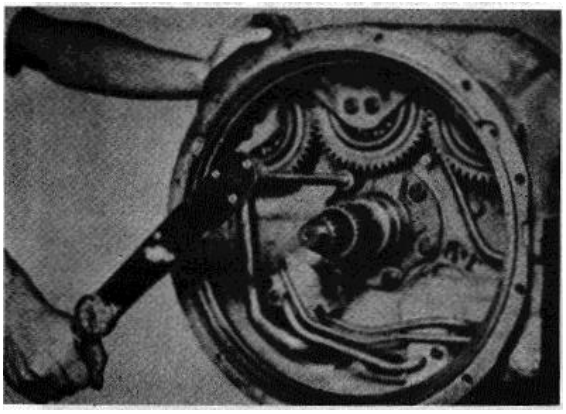


Figure 142

Install stator support bolts and tighten to specified torque.

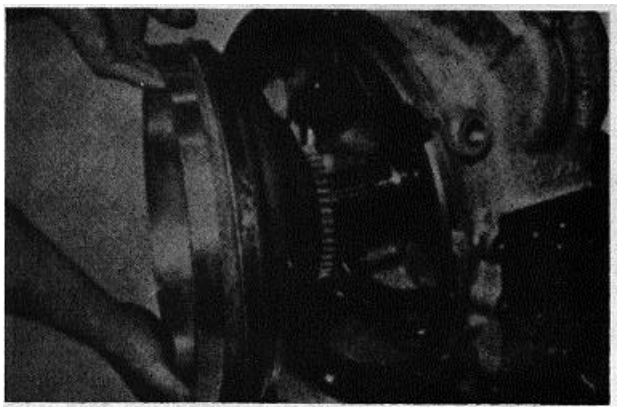


Figure 143

Grease stator support piston ring, oil baffle oil seal and seal ring to facilitate reassembly. Install impeller and oil baffle assembly in converter housing.

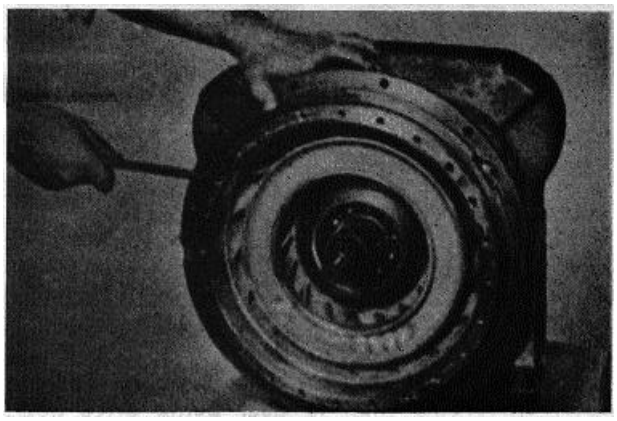


Figure 144

Position oil baffle In housing. Secure with oil baffle retainer ring, being sure ring is In full position In ring groove.

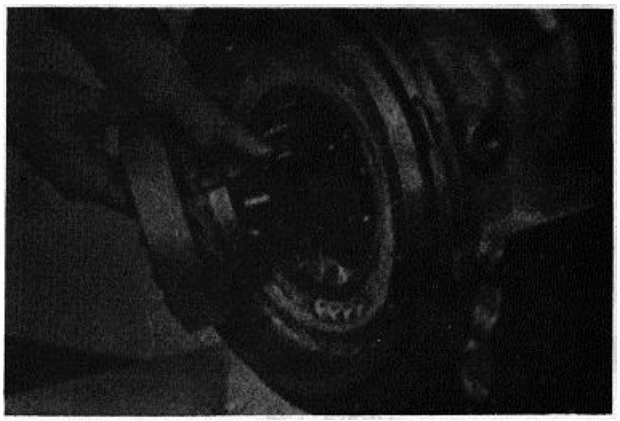


Figure 145

Install reaction member spacer with tang of spacer out. Install reaction member.



Figure 146

Install reaction member retainer ring.



Figure 147

Install turbine locating ring on turbine shaft.

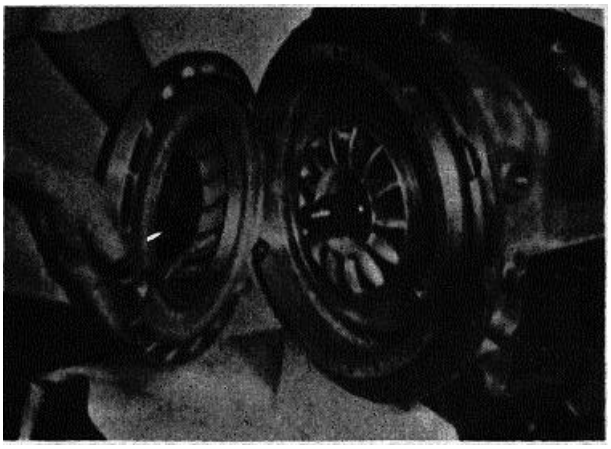


Figure 148

Install turbine.

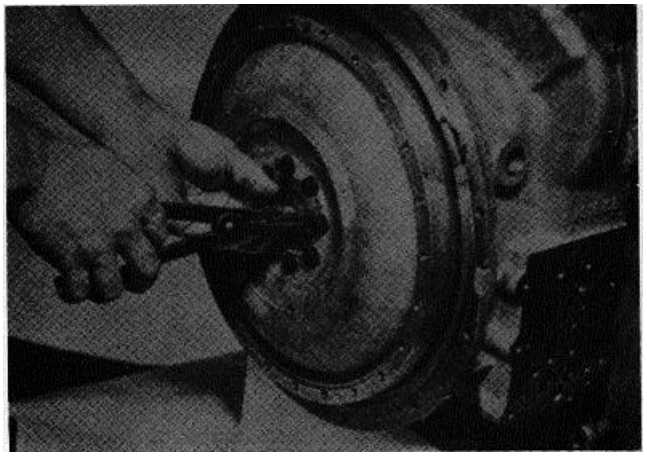


Figure 149

Install turbine to turbine shaft retainer ring.

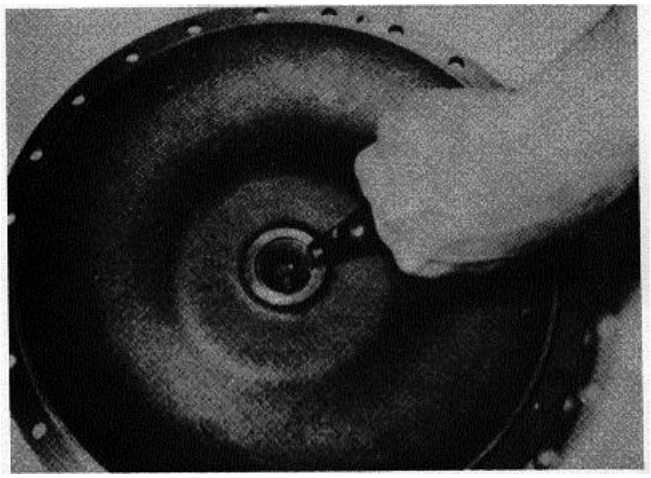


Figure 110

If Impeller cover bearing was removed, press bearing In position and secure with retainer ring.

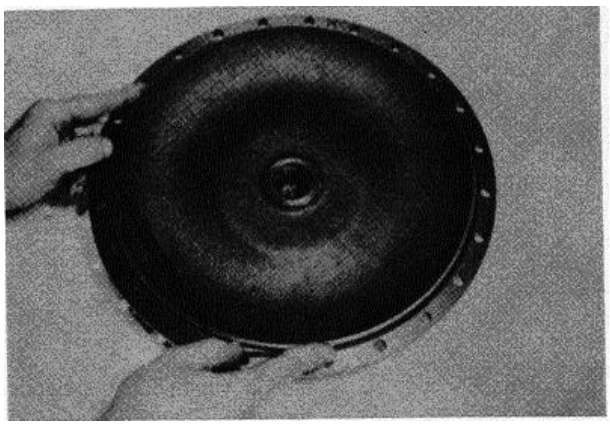


Figure 151

Install a new Impeller cover "0" ring and grease lightly to facilitate reassembly.

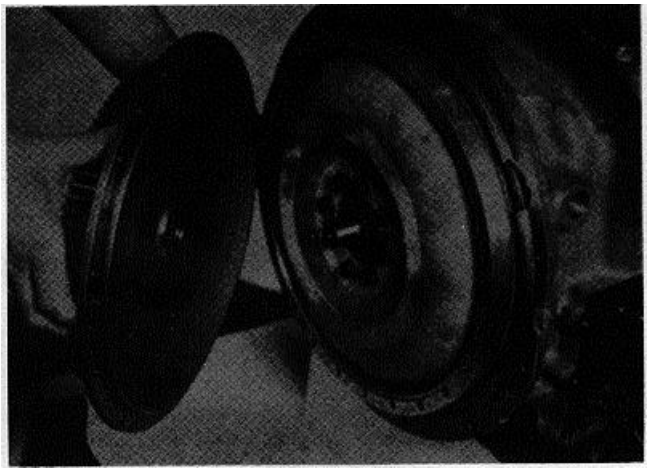


Figure 152

Align holes in impeller cover with holes in impeller. Install bolts and washers and tighten to specified torque.

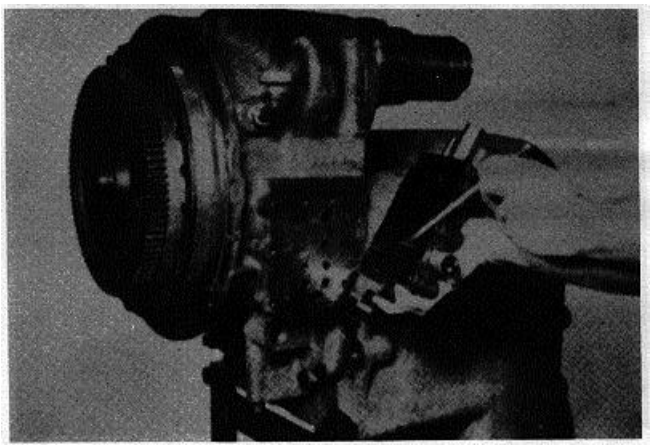


Figure 153

Locate detent balls and springs In control valve. Position new gasket. Secure valve with bolts and washers. Tighten to specified torque.

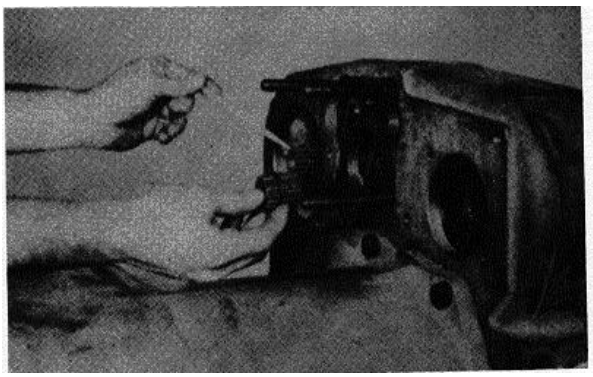


Figure 154

Install pump drive sleeves.

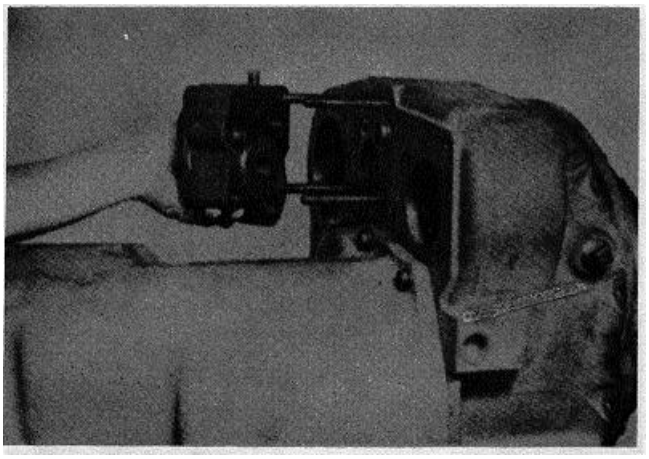


Figure 155

Position new gasket and "O" rings on pressure regulator valve. Install valve on studs.

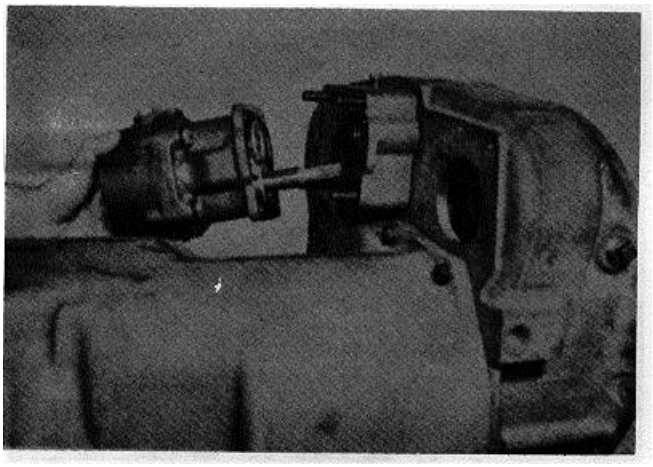


Figure 156

With new valve body to pump gasket in position insert pump drive shaft through valve body. Use caution as not to damage valve body oil seal. It may be necessary to turn impeller one way or the other to align pump shaft with drive sleeves.



Figure 157

Install new "0" ring in filter adopter housing. Install filter element and housing. Tighten filter housing 20 to 25 ft. lbs. torque [2, 8-3, 4 m.kg].

SERVICING MACHINE AFTER TRANSMISSION OVERHAUL

The transmission, torque converter, and its allied hydraulic system are important links in the drive line between the engine and the wheels. The proper operation of either unit depends greatly on the condition and operation of the other; therefore, whenever repair or overhaul of one unit is performed, the balance of the system must be considered before the job can be considered completed.

After the overhauled or repaired transmission has been installed in the machine, the oil cooler, and connecting hydraulic system must be thoroughly cleaned. This can be accomplished in several manners and a degree of judgment must be exercised as to the method employed.

The following are considered the minimum steps to be taken:

1. Drain entire system thoroughly.

2. Disconnect and clean all hydraulic lines. Where feasible, hydraulic lines should be removed from machine for cleaning.

3. Replace oil filter elements, cleaning out filter cases thoroughly.

4. The oil cooler must be thoroughly cleaned. The cooler should be "back flushed" with oil and compressed air until all foreign material has been removed. Flushing in direction of normal oil flow will not adequately clean the cooler. If necessary, cooler assembly should be removed from machine for cleaning, using oil, compressed air and steam cleaner for that purpose. **DO NOT** use flushing compounds for cleaning purposes.

5. On remote mounted torque converters remove drain plug from torque converter and inspect interior of converter housing, gears, etc. If presence of considerable foreign material is noted, it will be necessary that converter be re. moved, disassembled and cleaned thoroughly. It is realized this entails extra labor; however, such labor is a minor cost compared to cost of difficulties which can result from presence of such foreign material in the system.

6. Reassemble all components and use only type oil recommended in lubrication section. Fill transmission through filler opening until fluid comes up to **LOW** mark on transmission dipstick. **NOTE:** If the dipstick is not accessible oil level check plugs are provided.

   Remove **LOWER** check plug, fill until oil runs from **LOWER** oil hole. Replace filler and level plug.

   Run engine two minutes at 500-600 RPM to prime torque converter and hydraulic lines. Recheck level of fluid in transmission with engine running at idle (500-600 RPM).

   Add quantity necessary to bring fluid level to **LOW** mark on dipstick or runs freely from **LOWER** oil level check plug hole. Install oil level plug or dipstick. Recheck with hot oil (180-200° F.) [82, 2-93, 3° C].

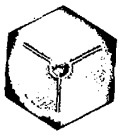
   Bring oil level to **FULL** mark on dipstick or runs freely from **UPPER** oil level plug.

7. Recheck all drain plugs, lines, connections, etc., for leaks and tighten where necessary.

TORQUE IN (LBS.-FT.)
BOLTS, CAPSCREWS, STUDS AND NUTS

Grade 5 Identification, 3 Radial
Dashes 120° Apart on Head of Bolt

Grade 8 Identification, 6 Radial
Dashes 60° Apart on Head of Bolt



LUBRICATED OR PLATED



Nominal Thread Size	Grade 5 FINE THREADS	Grade 5 COARSE THREADS	Grade 8 FINE THREADS	Grade 8 COARSE THREADS
3/8	26-29 [3, 6-4, 0m.kg]	23-25 L3, 2-3, 4m.kgl	37-41 L5, 1-5, 6m.kgi	33-36 [4, 6-4, 9m.kg]
7/16	41-45 [5, 7-6, 2m.kg]	37-41 15, 1-5, 6m.kgl	58-64 18, 0-8, 8m.kgl	52-57 17, 2o7, 8m.kgl
1/2	64-70 [8, 8-9, 6m.kg]	57-63 [7, 9-8, 7m.kg]	90-99 112, 4-13, 6m.kg]	80-88 [11, -12, 1m.kg]
9/16	91-100 [12, 6-13, 8m.kg]	82-90 L11, 3-12, 4m.kg]	128-141 L17, 7-19, 4m.kg]	115-127 [15, 9-17, 5m.kg]

CONVERTER OUT PRESSURE	25 min. - 40 max. psi. [1,7-2,8 kg/cm²] Transmission in neutral. Oil Temperature 180-200° F. [82,2-93,3° C.] Engine at 2000 RPM.
CONTROLS	Forward and Reverse — Manual Speed Selection — Manual
CLUTCH TYPE	Multiple discs, hydraulically actuated, spring released, automatic wear compensation and no adjustment. All clutches oil cooled and lubricated.
CLUTCH INNER DISC	Friction
CLUTCH OUTER DISC	Steel
OIL FILTRATION	Full flow oil filter safety by-pass, also strainer screen in sump at bottom of transmission case.

CLUTCH PRESSURE — 240 - 280 psi [16,9-19,6 kg/cm²] — With parking brake set (see note), oil temperature 180 - 200° F. [82,2-93,3° C], engine at idle (400 to 600 RPM), shift thru direction and speed clutches. **All clutch pressure must be equal within 5 psi. [0,4 kg/cm²]. If clutch pressure varies in any one clutch more than 5 psi. [0,4 kg/cm²] repair clutch.**

NOTE: Never use service brakes while making clutch pressure checks. Units having brake actuated declutching in forward and/or reverse will not give a true reading.

ALWAYS USE PARKING BRAKE WHEN MAKING CLUTCH PRESSURE CHECKS.

LUBRICATION

TYPE OF OIL	See Lube Chart.
CAPACITY	Consult Operator's Manual on applicable machine model for system capacity. Torque Converter, Transmission and allied hydraulic system must be considered as a whole to determine capacity.
CHECK PERIOD	Check oil level DAILY with engine running at 500-600 RPM and oil at 180 to 200° F. [82,2, - 93, 3° C]. Maintain oil level to FULL mark.
DRAIN PERIOD	Every 250 hours, change oil filter element. Every 500 hours, drain and refill system as follows: Drain with oil at 150 to 200° F. [65, 6 - 93, 3° C].

(a) Drain transmission and remove sump screen. Clean screen thoroughly and replace, using new gaskets.

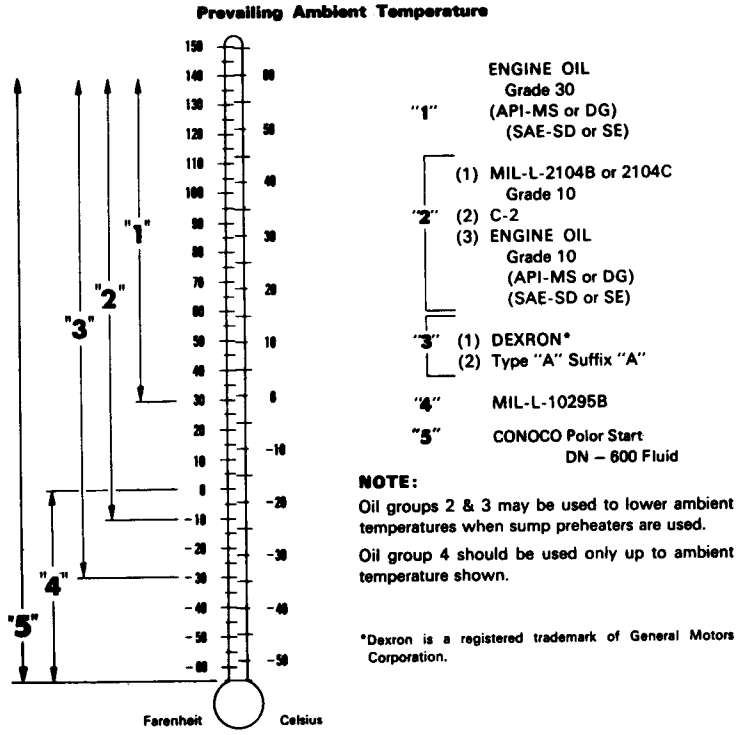
(b) Drain oil filters, remove and discard filter elements. Clean filter shells and install new elements.

(c) Refill transmission to LOW mark.

(d) Run engine at 500-600 RPM to prime converter and lines.

(e) Recheck level with engine running at 500-600 RPM and add oil to bring level to LOW mark.. When oil temperature is hot (180-200°F.) [82, 2-93, 3°C] make final oil level check. **BRING OIL LEVEL TO FULL MARK.**

RECOMMENDED LUBRICANTS FOR CLARK POWER SHIFTED TRANSMISSION AND TORQUE CONVERTERS



"1" ENGINE OIL Grade 30 (API-MS or DG) (SAE-SD or SE)

"2" (1) MIL-L-2104B or 2104C Grade 10
(2) C-2
(3) ENGINE OIL Grade 10 (API-MS or DG) (SAE-SD or SE)

"3" (1) DEXRON*
(2) Type "A" Suffix "A"

"4" MIL-L-10295B

"5" CONOCO Polor Start DN — 600 Fluid

NOTE:

Oil groups 2 & 3 may be used to lower ambient temperatures when sump preheaters are used.

Oil group 4 should be used only up to ambient temperature shown.

*Dexron is a registered trademark of General Motors Corporation.

TROUBLE SHOOTING GUIDE
For The
R and HR Model, 28000 Transmission

The following data is presented as an aid to locating the source of difficulty in a malfunctioning unit. It is necessary to consider the torque converter charging pump, transmission, oil cooler, and connecting lines as a complete system when running down the source of trouble since the proper operation of any unit there in depends greatly on the condition and operations of the others. By studying the principles of operation together with data in this section, it may be possible to correct any malfunction which may occur in the system.

TROUBLE SHOOTING PROCEDURE BASICALLY CONSISTS OF TWO CLASSIFICATIONS: MECHANICAL AND HYDRAULIC .

MECHANICAL CHECKS

Prior to checking any part of the system from a hydraulic standpoint, the following mechanical checks should be made:

1. A check should be made to be sure all control lever linkage is properly connected and adjusted at all connecting points.

2. Check shift levers and rods for binding or restrictions in travel that would prevent full engagement. Shift levers by hand at control valve, if full engagement cannot be obtained, difficulty may be in control cover and valve assembly.

HYDRAULIC CHECKS

Before checking on the torque converter, transmission, and allied hydraulic system for pressures and rate of oil flow, it is essential that the following preliminary checks be made.

1. Check oil level in transmission. This should be done with oil temperatures of 180 to 200° F. [82, 2-93, 3° C]. **DO NOT ATTEMPT THESE CHECKS WITH COLD OIL.** To bring the oil temperature to this specification it is necessary to either work the machine or "stall" out the converter. Where the former means is impractical, the latter means should be employed as follows:

Engage shift levers in forward and high speed and apply brakes. Accelerate engine half to three-quarter throttle.

Hold stall until desired converter outlet temperature is reached. **CAUTION: FULL THROTTLE STALL SPEEDS FOR AN EXCESSIVE LENGTH OF TIME WILL OVERHEAT THE CONVERTER**.

LOW CLUTCH PRESSURE

Cause	Remedy
1. Low oil level.	1. Fill to proper level.
2. Clutch pressure regulating valve spool stuck open.	2. Clean valve spool and housing.
3. Faulty charging pump.	3. Replace pump.
4. Broken or worn clutch shaft or piston sealing rings.	4. Replace sealing rings.
5. Clutch piston bleed valve stuck open.	5. Clean bleed valves thoroughly.

LOW CONVERTER CHARGING PUMP OUTPUT

1. Low oil level.	1. Fill to proper level.
2. Suction screen plugged.	2. Clean suction screen.
3. Air leaks at pump intake hose and connections or collapsed hose. (R-28000 only)	3. Tighten all connections or replace hose if necessary.
4. Defective oil pump.	4. Replace pump.

OVERHEATING

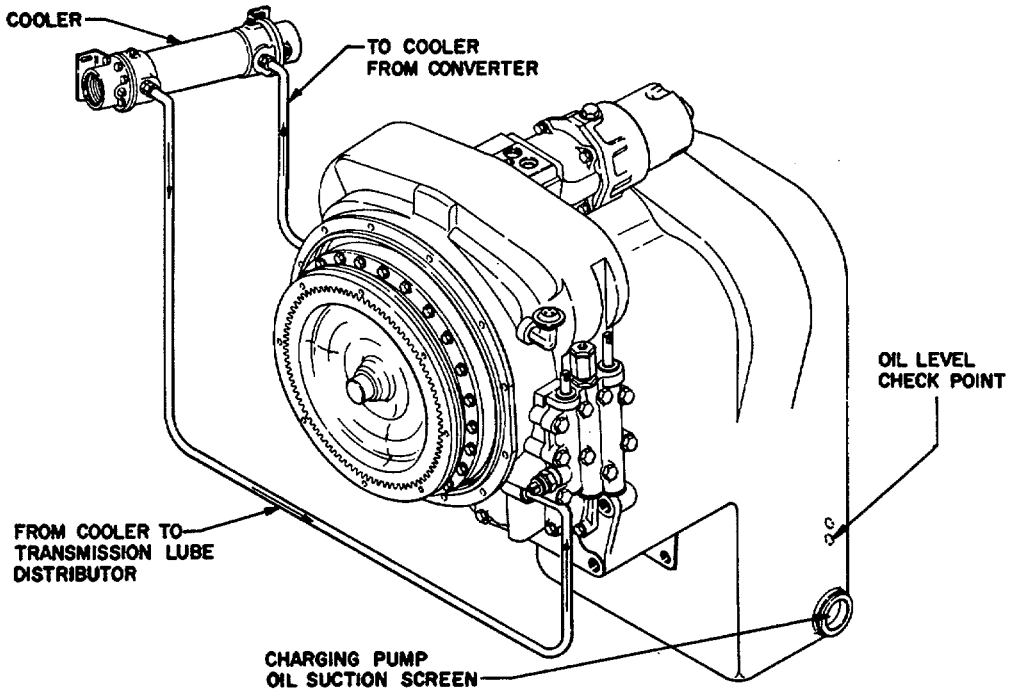
1. Worn oil sealing rings.	1. Remove, disassemble, and -rebuild converter assembly.
2. Worn oil pump.	2. Replace.
3. Low oil level.	3. Fill to proper level.
4. Pump suction line taking air. (R-28000 only)	4. Check oil line connections and tighten securely.

NOISY CONVERTER

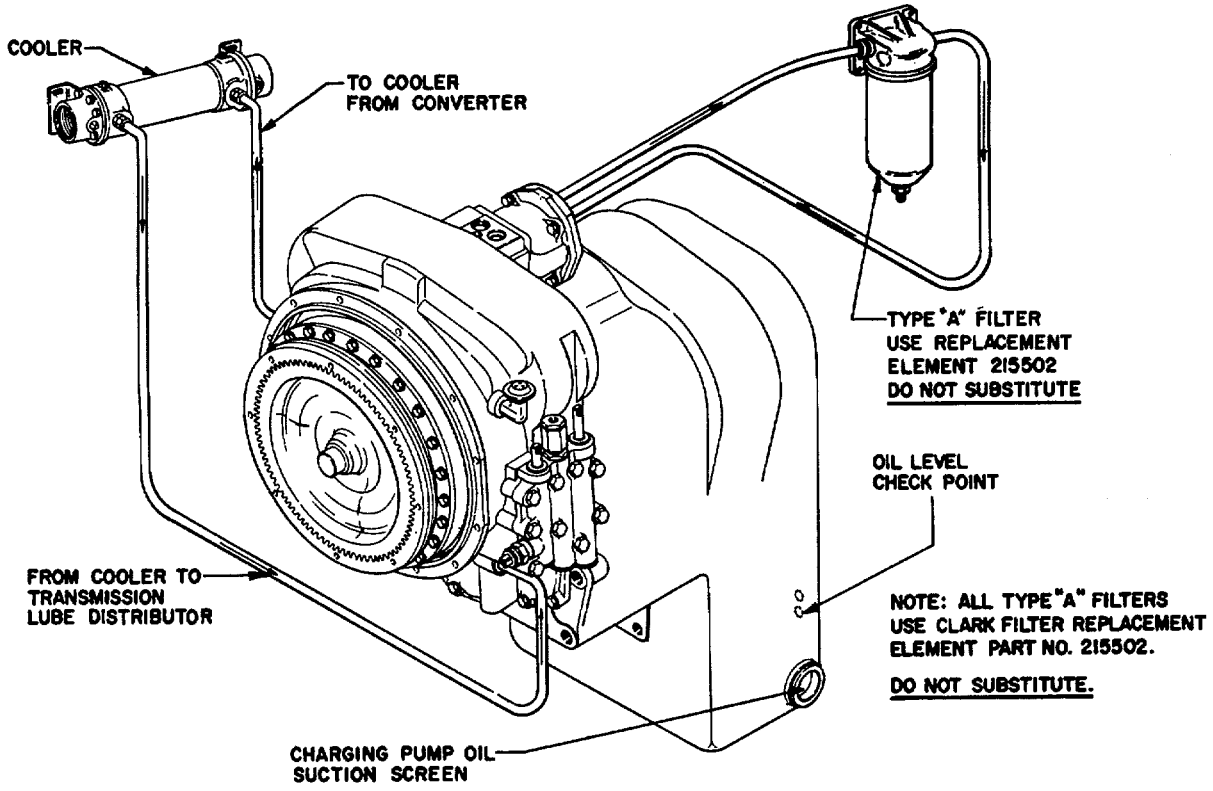
1. Worn coupling gears.	1. Replace.
2. Worn oil pump.	2. Replace.
3. Worn or damaged bearings.	3. A complete disassembly will be necessary to determine what bearing is faulty.

LACK OF POWER

1. Low engine RPM at converter stall.	1. Tune engine check governor.
2. See "Overheating" and make same checks.	2. Make corrections as explained in "Over-Heating."

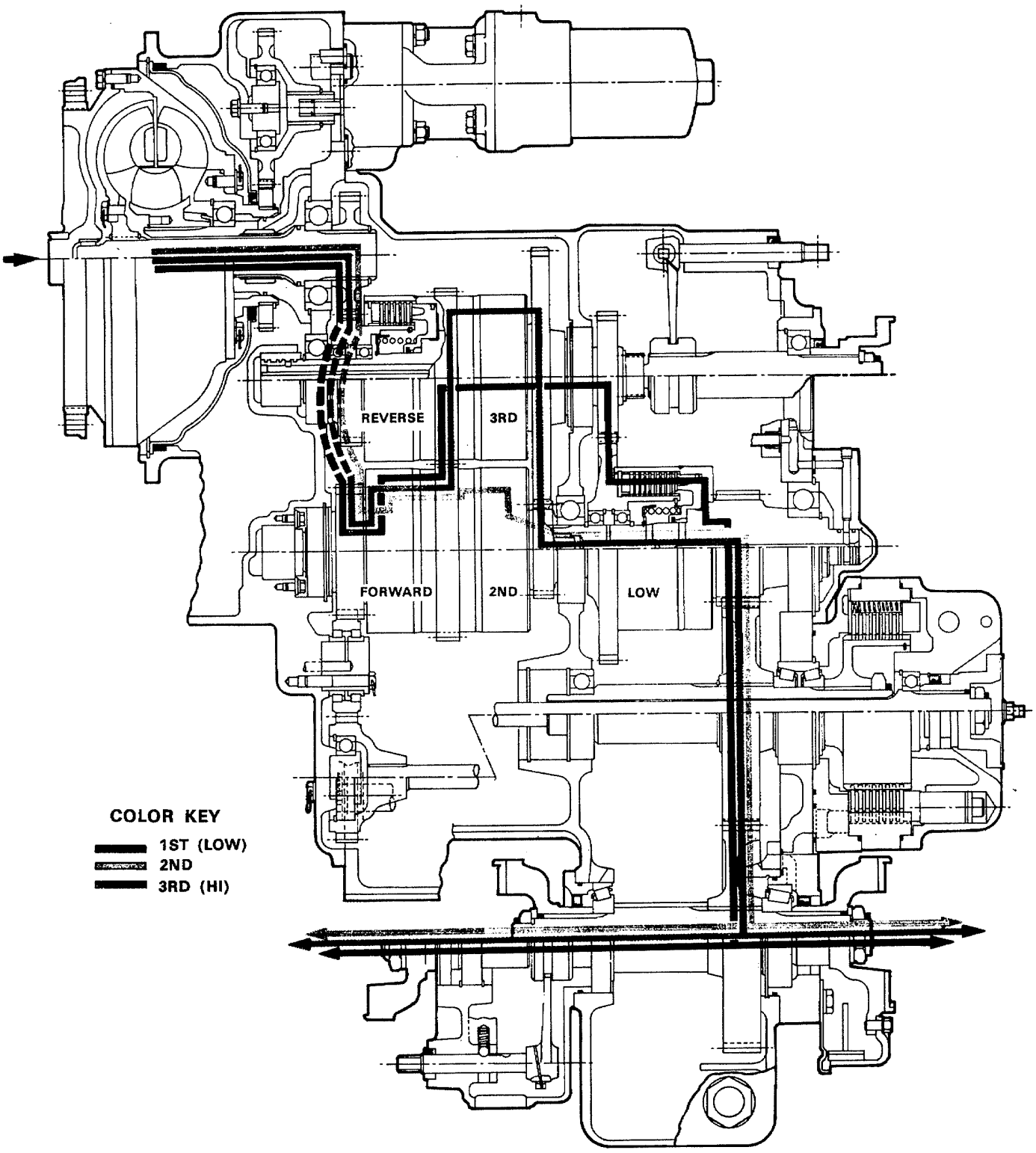


28000 SERIES PLUMBING DIAGRAM



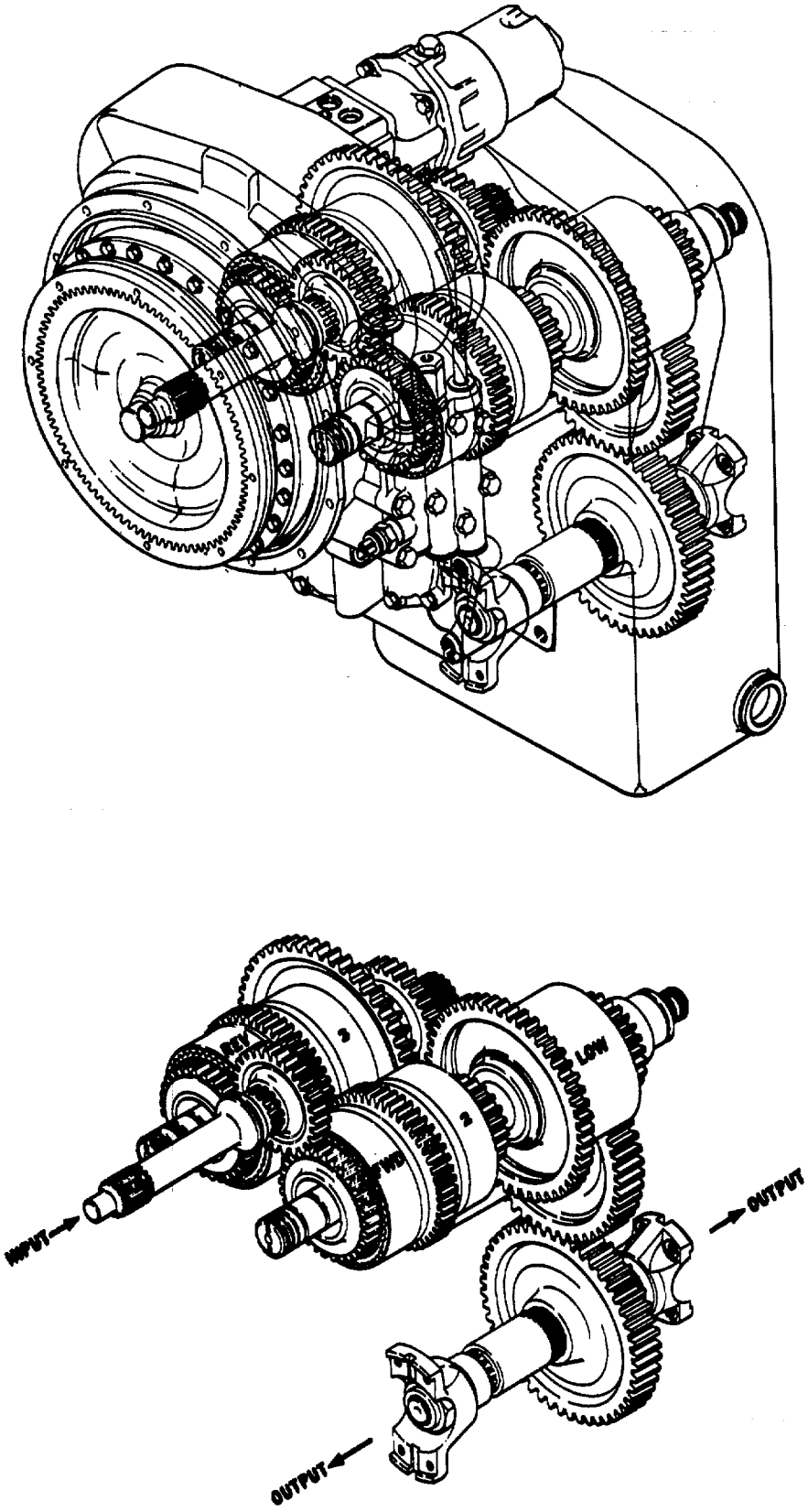
28000 SERIES PLUMBING DIAGRAM (WITH REMOTE FILTER)

FIG. J



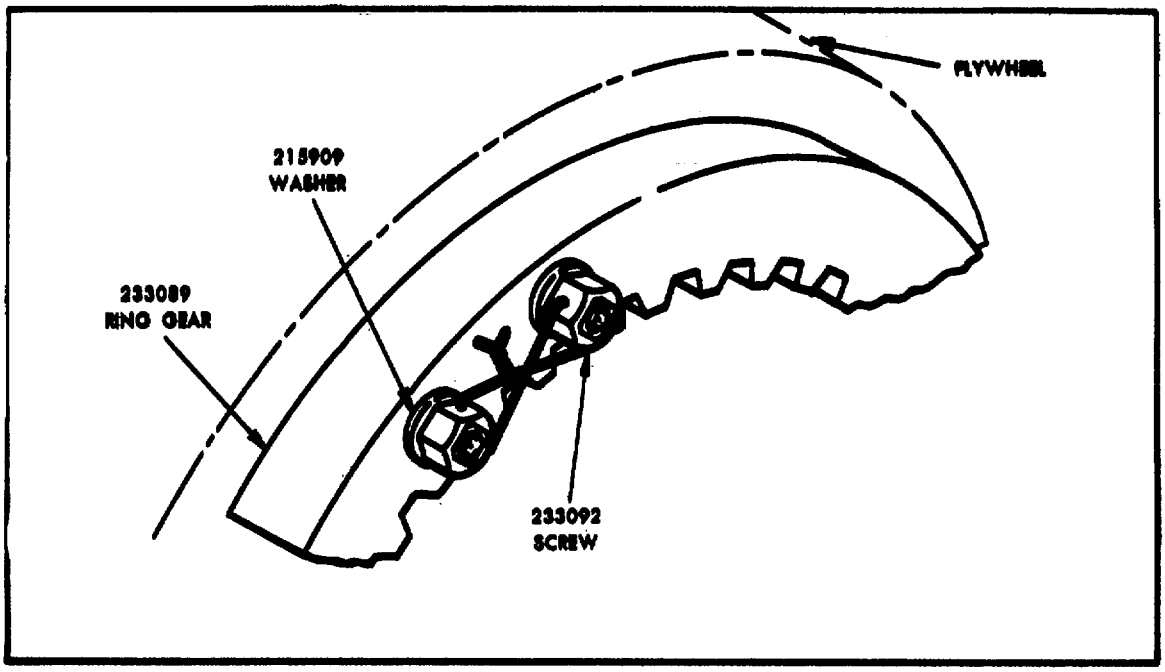
3 SPEED TRANSMISSION

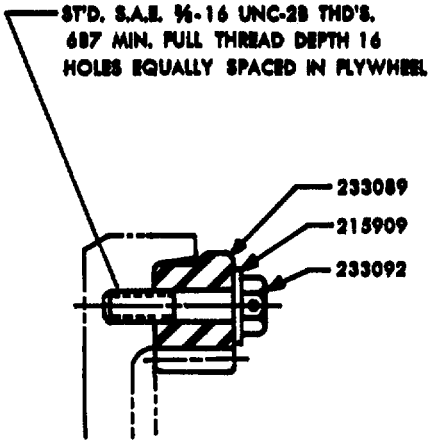
FIG. K



28000 SERIES-SPEED CLUTCH & GEAR ARRANGEMENT

FIG. L





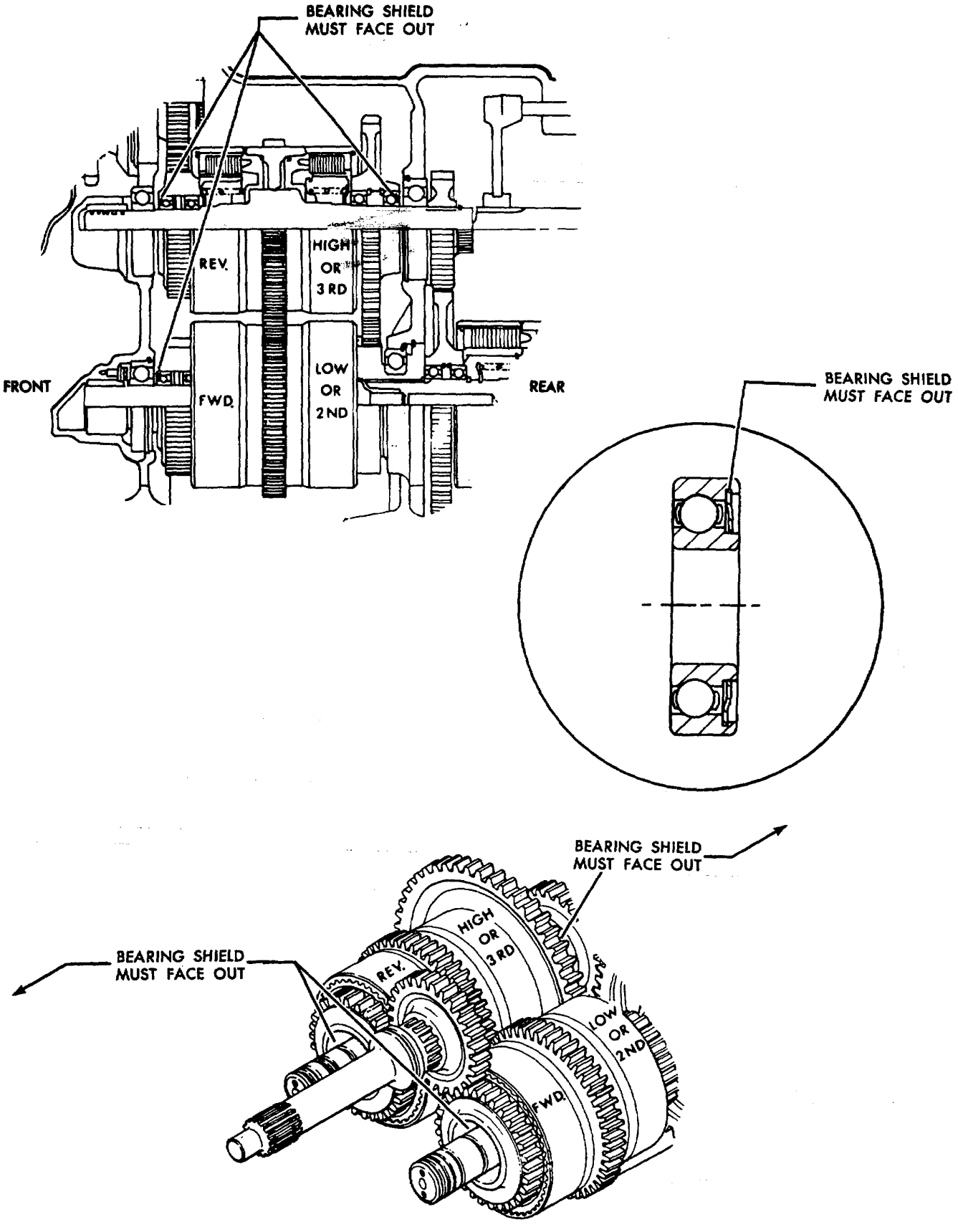
16 HOLE RING GEAR INSTALLATION AND ASSEMBLY PRODUCTION

1. REMOVE ALL BURRS FROM FLYWHEEL MOUNTING FACE AND PILOT BORE, CLEAN WITH SOLVENT. THE ENGINE FLYWHEEL AND HOUSING MUST CONFORM TO STANDARD S.A.E. No. 3 (S.A.E. J927) TOLERANCE SPECIFICATIONS FOR PILOT BORES, ECCENTRICITIES, AND MOUNTING FACE DEVIATIONS.

2. INSTALL RING GEAR No. 233089 AS SHOWN.

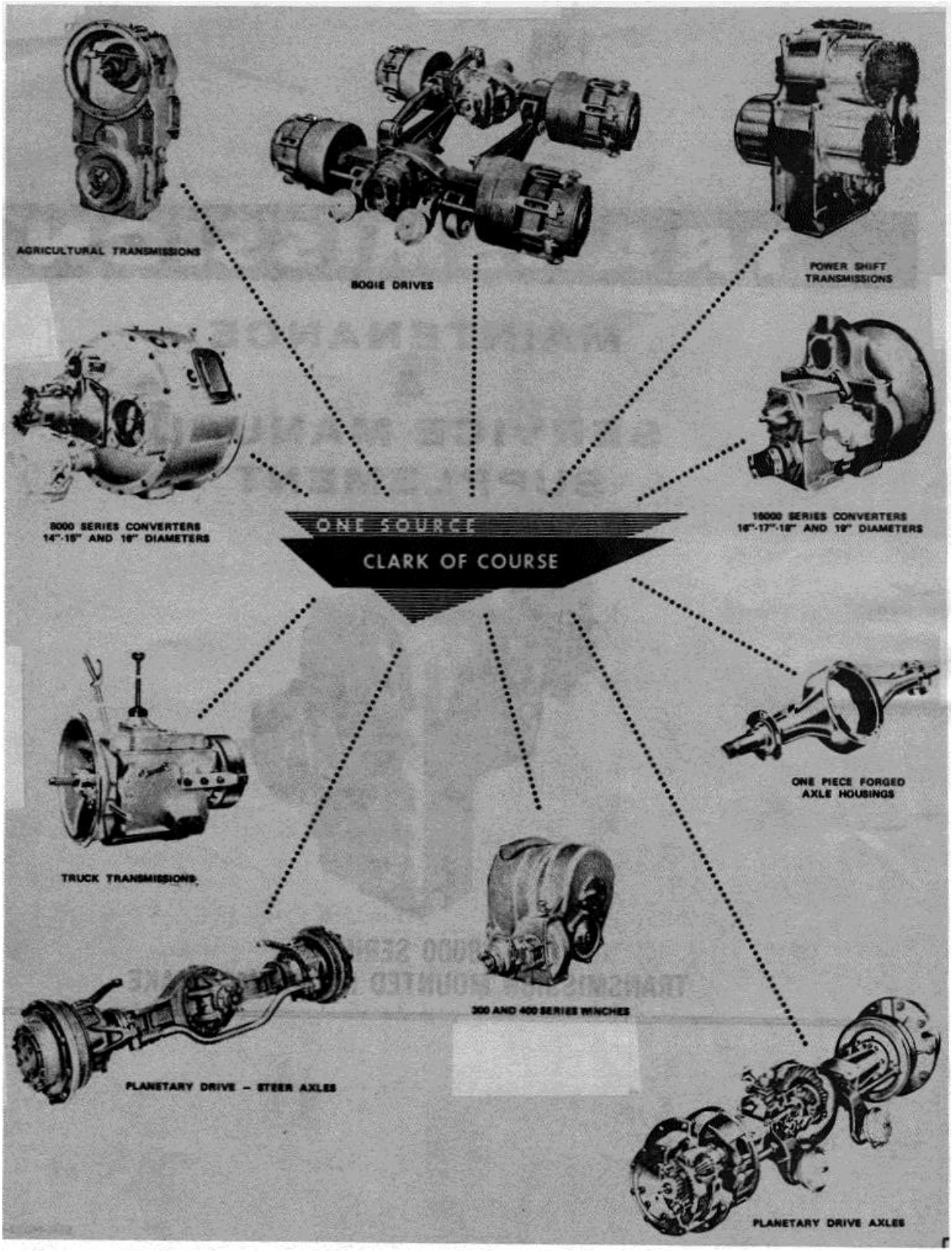
3. INSTALL SPECIAL WASHERS No. 215909 AND SPECIAL SCREWS No. 233092. TIGHTEN SCREWS TO 30 TO 33 LBS. FT. TORQUE. LOCK WIRE IN PLACE AS SHOWN.

FIG. M



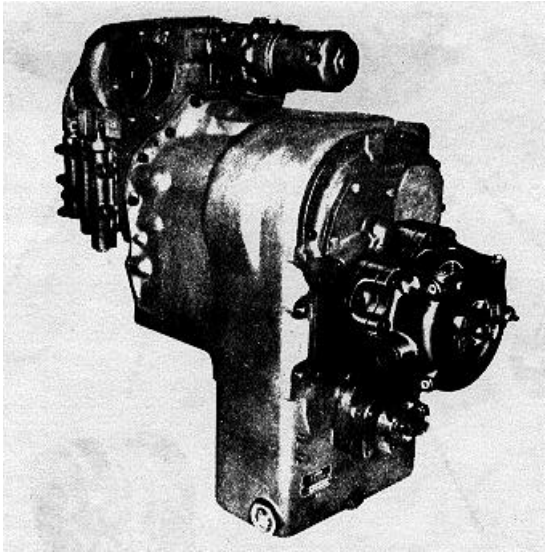
SHIELDED BEARING INSTALLATION

FIG. N


AGRICULTURAL TRANSMISSIONS
BOGIE DRIVES
POWER SHIFT TRANSMISSIONS
8000 SERIES CONVERTERS 14"-15" AND 16" DIAMETERS
ONE SOURCE
CLARK OF COURSE
18000 SERIES CONVERTERS 16"-17"-18" AND 19" DIAMETERS
TRUCK TRANSMISSIONS
ONE PIECE FORGED AXLE HOUSINGS
300 AND 400 SERIES WINCHES
PLANETARY DRIVE – STEER AXLES
PLANETARY DRIVE AXLES

TRANSMISSION

MAINTENANCE
&
SERVICE MANUAL
SUPPLEMENT

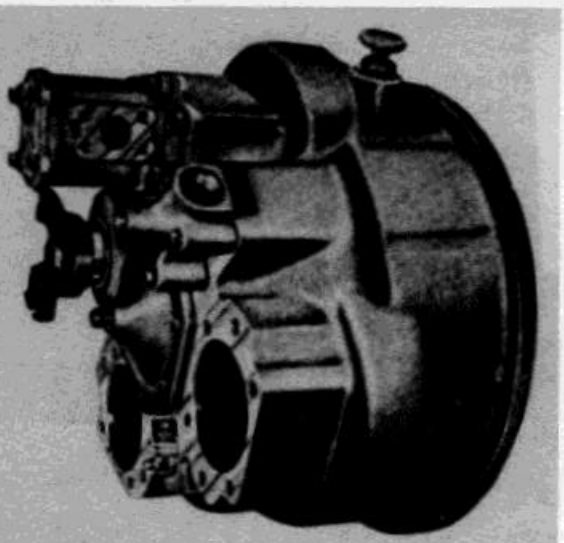


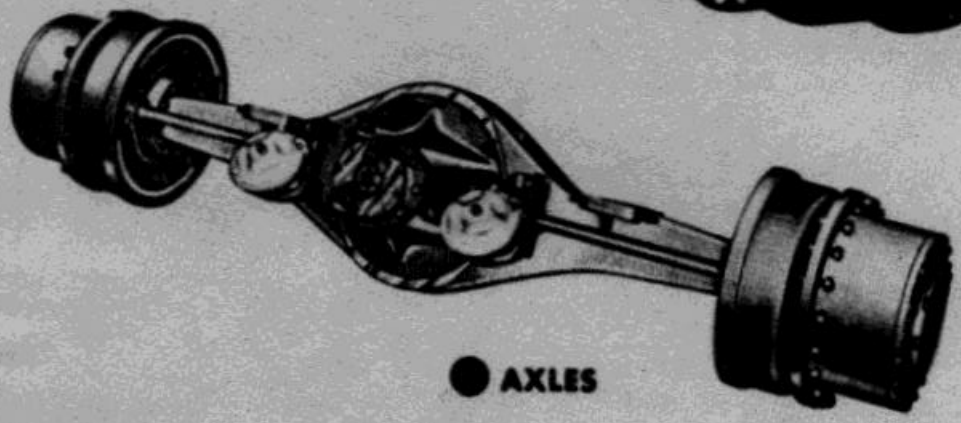
28000 SERIES
TRANSMISSION MOUNTED HYDRAULIC BRAKE

SMS-HB28-Rev. 11-73

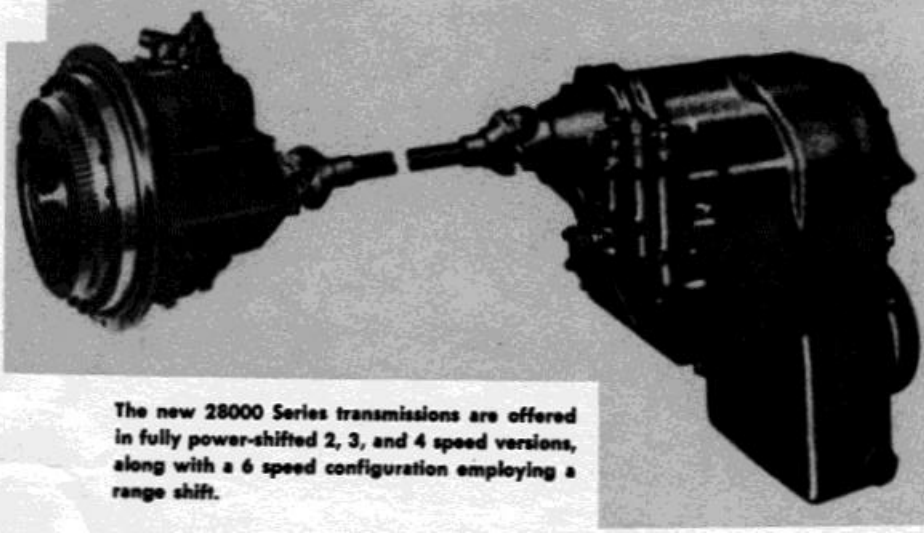
- **TORQUE CONVERTERS UP TO 1000 HORSEPOWER (745700 w)**

- **TRANSMISSIONS UP TO 1000 HORSEPOWER (745700 w)**





- **AXLES**



The new 28000 Series transmissions are offered in fully power-shifted 2, 3, and 4 speed versions, along with a 6 speed configuration employing a range shift.

FOREWORD

This manual has been prepared to provide the customer and the maintenance personnel with information and instructions on the maintenance and repair of the CLARK Power Shift Transmission.

Extreme care has been exercised in the design, selection of materials and manufacturing of these units. The slight outlay in personal attention and cost required to provide regular and proper lubrication, inspection at stated intervals, and such adjustments as may be indicated will be reimbursed many times in low cost operation and trouble free service.

In order to become familiar with the various parts of the transmission, its principal of operation, trouble shooting and adjustments, it is urged that the mechanic study the instructions in this manual carefully and use it as a reference when performing maintenance and repair operations.

Whenever repair or replacement of component parts is required, only Clark-approved parts as listed in the applicable parts manual should be used. Use of "will-fit" or non-approved parts may endanger proper operation and performance of the equipment. The Clark Equipment Company does not warrant repair or replacement parts, nor failures resulting from the use thereof, which are not supplied by or approved by the Clark Equipment Company. IMPORTANT: **Always furnish the Distributor with the transmission serial and model number when ordering parts.**

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Function of the Transmission Mounted
Hydraulic Brake .....
28000 Series Transmission Mounted Hydraulic Brake
(with unidirectional P.T.O.) Parts Nomenclature opposit page..... Fig. A
28000 Series Transmission Mounted Hydraulic Brake
(less unidirectional P.T.O.) Less Parts Nomenclature ..... Fig. B

Disassembly of Brake 1

Cleaning and Inspection 2

Reassembly of Brake 3

Trouble Shooting 5

Brake Adjustment 5

External Plumbing Diagram 6

Lube Specifications 6

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FUNCTION OF THE TRANSMISSION MOUNTED HYDRAULIC BRAKE

The transmission mounted hydraulic brake is designed for the most part to be used on rough terrain vehicles. The hydraulic brake mounted on the transmission is used as the main braking source in log skidder applications where wheel brakes are not practical.

The transmission mounted hydraulic brake consists of an internally splined housing bolted to an adaptor plate that is bolted directly to the transmission case. A brake disc hub is splined to the idler shaft and also has splines on the outer diameter. This hub is free to turn until brake pressure is applied.

Steel discs with splines on the outer diameter are alternated with frictional discs having splines on the inner diameter.

The steel disc splined in the brake housing cannot turn, but are free to move in or out. The frictional discs splined to the hub on the idler shaft may turn in either direction or may increase or decrease in speed depending on the operator's discretion. The frictional discs are also free to move in or out.

The brake system has a positive displacement of fluid from the master cylinder to the three brake actuating pistons.

The cooling of the clutch disc brake is accomplished by return oil from the cooler plumbed to the brake disc compartment with a tee fitting.

When the brake Is applied, pressure behind the pistons forces a heavy end plate to overcome the return spring pressure. The steel discs (splined In the stationary housing) are compressed against the friction discs (splined on and turning with the Idler shaft). As more brake pressure Is applied the discs are compressed tighter until the Idler shaft is stopped. The output shaft which Is geared directly to the Idler shaft Is also stopped. As the brake Is engaged, brake pressure overcomes a spring loaded brake valve spool and moves the brake spool open allowing a 70% volume of return oil to cool the brake discs. The volume of return oil remaining Is directed to the lube distributor and Is sufficient to cool and lube the transmission.

When the brake is released, return springs push the end plate and pistons to a neutral position allowing the inner and outer discs to separate. The friction disc and idler shaft is now free to turn.

When the brake is disengaged the spring loaded brake valve spool is closed allowing a 20% volume of return oil to cool the brake disc, the remaining oil is directed to the lube distributor.

The transmission mounted hydraulic brake can also be used as a parking brake. It is actuated by a hand brake lever and linkage to a shaft on the side of the brake housing. The shaft is connected internally to a yoke. When the hand brake lever is set, the yoke presses against the heavy end plate and compresses the inner and outer clutch brake discs, thus making the idler shaft immobile.

When the hand brake lever is released the yoke moves away from the end plate allowing the return springs to move the end plate away from the discs. The friction disc and idler shaft is now free to turn.

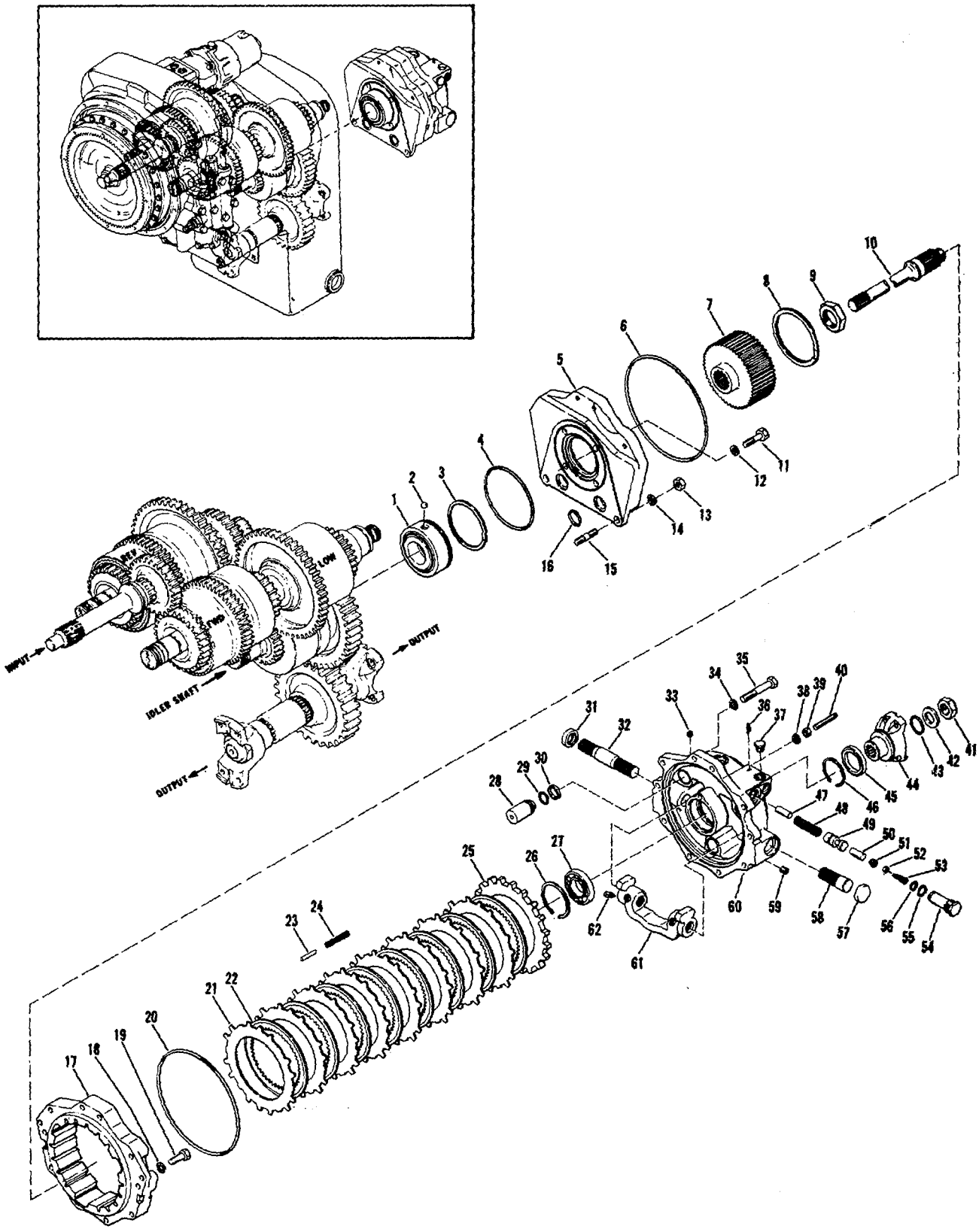


FIGURE A
28000 SERIES TRANSMISSION MOUNTED HYDRAULIC BRAKE
(WITH UNIDIRECTIONAL P. T. O.)

28000 SERIES TRANSMISSION MOUNTED HYDRAULIC BRAKE (WITH UNIDIRECTIONAL P.T.O.)

Item	Description	Qty.
1	Idler Shaft Rear Bearing	1
2	Rear Bearing Lock Ball	1
3	Rear Bearing Locating Ring	1
4	Brake Housing Adaptor O-Ring	1
5	Brake Housing Adaptor	1
6	Brake Disc Housing to Adaptor O-Ring	1
7	Brake Disc Hub	1
8	Oil Baffle Ring	1
9	Disc Hub Retainer Nut	1
10	P.T.O. Shaft	1
11	Adaptor to Transmission Case Place Bolt	4
12	Adaptor to Transmission Case Place Bolt Lockwasher	4
13	Adaptor to Transmission Case Stud Nut	2
14	Adaptor to Transmission Case Stud Nut Lockwasher	2
15	Adaptor to Transmission Case Stud	2
16	Adaptor to Case O-Ring	2
17	Brake Disc Housing	1
18	Brake Disc Housing to Adaptor Bolt Lockwasher	2
19	Brake Disc Housing to Adaptor Bolt	2
20	Brake Cover to Disc Housing O-Ring	1
21	Brake Outer Disc	8
22	Brake Inner Disc	8
23	Return Spring Pin	6
24	Return Spring	6
25	End Plate	1
26	P.T.O. Shaft Rear Bearing Retainer Ring	1
27	P.T.O. Shaft Rear Bearing	1
28	Brake Piston	3
29	Piston O-Ring	3
30	Piston Glyd Ring	3

Item	Description	Qty.
31	Brake Operating Shaft Oil Seal	1
32	Brake Operating Shaft	1
33	Brake Housing Plug	1
34	Brake Cover to Disc Housing Bolt Lockwasher	10
35	Brake Cover to Disc Housing Bolt	10
36	Bleeder Screw	1
37	Brake Housing Plug	2
38	Brake Adjusting Screw Sealing Washer	1
39	Brake Adjusting Screw Lock Nut	1
40	Brake Adjusting Screw	1
41	P.T.O Flange Nut	1
42	P.T.O Flange Washer	1
43	P.T.O Flange O-Ring	1
44	P.T.O Flange	1
45	P.T.O Flange Oil Seal	1
46	Oil Seal Locating Ring	1
47	Brake Valve Stop	1
48	Brake Valve Spring	1
49	Brake Valve Spool	1
50	Brake Valve Piston	1
51	Sealing Cup	1
52	Spring Retainer Pin	1
53	Balance Spring	1
54	Piston Handling	1
55	Piston Housing O-Ring	1
56	Piston Housing O-Ring	1
57	Brake Housing Bore Plug	1
58	Brake Yoke Stub Shaft	1
59	Brake Housing Plug	1
60	Hydraulic Brake Cover	1
61	Brake Yoke	1
62	Brake Yoke Lock Screw	2

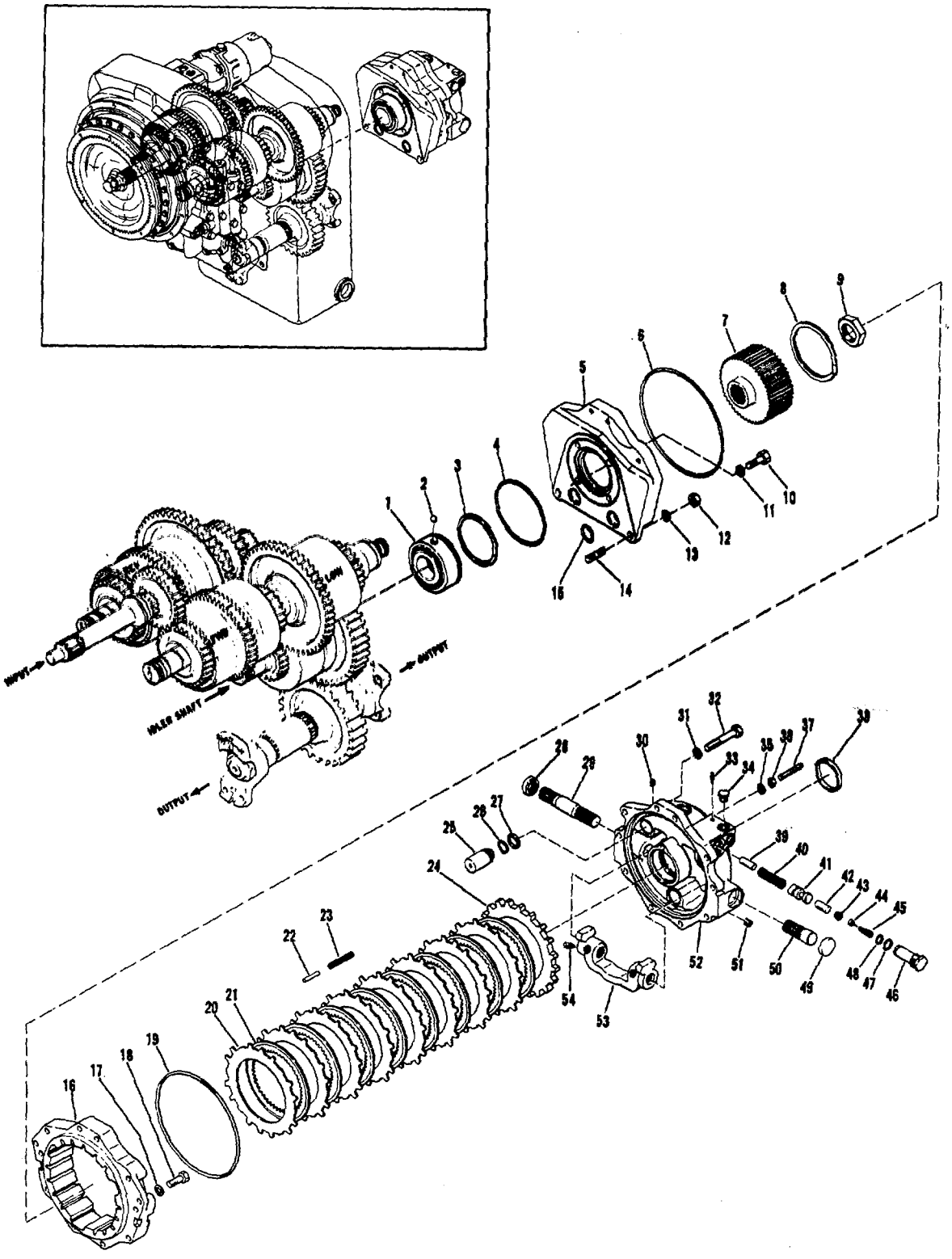


FIGURE B
28000 SERIES TRANSMISSION MOUNTED HYDRAULIC BRAKE
(LESS UNIDIRECTIONAL P.T.O.)

MAINTENANCE AND SERVICE

The instructions contained herein cover the disassembly and reassembly of the transmission mounted hydraulic brake. The unit shown has been removed from the machine and the brake is to be completely overhauled. If clearance will allow the brake can be repaired in the machine.

The brake assembly shown is a unit without unidirectional power take off. If a P.T.O. was used it is not necessary to remove the companion flange unless the hydraulic brake cover and valve assembly is to be replaced.

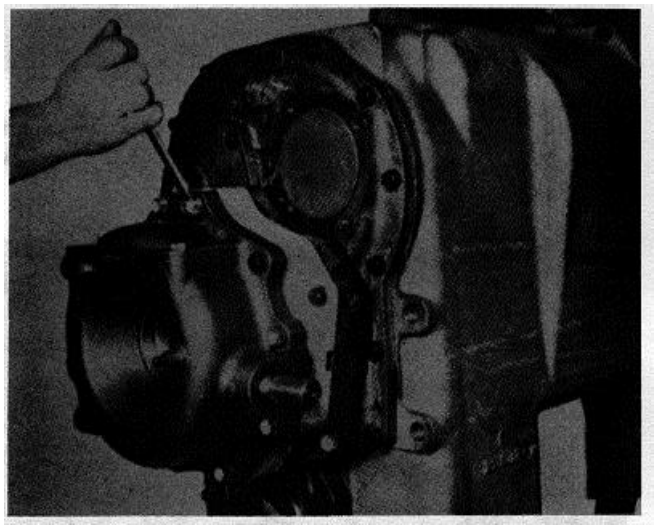


Figure 1
Remove the brake cover bolts evenly around the brake cover as the return springs will push the cover away from the disc housing.

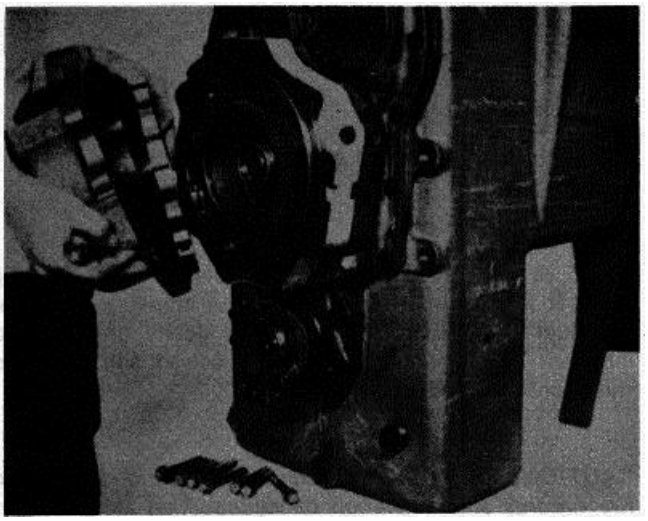


Figure 2
Remove brake cover assembly and end plate from disc housing.

NOTE: If P.T.O. is used pull cover straight out to remove P.T.O. shaft from idler shaft.

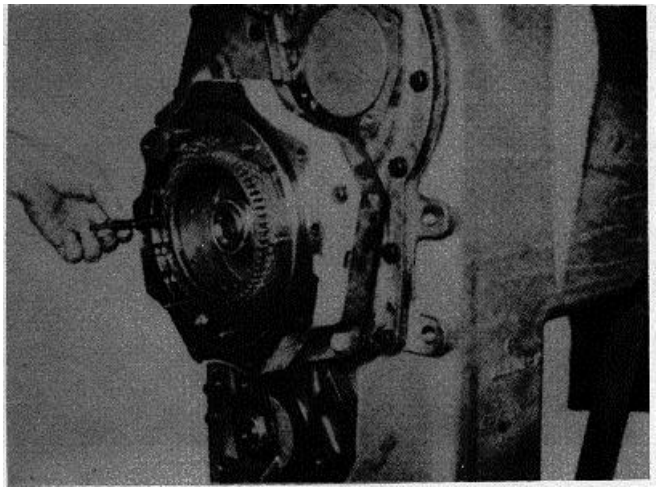


Figure 3
Remove return springs and pins from disc housing.

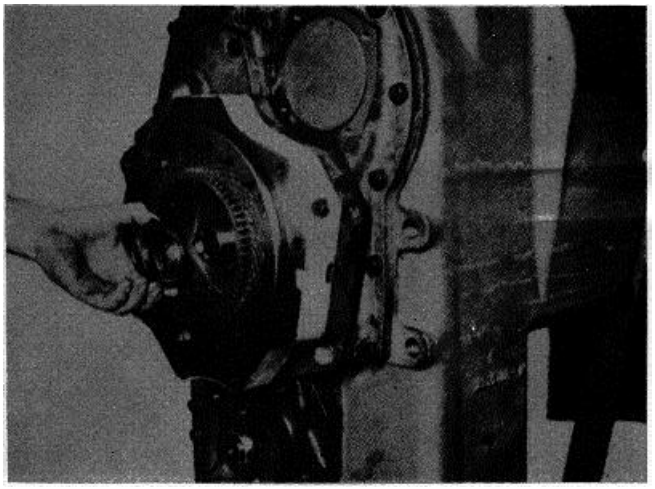


Figure 4
Secure output shaft to prevent turning and remove disc hub nut.

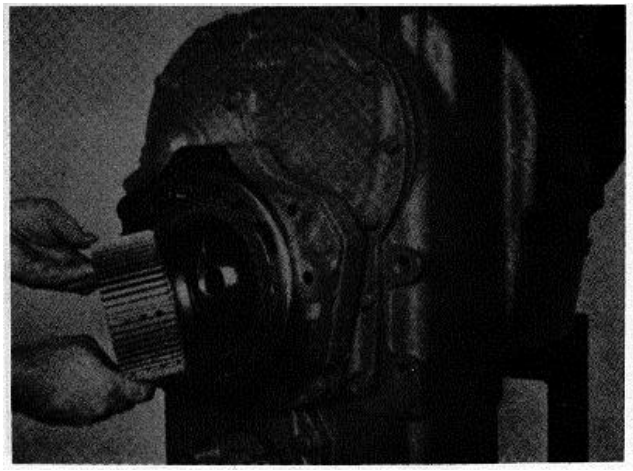


Figure 5
Remove disc hub.

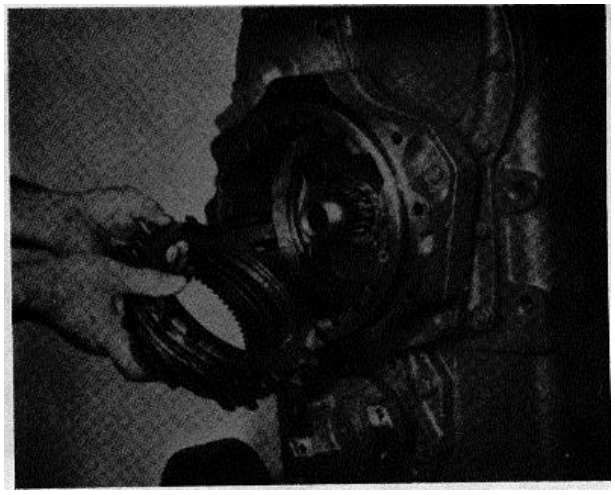


Figure 6
Remove the inner and outer brake disc.

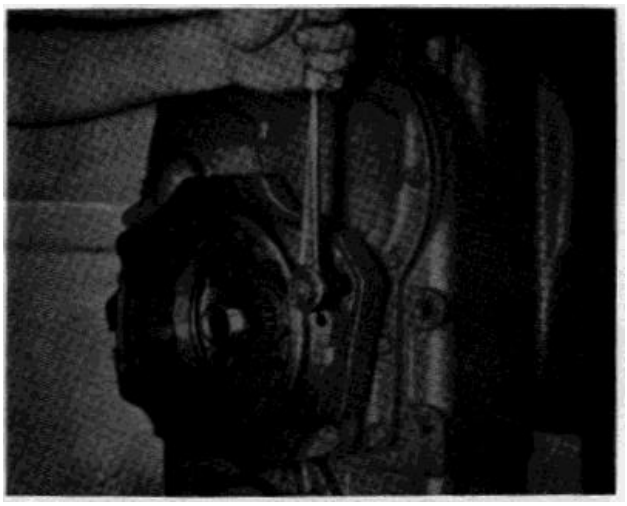


Figure 7
Remove the disc housing to adaptor plate bolts.

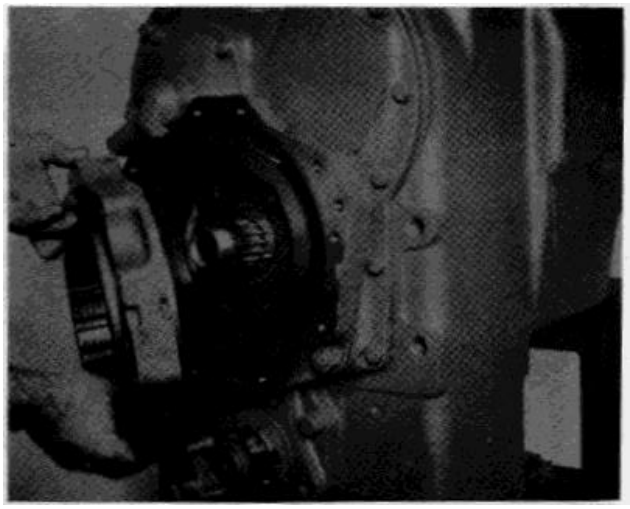


Figure 8
Remove disc housing.

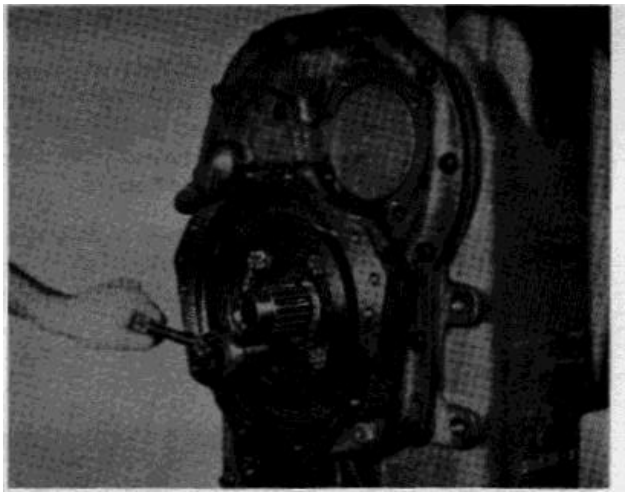


Figure 9
Remove the brake housing adaptor plate place bolts, and lower hole stud nuts and washers. (See page 8 for brake adaptor update.)

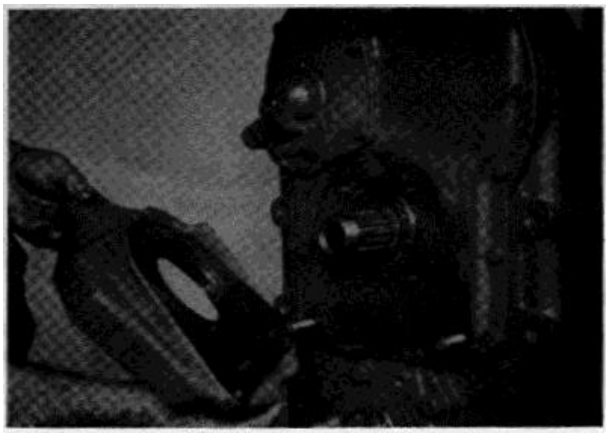


Figure 10
Remove adaptor plate.

CLEANING AND INSPECTION

CLEANING

Clean all parts thoroughly using solvent type cleaning fluid. It is recommended that parts be immersed in cleaning fluid and moved up and down slowly until all old lubricant and foreign material is dissolved and parts are thoroughly cleaned.

CAUTION: Care should be exercised to avoid skin rashes, fire hazards and inhalation of vapors when using solvent type cleaners.

INSPECTION

The importance of careful and thorough inspection of all parts cannot be overstressed. Replacement of all parts

showing indication of wear or stress will eliminate costly and avoidable failures at a later date.

Housing, Covers, etc.

Inspect housings, covers and bearing caps to be certain they are thoroughly cleaned and that mating surfaces, bearing bores, etc., are free from nicks or burrs. Check all parts carefully for evidence of cracks or condition which would cause subsequent oil leaks or failures.

O-Rings

Replacement of O-Rings is more economical when unit is disassembled than premature overhaul to replace these parts at a future time. Further loss of lubricant through a worn seal may result in failure of other more expensive parts of the assembly. Sealing members should be handled carefully, particularly when being installed. Cutting or scratching, seriously impairs its efficiency. Lubricate all O-Rings and seals with recommended type Automatic Transmission Fluid before assembly.

When cleaning and replacing parts in the hydraulic brake cover and valve assembly refer to Figure A for Location and sequence of parts.

REASSEMBLY



Figure 11

Using new O-Rings, position brake housing adaptor on transmission.

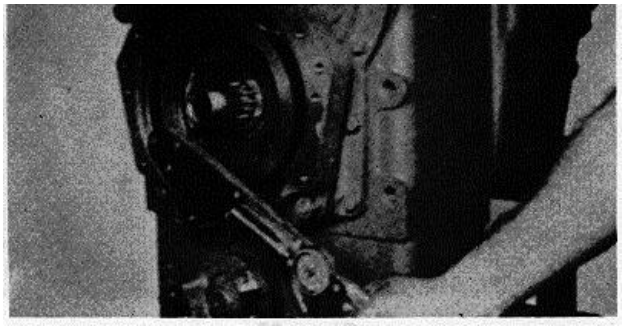


Figure 12

Install adaptor to transmission place bolts and washers (Qty. 4 each). Install stud nuts and washers (Qty. 2 each). Tighten place bolts 115 to 127 ft.-lbs. Torque [15,9-17,5 mm] tighten stud nuts 180 to 198 ft.-lbs. torque [24,9-27,3 mm].

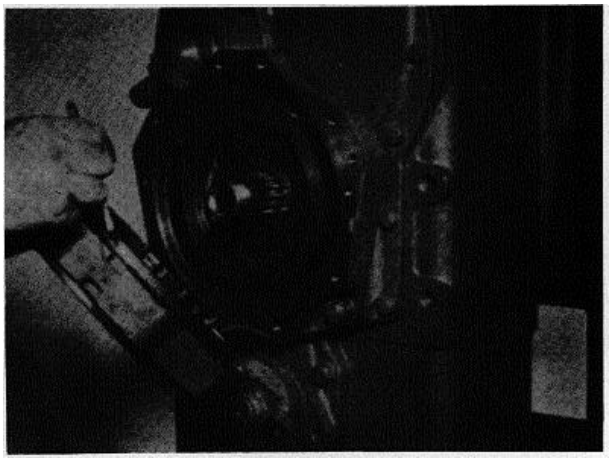


Figure 13

Install a new brake disc housing O-Ring and position disc housing on adaptor.

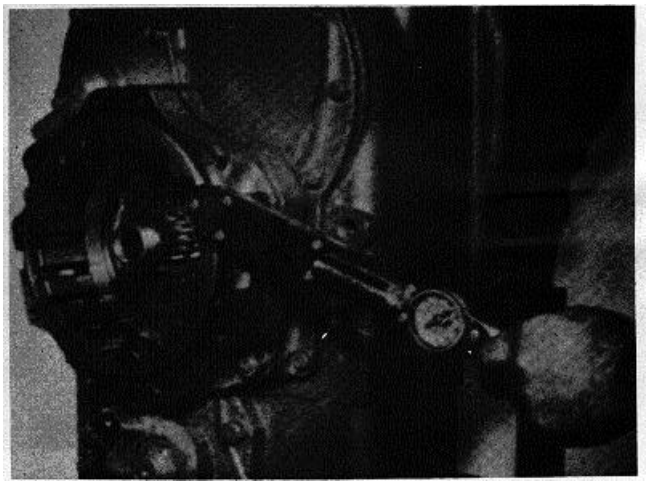


Figure 14

Install disc housing to adaptor bolts and tighten 37 to 41 ft.lbs. torque [5,1-5,6 mm].

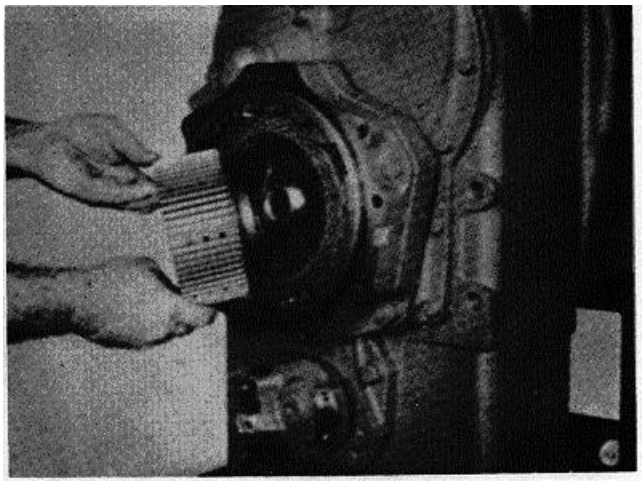


Figure 15

Align brake disc hub splines with idler shaft splines and install disc hub and disc hub nut.

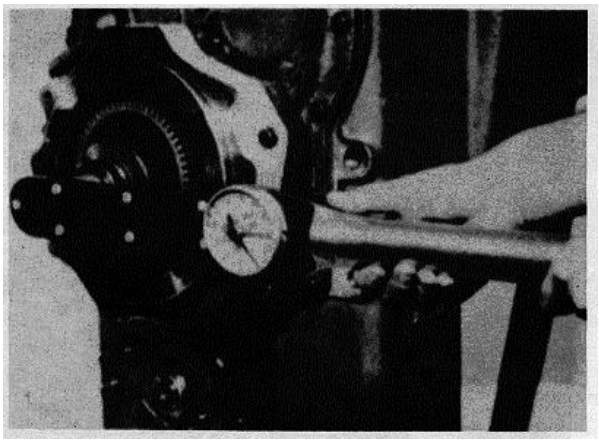


Figure 16

Block, output shaft and tighten disc hub nut 250 to 30C ft.-lbs. torque 134,6-41,4 mm].

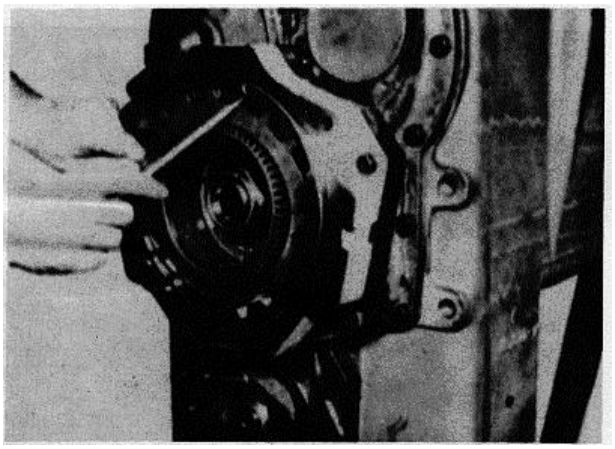


Figure 17

Install one steel disc (splined on the outer diameter) into disc housing. A mark (x) was made on the disc housing in a space between a two spline section and a three spline section.

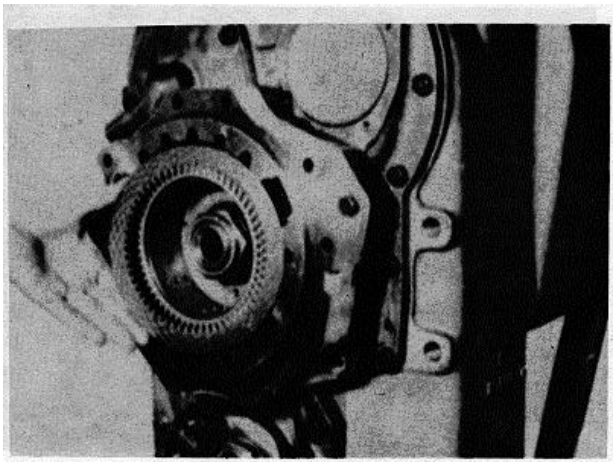


Figure 18

Install one frictional disc (splines on the inner diameter) against first steel disc.

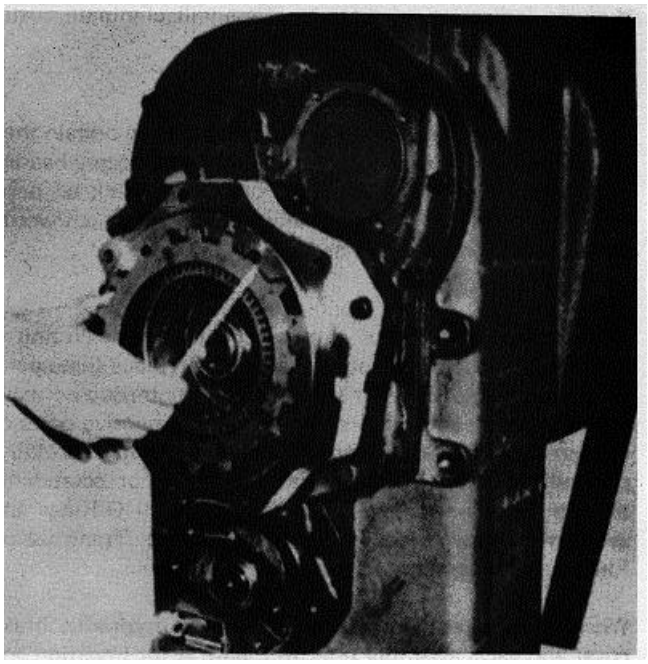


Figure 19

Move the second steel disc one spline to the right. This misaligns the first steel disc and the second steel disc by one spline. Another mark (x) was made and this mark must be used during the remainder of the assembly. This marked area and five other places will allow passage for the six return springs with the springs bottoming on the teeth of the first steel disc. Alternate friction and steel discs being certain the splines on each steel disc are aligned with the splines on the previous steel disc.

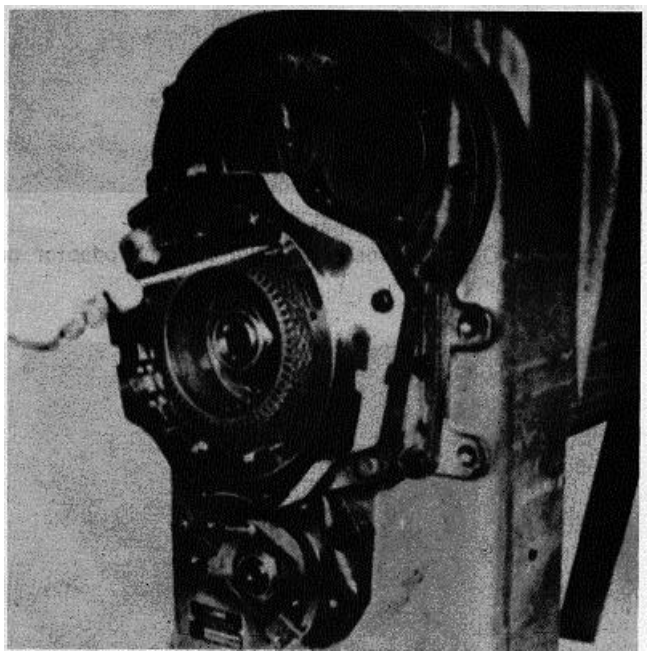


Figure 20

Figure 20 shows the return springs and pins to the spring passages.

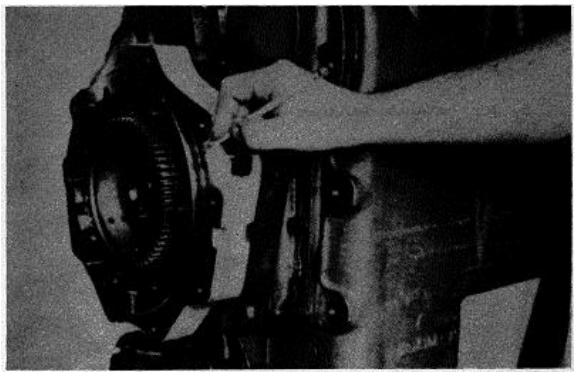


Figure 21
Position a new O-Ring as shown on the brake disc housing.

NOTE: Before installing the brake end cover, loosen the brake adjusting screw jam nut and turn adjusting screw out two or three turns.

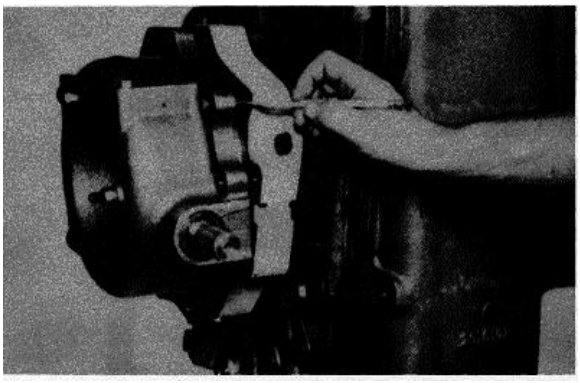


Figure 22
A guide pin located at the two top corners will assist in aligning the heavy end plate and brake valve and end cover on the disc housing. Install cover to disc housing bolts and tighten evenly being certain splines on the outer diameter of the end plate are aligned with the splines in the disc housing.

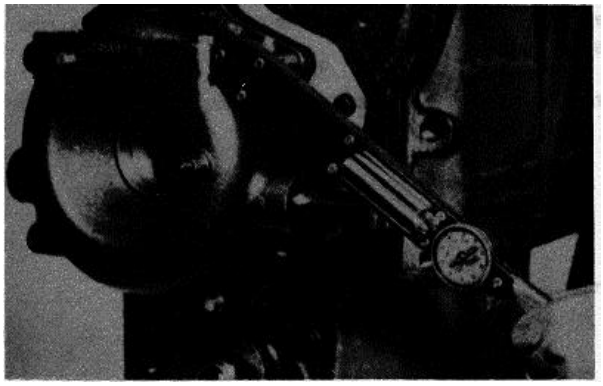


Figure 23
Remove guide pins, install upper corner bolts, tighten all brake valve and end cover bolts 37 to 41 ft.-lbs. torque [5,1-5,6 mm].

TROUBLESHOOTING

If the transmission mounted hydraulic brake does not function properly a number of points can be checked to determine the malfunction.

1. Is the master cylinder full of the proper fluid? (See section on types of fluid used with the transmission mounted hydraulic brake.)

2. Is the brake adjusted properly? (See below for proper brake adjustment.)

3. When used as a parking brake is the linkage between the hand brake lever and the brake arm on the side of the brake housing adjusted properly, if so, again is the brake adjusted properly? (See below).

BRAKE ADJUSTMENT

1. Loosen brake adjusting screw jam nut.

2. Disconnect linkage from brake lever arm to parking brake. (Brake lever arm end only.)

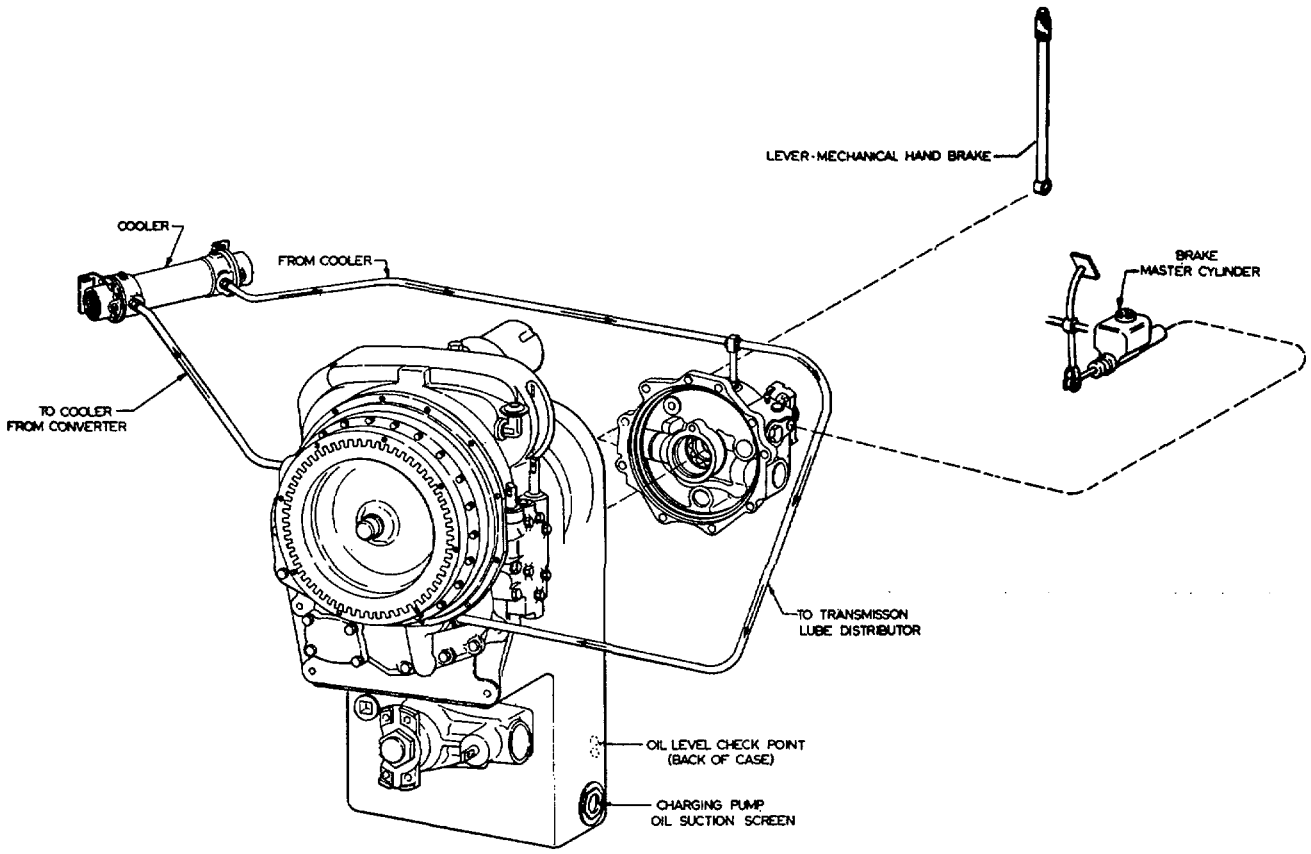
3. Apply pressure by turning brake arm until springs and clutch brake plate clearance Is removed and brake assembly is locked up.

4. Turn brake adjusting screw until tight against brake yoke.

6. Back screw out 1 to 1½ turns or .062 to .093 clearance [1,6-2,4 mm].

6. Hold adjusting screw from turning and tighten jam nut.

7. Connect parking brake linkage to brake lever arm.



TRANSMISSION MOUNTED HYDRAULIC BRAKE LUBE SPECIFICATIONS

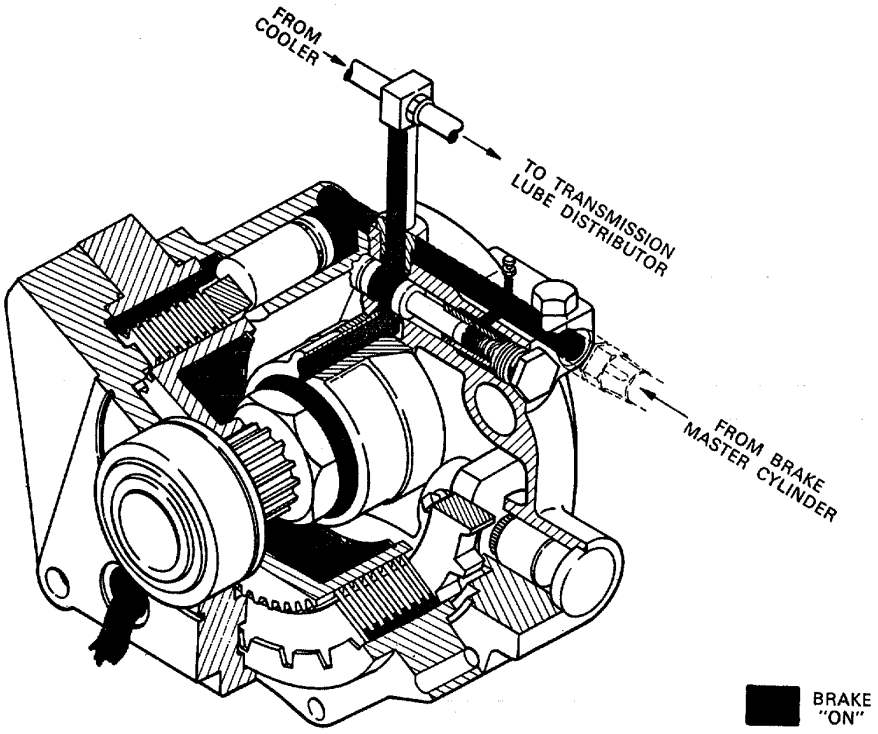
Three types of fluid are approved for use in the transmission mounted hydraulic brake master cylinder.

1. Type A Suffix "A" Automatic Transmission Fluid.
2. *Dexron Automatic Transmission Fluid.
3. C^2 Hydraulic Fluid (for use above 0°F.)

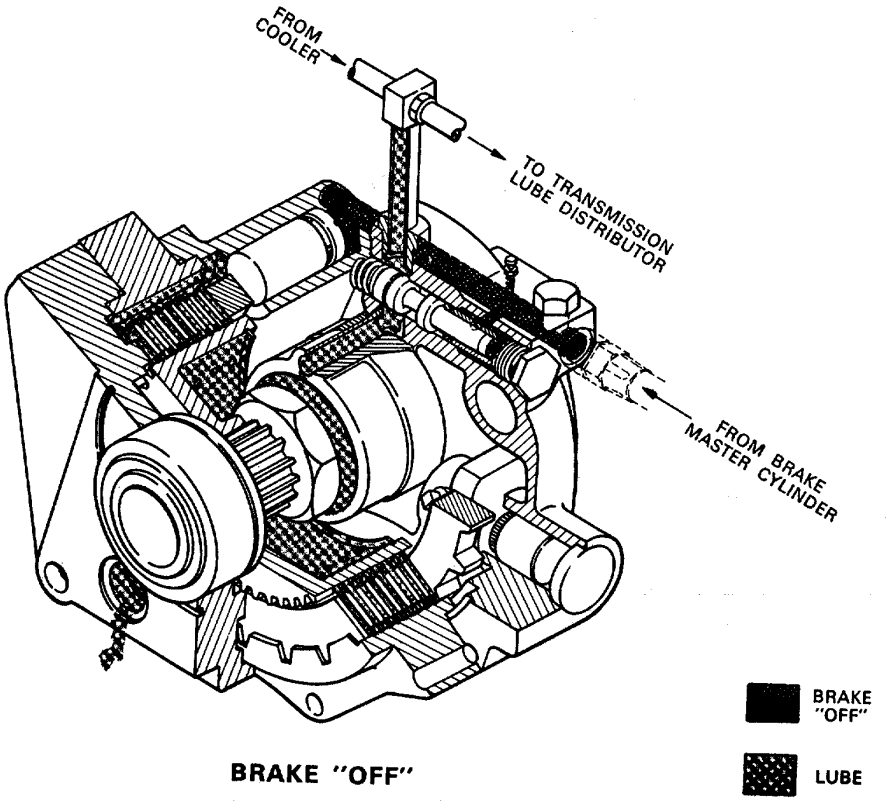
NOTE: When one of these fluids have been selected for the transmission the same fluid is to be used in the master cylinder which applies the transmission mounted hydraulic brake.

When using the transmission brake in conjunction with wheel brakes a separate system must be used to operate the wheel brakes.

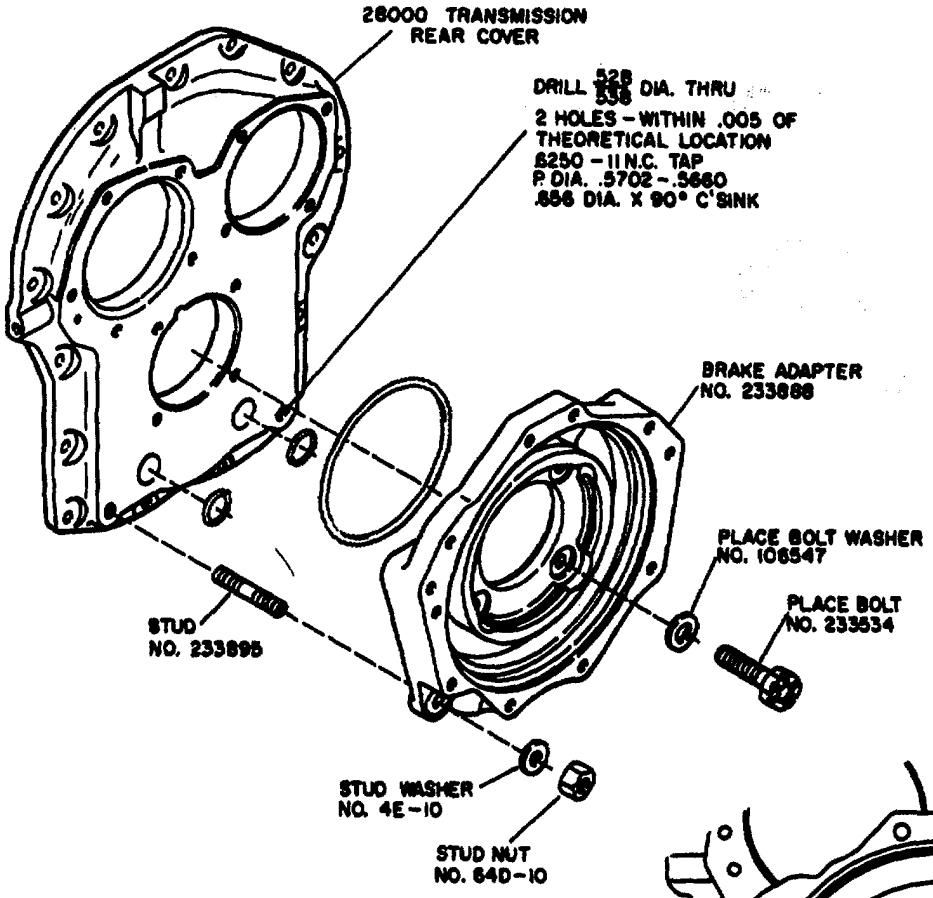
*DEXRON is a registered trademark of General Motor Corporation.

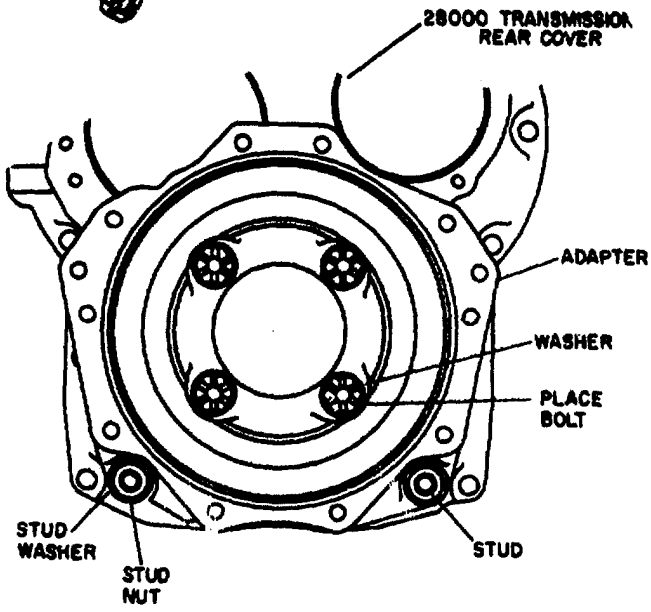


BRAKE "ON"



BRAKE "OFF"





801822 Hydraulic Brake Adaptor Kit

1 -	233888	Brake Adaptor
4 -	106547	Place Bolt Washer
4 -	233534	Place Bolt
2 -	233895	Stud
2 -	64D-10	Stud Nut
2 -	4E-10	Stud Nut Lock-washer
1 -	801832	Adaptor Kit Instruction Sheet

When replacing the hydraulic brake adaptor on the 28000 series transmission the following procedure must be followed:

Refer to applicable maintenance manual for rear cover removal.

Drill and tap two lower brake adaptor attaching holes as shown in diagram.

Clean rear cover.

Reinstall rear cover a explained In maintenance manual.

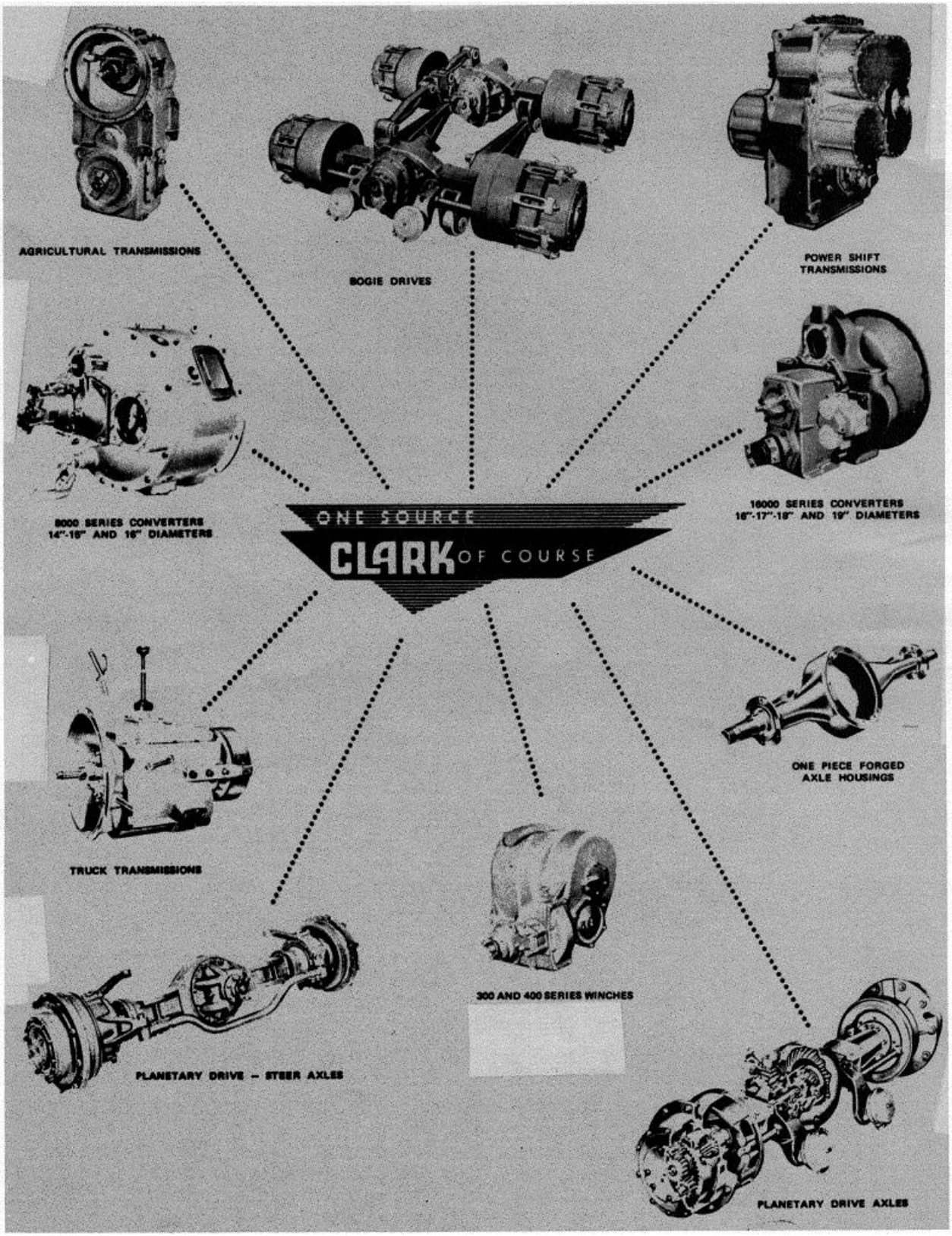
Install two studs a shown.

Install new brake adaptor O-rings and brake adaptor.

Install place bolts and washers, tighten bolts 115 to 127 ft.-lbs, torque [15, 9-17, 5 mm].

Install stud nut washers and stud nuts. Tighten nuts 180 to 198 ft.-lbs. torque (24, 9-27, 3 mm].

Reassemble hydraulic brake as explained in the maintenance and service manual supplement

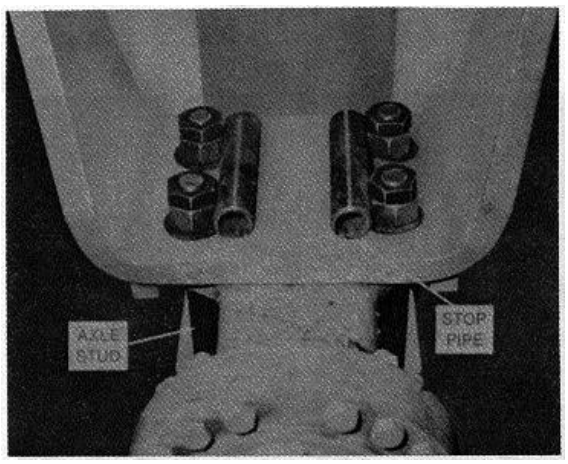

AGRICULTURAL TRANSMISSIONS
BOGIE DRIVES
POWER SHIFT TRANSMISSIONS
8000 SERIES CONVERTERS 14"-15" AND 16" DIAMETERS
ONE SOURCE
CLARK OF COURSE
16000 SERIES CONVERTERS 16"-17"-18" AND 19" DIAMETERS
TRUCK TRANSMISSIONS
ONE PIECE FORGED AXLE HOUSINGS
300 AND 400 SERIES WINCHES
PLANETARY DRIVE – STEER AXLES
PLANETARY DRIVE AXLES

MAINTENANCE:

CHECK DIFFERENTIAL AND PLANETARY OIL LEVELS every 50 hours after machine operation but allow 5 minutes for all the oil to drain to its normal level. Planetary oil level is checked at filler plug on planetary end cap with arrow at its lowest position. Differential oil level is checked at filler plug on differential housing. Add lubricant as necessary (refer to LUBRICANTS SPECIFICATION CHART).

CHANGE OIL after initial 50 hours of operation and thereafter every 800 hours. Oil change should be made with oil at operating temperature. Remove plug at bottom of axle housing and allow lubricant to drain. Rotate wheel until planetary filler hole is at lowest position, remove plug and allow to drain. Replace drain plugs and fill with a light flushing oil. Operate axles for a short period of time, then drain. Inspect the magnetic drain plug for foreign particles indicative of wear or possible failure. Replace drain plugs and refill with clean oil (refer to LUBRICANTS SPECIFICATION CHART). Be sure thrust cap oil level is in proper position' when refilling planetary.

CHECK WHEEL AND AXLE MOUNTING NUTS. Torque wheel mounting nuts every 100 hours to 450 ft-lbs (62 m-kg). Every 200 hours torque axle mounting nuts to 700 ft-lbs (97 m-kg). Replace any damaged nuts or studs.



Axle Mounting Studs

WHEEL BEARING PRELOAD ADJUSTMENT:

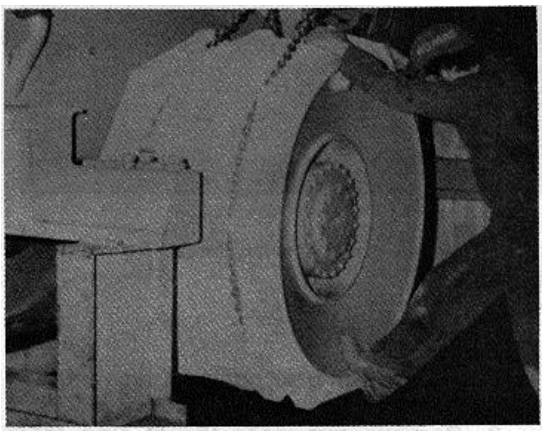
Wheel hub bearing preload should be adjusted every 800 hours.

1. Park machine on level ground, set parking brake and lower blade.

2. Jack up each wheel individually and block securely, so that wheel clears ground level.

3. Remove all cleaner teeth and fenders.

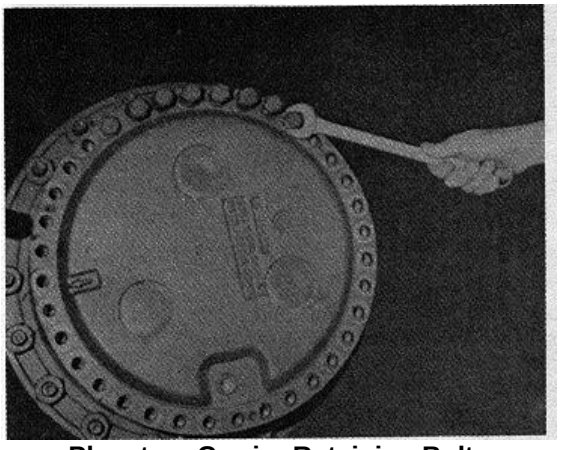
4. Attach hoist and sling to wheel and hold taut. Now wheel mounting nuts can be removed and wheel lifted from axle.



Wheel Removal

5. Drain oil from planetary housing.

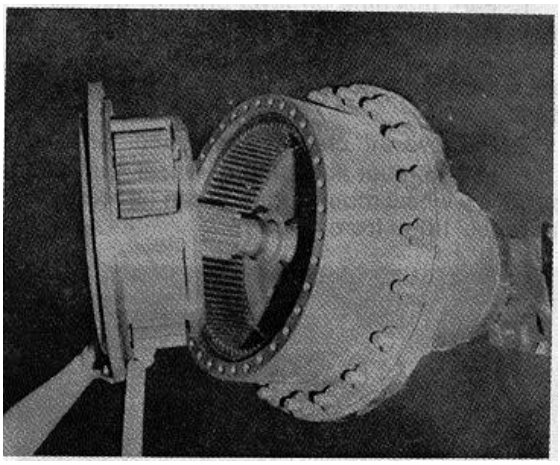
6. Remove bolts from planetary carrier assembly. Remove plant carrier from hub assembly.



Planetary Carrier Retaining Bolts

AXLES:

7. Remove planet carrier from hub assembly.



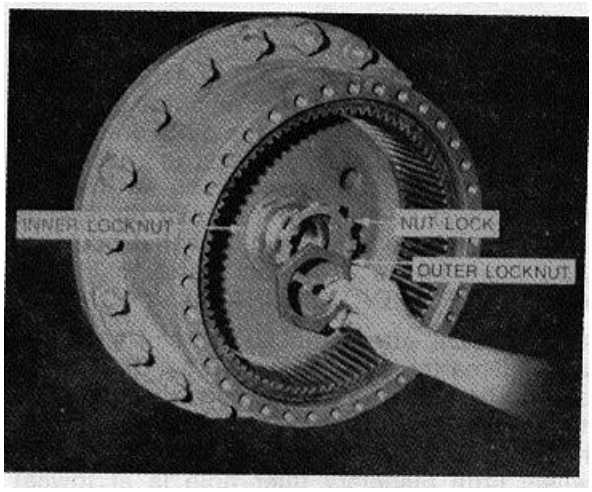
Removing Planetary Carrier

8. Remove sun gear retaining ring and pull off sun gear.

9. Remove sun gear thrust ring from spindle end.

10. Straighten tangs on outer lock nut.

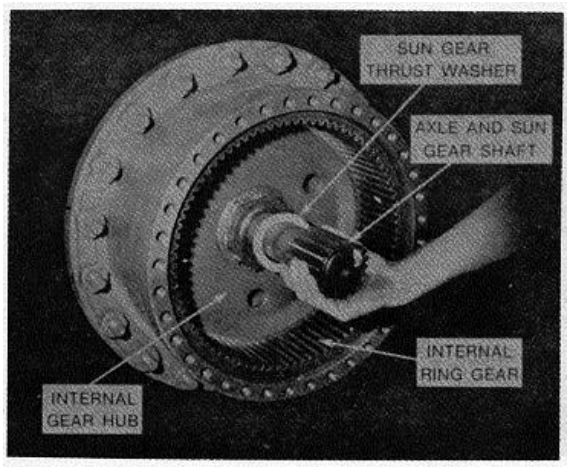
11. Wrap shim stock around end of axle shaft to protect shaft splines and install special wrench (PN 954940) on outside spindle nut.

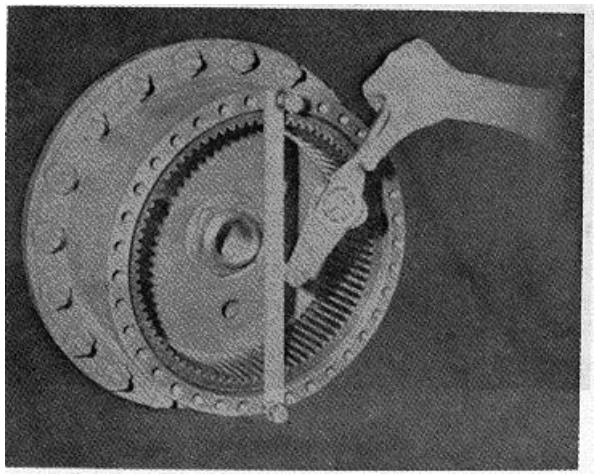


12. Tighten wrench guide screws lightly against shim stock and remove outside spindle nut and lock ring.

13. Check rolling torque of hub assembly by attaching torque wrench adapter bar across face of hub assembly and attach torque wrench to center of bar.

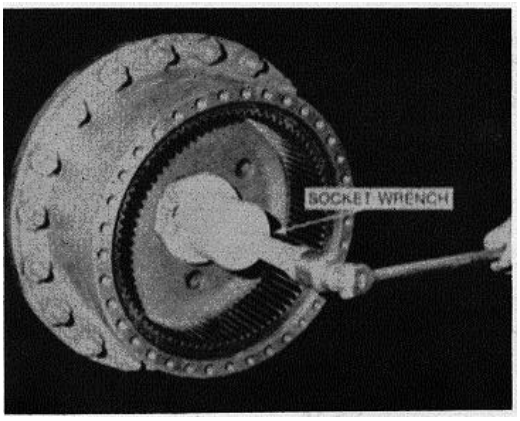
14. Attach a 50 ft-lb (7 m-kg) torque wrench and check rolling resistance of wheel hub. Rolling resistance when using new bearing should be 15 to 20 ft-lbs (2,0 to 2,8 m-kg). On used bearings, the rolling resistance should be 6 to 12 ft-lbs (0,8 t 1, 7 m-kg).





Checking Torque

AXELS:



Bearing Preload Adjustment

15. Rolling resistance can be adjusted by adjusting the spindle nut.

16. When proper rolling torque is obtained, install new lock and apply grease to outer face of lock. Install outer locknut and tighten securely.

17. Recheck rolling resistance, readjusting if required.

18. If rolling torque is within specification, bend two tangs inward and two outward.

19. Install sun gear thrust ring and tap into end of spindle.

20. Install sun gear on axle and replace retaining ring.

21. Install planetary carrier assembly and bolt into place. Tighten capscrews to specified torque (refer to TORQUE SPECIFICATIONS CHART).

22. Install sun gear thrust cap and new O ring, tighten capscrews to specified torque (refer to TORQUE SPECIFICATIONS CHART).

23. Replace drain plug in planetary housing and refill planetary and differential housings to proper levels with correct fluid (refer to LUBRICANTS SPECIFICATION CHART).

24. Install wheel on axle, install wheel nuts and torque to 450 ft-lbs (67 m-kg).

25. Install wheel cleaner teeth and fenders. Adjust cleaner teeth to proper clearance on wheel. Rotate wheel and check cleaner teeth clearance.

26. Jack up machine, remove blocking and lower machine to ground.

DIFFERENTIAL PINION END PLAY :

At each 800 hour interval, the differential pinion flange bearings should be checked for endplay. If any endplay is found, the following procedure should be followed in conjunction with the vendor service manual:

1. Park machine on level ground, set parking brake and lower blade.

2. Drain planetary and differential housings.

3. Using a small hooked rod, pull out sun gear and axle shaft about 12 inches (30 cm) till axle shafts are disconnected from differential splines.

4. Remove drive shaft and support differential housing with jack.

5. Remove differential housing nuts and ferrules.

6. Remove differential assembly from axle housing.

7. Mount differential on differential over- haul stand.

8. Check and record ring gear backlash with a dial indicator. The backlash reading should be .010 to .014 inches (0, 25 to 0, 36 mm). This information is necessary for reassembly unless a new gear set is installed.

9. Loosen companion flange to facilitate flange removal later. Loosen thrust screw nut and remove thrust screw. When installing thrust screw, screw in until it contacts ring gear and then back out .012 inch (0, 3 mm) and lock with jam nut.

10. Remove adjusting nut lock. Before re- moving bearing cap bolts, use center punch to match mark bearing caps to carrier assembly. This is to ensure correct match in reassembly.

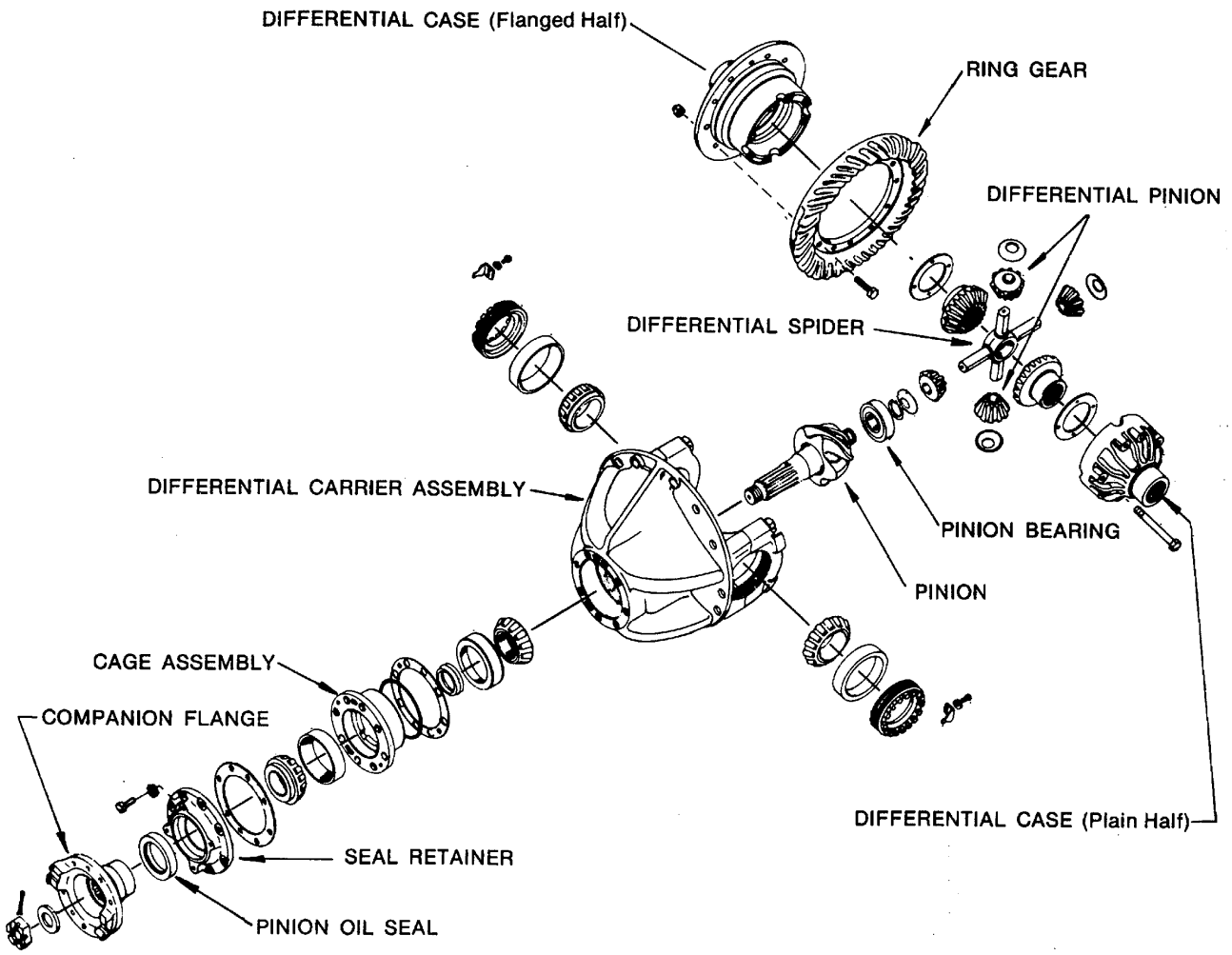
11. Remove bearing cap bolts and bearing caps.

12. Insert metal bar through differential to facilitate hoisting. Raise ends individually and remove adjusting nuts and bearing cups.

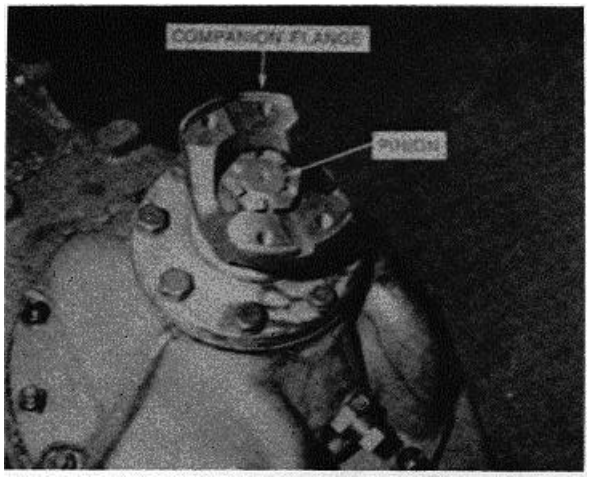
13. Hoist differential with assembled bearing cones from carrier assembly. Tilt differential to allow ring gear to pass web in differential carrier.

14. Remove pinion shaft nut that was previously loosened and remove washer. Remove companion flange from pinion shaft with puller.

15. Remove bolts securing seal retainer to carrier and remove retainer. If necessary, tap with a soft mallet to break seal between parts.



Differential and Carrier Assembly



16. Screw two bolts in puller holes and pull bearing cage from carrier assembly. This pulls the outer pinion bearing cone from shaft. Turn each bolt equally to prevent damage to carrier shaft or bearing. After bearing cage is pulled out a short distance, back off puller screws and insert .030 inch (8 mm) shim stock under puller screws to reduce possible damage to shim pack under flange of bearing cage.

17. Remove pinion shaft assembly from carrier. Retain bearing cage shim pack intact for reuse in reassembly.

18. Inspect pinion bearings and pinion gear. If bearings and gear are in good condition, remove spacer from pinion shaft.

19. A pinion bearing spacer and shim kit is provided for service repair of differential and carrier assemblies. This kit consists of a spacer and a quantity of shims and is used to obtain proper pinion bearing preload. Position the bearing spacer and a .010 inch (0,25 mm) shim on pinion shaft.

20. Position pinion bearing cage assembly on pinion shaft. Position outer pinion bearing cone on pinion shaft and press into place using steel tubing 3.25 inch (8, 3 cm) outside diameter, 2.75 inch (7,0 cm) inside diameter and approximately 7 inches (17,8 cm) in length for driver.

21. Keep pinion and cage assembly in press with approximately 500 pounds (227 kg) of pressure exerted on driver. Wrap several turns of soft wire or cord around pinion cage and pull in horizontal line with spring scale. While pulling in straight line, read spring scale and rotating torque. Multiply reading on spring scale by one-half diameter of bearing cage to obtain preload torque. Correct preload torque is 13 to 23 in-lbs (0,15 to 0,27 m-kg/1,47 to 2,60 joules). If preload is not within these limits, remove shims to increase preload or add shims to decrease preload.

Note: *This is a preliminary check. Final bearing preload check must be made with pinion shaft and bearing cage assembly in differential carrier housing.*

22. Install pinion assembly in differential carrier housing, using original shim pack or its equivalent thickness. Use four pinion oil seal retainer bolts with flat washers to pull pinion shaft assembly fully into carrier assembly. Make sure oil passages are aligned.

23. Temporarily install companion flange on end of pinion shaft, without installing oil seal retainer and torque companion flange nut to 600 ft-lbs (83 m-kg/814 joules).

24. Recheck the bearing preload making sure that the reading is 13 to 23 in-lbs (0,15 to 0,27 m-kg/1,47 to 2,60 joules). If necessary, disassemble parts and add shims to decrease preload or remove shims to increase preload.

25. When proper preload has been achieved on pinion bearings, reverse removal procedure-items 13 through 8-for installation.

26. Remove companion flange nut and companion flange. Clean and inspect seal retainer and seal, replacing seal if necessary. Replace seal retainer gasket and install gasket retainer. Secure with proper bolts and lockwashers and tighten to specified torque (refer to TORQUE SPECIFICATIONS CHART).

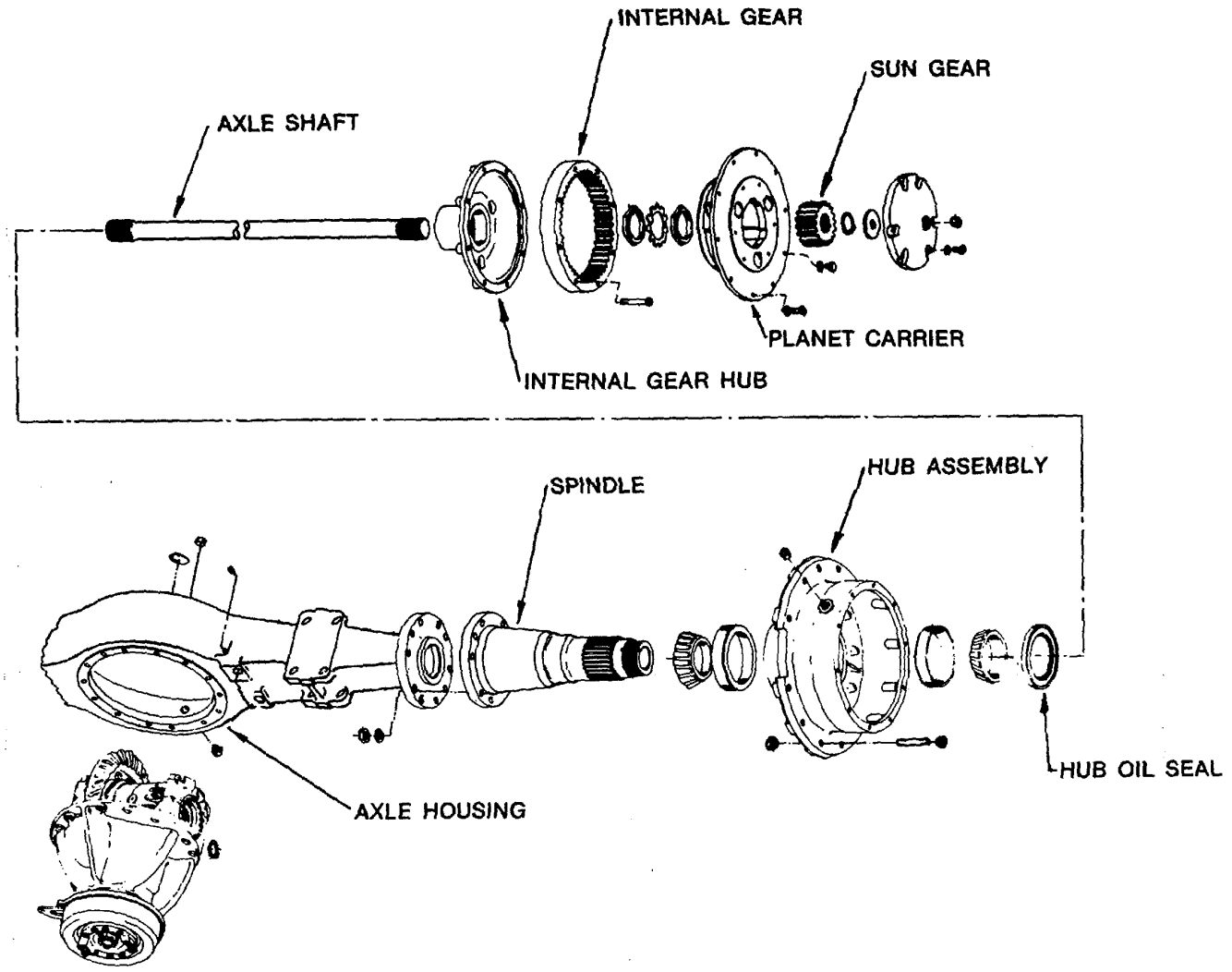
27. Install companion flange and nut and torque to 600 ft-lbs (83 m-kg 814 joules). Install cotter pin to lock nut.

28. Remove differential from overhaul stand. Reverse removal procedure-items 7 through 2 -for installation. Refill planetary and differential housings (refer to LUBRICANTS SPECIFICATION CHART).

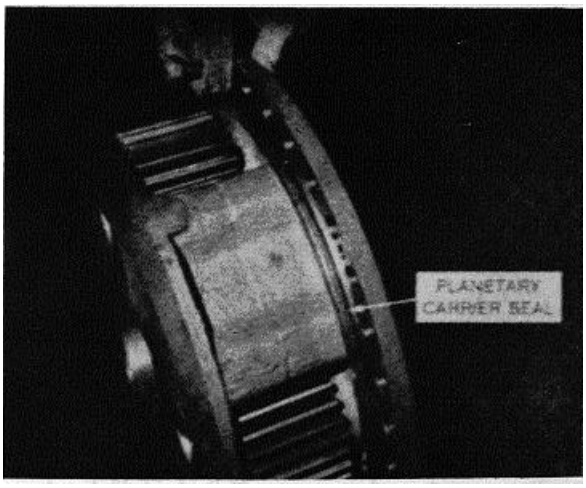
29. For differential setup refer to vendor service manual.

AXLE REMOVAL:

1. Park machine on level ground, set parking brake and lower blade.
2. Jack up each wheel individually, blocking securely on frame so that wheels clear the ground.
3. Remove all wheel scrapers and fenders.
4. Attach hoist and sling to wheel and hold taut.
5. Remove wheel nuts and lift wheel from axle.



Drive Axle Assembly



6. Attach hoist to axle outer ends and support weight. A spreader bar may be required to prevent sling from interfering with machine.

7. Remove axle mounting nuts and lower axle gently to ground.

8. Reverse procedure for installation. Torque axle stud mounting nuts to 700 ft-lbs (97 m-kg). Torque wheel mounting nuts to 450 ft-lbs (62 m-kg).

AXLE DISASSEMBLY:

The following instructions will cover the disassembly and reassembly of the drive axle assembly in a sequence that would normally be followed when unit is to be removed from the machine and completely overhauled.

Disassembly procedure should be followed in conjunction with axle parts section and with axle vendor manual.

Caution: *Cleanliness is of extreme importance and an absolute must in the repair and overhaul of these units. Before attempting any repairs, the exterior of each unit must be thoroughly cleaned to prevent the possibility of dirt and foreign matter entering the mechanism.*

Inverting axles on steel horses provides greater stability and facilitates disassembly and reassembly.

1. Drain planetary and differential housings.
2. Remove hub thrust cap, O ring and washer assembly.
3. Remove axle shaft and sun gear assembly.
4. Remove sun gear retaining ring and sun gear from axle shaft.

Note: *If axle shaft replacement only is required, disassembly need only be carried to this point.*

5. Remove differential carrier bolts and lockwashers and lift differential and carrier assembly from housing.

6. Remove planet spider assembly from hub assembly. Remove sun gear thrust washer.

7. Straighten tangs on housing nut lock and remove outer tube nut, nut lock and inner tube nut.

8. Remove internal gear hub, internal gear, and outer hub bearing cone. Using suitable puller, pull hub bearing cone from hub. Remove bolts and lock plates and remove internal gear from hub.

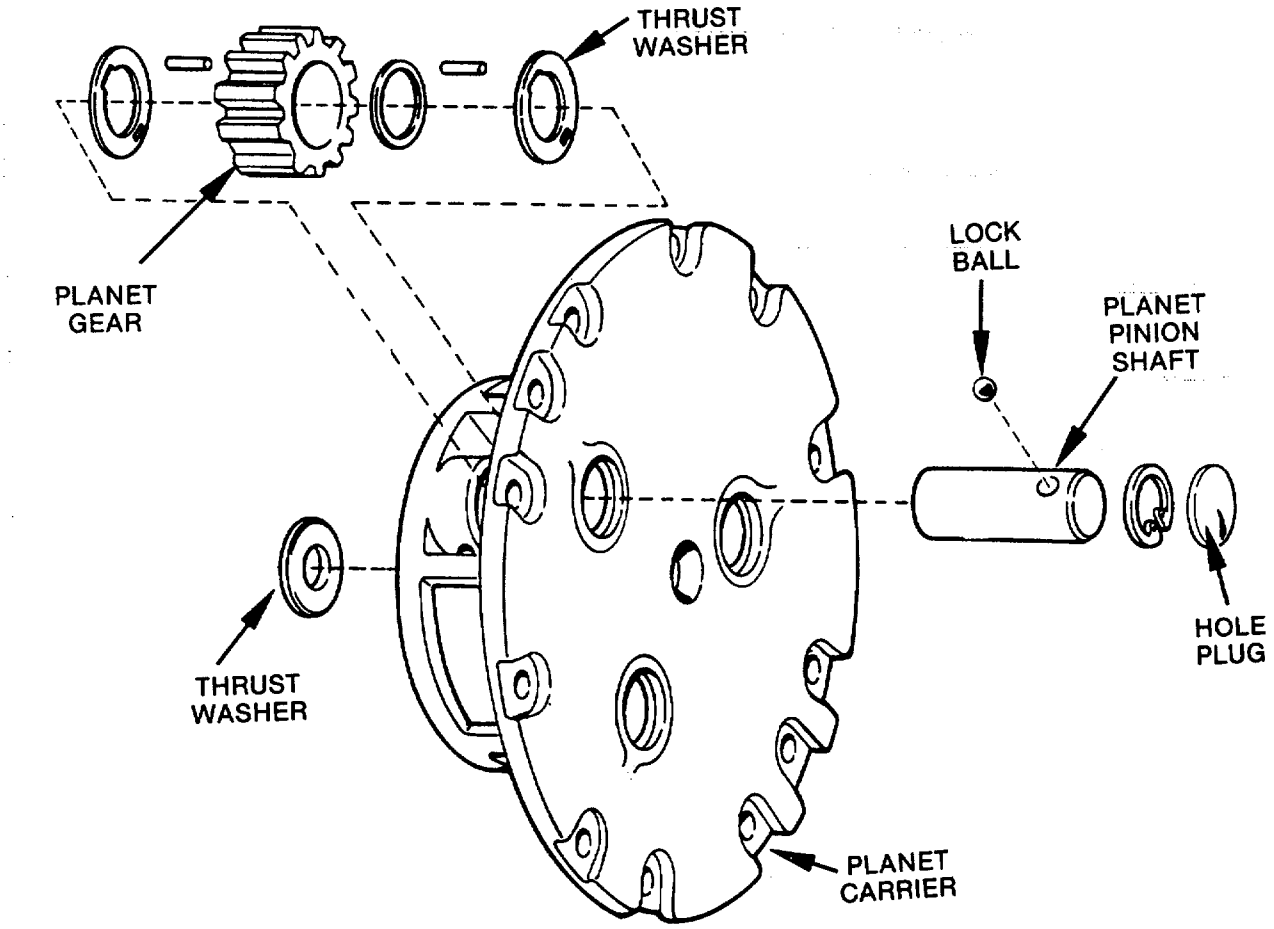
9. Remove hub and cup assembly. If replacement is required, remove hub oil seal, inner hub bearing cone and outer and inner hub bearing cups.

PLANET SPIDER DISASSEMBLY:

1. Drive the planet pinion shaft outward from side opposite lock ball.
2. Planet pinion gear may be removed with needle bearings, spacer and thrust washers.
3. The same other planet spider assemblies may be removed in the same manner.

PLANET SPIDER REASSEMBLY:

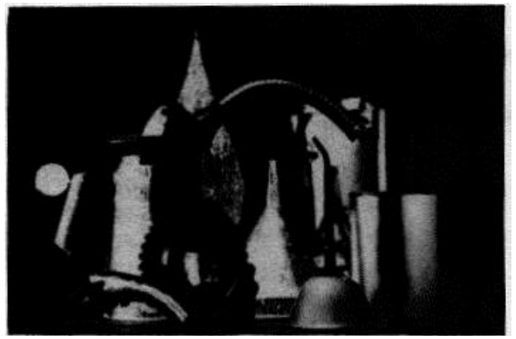
1. Lubricate the inside of planet gear with a heavy grease. This is to hold bearings in place during assembly.
2. Set planet pinion on thrust washer with tang side away from planet pinion gear.
3. Insert one-half of bearings and install spacer, then remaining one-half of bearings.
4. Set thrust washer on top with tang side away from planet pinion gear.
5. Install pinion gear, bearings spacer and thrust washer assembly into planet spider with tang into indentation of planet spider.
6. Install shaft through planet spider with lock ball in place.
7. With a small center punch stake planet spider near shaft Ice, ball so shaft will not fall out during installation of the complete planet spider assembly to axle.



Planetary Carrier Assembly

DRIVE AXLE REASSEMBLY:

1. Being certain housing face is clean, apply Permatex No. 2 and install differential and carrier in housing, securing in place on housing studs and tightening nuts to specified torque (refer to TORQUE SPECIFICATIONS CHART).
2. If spindle ends have been removed from housing, secure in place with special bolts, nuts and washers provided. Tighten to specified torque (refer to TORQUE SPECIFICATIONS CHART).
3. Install inner and outer hub bearing cups into hub assembly. Place inner hub bearing cone in position and install hub oil seal with lip of seal toward bearing. Fill oil seal lip with clean grease. Assemble hub on spindle.
4. Assemble internal gear into internal gear hub, securing in place with special capscrews provided. Tighten to specified torque (refer to TORQUE SPECIFICATIONS CHART). Assemble outer hub bearing cone in place on internal gear hub and assemble gear, hub and bearing in position on housing.
5. Install wheel bearing adjusting nut. While tightening nut, rotate wheel hub, and rap with a rubber or rawhide mallet until a definite drag is felt. Install sun gear thrust washer and adjust wheel bearing preload.
6. Use Permatex No. 2 on face of wheel hub and install a new O ring when installing planet spider assembly in position. Secure In place with special capscrews and lockwashers provided. Tighten to specified torque (refer to TORQUE SPECIFICATIONS CHART).
7. Assemble sun gear in place on axle shaft and place retaining ring in position in groove on shaft.
8. Insert splined end of shaft into axle housing, aligning splines with differential side gear and aligning gear teeth on sun gear with teeth on planet pinions.
9. Use Permatex No. 2 on face of planet spider and install a new O ring when installing hub thrust cap assembly in position. Secure in place with capscrews and lockwashers and tighten to specified torque (refer to TORQUE SPECIFICATIONS CHART).



RECOMMENDED LUBRICANTS FOR CLARK DRIVE AXLES

Prevailing Ambient Temperature or Refills use only	SAE Specification of Viscosity	Original Fill, Subsequent Fills,
Below minus 10° F.	MIL-L-10324A	Extreme Pressure
Minus 10° F. to Zero	SAE-80	(E.P.) "SCL" (Sulfo. Chloro.Lead)
Zero to 100° F	SAE-90	See Clark Recommended Lubricant Specification
Above 100° F.	SAE-140	Number MS-8
For All Normal Prevailing Ambient Temperatures	SAE-90	DO NOT ADD DIFFERENT TYPE OF LUBRICANT

Note: SAE-80 and SAE-140 are not covered by Clark Lubricant Specification MS-8; these viscosities, when used, should contain additives, as in MS-8.

MS-8 EXTREME PRESSURE GEAR LUBRICANT

This specification covers a lubricant for use In gear cases to lubricate gears and pinions.
It shall be a well refined mineral oil properly compounded with sulphur-chlorine-lead (SCL) type extreme pressure additives.
It shall be free of fillers or abrasives, such as fuller's earth, talc, graphite, cork, etc. It shall be stable, non-abrasive and non-corrosive to the materials used in the case gear mechanism whether or not in the presence of small percentages of water.

Physical and Chemical Properties

Saybolt Universal Viscosity @ 210°F	90-100 seconds
Saybolt Universal Viscosity @ 100°F	1400 seconds Max.
A.P.I. Gravity	13.6-15.9 degrees
Pour Point	Minus 10°F. Max.
Flash Point	350°F. Min.
Fire Point	400°F. Min.
Sulphur (Added)	1.20% Min.
Sulphur (Total)	3.00% Min.
Chlorine	1.20% Min.
Lead as Lead Oxide (PbO)	1.7% Min.
Moisture	.20% Max.
Load Carrying Capacity (Timken Test)	70 lbs. lever load Min.
Abrasion Test (33 lbs., 6 hrs.)	2.0 milligrams loss, Max.
SAE Test 750 RPM	350 lbs. Min.

Heat Test (oxidation)

Weigh 200 grams of sample into 400 CC beaker 3" in diameter. Heat in electric oven equipped with automatic temperature control, but without fan or turntable, maintaining temperature between 185° F. and 200° F. for approximately 8 hours per day. Turn off heat nights, Saturdays and Sundays, leaving sample in oven. After 125 hours of heating (approximately 22 days elapsed time), cool, weigh and determine viscosity. It shall not show a change in viscosity at 210° F. of over 10%, nor an evaporation loss of over 4%.

CHECKING OIL LEVEL IN DRIVE AND DRIVE STEER AXLES

For off-highway operation, check lubricant level after each 50 hours of operation. Always maintain lubricant level to bottom of filler plug hole. Drain oil every 1,000 operating hours.

For highway operation, lubricant should be checked each 1,000 miles. Maintain lubricant level to bottom of filler plug hole. Drain oil every 10,000 operating miles. NEVER ADD LUBRICANT TO AXLE UNLESS IT IS THE SAME MAKE AND GRADE AS THAT ALREADY IN USE.

To check oil level with differential drive, or axles with differential and planetary wheel ends, the axle should be run first, then allowed to stand for a minimum of five minutes on level ground. This procedure will allow oil to drain back to its normal level.

After the five minute interval, which allows the lubricant to settle to the proper level, proceed as follows: Remove oil filler plug in rear center of axle housing for oil level inspection. If oil level is not to the bottom of the filler hole, add necessary lubricant.

CHECKING AND FILLING PLANETARY WHEEL ENDS

Always check lubricant level in planetary wheel ends, with wheel hub thrust cap oil level plug in a down position. The wheel hub oil filler plug, located on the outer diameter of the wheel hub, will be within 35" of top dead center. Remove thrust cap level plug. If lubricant is below oil level hole, remove filler plug and fill to oil level hole. Reinstall pipe plugs. When filling wheel hub through oil level hole in thrust cap, remove vent plug above oil level plug before filling.

INTERAXLE DIFFERENTIAL

To fill axles with interaxle differential, add four (4) pints of lubricant in the input shaft differential case filler hole, install filler plug. Fill axle center until oil drips from bottom of filler hole, install housing filler plug.

FILLING DRIVE AND DRIVE STEER AXLES

Axles with single or double reduction at center: Fill axle housing through center filler hole until lubricant is at bottom of filler hole.

Axles with planetary wheel ends: Follow procedure in "checking and filling planetary wheel ends."

DRIVE STEER JOINT LUBRICATION

When Bendix-Weiss Joint Axle Shafts are used-remove pipe plug in spindle support and fill joint housing with (E.P.) Extreme Pressure Lithium Soap Base Grease No. 1. Reinstall pipe plug. DO NOT ADD DIFFERENT TYPE GREASE.

When Mechanics Joint Axle Shafts are used-grease with ordinary chassis grease.

Steering trunnion bearings should be lubricated with General Purpose Wheel Bearing Grease No. 2.

No. 2.

DRAINING

Draining is best accomplished immediately after vehicle has operated a short time or completed a trip. The lubricant is then warm and will flow freely, allowing full drainage in minimum time. This is particularly desirable in cold weather.

Remove plug at bottom of axle housing and allow sufficient time for lubricant to drain. With planetary wheel ends, rotate wheel until filler hole is down. Remove plug and allow sufficient time for draining. Be sure thrust cap oil level hole is in proper position when refilling wheel ends.

FLUSHING

After draining, axles should be flushed. Replace drain plugs and fill axles to proper level with a light flushing oil. Operate the axles for a short period of time, then drain. Be sure to drain all of the flushing oil before refilling with new oil. Inspect the magnetic drain plug for metal particles or other foreign matter indicative of wear or possible failure. When refilling, cleanliness is extremely important.

Note: Specifications are subject to change.



APPROXIMATE LUBRICANT CAPACITIES

Note: All *quantities are* shown *in pints; 1 pint-1 pound*

Model	Each Hub	Diff.	Total
FD-5700	NP	7	7
FD-6500	5	11	21
FD-9000	NP	7	7
FD-9350	NP	7	7
RD-10100	5	16	26
FD-11500	5	12	22
FD-13500	5	16	26
FD-14000	NP	8	8
FD-14500	NP	17	17
FD-17000	8	14	30
FD-17500	8	17	33
RD-FD-17600	13	15	41
RD-FD-17700	13	15	41
FD-19000	13	26	52
RD-FD-19100	8	26	42
FD-21000	NP	18	18
FD-21150	NP	8	*8*
RD-FD-22500	8	18	34
RD-FD-22500*	8	21	37
RD-FD-22700	8	18	34
FD-24000	13	26	52
RD-FD-24500	13	26	52
RD-FD-24600	13	26	52
RD-FD-28000	NP	17	17
FD-30000	13	24	50
RD-FD-30500	13	34	60
RD-FD-30600	13	34	60
FD-31201	NP	18	18
RD-FD-36500	13	52	78
RD-FD-36600	13	52	78
RD-FD-36700	13	52	78
RD-FD-37400	13	52	78
RD-FD-37500	13	52	78
RD-FD-38000	8	14	30
FD-42000	16	24	56
FD-45000	26	67	119
RD-FD-47000	*26*	*52*	*104*
RD-FD-65000	30	100	160
RD-FD-70000	26	67	119
FD-70500	26	69	121
FD-70501	26	69	121
FD-71000	26	69	121
RD-FD-75000	18	34	70
FD-85000	30	100	160
RD-FD-86000	40	100	180

Model	Each Hub	Diff.	Total
RD-FD-86500	74	100	248
FDS-9050	NP	14	14
RDS-FDS-11000	8	16	32
RDS-FDS-11001	8	16	32
FDS-12050*	8	21	37
FDS-12050	8	14	30
RDS-FDS-16000	11	26	48
RDS-FDS-16750	16	18	50
FDS-20000	8	18	34
FDS-20000*	8	21	37
FDS-RDS-21000***	4	21	29
FDS-RDS-22000	8	21	37
FDS-22500 3.529 Ratio	11	35	57
FDS-22500 3.666 Ratio	16	35	67
RD-4600	NP	7	7
RD-5800	NP	7	7
RD-6000**	NP	20	20
RD-6000	NP	7	7
RD-9200	NP	7	7
RD-9600	3	9	15
RD-15750	8	14	30
RD.16002	8	14	30
RD-24050	13	26	52
RD-30050	13	24	50
RD-37000	13	30	56
RDS-8000	5	16	26
RDS-18000	16	28	60
RDS-18100	16	28	60
RDS-20000	16	22	54
RDS-22500	16	35	67
RDS-22600	16	35	67
RDS-22700	13	48	74
RDS-35000	24	24	72
RDS-35000-1	24	64	112
RDS-40000	24	64	112
RDS-65000	36	100	172
FRD-RRD-22-30	8	21	37
FRD-RRD-25-30	8	21	37
FRD-RRD-25-35	8	35	51
FRD-RRD-32500	8	37	53
FRD-RRD-33000	8	35	51
FRD-RRD-35000	16	35	67
FRD-RRD-40-60	16	35	67
FRD-RRD-45000	16	35	67
FRD-RRD-50000	16	35	67

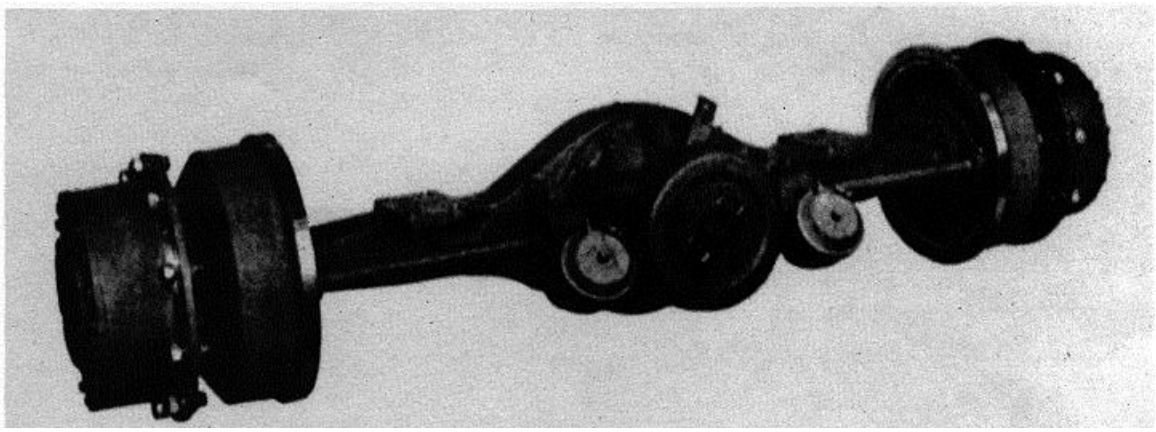
NP-Non-planetary *Drop Gear Carrier **Three Gear Reduction Carrier

***Disassemble and pack Inner Wheel Bearing every 1000 hours operation.

NOTE: Increase Lubricant Capacity Four (4) Pints in all Axles with Inter-Axle Differential.

AXLE

MAINTENANCE
&
SERVICE MANUAL



THIS MANUAL COVERS FOLLOWING SERIES OF DRIVE AXLES

FD-30001	F D-37500	RD-37500
FD-30500	RD-30500	FD-36500
FD-30600	RD-30600	RD-36500

EXPLODED VIEWS

To supplement the illustrations provided in the overhaul section of the manual, exploded view illustrations are supplied. Legends, keyed to the index numbers on the illustrations, are adjacent to the illustrations to aid in parts identification on the axles. The exploded views are as follows:

Fig. A-Drive Axle Assembly

Fig. B-Differential and Carrier Assembly

Fig. C-NoSPIN Differential

Fig. D-Planet Carrier Assembly

Fig. E-Service Brake Assembly

Fig. F-Parking Brake Assembly

The following compounds, or their equivalent, are required for the overhaul of these axles:

Material	Use
Lubriplate	Apply to lips of all oil seals at reassembly.
Mixture of Red Lead and Linseed Oil	Paint ring gear teeth to check for proper differential gear and pinion engagement.
Never-Seez Compound	Apply to eccentric anchor ins of brake.
Permatex No. 2 .	Used for numerous sealing applications

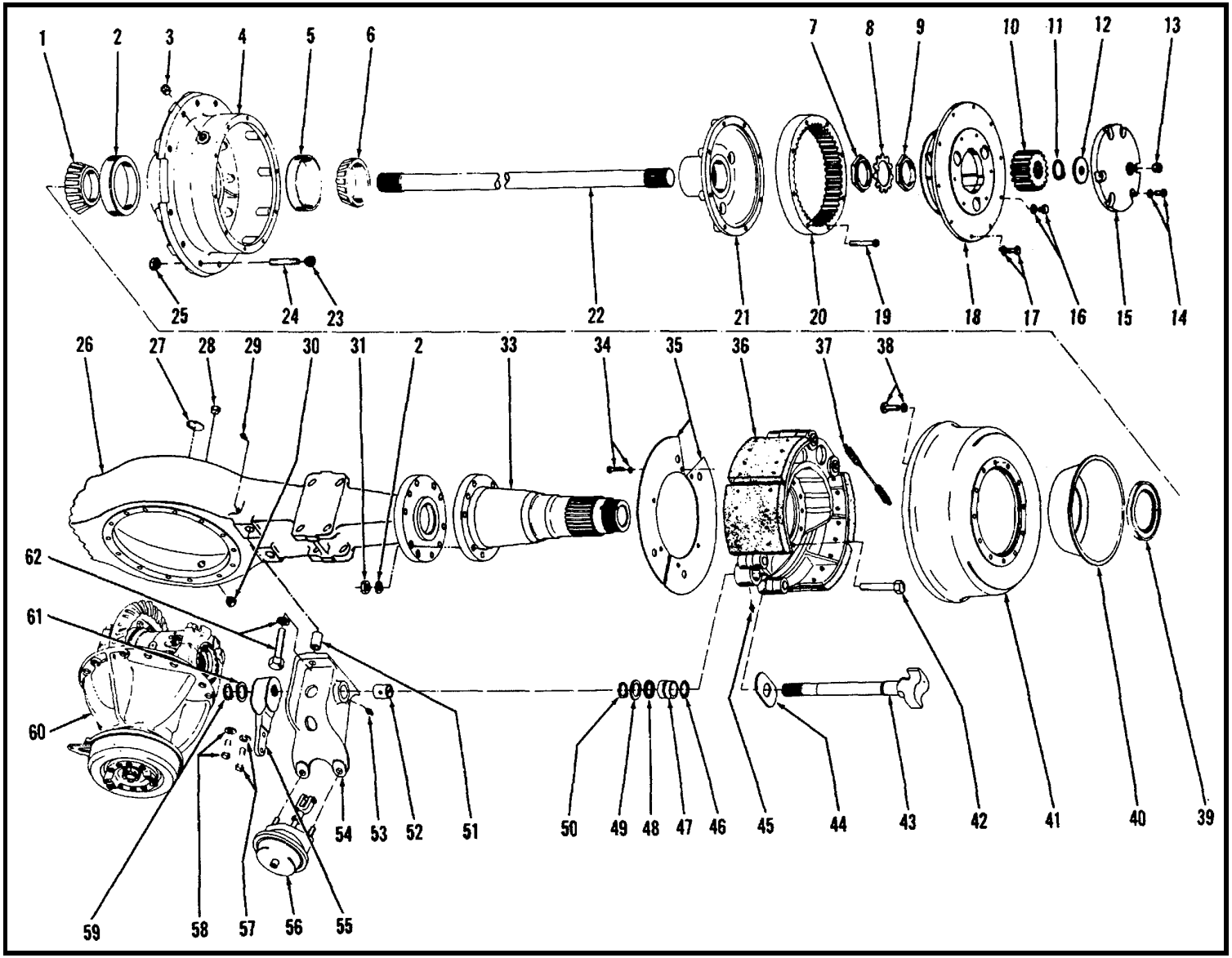


FIG. A DRIVE AXLE ASSEMBLY TS-3015

DRIVE AXLE ASSEMBLY

Item No.	Description	No. Req'd.
1	CONE, Inner Hub Bearing	2
2	CUP, Inner Hub Bearing	2
3	PLUG, Hub Filler	2
4	HUB ASSY	2
5	CUP, Outer Hub Bearing	2
6	CONE, Outer Hub Bearing	2
7	NUT, Inner Spindle	2
8	LOCK, Spindle Nut	2
9	NUT, Outer Spindle	2
10	GEAR, Sun	2
11	RING, Sun Gear Retaining	2
12	WASHER, Sun Gear Thrust	2
13	PLUG, Thrust Cap	2
14	BOLT & LOCKWASHER, Thrust Cap	12
15	CAP, Sun Gear Thrust	2
16	BOLT & LOCKWASHER, Puller Hole	4
17	BOLT & WASHER, Planet Carrier to Hub	20
18	PLANET CARRIER	2
19	BOLT, Internal Gear to Hub	16
20	GEAR, Internal	2
21	HUB, Internal Gear	2
22	AXLE SHAFT	2
23	NUT, Wheel	20
24	STUD, Wheel	20
25	NUT, Wheel Stud	20
26	HOUSING, Axle	1
27	PLUG, Expansion	2
28	PLUG, Housing Filler	1
29	BREATHER, Axle Housing	1
30	PLUG, Housing Drain	1
31	NUT, Spindle & Brake Attaching	20
32	WASHER, Spindle & Brake Attaching	20
33	SPINDLE	2
34	BOLT & LOCKWASHER, Dust Cover	8
35	COVER, Brake Dust	4
36	REAR BRAKE ASSY	2
37	SPRING, Brake Shoe Return	2
38	BOLT & WASHER, Brake Drum to Hub	24
39	SEAL, Hub Oil	2
40	CATCHER, Oil	2
41	DRUM, Brake	2
42	BOLT, Spindle & Brake Attaching	20
43	CAM SHAFT	1
44	WASHER, Cam Shaft Thrust	2
45	FITTING, Brake Spider Grease	2
46	"O" RING, Cam Shaft	2
47	BUSHING, Brake Spider	2
48	RETAINER, Brake Spider Grease	2
49	WASHER, Cam Shaft	2
50	RING, Washer Retaining	2
51	SPACER, Air Chamber Bracket	4
52	BUSHING, Air Chamber Bracket	4
53	FITTING, Air Chamber Bracket Grease	2
54	BRACKET ASSY, Air Chamber	2
55	ADJUSTER, Slack	2
56	AIR CHAMBER	2
57	BOLT & WASHER, Carrier to Axle Housing	10
58	BOLT & WASHER, Carrier to Axle Housing	4
59	RING, Slack Adjuster Retaining	2
60	DIFFERENTIAL & CARRIER ASSY	1
61	WASHER, Slack Adjuster Retaining	2
62	BOLT, Air Chamber Bracket	4

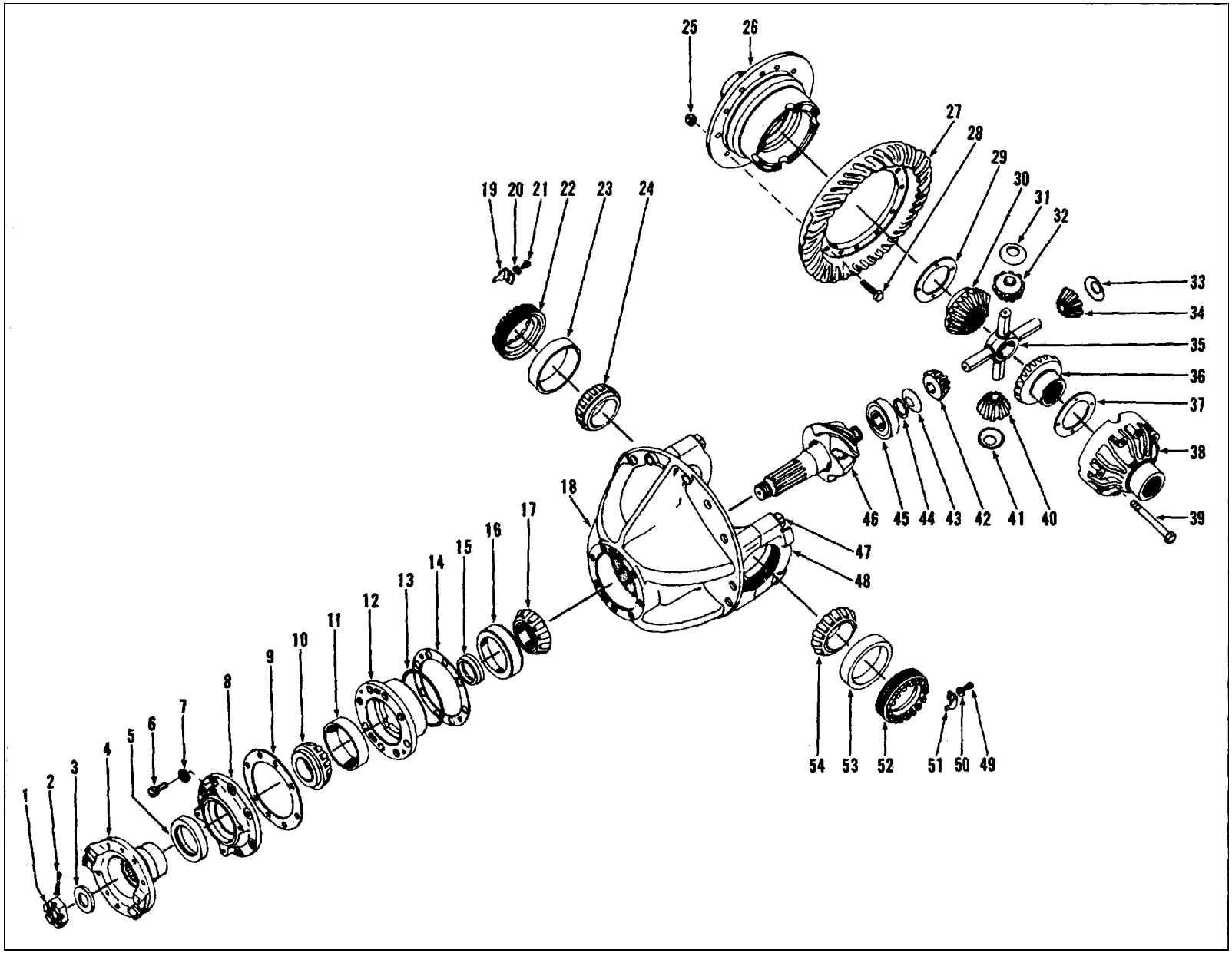


FIG. B DIFFERENTAL AND CARRIER ASSEMBLY TS-4989

DIFFERENTIAL AND CARRIER ASSEMBLY

Item No.	Description	No. Req'd.
1	NUT, Pinion Shaft	1
2	COTTER, Pinion Shaft Nut	1
3	WASHER, Pinion Shaft	1
4	FLANGE, Companion	1
5	SEAL, Pinion Oil	1
6	BOLT, Pinion Oil Seal Retainer	8
7	LOCKWASHER, Pinion Oil Seal Retainer	8
8	RETAINER, Pinion Oil Seal	1
9	GASKET, Pinion Oil Seal Retainer	1
10	CONE, Outer Pinion Bearing	1
11	CUP, Outer Pinion Bearing	1
12	CAGE ASSEMBLY, Pinion Bearing	1
13	"O" RING, Outer Pinion Bearing Cage	1
14	SHIM, Bearing Cage	AR
15	SPACER, Pinion Bearing	1
16	CUP, Center Pinion Bearing	1
17	CONE, Center Pinion Bearing	1
18	CARRIER ASSEMBLY, Differential	1
19	LOCK, Adjusting Nut	1
20	LOCKWASHER, Adjusting Nut Lock	1
21	BOLT, Adjusting Nut Lock	1
22	Nut, Differential Adjusting	1
23	CUP, Differential Bearing	1
24	CONE, Differential Bearing	1
25	NUT, Ring Gear	12
26	DIFFERENTIAL CASE, Flange Half	1
27	RING GEAR	1
28	BOLT, Ring Gear	12
29	WASHER, Side Gear Thrust	1
30	GEAR, Differential Side	1
31	WASHER, Differential Pinion Thrust	1
32	PINION, Differential	1
33	WASHER, Differential Pinion Thrust	1
34	PINION, Differential	1
35	SPIDER, Differential	1
36	GEAR, Differential Side	1
37	WASHER, Side Gear Thrust	1
38	DIFFERENTIAL CASE, Plain Half	1
39	BOLT, Differential Case	8
40	PINION, Differential	4
41	WASHER, Differential Pinion Thrust	1
42	PINION, Differential	1
43	WASHER, Differential Pinion Thrust	1
44	RING, Inner Bearing Snap	1
45	BEARING, Inner Pinion	1
46	PINION	1
47	BOLT & WASHER, Carrier Cap	4
48	CAP, Carrier	2
49	BOLT, Adjusting Nut Lock	1
50	LOCKWASHER, Adjusting Nut Lock	1
51	LOCK, Adjusting Nut	1
52	NUT, Differential Adjusting	1
53	CUP, Differential Bearing	1
54	CONE, Differential Bearing	1

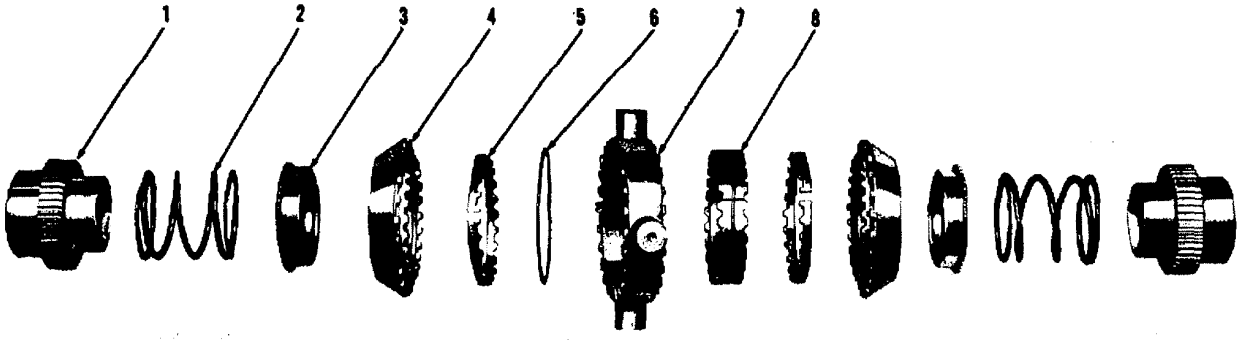


FIG. C TS-249-P

NoSPIN DIFFERENTIAL ASSEMBLY

Item No.	Description	No. Req'd.
1	GEAR, Side	2
2	SPRING	2
3	RETAINER, Spring	2
4	CLUTCH, Driven	2
5	RING, Holdout	2
6	RING, Retaining	1
7	SPIDER	1
8	CAM, Center	1

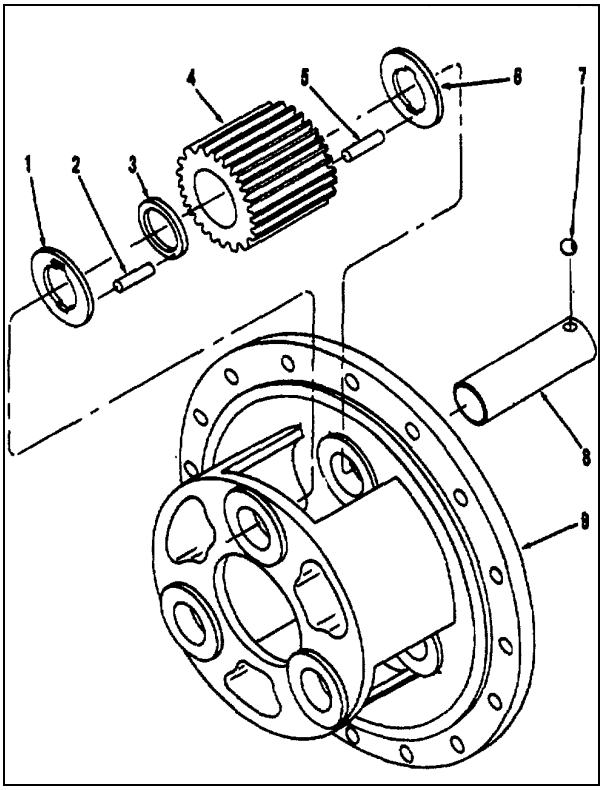


FIG. D TS-460P

Figure D-PLANET CARRIER ASSEMBLY

Item No.	Description	No. Req'd,
1	WASHER, Pinion Thrust	3
2	ROLLER, Pinion	78
3	SPACER, Pinion Roller	3
4	PINION ,	3
5	ROLLER, Pinion	78
6	WASHER, Pinion Thrust	3
7	BALL, Pinion Shaft Lock	3
8	SHAFT, Pinion	3
9	CARRIER, Planet	1

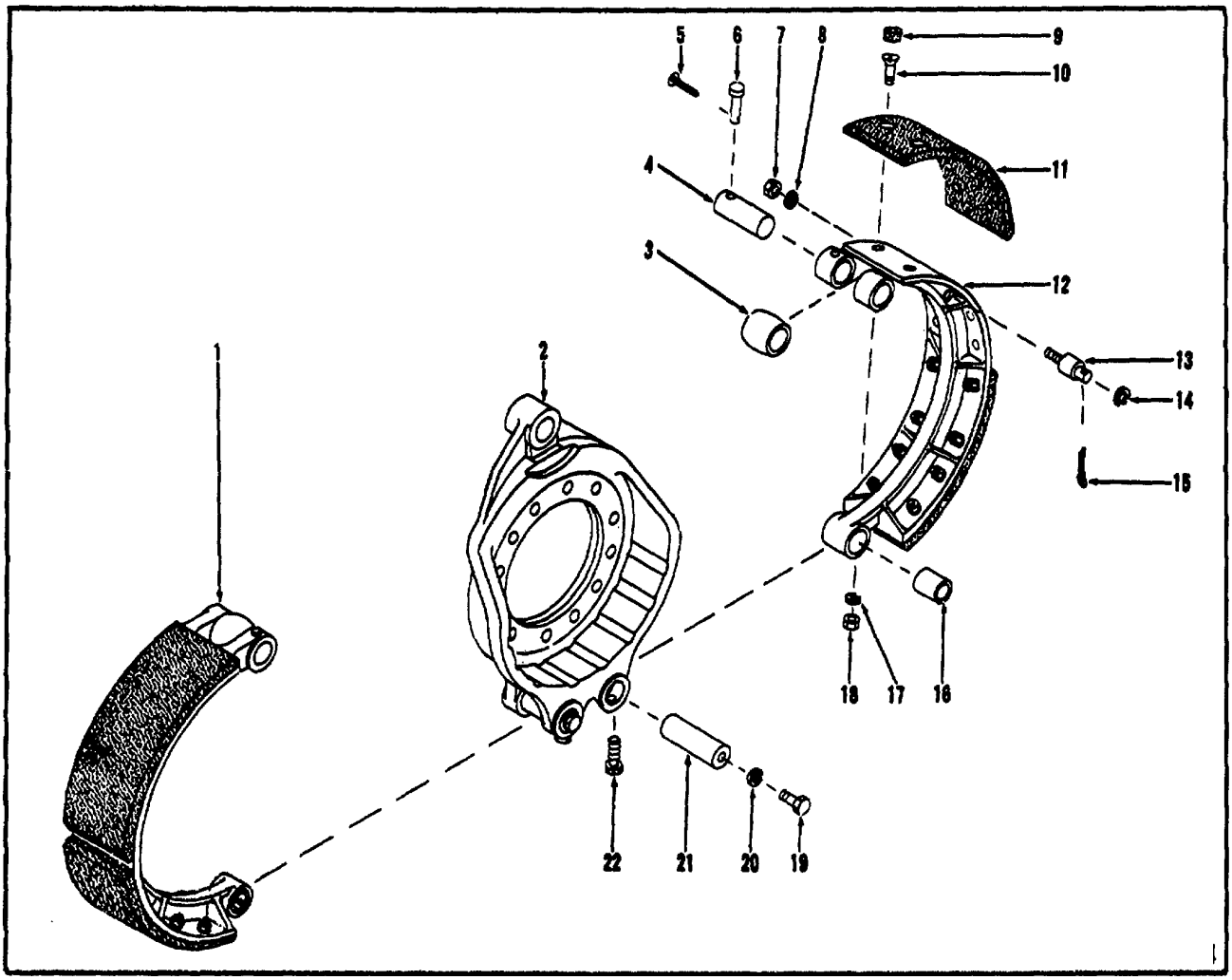


FIG. E **TS-5014**

SERVICE BRAKE ASSEMBLY

Item No.	Description	No. Req'd.	Item No.	Description	No. Req'd
1	SHOE ASSEMBLY, Brake	2	12	SHOE Brake	2
2	SPIDER, Brake	1	13	PIN, Spring Anchor	2
3	ROLLER, Brake Cam	2	14	WASHER, Spring Anchor Pin	2
4	PIN, Brake Cam Roller	2	15	COTTER, Spring Anchor Pin	2
5	COTTER, Roller Pin Lock	2	16	BUSHING, Brake Shoe	32
6	PIN, Cam Roller Pin Lock	2	17	LOCKWASHER, Lining to Shoe	32
7	Nut, Spring Anchor Pin ,	2	18	NUT, Lining to Shoe	32
8	LOCKWASHER, Spring Anchor Pin	32	19	BOLT, Puller Hole Plug	2
9	PLUG, Broke Lining	32	20	LOCKWASHER, Puller Hole Plug	2
10	BOLT, Lining o Shoe	32	21	PIN, Anchor	2
11	LINING, Brake Shoe	4	22	SCREW, Anchor Pin Set	22

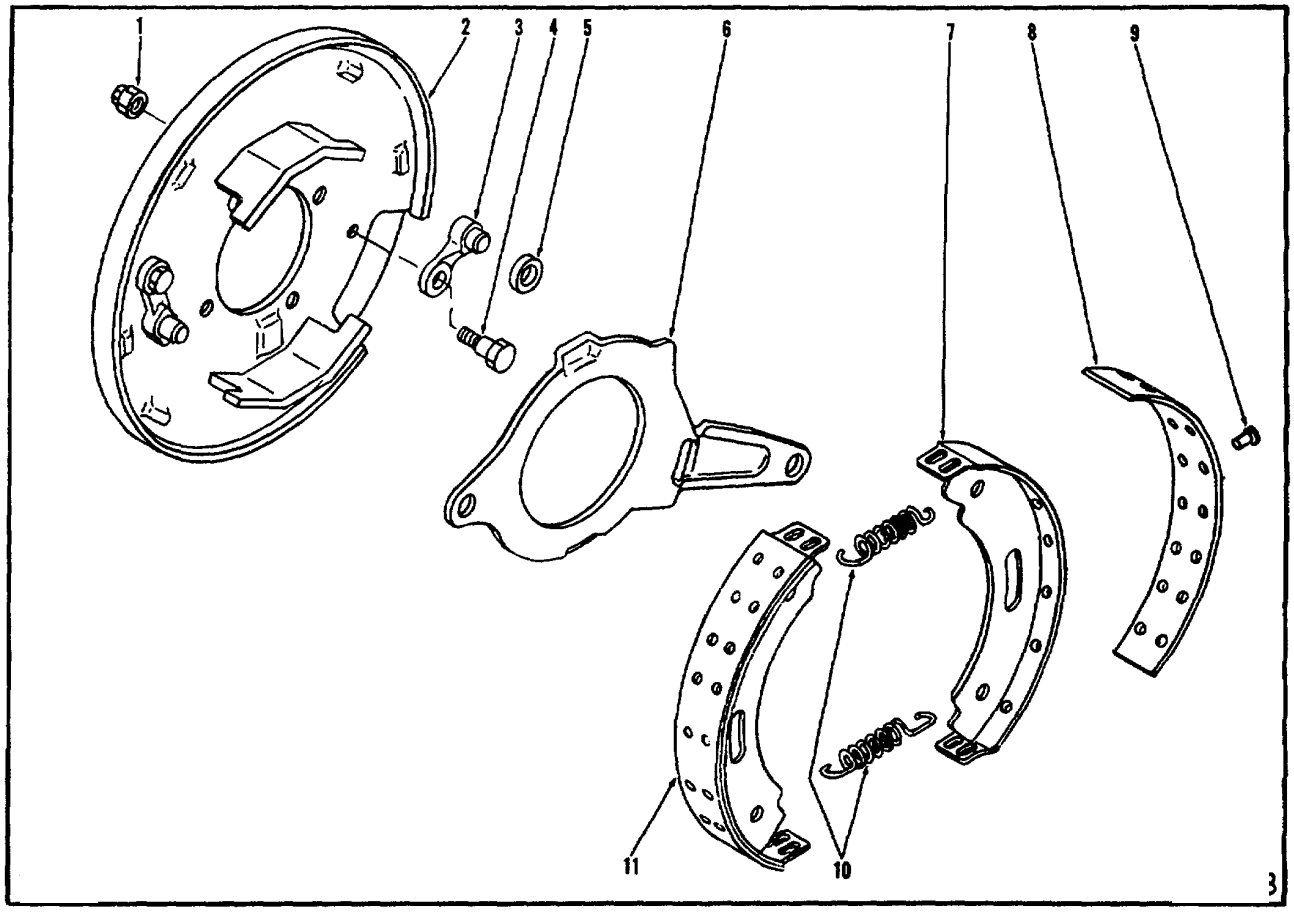


FIG. F **TS-3298**

PARKING BRAKE ASSEMBLY

Item No.	Description	No. Req'd.
1	NUT, Pawl to Plate	2
2	PLATE, Brake Backing	1
3	PAWL, Brake	2
4	BOLT, Pawl to Plate	2
5	ROLLER, Brake Actuating	1
6	LEVER, Cam Operating	1
7	SHOE, Brake	2
8	LINING, Brake Shoe	1
9	RIVET, Lining to Shoe	28
10	SPRING, Shoe Return	2
11	SHOE ASSEMBLY, Brake	2

OVERHAUL OF AXLE ASSEMBLY

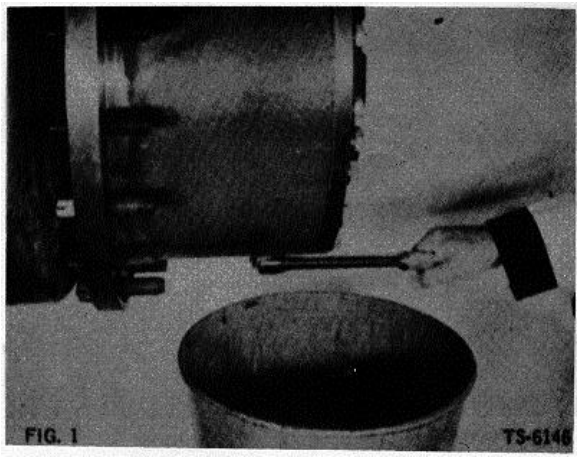
The instructions contained herein cover the disassembly and reassembly of the axle assembly in a sequence that would normally be followed after the unit has been re- moved from the machine and is to be completely over- hauled.

CAUTION: Cleanliness is of extreme importance and an absolute must in the repair and overhaul of this unit. Before attempting any repairs, the exterior of the unit must be thoroughly cleaned to prevent the possibility of dirt and foreign matter entering the mechanism.

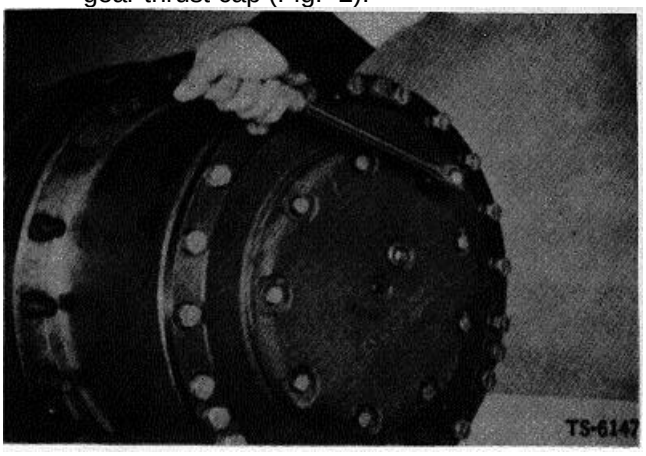
NOTE: Placing axles on steel horses facilitates disassembly and reassembly. Greater stability is gained by resting axle mounting pads on horses so that axles are inverted from normal operating positions. Photographs showing this overhaul procedure were taken with axle in inverted position.

DISASSEMBLY OF AXLE

1. Remove drain plugs from planetary housings and from differential housing to drain axle (Fig. 1).

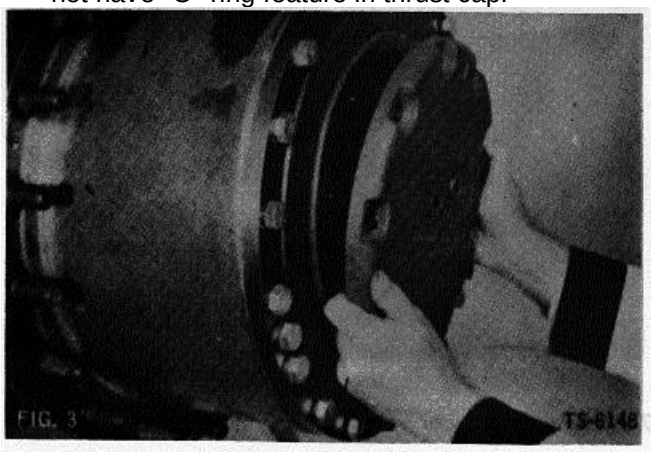


2. Remove bolts and flat washers securing sun gear thrust cap (Fig. 2).

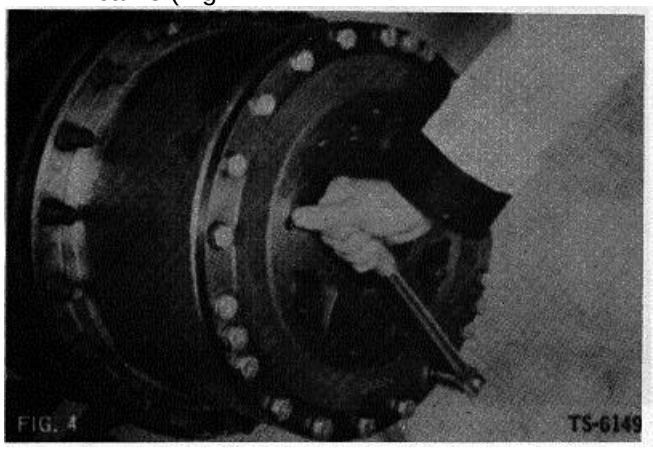


3. Remove sun gear thrust cap (Fig. 31. Remove "O" ring from cap.

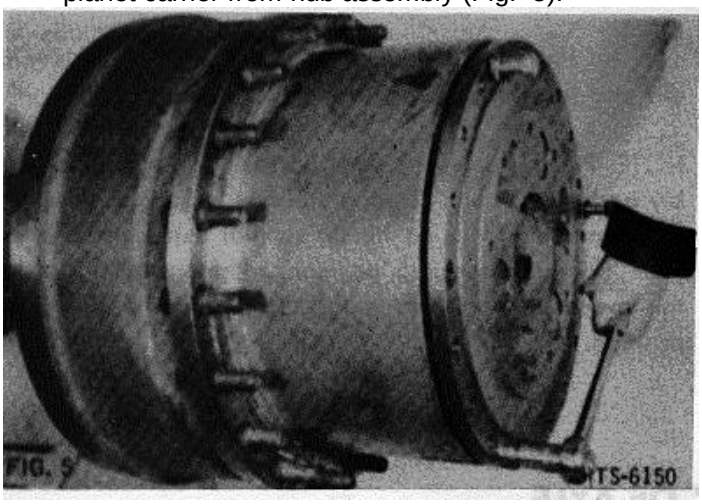
NOTE: Some early versions of axle assemblies do not have "O" ring feature in thrust cap.



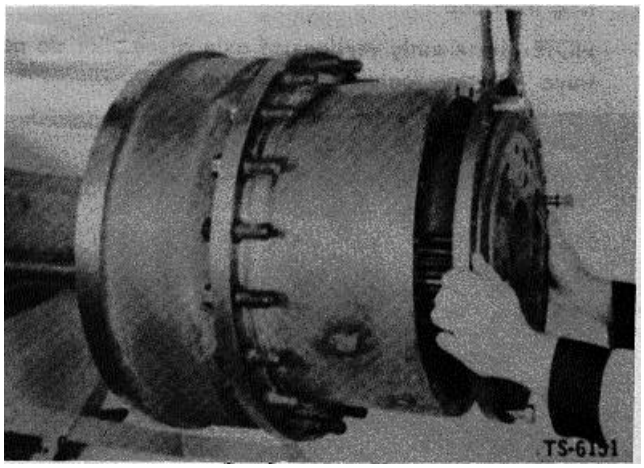
4. Remove bolts and lockwashers retaining planer came (Fig. 41.



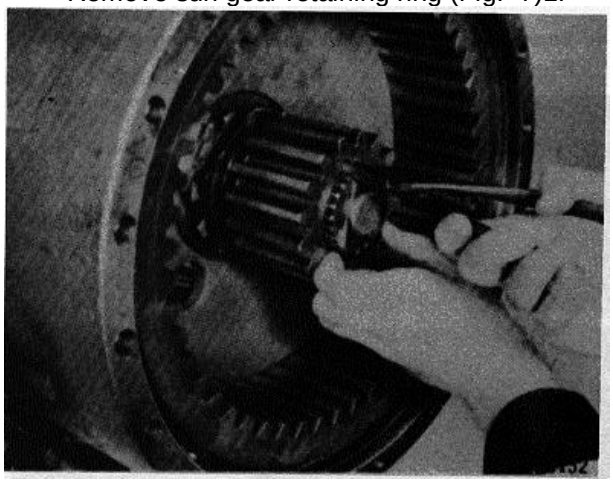
5. Install three mounting bolts in puller holes to pull planet carrier from hub assembly (Fig. 5).



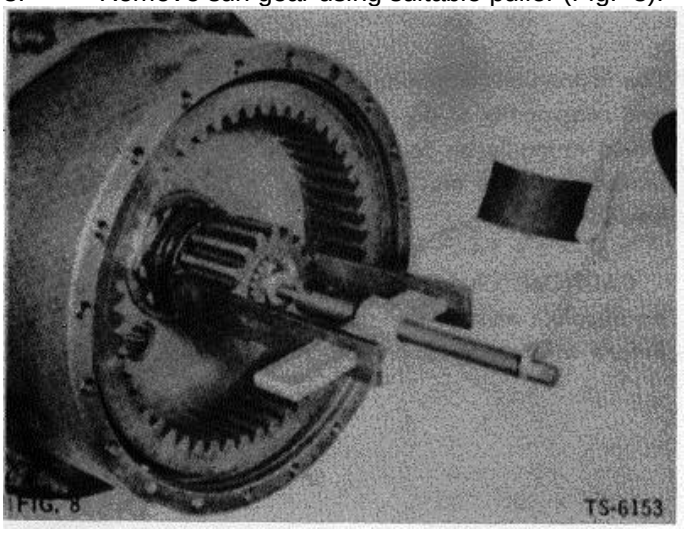
6. Remove planetary assembly (Fig. 6). Remove "O" ring from planetary assembly.



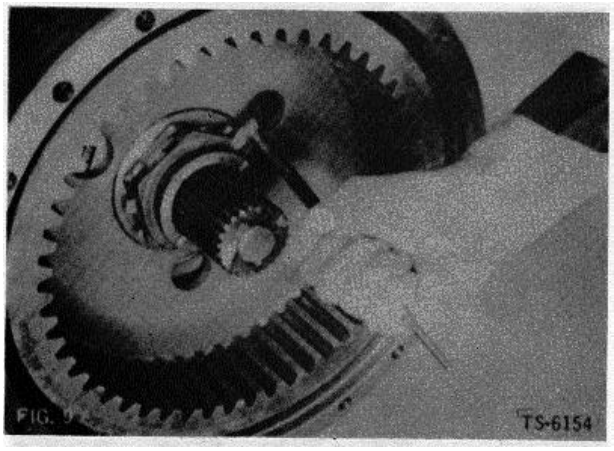
7. Remove sun gear retaining ring (Fig. 7)1.



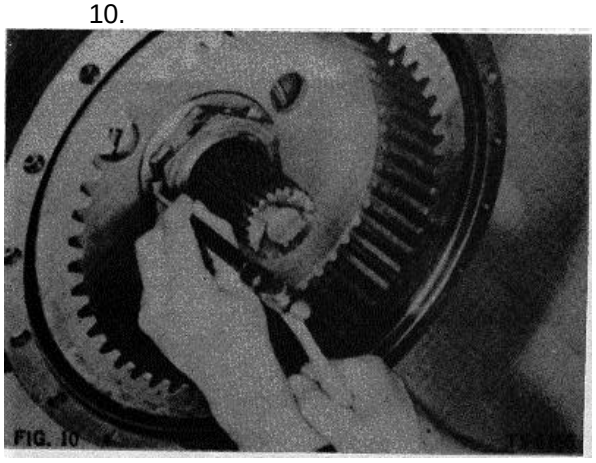
8. Remove sun gear using suitable puller (Fig. 8).



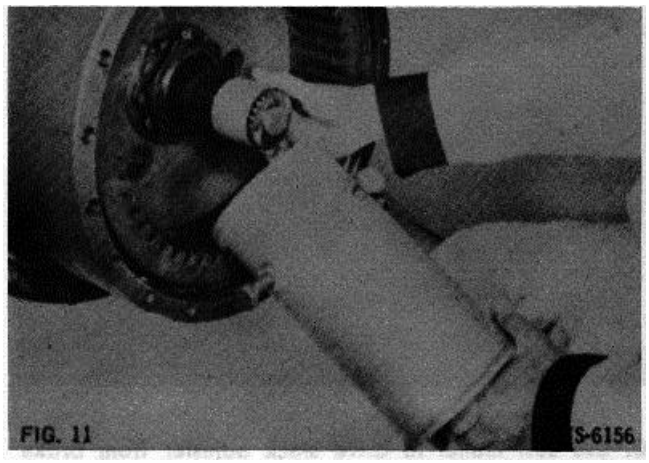
9. Some axle models have thrust ring pressed lightly into end of spindle. If provided, use pry bar to remove thrust ring from end of spindle (Fig. 9).



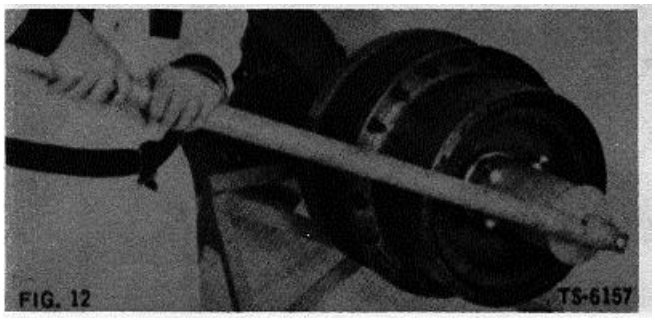
10. Straighten tangs on nut lock as shown in Fig. 10.



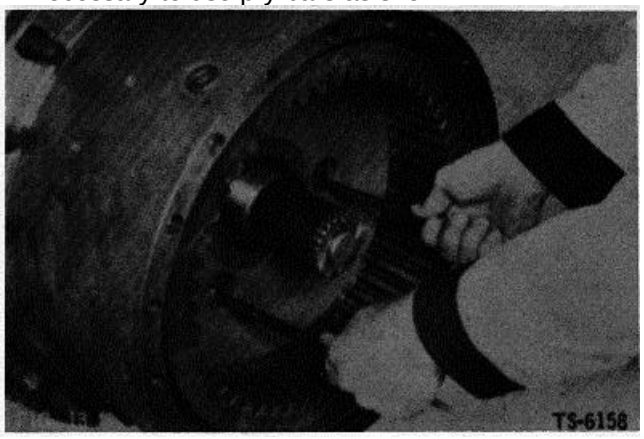
11. Support weight of hub and drum assembly with hoist. Wrap several turns of .010" to .020" shim stock around end of axle shaft to protect shaft splines (Fig. 11). Install special wrench (Clark No. 945940) on outside spindle nut. Tighten guide screws lightly against shim stock.



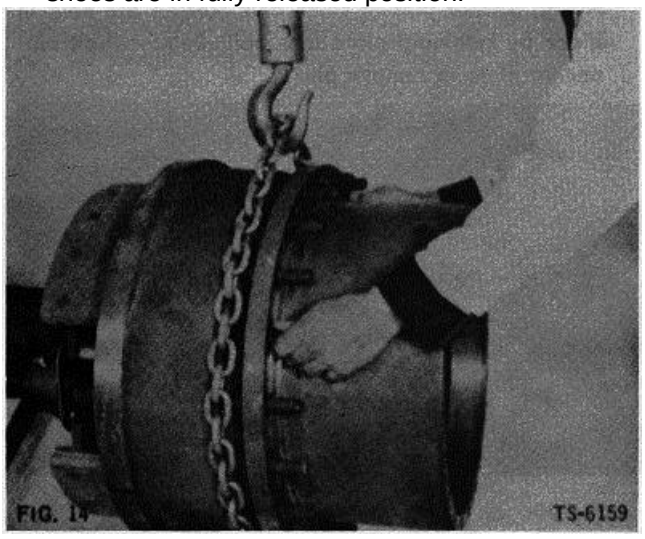
12. Remove outside spindle nut, nut lock, and inside spindle nut (Fig. 121.



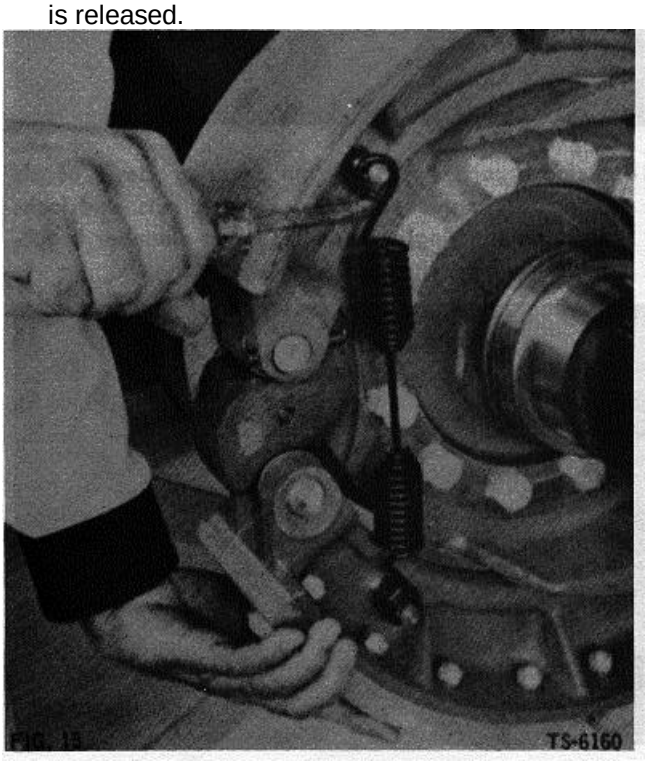
13. Support weight of brake drum and hub assembly with hoist. Remove internal gear and hub from spindle assembly (Fig. 13). In some cases it will be necessary to use pry bars as shown.



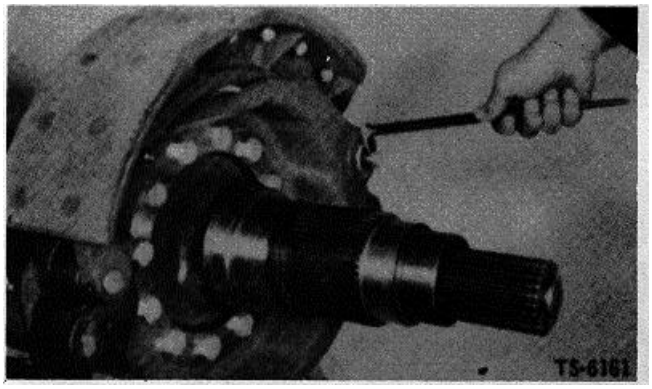
14. Pull straight out on brake drum and hub assembly to remove it from axle (Fig. 14). Be sure brake shoes are in fully released position.



15. Remove cotter pin and spring anchor pin washer. Disengage and remove brake shoe return spring from anchor pin (Fig. 15). Discard old return spring. CAUTION: Use care when removing return spring so as not to cause injury. Spring is under tension and can be projected some distance when released from anchor pin. Support lower brake shoe or it will pivot around anchor pin when spring is released.



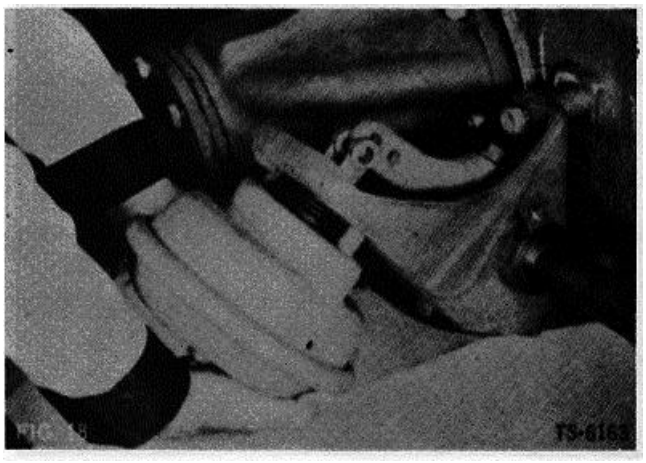
16. Cut lockwire and remove anchor pin set screws. Unscrew bolt in anchor pin several turns. Use pry bar under screw head to start anchor pin from spindle support assembly (Fig. 16). NOTE: Anchor pins of some axle models are held in, place by retaining plate and bolt. Remove bolt and' anchor plate to remove pins.



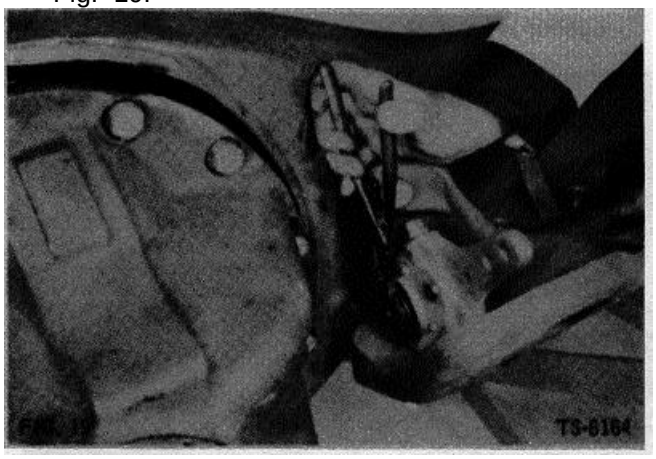
17. Remove anchor pin and remove brake shoe (Fig. 17).



18. Remove cotter pin and pin securing clevis of air chamber to slack adjuster. Remove nuts and lock-washers securing air chamber to air chamber bracket; remove air chamber (Fig. 18). ,



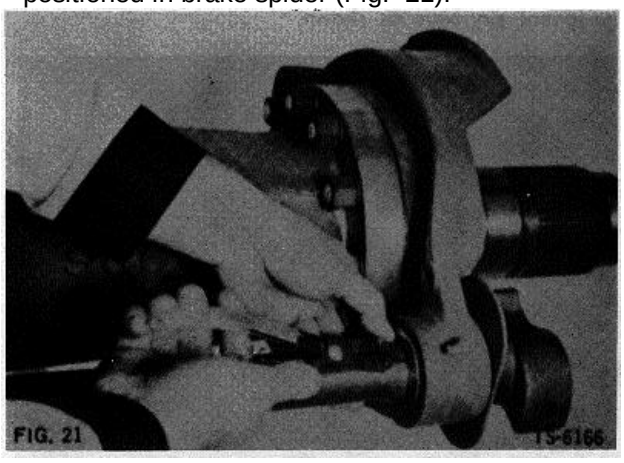
19. Remove slack adjuster retaining ring (Fig. 19). Remove slack adjuster retaining washer. Note position of slack adjuster adjusting screw. In some applications, screw is adjacent to air chamber bracket. In other applications, it is as shown in Fig. 19.



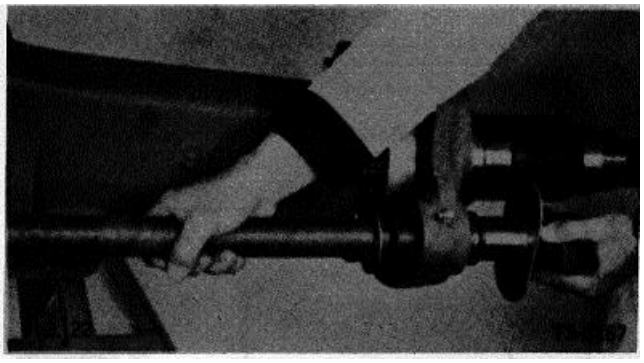
20. Use soft mallet to drive slack adjuster from brake cam shaft (Fig. 20).



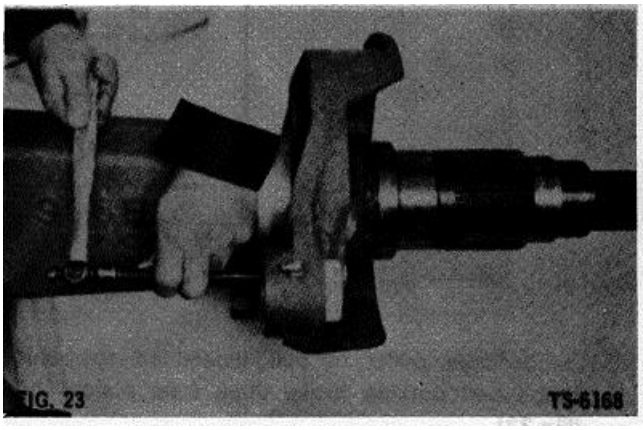
21. Unseat retaining ring that holds cam shaft positioned in brake spider (Fig. 21).



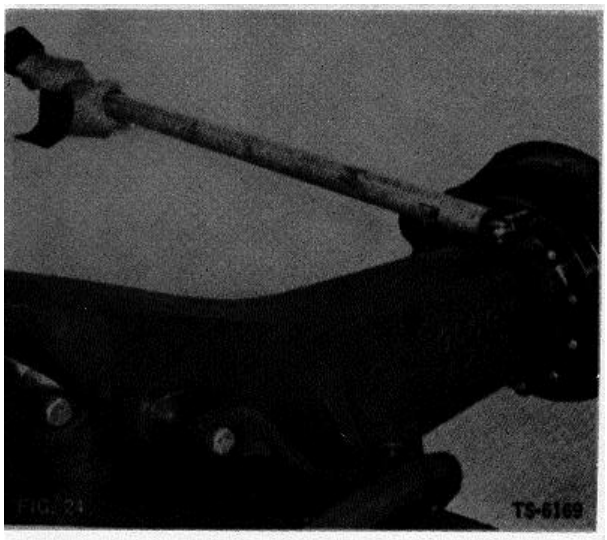
22. Remove brake cam shaft and cam shaft thrust washer from brake spider (Fig. 22). Remove cam shaft grease washer, felt grease retainer, and "0O" ring.



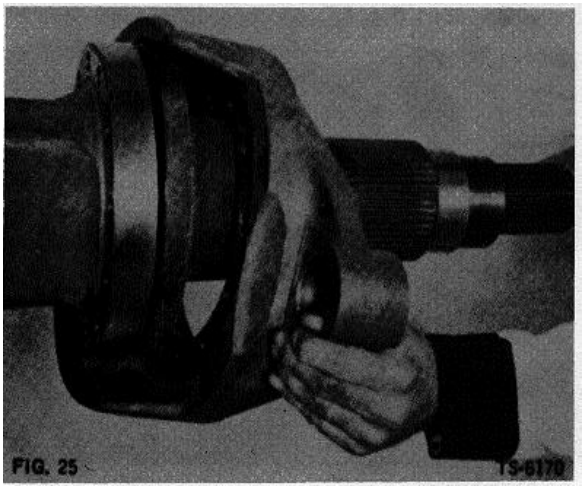
23. If damaged, drive brake cam shaft bushing from brake spider (Fig. 23).



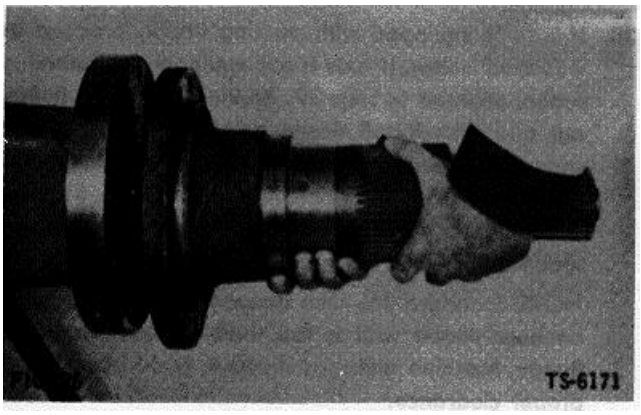
24. Remove mounting bolts and washer securing spindle and brake spider to axle housing (fig. 24).



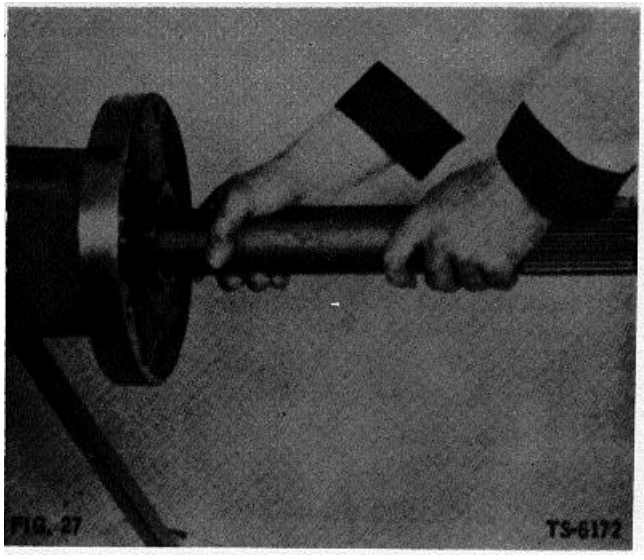
25. Remove brake spider from spindle (Fig. 25).



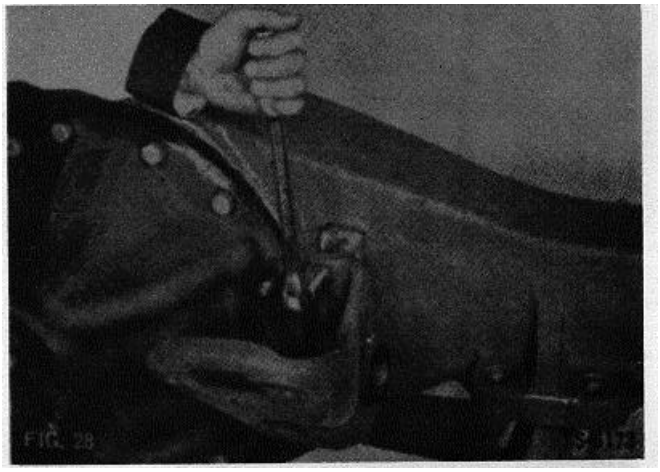
26. Remove spindle from axle housing (Fig. 26).



27. Remove axle shaft from axle housing (Fig. 27).



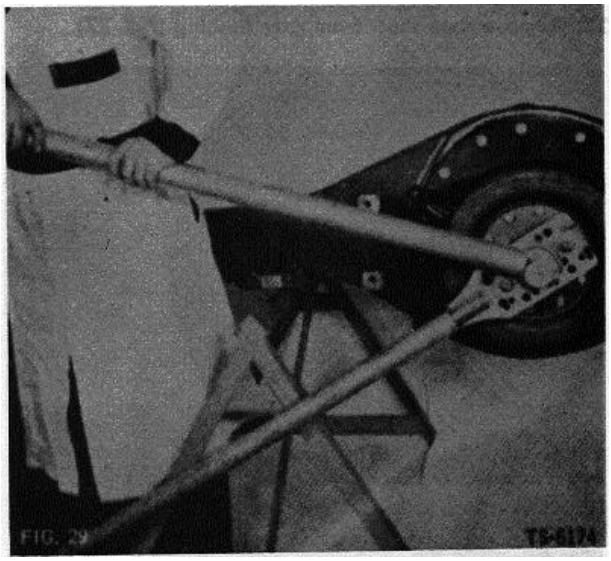
28. Remove two bolts and lock washers that secure air chamber bracket to axle housing; remove bracket and spacers (Fig. 281.

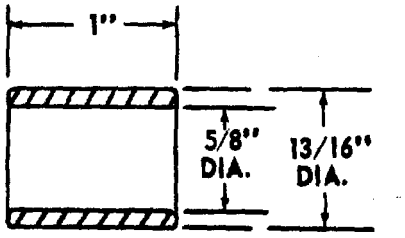


29 Disassemble opposite side of axle following instructions given in steps 2 through 28.

30. If axle is equipped with parking brake, proceed as indicated below. If axle is not equipped with parking brake, proceed to step 39. Position socket on flange nut and then install flange retaining tool with two spacers between tool and flange. Spacer dimensions are given in Fig. 30. Loosen flange nut (Fig. 29). Re- move flange retaining tool and remove flange nut and washer.

NOTE: Standard 2 % -inch socket will not fit flange nut because socket wall is too thick to enter recess In flange. Machine socket as shown in Fig. 31 to provide proper clearance.





1/32" DIA RADIUS ALL CORNERS

FIG. 30 TS-5685

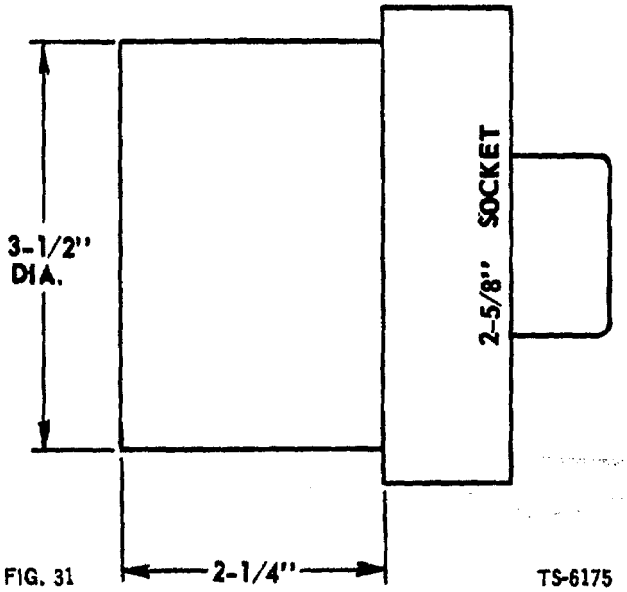
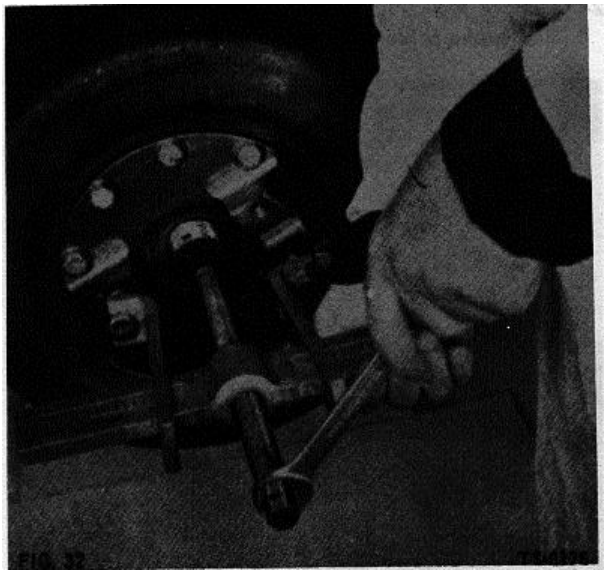
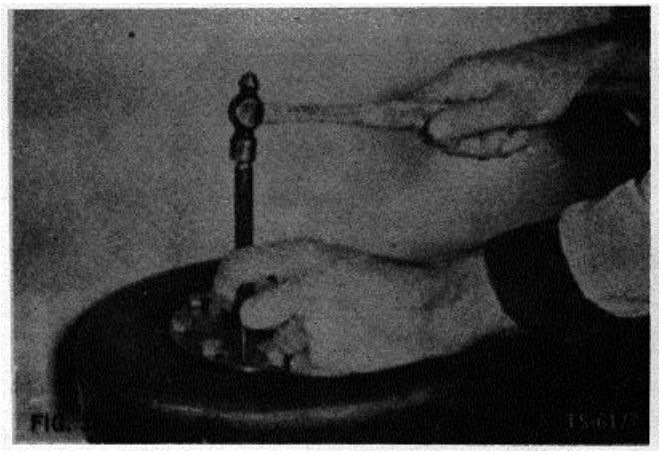


FIG. 31 TS-6175

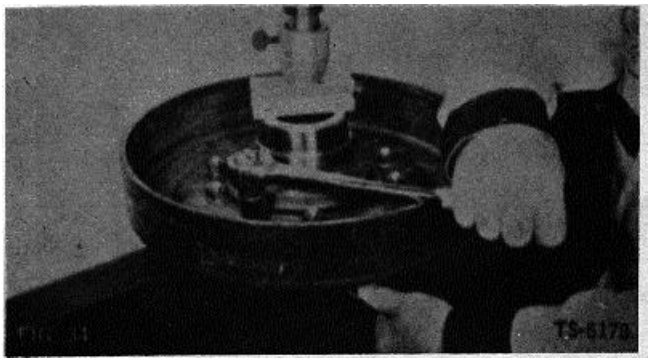
31. Use suitable puller to pull assembled companion flange and parking brake drum from pinion shaft (Fig. 32).



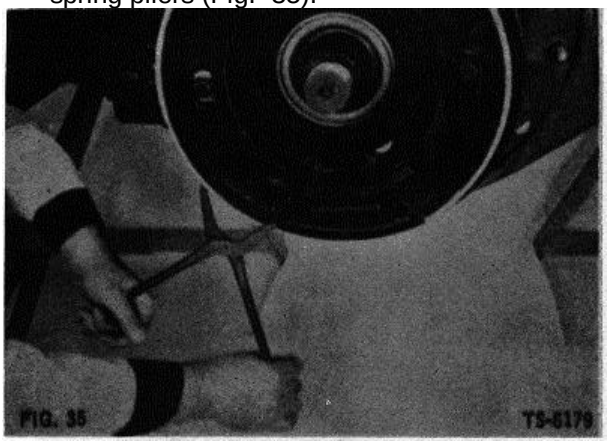
32. Match mark parking brake drum to companion flange (Fig. 33). This will assure proper balance of parts when reassembled.



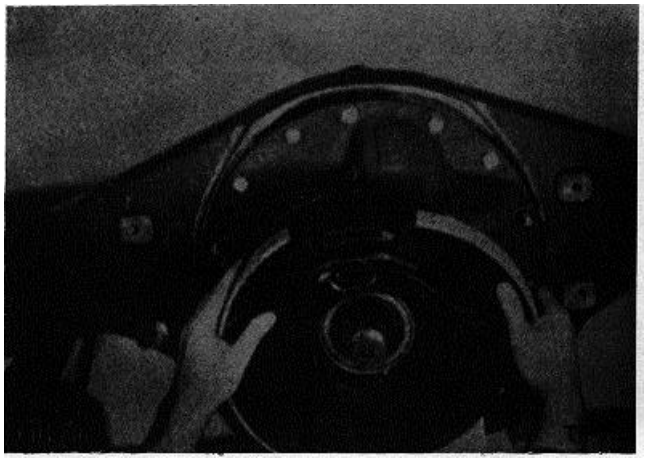
33. Position assembled parking brake drum and companion flange on press and apply light press pressure to retain parts while removing nuts; lockwashers, and bolts (Fig. 34). Do not distort or score parking brake drum by clamping tightly in vise.



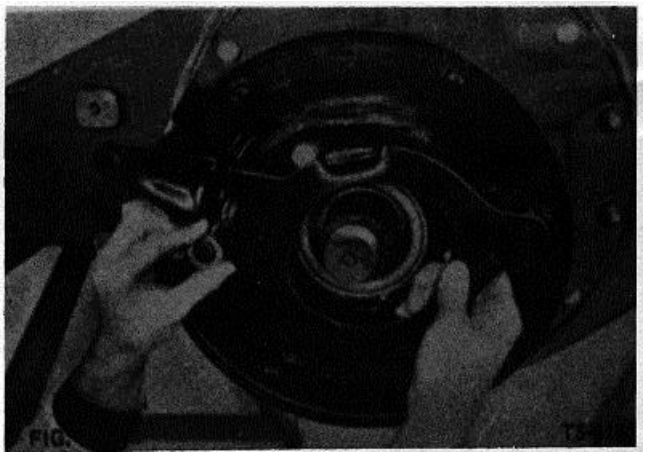
34. Remove lower parking brake spring with brake spring pliers (Fig. 35).



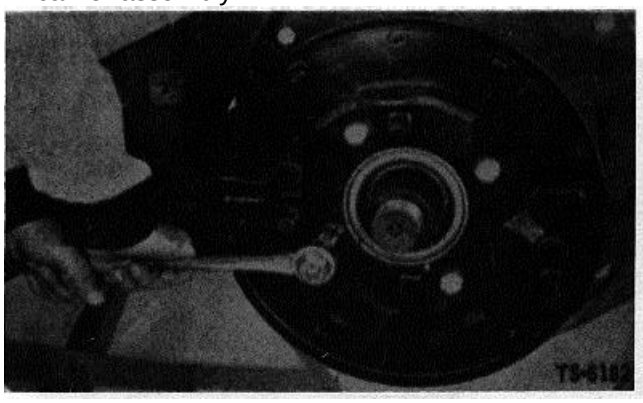
35. Spread brake shoes and remove assembled brake shoes and upper parking brake return spring (Fig. 36).



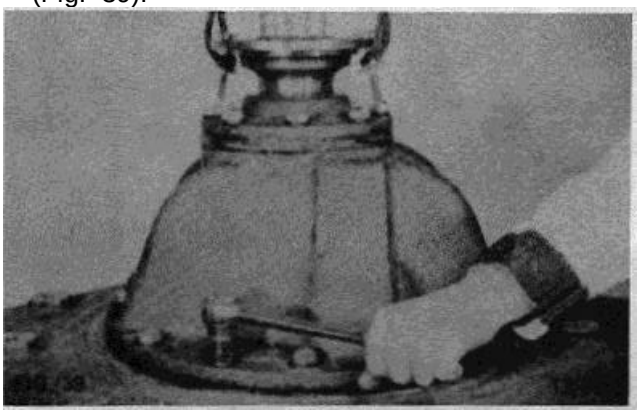
36. Remove brake operating cam lever and roller from brake backing plate (Fig. 37).



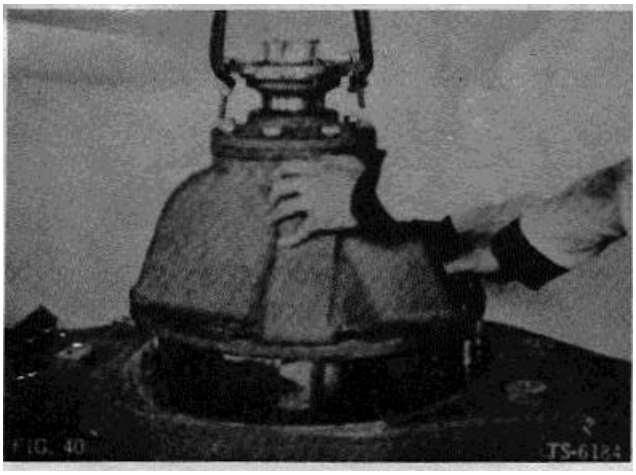
37. Remove bolts and lockwashers securing brake backing plate to differential and carrier assembly (Fig. 38). Temporarily reinstall companion flange on pinion shaft to facilitate removal of differential and carrier assembly.



38. Support weight of differential and carrier assembly with hoist. Remove bolts, nuts, washers, and dowels securing differential carrier to axle housing (Fig. 39).

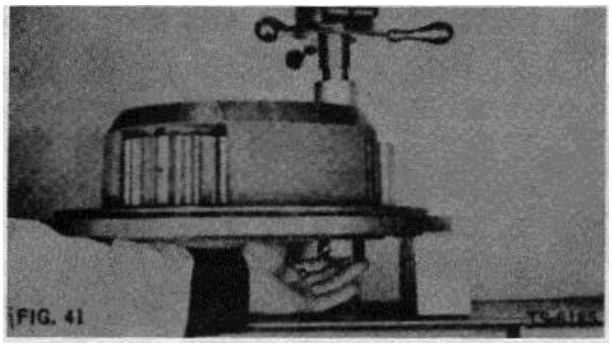


39. Lift differential and carrier assembly from axle housing with hoist (Fig. 40). If necessary, break seal between parts by tapping with plastic hammer. Remove differential gasket.

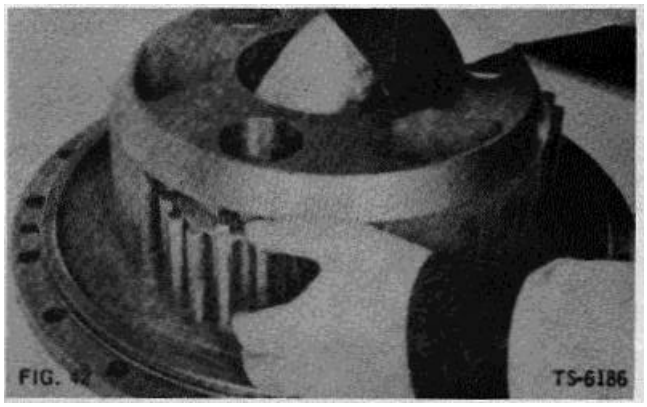


Disassembly of Planet Carrier Assembly

1. Place planet carrier assembly in press as shown and press out pinion shaft (Fig. 41). Take care to catch pinion shaft lock ball released as shaft is pressed out.

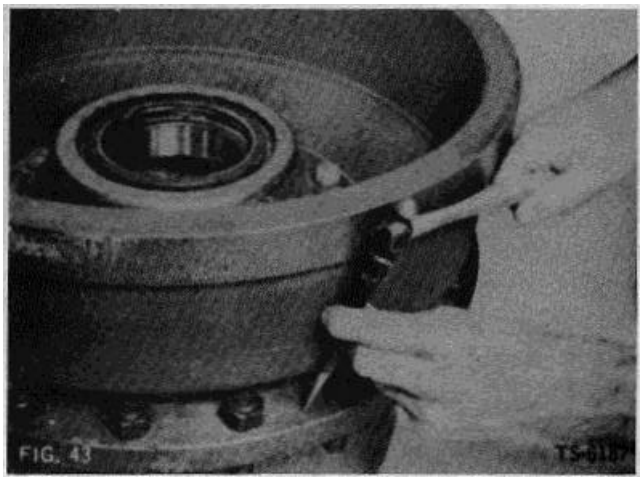


2. Carefully remove pinion shaft, planet pinion, pinion thrust washers, pinion rollers, and pinion roller spacer (Fig. 42). Rollers will drop from pinions. Take care to prevent losing them.

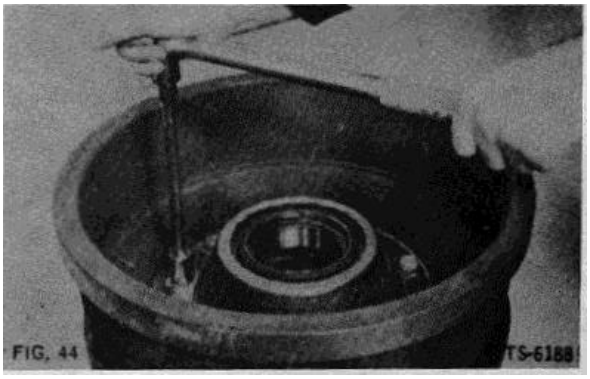


Disassembly of Hub and Drum Assembly

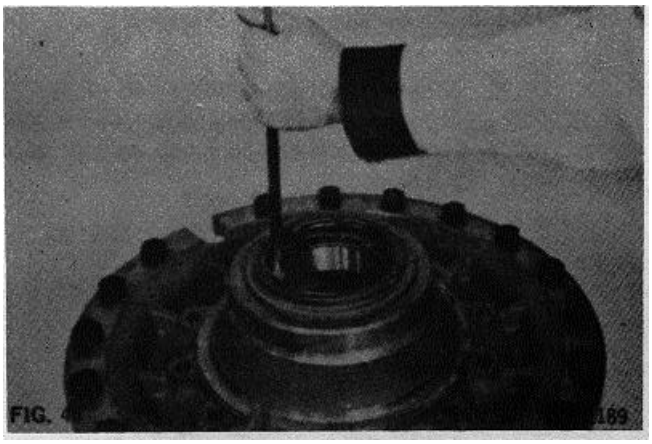
1. Match-mark hub and drum to insure proper reassembly (Fig. 43).



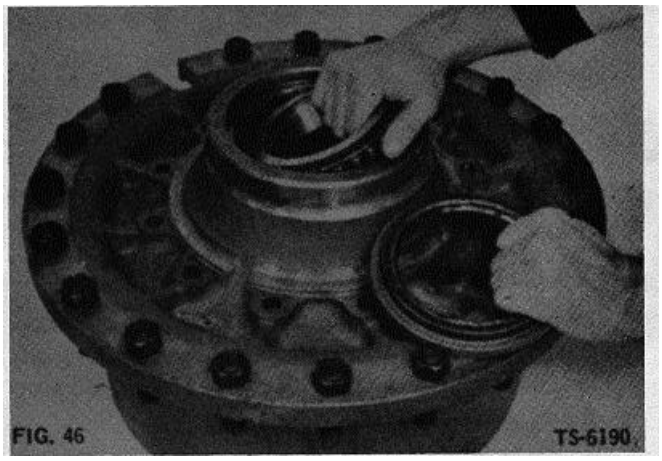
2. Cut lockwires and remove bolts securing brake drum to hub (Fig. 44). Remove brake drum and oil catcher.



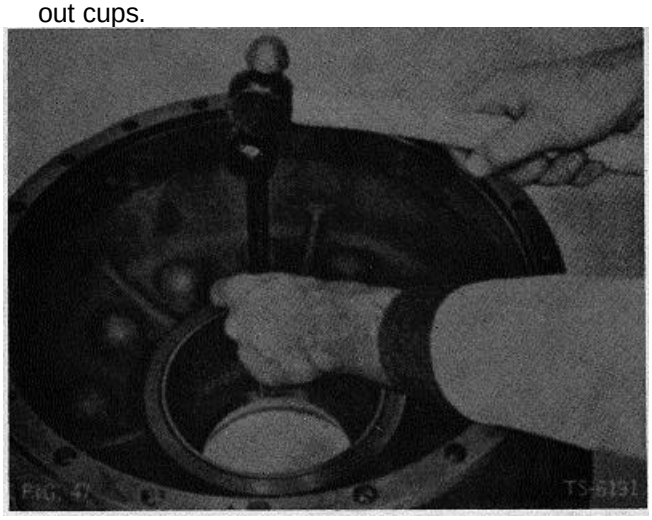
3. Pry out oil seal (Fig. 45).



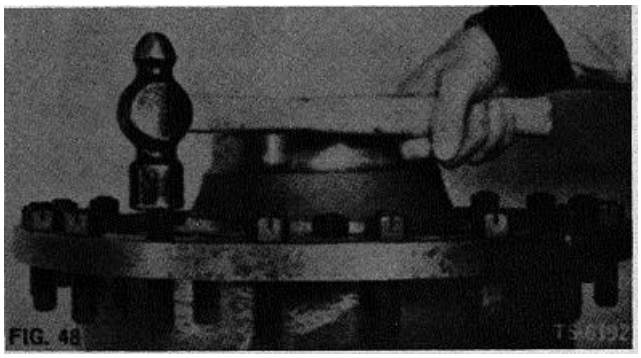
4. Lift out bearing cone (Fig. 46).



5. If replacement of the bearing cups is required, drive out cups with a soft drift (Fig. 47). Exercise care to prevent damage to the bearing bores when driving out cups.

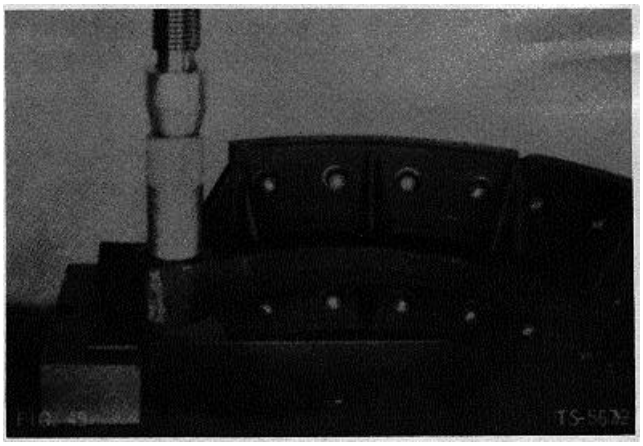


6. If any wheel studs are damaged, remove nut that secures each stud to hub. Drive out studs. Always re- place entire set if any are damaged (Fig. 48).

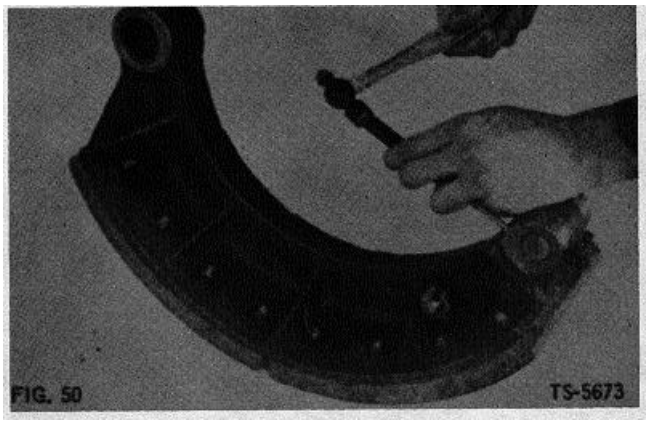


Disassembly of Brake Shoes

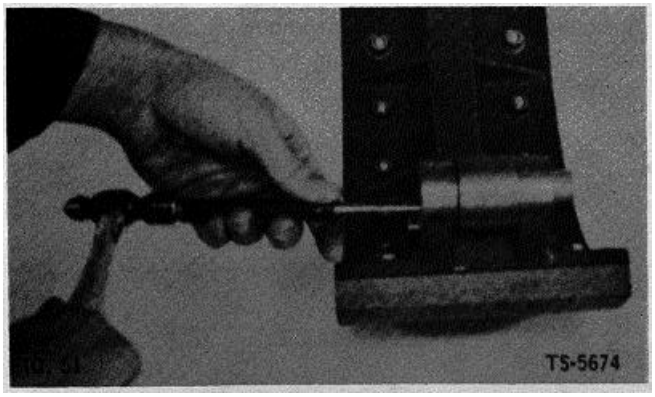
1. If worn or damaged, press brake shoe bushing from brake shoe (Fig. 49). If inside diameter of bushing exceeds 1.513" for 20x5 brakes, or 1.263" for 161/2x6 brakes, it should be replaced.



2. Remove cotter pin and drive out cam roller pin lock pin with punch (Fig. 50).

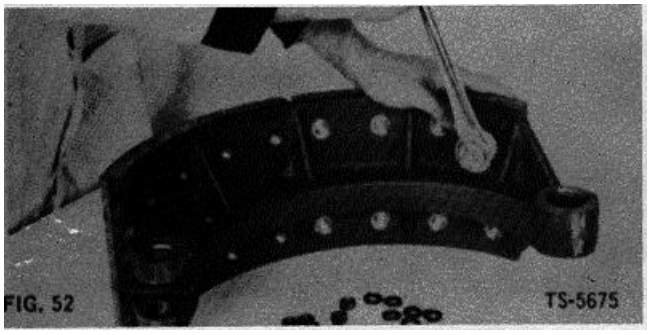


3. Drive out cam roller pin (Fig. 51). Remove roller.



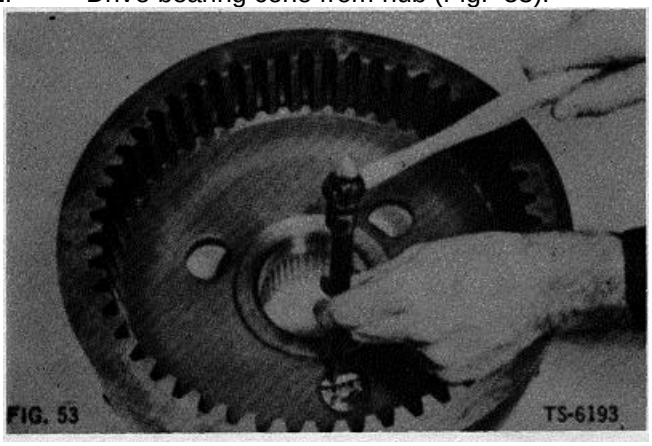
4. Check brake lining for oil or grease saturation, wear, and looseness. If loose, tighten retaining bolts to 200 to 220 inch-pounds torque. If saturated with grease, replace all lining blocks. To remove linings, remove nuts, lockwashers, and bolts retaining lining to shoes (Fig. 52).

   NOTE: When replacing brake linings, all linings on both sides of axle assembly should be replaced at the same time.



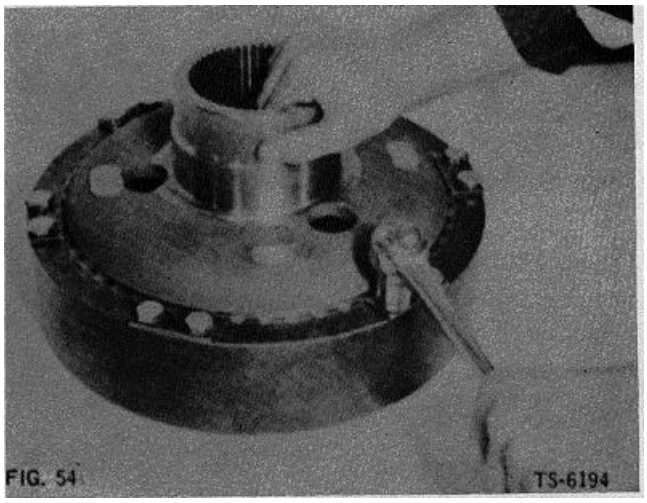
Disassembly of Internal Gear and Hub

1. Drive bearing cone from hub (Fig. 53).



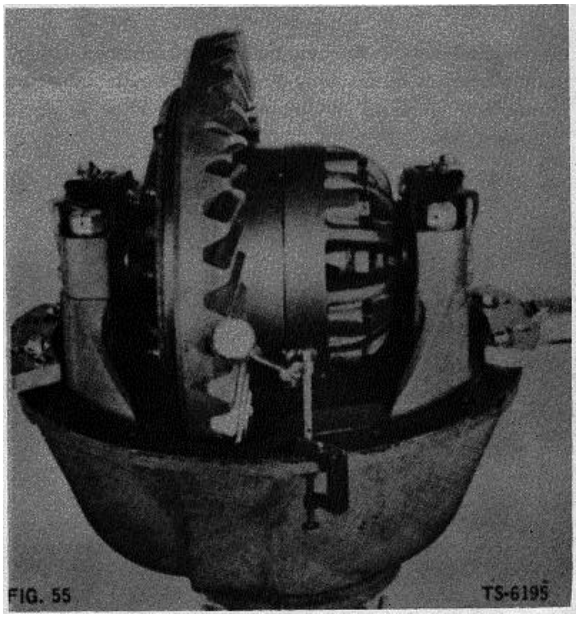
2. If replacement of internal gear is necessary, cut lock- wires and remove bolts securing internal gear to hub (Fig. 54). Separate internal gear from hub.

   NOTE: On some axle models, internal gears are se- cured to hubs with bolts inserted through drilled holes in internal gear and screwed into hub instead of as shown in Fig. 54.



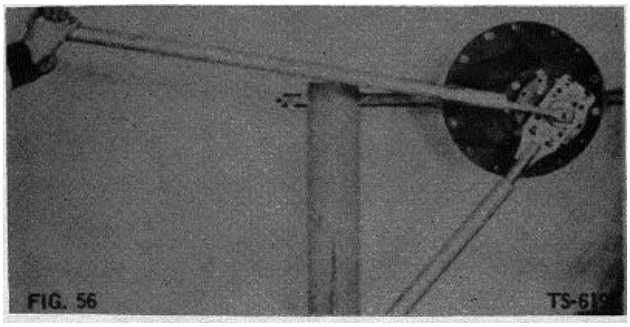
Disassembly of Differential and Carrier

1. Mount differential on differential overhaul stand. Check and record ring gear backlash with dial indicator. This information is necessary for reassembly unless a new gear set is installed (Fig. 55).

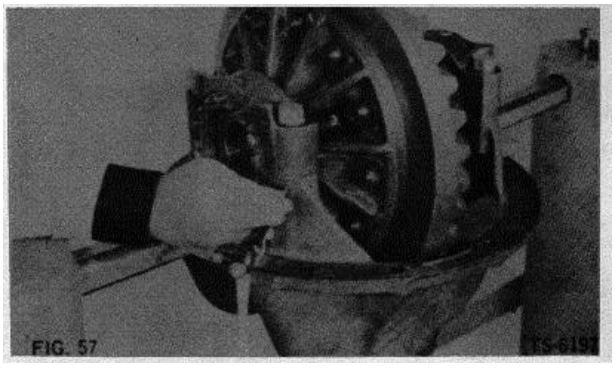


2. If axle is not equipped with parking brake, companion flange nut should be loosened now to facilitate flange removal later. Position socket on flange nut and then install flange retainer tool with two spacers between tool and flange. Spacer dimensions are given in Fig. 30. Loosen flange nut (Fig. 56).

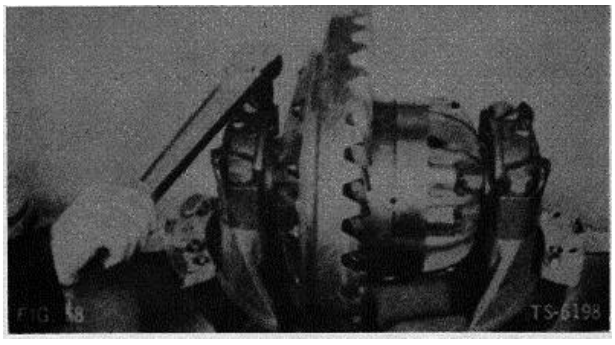
   NOTE: Standard 2 %-inch socket will not fit flange nut because socket walls are too thick to enter flange. Machine socket as shown in Fig. 31 to provide proper clearance.



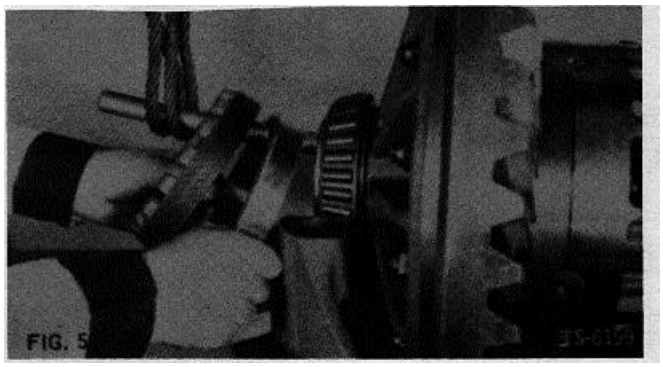
3. Remove lockwire and adjusting nut lock. Before removing bearing cap bolts, use center punch to matchmark bearing caps to 'carrier assembly. This is to insure correct match in reassembly (Fig. 57).



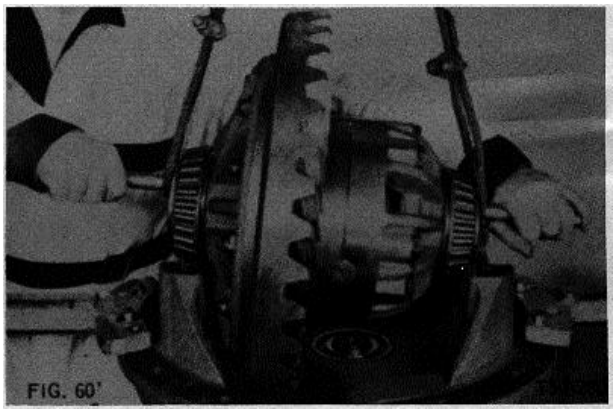
4. Remove bearing cap bolts and bearing caps (Fig. 58).



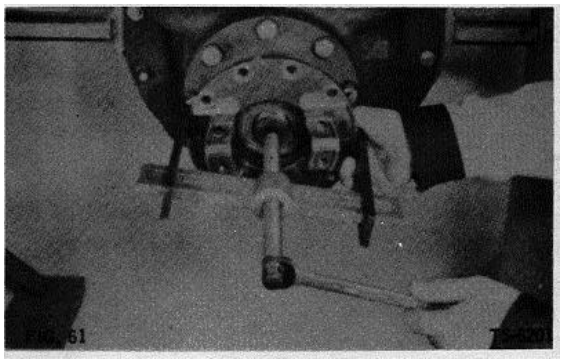
5. Insert metal bar through differential to facilitate hoisting. Raise ends individually and remove adjusting nuts and bearing cups (Fig. 59).



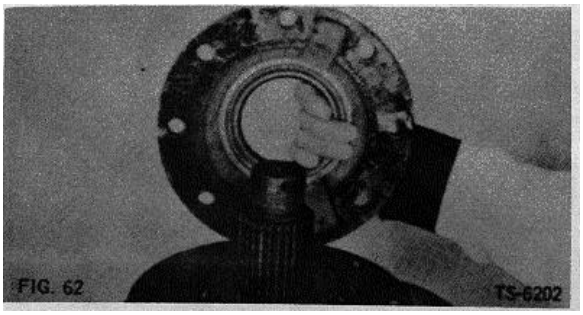
6. Hoist differential with assembled bearing cones from carrier assembly (Fig. 60). Tilt differential to allow ring gear to pass web in differential carrier.



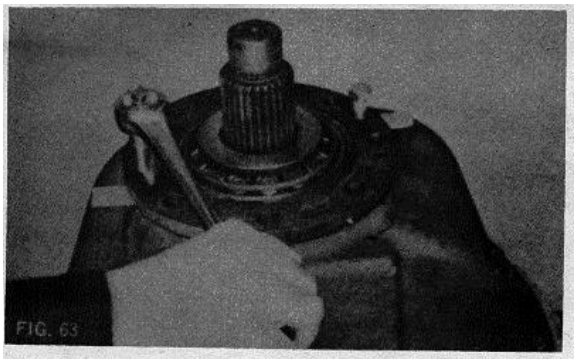
7. If axle is not equipped with parking brake, remove shaft nut that was loosened as shown in Fig. 56. Re- move washer. Remove companion flange from pinion shaft with puller (Fig. 61). If companion flange was removed to provide access to parking brake and re- installed to facilitate handling differential, it can probably be removed by hand.



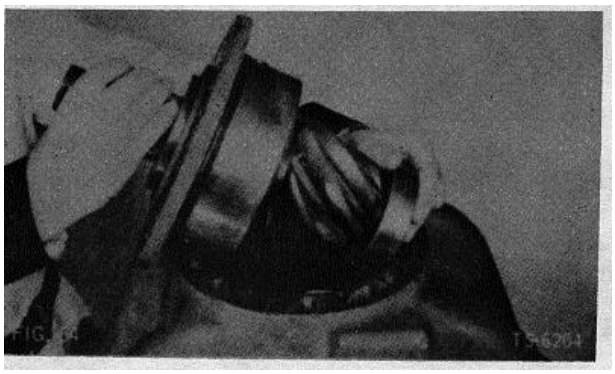
8. Remove bolts securing seal retainer to carrier and remove retainer (Fig. 62). If necessary, tap with soft mallet to break seal between parts.



9. Screw two bolts in puller holes and pull bearing cage from carrier assembly (Fig. 63). This pulls outer pinion bearing cone from shaft. Turn each bolt equally to pre- vent damage to carrier, shaft, or bearings. After bearing cage is pulled out a short distance, back off puller screws and insert .030" shim stock under puller screws before pulling is continued, to reduce possible dam. age to shim pack under flange of bearing cage.



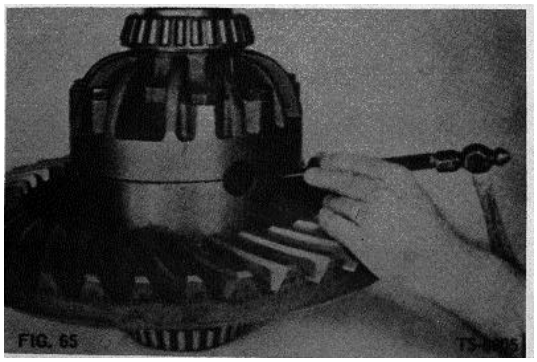
10. Remove pinion shaft assembly from carrier (Fig. 64) Remove bearing cage shims. Retain bearing cage shim pack intact for possible reuse in reassembly.



Disassembly of Standard Differential

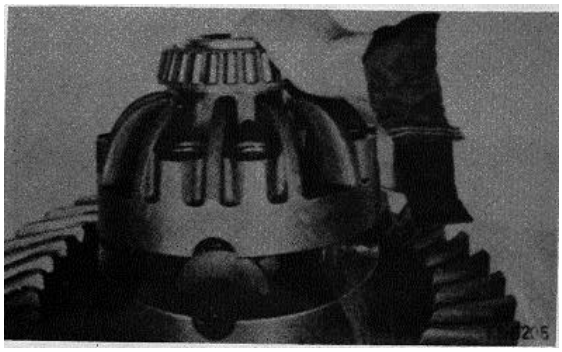
1. Match-mark case halves to insure correct reassembly (Fig. 65). Cut lockwires that secure differential case bolts.

   NOTE: If axle assembly is equipped with NoSPIN differential, proceed to Fig. 68 for special instructions.

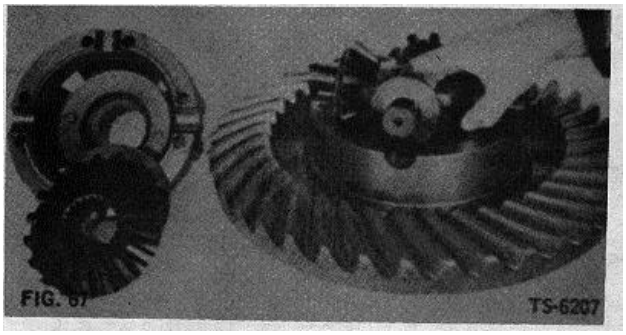


2. Remove differential bolts securing case halves. Lift off plain case half (Fig. 66). Use soft mallet if necessary to aid removal.

   NOTE: Some differential case halves are secured with bolts and self-locking nuts instead of bolts and lock- wires.

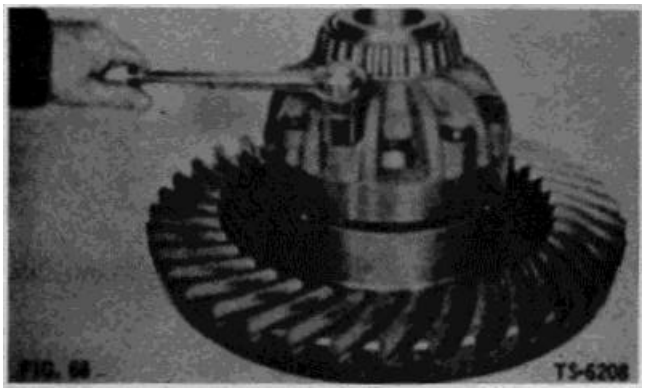


3. Remove spider, pinions, and thrust washers (Fig. 67).

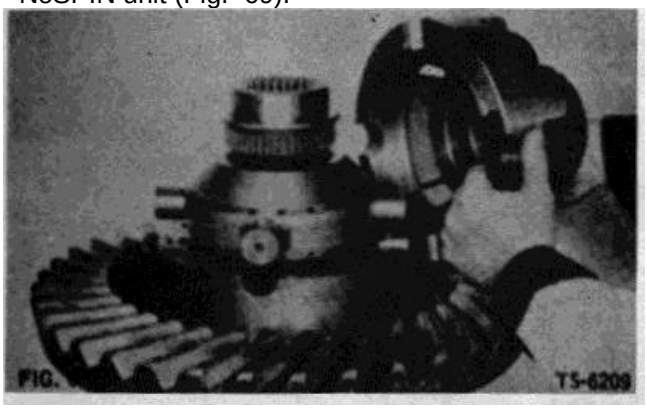


Disassembly of NoSPIN Differential

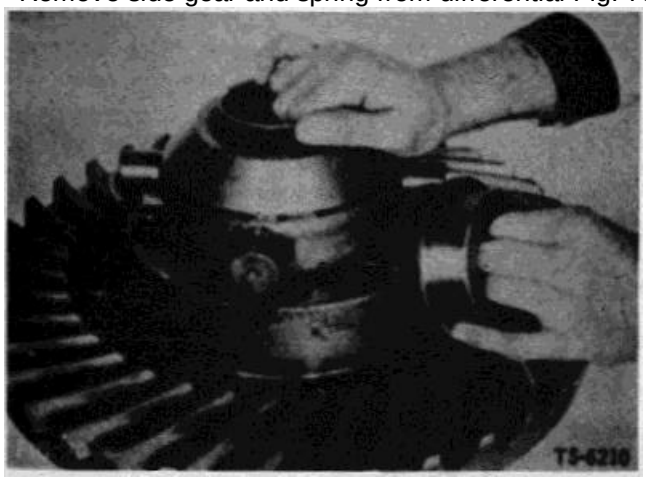
1. Remove alternate differential case half bolts. Back off remaining bolts slowly and evenly, turning each a few turns at a time (Fig. 68). This will release spring load of NoSPIN unit.



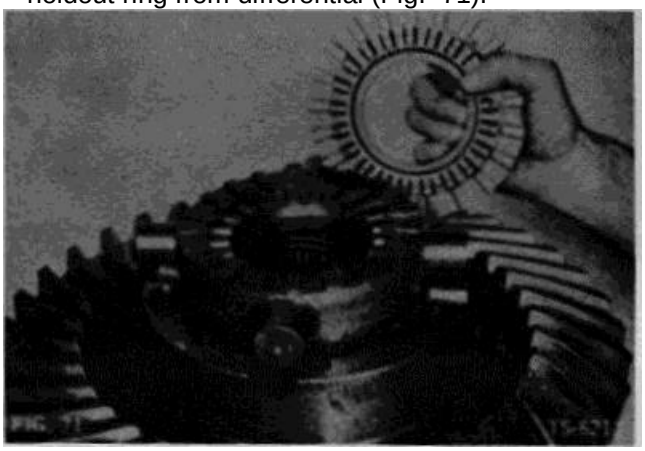
2. Lift off differential case half to provide access to NoSPIN unit (Fig. 69).



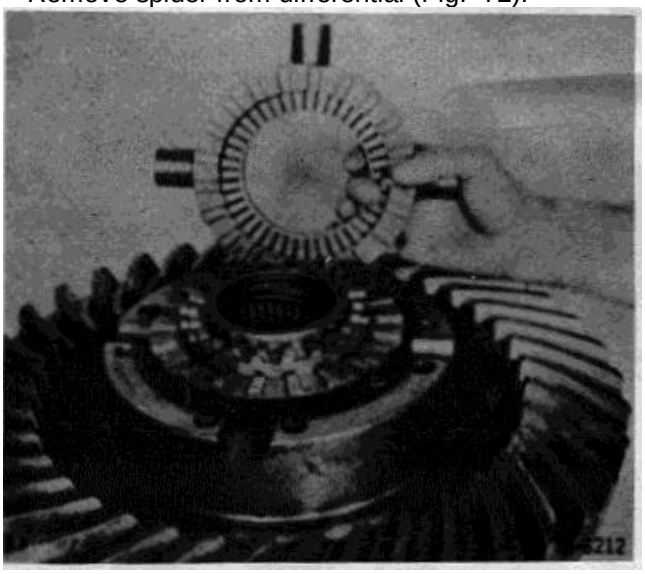
3. Remove side gear and spring from differential Fig. 70).



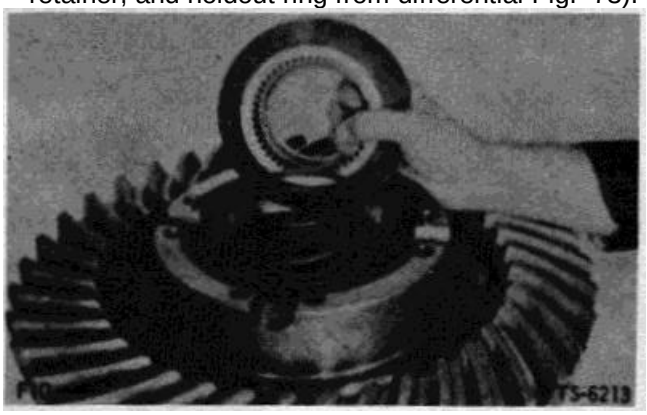
4. Remove assembled driven clutch, spring retainer, and holdout ring from differential (Fig. 71).



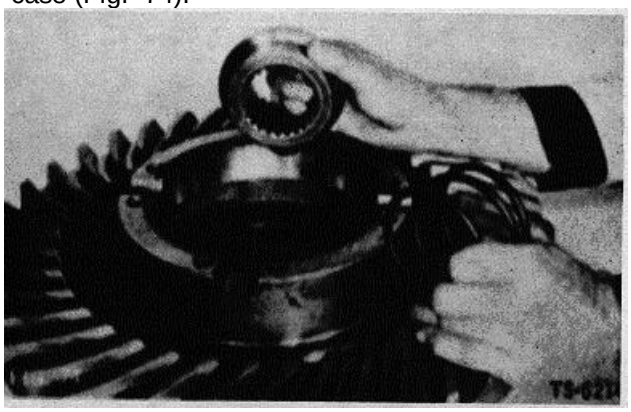
5. Remove spider from differential (Fig. 72).



6. Remove lower assembled driven clutch, spring retainer, and holdout ring from differential Fig. 73).



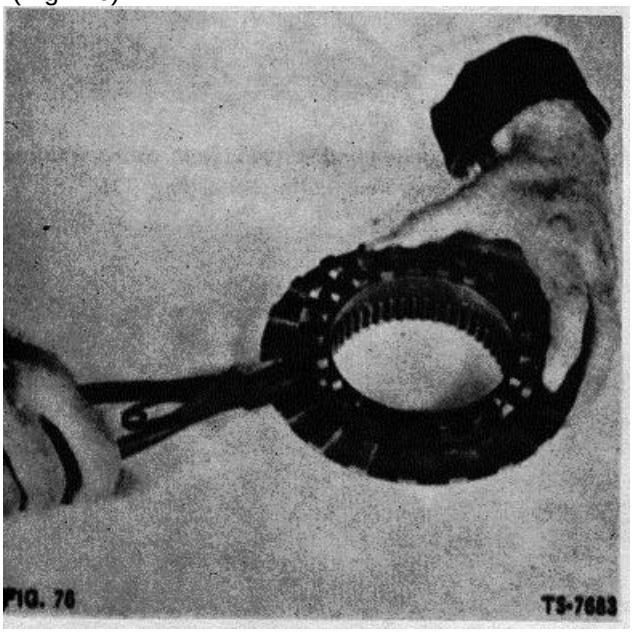
7. Remove lower spring and side gear from differential case (Fig. 74).



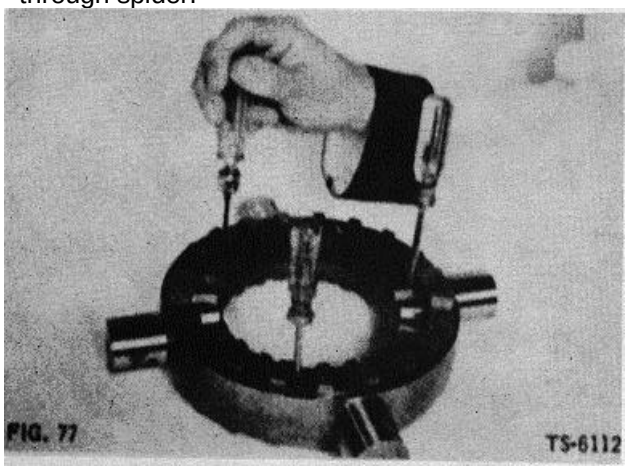
8. Lift spring retainer from driven clutch (Fig. 75).



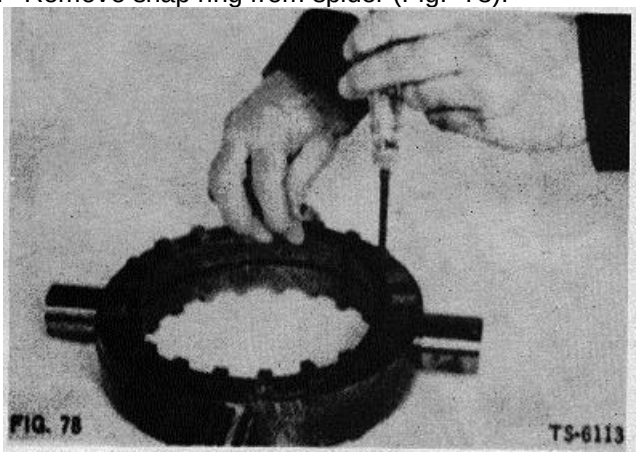
9. Remove holdout ring, using expanding snap ring pliers (Fig. 76).



10. If necessary to remove center cam from spider, use three small screwdrivers or tapered wedges to spread snap ring into spider (Fig. 77). Press center cam out through spider.

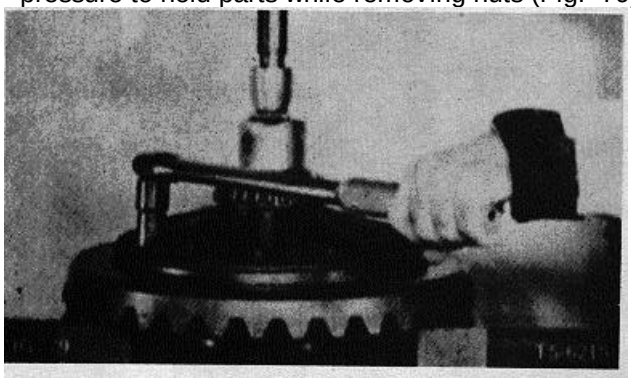


11. Remove snap ring from spider (Fig. 78).

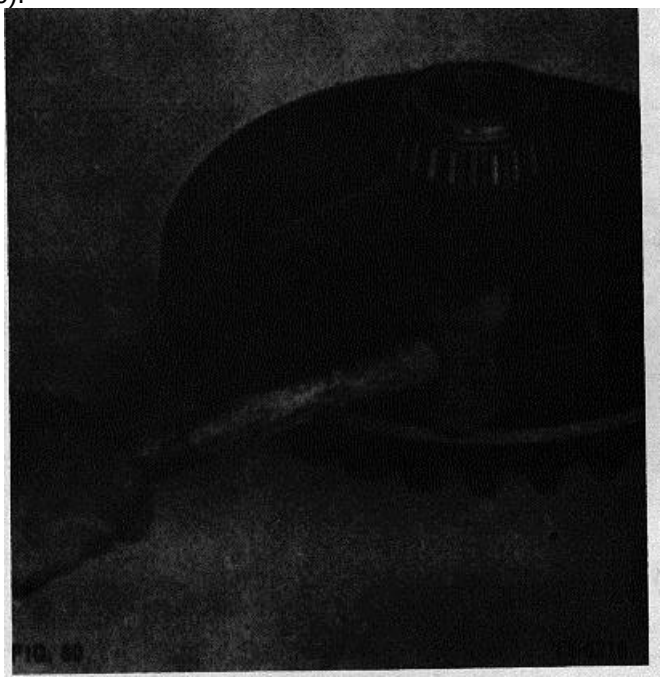


Disassembly of Differential Case Parts

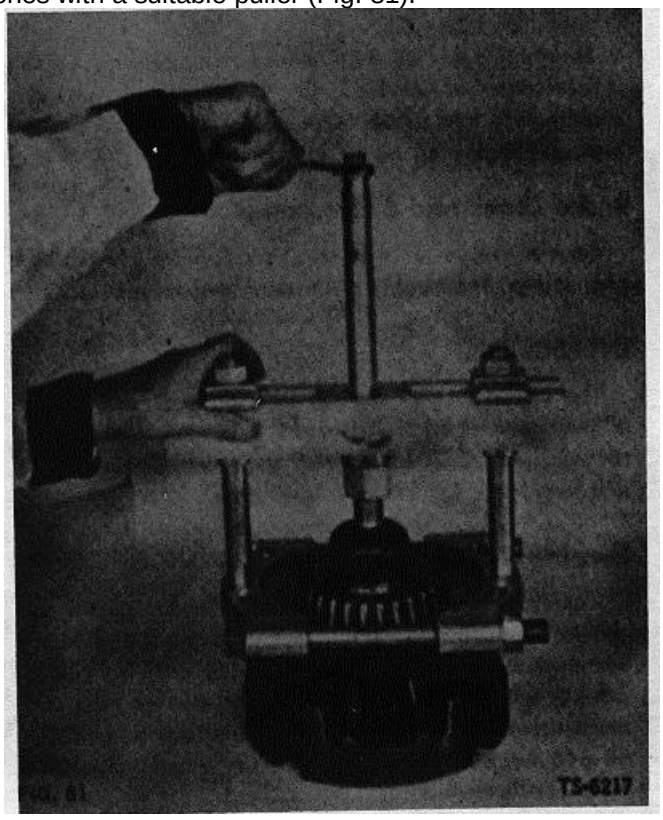
1 Remove nuts that secure ring gear to case half. Place case half and ring gear in press and apply light pressure to hold parts while removing nuts (Fig. 79).



2. Use soft hammer to drive ring gear from case half (Fig. 80).

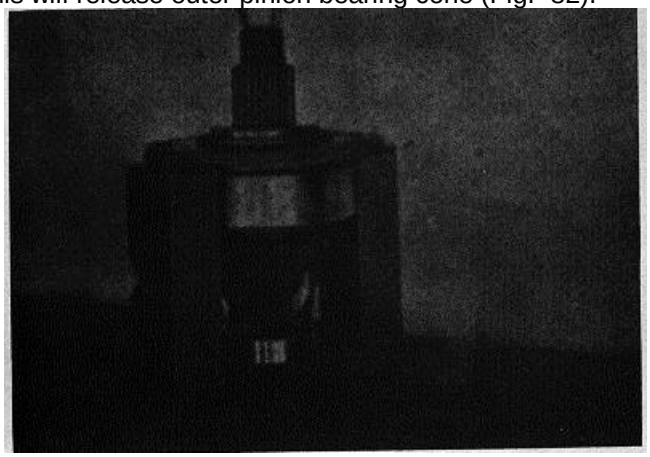


3. If replacement is required, remove differential bearing cones with a suitable puller (Fig. 81).

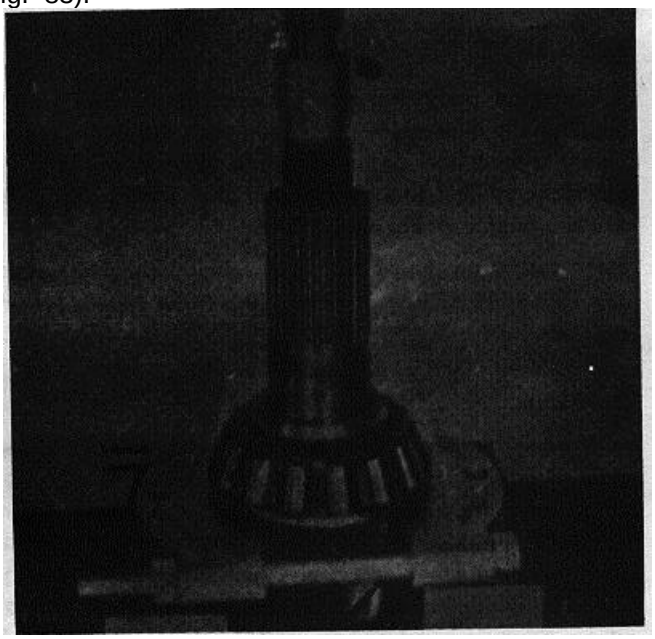


Disassembly of Pinion Shaft Assembly

1. Press pinion shaft from pinion bearing cage assembly. This will release outer pinion bearing cone (Fig. 82).



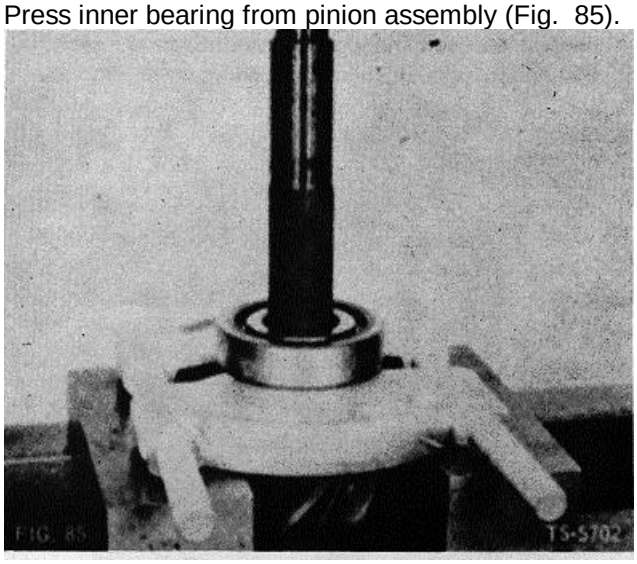
2. Press center pinion bearing cone from pinion assembly (Fig. 83).



3. Remove inner pinion bearing retaining ring (Fig. 84).



4. Press inner bearing from pinion assembly (Fig. 85).



5. If worn or damaged, drive bearing cups from pinion bearing cage (Fig. 86).



CLEANING AND INSPECTION

CLEANING

Clean all parts thoroughly using solvent type cleaning fluid. It is recommended that parts be immersed in cleaning fluid and slushed up and down slowly until all old lubricant and foreign material is dissolved and parts are thoroughly cleaned.

CAUTION: Care should be exercised to avoid skin rashes, fire hazards and inhalation of vapors when using solvent type cleaners.

Bearings

Remove bearings from cleaning fluid and strike larger side of cone flit against a block of wood to dislodge solidified particles of lubricant. Immerse again in cleaning fluid to flush out particles. Repeat above operation until bearings are thoroughly clean. Dry bearings using moisture-free compressed air. Be careful to direct air stream across bearing to avoid spinning. Do not spin bearings when drying. Bearings may be rotated slowly by hand to facilitate drying process.

Housings

Clean interior and exterior of housings, bearing caps, etc., thoroughly. Cast parts may be cleaned in hot solution tanks with mild alkali solutions providing these parts do not have ground or polished surfaces. Parts should remain in solution long enough to be thoroughly cleaned and heated. This Will aid the evaporation of the clean- ing solution and rinse water. Parts cleaned in solution *tanks must* be thoroughly rinsed with clean water to re- move all traces of alkali. Cast parts may also be cleaned with steam cleaner.

CAUTION: Care should be exercised to avoid skin rashes and inhalation of vapors when using alkali cleaners.

Thoroughly dry all parts cleaned immediately by using moisture-free compressed air or soft, lintless absorbent wiping rags free of abrasive materials such as metal filings, contaminated oil or laping compound.

Brake Shoes and Brake Bands

Do not use solvents or cleaning fluids on brake shoes and linings. Thoroughly clean them with wire brush.

INSPECTION

The importance of careful and thorough inspection of all parts cannot be overstressed. Replacement of all parts showing indication of wear or stress will eliminate costly and avoidable failures at a later date.

Bearings

Carefully inspect all rollers, cages and cups for wear, chipping or nicks to determine fitness of bearings for further use. Do not replace a bearing cone or cup individually without replacing the mating cup or cone at the same time. After inspection, dip bearings in clean light oil and wrap in clean lintless cloth or paper to protect them until installed.

Oil Seals, Gaskets and Retaining Rings

Replacement of spring loaded oil seals, gaskets and snap rings is more economical when unit is disassembled han to risk premature overhaul to replace these parts at a future time. Loss of lubricant through a worn seal may result in failure of other more expensive parts of the assembly. Sealing members should be handled carefully, particularly when being installed. Cutting, scratching, or curling under of lip of seal seriously impairs its efficiency. At reassembly, lubricate lips of oil seals with Lubriplate.

Gears and Shafts

If magna-flux process is available, use process to check parts. Examine teeth and ground and polished surfaces on all gears and shafts carefully for wear, pitting, chipping, nicks, cracks or scores. If gear teeth are cracked or show spots where case hardening is worn through, replace with new gear. Small nicks may be removed with suitable hone. Inspect shafts to make certain they are not sprung, bent, or splines twisted, and that shafts are true. Differential pinions and side gears must be replaced as sets. Differential ring gear and bevel pinion must also be replaced as a set if either is damaged.

Housing and Covers

Inspect housing, covers and planet spider, and differential case to be certain they are thoroughly cleaned and that mating surfaces, bearing bores, etc., are free from nicks or burrs. Check all parts carefully for evidence of cracks or conditions which would cause subsequent oil leaks or failures.

Service Brakes

Inspect anchor pins for wear or damage. If they are worn beyond dimensions indicated in Brake Wear Limits Chart, or if they are pitted, scored or deeply nicked, replace anchor pins.

Check brake shoe bushings for wear. If inside diameter exceeds dimensions indicated in Brake Wear Limits Chart, replace bushings.

Check cam roller for wear and distortion. If inner diameter is worn beyond dimensions indicated in Brake Wear Limits Chart, or if outer diameter has flat spot more than 1/4 inch wide extending across roller, replace rollers. Check cam roller pins for wear and corrosion. If worn beyond dimensions indicated in Brake Wear Limits Chart, or if pitted, scored, or deeply nicked, replace cam roller pins.

Inspect cam shafts for wear or corrosion of bearing surfaces. If worn beyond dimensions indicated in Brake Wear Limits Chart, or if bearing surfaces are pitted, scored, or deeply nicked, replace cam shafts.

Check brake linings for wear, cracks, and oil saturation. If linings are worn to within 1/16" of retaining bolts or otherwise damaged, replace brake linings.

Check cam shaft brake spider bushings and brake chamber bracket bushings for wear, cracks, distortion, or other damage. If inside diameter is worn beyond dimensions indicated in Brake Wear Limits Chart, replace bushings.

Inspect brake drums for cracks, heat checks, scoring, or other damage. Turn down on lathe if necessary. If drum diameter exceeds dimensions indicated in Brake Wear Limits Chart, replace drum.

Replace brake shoe return springs each time axle is overhauled.

BRAKE WEAR LIMITS CHART

ITEM	20x5 20x7	16 ½ x 6
Anchor Pins-O. D	1.478"	1.228"
Broke Drum-Max. Rebore	20.250"	16.750"
Broke Shoe Bushings-I. D	1.51"	1.263"
Camshaft Bushings-I. D	1.526"	1.526"
Camshaft-O. D	1.469"	1.469"
Cam Roller-I. D	.895"	.770"
Cam Roller Pin-O. D	.859"	.735"

Parking Brake

Inspect brake backing plate for distortion. Check that cam levers on backing plate swivel freely, but that mounting rivets are firmly seated in plate. Replace backing plate if damaged or if cam levers are loosely mounted.

Inspect brake linings for grease saturation, wear, or looseness. Replace if worn to less than 5/32 inch. Rivet new brake linings to shoes following sequences indicated in Fig. 87.

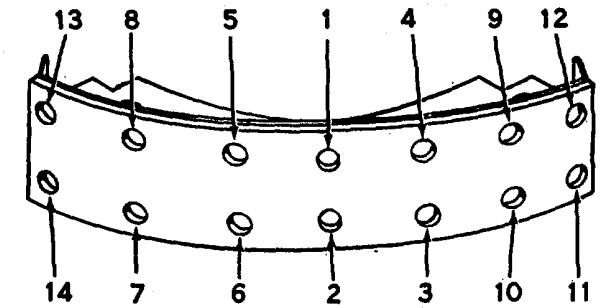


FIG. 87 TS-6219

Inspect brake drums for cracks, heat checks, scoring, or other damage. Turn down on lathe if necessary. If drum diameter exceeds 13.340 inches, replace drum.

NoSPIN Differential

Check splines on the side gear and driven clutch. Remove any burrs or small chipped edges with stone or burr grinder. If large sections of spline are broken away, replace part. Check side gear hub for fractures.

New springs will measure 4 1/4 inch or more in height. Old springs should not be less than 4 1/4 inch high.

Failure of hydrogen copper weld between cam and clutch member will result in erratic operation by alternately driving on one side only or driving both wheels with the NoSPIN locked. If weld failure has occurred, it will be possible to rotate cam ring in driven clutch member by lightly tapping cams.

Inspect driven clutch teeth on spider and driven dutches. Very slight chips can be touched up with a stone. If excessively chipped or rounded, these parts must be replaced. Compare shape of teeth with those on a new port. If a part is replaced due to chipped teeth, always replace the mating part as it may have invisible fractures.

Cams on the center cam and driven clutch must not be excessively chipped. A smooth wear pattern up to 50 percent face width is acceptable on clutch cams.

Holdout rings have a frictional resistance to rotation obtained by friction spring. Check for fractures or severe chipping of cams on this part.

Friction spring wear should not exceed .003 inch at points of contact. Compare with measurement at unworn portion. If extreme care is not exercised in removing this part, It may be damaged. Replace with new part if, after assembly, the holdout ring rotates easily. It should, how- ever, be possible to rotate it by hand. Compare with a new port.

Center cam must be free to rotate within limits of keys in spider.

Check the spring retainers for fractures or spline damage.

Breathers

Wash breather on axle housing with solvent shake dry. Make sure breather is not clogged.

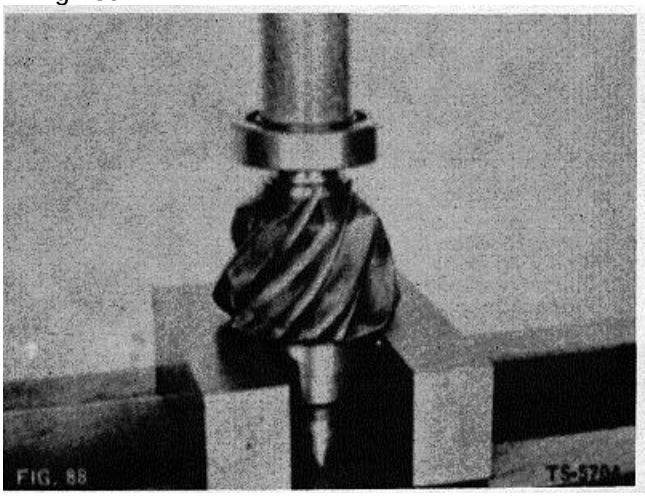
The following instructions describe the procedure to be followed when reassembling and installing components of axle. Instructions cover reassembly of only one side of axle. Reassembly of opposite group is identical unless otherwise noted.

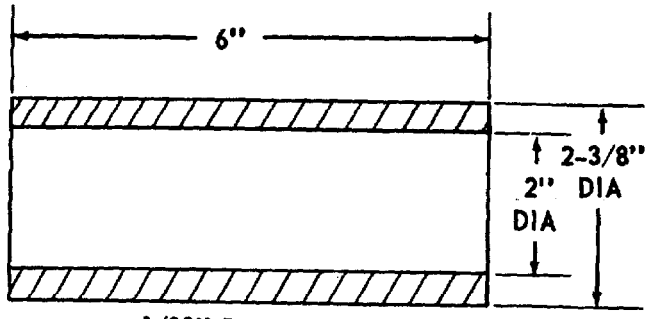
IMPORTANT: Both Grade 5 and Grade 8 fastening hardware have been used in the production of the axle assemblies covered by this manual. A table of proper torque values for both Grade 5 and Grade 8 hardware is provided at the rear of this manual. Grade of hardware may be determined by the "hash" marks contained on the head of each bolt; Grade S having three hash marks and Grade 8 having six hash marks as indicated below. In all cases except where specified in text, use torque value specified in table for applicable bolts.



Reassembly of Pinion Shaft

1. Press inner pinion bearing on pinion using steel tubing for driver (Fig. 88). Driver dimensions are given in Fig. 89.



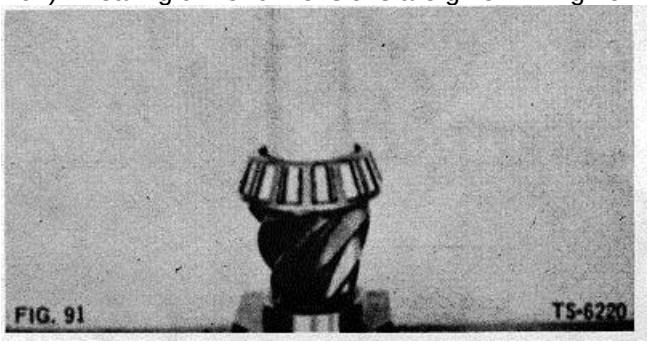


1/32" DIA RADIUS ALL CORNERS TS-7684

2. Install inner pinion bearing retaining ring (Fig. 90).



3. Press center pinion bearing cone onto pinion shaft (Fig. 91). Bearing driver dimensions are given in Fig. 92..



4. A pinion bearing spacer and shim kit is provided for service repair of differential and carrier assemblies. This kit, consisting of a spacer and quantity of shims, is used to obtain proper pinion bearing preload as described below. Position bearing spacer and one .010" shim on pinion shaft (Fig. 93).

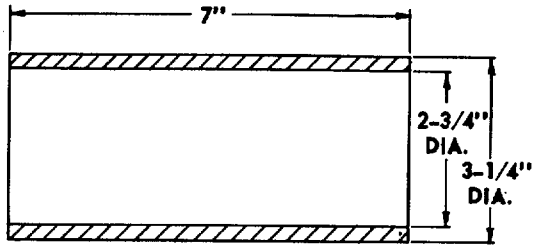
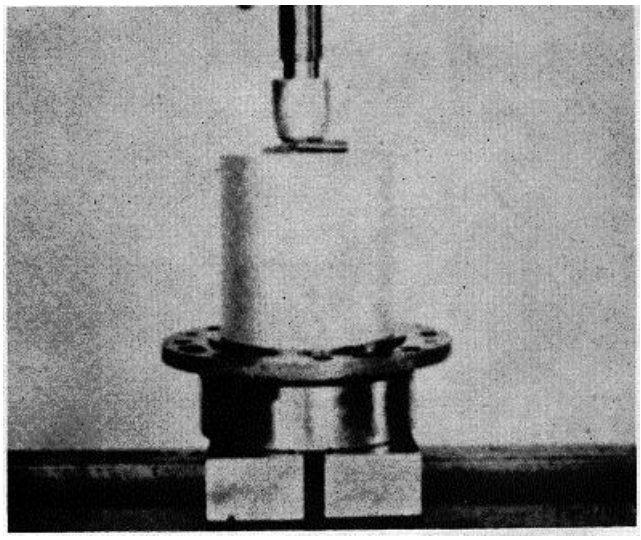


FIG. 92 1/32" DIA RADIUS ALL CORNERS TS-6221

5. Press bearing cups into pinion bearing cage (Fig. 94). Bearing driver dimensions are shown in Figs. 95 and 96.



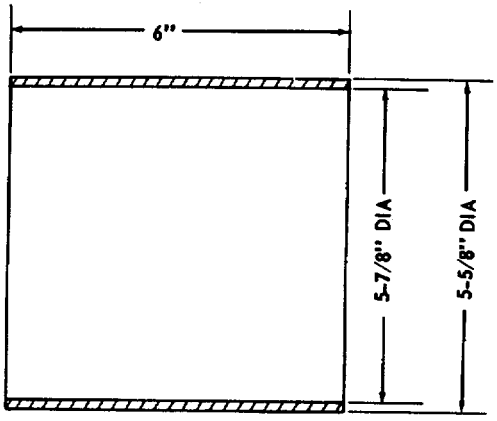


FIG. 95 1/32" DIA RADIUS ALL CORNERS TS-6284

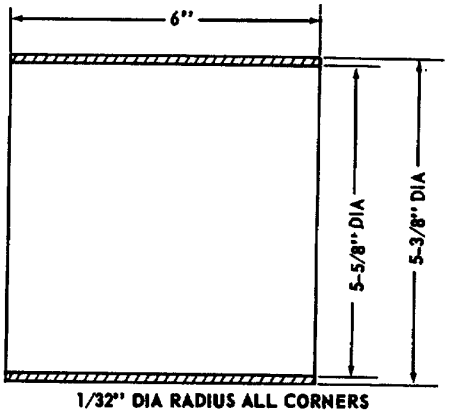
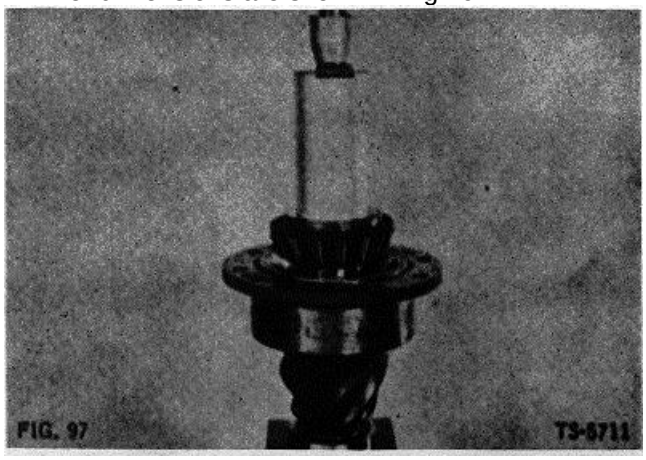


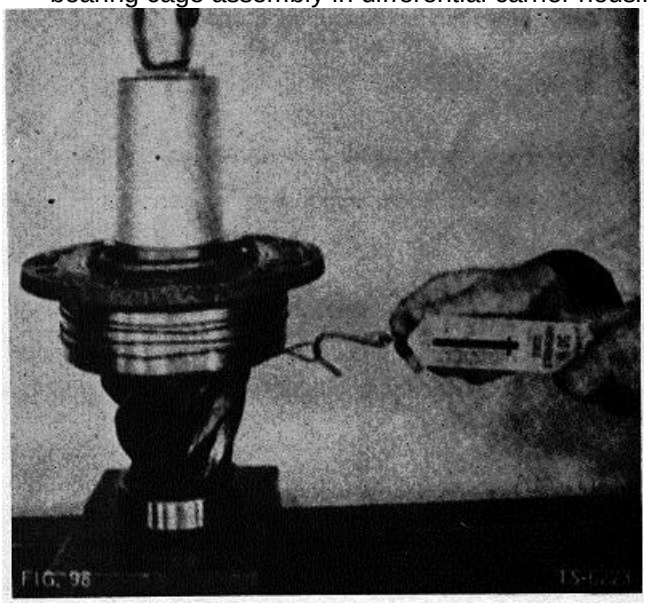
FIG. 96 1/32" DIA RADIUS ALL CORNERS TS-6222

6. Position pinion bearing cage assembly on pinion shaft. Position outer pinion bearing cone on pinion shaft and press into place using steel tubing for driver (Fig. 97). Driver dimensions are shown in Fig. 92.



7. Keep pinion and cage assembly in press with approximately 500 pounds of press pressure exerted on driver. Wrap several turns of soft wire or cord around pinion cage and pull in horizontal line with spring scale. While pulling in straight line, (90 degrees from centerline of shaft), read spring scale and measure rotating torque (Fig. 98). Multiply reading on spring scale by one-half diameter of bearing cage to obtain preload torque. Correct preload torque is 13 to 23 in. lbs. If preload is not within these limits, remove shims to increase preload or add shims to decrease preload.

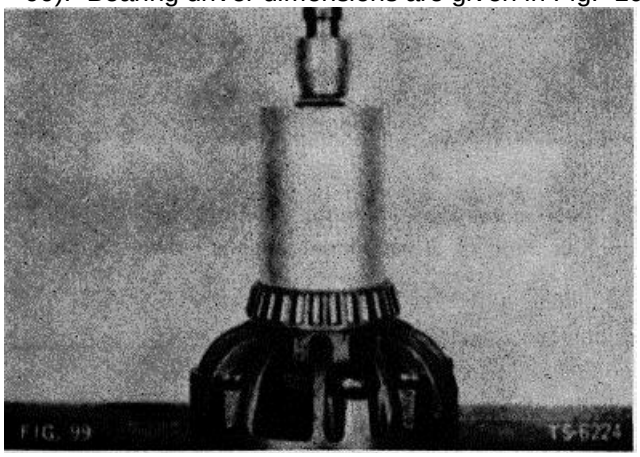
   NOTE: This is a preliminary check. Final bearing preload check must be made with pinion shaft and bearing cage assembly in differential carrier housing.



Reassembly of Differential Ring Gear and Bearings

NOTE: Lubricate all differential bearings, gears, and thrust washers with SAE 90 EP lubricant, SCL type.

1. Press differential bearing cones on case halves (Fig. 99). Bearing driver dimensions are given in Fig. 100.



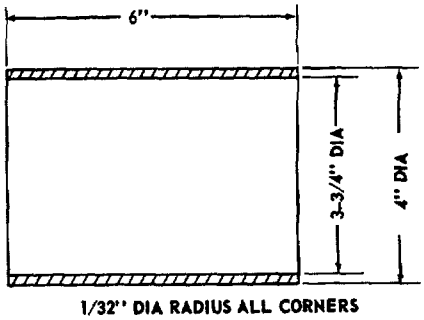
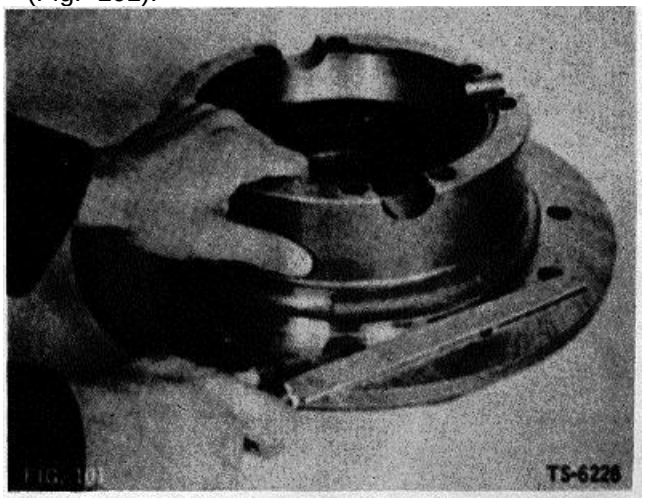


FIG. 100 TS-6225

2. Check ring gear mounting surface of flanged half of differential case for burrs. Remove burrs with file (Fig. 101).



3. Install ring gear. Install bolts so internal diameter of ring gear prevents turning of hex head. Install ring gear bolt nuts and torque to 120 to 135 ft. lbs. Position ring gear and flanged hub in press and apply light press pressure to facilitate torquing nuts (Fig. 102).

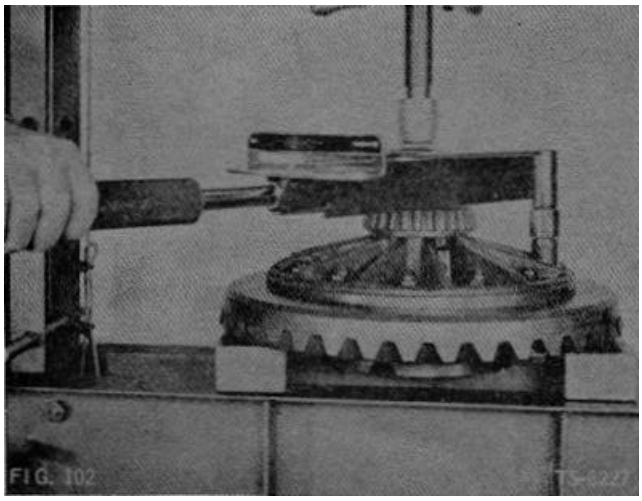


FIG. 102

NOTE: Axle Part Nos. 130788, 131507, and 190010 are equipped with NoSPIN differentials. Refer to Figs. 107 through 118 for reassembly instructions.

Reassembly of Conventional Differential

1. Lubricate and install thrust washer and side gear in differential case and ring gear assembly (Fig. 103). Engage holes in thrust washer on dowels projecting from thrust washer bearing surface in differential case.



FIG. 103

2 Place pinions and thrust washers on differential spider, lubricate, and set in position on installed side gear.

NOTE: It is very important that tang on each pinion thrust washer engages groove in case halves as shown by arrows in Fig. 104.

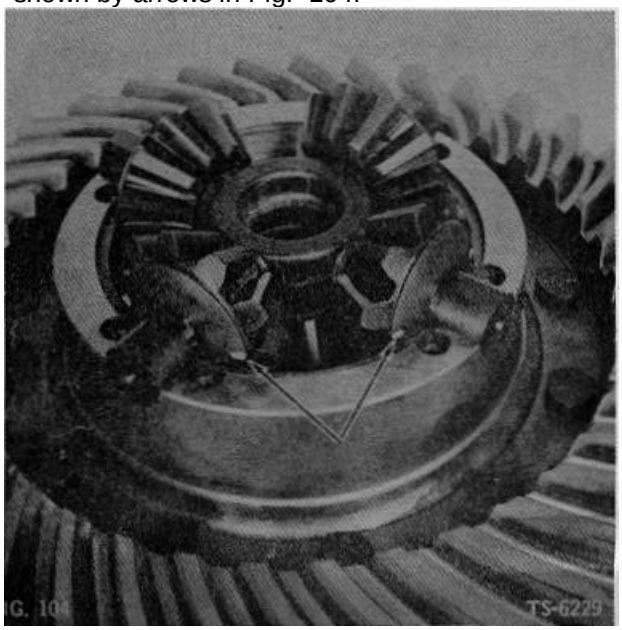


FIG. 104

3. Align match-marks and install remaining case half on other case half assembly, making sure of full gear engagement (Fig. 105). Install bolts and tighten to specified torque.

NOTE: Some differential cases are held together with thru bolts and self-locking nuts instead of bolts in tapped holes. The bolt heads must extend from the ring gear side of the case assembly.

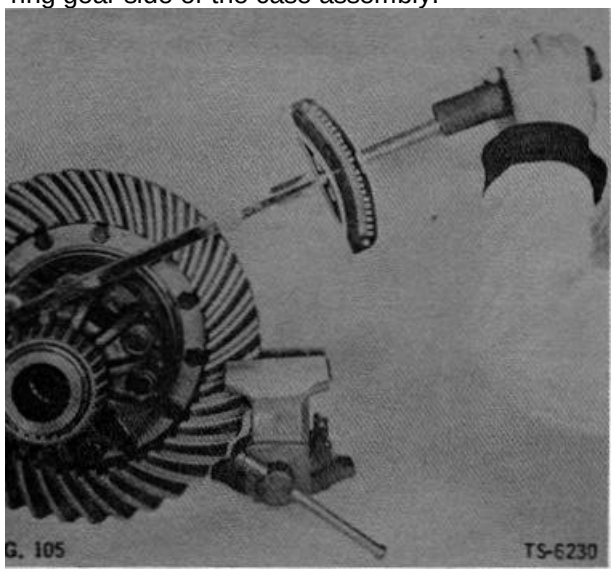


FIG. 105

4. Lockwire bolts in pairs (Fig. 106) on axles that use tapped differential case bolt holes.

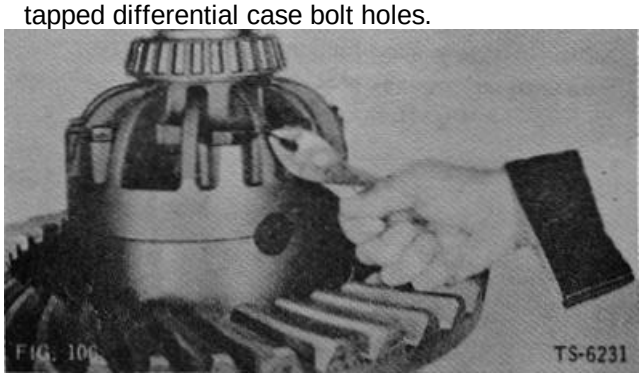


FIG. 106

Reassembly of NoSPIN Differential

NOTE: Lightly lubricate parts of NoSPIN differential during assembly. Special lubricants are not required for use with *this* differential.

1. Install snap ring In Internal groove of spider (Fig. 107).

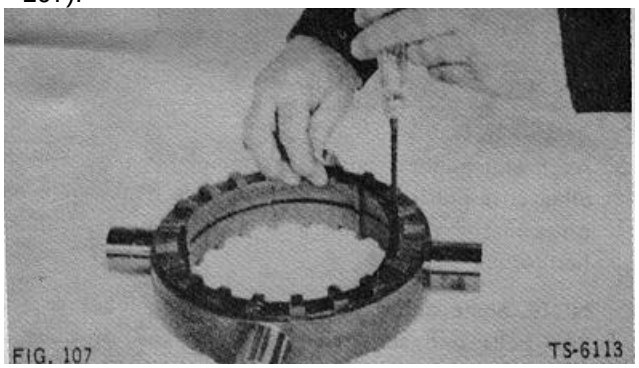


FIG. 107

2. Position center cam In spider, Spread snap ring while inserting center cam (Fig. 108). Make sure center cam ring groove is fully engaged by snap ring to retain center cam.

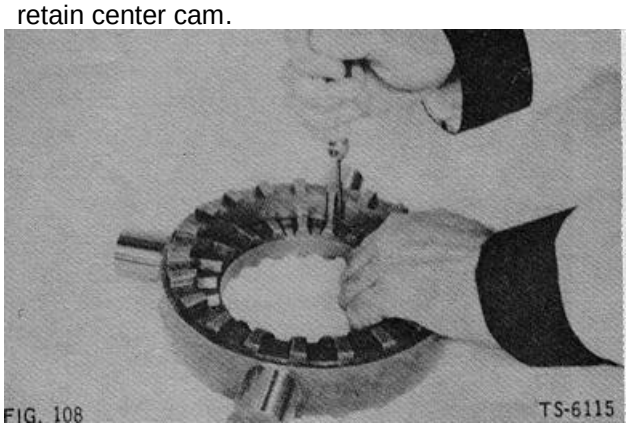


FIG. 108

3. Install holdout ring on drive clutch with snap ring pliers (Fig. 109).

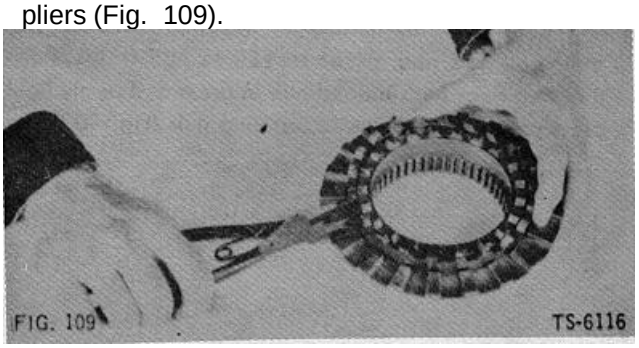


FIG. 109

4. Install spring retainer in driven clutch (Fig. 110).

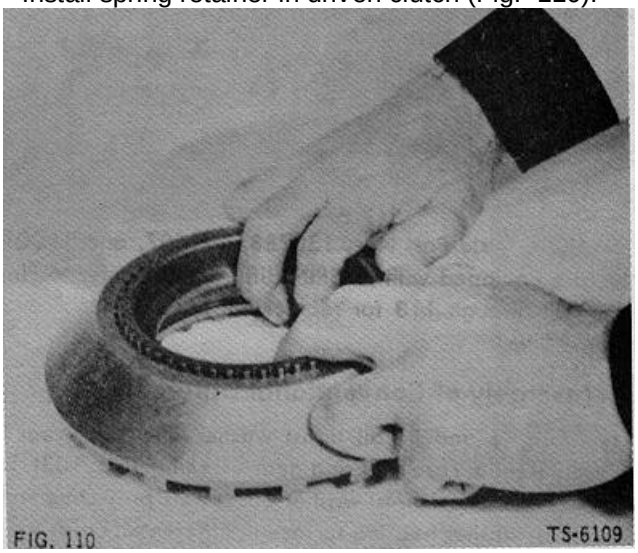


FIG. 110

5. Install side gear and spring in differential case half (Fig. 111).

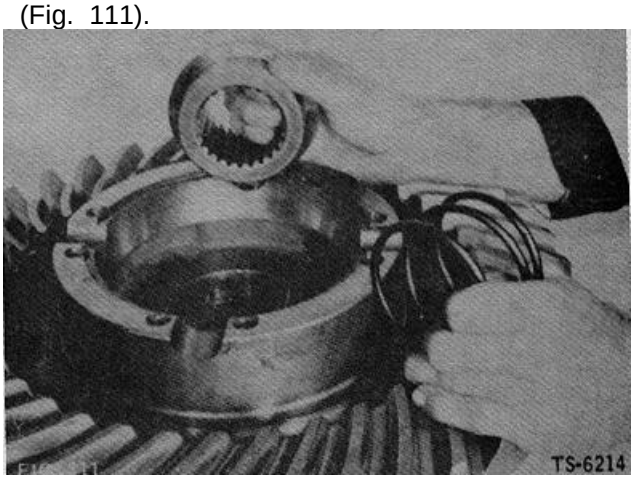


FIG. 111

6. Position assembled driven clutch, holdout ring, and spring retainer on spring (Fig. 112).

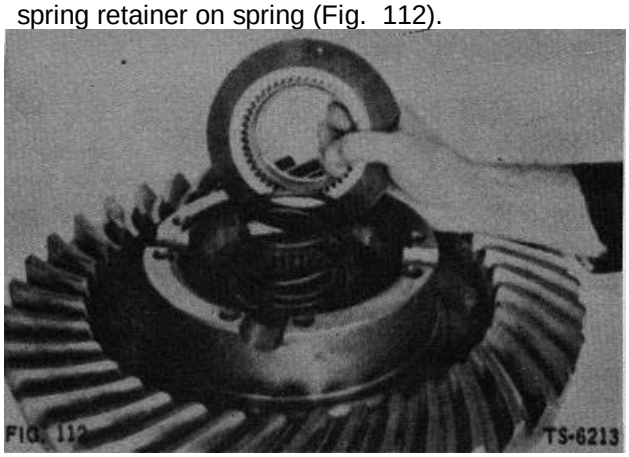


FIG. 112

7. Install assembled spider and center cam on driven clutch. Make sure that keys on spider engage keyways on driven clutch (Fig. 113).

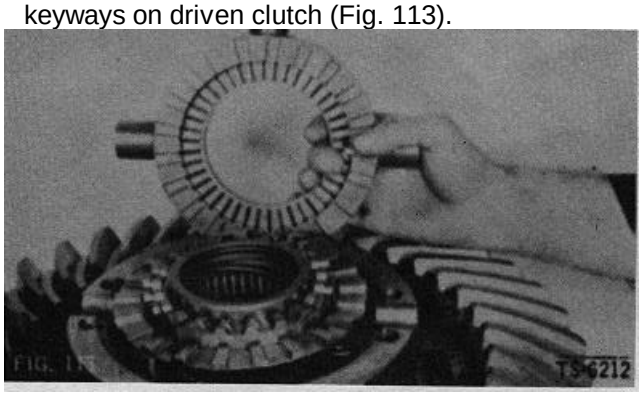


FIG. 113

8. Install the upper driven clutch, with Its assembled holdout ring and spring retainer, on the spider. Make sure spider keys engage keyways In driven clutch **(**Fig. 114).

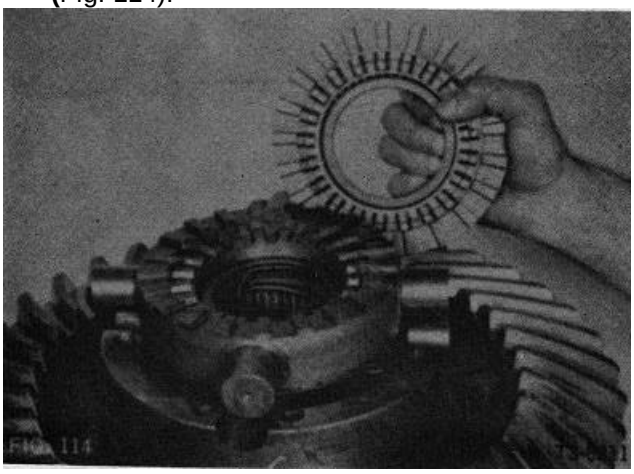


FIG. 114

9. Install spring and side gear on driven clutch (Fig. 115).



FIG. 115

10. Position case half on differential (Fig. 116). Manually press on case half to compress springs to assure that case halves seat fully together. If they do not, splines in the NoSPIN parts are not properly aligned. Align parts and again check to make sure that case halves seat fully.

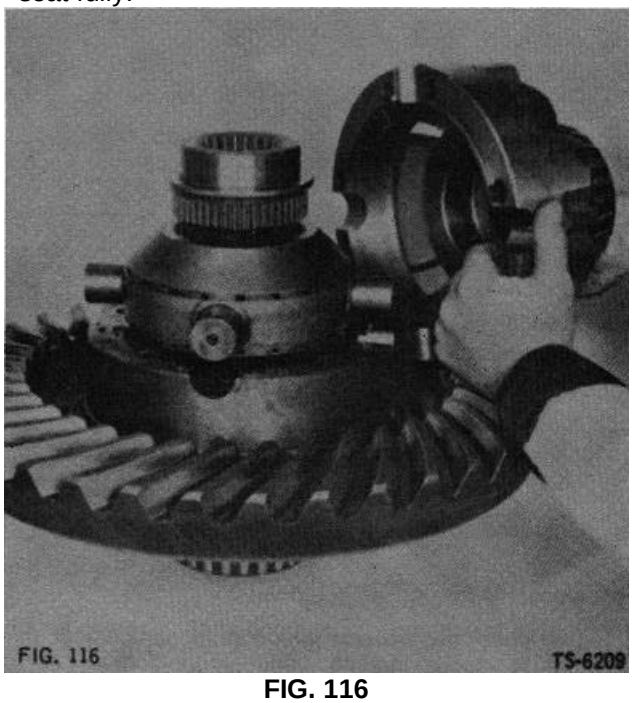


FIG. 116

11. Install four case bolts in alternate holes and tighten them evenly until all are seated, taking care that NoSPIN parts do not bind (Fig. 117). Install remaining bolts and tighten all bolts to specified torque as shown in Fig. 105.

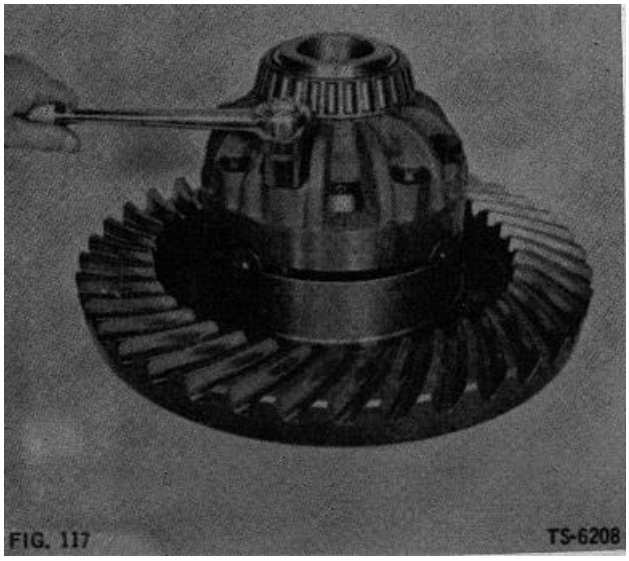


FIG. 117

12. After torquing bolts, insert axle shaft into differential so that it engages side gear and check for backlash between clutch teeth of NoSPIN differential (Fig. 118). A backlash of approximately 5/32 inch must be present. If proper backlash does not exist; disassemble differential case halves and recheck for correct assembly. After reassembly, torque case bolts and lockwire bolts in pairs as shown in Fig. 106.

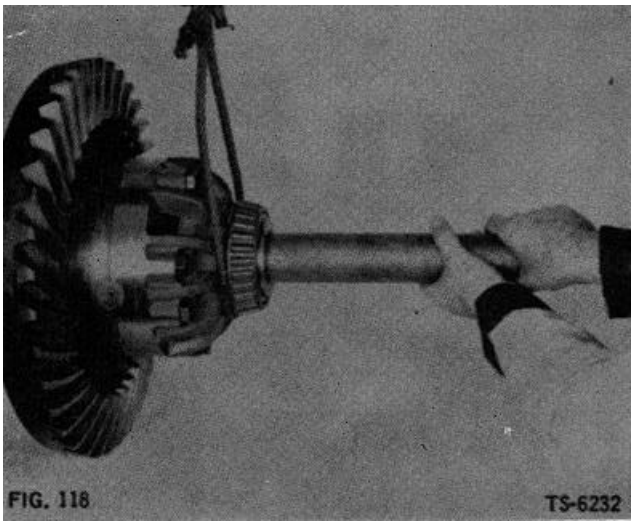


FIG. 118

Reassembly of Differential and Carrier

1. Install bearing cage and pinion shaft assembly in differential carrier assembly, using original shim pack or its equivalent thickness. Use four pinion oil seal retainer bolts with flat washers to pull pinion shaft assembly fully into carrier assembly (Fig. 119). Make sure oil passages are aligned.

NOTE: Some differential carrier housings have blind tapped holes for mounting pinion shaft assembly. If holes are blind, use stacks of flat washers on bolts when installing pinion shaft assembly without oil seal retainer to prevent bolts from bottoming in blind holes.

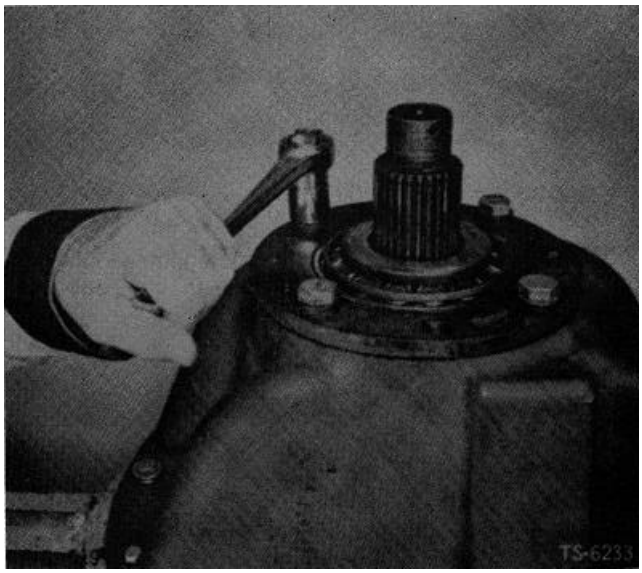


FIG. 119

2. Temporarily install companion flange on end of pinion shaft without installing pinion oil seal retainer. Install companion flange retaining tool on companion flange using spacers shown in Fig. 30 and socket shown in Fig. 31. Torque companion flange nut to 600 ft. lbs. (Fig. 120).

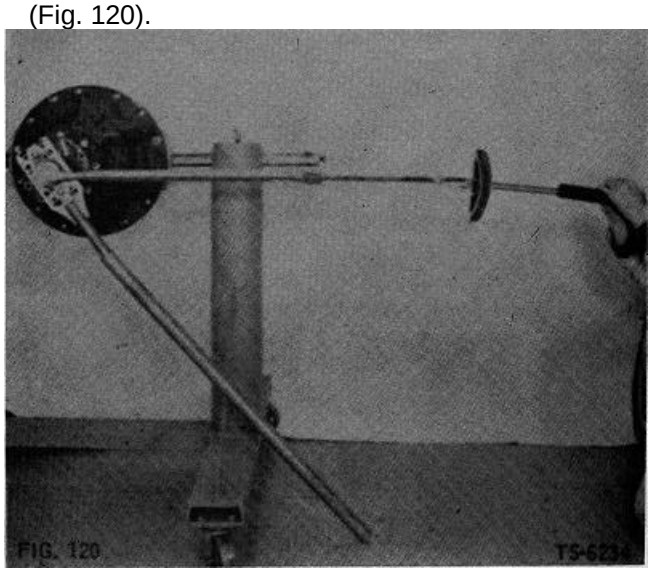


FIG. 120

3. Use "inch-pound" torque wrench to check bearing preload (Fig. 121). If bearing preload is not between 13 and 23 in. lbs., disassemble parts and add shims to decrease preload or remove shims to increase preload.

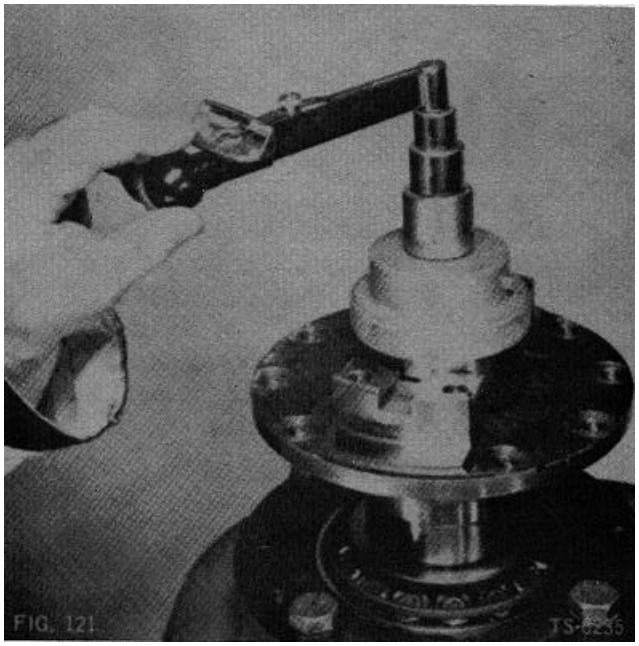


FIG. 121

4. Position differential carrier and pinion assembly in differential stand so that pinion shaft is down. Insert bar through differential to facilitate' hoisting. Position differential into carrier, tilting it so that ring gear will clear inner bearing boss in carrier (Fig. 122).

   NOTE: If differential bearing cones are replaced it is also necessary to replace differential bearing cups.

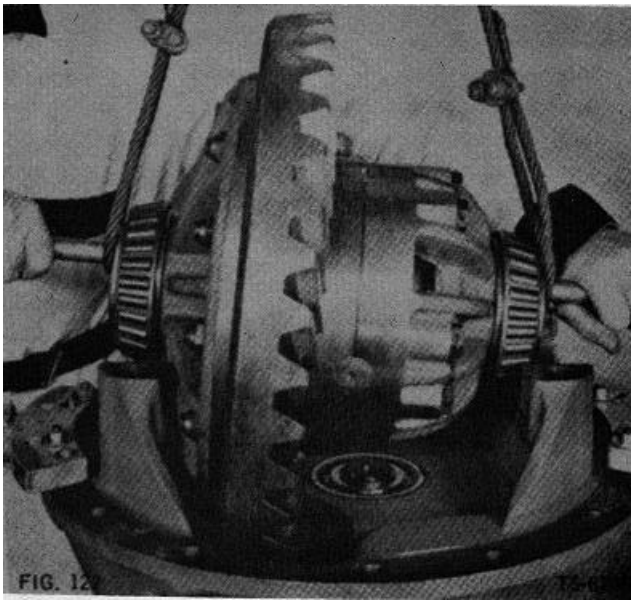


FIG. 122

5. Position differential bearing cup and differential adjusting nut on lifting bar on one side of differential and lift bar slightly with hoist. Position bearing cup and adjusting nut on carrier (Fig. 123). Repeat procedure to install opposite bearing cup and adjusting nut. Take care to prevent cross-threading of nuts.

   NOTE: If differential bearing Cones are replaced, new bearing cups must be used.

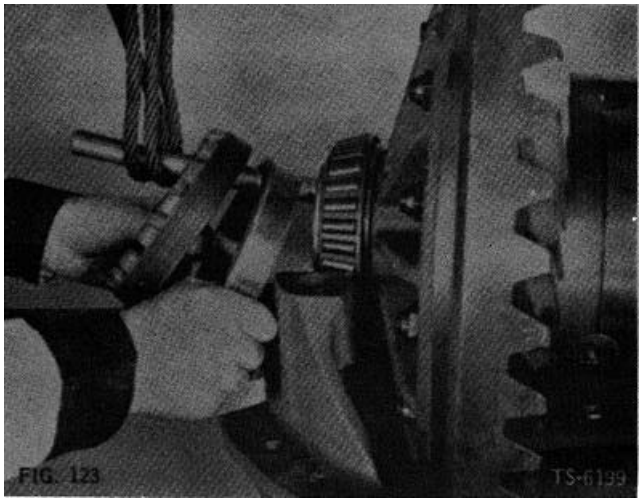


FIG. 123

6. Position bearing caps on bearings and nuts, making sure match-marks made during disassembly are properly aligned. Install bearing cap bolts (Fig. 124) and tighten until snug, but do not torque. Rotate adjusting nuts from time to time to assure that they are not crossthreaded.

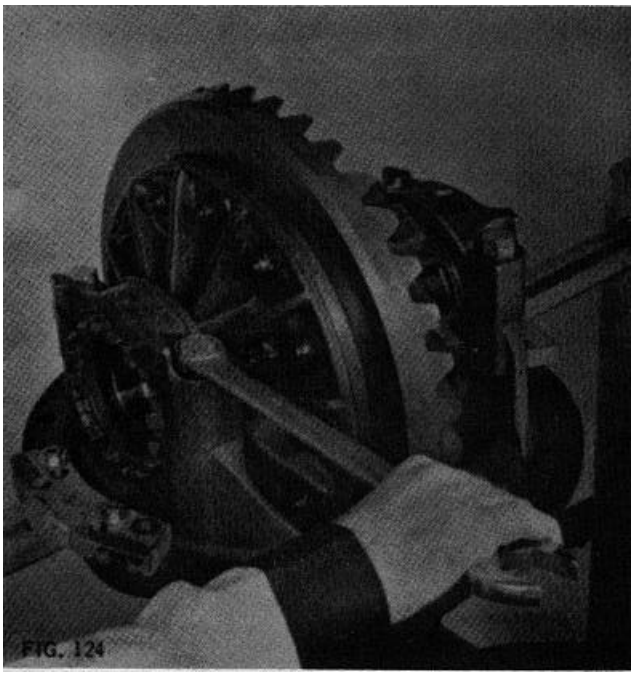


FIG. 124

7. Tighten bearing adjusting *nuts* to adjust bearings to zero end play (Fig. 125). This condition may be checked with screwdriver as shown (Fig. 126). All bearing rollers *must* rotate as ring gear rotates, but it should not be possible to move bearing rollers sideways in cage when prying against them with screwdriver.

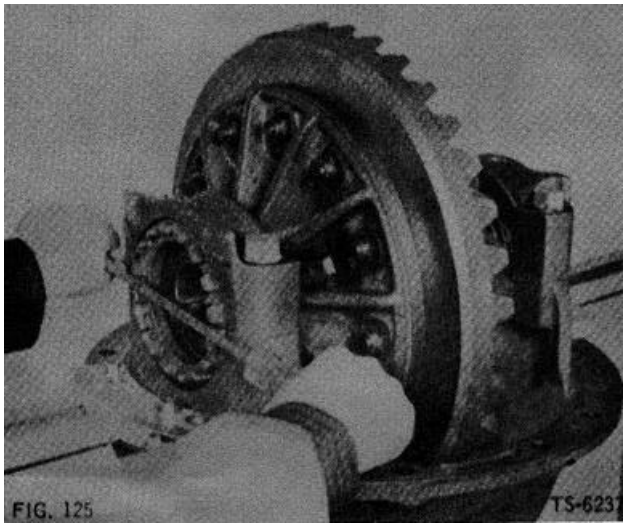


FIG. 125

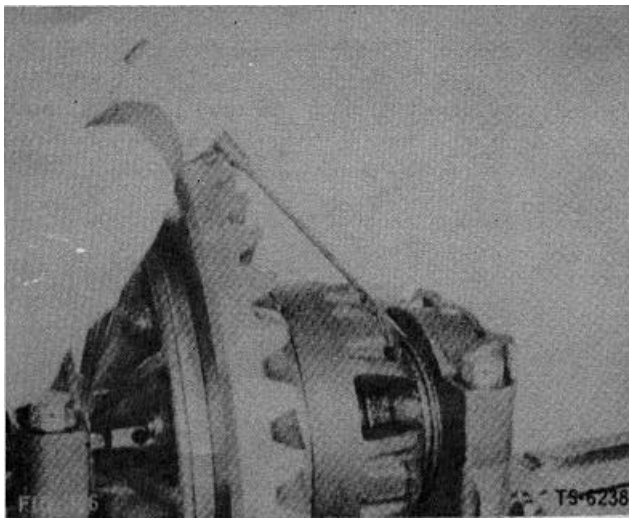


FIG. 126

8. Use a dial indicator to check backlash between ring gear and pinion shaft gear. Backlash is adjusted by moving ring gear toward or away from pinion shaft gear as shown in Fig. 127. Move ring gear by loosening one adjusting nut and tightening opposite lock nut. When loosening one lock nut and tightening opposite, move each lock nut same distance so that bearing adjustment made in previous paragraph is not disturbed. Adjust position until gear backlash is between .010" and .014" if new gear set is used, or adjust to backlash noted at disassembly for old gears.

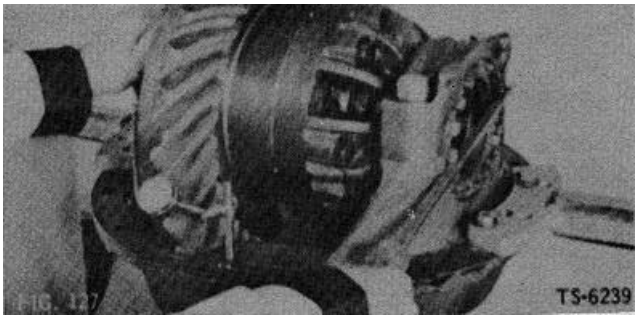


FIG. 127

9. Check ring and pinion gear for proper tooth contact. Paint ring gear with a mixture of red lead and linseed oil (Fig. 128). When ring and pinion gears are rotated, the red lead is squeezed away by the contact of the teeth, leaving bare areas the exact size, shape and location of the contacts. As a rule, painting about 10 or 12 teeth is sufficient for checking purposes.

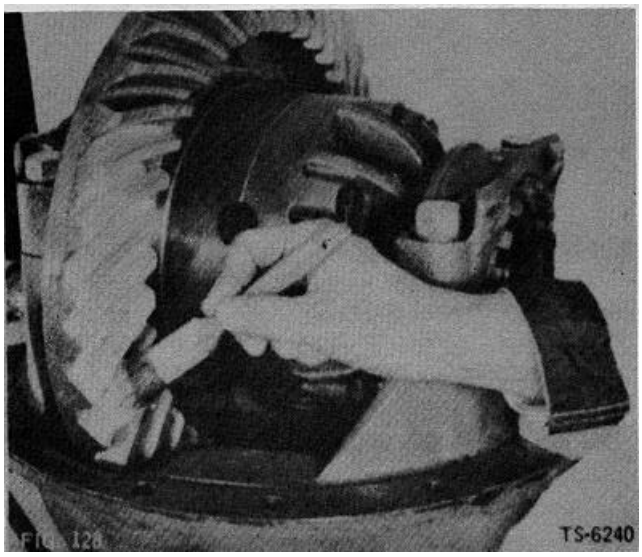
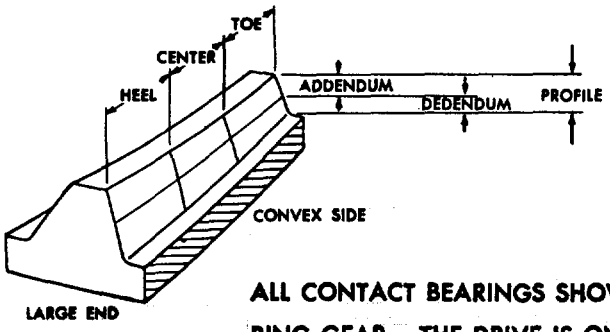


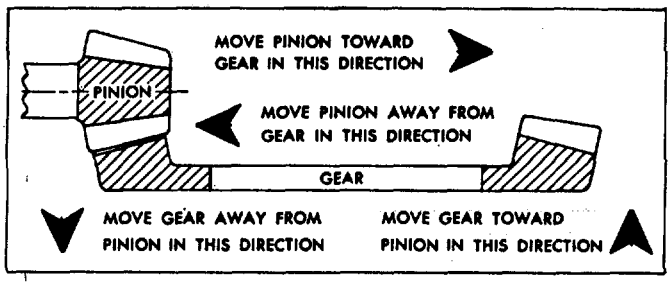
FIG. 128

Sharper impressions may be obtained by applying a small amount of resistance to the ring gear with a flat steel bar *and* using a wrench to rotate the pinion. Gears should be rotated, under slight load, until ring gear has turned at least one revolution in both directions.

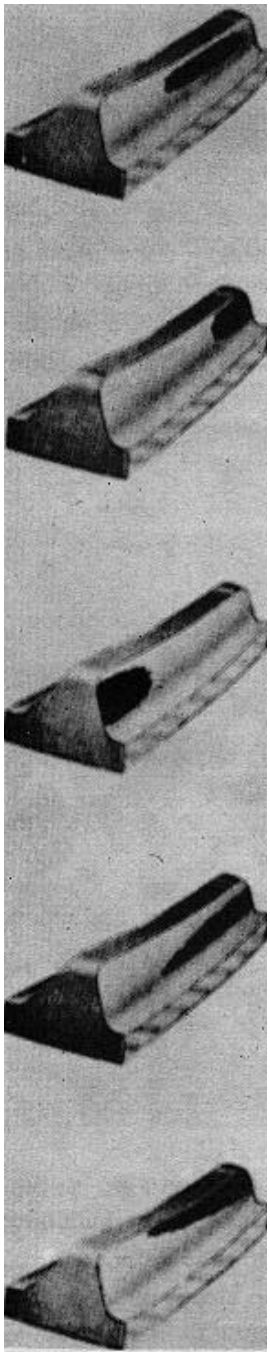
Check tooth contact pattern on drive side (convex side) of ring gear teeth. Coast side will automatically correct when drive side pattern is correct. Refer to gear tooth contact chart (Fig. 129). If proper tooth contact pattern is not as shown, readjust backlash or add to or subtract from shim pack between bearing cage flange and differential housing. Addition of or subtraction of shims should be made in small increments until proper contact is established. Split shims are provided to permit removal or insertion between bearing cage and differential housing.

SPIRAL BEVEL AND HYPOID TOOTH BEARING CONTACT CHART





ALL CONTACT BEARINGS SHOWN BELOW ARE ON RIGHT HAND SPIRAL RING GEAR — THE DRIVE IS ON THE CONVEX SIDE OF THE TOOTH.



CONDITION 1
TYPICAL PREFERRED BEARING ON BOTH SIDES OF TOOTH WHILE UNDER A LIGHT LOAD

CONDITION 2

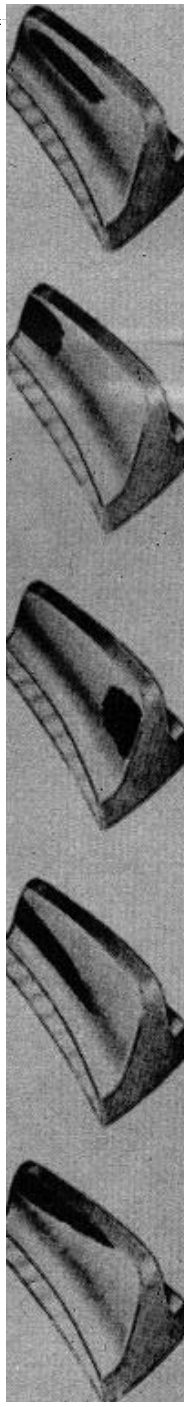
TOE BEARING ON BOTH SIDES OF TOOTH-GEAR SET NOISY. TO MOVE BEARING TOWARD HEEL INCREASE BACKLASH WITHIN LIMITS BY MOVING GEAR AWAY FROM PINION.

CONDITION 3
HEEL BEARING ON BOTH SIDES OF TOOTH- GEAR SET NOISY AND COULD RESULT IN EARLY GEAR FAILURE. TO MOVE BEARING TOWARD TOE DECREASE BACKLASH WITHIN LIMITS BY MOVING GEAR TOWARD PINION.

CONDITION 4
LOW BEARING ON GEAR AND HIGH BEARING ON PINION. CORRECT BY PULLING PINION AWAY FROM GEAR. INCREASE MOUNTING DISTANCE BY ADDING SHIMS BETWEEN BEARING CAGE AND DIFFERENTIAL HOUSING.

CONDITION 5
HIGH BEARING ON GEAR AND LOW BEARING ON PINION. CORRECT BY MOVING PINION IN TOWARD GEAR. DECREASE MOUNTING DISTANCE BY REMOVING SHIMS FROM BETWEEN BEARING CAGE AND DIFFERENTIAL HOUSING.

BACKLASH
BACKLASH SHOULD BE MEASURED WITH A DIAL INDICATOR RIGIDLY MOUNTED WITH THE STEM PERPENDICULAR TO THE TOOTH SURFACE AT THE EXTREME HEEL.



10. Tighten bearing cap bolts to specified torque (Fig. 130). With dial indicator, recheck ring gear and pinion backlash. Recheck differential bearings for end play as described in step 4.

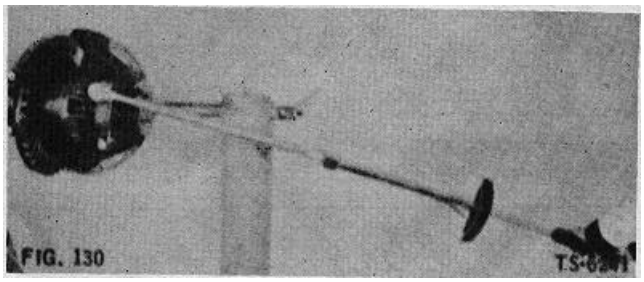


FIG. 130

11. Use dial indicator to check back face of ring gear. Rotate at least one full turn (Fig. 131). Runout must not exceed .005 total indicator reading. If runout is excessive, remove assembly and check for burrs or dirt under mounting surface of ring gear. Reassemble and recheck.

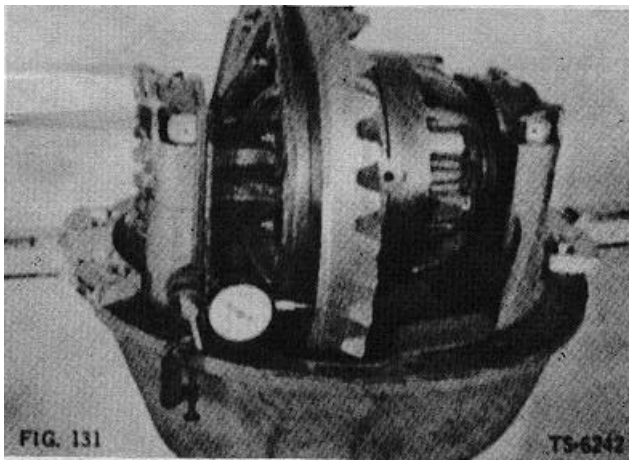
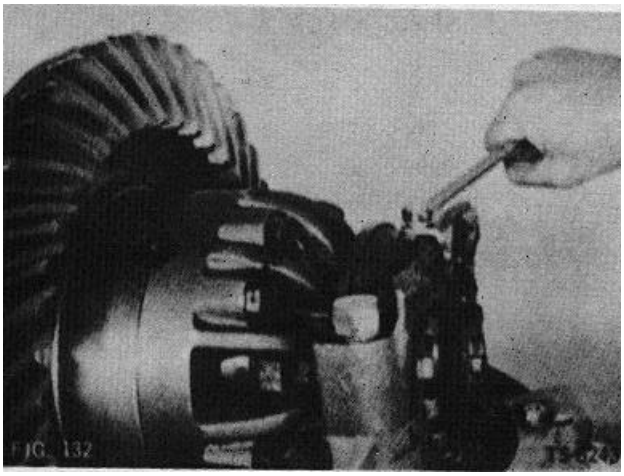


FIG. 131

12. Install adjusting nut lock with bolt and lockwasher (Fig. 132).



13. Lockwire together the bearing cap bolts and adjusting nut bolt (Fig. 133).

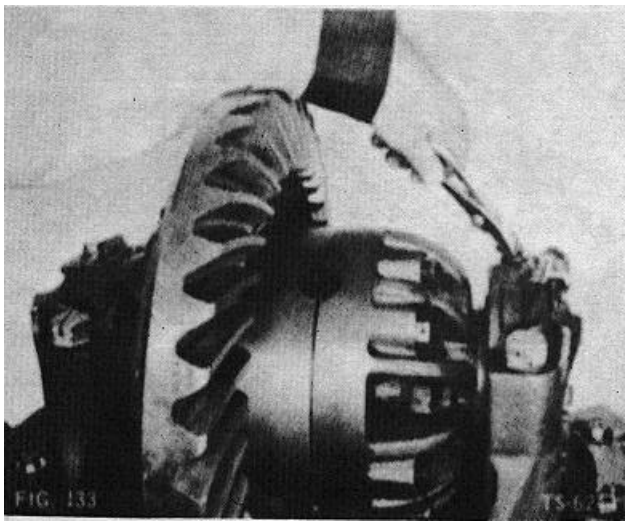


FIG. 133

14. Remove companion flange and remove bolts and washers that were used for temporary installation of pinion shaft assembly. Coat outside diameter of seal with Permatex No. 2 and press into pinion oil seal retainer so' that lip of seal will face toward pinion. Coat lip with Lubriplate. Install gasket and pinion oil seal retainer. Secure with 8 bolts and lockwashers and tighten bolts to specified torque (Fig. 134).

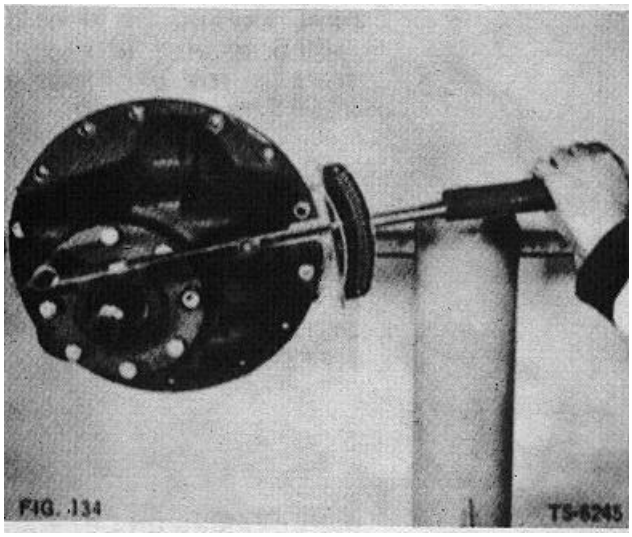


FIG. 134

15. On axle models that do not have a parking brake, install companion flange on end of pinion shaft with flat washer and nut. Torque nut to 600 ft. lbs. As shown in Fig. 120. Secure nut with cotter pin. On axle models with parking brake, companion flange should be installed temporarily to facilitate handling the differential.

Reassembly of Internal Gear and Hub

1. Position internal gear on hub, aligning matchmarks made at disassembly. Secure with bolts and locking plates and tighten to specified torque (Fig. 135). Lockwire bolts in pairs.

   NOTE: Some axles use bolts without locking plates, with bolts inserted through internal gear and threaded into hub.

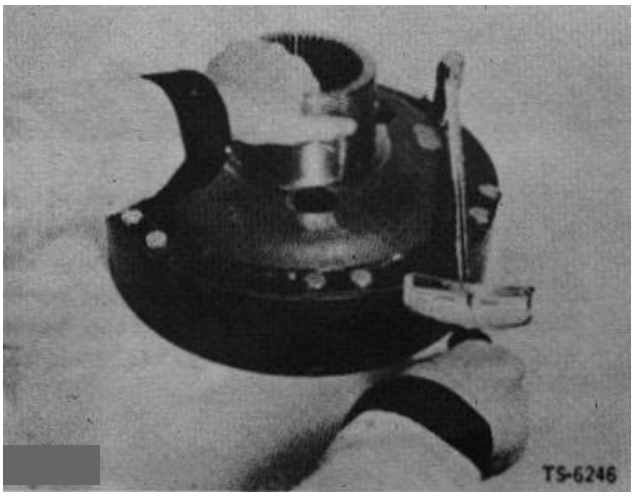


FIG. 135

2. Check that bearing seat on hub is free of nicks and burrs. Press bearing cone on internal gear and hub using bearing driver (Fig. 136). Bearing driver dimensions are given in Fig. 137.

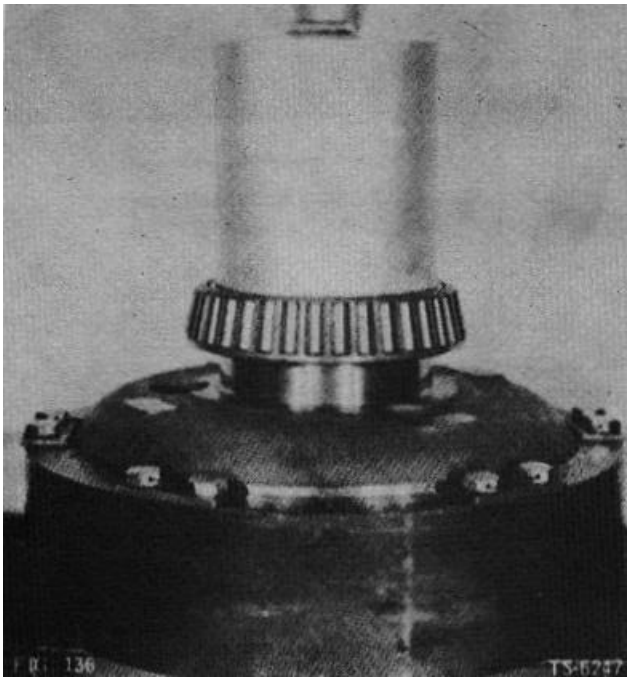


FIG. 136

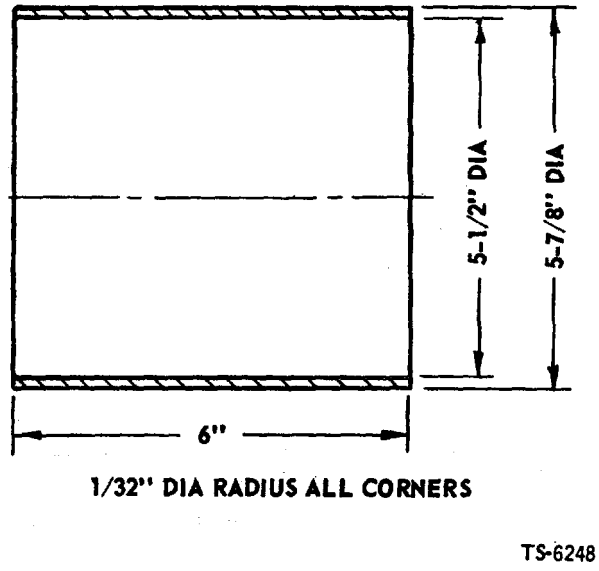


FIG. 137

Reassembly of Brake Shoes

1. Install brake linings on brake shoes with washers and nuts. Torque nuts to 200 to 220 in. lbs. (Fig. 138). Tighten nuts in sequence shown in Fig. 139.

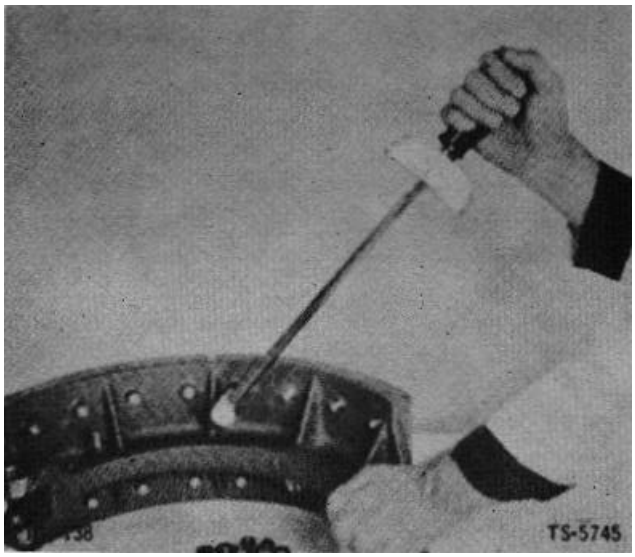


FIG. 138

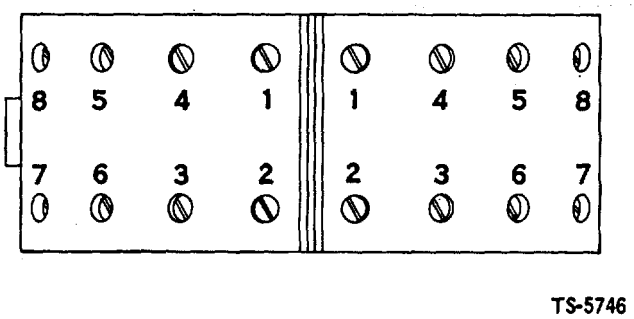


FIG. 139

2. Top brake lining plugs into brake lining bolt holes (Fig. 140).

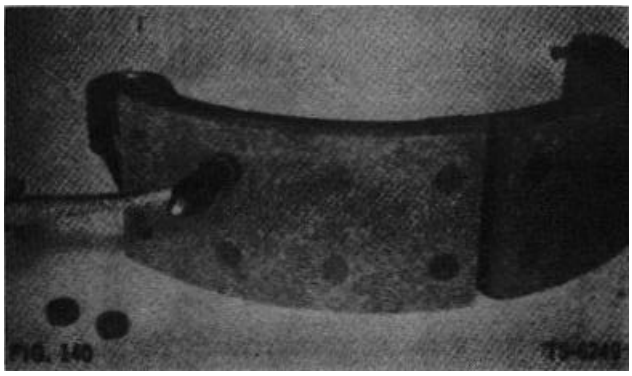


FIG. 140

3. Position brake cam roller on brake shoe. Apply light coat of Never-Seez on broke cam roller pin and insert pin. Secure pin with cam roller pin lock pin and cotter pin (Fig. 141).



FIG. 141

4. Press brake shoe bushings into brake shoe (Fig. 142).

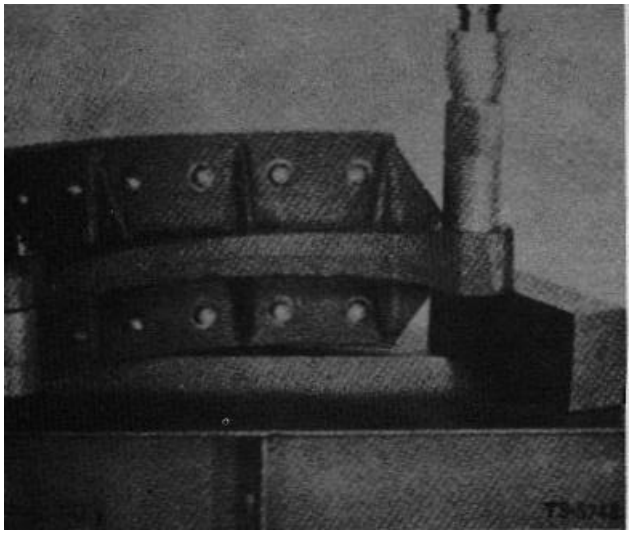


FIG. 142

Reassembly of Hub and Drum Assembly

1. If wheel studs were removed, replace entire set of studs with new set. Install stud nuts and tighten to 200 ft. lbs. torque (Fig. 143).

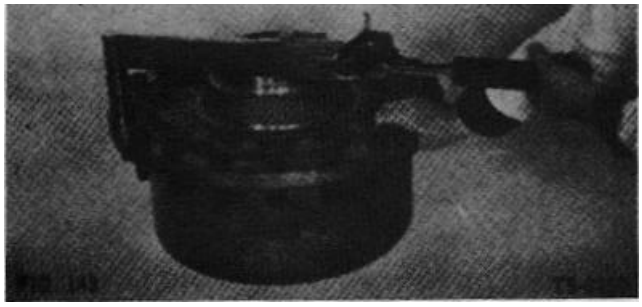


FIG. 143

2. Check bearing bores In wheel hub to be sure all nicks and burrs have been removed from both bores and bearing seats. Install bearing cups In hub with wide diameter of taper toward outside of hub. Use bearing driver to drive cups Into place (Fig., 144). Bearing driver dimensions are given In Fig. 145. Make sure bearings are fully seated.

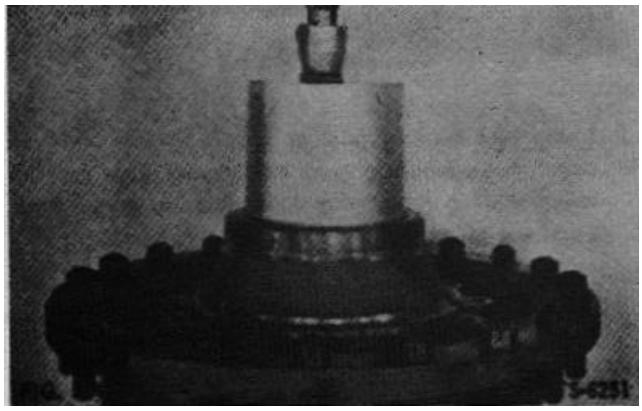


FIG. 144

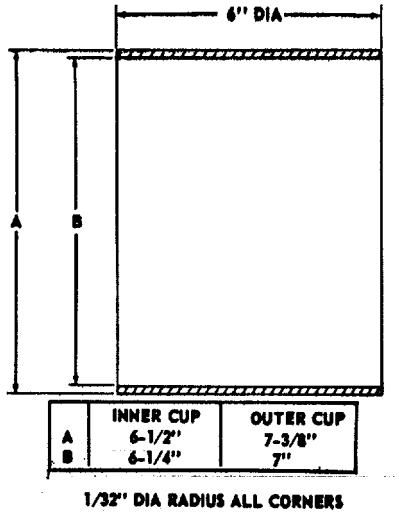


FIG. 145

3. Lubricate inner wheel hub bearing cone with gear oil and position in wheel hub bearing cup (Fig. 146).

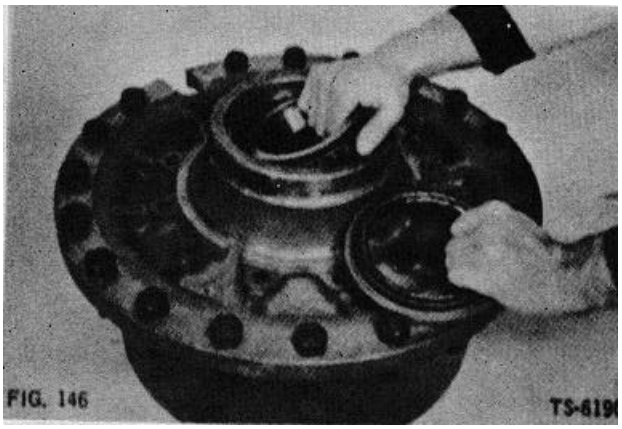


FIG. 146

4. Coat outside diameter of oil seal with Permatex No. 2. Lubricate lip of seal with Lubriplate. Press or drive oil seal into hub using seal driver (Fig. 147). Fig. 148 shows driver dimensions. Spring-loaded lip of seal must face inward. Wipe off excessive Permatex after seating seal.

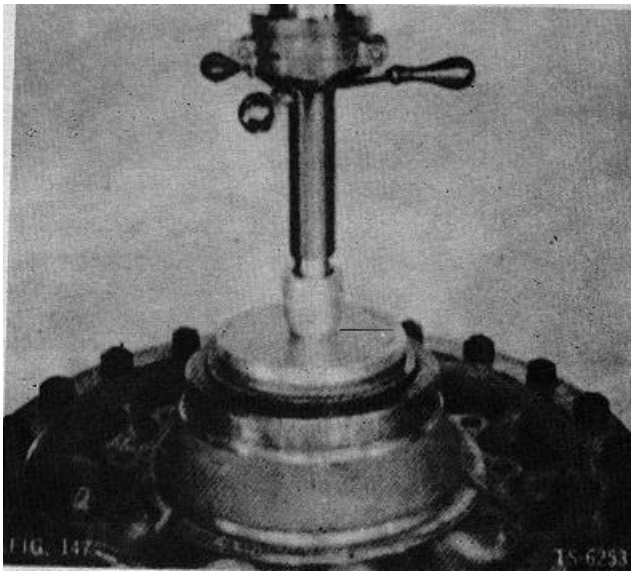


FIG. 147

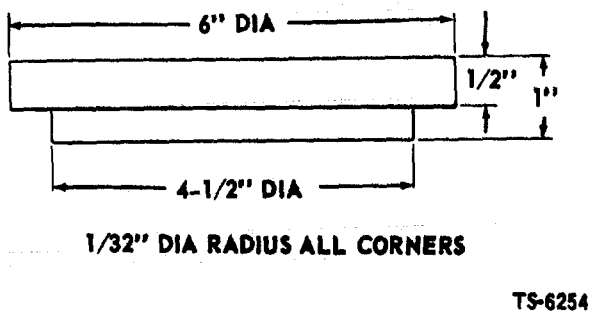


FIG. 148

5. Position oil catcher on hub (Fig. 149).

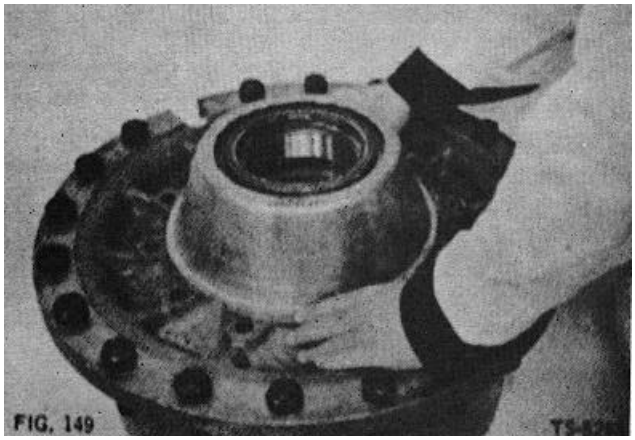


FIG. 149

6. Position brake drum on hub. Install bolts and flat washers. Tighten bolts to torque specifications (Fig. 150).

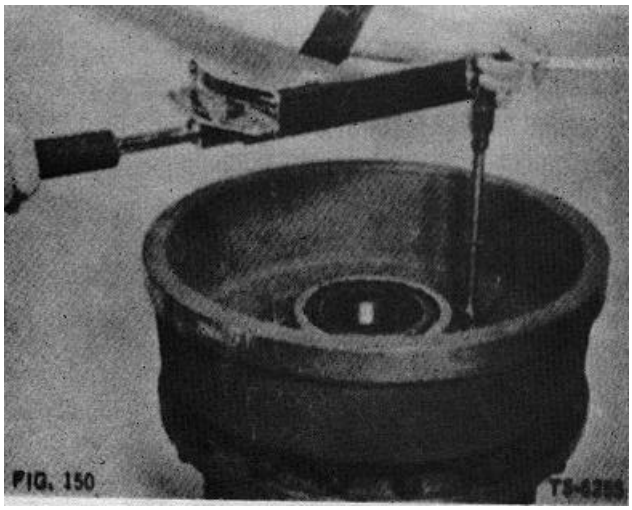


FIG. 150

7. Lock-wire bolts in pairs (Fig. 151).

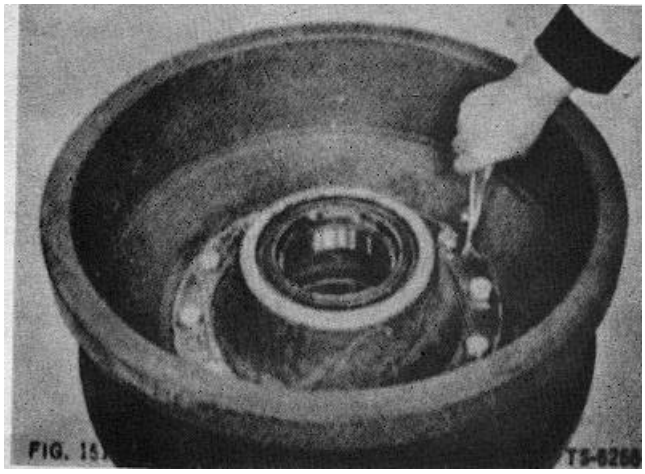


FIG. 151

Reassembly of Planet Carrier

1. Coat inside of planet pinion with chassis grease to retain pinion needle rollers. Each pinion contains a double row of needle rollers, with a spacer between rows. Install a row of 28 rollers, roller spacer and another row of 28 rollers in each pinion (Fig. 152).

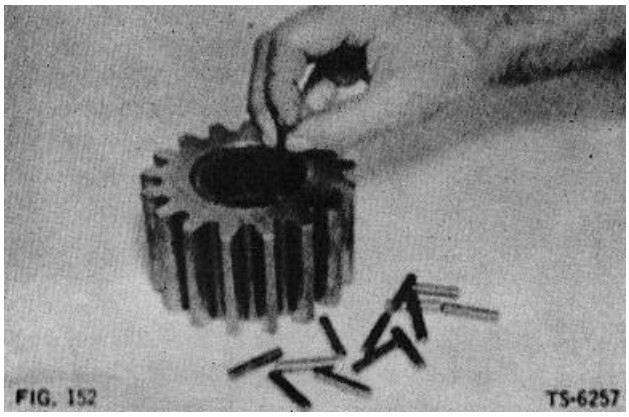


FIG. 152

2. Position assembled pinion and two pinion thrust washers in planet carrier, making sure tangs on thrust washer engage the grooves in the spider (Fig. 153).

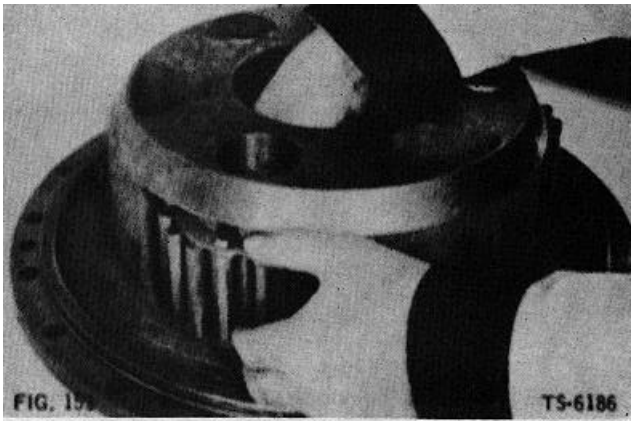


FIG. 153

3. Press in pinion shaft, making sure the pinion shaft ball recess aligns with groove in spider. Insert pinion shaft ball and complete press (Fig. 154L) Press end of pinion shaft flush with face of carrier.

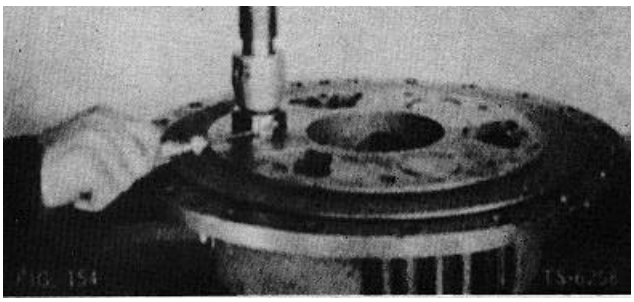


FIG. 154

4. Stake pinion shaft ball groove in two places to retain shaft (Fig. 155).

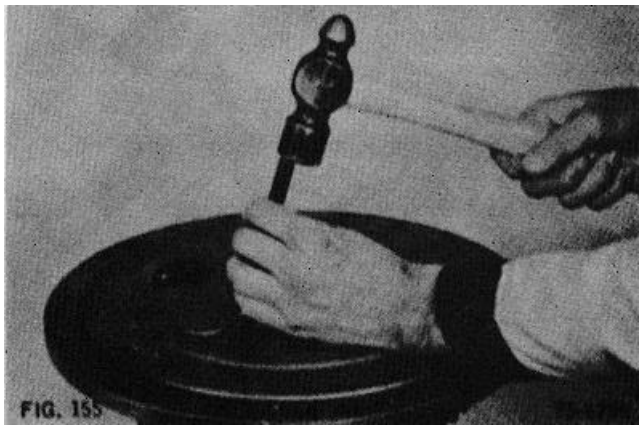


FIG. 155

Reassembly of Axle Parts

1. Coat both sides of differential gasket lightly with gasket sealer and position carefully on axle housing (Fig. 156).

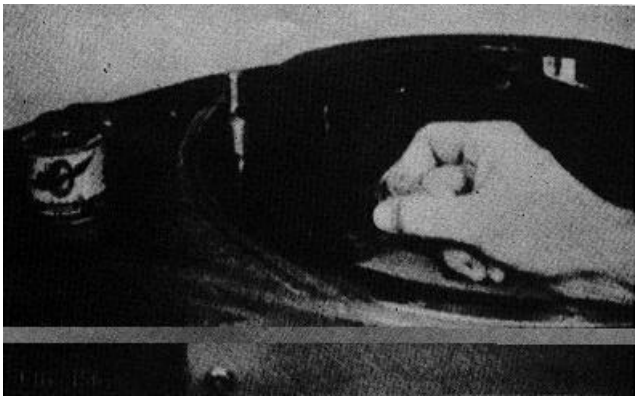


FIG. 156

2. Position differential carrier on axle housing Fig. 157).

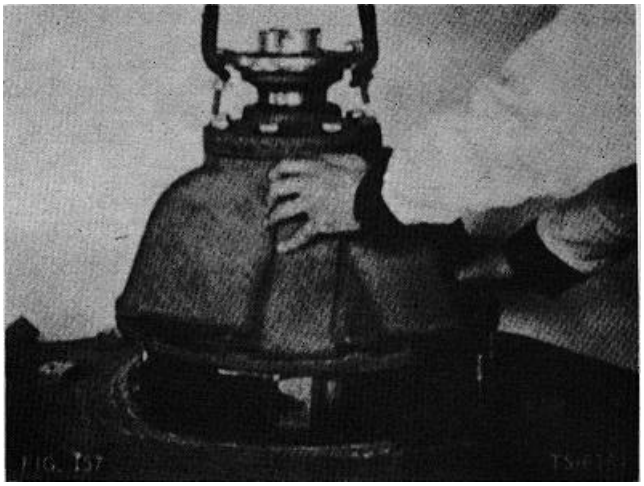


FIG. 157

3. Secure differential carrier to axle housing with bolts, nuts, washers, and tapered dowels (Fig. 158}. Tighten nuts on the four studs first, then tighten all bolts evenly until they are snug. Tighten all nuts and bolts to specified torque.

   NOTE: Some axles use bolts of several different lengths without nuts and dowels. Determine length of bolt required by checking thickness of differential carrier flange and depth of mounting holes. Select correct bolt for each position.

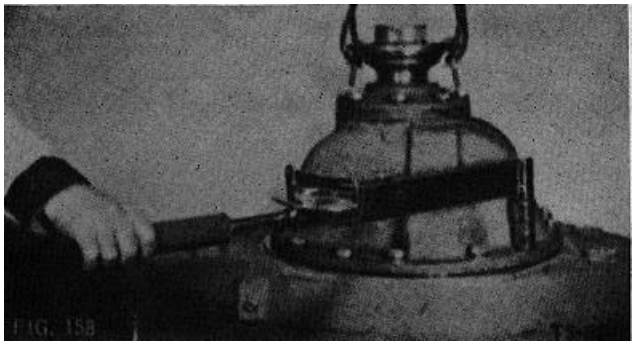


FIG. 158

4. On axles which incorporate a parking brake, remove companion flange which was temporarily installed to facilitate hoisting differential. Position parking brake backing plate on differential and carrier assembly and secure with four bolts and lockwashers. Tighten bolts to specified torque (Fig. 159).

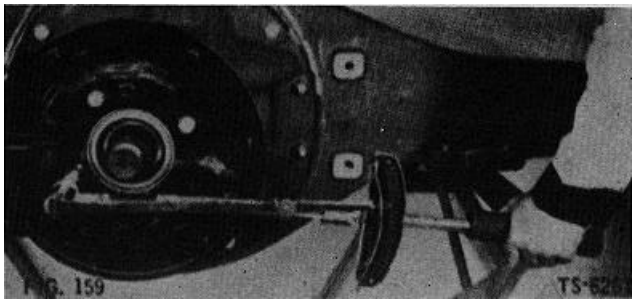


FIG. 159

5. Position brake operating cam lever and roller on brake backing plate (Fig. 160).

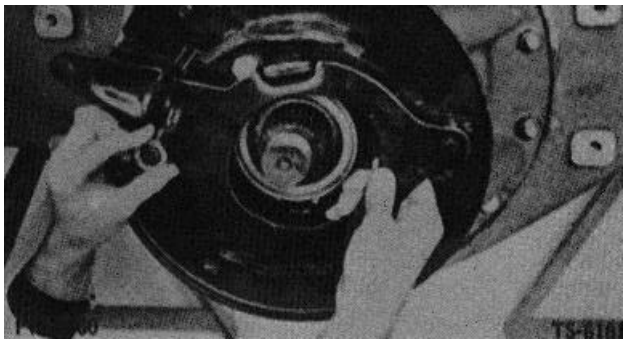


FIG. 160

6. Assemble parking brake shoes and upper brake shoe return spring. Spread shoes apart and position shoes on brake backing in engagement with operating cam lever and roller (Fig. 161).



FIG. 161

7. Install lower brake shoe return spring with brake spring pliers (Fig. 162).

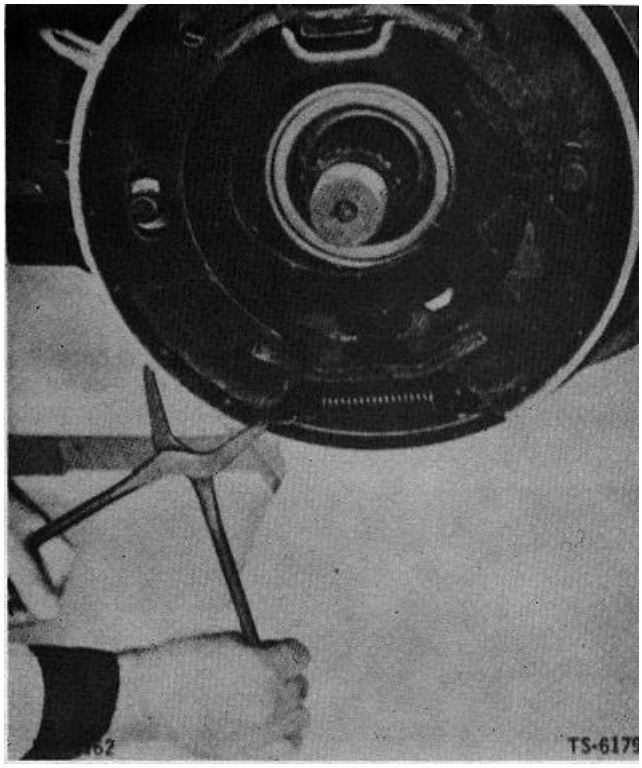


FIG. 162

8. Position parking brake drum on companion flange, taking care to match punch marks made at disassembly. Secure parts with bolts, nuts, and lockwashers. Tighten bolts to specified torque Fig. 163). When torquing bolts, place companion flange under light pressure in press to hold assembled parts. Do not score or distort parking brake drum by clamping in a vise.

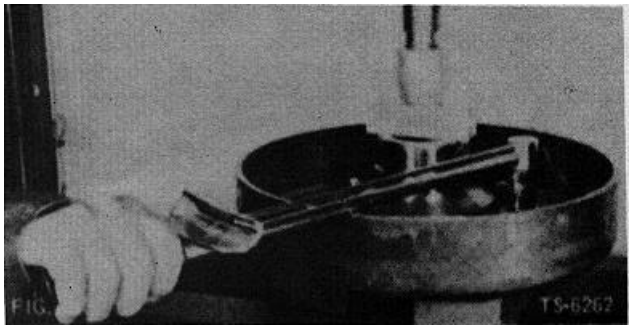


FIG. 163

9. Position assembled parking brake drum and companion flange on pinion shaft. Secure with flat washer and companion flange nut. Torque nut to 600 ft. lbs. (Fig. 164). Install cotter pin to retain nut.

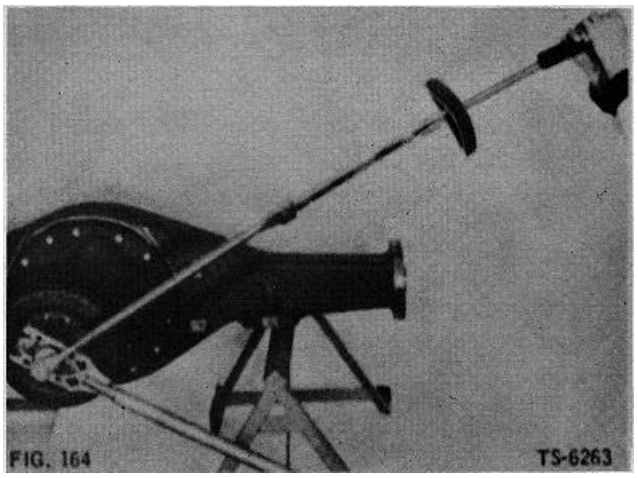


FIG. 164

10. Position air chamber brackets and spacers on axle housing; secure each bracket with two bolts and lockwashers. Tighten finger tight only to permit alignment of bracket after brake camshaft is installed (Fig. 165).

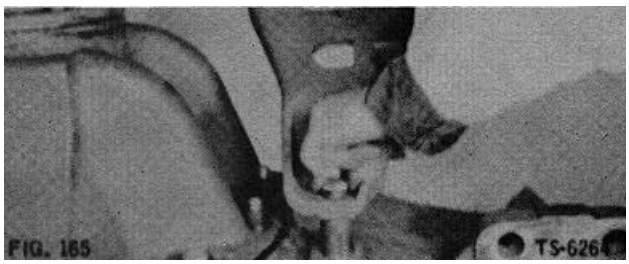


FIG. 165

11. Slide axle shaft into position in axle housing so that splines engage differential side gear. Position shaft so that end having retaining ring groove for sun gear is toward the outside (Fig. 166).

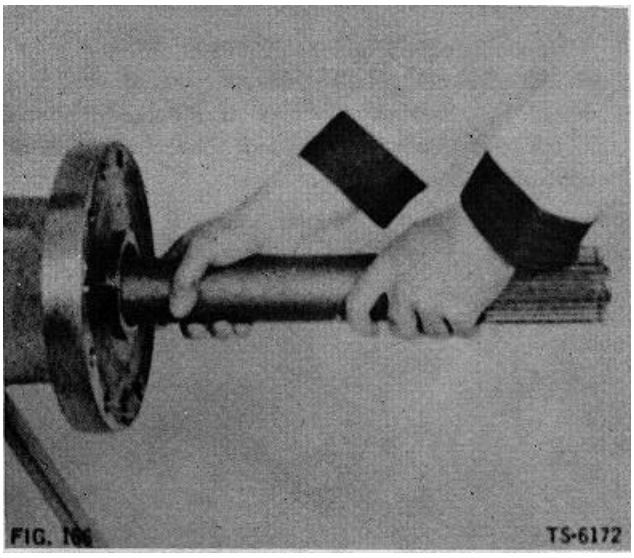


FIG. 166

12. Position spindle on spindle support assembly (Fig. 167).

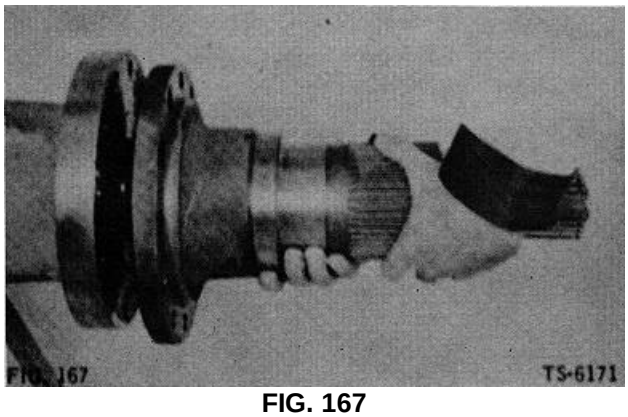


FIG. 167

13. Position brake spider on spindle (Fig. 168).

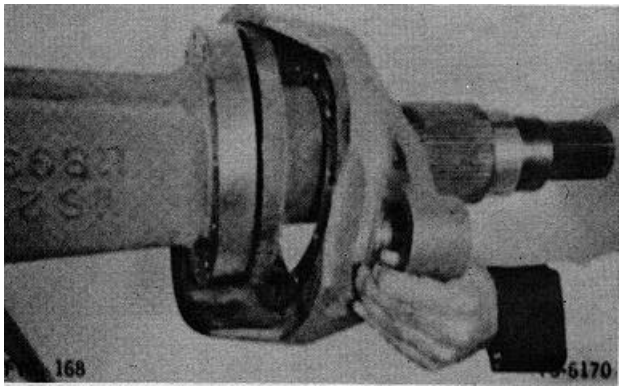
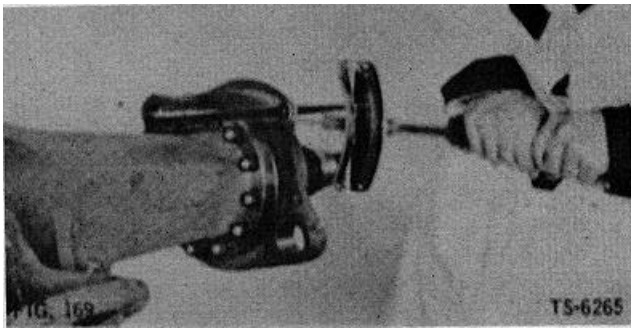
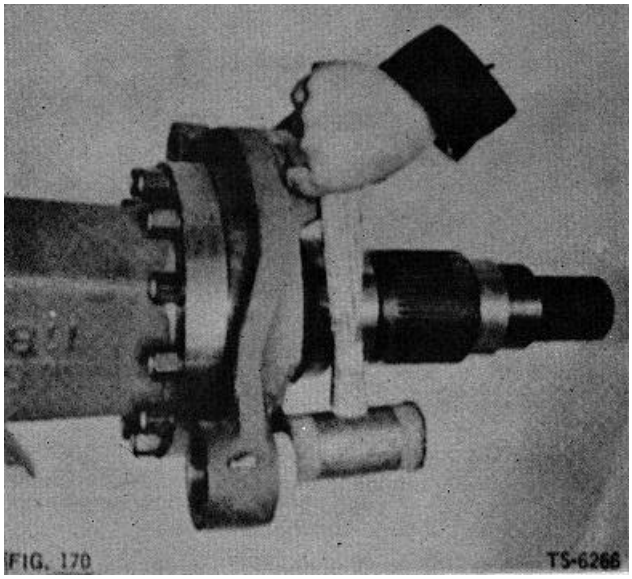


FIG. 168

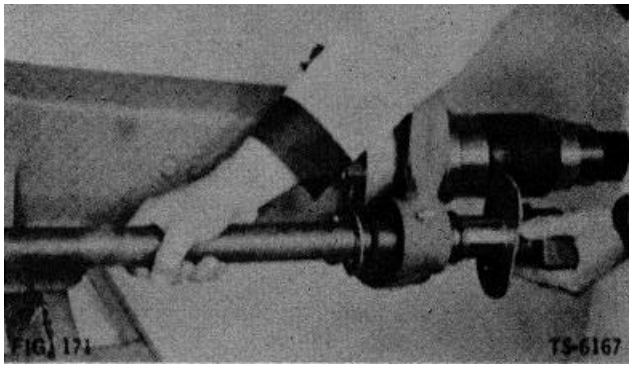
14. Secure spindle and brake spider to axle housing with bolts, lockwashers, and nuts and tighten to specified torque (Fig. 169).



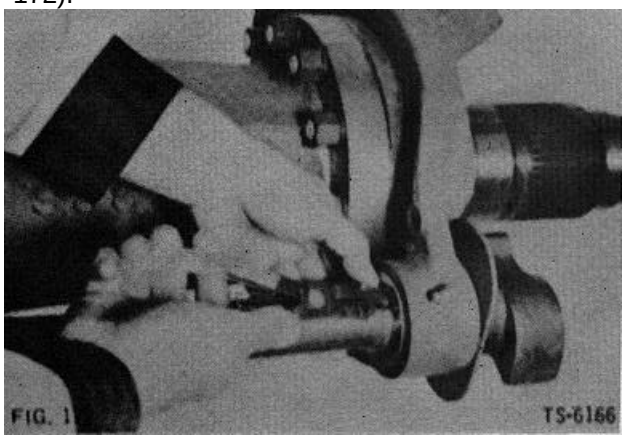
15. Tap brake camshaft bushing into brake spider (Fig. 170).



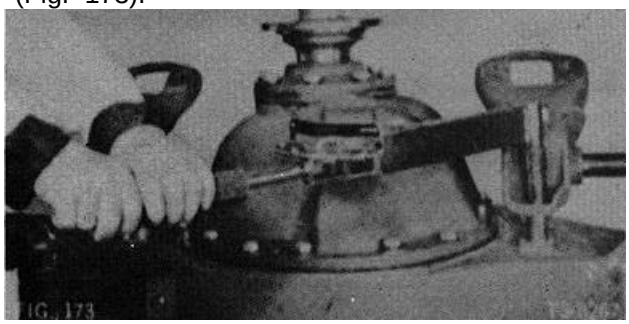
16. Position thrust washer and "O" ring on brake cam shaft. Insert cam shaft through bushing in brake spider and position felt grease retainer, grease washer, and retaining ring on cam shaft (Fig. 171).



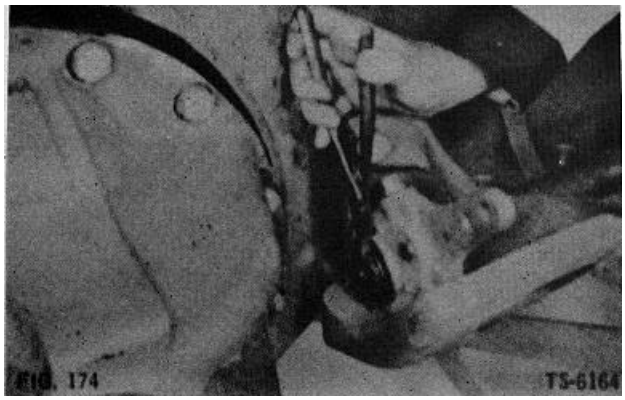
17. Seat felt grease retainer in recess in brake spider. Install retaining ring in retaining ring groove. (Fig. 172).



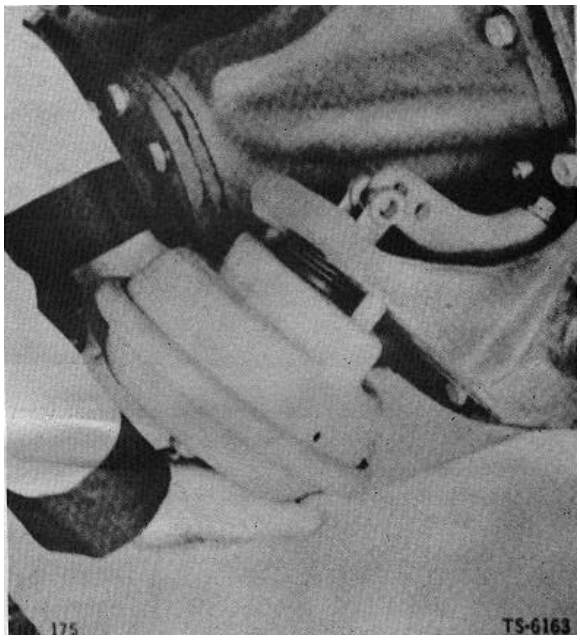
18. Position air chamber bracket and spacers, which were previously installed, so that there is no binding between cam shaft and air chamber bracket bushing. Tighten bracket mounting bolts to specified torque (Fig. 173).



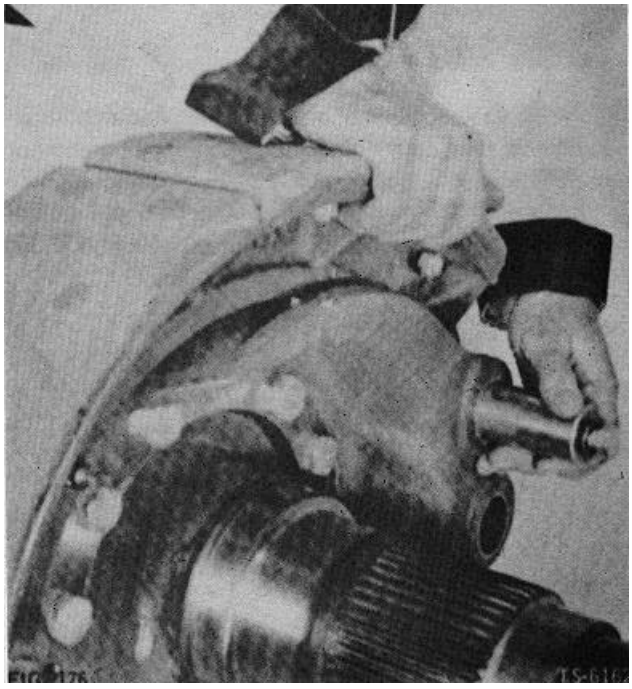
19. Position slack adjuster on cam shaft. Secure with retaining ring and washer (Fig. 174). Be sure to install slack adjuster so that adjusting screw points in same direction as before disassembly. In some applications adjusting screw is adjacent to air chamber bracket. In others it is as shown in Fig. 174.



20. Position air chamber on air chamber bracket (Fig. 175). Secure with nuts and lockwashers. Tighten nuts to specified torque. Secure clevis of brake chamber to slack adjuster with pin and coffer pin.

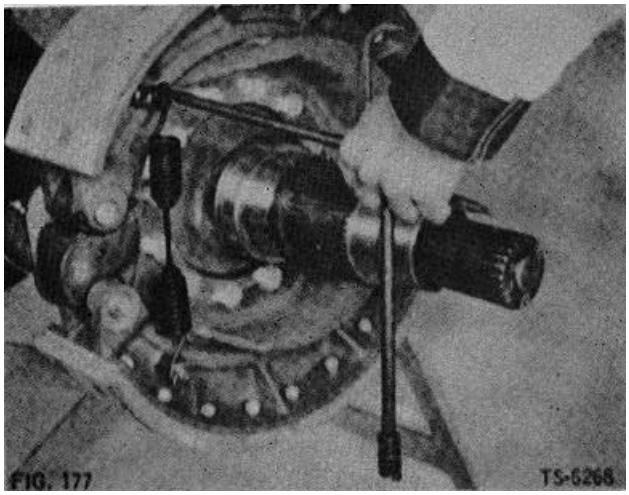


21. Position broke shoe on spindle support. Retain brake shoe by inserting brake shoe anchor pin (Fig. 176). Install second brake shoe in same manner.



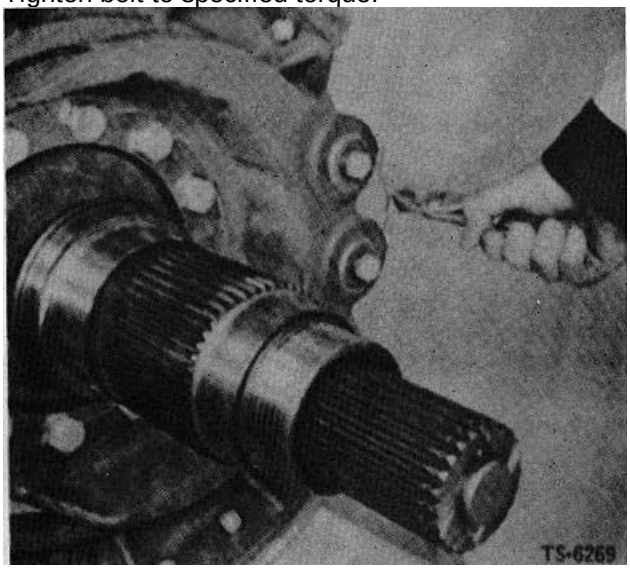
22. install brake shoe return spring (Fig. 177). Before installing spring, make sure that slack adjusters are adjusted to allow brake shoes to come together as closely as possible so that spring tension will be at a minimum during installation. Install spring anchor pin washers and cotter pins.

CAUTION: *Do not use pliers with serrated jaws to assemble brake spring. Do not use any tool which will nick or score spring. This will cause early failure. Tool shown is broke pliers which has provisions on end of handle for installing spring.*

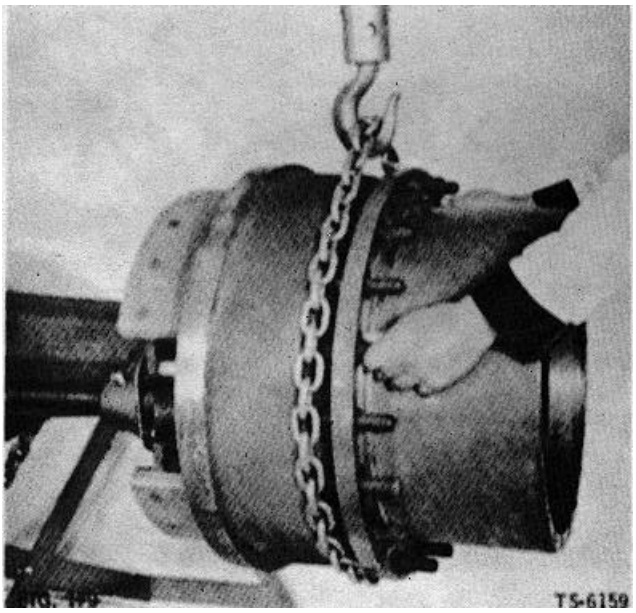


23. Lock brake shoe anchor pins with anchor pin set screws. Lockwire set screws (Fig. 178).

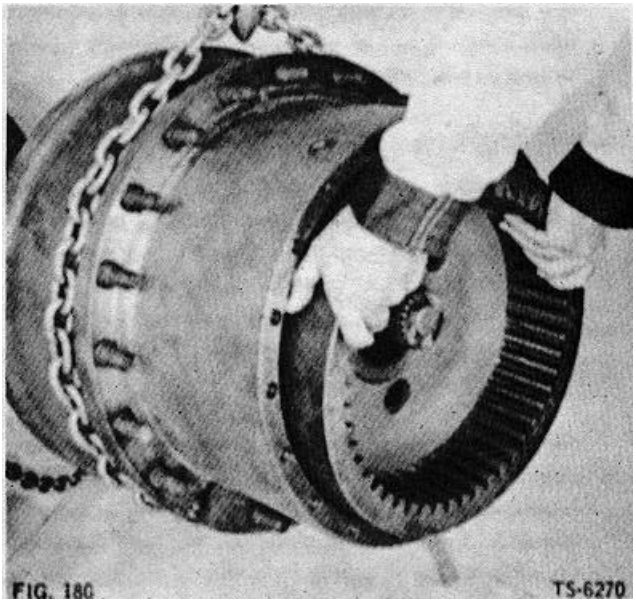
NOTE: On some axles, brake anchor pins are held in place with retaining plate, bolt, and lockwasher. Tighten bolt to specified torque.



24. Lubricate lip of hub and drum oil seal with Lubriplate. Position hub and drum on axle (Fig. 179). Care should be taken to align hub and drum assembly with spindle so that no cocking of inner hub bearing occurs when sliding assembly on spindle. If difficulty is encountered when trying to position the brake drum over the brake shoes, check for improper adjustment of slack adjuster. During installation, slack adjusters must be adjusted to minimize brake spring tension.

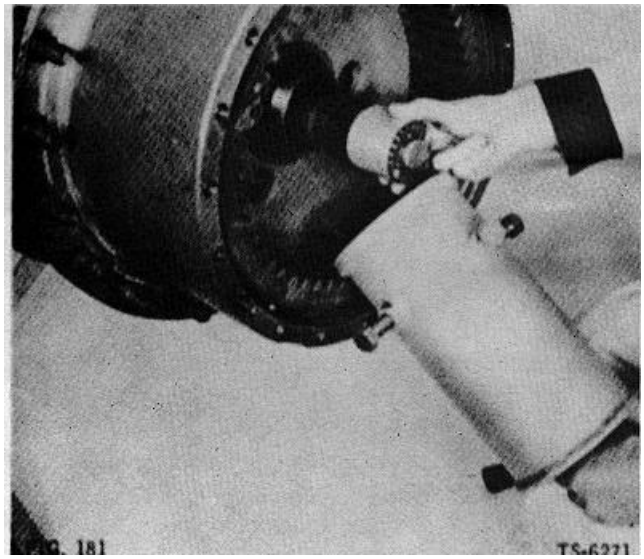


25. Continue to support hub and drum with hoist. Position internal gear and hub on axle so that it engages splines on spindle (Fig. 180).



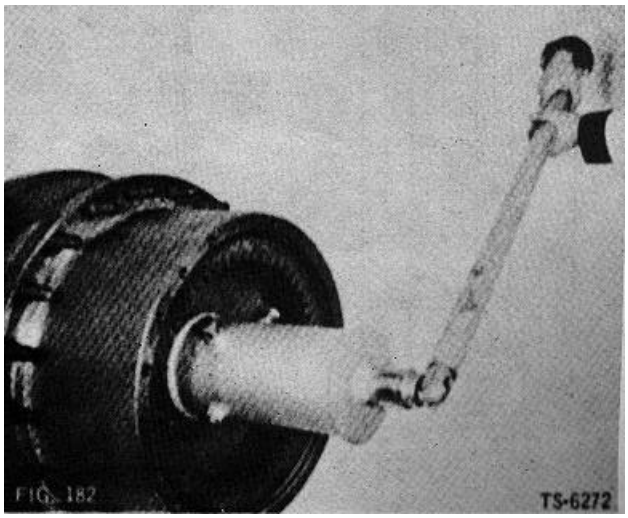
26. Install inner spindle nut on spindle. Wrap several turns of .010 inch to .020 inch shim stock around splines of axle shaft to protect splines. Install spindle nut socket wrench, Part No. 945940, on nut (Fig. 181) and tighten guide bolts lightly against axle shaft.

NOTE: The tapered roller bearings utilized in wheel hub must be preloaded in accordance with procedure steps and specifications given below. One of two methods may be used in adjusting the required preload on these bearings. It should be noted that preload specifications differ for use of new bearings and when wheel bearings are being reused.

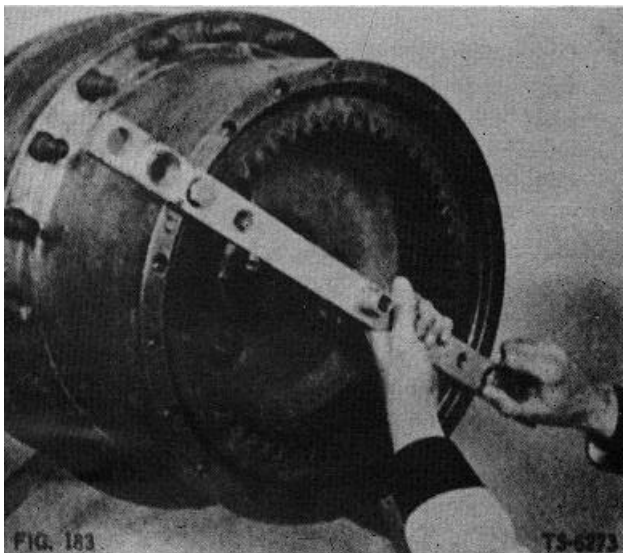


First (Preferred) Method

27. Tighten inner nut while rotating wheel hub in both directions until there is a slight binding (Fig. 182).



28. Install torque wrench adapter bar, as shown in Fig. 183. The adapter bar can be fabricated locally to specifications outlined in Fig. 184. Bar illustrated will accommodate wheel hubs with planetary bolt circle diameters of 12 1/2, 16 1/2, 19 1/2, and 23 inches.



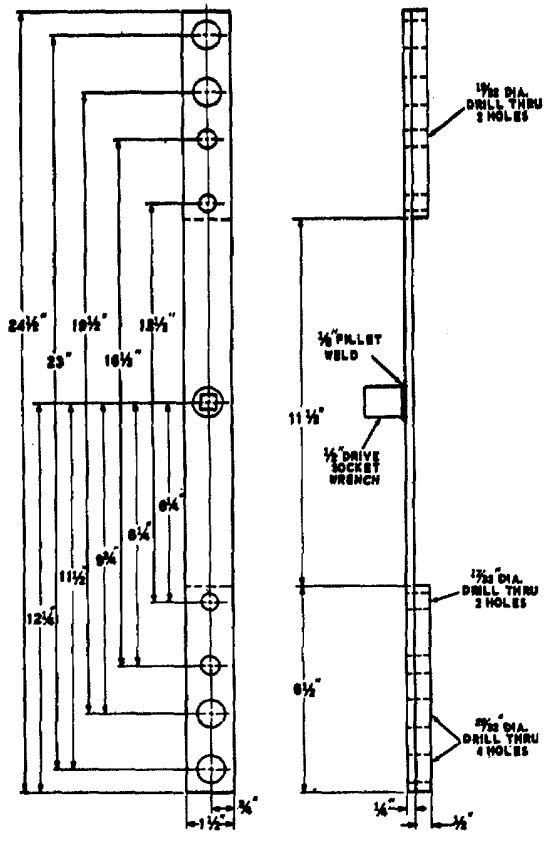
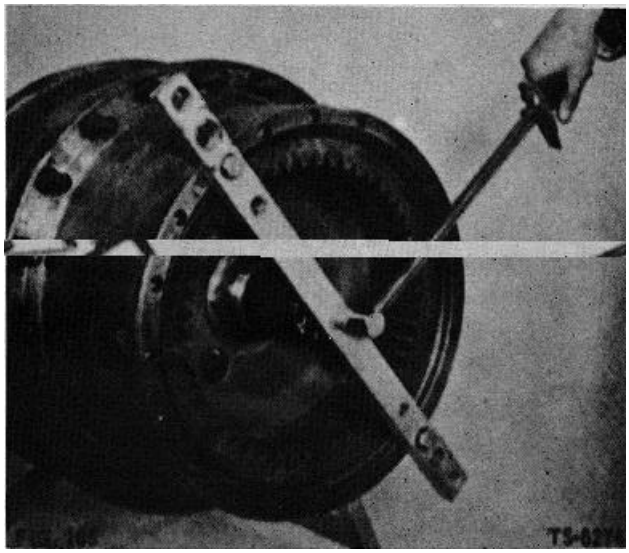


FIG. 184 TS-5623

29. Install torque wrench, 0 to 50 ft. lb. scale, if available, and check rotating torque or rolling resistance of wheel hub (Fig. 185). Rotating torque when using new bearings should be between 15 and 20 ft, lbs, On used bearings rotating torque should be between 6 and 12 ft. lbs.

***CAUTION**: Make certain wheel brake is in complete release position and that it is not dragging on brake drum.*



30. If rotating torque is not to specifications given above, remove adapter bar and tighten or loosen Inner nut until rotating torque Is within specifications. After tightening or loosening nut as required, rap wheel hub several times with plastic or rawhide faced mallet while rotating hub to seat bearings. Recheck rotating torque as Indicated In step 29.

Second (Optional) Method

31. Attach heavy string or cord to one of wheel studs on hub and wrap cord around wheel hub several times attaching pound pull scale to end of cord as shown in Fig. 186. Tighten inner nut until rotating torque measured on pull scale is between 21 and 28 lbs. for new bearings and between 9 and 17 lbs. for used bearings.

NOTE: Bearing preload rotating torque, using a pound pull scale, is figured by multiplying the radius (distance from center of wheel to outside diameter of wheel hub) by the reading on the pull scale and dividing by 12 to arrive at ft. lbs. of torque. For ex. ample: Wheel hub radius of 8-5/16 Inches times 24

lbs. (reading on pull scale) equals 211 in. lbs. Dividing by 12 equals approximately 17 ft. lbs. which is within specifications of 15 to 20 ft. lbs. rotating torque for new bearings.

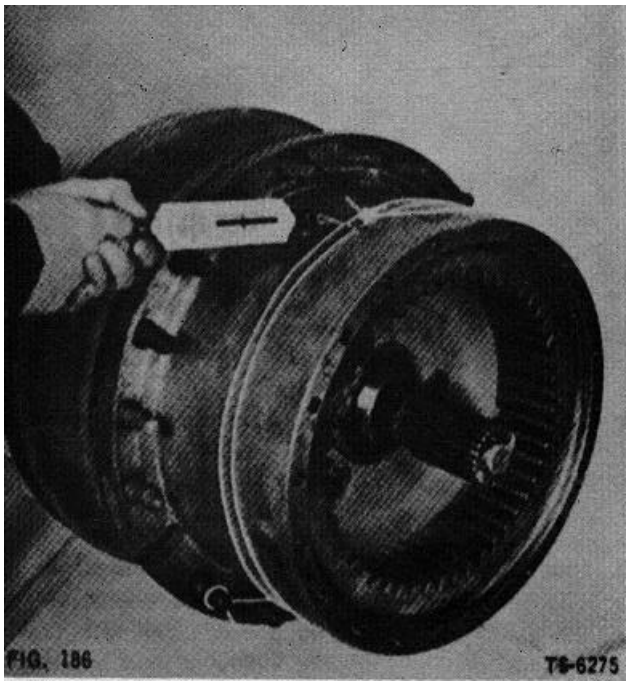


FIG. 186

32. Install nut lock and outer nut and tighten securely as shown In Fig. 182 to lock Inner nut In position, Re. check rotating preload torque by one of two methods outlined above.

33. Bend two tangs of nut lock against fiats on Inner nut and bend two tangs against flats of outer nut (Fig. 187).

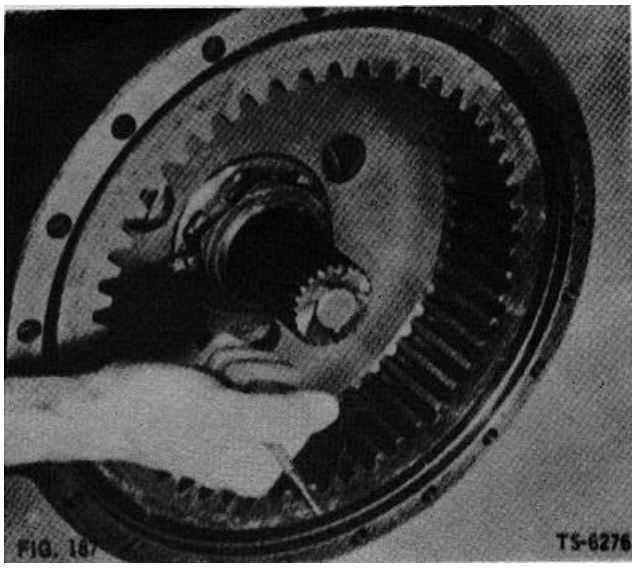
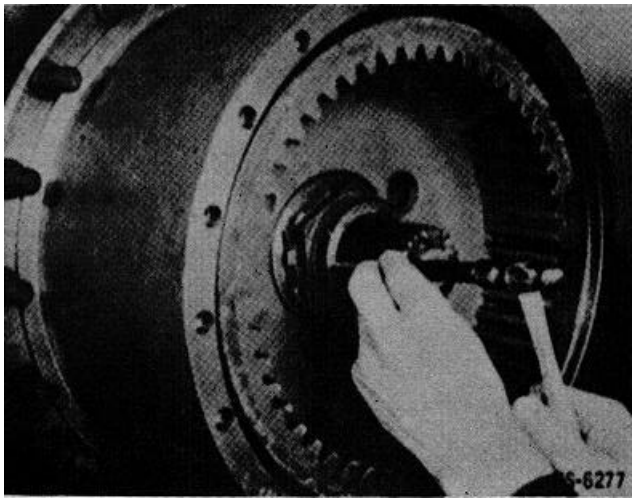
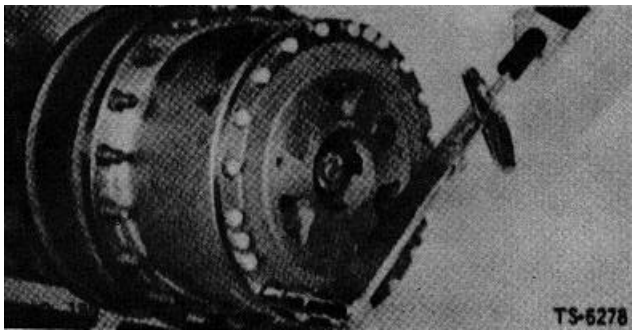


FIG. 187

34. Some axles use thrust ring in end of spindle. If provided, tap thrust ring into spindle until it is fully seated (Fig. 188).



35. Install planet carrier "O" ring on planet carrier assembly, and install planet carrier assembly on hub with bolts and lockwashers. Tighten bolts to specified torque (Fig. 189).



36. Position sun gear on axle shafti secure with sun gear retaining ring (Fig. 190).

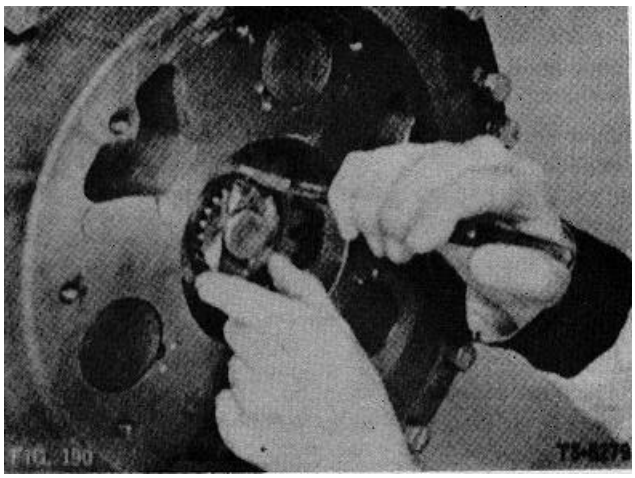
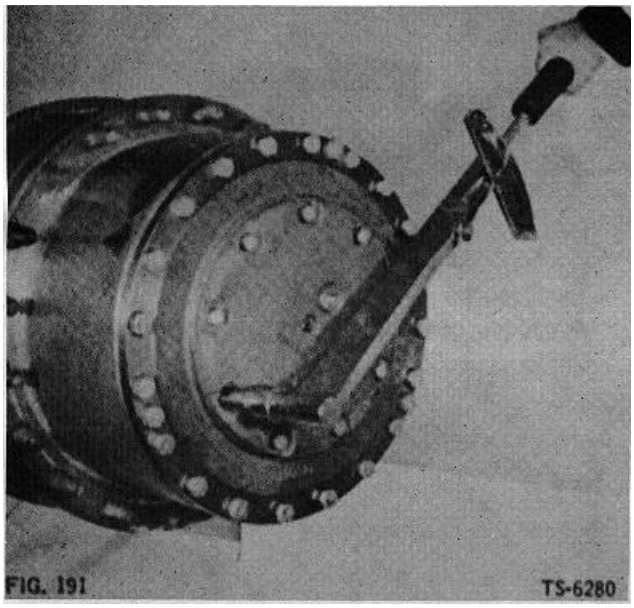


FIG. 190

37. Install cap-to-carrier "O" ring seal in groove in sun gear thrust cap assembly. Install thrust cap on planet carrier. Make certain that "O" ring, if used, is properly positioned in the groove in the mounting face, and is not twisted. Apply light coat of Permatex No. 2 to threads of bolts and install. Tighten to specified torque (Fig. 191).

NOTE: Early versions of some axles -did not include "O" ring feature. On these units, apply light coat of Permatex No. 2 on mounting face of thrust cap before installing on planet carrier.


FIG. 191 TS-6280

Brake Adjustment

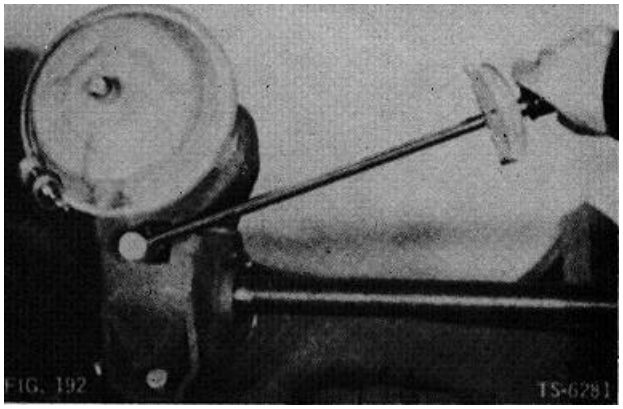
NOTE: Some axle models have slack adjuster positioned so that adjusting screw is adjacent to air chamber bracket (Fig. 192). Others have slack adjuster positioned so that adjusting screw points away from air chamber bracket (Fig. 193).

Adjust brakes of axle models that have slack adjusters positioned so that the adjusting screw is adjacent to the air chamber bracket as follows:

1. Use torque wrench and 9/16 inch socket to adjust slack adjusters to attain correct brake lining-to-brake drum clearance.

2. Position socket on adjusting screw and press it on screw far enough to cause locking collar to disengage locking mechanism.

3. While holding in locking collar, rotate adjusting screw clockwise until 20 ft. lbs. torque is indicated on torque wrench (Fig. 192).

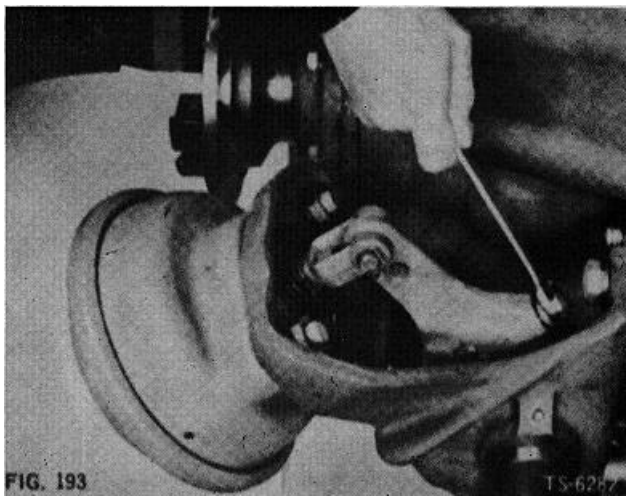

FIG. 192 TS-6281

4. Back off adjusting screw one-half turn. Locking collar should automatically return to locking position to lock adjustment when socket is removed. This provides proper brake lining-to-drum clearance.

5. After axle is assembled into machine and brake air lines are connected, recheck broke adjustment as follows: With minimum air pressure and with brakes fully activated and applied, adjust at slack adjuster to obtain 1 1/2 inch travel on brake chamber push rod when brakes are released. Adjust all slack adjusters on machine for same travel distance.

Adjust brakes of axle models that have slack adjusters positioned so that adjusting screw points away from air chamber bracket as follows:

6. Use 9/16-inch, open-end wrench to make adjustment. Position wrench on adjusting screw and push in until locking collar releases adjusting screw (Fig. 193).


FIG. 193 TS-6282

7. While holding locking collar in, rotate adjusting screw clockwise until brake lining is snug against inside of brake drum.

8. Back off adjusting screw one-half turn. Locking collar should automatically return to locking position to lock adjustment when wrench is removed. This provides proper brake lining-to-drum clearance.

9. After axle is assembled into machine and air brake lines are connected, recheck brake adjustment as directed in step 5 above.

TABLE OF TORQUE LIMITS





	GRADE 5		GRADE 8	
COARSE THREADS	**DRY**	**LUBRICATED OR PLATED**	**DRY**	**LUBRICATED OR PLATED**
3/8-16	30-35	20-25	45-50	30-35
7/16-14	50-55	35-40	70-75	50-55
1/2-3 7	5-85	60-65	105-115	80-90
9/16-12	110-120	80-90	155-165	115-125
5/811	150-165	115-125	215-230	160-175
3/4-10	265-290	200-220	375-415	285-310
7/8-9	395-430	295-325	605-670	455-500
1-8	590-650	445-490	910-1000	685-750
1-1/8-7	795-875	595-655	1290-1415	965-1065
1-1/4-7	1120-1230	840-925	1820-2000	1360-1495
FINE THREADS				
3/8- 24	35-40	25-30	50-55	35-40
7/16- 20	55-60	40-45	80-85	60-65
1/2-20	85-95	65-70	120-130	90-100
9/16- 18	120-130	90-100	175-185	130-140
5/8 - 18	170-185	130-140	240-260	180-200
3/4- 16	300-325	225-245	420-460	315-345
7/8- 14	435-475	325-360	670-735	500-550
1-12	645-710	485-535	995 1095	745-820
1-1/8-12	890-980	670-735	1445 1590	1085-1190
1-1/4-12	1240-1365	930.1025	2015-2215	1510-1660

MAINTENANCE:

CHECK HYDRAULIC TANK OIL LEVEL daily with machine level, blade lowered and engine off. The level gauge is mounted on the forward surface of the hydraulic tank on the operator's left. Add the proper fluid as necessary (refer to LUBRICANTS SPECIFICATION CHART).

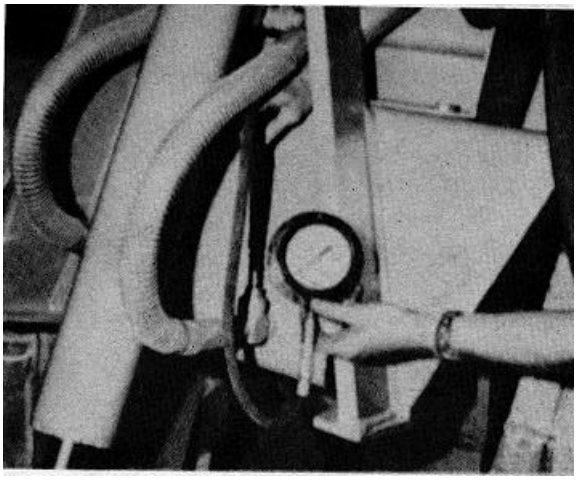


Hydraulic Oil Level Gauge

CHECK ALL HOSES AND CONNECTIONS every 50 hours for leaks, correcting where necessary. Damaged hoses should be replaced immediately.

DOZER SYSTEM PRESSURE:

TESTING AND ADJUSTMENT should be made every 400 hours after machine operation with hydraulic oil at operating temperature.



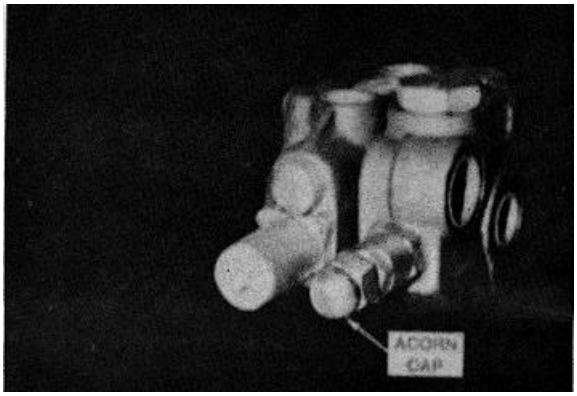
Dozer System Pressure Test

1. Install a 3000 psi (20,000 kPa/200 kg sq/ cm) pressure gauge in dozer hydraulic system test port on front frame bulkhead at dozer cylinder hose.

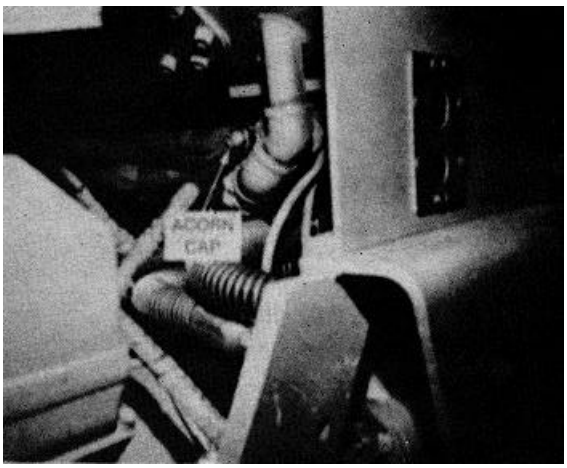
2. With engine RPM at 2000, check relief valve pressure by raising dozer blade to maximum height and taking gauge reading.

Caution: ***Do not hold for more than 30 seconds*****.**

3. If pressure is more than 50 psi (345 kPa/3,5 kg/sq. cm.) above or below 1500 psi (J0335 kPa/106 kg/sq cm), the relief valve should be adjusted.

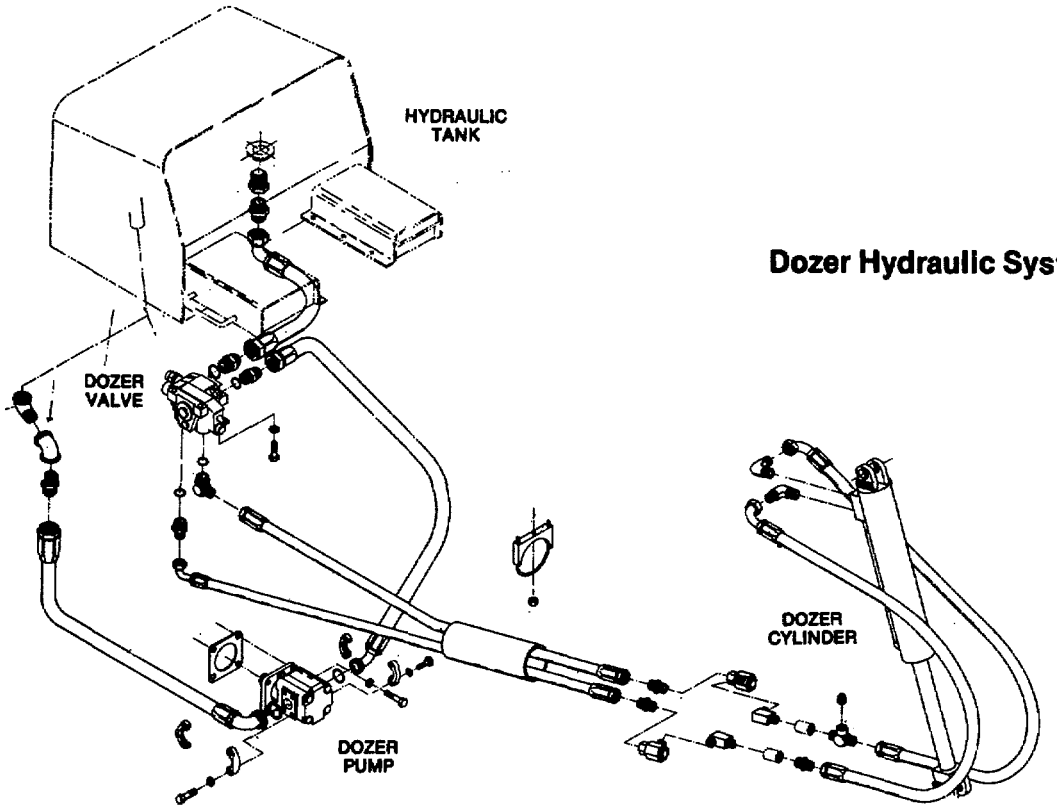


4. Remove acorn cap on relief valve.
5. Loosen jam nut.
6. Turn adjusting screw one quarter turn at a time, in to raise pressure, or out to lower pressure.

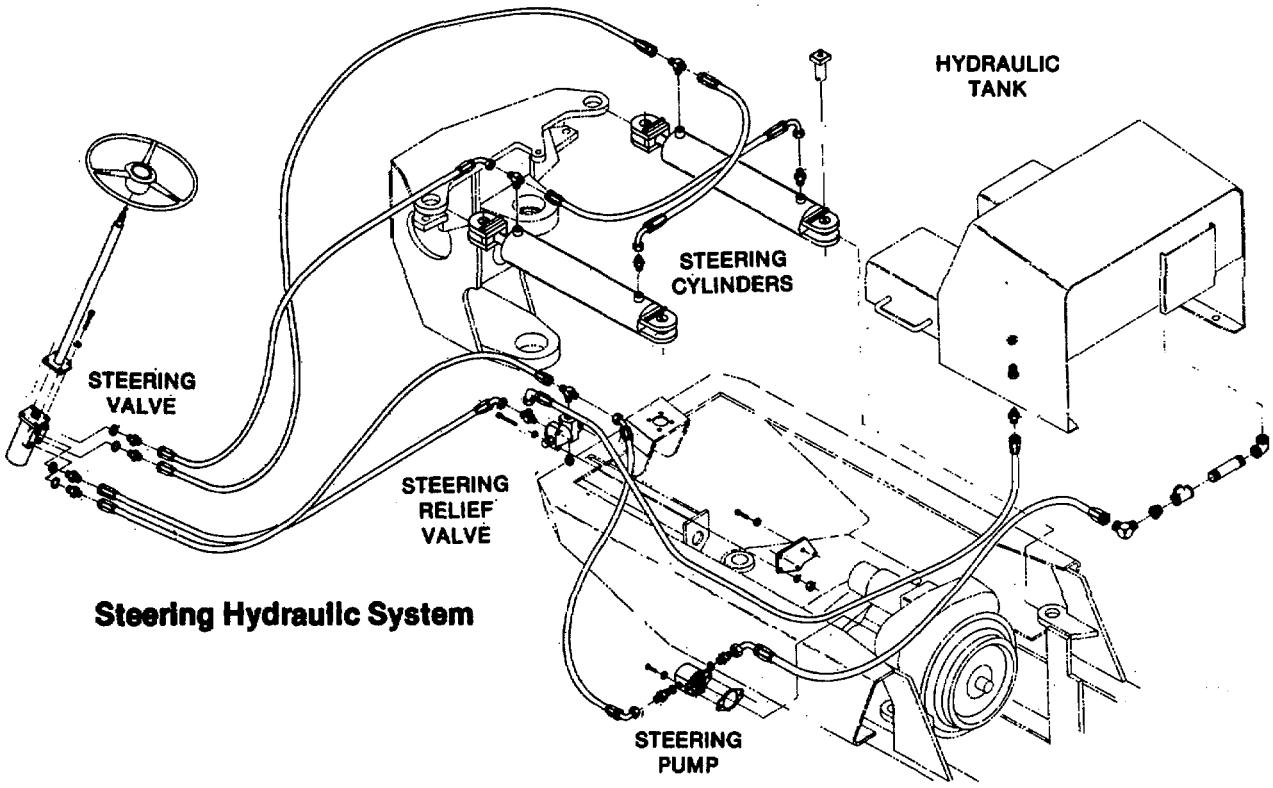


Dozer Relief Adjustment

HYDRAULIC SYSTEM:

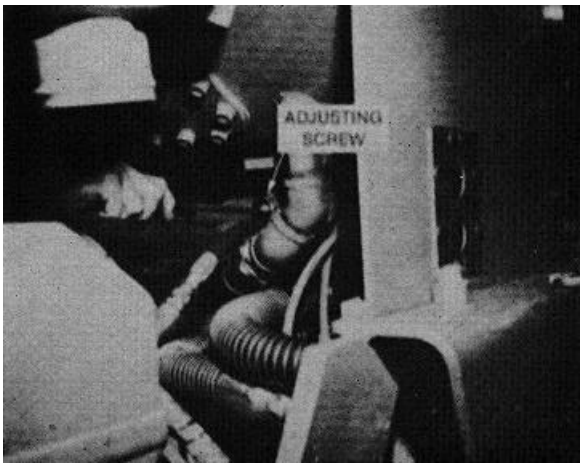


Dozer Hydraulic System



Steering Hydraulic System

HYDRAULIC SYSTEM



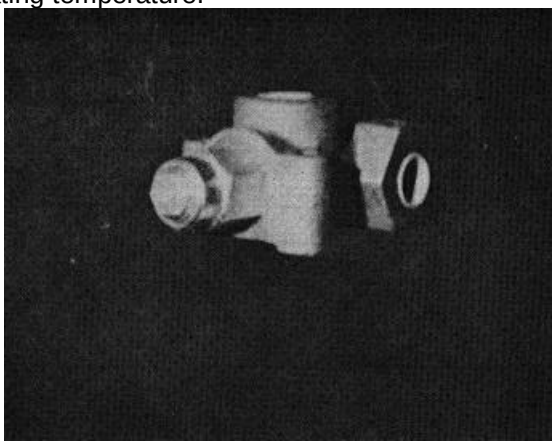
Dozer Relief Adjustment

7. Recheck relief valve pressure with engine RPM at 2000 and dozer at maximum height.
8. If the pressure is satisfactory, tighten locknut and replace cap.

Caution: ***After valve or pump repair or replacement, before stating engine, back-off relief valve until spring tension on adjusting screw is relieved***.

STEERING SYSTEM PRESSURE

TESTING AND ADJUSTMENT should be made every 400 hours after machine operation with hydraulic oil at operating temperature.



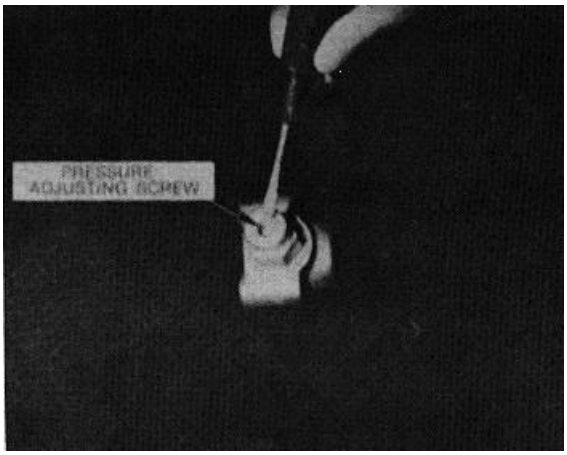
Steering Relief

1. Park machine on level ground, set parking brake and lower blade.
2. Remove top bulkhead cover and rear floor plate.
3. Install a 3000 psi (20000 kPa/200 kg sq/cm) pressure gauge in test port on bottom of steering relief valve.
4. With engine RPM at 2000, check steering relief pressure by turning machine to a full lock (fully turned) position and taking gauge reading.

Caution: Do not hold for more than 30 seconds.

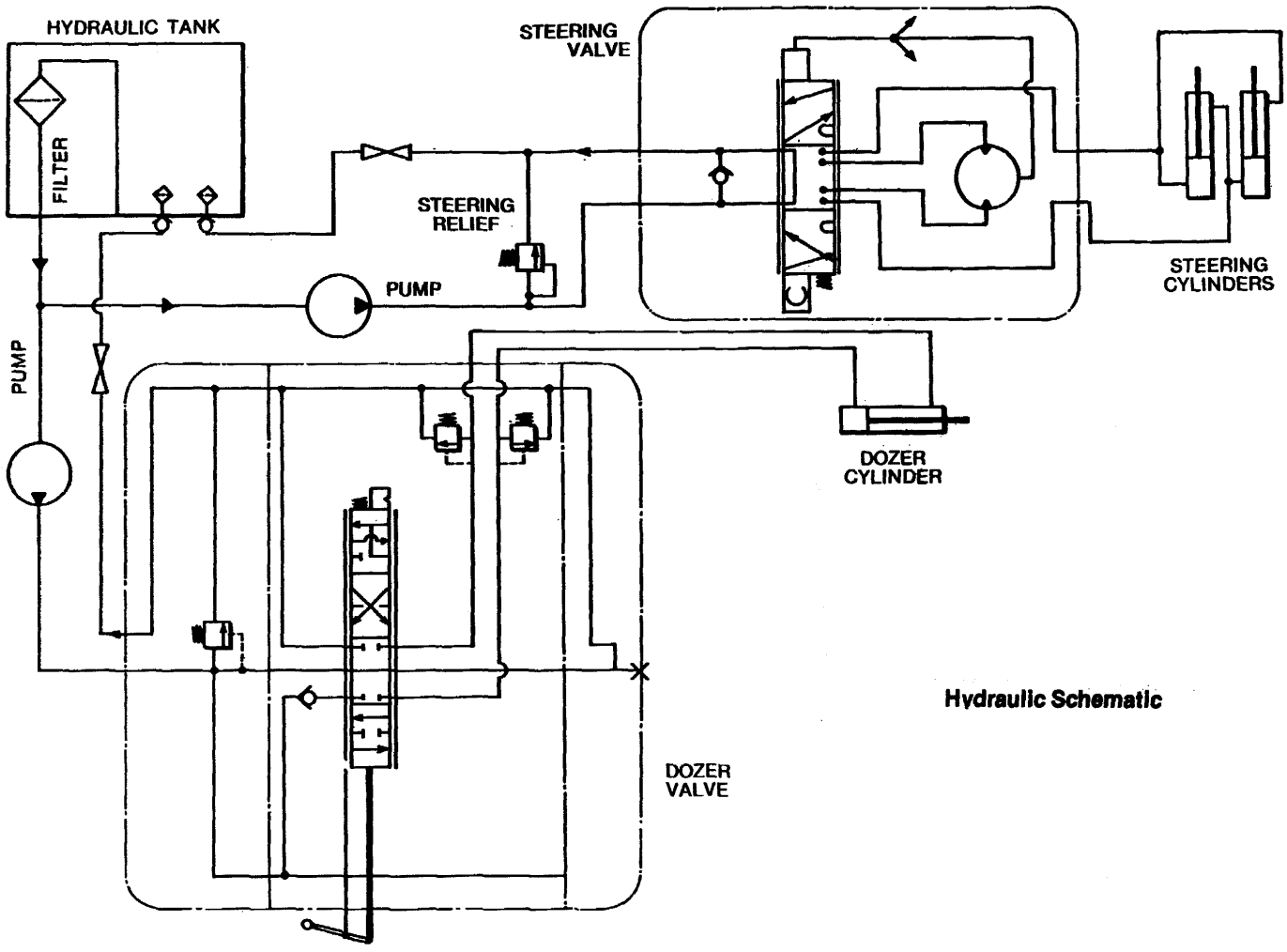
5. If pressure is more than 50 psi (345 kPa/3.5 kg /sq cm) above or below 2000 psi (13780 kPa/140 kg sq cm), the steering relief valve should be adjusted.
6. Remove valve cap for access to adjusting screw.
7. Turn adjusting screw one quarter turn at a time, in to raise pressure, or out to lower pressure.
8. Recheck steering relief pressure.
9. If the pressure is satisfactory, tighten locknut and replace cap.

Caution: ***After steering valve or steering pump repair or replacement, before starting engine, back off relief valve until spring tension on adjusting screw is relieved.***



Steering Relief Adjustment

Steering Relief Valve



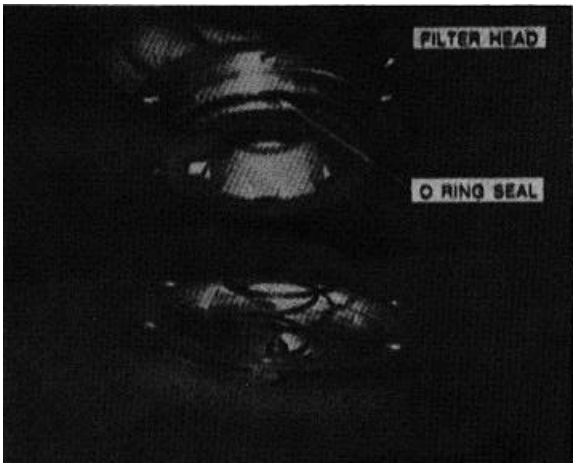
Hydraulic Schematic

DOZER VALVE ASSEMBLY

REMOVAL:

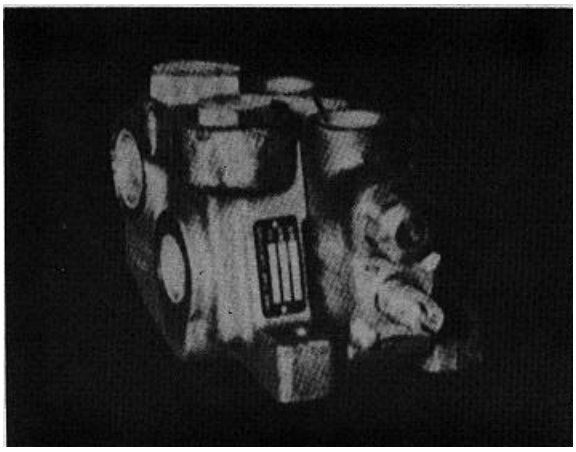
1. Park machine on level ground, set parking brake, lower blade and place dozer control lever In HOLD position.
2. Remove top bulkhead cover and rear floor plate.
3. Clean all dirt from around hydraulic tank filter head. Remove capscrews and lift off filter head to vent suction line.

Note: *Check valves are located In hydraulic tank return lines to prevent tank from draining. Filter head must be vented to prevent hydraulic oil from siphoning out.*

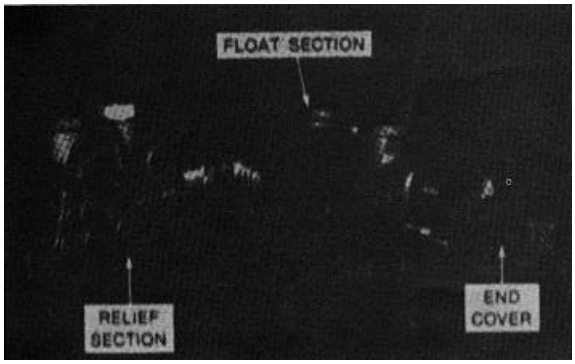


Venting Suction Line

4. Disconnect all linkage from valve. Disconnect all hoses from valve.
5. Remove mounting bolts and remove valve from machine.
6. For valve Installation, reverse removal procedure.



Dozer Valve Assembly



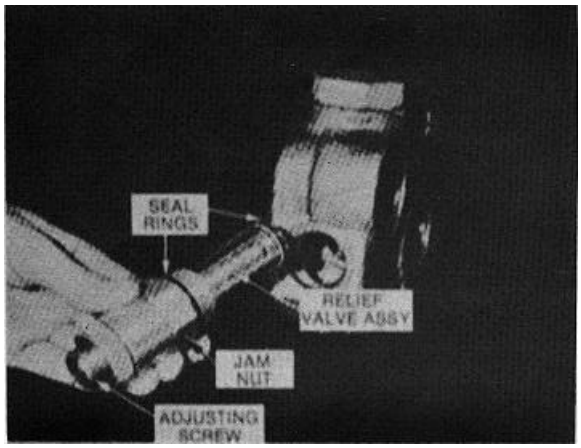
Dozer Valve Sections

DISASSBEMLY:

Disassemble the control valve on a bench in clean environment. Remove bolts connecting valve sections. Keep parts for each section separated and in order of disassembly for easier assembly. Section disassembly (a described separately below, but if component wear or damage is discovered, replacement in most cases, can only be made by complete section. it is recommended when disassembling valve to replace all seals.

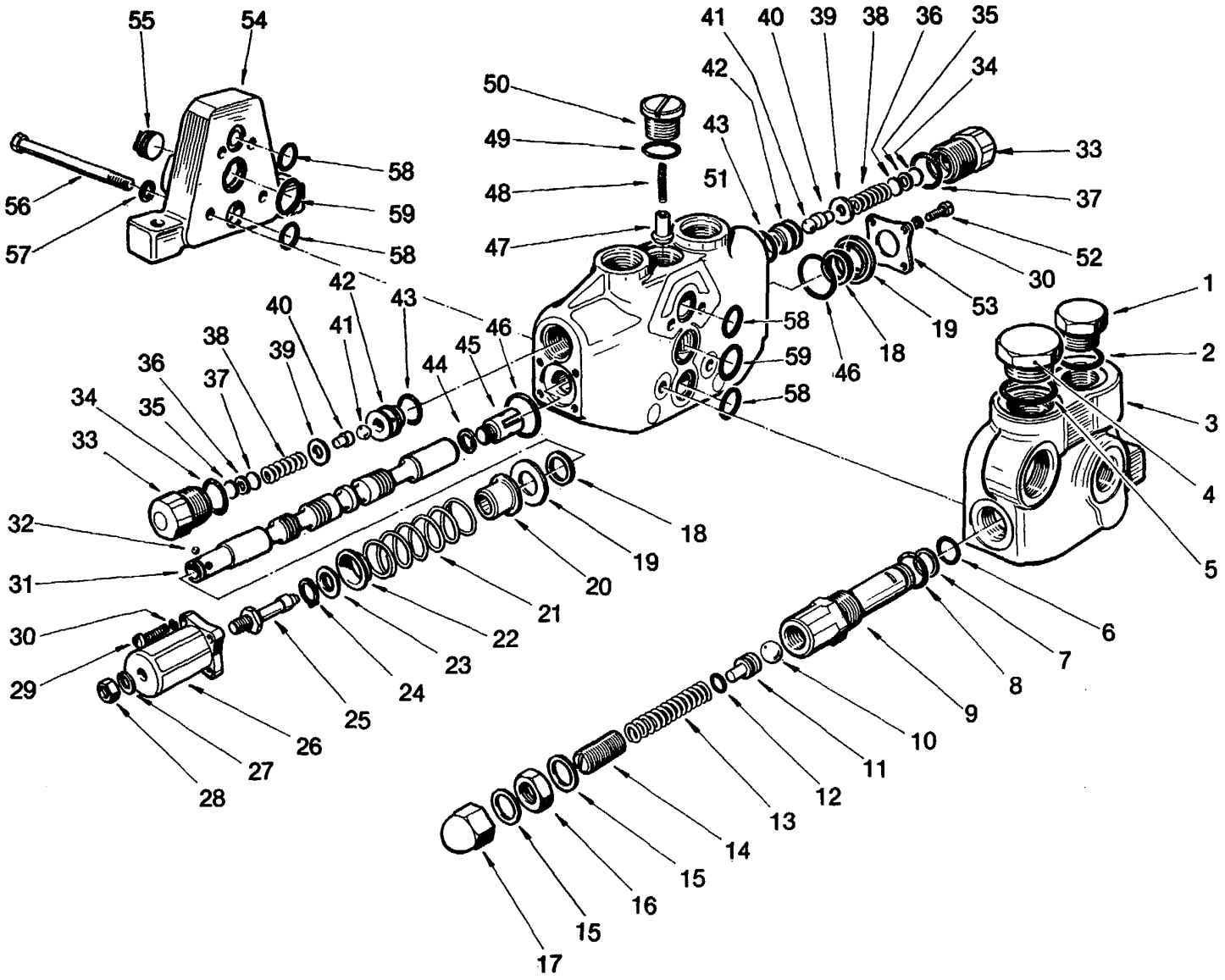
RELIEF VALVE SECTION:

1. Remove relief valve assembly from relief section housing (item 3).



Removing Relief Valve Assembly

DOZER VALVE:



DOZER VALVE ASSEMBLY

DOZER VALVE

RELIEF SECTION ASSEMBLY

REF. NO.	DESCRIPTION	REF. NO.	DESCRIPTION
1	Plug, No. 16	10	Ball, Relief
2	Seal, No. 16 Plug	11	Guide, Relief Ball
3	Housing, Relief Section	12	Seal, Ball Guide
4	Plug, No. 20	13	Spring, Main Relief
5	Seal, No. 20 Plug	14	Screw, Relief Adjusting
6	Seal, O Ring	15	Washer, Screw Seal
7	Washer, Back Up	16	Nut, Relief Jam
8	Seal, Relief Body	17	Cap, Relief Acorn
9	Body, Main Relief		

FLOAT SECTION ASSEMBLY

18	Seal, Quad Spool	36	Washer, Port Relief Shim
19	Plate, Seal	37	Seal, Port Relief Body
20	Collar, Stop	38	Spring, Port Relief
21	Spring, Centering	39	Washer, Port Relief
22	Collar, Stop	40	Follower, Ball
23	Retainer, Ball	41	Ball, Port Relief
24	Ring, Retainer	42	Seat, Port Relief
25	Positioner, Spool	43	Seal, Port Relief Seat
26	Bonnet, Float Positioner	44	Lockwasher
27	Lockwasher	45	Yoke, Spool
28	Nut, Hex	46	Seal, Outer Spool
29	Screw, Machine	47	Poppet, Check
30	Lockwasher	48	Spring, Poppet
31	Spool	49	Seal, Check Plug
32	Ball, Spool	50	Plug, Check
33	Body, Port Relief	51	Housing, Float Section
34	Washer, Port Relief Shim	52	Screw, Machine
35	Spacer, Port Relief	53	Plate, Seal Retainer

END COVER SECTION ASSEMBLY

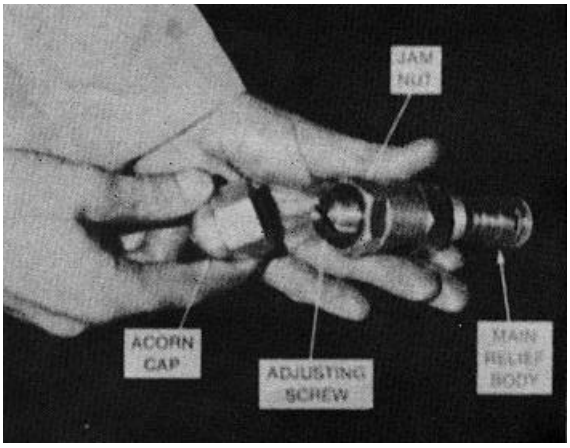
54	Housing, End Cover	55	Plug, End Cover

VALVE RETAINER ASSEMBLY

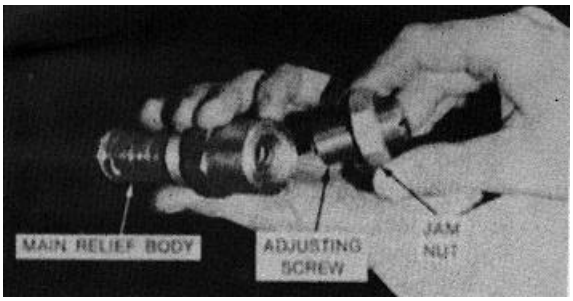
56	Bolt, Hex Retainer	57	Lockwasher

SECTION SEAL ASSEMBLY

58	Seal, Small Section	59	Seal, Large Section

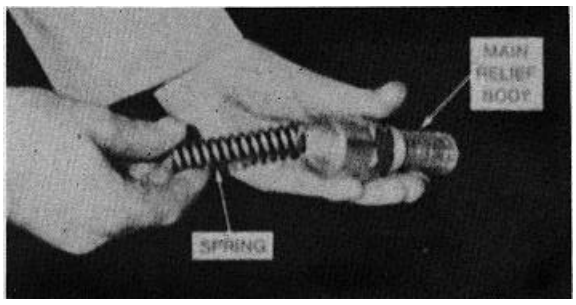


2. Remove acorn cap (item 17), loosen jam nut (item 16) and remove adjusting -screw (item 14).



3. Remove spring (item 13) and check for wear or damage.

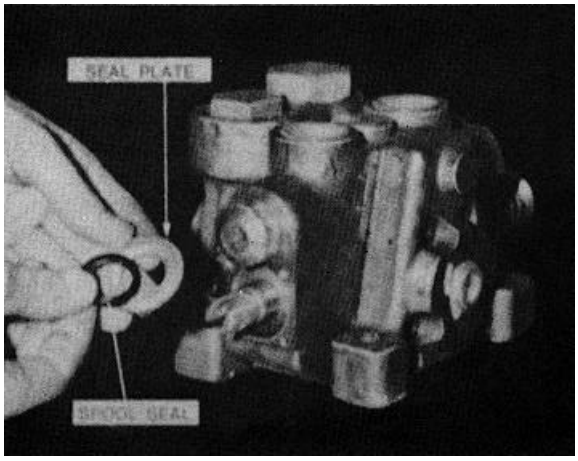
4. Remove ball guide *(item* 11) and ball (item 10) and inspect for wear or scoring.



FLOAT SECTION:

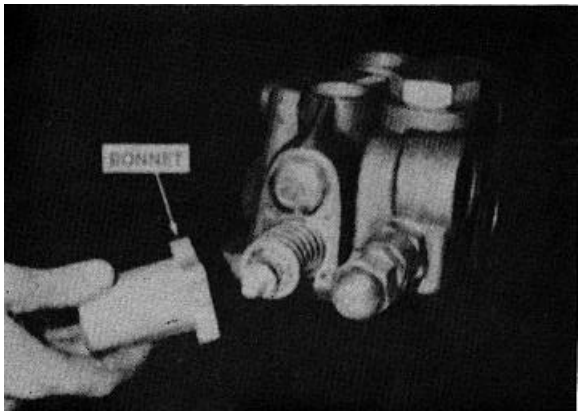
1. Remove machine screws (item 52) securing seal retainer plate (item 53).

2. Remove seal retainer plate (item 53) and seal plate (item 19). Remove spool seals (item 18 and 46).

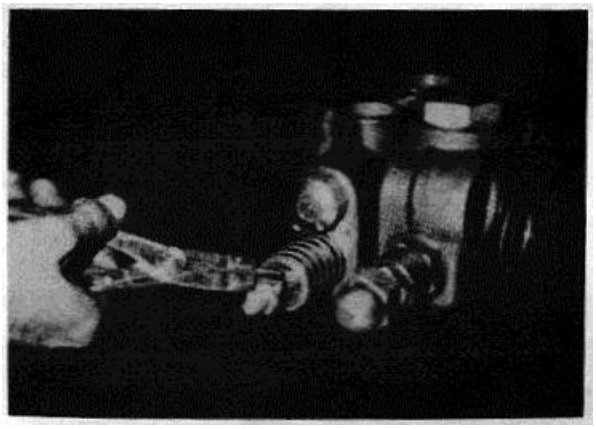


Spool Seal Removal

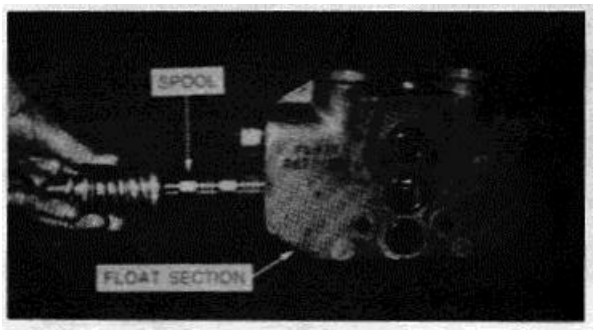
3. Remove hex nut (item 28) and screws (item 29) which allow the removal of float positioner bonnet (item 26).



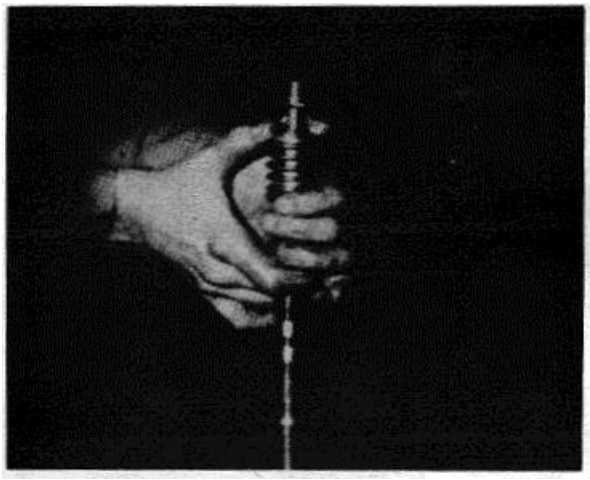
Bonnet Removal

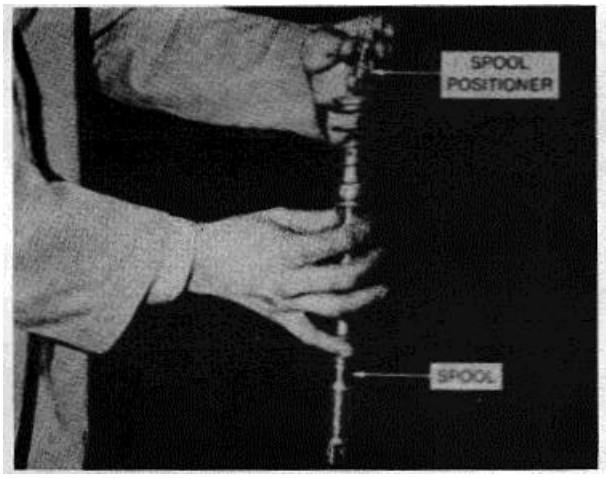


4. Remove retainer ring (item 24).
5. Remove spool assembly from float section housing (item 51) and check for wear or scoring.



6. Depress spring (item 21) to release spool positioner (item 25). Inspect spring for wear or damage.



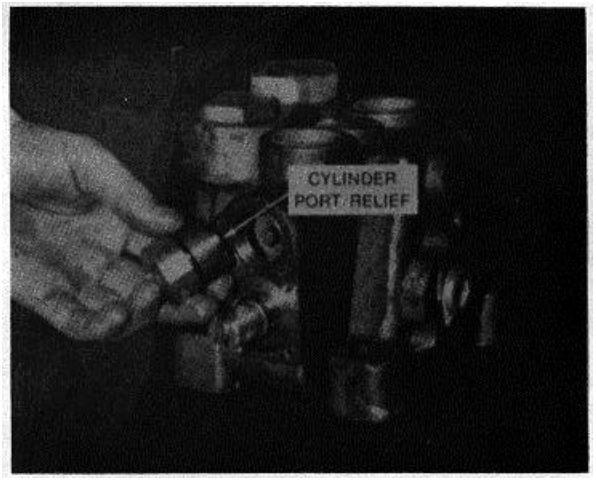


Spool Positioner Removal

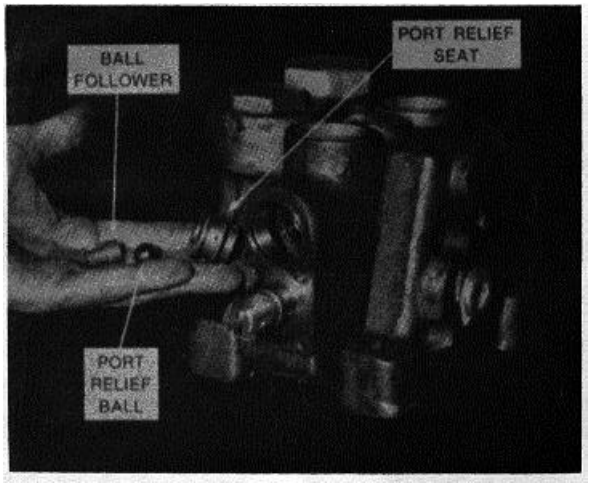
7. Remove spool positioner (item 25) and ball retainer (item 23).
8. Remove spring (item 21). stop collar (item 20) and seal plate (item 19).
9. Inspect spool for wear or scoring.



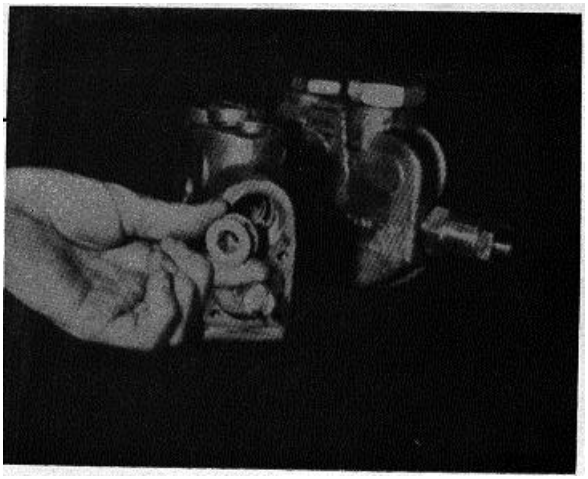
Spool Disassembly

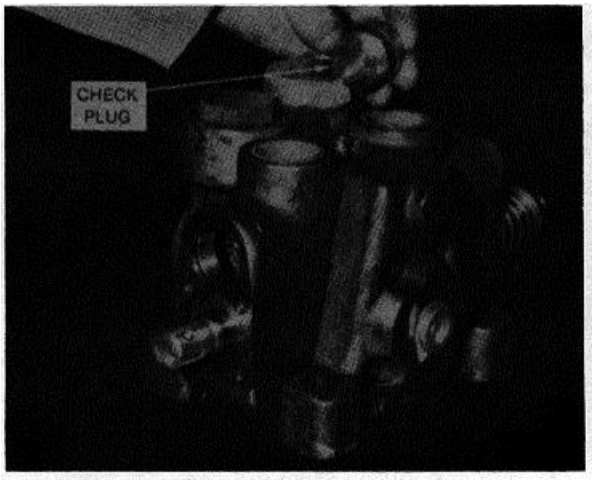


10. Remove cylinder port relief body (item 33) from float section housing (item 51).



11. Remove ball follower (item 40), ball (item 41) and port relief seat (item 42).



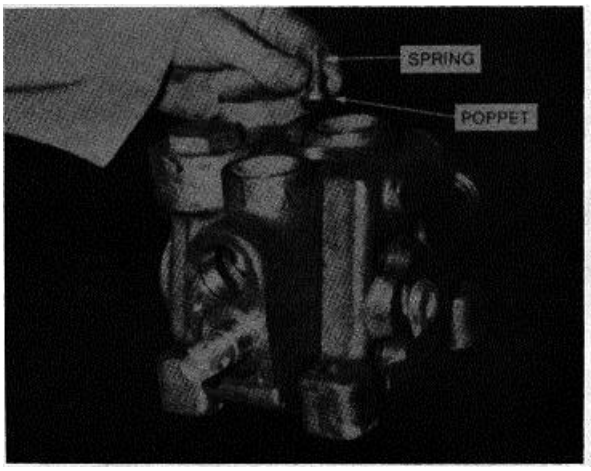


Check Plug Removal

12. Disassemble other cylinder port relief in similar manner. There is no need to disassemble shim assembly (items 35 to 37) unless the cylinder port relief is cracking at 'incorrect pressure.

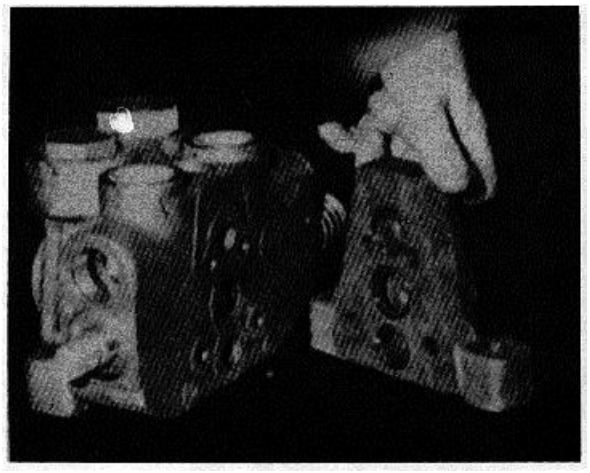
13. Remove seals (item 37 and 43) from port relief body and from float section housing.

14. Remove check plug (item 50), poppet spring (item 48) and poppet (item 47). Inspect for wear or damage.

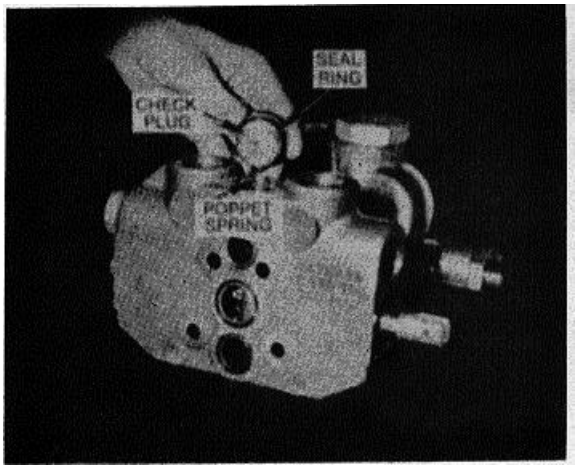


END COVER SECTION:

This section is an end block only to retain other valve section. The only removable part is the end cover plug (item 55).



Dozer Valve End Cover

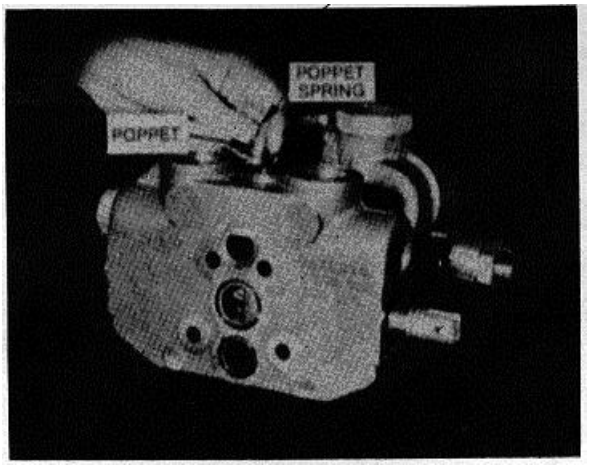


Check Plug Installation

ASSEMBLY:

1. Before reassembling dozer valve assembly, clean all parts and wash with clean solvent. New seals should be lightly oiled before installation.

2. Reassemble check poppet.(item 47) and spring (item 48). Install new seal (item 49) on check plug and replace plug.

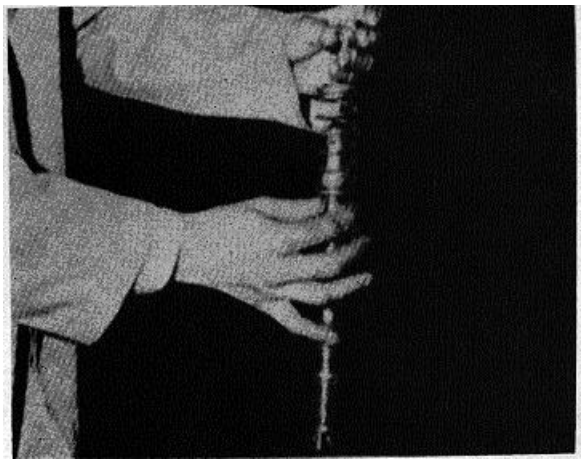


Poppet Installation

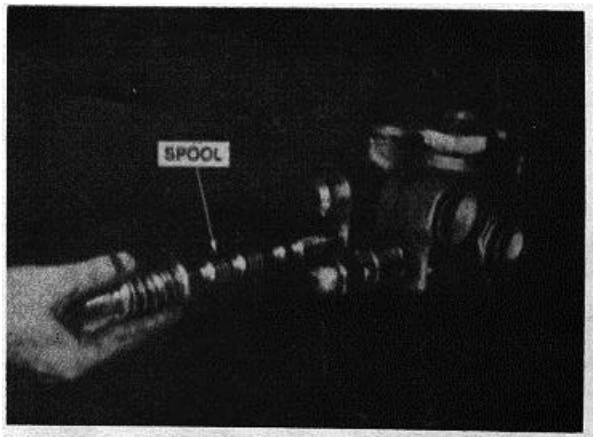
3. Install new seals on port relief body and port relief seat and reassemble cylinder port reliefs.

4. Install outer spool seal (item 46) and quad spool seal (item 18) on seal plate (item 19). Gently slide over spool (item 31) being careful not to catch seals on sharp corners of spool.

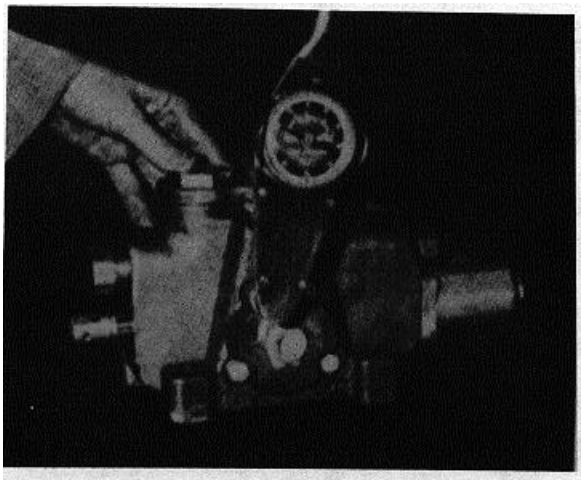
5. Reassemble stop collar, spring, balls and float positioner. Spring must be depressed to assemble float positioner. Install retaining ring (item 24).



Spool Assembly



Spool Installation



6. Install spool Into valve body with a turning motion. Caution: Do not force spool.

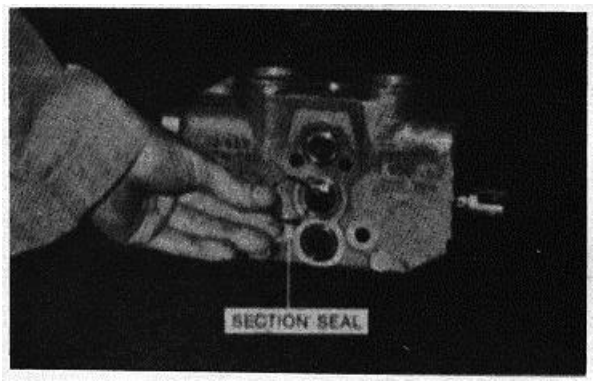
7. Replace bonnet, retaining screws and hex nut.

8. Install lightly oiled outer spool seal and quad spool seal on seal plate. Place over yoke end of spool and secure' with retainer plate and machine screws.

9. Reassemble main relief, Installing new seals.

10. Replace seals (Items 2 and 5) In relief section top plugs.

11. Install new section seals (Items 58 and 59) In seal grooves and assemble sections. Care should be taken when stacking sections that seals do not move from grooves.



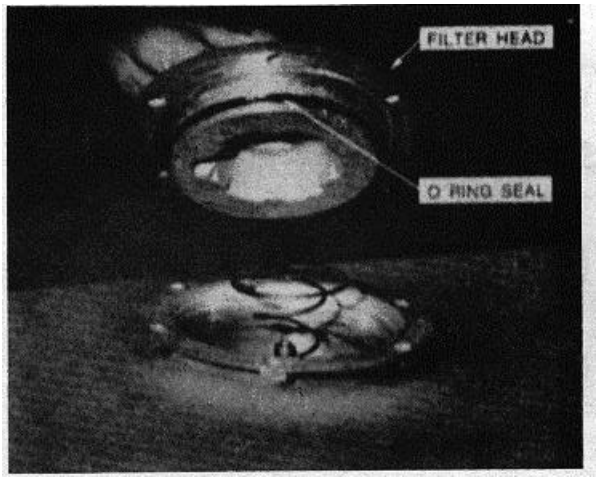
12. Install section retainer fasteners and torque evenly to 20 ft-lbs (2,8 m-kg). If bolts are not tightened to the proper torque, valve spool may bind or stick, or cause section 'seals to extrude.

DOZER PUMP ASSEMBLY

REMOVAL:

1. Park machine on level ground, set parking brake, lower blade and place dozer control lever In HOLD position.
2. Remove seat mounting base and seat for easier access to dozer pump.
3. Remove rear floorplate and bulkhead cover.
4. Clean all dirt from around hydraulic tank filter head. Remove capscrews and lift off filter head to vent suction line.

Note: *Check valves are located In hydraulic tank return lines to prevent tank from draining. Filter head must be vented to prevent hydraulic oil from siphoning out.*

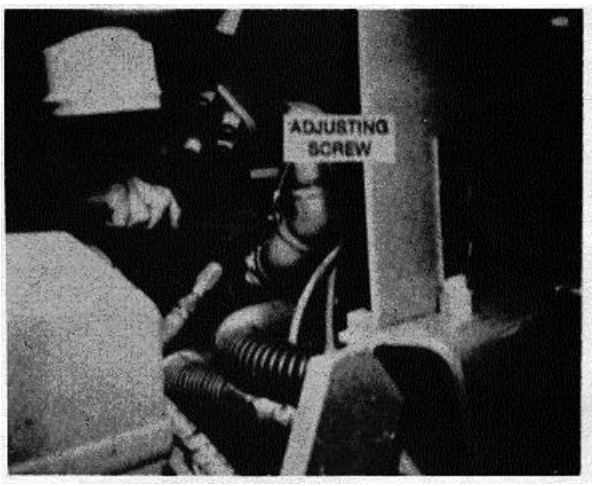


Venting Suction Line

5. Remove and cap Inlet and outlet hoses on pump.
6. Remove pump mounting bolts and remove pump from machine.

INSTALLATION:

1. When installing hydraulic pump, splines on drive gear sleeve should be checked to ensure good condition. If splines are not satisfactory, replace sleeve.
2. Clean pump mounting surface and install new gasket on pump mounting face.
3. Install pump and mounting bolts (refer to TORQUE SPECIFICATION CHART).
4. Connect outlet hose on pump only.



Relief Valve Adjustment

5. Fill hydraulic pump with clean hydraulic oil (refer to LUBRICANTS SPECIFICATION CHART) and connect inlet hose to pump. Warning: *Back off main relief valve until spring tension on the adjusting screw Is relieved.*
6. If Installing a new unit, to avoid seizure, never feed hot hydraulic oil Into a cold pump.
7. Refill hydraulic tank to proper level with clean hydraulic oil (refer to LUBRICANTS SPECIFICATION CHART).

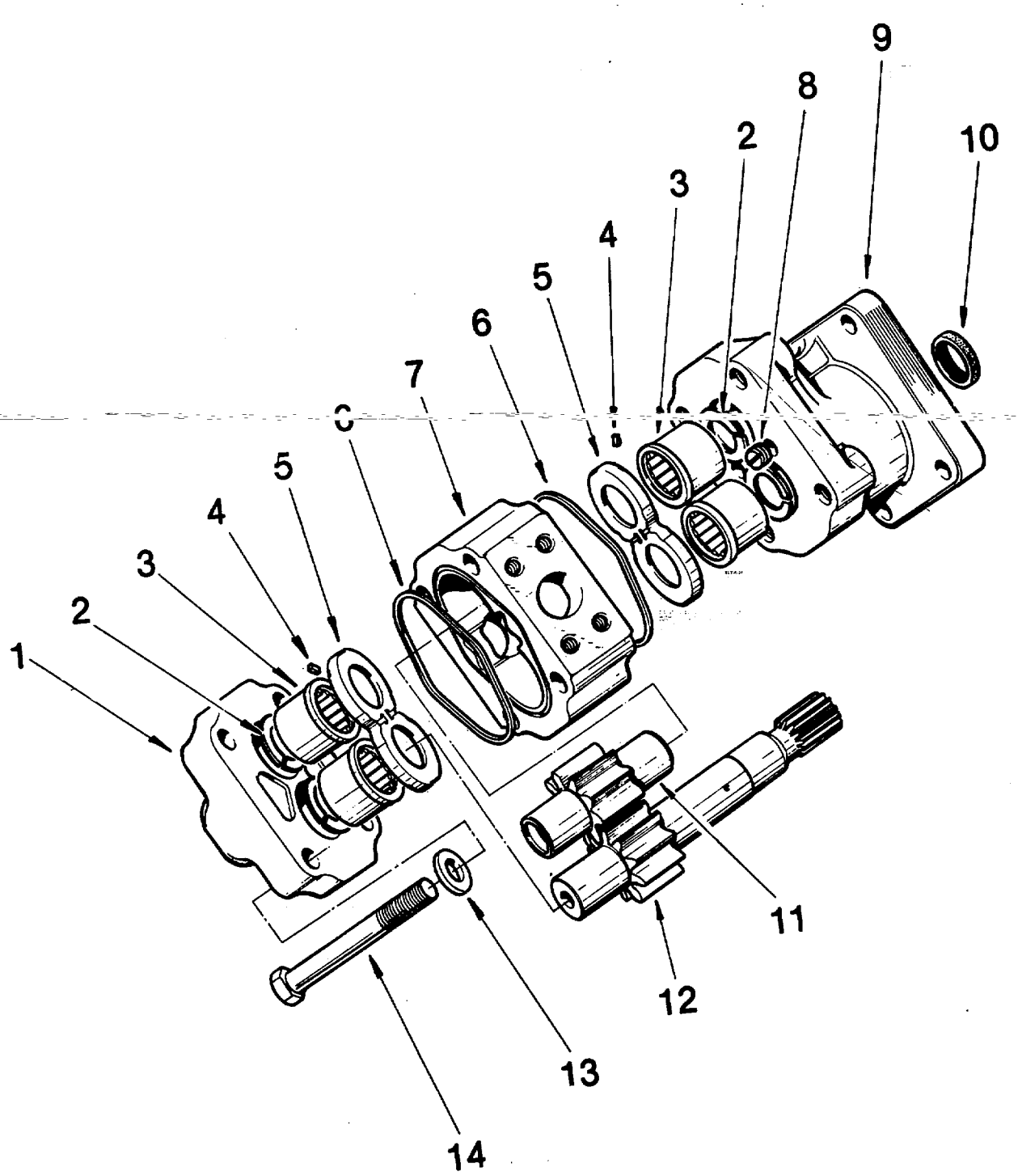
DISASSEMBLY

To facilitate the repair of these units, before any work is done, we suggest that you first read all of the steps used in disassembly and assembly of the pump. Whenever disassembly of a hydraulic unit Is required, replace all seals.

Dirt is the enemy of any hydraulic system. The first requirement of good maintenance of hydraulic equipment is cleanliness. Make sure you disassemble and assemble your hydraulic equipment in a clean area.

It is important to airblast all parts and wipe them with a clean lintless cloth before assembly. Use caution In gripping all parts in the vise to avoid damaging machined surfaces.

A pump must be driven in the direction of rotation for which it was built; otherwise, pressure will blow the. shaft seal. It is a good idea to check all replacement parts closely before installing to ensure that no damage occurred during shipment.



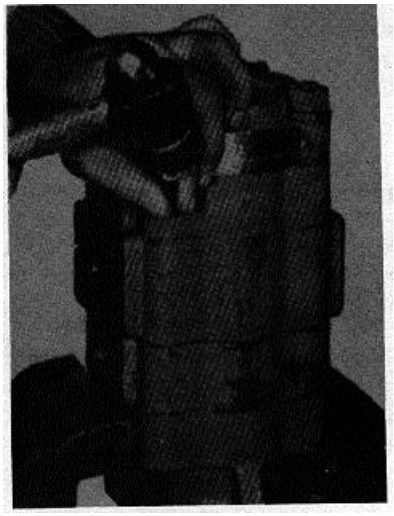
Dozer Pump Assembly

REF. NO.	DESCRIPTION	REF. NO.	DESCRIPTION
1	**Cover,** Port **End**	**8**	**Plug,** Port
2	**Seal**, Ring	**9**	**Cover,** Shaft End
3	**Bearing,** Roller	**10**	**Seal,** Shaft Lip
4	**Seal,** Pocket	**11**	**Gear**, Driven
5	**Plate,** Thrust	**12**	**Gear and Shaft,** Drive
6	**Seal,** Gasket	**13**	**Washer**
7	**Housing,** Gear	**14**	**Capscrew**

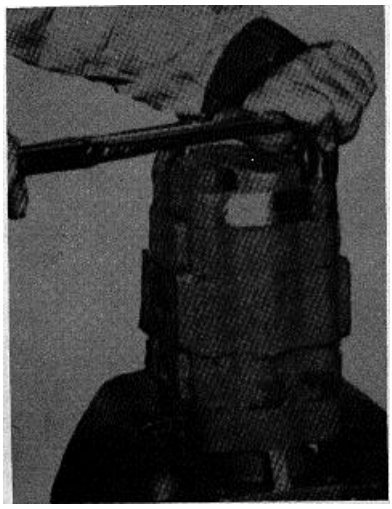
1. Place the pump in a vise with the drive shaft pointing down. Do not grip on or near any machined surfaces during disassembly or assembly. Index mark all sections with a prick punch. Be sure to align these marks when re- assembling.

2. Remove the four cap screws (item 14) with a socket wrench.

3. Lift off the port end cover (item 1). If it is necessary to pry it loose, be careful not to damage the machined surfaces.



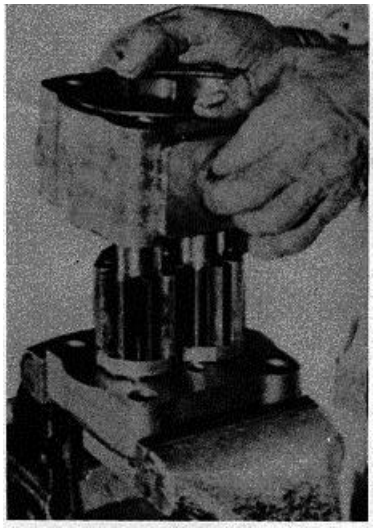
Marking Sections



Pump Disassembly

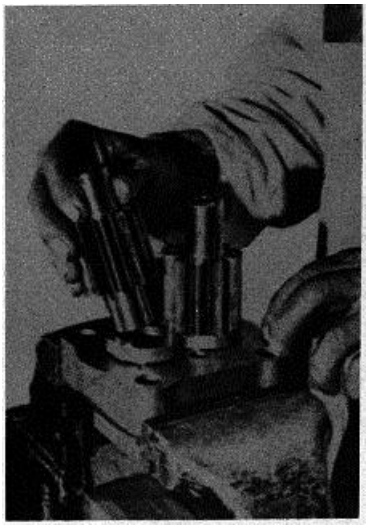


Port End Cover Removal



Gear Housing Removal

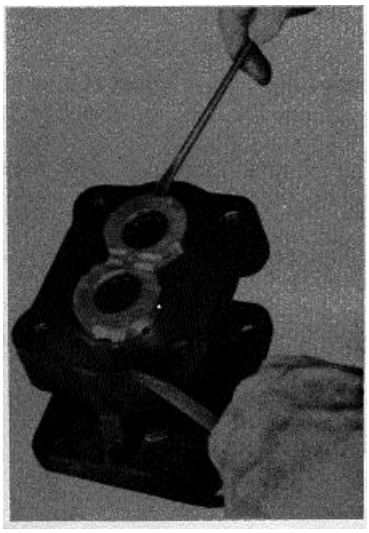
4. Lift or pry off the gear housing (item 7). Be careful not to damage machined surfaces. Inspect the gear housing for damage or wear. Wear In excess of .005 inch (0,127 mm) cut-out necessitates replacement of the housing. Place a straight edge across the housing bore. If you can slip a .005 inch (0,127 mm) feeler gauge under the straight edge, replace the gear housing. Excessive cut-out in a short time period indicates excessive pressure or oil contamination. Where the cut-out Is moderate, .005 inch (0,127 mm) or less, gear housing may be flipped over and reused.



Gear Removal

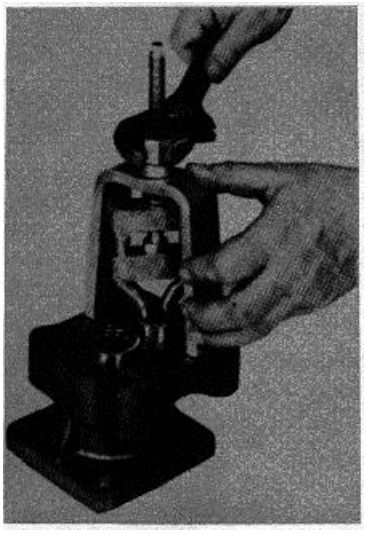
5. Remove the driven gear (item 11) and the drive gear and shaft (item,12). Inspect for wear. Any wear on gear hubs, at the drive coupling or in the seal areas detectable by touch, or In excess of .002 inch (0,051 mm) necessitates replacement. Any evidence of scoring, grooving or burring of outside diameter of teeth or teeth surfaces requires replacement. Wear in the shaft seal areas indicates oil contamination. Replacement can only be made by drive and driven gear set.

6. Pry the thrust plates (item 5) from the shaft and cover (item 9) and port end cover (item 1) with a screw driver. Avoid distorting the thrust plate. Remove and discard all rubber pocket seals (item 4) and gasket seals (item 6).



Thrust Plate Removal

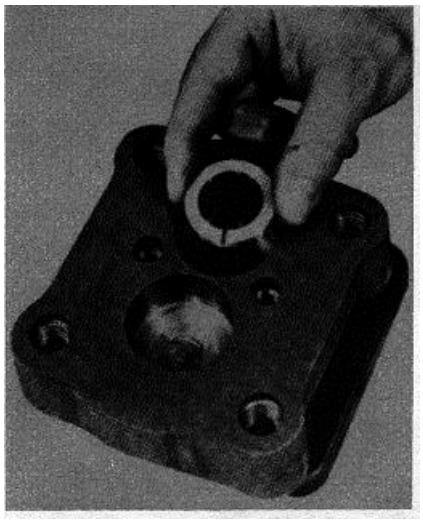
7. The thrust plates seal the gear section at the sides of the gears. Wear here will allow internal slippage, that is, oil will bypass within the pump. Maximum allowable wear is .002 inch (0,051 mm). Replace the thrust plates If they are scored, eroded or pitted. Erosion In the center area where the gears mesh indicates oil contamination. Over-heating results in *dis*colored thrust plates. Pitting is a sign of cavitation or oil aeration.



Bearing Removal

8. Examine all roller bearings (item 3) for scoring, spauling or pitting. If gears are re- placed, bearings must be replaced. If re- placement is necessary, pull the bearings out with a bearing puller. Bearings should fit into bore with a light press fit. A neat hand fit is allowable.

9. Remove the ring seals (item 2) from the bottom of bearing bore.

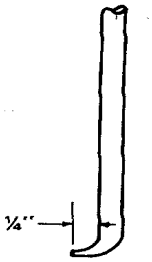


Ring Seal Removal

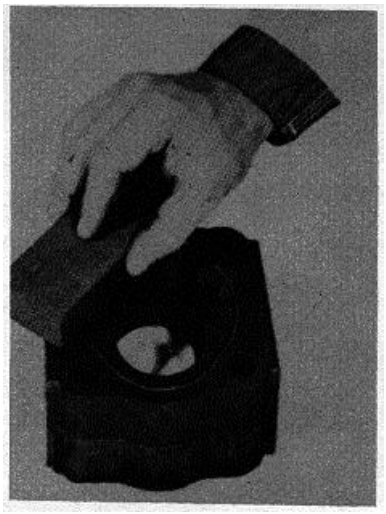


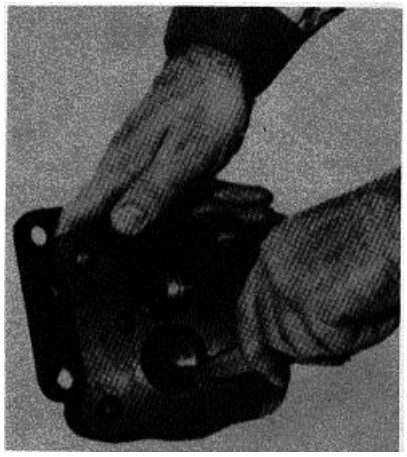
10. Grip the shaft end cover (item 9) in a vise with the mounting face down. Remove shaft lip seal (item 10) by inserting the special tool into the notch between the shaft lip seal and shaft end cover. Tap the seal out and discard.

Seal removal tool can be easily made from an old screwdriver. Heat the tip and bend as shown. Grind off the tip to fit the notch behind the shaft seal.



11. Stone off all machined surfaces with a medium grit carborundum stone.

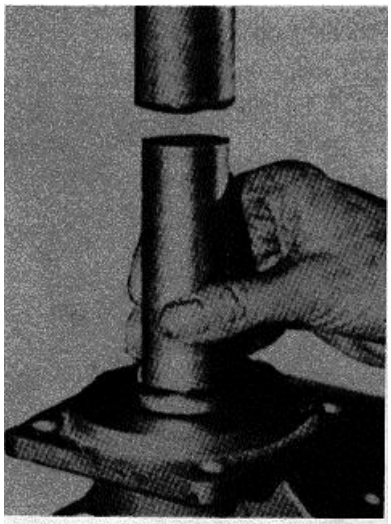




ASSEMBLY:

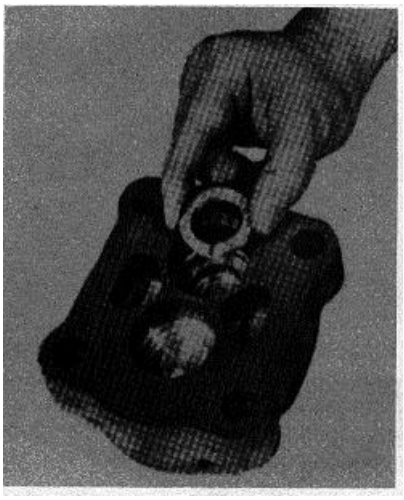
1. If bearings have been removed, deburr the bearing bores. Rinse parts in a solvent. Air blast all parts and wipe with a clean lintless cloth before reassembly.

2. Grip shaft end cover (item 9) in a vise with mounting face down. Examine plug (item 8) to be sure it is tightly in place. If replacement is necessary, screw in new plug tightly and stake plug with prick punch at both ends of screw driver slot and around edges. Plug must be in correct opening as this determines direction of pump rotation. If plug is replaced in the wrong position, operation of the pump will result in pressure blowing the shaft seal. When the drive gear and shaft (item 12) is above the driven gear (item 11), the plug should be in the left port.



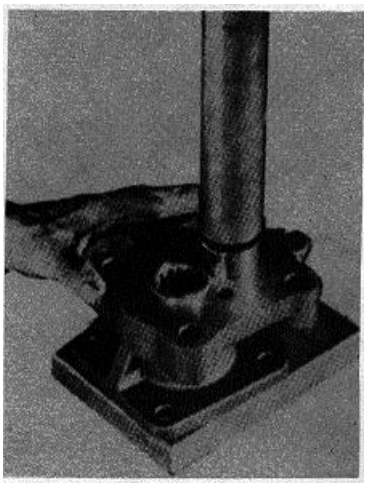
Installing Shaft Lip Seal

3. Coat outside of shaft lip seal (item 10) and its recess with purple Loctite Seal Retainer. With the metal side of the shaft lip seal up, press it into the mounting flange side of the shaft end cover (item 9) with an arbor press and bar. Make certain that lip seal is fully seated in the recess. Wipe off surplus Loctite.



4. Insert ring seals (item 2) into bottom of drive gear bearing bore. The notch in the ring seal must be visible. This is a check to be certain the notched side is next to the bearing.

5. Press 'the bearings into bearing bores with an arbor press.



Bearing Replacement



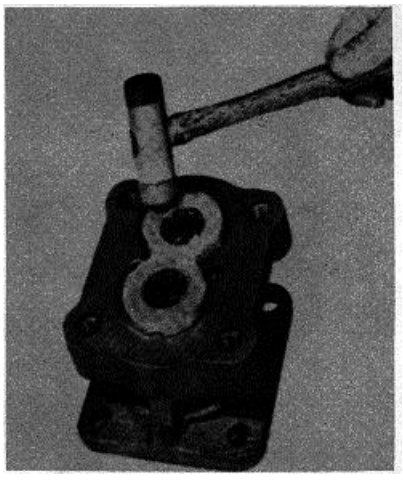
Pocket Seal Installation



Trimming Pocket Seals

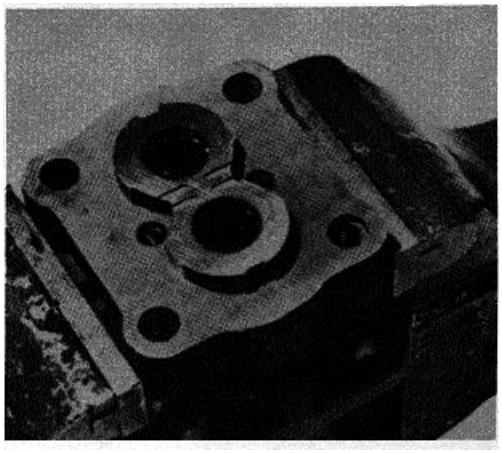
6. Pocket seals (item 4) are replaced from a pocket seal strip. Cut two pocket seals 7/32 inch (5,5 mm) long from the pocket seal strip. Grease and insert into the middle slots in the thrust plate.

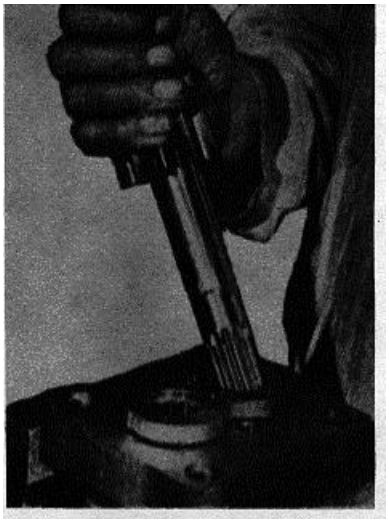
7. With the pocket seals down, place the thrust plate (item 5) over the bearings in the shaft end cover. Tap thrust plate with a soft hammer to about 1/32 inch (0,8 mm) from the machined surface.



8. Cut four pocket seals approximately ¼ inch (6,35 mm) long from the pocket seal strip. Insert one pocket seal into each of the slots in the thrust plate. Push each pocket seal all the way in so that they touch the roller bearings. Tap the thrust plate down firmly against the machine surface with a soft hammer. Use a sharp razor blade to trim exposed end of the pocket seal square and flush with the thrust plate.

9. Grip the shaft end cover (item 9) in the vise with the mounting face down. Do not grip on or near any machined surfaces.





Drive Shaft Installation

10. Lightly grease the drive shaft (Item 12). Insert the Integral gear and drive shaft with a twisting motion. Be careful not to damage the shaft lip seal (item 10). Push down carefully until gear rests against thrust plate. Insert the driven gear (item 11).

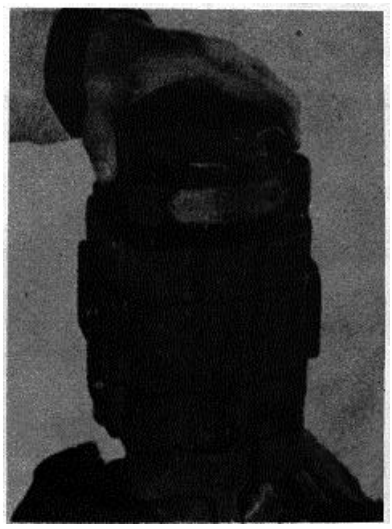
11. Grease the new gasket seals (item 6) and Insert them Into the grooves In both sides of gear housing (Item 7).



Seal Replacement

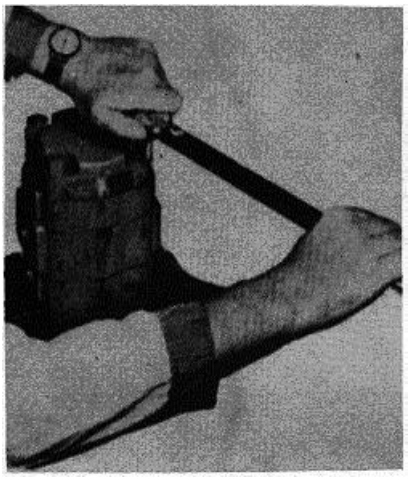
12. Slide the gear housing over the gears and tap It with a soft hammer until It rests tightly against the shaft end cover. Be careful not to pinch the gasket seal. Squirt oil over the gears.

13. Place the port end cover (Item 1) over the gear Journals and tap lightly against the gear housing. Be careful not to pinch the gasket seal.



14. Thread the tour fasteners Into the shaft end cover and snug up. Rotate the drive shaft with a" (15,3 cm) wrench to make sure there Is no binding In the pump.

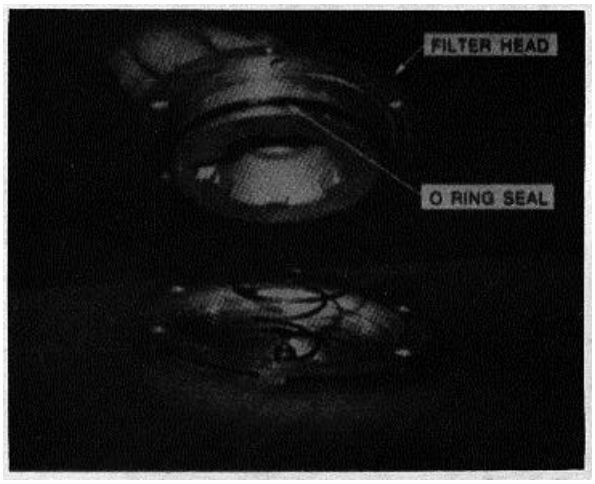
15. After the fasteners are tight and you are sure there Is no Internal binding, torque the diagonally opposite fasteners to 200 ft-lbs (27,7 m-kg).



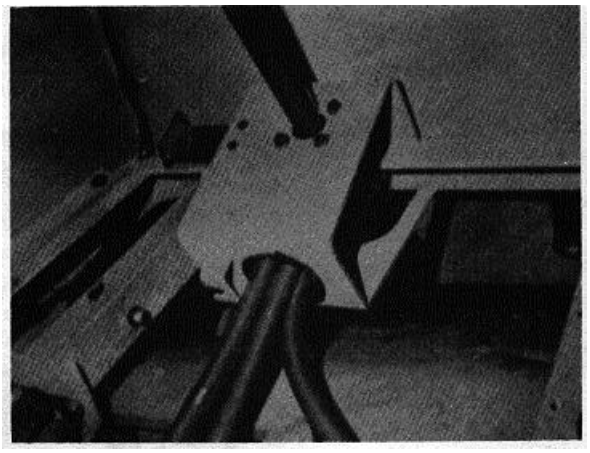
REMOVAL:

1. Park machine on level ground, set parking brake, lower blade and place dozer control lever in HOLD position.
2. Remove front and rear floor plates.
3. Clean all dirt from around hydraulic tank filter head. Remove capscrews and lift off filter head to vent suction line.

Note: *Check valves are located In hydraulic tank return lines to prevent tank from draining. Filter head must be vented to prevent hydraulic oil from siphoning out.*

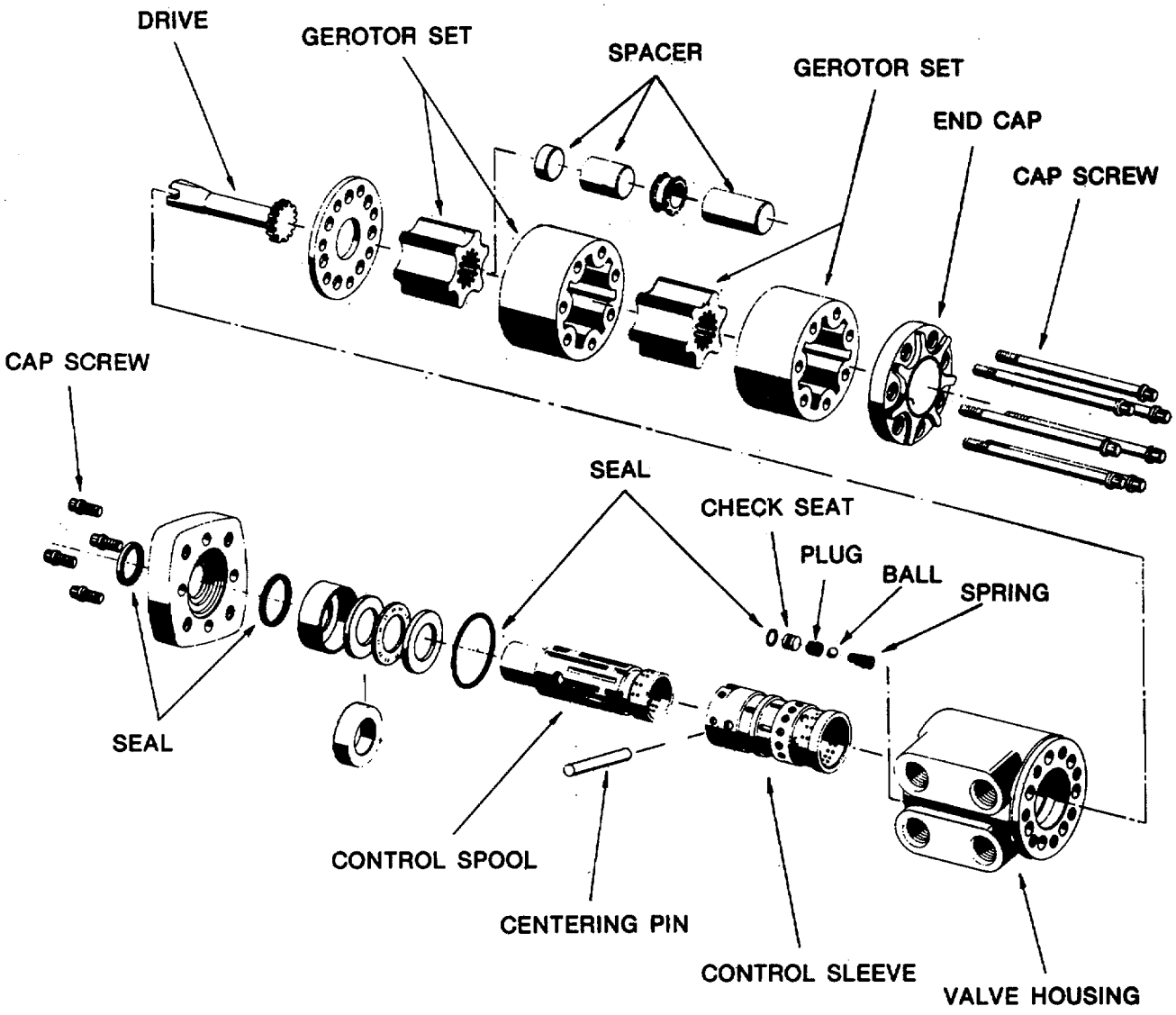


Venting Suction Line



Steering Valve and Column Mounting

4. Clean area around steering valve and hose connections.
5. Disconnect hoses from steering valve. Plug hoses and valve fittings and tag hoses with position for easier assembly.
8. Remove valve mounting bolts and remove valve assembly.
7. Reverse procedure for reassembly.



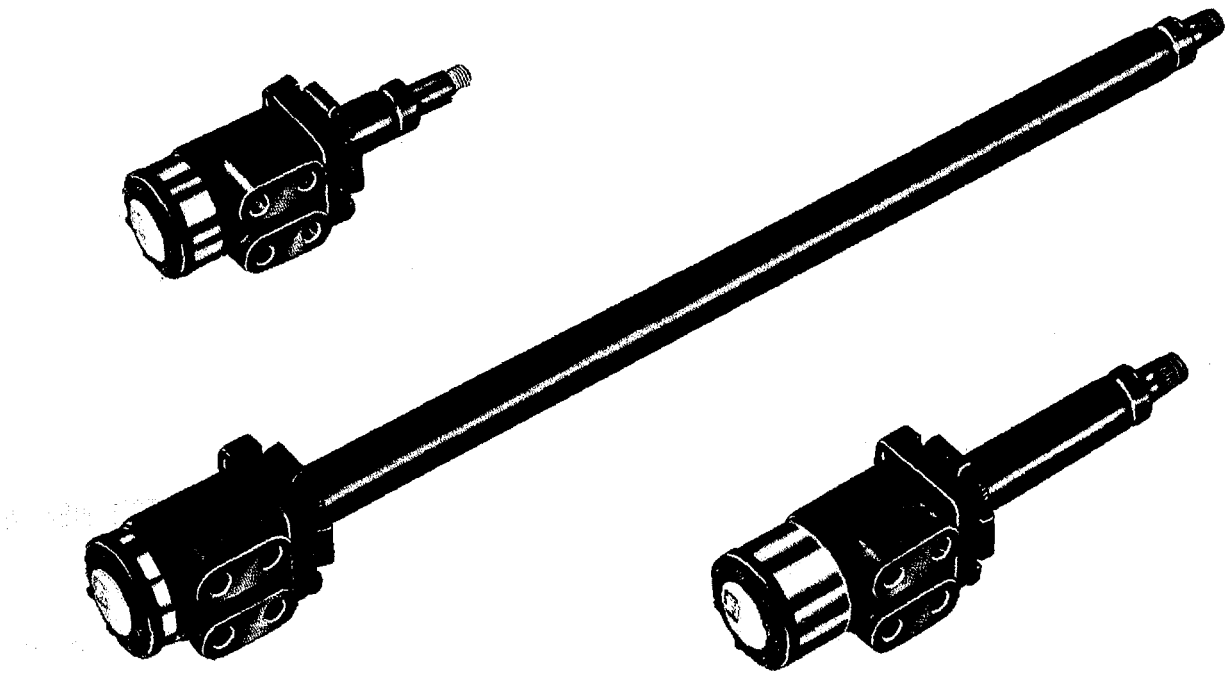
Steering Valve Assembly

NO. 7204
SERVICE
INFORMATION
ORBITROL

ORBITROL SERVICE MANUAL

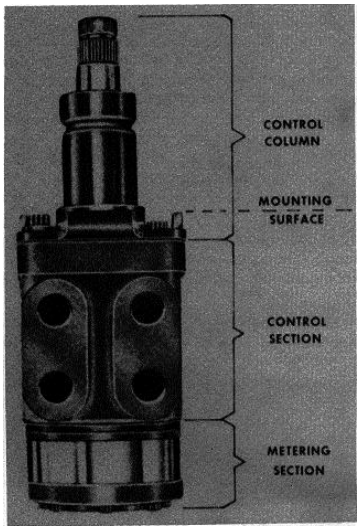
MODELS:

U(X)2-01
U(X)2-11
W(X)2-01
W(X)2-11
U(X)-2
W(X)-2



ORBITROL®
SERVICE
MANUAL

MODELS: U(*)2-01
U(*)2-11
W(*)2-01
W(*)2-11
U(*)2
W(*)2



RE 25,126
RE 25,291

Your ORBITROL power steering control has been designed and manufactured with the greatest care to sustain all parts in peak operating condition throughout a long period of trouble-free service. As are many hydraulic components the ORBITROL is continuously lubricated by the fluid which is used to power the system. A good selection of adequate materials allows the unit to function well over a wide temperature range.

The ORBITROL is specifically designed for use with automatic transmission fluid, Type A. All standard units - unless otherwise specifically ordered - have synthetic seals which are compatible with ATF-A at temperatures up to over 200 F.

A normal periodic functional check of the entire vehicle power steering system will generally be adequate to insure satisfactory service. The oil level of the reservoir that supplies the system is MOST IMPORTANT. If the oil level drops appreciably over short periods of use, it will be wise to search for a leak in the system.

A black accumulation of dirt at a fitting can indicate a leakage point. If the fitting is taken apart to correct leakage, first - clean the area completely with a solvent-wetted cloth, steam clean, or otherwise clean off any debris from the immediate area and any dirt accumulation above the area so that contamination will not enter the system while the connection is open. Then be extremely careful to apply compound sparingly to the male fitting only. Do not let any compound enter an area in which it may be washed into the oil stream.

WARNING

Never use fluid system 'stop leak' additives to attempt to seal fluid leakage. Many good automotive power steering systems have been ruined by such attempts.

To continue the functional check of the system, turn the steering wheel through the full travel with the vehicle power on. Do this at engine idle and full throttle - with the machine standing still with the steered wheels on dry concrete and with the machine rolling slowly. Note any speed irregularities and sticky sensation. These may indicate dirt in the fluid. If under any of these conditions the steering wheel continues to rotate when started and released, a condition known as MOTORING exists. This may also indicate ditty fluid in the system.

If a dirty fluid is suspected, clean or replace the filter element in the system. This is generally located in or near the pump or reservoir. There is no' filter in the *ORBITROL.* Drain

and replace as much of the oil as possible; crank the pump over by hand to exhaust oil from it and swing the cylinder through a full travel; but do not forcibly rotate the ORBITROL steering wheel if a dirty fluid is suspected. Refill the system with clean oil, run the system briefly recheck and refill as necessary to obtain proper fluid level. Operate the system for a short time to determine whether a correction has resulted. It is sometimes less costly to rinse and reclean the system twice than to completely tear down and reassemble a unit and the clean fluid will definitely protect all of the components of the system.

In the functional check, determine also that the actuating cylinder achieves full travel without hesitation. If the cylinder seems to pause in its travel while it should .be moving smoothly, this may indicate that it contains trapped air. In filling and refilling a system, it is sometimes necessary to lift the vehicle weight off the steered axle or to remove the cylinder and hold it in a position so that the ports are uppermost so that air will be bled back to the system reservoir and effectively exhausted from the system at the reservoir vent. During this inspection, determine that the mechanical or other limit stops at the axle are functioning properly. Proper wheel alignment is every bit as important on power-steered vehicles as on any other to insure satisfactory tire life and geometrically true steering.

Inspect to insure that the system has adequate power. Some machines are designed so that they can not be steered unless they are rolling. Most, though, will steer completely while standing still on a smooth hard surface. If there is an indication of "hard-steering", this can indicate either a reduced oil flow to the control or a reduced system relief pressure. Adequate oil flow under all conditions can best be checked by timing the full travel of the cylinder with the steered axle unloaded and loaded. If there is a great difference at low engine and slight difference at high engine speed, this may indicate a defective pump drive. Adequate oil pressure can only be determined by connecting a pressure gage (2000 psi full scale recommended) at the pump outlet port or at the "IN" port of the ORBITROL. With the engine running at a medium speed, turn the steering wheel to one end of the travel and hold the cylinder at the travel limit briefly - just long enough to read the pressure gage. Never hold a system at relief pressure for more than a few seconds at a time. Longer operation at relief pressure can overheat most systems quite rapidly. The pressure relief valve is a protection for all of the various parts of the steering system. There is no pressure relief in the ORBITROL. Power steering pressure relief valves are usually located in the power steering pump or flow control valve or very near the discharge line of either of these. Check or adjust to the vehicle manufacturer's recommended pressure setting.

If the system is reported to operate extremely hot, connect a pressure gage as above and operate the engine at near full throttle. Rotate the steering wheel slowly in each direction and bring the wheel to the position that shows the lowest pressure reading. This places the control section of the unit in neutral. Then turn the steering wheel to a limit stop and hold it there for one to two seconds. Release the steering wheel gently and watch the gage. If the pressure does not drop to very nearly the same neutral pressure as measured when placing the control in neutral deliberately, a binding control shaft or dirt between the spool and sleeve of the control valve can be the cause of difficulty.

If the reentering characteristic as measured above is erratic and if the control feels slightly sticky through most of the travel, apply the pressure gage in the "OUT" line of the ORBITROL. This return line pressure should be below 30 psi during all periods of normal operation. Check this "downstream" line to insure that no fittings are obstructed. If the system uses a return line filter, as in many common power steering pump tank units, a higher return line pressure may indicate that the filter needs cleaning.

If after the Inspections described, a functional difficulty Is Indicated in the ORBITROL, Char-Lynn Company maintains a complete service and repair department so that your unit, shipped to 15151 Highway 5, Eden Prairie, Minnesota, and togged "Repair and Return," will receive prompt, skilled attention.

If instead you need or wish to accomplish repairs within the unit, use the following procedure for disassembly, inspection and reassembly.

Before removing the ORBITROL from the vehicle, be certain that it - the entire area around it - and the connecting lines are cleaned free from dirt and contamination. If the vehicle must be moved while the steering control is off, you will need two 3/8 pipe elbows if the unit is connected with hose or four elbows and two close nipples if it is connected with tubing. Use the fittings to couple the "'N" to the "OUT" line and the "L" to the "R" line when these are removed from the unit. If it is necessary to remove the steering wheel, make sure to use a wheel puller. Do not hammer the end of the shaft or the steering wheel nut because this disrupts the upper column bearing which is designed to allow the critical freedom required for satisfactory function. If you must use a hammer, order a spare bearing and snap rings first.

On some machines it may not be necessary to remove the upper column. Remove the two mounting screws and lower the entire assembly far enough to provide access to the two screws which fasten the column to the lower unit.

Observe the shaft area of the lower unit immediately upon removal of the column assembly. If it shows an appreciably oil-wetted appearance this indicates that the shaft seal may have been leaking.

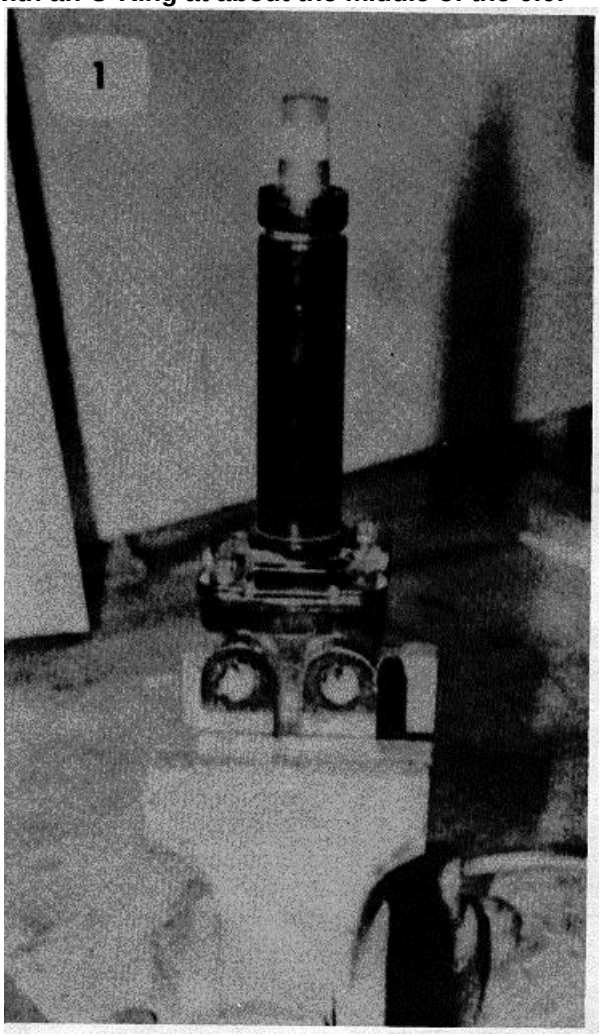
If there is a functional problem or leakage at the control end of the unit only, the disassembly of the control end of the unit only will be required and it is generally advisable to leave the 7-bolted end assembled.

If a complete tear down and reassembly of the unit is planned, clean all paint and surface contamination from the unit at points of separation. This is extremely important at the meter end of the unit so that no paint flakes or particles will enter these closely fitted parts as they are being reassembled. To clean the unit adequately, first plug all four ports, then wire brush around the meter area and rinse and blow away all surface contamination before any disassembly is begun.

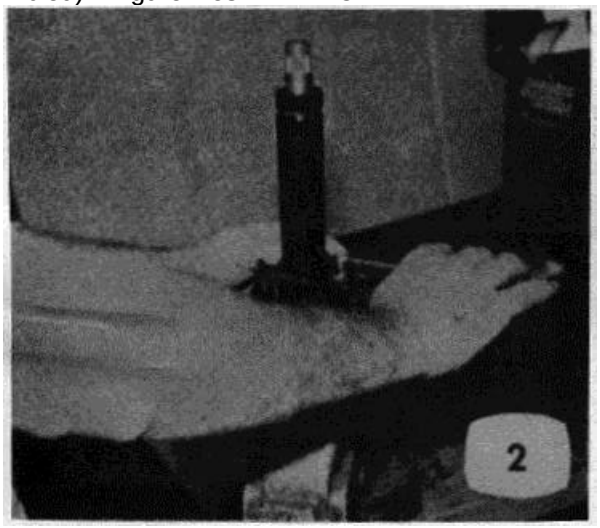
For any disassembly, an extremely clean bench area is necessary. Do not use shop cloths or cotton waste to wipe or clean the parts. The lint deposited by these can disrupt function or cause leaks. The clean inside surface of a corrugated container is frequently a very adequate assembly surface. Assembly is generally easier and more satisfactory with clean dry parts. After parts are rinsed clean in solvent they may be blown dry with an air hose or placed on clean paper towel to drain and air dry.

If parts are thus prepared as they are removed, they are frequently ready for reassembly by the time they are needed.

The following procedure applies to all units with Model numbers starting with U or W. They can be identified by a one-piece housing and a check hole plug with an O-Ring at about the middle of the 0.0.



Place the unit in vise, control end up. Clamp across port surface and opposite side of housing lightly. Remove the two cap screws that fasten column to lower unit. Remove column and set aside. (Mark the two cap screw holes so that the ports will be in the proper direction when reassembled). Figure Nos. 1 - 2 - 3.

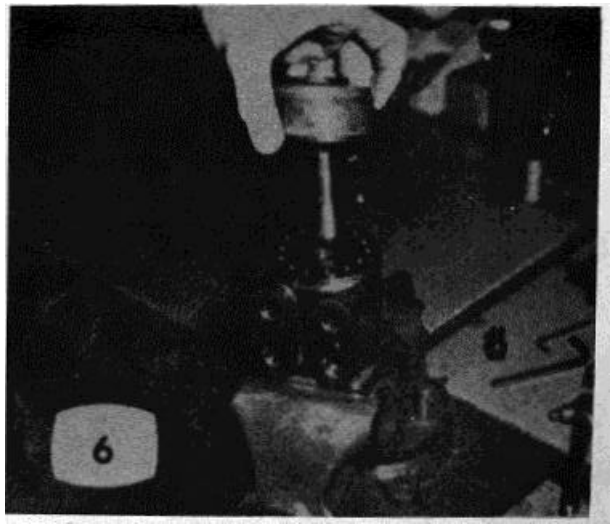




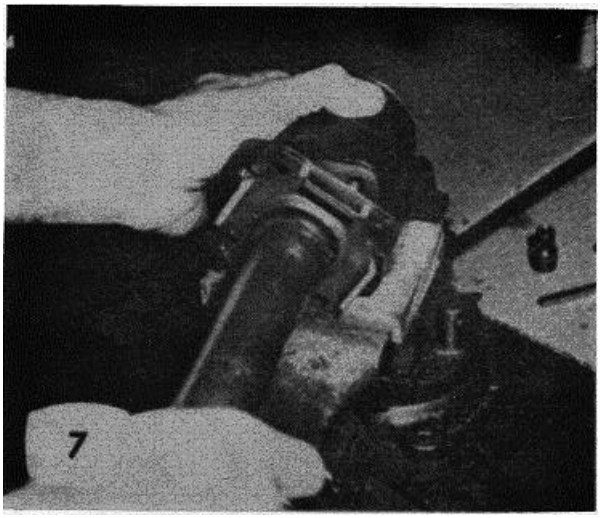
Clampunitin vise across mounting plate edges with meter end up and remove 7 cap screws. **Figure No. 4.**



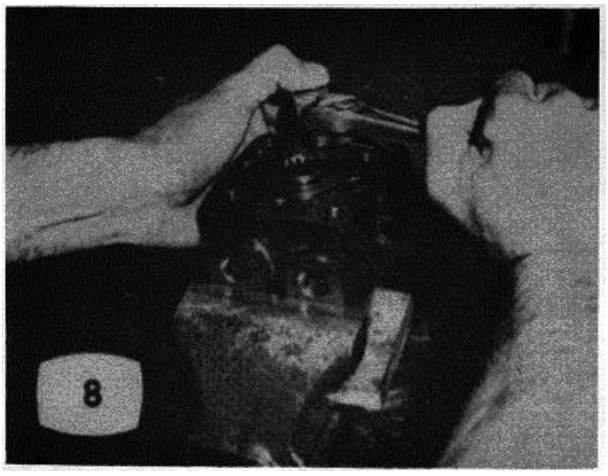




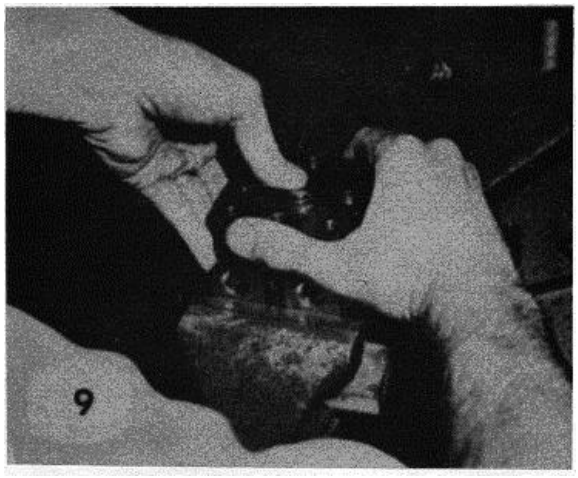
Remove control assembly from vise and check for free rotation of the control spool and sleeve parts with column shaft. **Figure No. 7**.

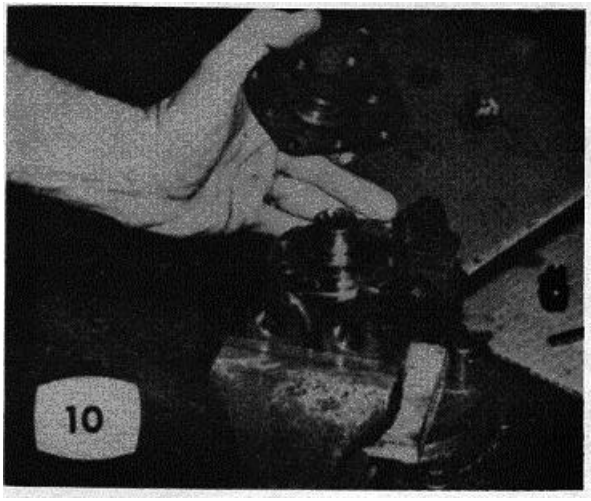


Place clean wooden block across vise throat to support spool parts and clamp unit across port face with control end up. Remove and set aside four cap screws. **Figure No. 8**.



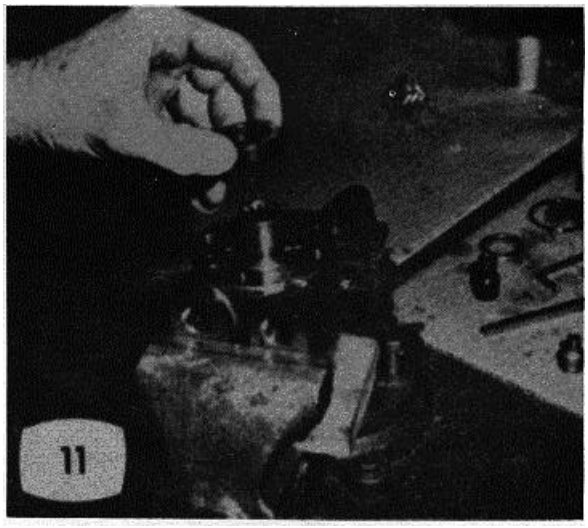
Hold spool assembly down against block In vise and lift off end cap. **Figure No. 9**.

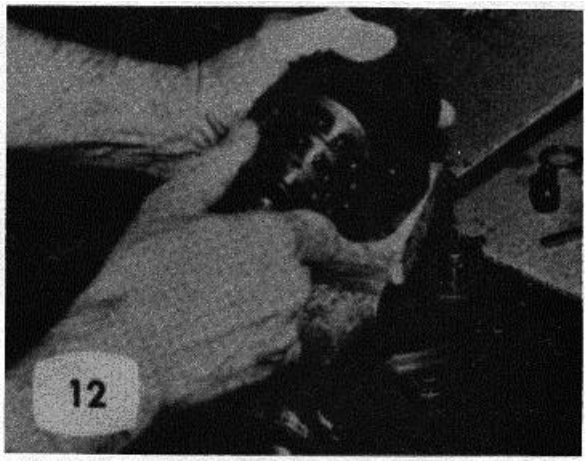




Inspect mating surfaces for obvious leakage path, wear, seal condition. **Figure No. 10**.

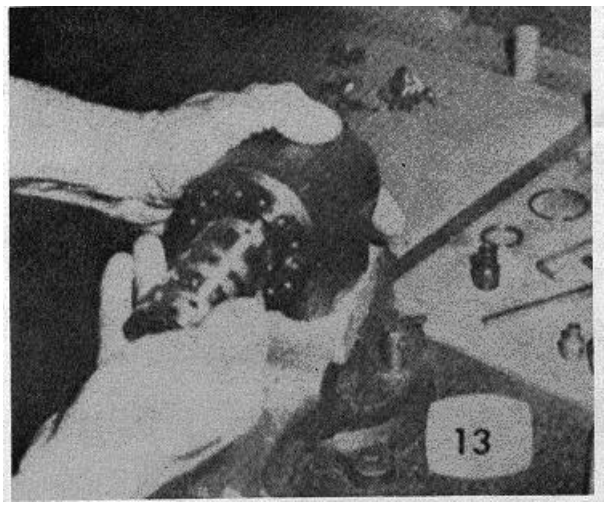
Remove cap locator bushing. **Figure No. 11.**



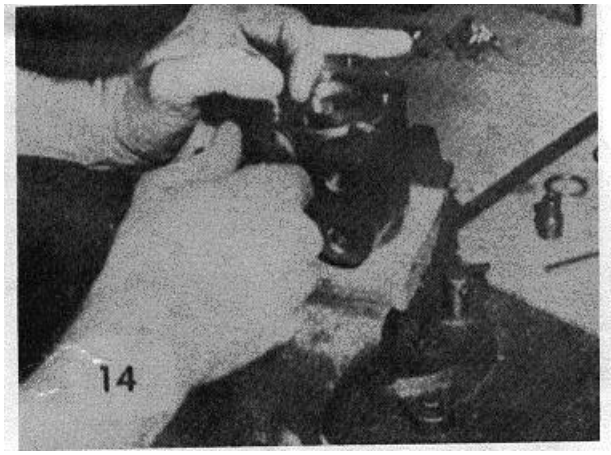


Place housing on solid surface with port face down so that it can be held securely and remove spool-sleeve assembly from the 14 hole end of housing. **Figure No. 12.**

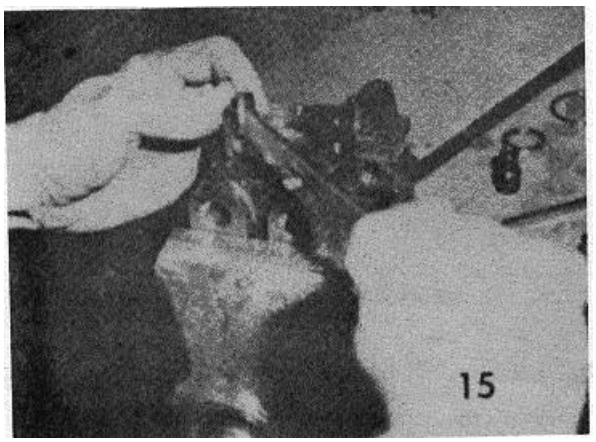
Be extremely careful to prevent these parts from binding as they are very closely fitted and must generally be rotated slightly as they are withdrawn. **Figure No. 13**.



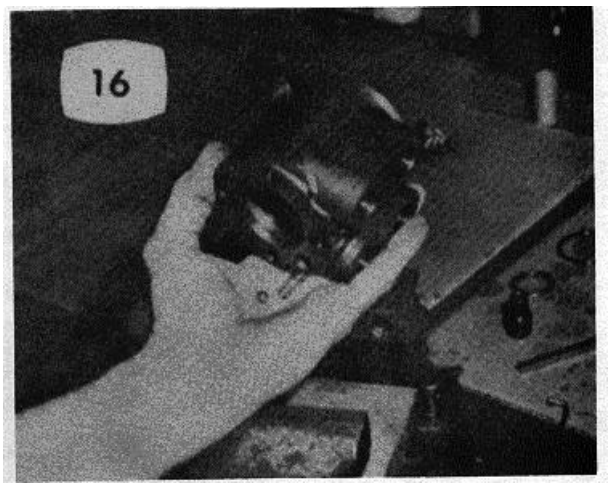
Using a small bent tool or wire, the check valve seal plug can be removed by pushing on it, reaching it through the "out" port. Do not pry against edge of hole in housing bore. **Figure No. 14**.

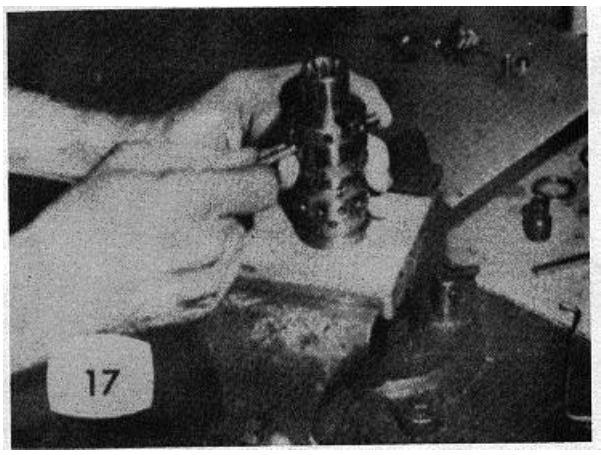


Place housing in vise, control end up, and unscrew check valve seat with 3/16 hex wrench. **Figure No. 15.**



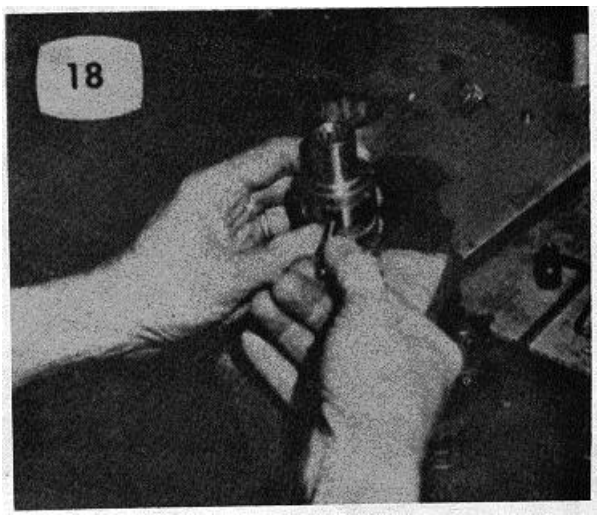
Up end the housing and tap slightly with butt of hand. Hold check valve hole toward lowest corner and remove check valve seat, ball and spring. **Figure No. 16**.

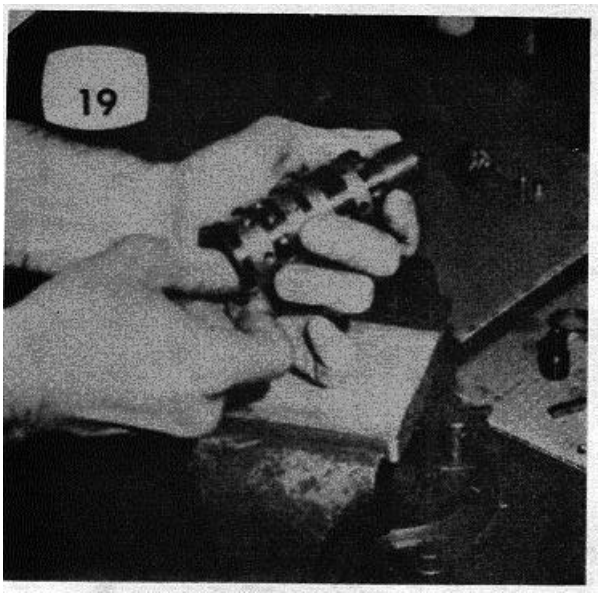




In spool assembly, push the cross pin to loosen from spool sleeve assembly. **Figure No. 17**.

Remove cross pin and set aside. **Figure No. 18**.







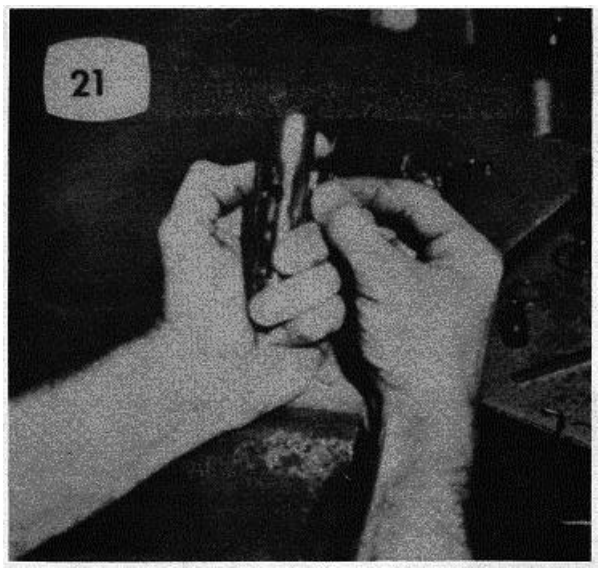
Push inside lower edge of spool so that spool moves towards splined end and remove carefully from sleeve. **Figure No. 19 and Figure No. 20.**

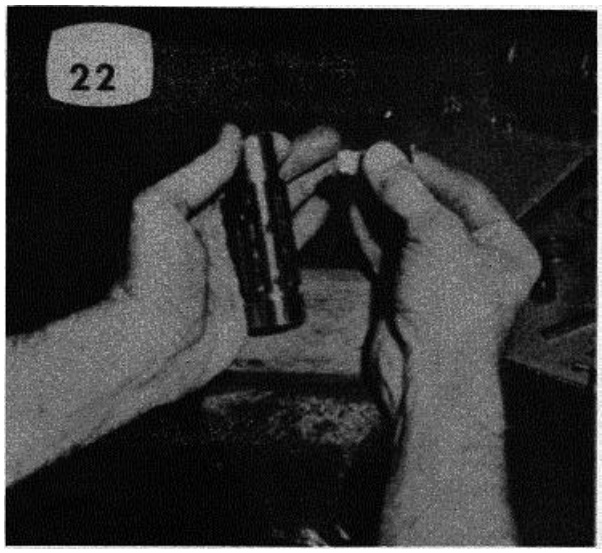
Push centering spring set out of spring slot in spool. **Figure Nos. 21 and 22.**

At this point all parts have been disassembled and removed from the unit. Each should be rinsed carefully in clean solvent, even such exterior parts as all cap screws and all seals that appear to be reusable. If in doubt, replace with new seals. It is good service policy to replace all seals when unit is reassembled. They are available in kit form, Part No. 5140. Rinsing and cleaning can be done while other parts of the unit are being disassembled and parts can be set to dry on clean paper towel. The meter gear set must be disassembled and cleaned similarity.

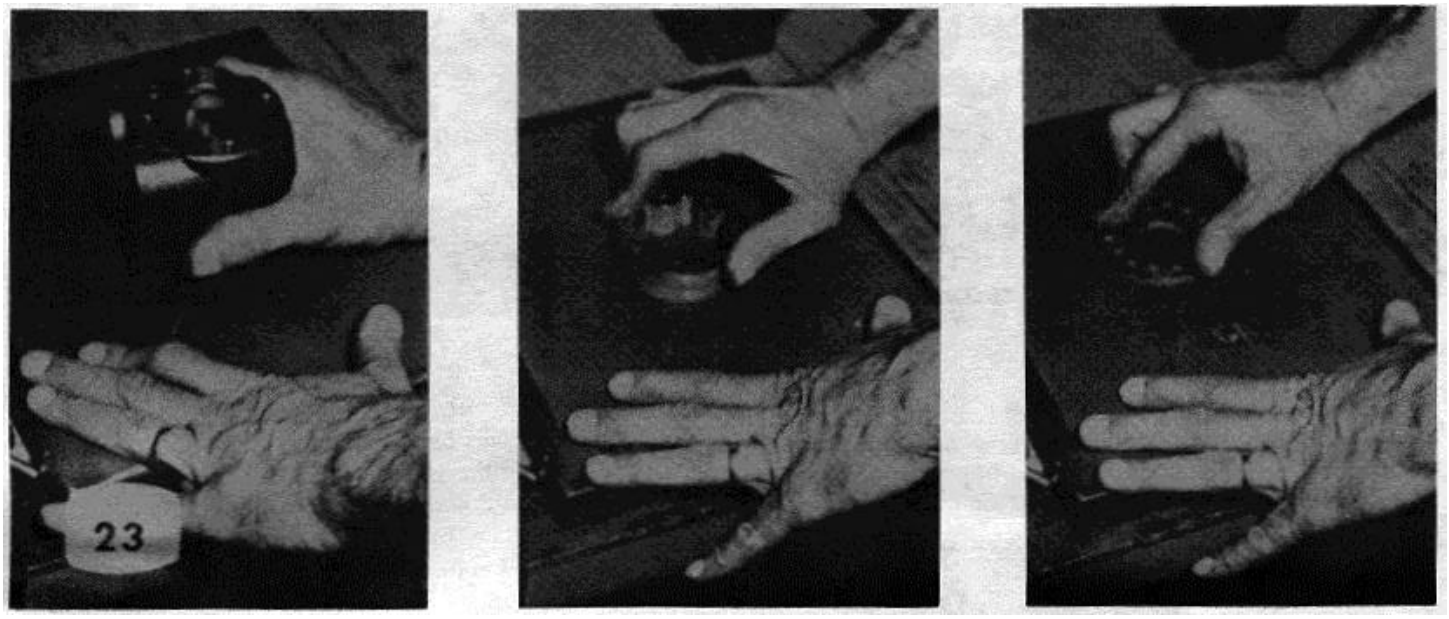
Inspect all moving surfaces to insure that they have not been scored or abraded by dirt particles or otherwise disrupted. Smooth burnished surfaces are normal in many areas. Slightly scored parts can be cleaned with 600 grit abrasive paper by hand rubbing only.

To prepare all surfaces of the meter section for reassembly and insure that all edges of the parts are burr free, place a piece of 600 grit abrasive paper face up on an extremely flat, clean, hard surface. The surface to be used for this purpose should be as flat as plate glass or better. If the 600 grit paper is new it should first be rubbed down with a scrap steel part to remove sharp grit which would produce scratches. The ends of the star gear can be used for this purpose if necessary. Then both sides of the ring gear, both sides of the plate, the 14 hole end of the housing and the flat side of the end cap should be cleaned lightly.





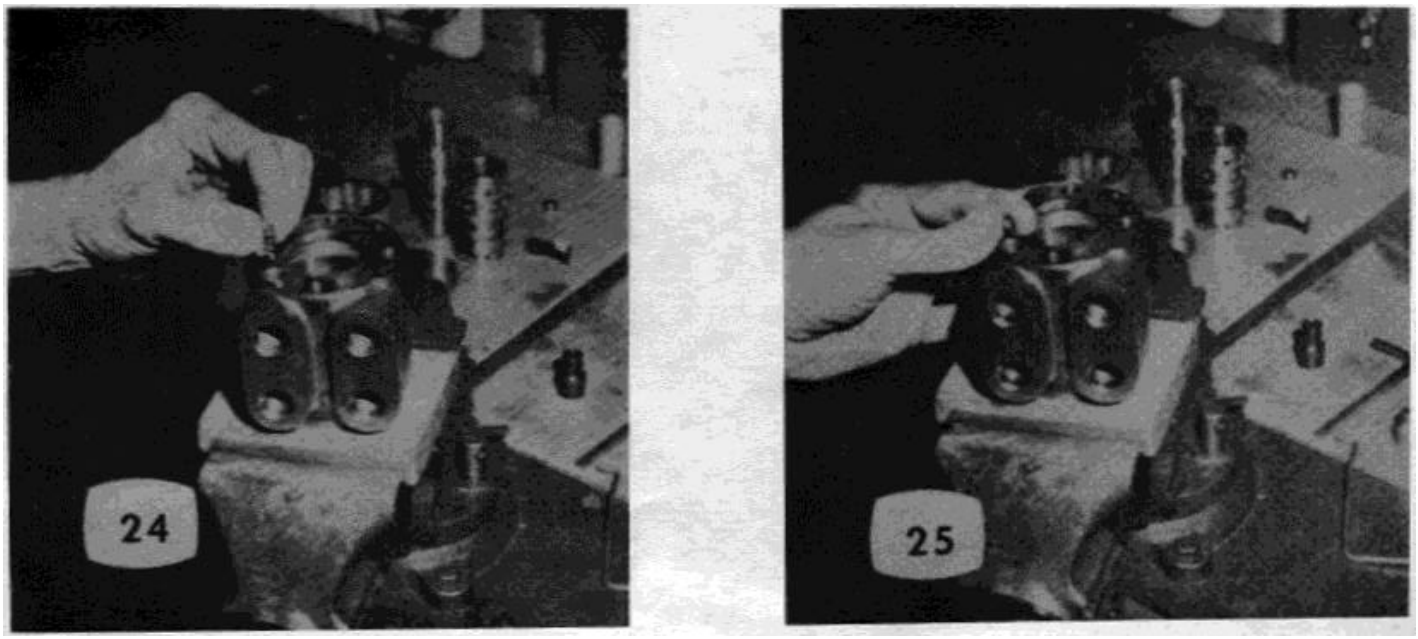
Stroke each surface across the abrasive several times and observe the part. **Figure No. 23**. Any small bright area near an edge indicates a burr which must be removed. Hold the part so that contact with the abrasive is as flat as possible. (Do not push one edge down hard or the flatness will become rounded) Check each part after 6 to 10 strokes across the abrasive. After polishing each part, rinse clean in solvent and blow dry. Keep these parts absolutely clean until they are assembled.



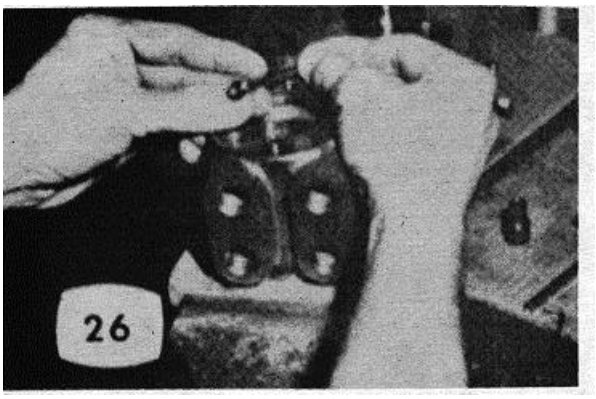
REASSEMBLY

Place housing in vise with control end up. Protect 14-hole end as before, and clamp across port surface lightly. Drop check valve spring into check hole with large end down. **Figure No. 24**.

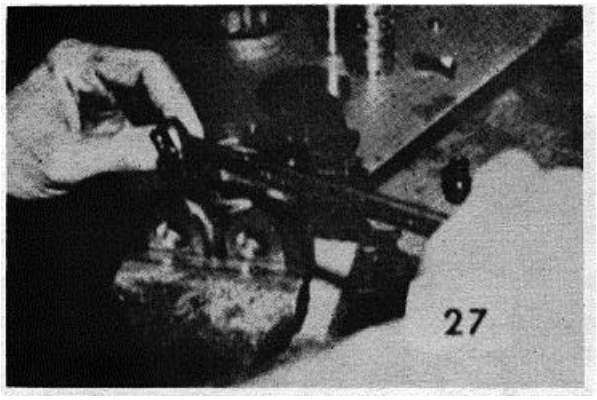
Drop check ball into check hole and insure that it rests on top of the small end of the spring within the hole. **Figure No. 25**. Place the check valve seat on hex wrench and screw into threads within



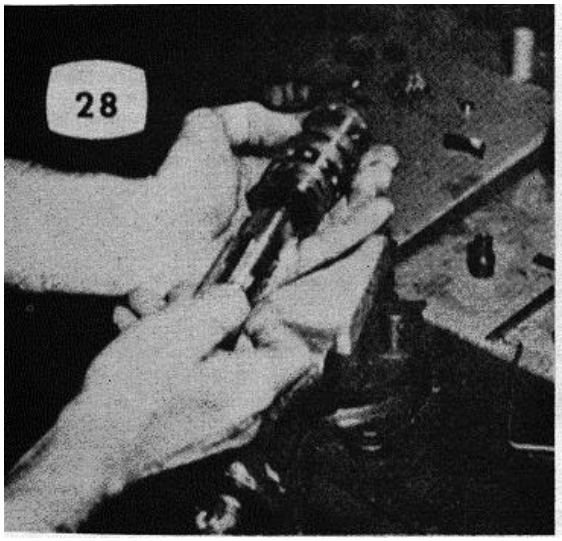
check hole so that the machined counterbore of the check seat is towards the ball. **Figure No. 26**.

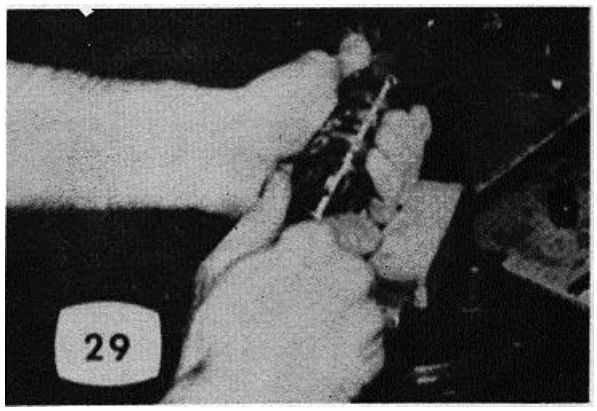


Tighten check seat to 150 inch-pounds torque. **Figure No. 27.** Test check ball action by pushing ball with small clean pin against spring force. Ball need **NOT** be snug against seat for proper function.

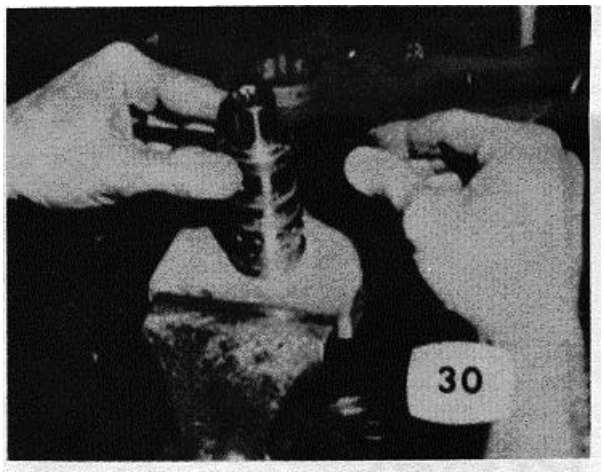


Install spool within sleeve carefully so that spring slots of both parts will be at same end. Rotate while sliding parts together. **Figure No. 28 and Figure No. 29**. Test for free rotation. Spool should rotate smoothly in sleeve with finger tip force applied at splined end.

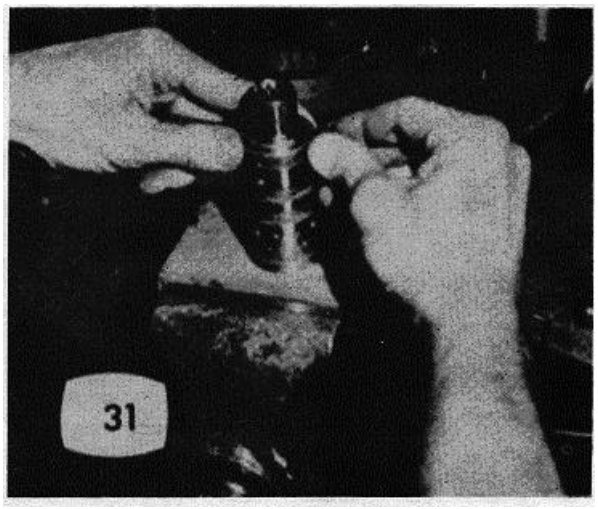




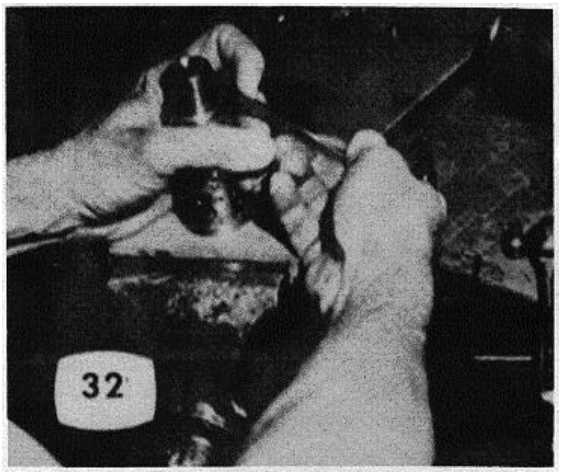
Bring spring slots of both parts in line and stand parts on end of bench. Insert spring installation tool through spring slots of both parts. Tool is available as Part No. 600057. Position 3 pairs of centering springs (or 2 sets of 3 each) on bench so that extended edge is down and arched center section is together. In this position, enter one end of entire spring set into spring installation tool. **Figure No. 30**.



Compress extended end of centering spring set and push into spool sleeve assembly withdrawing installation tool at the same time. **Figure No. 31**.



Center the spring set in the parts so that they push down evenly and flush with the upper surface of the spool and sleeve. **Figure No. 32**.



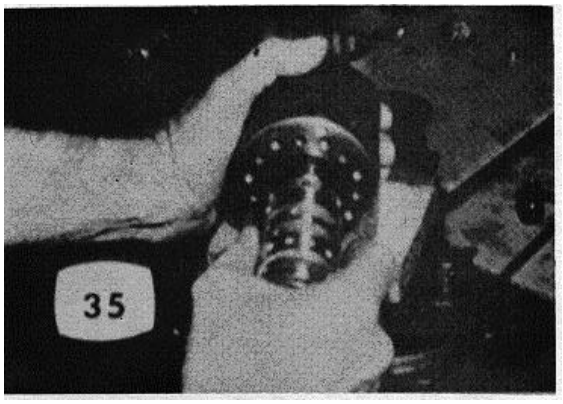
Install cross pin through spool assembly. **Figure No. 33.**



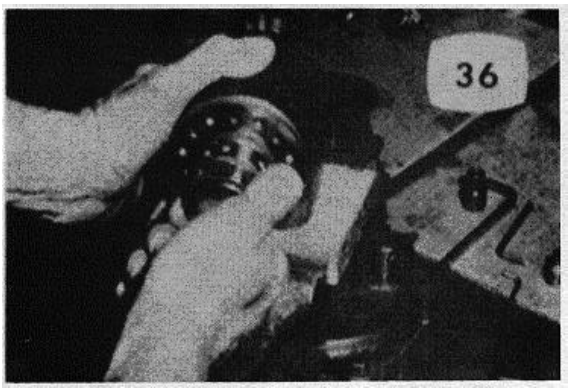
Push into place until cross pin is flush or slightly below the sleeve diameter at both ends. **Figure No. 34.**



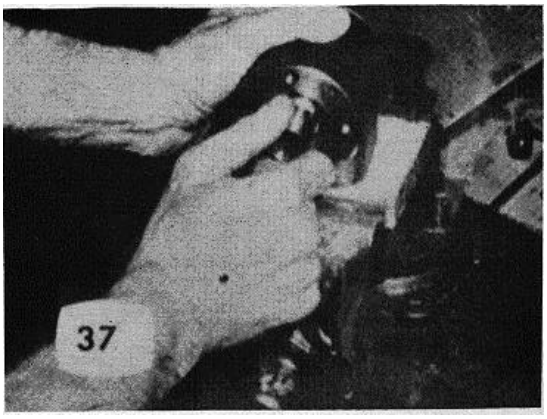
Position the housing on a solid surface with the port face down. Start the spool assembly so that the splined end of the spool enters the 14 hole end of the housing first. **Figure No. 35.**



Be extremely careful that the parts do not cock out of position while entering. Push parts gently into place with slight rotating motion. **Figure No. 36**. Bring the spool assembly entirely within the housing bore until the parts are flush



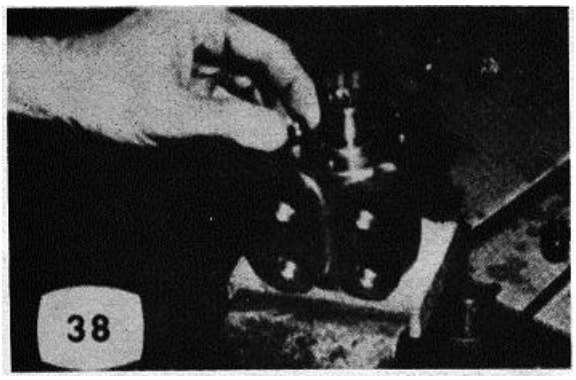
at the meter end or 14 hole end of the housing. Do not pull the spool assembly beyond this point to prevent the cross pin from dropping into the discharge groove of the housing. With the spool assembly in this flush position, check for free rotation within the housing by turning with light finger force at the splined end. **Figure No. 37**.

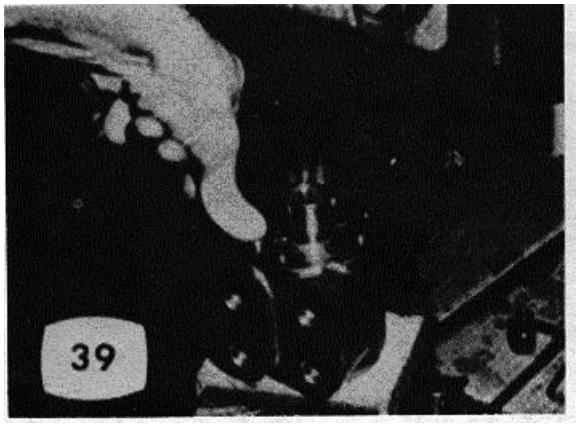


Hold the parts in this flush position and rest the 14 hole end of the assembly on the protective block on the vise throat and clamp lightly across the port face with the vise.

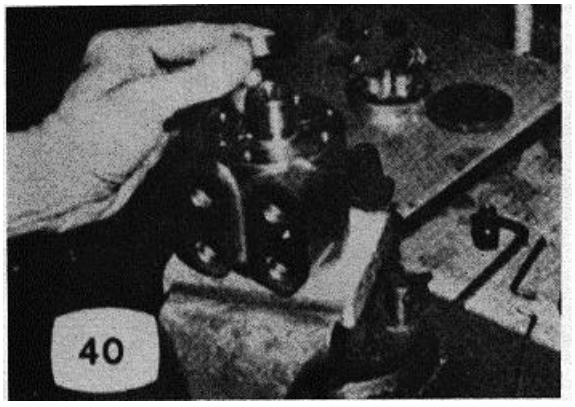
It is good service policy to replace all seals when unit is re-assembled. They are available in Kit form Part No. 5140.

Check the condition of the O-Ring seal on the check plug and replace it if necessary. Install the check plug in the check hole with a steady pressure while rocking it slightly so that the O-Ring feeds in smoothly without cutting. **Figure No. 38.39.**

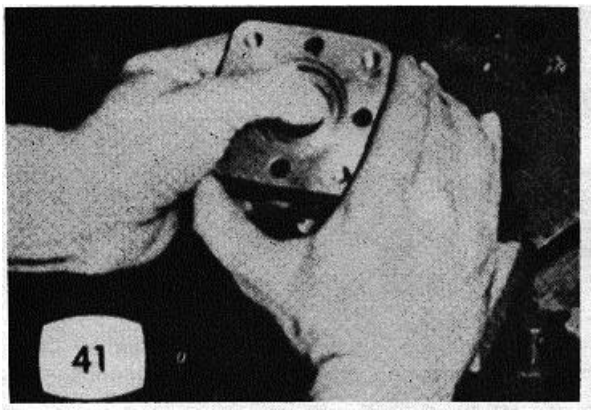




Position the cap locator bushing with large O.D. chamfer UP partly into end of housing. **Figure No. 40.** Insure that it seats against spool assembly flat and smooth by rotating with finger tips.



Check the mounting plate and shaft seal carefully to insure that they are clean and in good condition. Insure that the mounting plate seal grooves are clean and smooth. Each of these seals is slightly larger than its seal groove so that they will be adequately retained in service. Push each gently into place and smooth down into seal groove with finger tip. **Figure No. 41.**



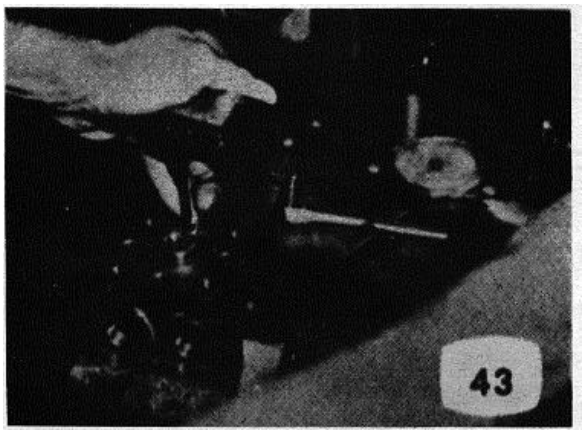
NOTE: Quad ring shaft seal may be used to replace O-Ring shaft seal in early units and will function properly in original seal groove.

Thin oil seal at exterior of mounting plate is a dirt exclusion seal and does not generally need replacement. If this is replaced it should be pressed into counterbore so that the lip is directed away from the unit.

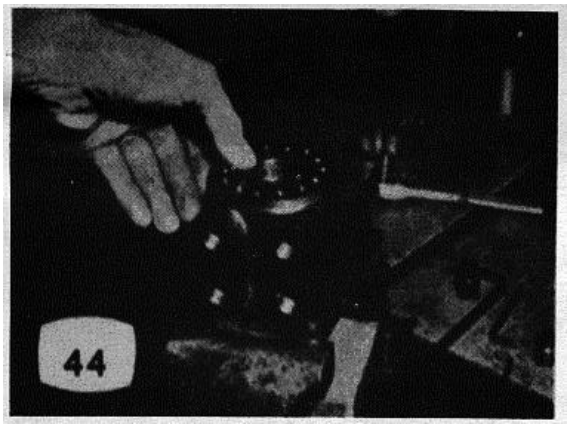
Place the mounting plate sub-assembly over spool shaft and slide down into place over cap locator bushing smoothly so that seals will not be disrupted in assembly. **Figure No. 42.** Align bolt holes with tapped holes. Be certain that the mounting plate rests fairly flush against end of housing assembly so that the cap locator bushing



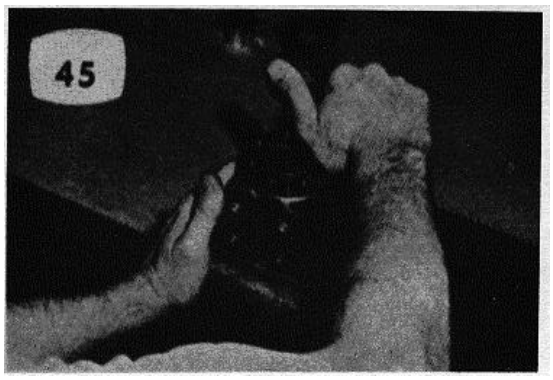
is not cocked and install four mounting plate cap screws. Tighten these evenly and gradually to a torque setting of 250 inch pounds. **Figure No. 43.**



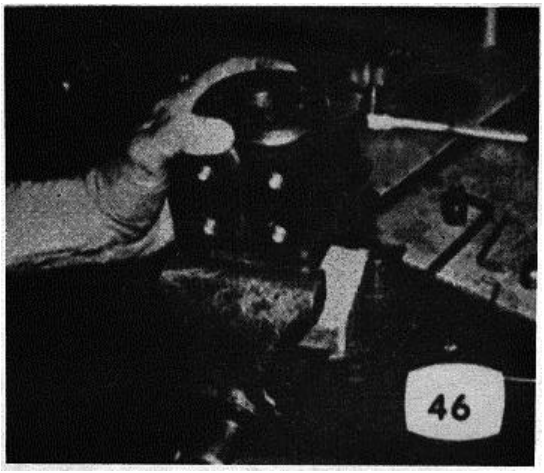
Reposition in vise and clamp across the edges of the mounting plate. Check to insure that the spool and sleeve are flush or slightly below the 14 hole surface of the control housing. **Figure No. 44.**



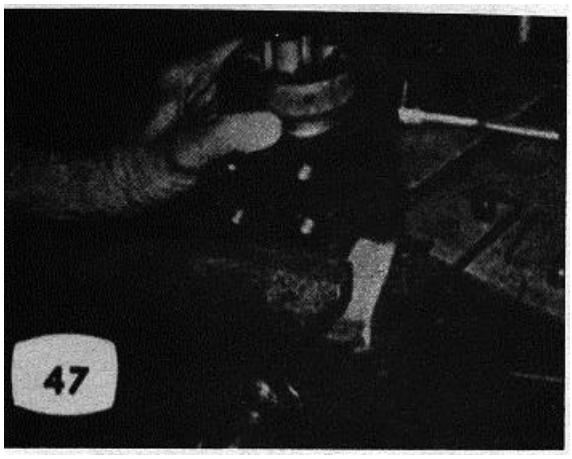
Clean the upper surface of the housing by wiping with the back of a clean hand or the butt of the thumb. Clean each of the flat surfaces of the meter section parts as It is ready for assembly in a similar way. **Figure No. 45.**



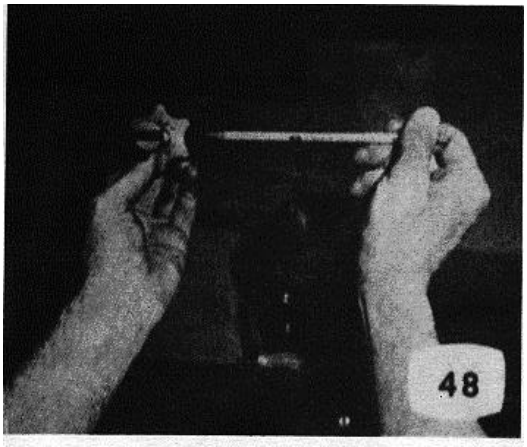
Place the plate over this assembly so that the bolt holes in the plate align with the tapped holes in the housing. **Figure No. 46.** Place the meter



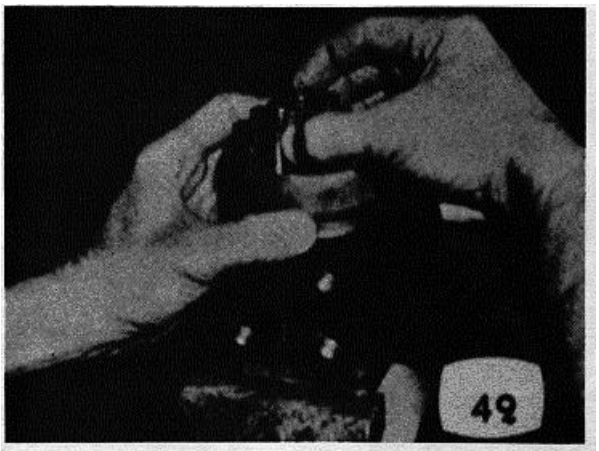
gear ring on the assembly so that the bolt holes align. **Figure No. 47.**

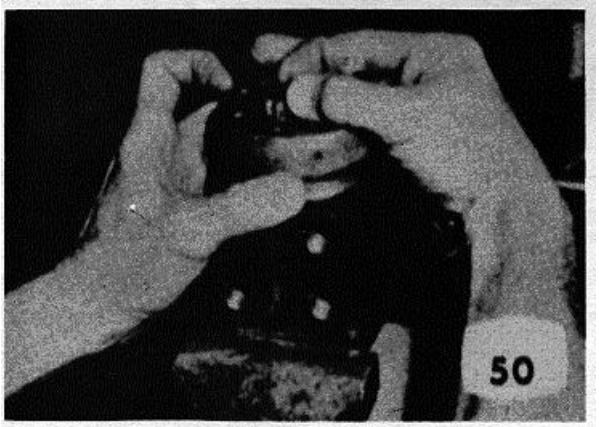


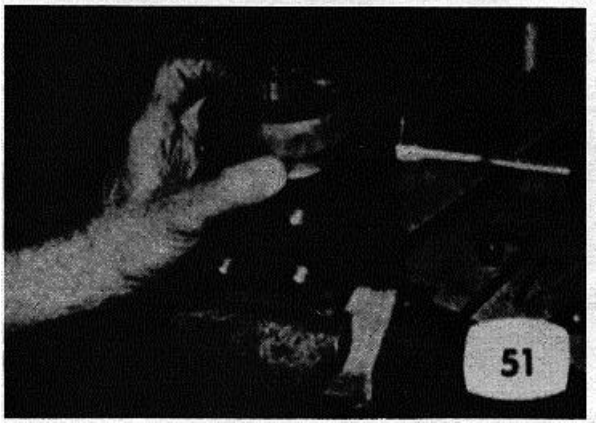
Place the splined end of the drive within the meter gear star so that the slot at the control end of the drive is in alignment with the valleys between the meter gear teeth, **Figure No. 48.** Push



the splined end of the drive through the gear so that the spline extends about one half its length beyond the meter gear star and hold it in this position while installing into the unit. Note the position or direction of the cross pin within the unit. Enter the meter gear star into the meter gear ring and wiggle the parts slowly in position so that the drive does not become disengaged from the meter gear star. Hold the plate and meter gear ring in position on the assembly while the star is being installed. Rotate the meter gearstar slightly to bring the cross slot of the drive into engagement with the cross pin and the splined end of the drive will drop down against the plate. **Figure Nos. 49. - 50 - 51.**







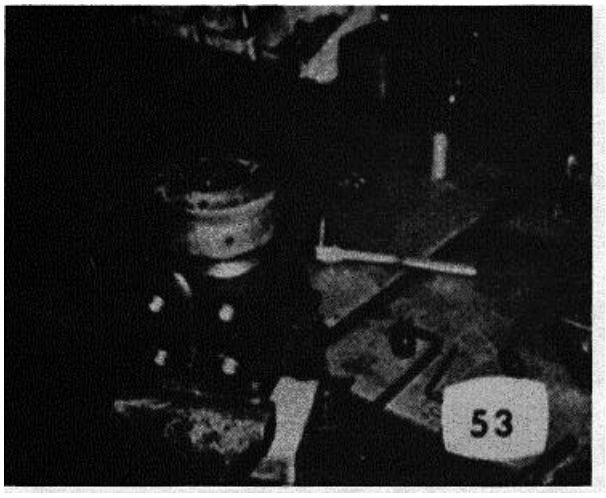
WARNING:

Alignment of the cross slot in the drive with valleys between the teeth of the m*eter* gear star determines proper valve timing of the unit. There are 12 tooth on the spline and 6 pump teeth on the star. Alignment is exactly right In 6 positions and exactly wrong In 6 positions, If the parts slip out of position during this part of the assembly, repeat until you are certain that correct alignment Is obtained. **Figure No. 48.**

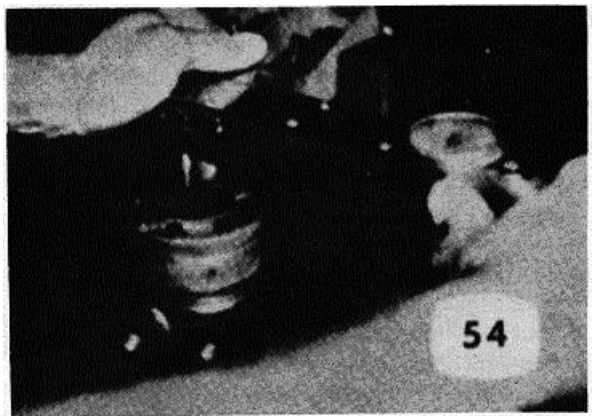
Place the spacer in position within the end of the meter gear star. **Figure No. 52.** (No spacer used on B size displacement units), If the spacer does not drop flush with the gear surface, the drive has not properly engaged the cross pin - RECHECK. Place the meter end cap over the assembly and install two cap screws, finger tight,



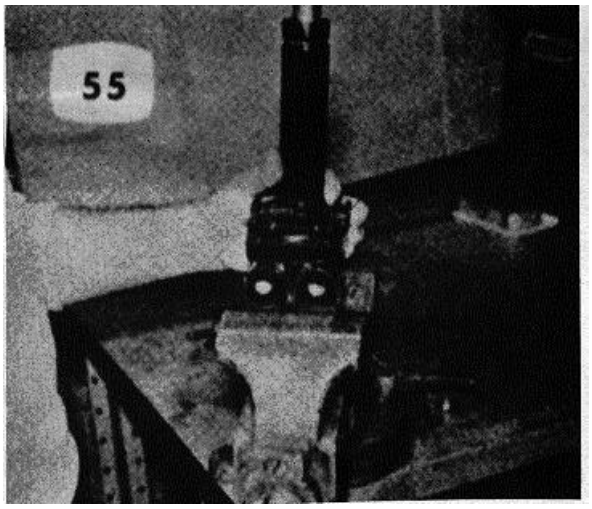
to maintain alignment of the parts. **Figure No. 53.** Install all seven cap screws and bring them gradually



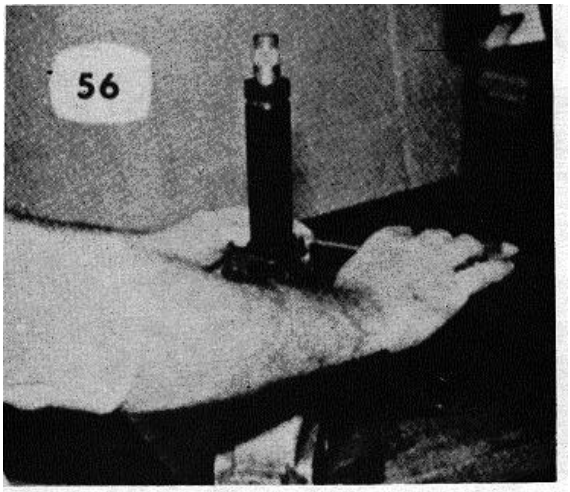
and evenly to 150 inch pounds torque. **Figure No. 54.**



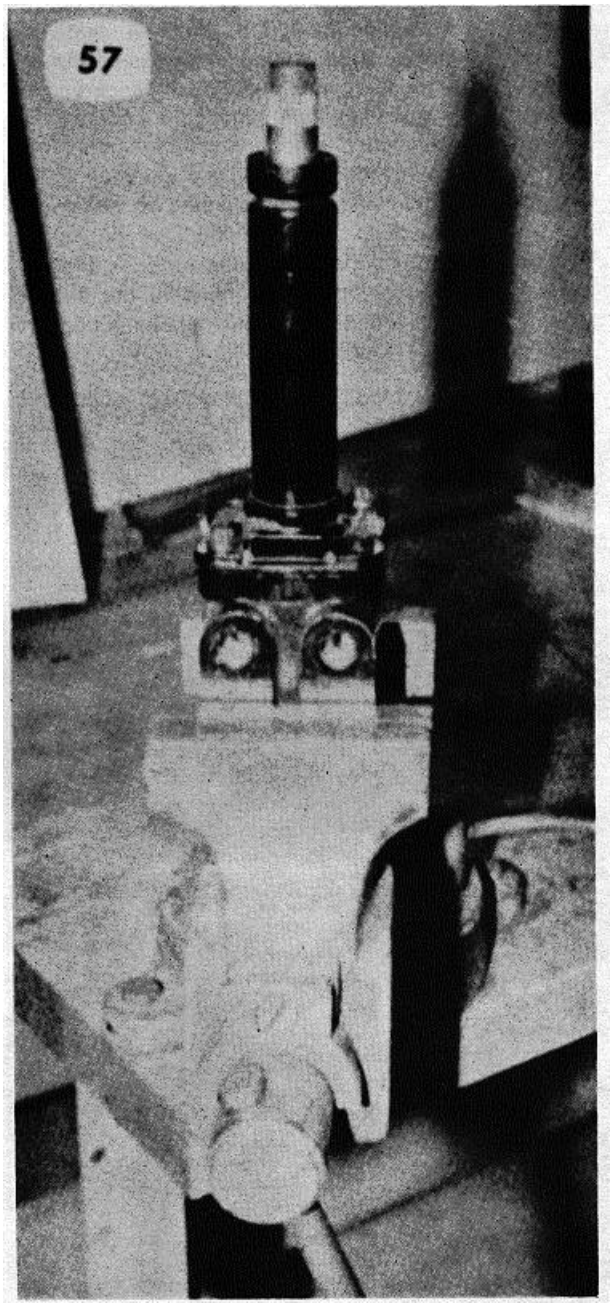
Check the condition of the column assembly, clean it, and replace on the unit with two cap screws oriented as before. Rotate the steering shaft while bringing the surfaces into contact to allow splines to engage. **Figure No. 55.** If in



doubt, follow the orientation as shown. Tighten cap screws to 280 inch pounds. **Figure No. 56.**



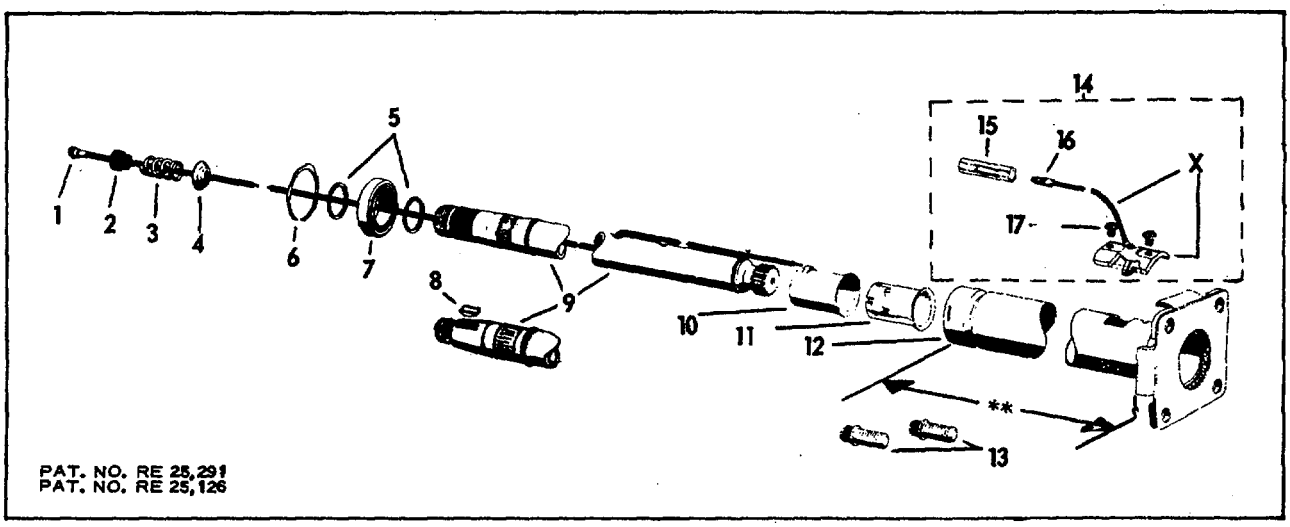
The unit is now ready to be returned to service.



To service earlier units, follow a similar procedure. In units with a hat-shaped check plug, use gasket No. 20911 between the housing and the mounting plate. Insure that each part is smooth and clean by rubbing on 400 grit abrasive paper before cleaning for reassembly.

In units which have thin plastic gaskets at the meter section seams a gasket MUST be used at each side of the ring gear unless the entire gear set is replaced. Replacement gear sets are sized so that the gasket should NOT be used.

MODELS: SCA, SCB, SCC, SCD, SCE, SCF, SCJ, SCK } (-3)



PARTS LIST

ITEM No.		PART No.	DESCRIPTION	QUANTITY REQUIRED FOR MODEL: SCA	SCB	SCC	SCD	SCE	SCF	SCJ	SCK
1	*	21142-1	Terminal & Wire							1	
	*	21142-2	Terminal & Wire								1
2	*	21138	Contact Insulator							1	1
3	*	5029	Contact Spring							1	1
4	*	5028	Contact Washer							1	1
5		14092	Snap Ring	2	2	2	2	2	2	2	2
6		5245	Retaining Ring	1	1	1	1	1	1	1	1
7		21146	Bearing Assembly	1	1	1	1	1	1	1	1
8		655	Key, Woodruff, 7/8" Dia. x 3/16"	1		1		1			
9		5249-1	Steering Shaft Assembly (Serrated)		1						
		5249-2	Steering Shaft Assembly (Serrated)				1				
		5249-3	Steering Shaft Assembly (Serrated)						1		
	*	5259-1	Steering Shaft Assembly							1	
	*	5259-2	Steering Shaft Assembly								1
		5260-1	Steering Shaft Assembly (Keyed)	1							
		5260-2	Steering Shaft Assembly (Keyed)			1					
		5260-3	Steering Shaft Assembly (Keyed)					1			
10	*	21149	Contact Ring							1	1
11	*	21151	Insulator, Contact Ring							1	1
12	*	5244-1	Tube & Flange Assembly							1	
	*	5244-2	Tube & Flange Assembly								1
		5246-1	Tube & Flange Assembly	1	1						
		5246-2	Tube & Flange Assembly			1	1				
		5246-3	Tube & Flange Assembly					1	1		
13		21047-1	Screw, Cap, 3/8"-16 NC x 3/4"	2	2	2	2	2	2	2	2
14	*	21141	Horn Brush Assembly							1	1
15	*	21173	Two-Wire Connector							1	1
16	*	21143	Terminal, Wire							1	1
17	*	21144	Screw, Self Tapping, 10-32 NC x 1/4"							2	2
* Column length. (Nominal jacket length. See drawing.)				21½"	21½"	6"	6"	30"	30"	6"	30"

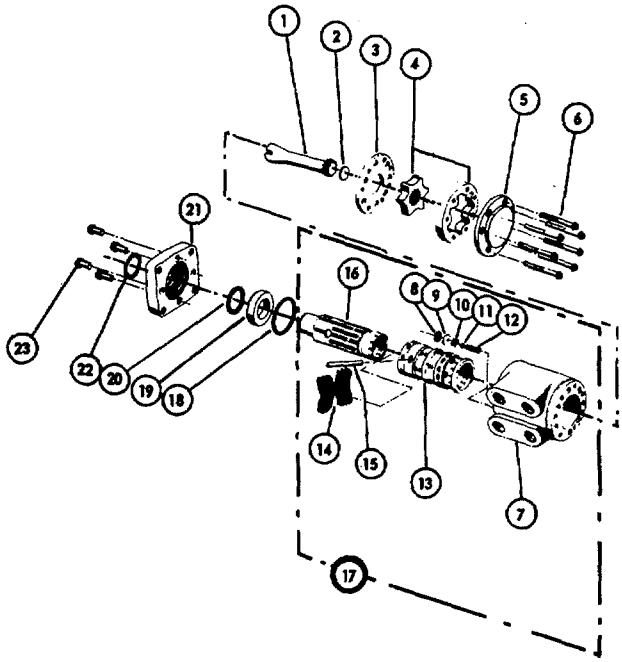
ORBITROL STEERING COLUMN DISASSEMBLY

Remove the snap ring from the column jacket. The shaft and bearing assembly can now be removed from the jacket by pushing on the lower end of the shaft. Do NOT use a hammer to pound the shaft free. When the shaft has been removed the beating and second retaining ring can be removed. Clean parts, replacing any that have been damaged and reassemble in the reverse order.

* Denotes Parts for Models SCJ & SCK only (with horn wire).

ORBITROL® PARTS DRAWING

Find part needed on drawing by item number. Order quantity needed by part number for your specific model Orbitrol.



PARTS INTERCHANGEABILITY

FORMER MODEL NUMBER	NEW MODEL NUMBER
UB	UB - 01
YB	UB - 11
WB	WB - 11
UC	UC - 01
YC	UC - 11
WC	WC - 01
UE	UE - 01
YE	UE - 11
WE	WE - 01
UK	UK - 01
YK	UK - 11
WK	WK - 01
UM	UM - 01
YM	UM - 11

ITEM NO.	PART NO.	DESCRIPTION See parts drawing Order by part number NOT item number.
1	839	Drive
	5126	Drive
2	858	Spacer
	838	Spacer
	20641	Spacer
	20642	Spacer
	5178	Spacer
	622	Spacer
3	594	Plate
4	20637	Gerotor Set (.37 Th)
	106	Gerotor Set (.52 Th)
	42	Gerotor Set (.86 Th)
	609	Gerotor Set (1.25 Th)
	612	Gerotor Set (1.50 Th)
	21080	Gerotor Set (2.00 Th)
5	21176	Cap, End
6	21045-2	Screw, Cap, 12 Pt. Hd. ¼-20 NC x 1¼
	21045-3	Screw, Cap, 12 Pt. Hd. ¼-20 NC x 1⅜
	21045-6	Screw, Cap, 12 Pt. Hd. ¼-20 NC x 2⅜
	21045-9	Screw, Cap, 12 Pt. Hd. ¼-20 NC x 1¾
	21045-13	Screw, Cap, 12 Pt. Hd. ¼-20 NC x 2⅞
	21045-17	Screw, Cap, 12 Pt. Hd. ¼-20 NC x 2⅛
	21045-18	Screw, Cap, 12 Pt. Hd. ¼-20 NC x 3⅜
	21045-19	Screw, Cap, 12 Pt. Hd. ¼-20 NC x 3⅞
7	21120-1	Housing, Valve (Not Sold Separately)
	21120-2	Housing, Valve (Not Sold Separately)
	5129	Housing, Valve (Not Sold Separately)
8	15006	Seal, O-Ring 7/16 OD x 1/16 Sec
9	21124	Plug, Seal
10	859	Seat, Check
11	194	Ball, Steel, ¼ Dia.
12	857	Spring, Compression
13	849	Sleeve, Control (Not Sold Separately)
	5127	Sleeve, Control (Not Sold Separately)
14	370	Spring, Centering
15	15	Pin, Centering
16	850	Spool, Control (Not Sold Separately)
	5128	Spool, Control (Not Sold Separately)
	5365	Spool, Control (Not Sold Separately)
17	847-1	Control Parts Assy (see view)
	847-2	Control Parts Assy
	21118-1	Control Parts Assy
	21118-2	Control Parts Assy
	5137	Control Parts Assy
18	20783	Seal, O-Ring 1-15/16 OD x 3/32 Sec.
19	846	Bushing, Cap Locator
20	20599	Seal, Quad Ring 1- 5/16 OD x ⅛ Sec.
21	843	Plate, Mounting
22	844	Seal, Oil, 1¼ OD x 1 ID x ⅛ Th
23	21046-1	Screw, Cap, 12 Pt. Hd. 5/16-18 NC x ⅝
24	5213	Spline
	5140	Seal Kit (1 each 844, 20599, 15006 and 20783

Prices subject to change without notice.

UB2-01	UC2-01	UE2-01	UK2-01	UM2-01
1	1	1	1	1
	1			
		1		
			1	
				1
1	1	1	1	1
1				
	1			
		1		
			1	
				1
1	1	1	1	1
7				
	7			
				7
		7		
			7	
NSS—See No. 847-1 (Item 17)				
1	1	1	1	1
1	1	1	1	1
1	1	1	1	1
1	1	1	1	1
1	1	1	1	1
NSS—See No. 847-1 (Item 17)				
6	6	6	6	6
1	1	1	1	1
NSS—See No. 847-1 (Item 17)				
1	1	1	1	1
1	1	1	1	1
1	1	1	1	1
1	1	1	1	1
1	1	1	1	1
1	1	1	1	1
4	4	4	4	4

UB2-11	UC2-11	UE2-11	UK2-11	UM2-11
1	1	1	1	1
	1			
		1		
			1	
				1
1	1	1	1	1
1				
	1			
		1		
			1	
				1
1	1	1	1	1
7				
	7			
				7
		7		
			7	
NSS—See No. 847-2 (Item 17)				
1	1	1	1	1
1	1	1	1	1
1	1	1	1	1
1	1	1	1	1
1	1	1	1	1
NSS—See No. 847-2 (Item 17)				
6	6	6	6	6
1	1	1	1	1
NSS—See No. 847-2 (Item 17)				
1	1	1	1	1
1	1	1	1	1
1	1	1	1	1
1	1	1	1	1
1	1	1	1	1
1	1	1	1	1
4	4	4	4	4

WB2-01	WC2-01	WE2-01	WK2-01
1	1	1	1
	1		
		1	
			1
1	1	1	1
1			
	1		
		1	
			1
1	1	1	1
7			
	7		
		7	
			7
NSS—See 21118-1 (Item 17)			
1	1	1	1
1	1	1	1
1	1	1	1
1	1	1	1
1	1	1	1
NSS—See 21118-1 (Item 17)			
6	6	6	6
1	1	1	1
NSS—See 21118-1 (Item 17)			
1	1	1	1
1	1	1	1
1	1	1	1
1	1	1	1
1	1	1	1
1	1	1	1
4	4	4	4

WB2-11	WC2-11	WE2-11	WK2-11	ITEM NO.
1	1	1	1	1
	1			2
		1		
			1	
1	1	1	1	3
1				4
	1			
		1		
			1	
1	1	1	1	5
7				6
	7			
		7		
			7	
NSS—See 21118-2 (Item 17)				7
1	1	1	1	8
1	1	1	1	9
1	1	1	1	10
1	1	1	1	11
1	1	1	1	12
NSS—See 21118-2 (Item 17)				13
6	6	6	6	14
1	1	1	1	15
				16
NSS—See 21118-2 (Item 17)				
				17
1	1	1	1	
1	1	1	1	18
1	1	1	1	19
1	1	1	1	20
1	1	1	1	21
1	1	1	1	22
4	4	4	4	23
				24

NSS. Not Sold Separately

Trouble Shooting

STEERING WHEEL DOES NOT CENTER	Binding In linkage valve	Re-align
	Broken centering springs	Replace spring (see page 11)
NO RESPONSE WHEN STEERING WHEEL IS TURNED SLOWLY	Dirt in system	Drain, flush and refill with clean oil (see page 3)
	Oil level is low	Fill to proper level
SLOW OR HARD STEERING	Dirt In system	Drain, flush and refill
	Wear on sleeve and spool	Replace
	Wear on Orbit gear	Replace
	Oil level low	Fill to proper level
	Trouble in pump	Check and correct
	Trouble in actuator	Check and correct
	Trouble In lines or filter	Check and correct
WRONG RESPONSE TO STEERING WHEEL	Lines hooked up to wrong ports.	Reconnect
	Orbit gear misaligned	Realign (see page 14)
CONTINUOUS STEERING WHEEL ROTATION	Dirty fluid	Drain, flush and refill
	Broken centering springs	Replace (see page 11)
	Input linkage is binding	Re-align
	Burr on sleeve or spool	Repair (see page 9)
NO RESPONSE	Sleeve and spool locked	Disassemble, repair or replace
	Pump failure	Check and correct
	Hose or filter clogged	Check and correct
	Relief valve stuck	Drain flush and refill

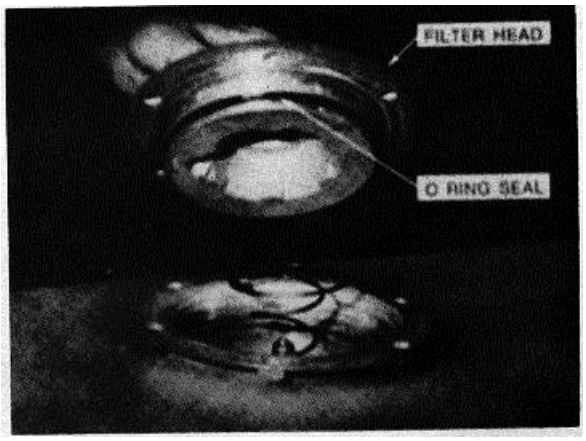
Form No. 7-204-16
Supersedes No. 7-201-64

STEERING PUMP

REMOVAL:

1. Park machine on level surface, lower blade and set parking brake.
2. Remove top bulkhead cover and rear floor plate.
3. Clean all dirt from around hydraulic tank filter head. Remove cap screws and lift off filter head to vent suction line.

Note: *Check valves are located in hydraulic tank return lines to prevent tank from draining. Filter head must be vented to prevent hydraulic oil from siphoning out.*

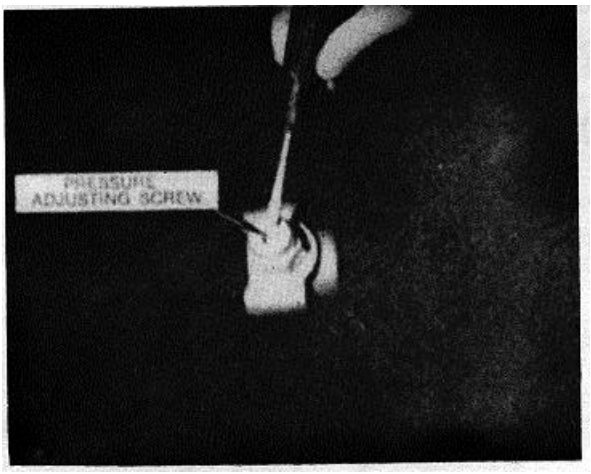


Venting Suction Line

4. Disconnect and cap hydraulic hoses at the pump.
5. Remove pump mounting bolts and remove pump assembly.

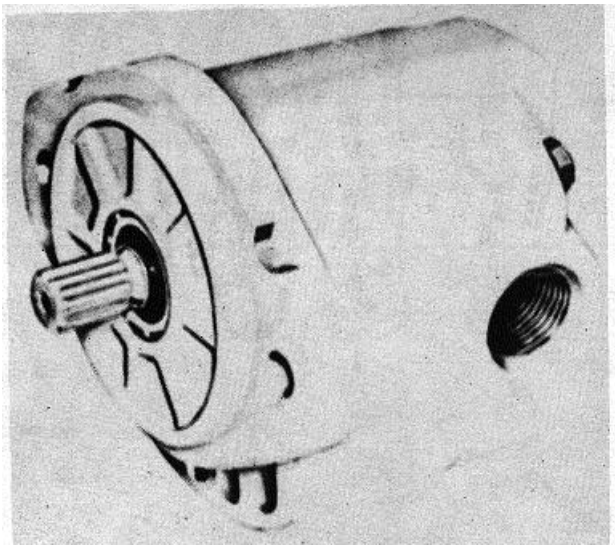
INSTALLATION:

1. Before installing steering pump, check condition of splines on drive gear.
2. Clean pump mounting surface and install new gasket on pump mounting face.
3. Install pump and mounting bolts (refer to TORQUE SPECIFICATIONS CHART).
4. Reconnect hydraulic hoses except pump inlet hose.
5. Fill hydraulic pump with clean hydraulic oil (refer to LUBRICANTS SPECIFICATION CHART) and connect inlet hose to pump.
6. Remove steering relief valve cap and back off adjusting screw.



Back Off Pressure Adjusting Screw

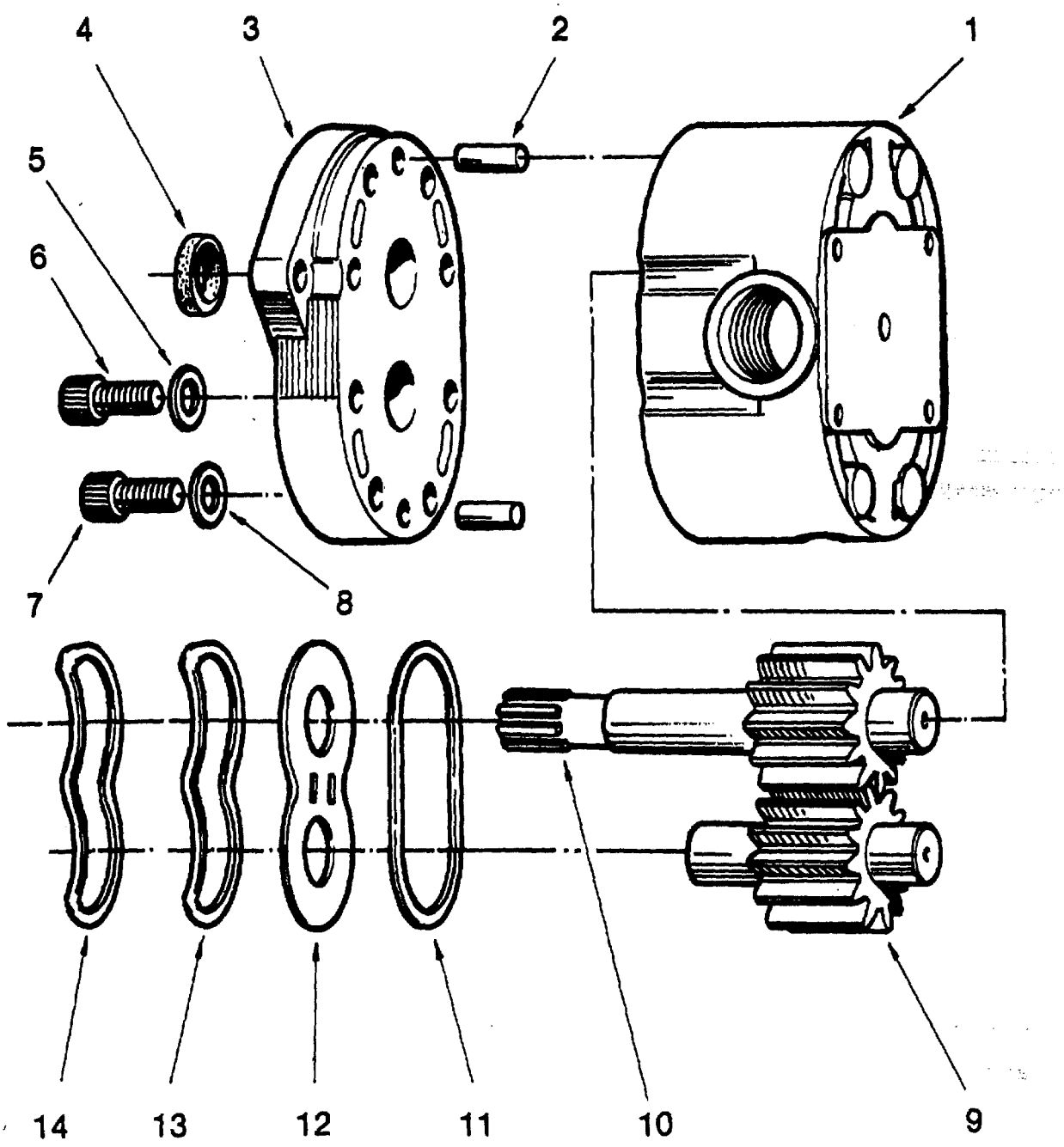
7. Refill hydraulic tank to proper level with clean hydraulic oil (refer to LUBRICANTS SPECIFICATION CHART).
8. Start engine and idle for three minutes. During this break in period, the steering pump should run free and not develop an excessive amount of heat.
9. After it has been determined that the pump is operating properly, the steering system pressure should be adjusted (refer to STEERING SYSTEM PRESSURE TESTING AND ADJUSTMENT).
10. Install top bulkhead cover and rear floor plate.



Steering Pump Assembly

STEERING PUMP:

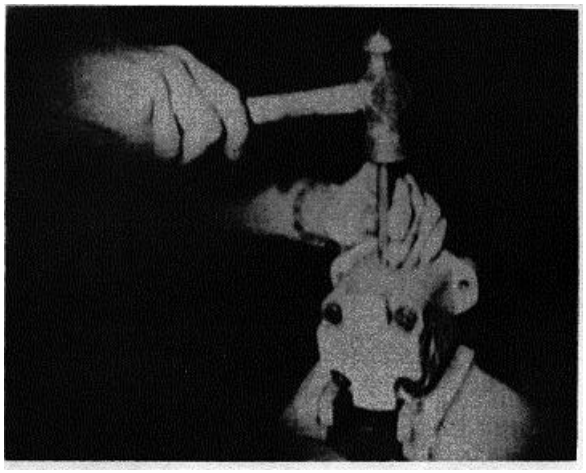
REF. NO.	DESCRIPTION	REF. NO.	DESCRIPTION
1	**Body**, Steering Pump	8	**Washer**
2	**Pin**, Dowel	9	**Gear**, Driven
3	**Cover**, Front	10	**Gear and Shaft**, Drive
4	**Seal**, Shaft	11	**Seal**, Body
5	**Washer**	12	**Plate**, Wear
6	**Screw**, Socket Head	13	**Seal**, Wear Plate
7	**Screw**, Socket Head	14	**Seal**, Rubber



Steering Pump Assembly

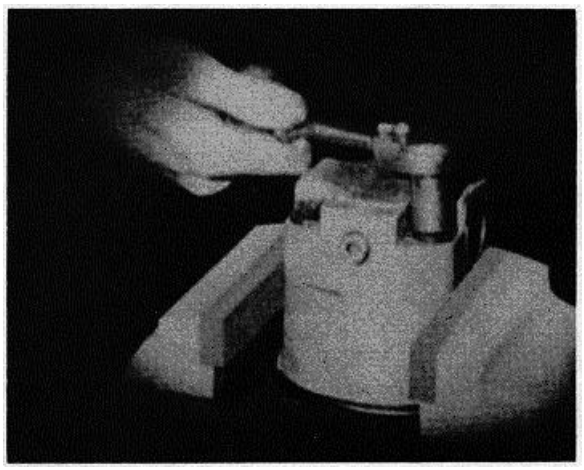
DISASSEMBLY:

The following instructions will cover the disassembly of the steering pump assembly after the unit has been - removed from the machine. Disassemble the pump In a clean, dust-free environment. Clean outside of pump with a good grade solvent and dry thoroughly.

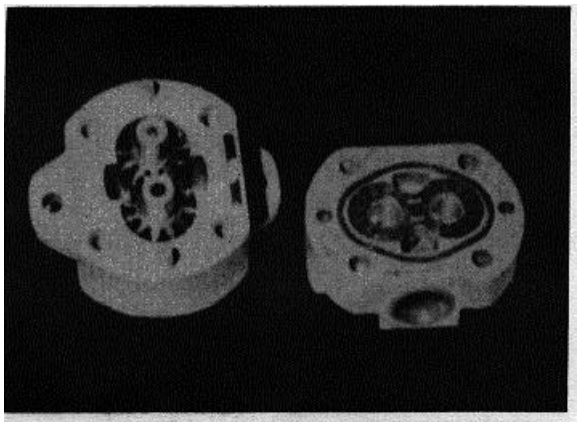


1. Center punch mark side port cover with pump body for proper alignment on assembly.
2. Secure pump body In a vise, loosen and remove side port cover mounting bolts.

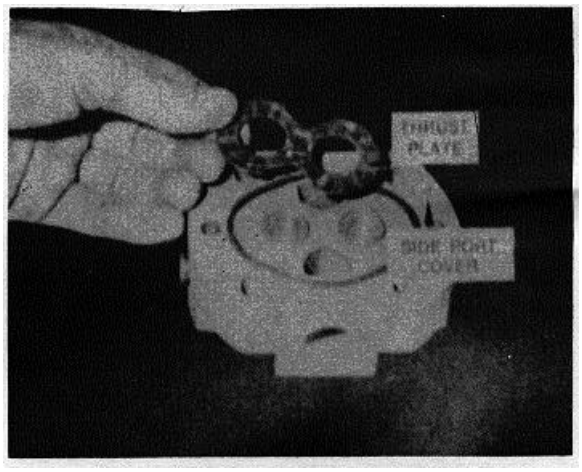
Note: *Be careful not to mar any machined surface. Remove all burrs.*



3. Remove the side port cover and inspect **f**or wear or scoring,

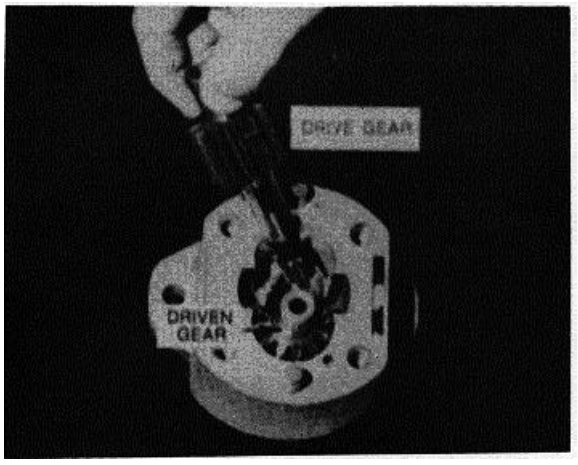


4. Remove the port cover thrust plate and check condition.



Thrust Plate Removal

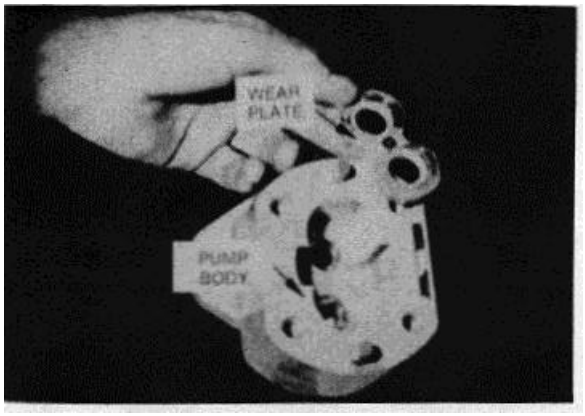
5. Remove drive and driven gear and inspect for excessive wear.



Drive and Driven Gear

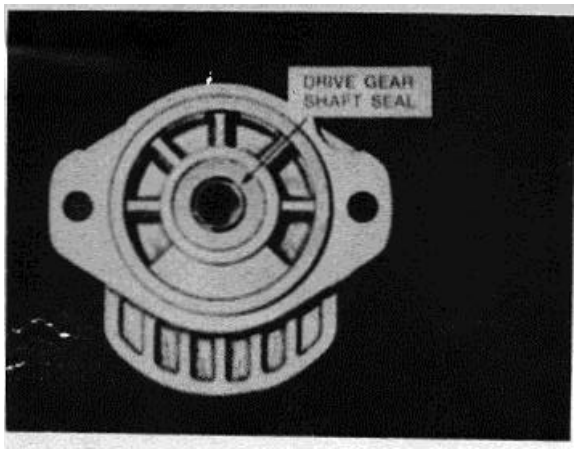
STEERING PUMP:

6. Remove body wear plate and check condition.

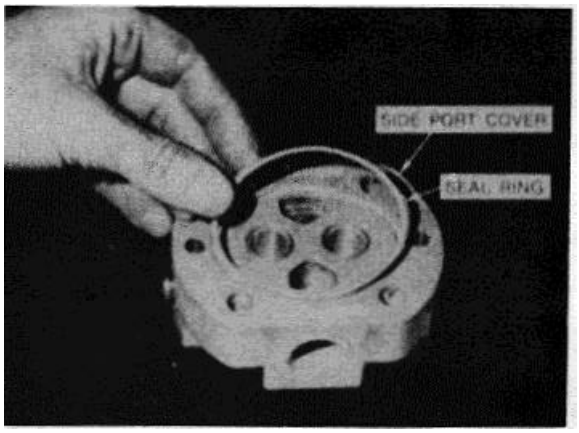


7. Inspect pump body for wear and scoring. If gear contact wear exceeds .005 inch (0,127 mm) on inlet side, replace body.

8. Install all new seals when overhauling pump. Lightly oil seals before installation. Install new seal in the body for the drive gear.

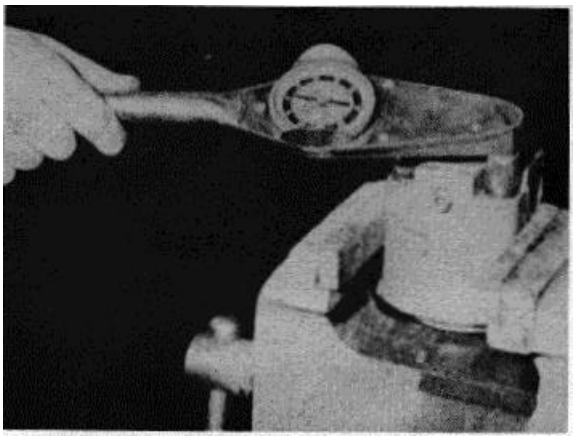


9. Install new seal rings on assembly.



Seal Ring Replacement

10. Reverse procedure for installation. Torque side port cover bolts evenly to 20 to 25 ft-lbs (2,8 to 3,5 m-kg).

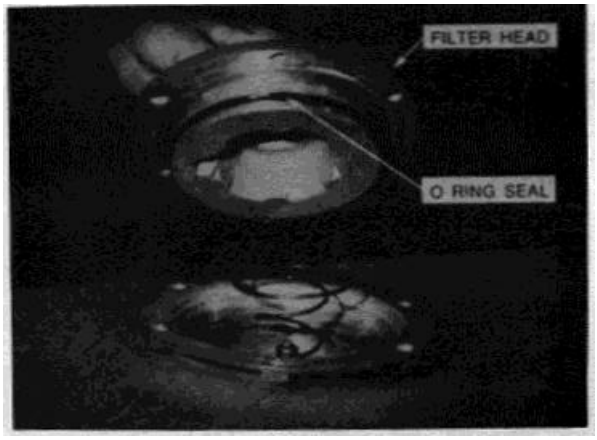


Torque Mounting Bolts

REMOVAL:

1. Park machine on level ground, set parking brake and lower blade or bucket.
2. Remove top bulkhead cover and rear floor plate.
3. Clean all dirt from around hydraulic tank filter head. Remove capscrews and lift off filler head to vent suction line.

Note: *Check valves are located in hydraulic tank return lines to prevent tank from draining. Filter head must be vented to prevent hydraulic oil from siphoning out.*

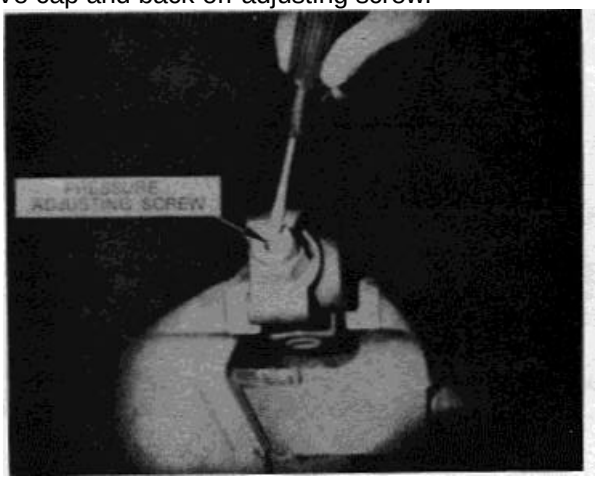


Venting Suction Line

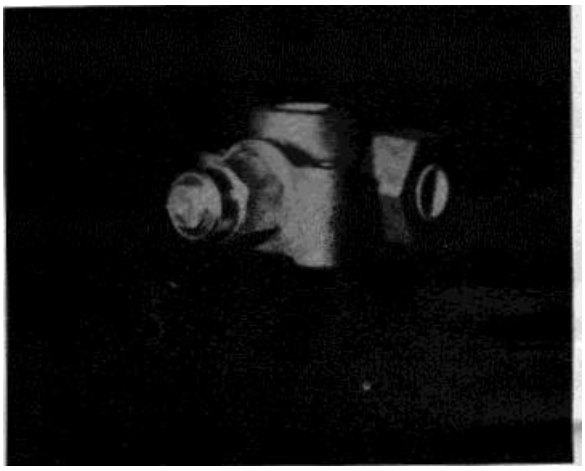
4. Disconnect and cap hydraulic hoses at the steering relief valve.
5. Remove valve mounting bolts and remove valve assembly.

INSTALLATION:

1. Before installing steering relief valve, remove valve cap and back off adjusting screw.



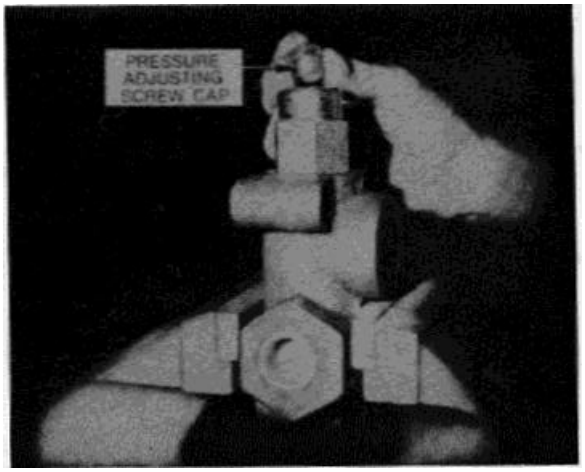
2. Install valve and mounting bolts (refer to TORQUE SPECIFICATIONS CHART).
3. Reconnect hydraulic hoses and fill hydraulic tank with clean hydraulic fluid (refer to LUBRICANTS SPECIFICATION CHART).
4. Test and adjust the steering. System pressure (refer to STEERING SYSTEM PRESSURE TEST).
5. Install top bulkhead cover and rear floor plate.

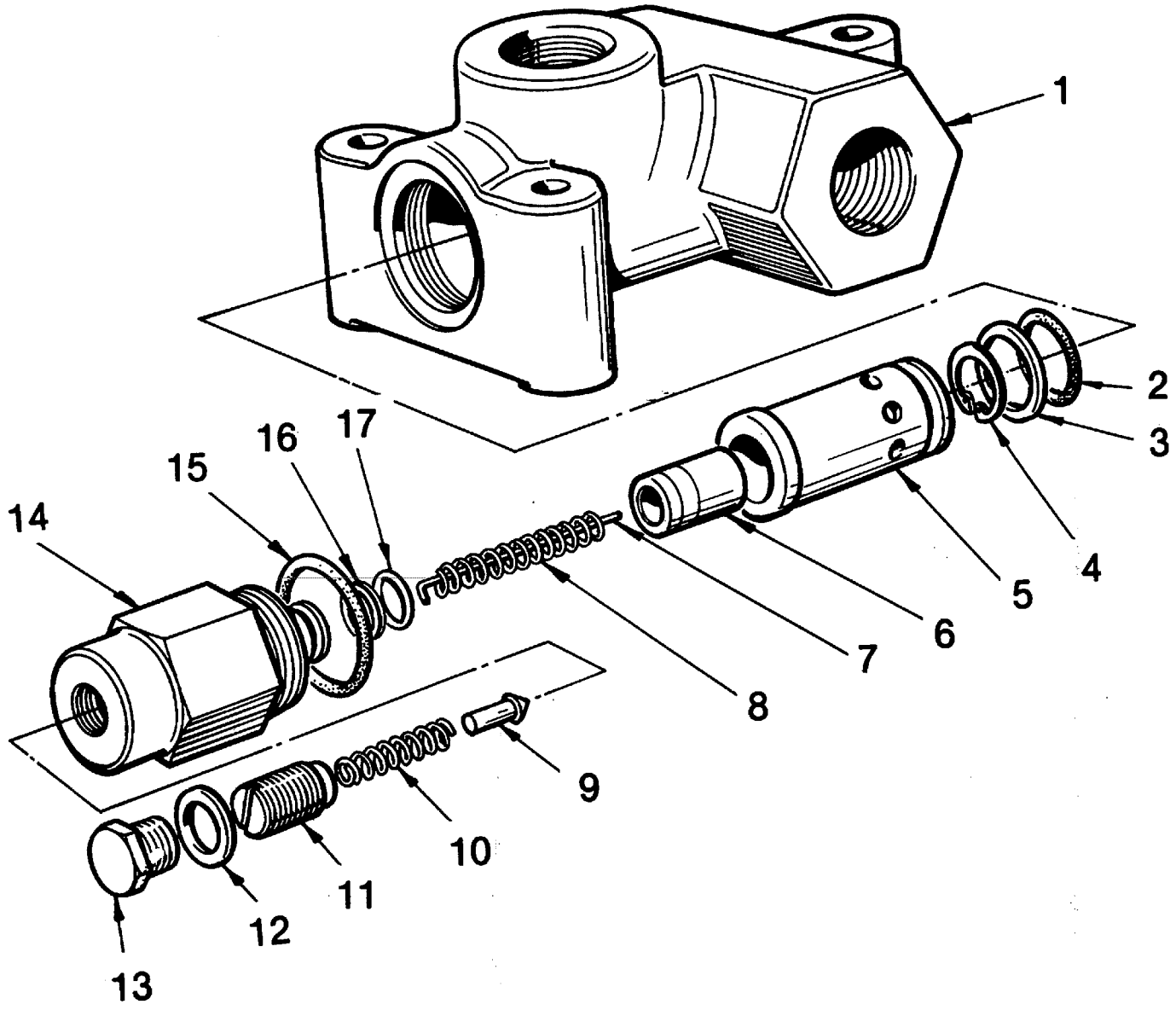


Steering Relief Valve

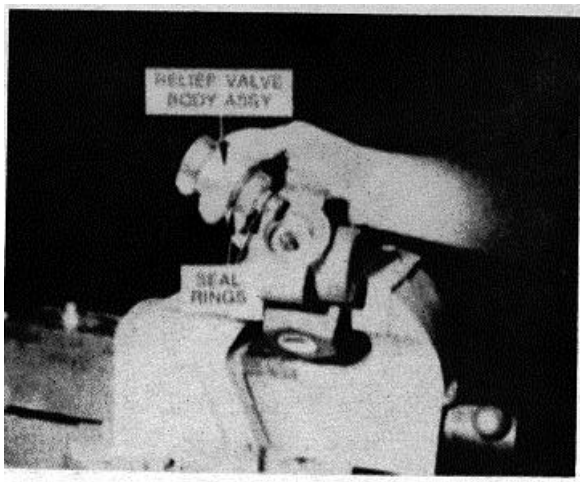
DISASSEMBLY AND ASSEMBLY:

1. With valve secured in a vise, remove cap, adjusting screw, pilot spring and poppet.

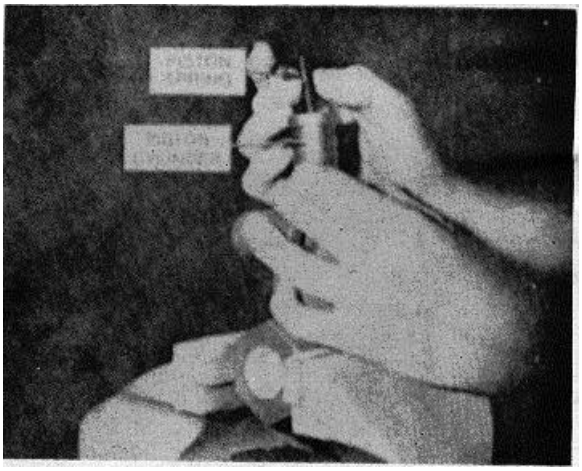


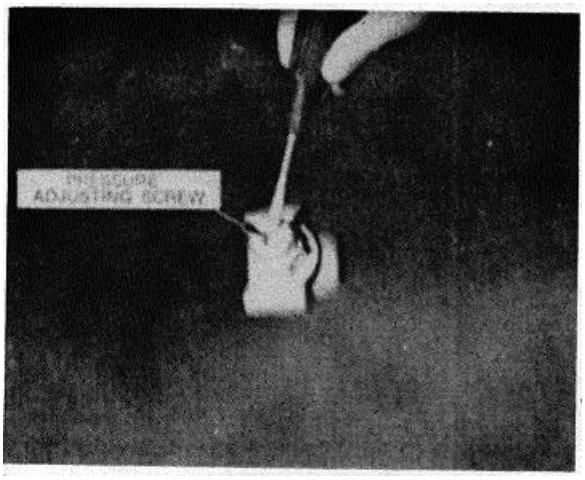

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REF. NO.	DESCRIPTION	REF. NO.	DESCRIPTION
1	Housing, Relief Valve	10	Spring, Pilot
2	Seal, Relief Body	11	Screw, Adjusting
3	Washer, Back Up	12	Gasket, Cap
4	Ring, Retaining	13	Cap
5	Cylinder	14	Body, Relief
6	Piston	15	Seal, Relief Body
7	Pin, Wire	16	Washer, Back Up
8	Spring, Piston	17	Seal, Body
9	Poppet		



2. Remove body and inspect seal rings.
3. Remove piston spring and piston and cylinder assembly.
4. Check condition of all valves and seats and inspect for signs of wear.
5. Reverse procedure for installation. Replace seal rings on assembly.
6. After valve is assembled, back pressure adjusting screw off to prevent excessive system pressures when valve is replaced on the machine.





MAINTENANCE:

REMOVE DEBRIS FROM AROUND DOZER CYLINDER daily to avoid damage to cylinder rod.

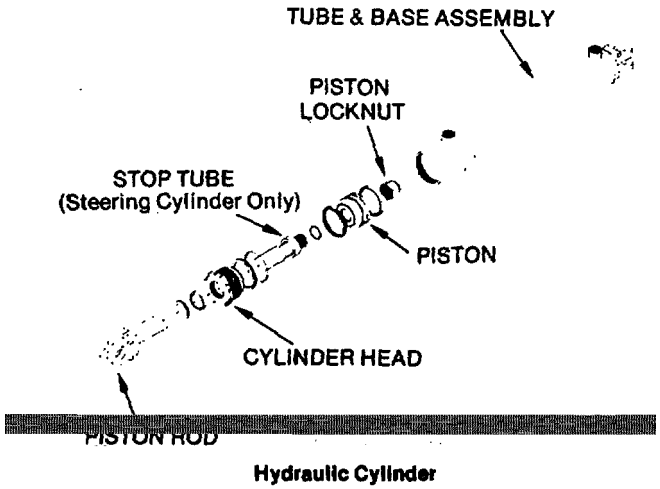
CHECK CYLINDERS FOR LEAKAGE every 100 hours. Excessive leakage may require seal replacement.

STEERING CYLINDER REMOVAL:

1. Park machine on level ground, set parking brake and lower blade.
2. Secure steering wheel so that valve cannot be opened, as this would result in loss of hydraulic fluid.
3. Remove front and rear floor plates. Remove engine side guards.
4. Disconnect all steering hoses at the cylinder and cap.
5. After removing cotter pin, remove steering cylinder clevis pins.
6. Remove cylinders from machine.
7. Reverse procedure for installation.

DOZER CYLINDER REMOVAL:

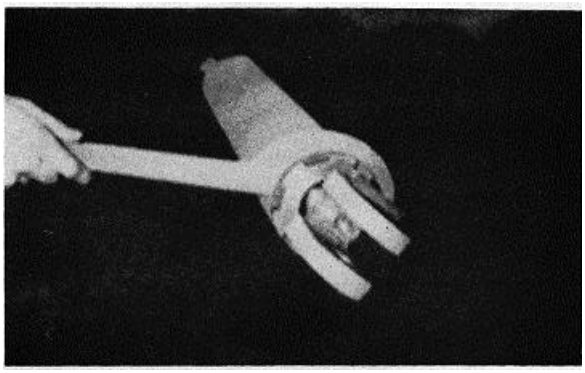
1. Park machine on level ground, set parking brake and lower blade.
2. After removing cotter pin, remove lower cylinder clevis pin.
3. Retract dozer cylinder shaft.
4. Secure dozer control lever in HOLD position so that valve cannot be opened, as this would result in loss of hydraulic fluid.
5. Disconnect and cap dozer cylinder hoses.
6. Sling cylinder and remove upper cylinder cotter and clevis pin.
7. Reverse procedure for installation.



Hydraulic Cylinder

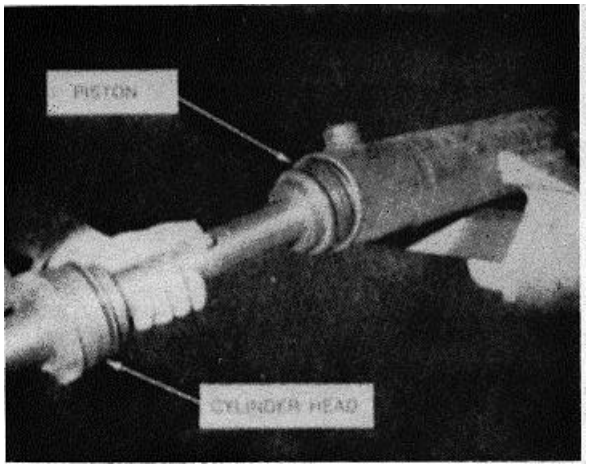
SEAL REPLACEMENT:

1. After removing cylinder from machine, drain oil and secure on bench.
2. Using proper wrench, loosen head of cylinder.

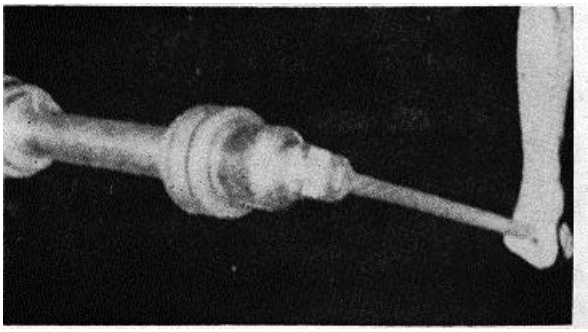


Removing Cylinder Head

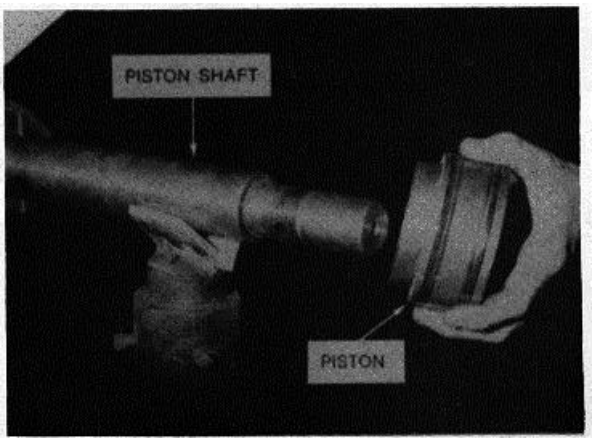
3. Remove piston and piston shaft from cylinder tube.



4. Inspect cylinder tube, shaft and head for scoring or pitting.
5. Remove nut on end of piston shaft and remove piston from piston shaft.

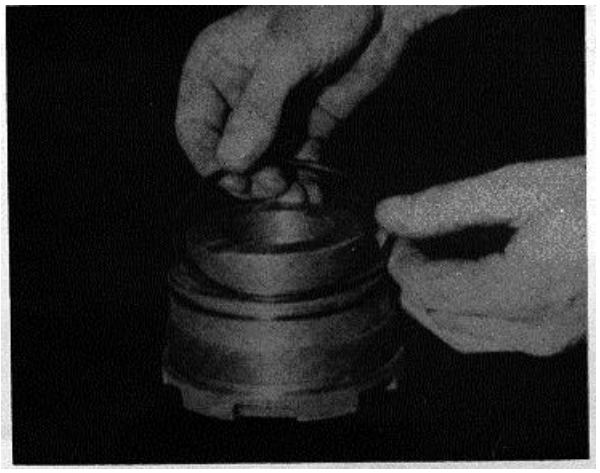


Removing Piston Shaft End Nut



Piston and Piston Shaft

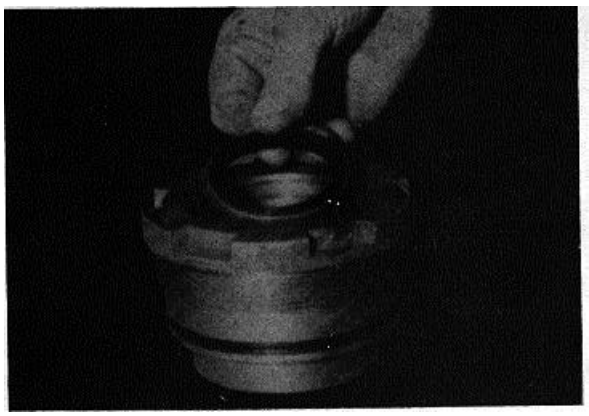
6. Remove all packings, seals and 0 rings.



7. Clean all seal and packing grooves and wash all parts in clean solvent.

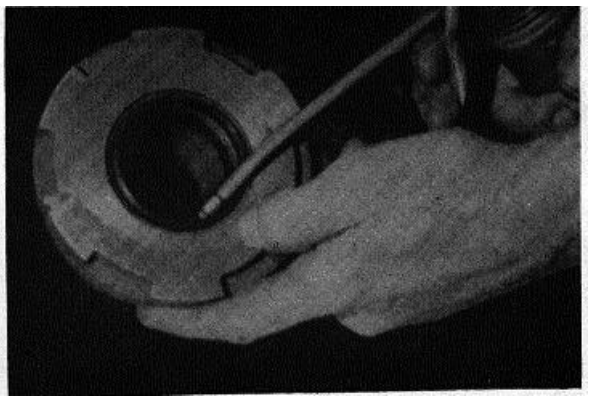
8. Replace all seals and packing from available seal kit.

Note: For easy seal replacement, place all seals and packing in warm water to eliminate excessive stretching.



Cylinder Head Seals

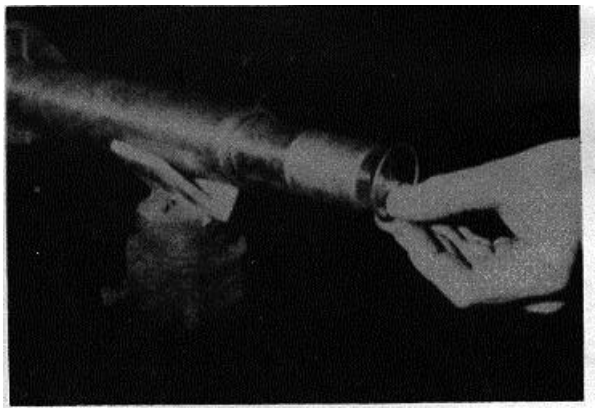
9. Oil new seals, packing and cylinder tube liberally before installing-piston into tube.



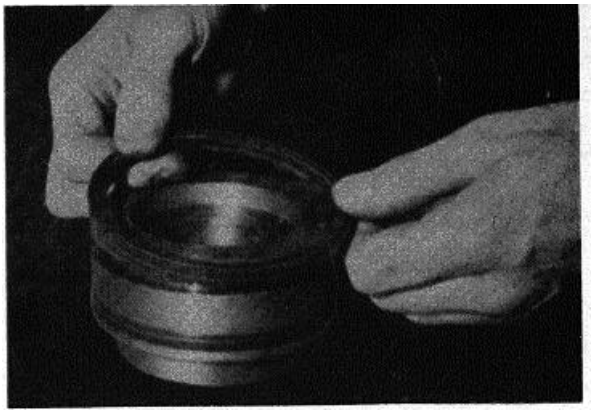
10. Install cylinder head and piston on piston shaft and torque to 700 ft-lbs (97 m-kg).

Caution: Care must be taken when installing piston in cylinder tube, that piston packings are not damaged.

11. Tighten cylinder head securely and cap the cylinder parts. Cylinder may now be reinstalled on machine.



Piston Shaft Seal



Piston Seals

MAINTENANCE:

CHECK HYDRAULIC TANK LEVEL dally with machine level, blade lowered and engine off. The level gauge is mounted on the forward surface of the hydraulic tank on the operator's left. Refill as necessary, adding proper fluid (refer to LUBRICANTS SPECIFICATION CHART).



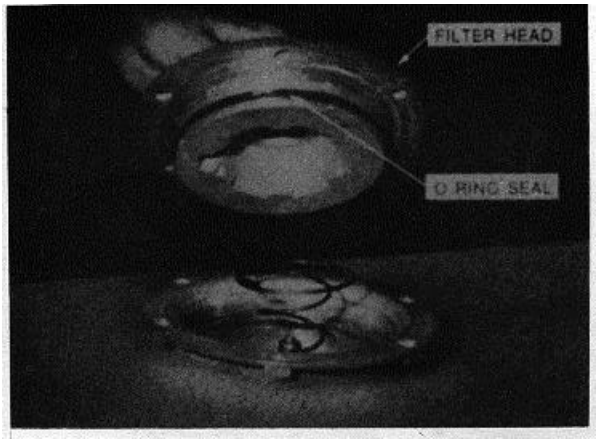
Hydraulic Oil Level Gauge

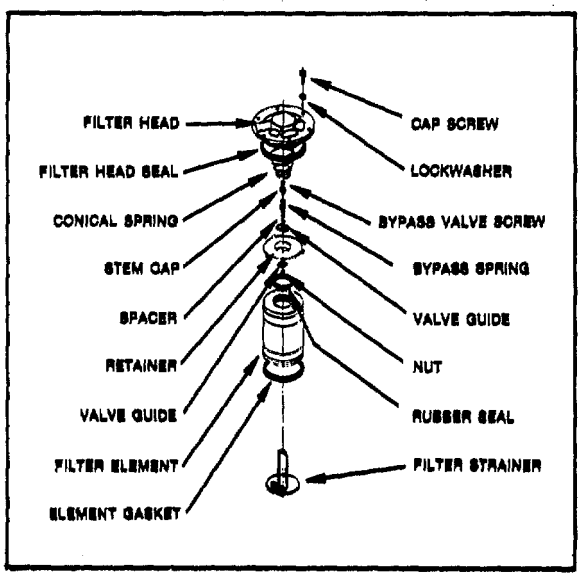
CHANGE HYDRAULIC FILTER every 200 hours.

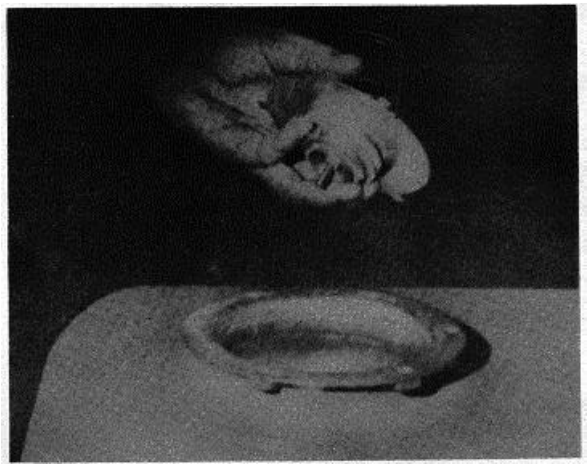
1. Clean all dirt *from* around filter head, remove capscrews and lift off head.

Caution: ***Care must be taken to replace all parts in proper sequence.***

2. Remove coil spring and filter by-pass valve assembly.

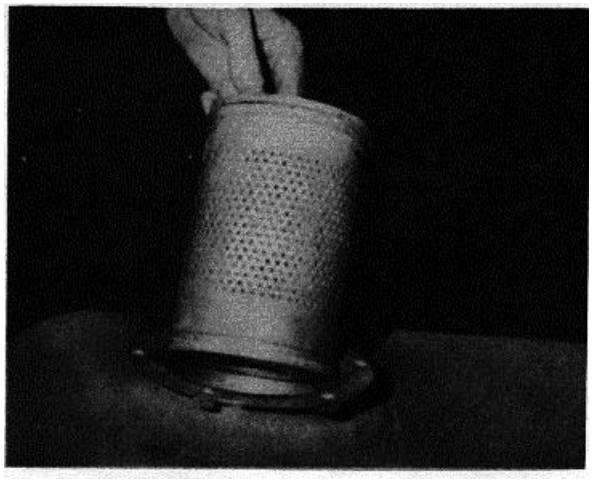




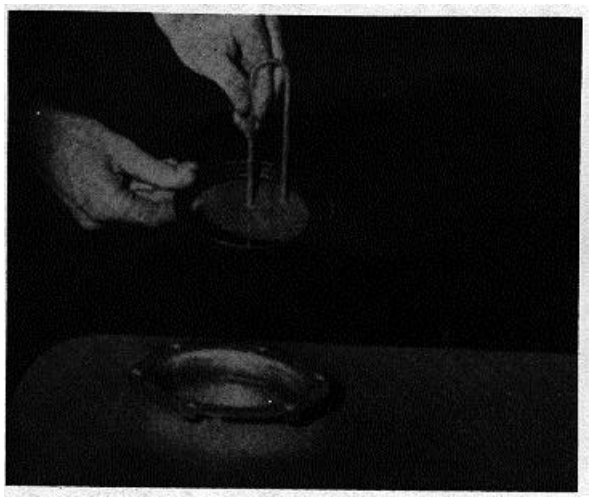


Removing By Pass Valve Assembly

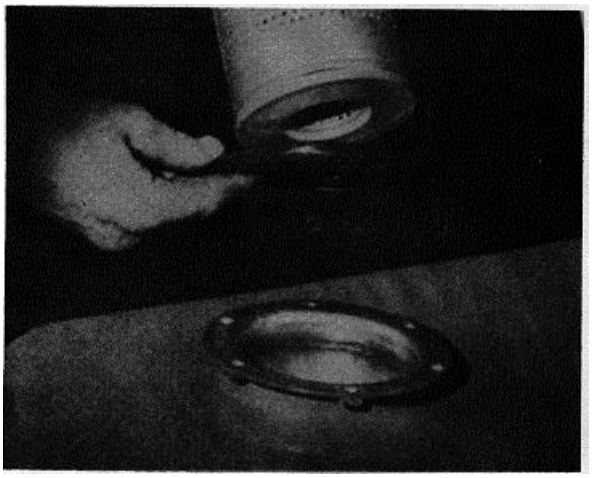
3. Remove filter element and check for foreign material.



4. Remove filter strainer. Wash all parts in clean solvent and dry with lint-free cloth.

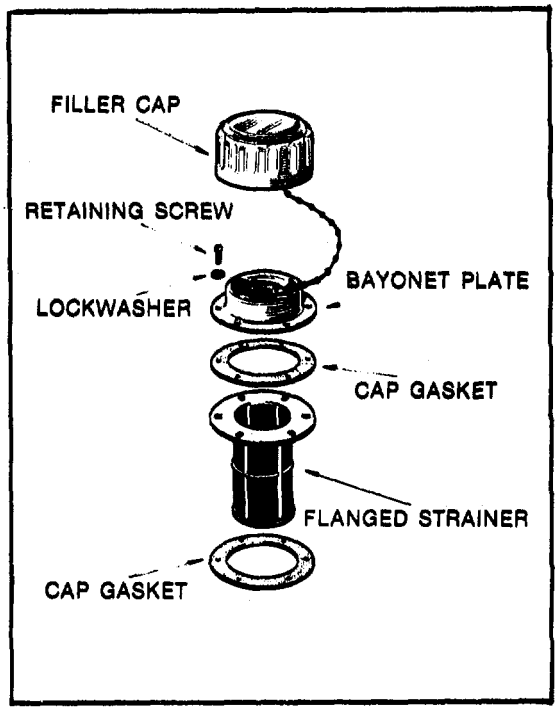


5. Install strainer, new filter element and O-rings.
6. Install by-pass valve assembly and replace O ring on filter head.
7. Place coil spring on filter head with large coil against the head.
8. Carefully place filter head and spring In housing. Care should be taken that spring Is sitting properly on by-pass valve.
9. Install capscrews In filter head and torque to 20 ft-lbs (2,8 m-kg).



Installing Filter Element

CLEAN FILLER-BREATHER CAP STRAINER every 200 hours with hydraulic filter change. Remove filler cap and mounting bolts securing filler flange. Remove strainer and wash in clean solvent. Blow dry and replace.



Hydraulic Oil Filler Cap

HYDRAULIC TANK:

DRAIN AND CLEAN hydraulic tank every 400 hours.

1. Park machine on level ground, set parking brake and. lower blade.

2. Drain hydraulic oil into a 50 Imp. Gallon (60 US gal/220 liter) container.

3. Remove hydraulic tank clean-out cover located low on engine side of tank.



4. Clean out all foreign matter and flush with clean hydraulic fluid.

5. Replace clean-out cover using new gasket.

6. Change hydraulic filter element and clean filler breather cap.

7. Refill tank with clean hydraulic fluid (refer to LUBRICANTS SPECIFICATION CHART).

HYDRAULIC TANK REMOVAL:

1. Park machine on level ground, lower blade, and place dozer control lever in HOLD position. Block machine.

2. Drain hydraulic tank.

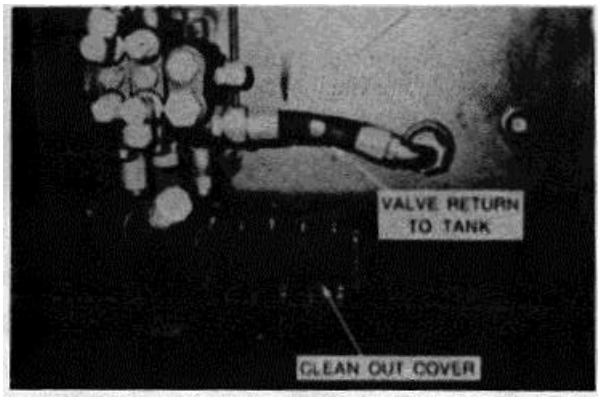
3. Remove air cleaner hood and cap air inlet tube.

4. Remove hood, rear floor plate and bulkhead plate.

5. Disconnect parking brake cable at lever end.

7. Disconnect transmission control cables at the levers.

8. Disconnect all hoses from the control valve, except the return line to tank.



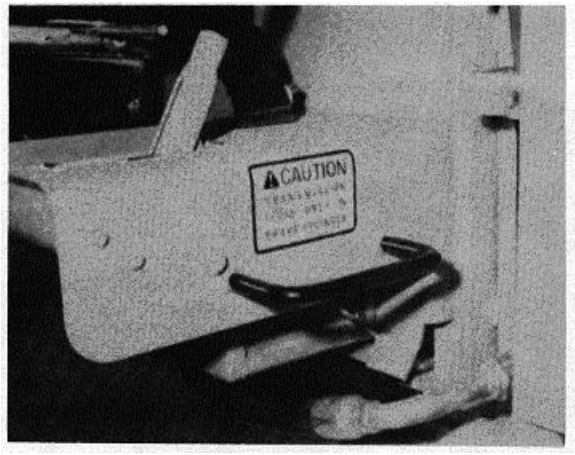
9. Disconnect suction line from bottom of tank.

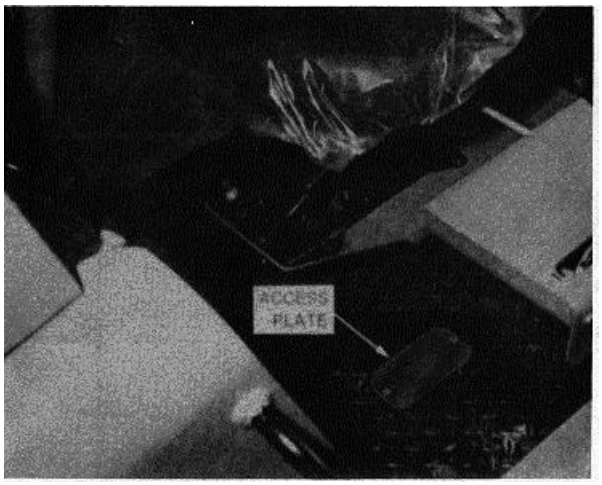
10. Remove hydraulic tank mounting bolts and lift off tank, complete with control valve.

11. Reverse procedure for installation. Refill the tank with clean hydraulic oil (refer to LUBRICANTS SPECIFICATION CHART).

MAINTENANCE:
CHECK MASTER BRAKE CYLINDER FLUID LEVEL every 50 hours by removing cover on rear floor plate.

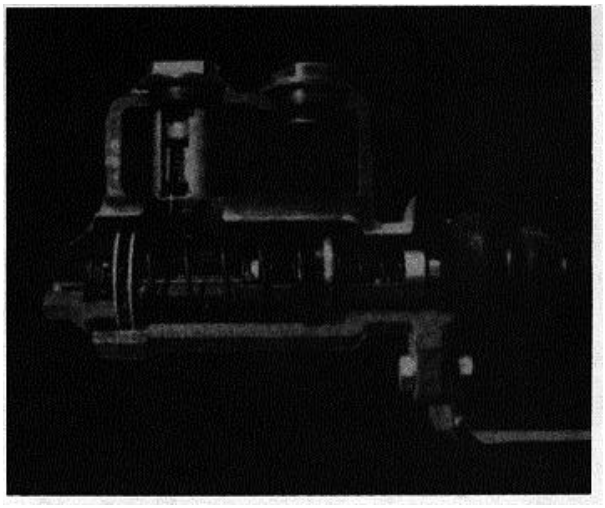
Note: *Use transmission fluid only [refer to LUBRICANTS SPECIFICATION CHART].*





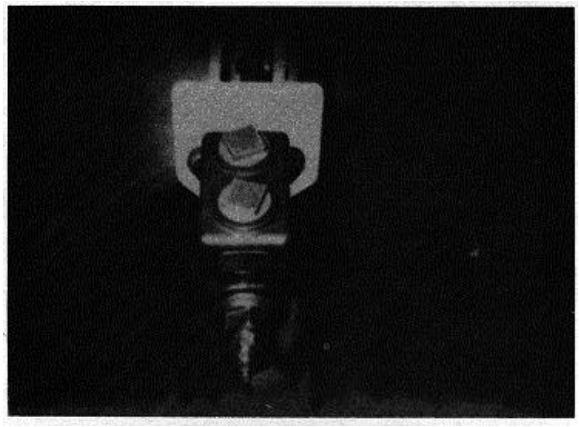
Master Brake Cylinder Access

ADJUSTMENT can be made on the brake control lever by adjusting the clevis and clevis lock nut.

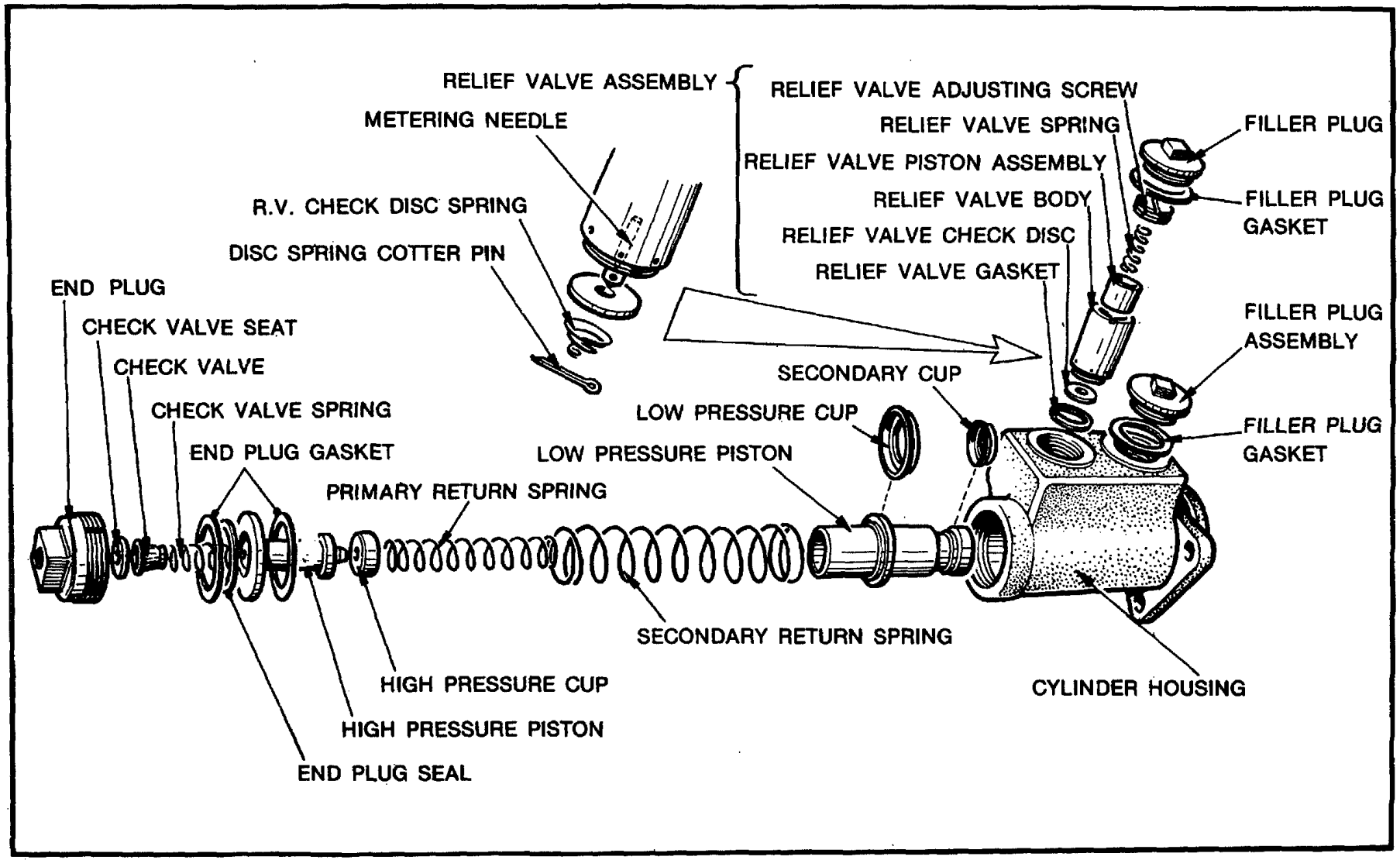


MASTER BRAKE CYLINDER REMOVAL:

1. Park machine on level surface, set parking brake and lower blade.
2. Remove rear floor plate.
3. Disconnect and cap transmission brake hose at the master cylinder.
4. Disconnect brake pedal pushrod.
5. Remove master cylinder mounting bolts and master brake cylinder.
6. Reverse procedure for installation.

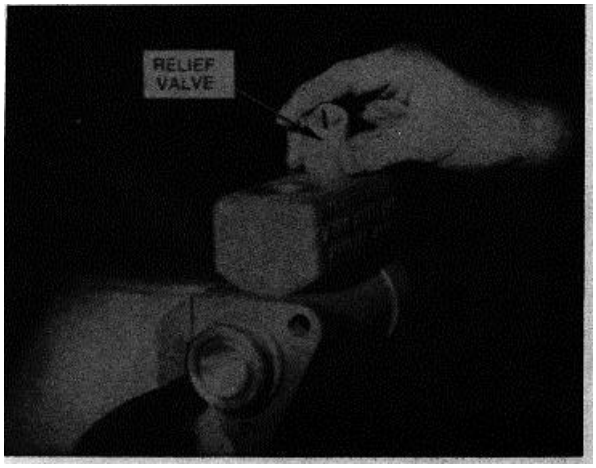


Master Brake Cylinder Mounting



Master Brake Cylinder Assembly

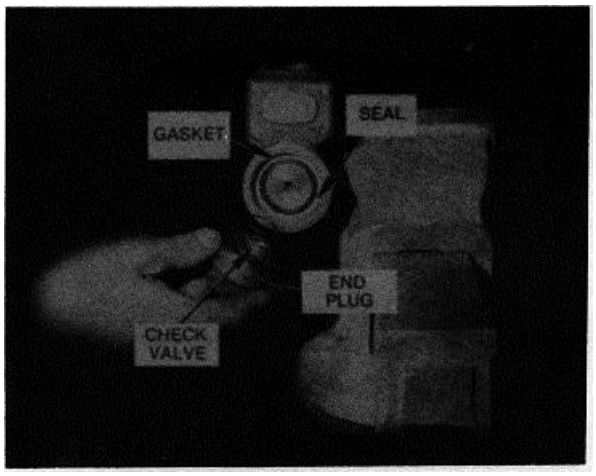
Rev. 760501



Relief Valve Removal

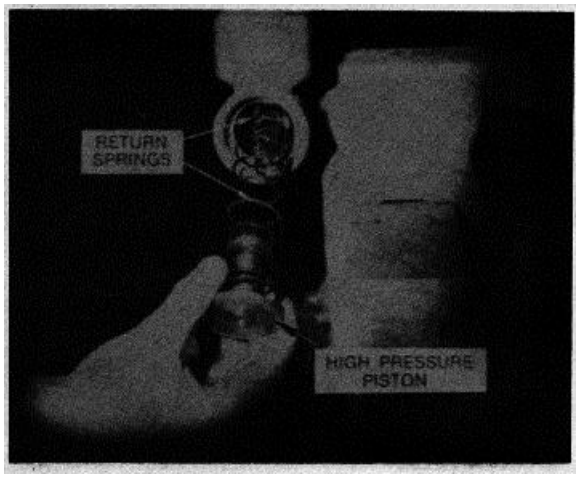
DISASSEMBLY:

1. Place master cylinder in a vise in horizontal position.
2. Remove the cover plug, then remove the relief valve by turning it counter-clockwise. The valve cylinder is slotted on the top edge to fit a wide screwdriver.

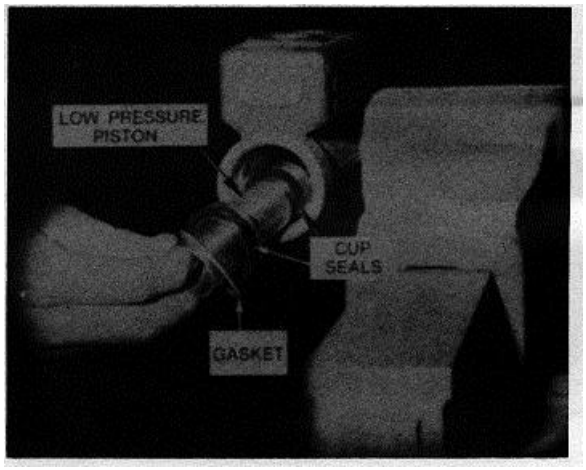


End Plug Removal

3. Remove the end plug. This nut is under spring pressure. The high pressure piston, end plug gasket and check valve assembly should "pop" out on the release of the end plug.
4. The low pressure piston may be removed by pushing the piston through the cylinder from the pushrod end.



High Pressure Piston Removal



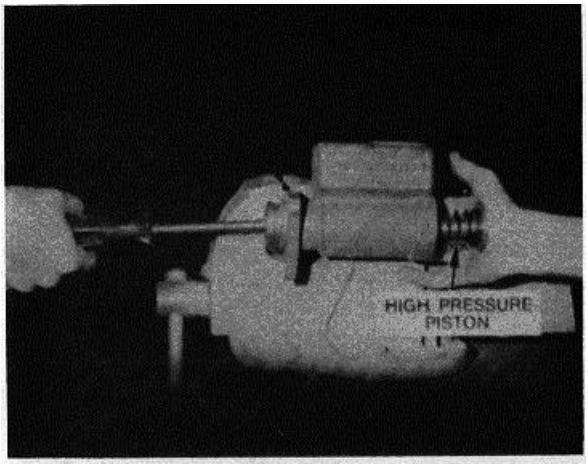
Low Pressure Piston Removal

ASSEMBLY:

1. Place the cylinder in horizontal position in a vise.

Note: *To prevent damaging the cups, be sure to lubricate the high pressure, low pressure and secondary cups with transmission fluid [refer to LUBRICANTS SPECIFICATION CHART.*

2. Replace the low pressure piston.
3. Replace first the small and then the large return springs.
4. Insert the inside end plug gasket.
5. In order to properly assemble the unit, it is essential to push the low pressure piston forward about 11/2 inches (4 cm) from the pushrod end with a rod or screwdriver and to hold the piston in this position until the high pressure piston has been installed.

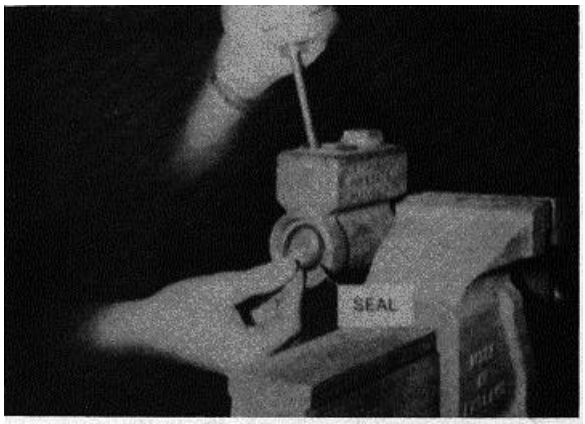


High Pressure Piston Installation

6. While holding the low pressure piston in position, enter high pressure cup into the low pressure piston. At this time, force the piston into the cylinder so that the base of the high pressure piston seals on the inside gasket. This operation will have to be performed under spring pressure because it is necessary to hold the low pressure piston forward in order to ensure proper entry of the cup.

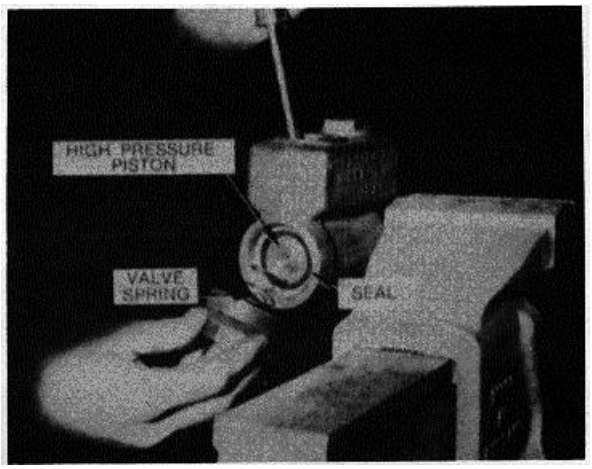
7. Release the pressure of the screwdriver or rod against the pushrod end and at the same time apply enough pressure against the base of the high pressure piston so as to prevent the high pressure cup from coming out of the high pressure cylinder.

8. Insert a rod or screwdriver into the relief valve opening and pry it sideways against the high pressure piston with enough force to prevent the assembled parts from moving out of position.



9. While holding the parts in position with the rod or screwdriver, replace the outside gasket and rubber seal. Place the retarding valve assembly into the end nut and screw the end nut tightly into the master brake cylinder.

Note: ***It is very important that the end nut be drawn in tightly.***



End Plug Installation

PRESSURE BLEEDING INSTRUCTIONS:

1. Pressure bleeding is performed when master brake cylinder is mounted on machine and fully connected. There must be at least 1/32 inch (1 mm) play between power cylinder piston and pushrod.

2. Fill reservoir with proper transmission fluid (refer to LUBRICANTS SPECIFICATION CHART).

3. Check that all fittings are tight to avoid leakage.

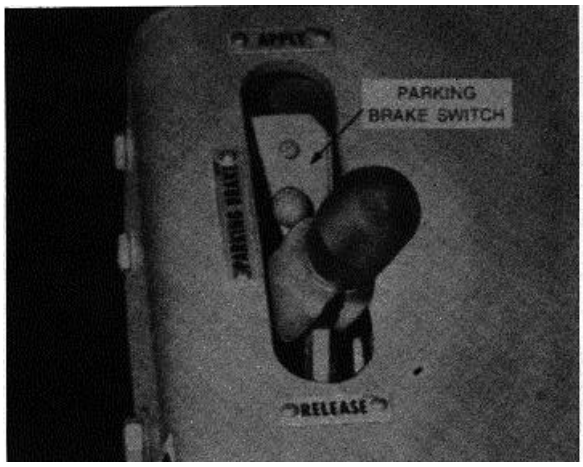
4. Open bleeder screw on transmission brake, depress brake pedal and hold'.

5. Tighten bleeder screw and release pedal. Repeat until all air is removed.

6. Recheck brake cylinder fluid level.

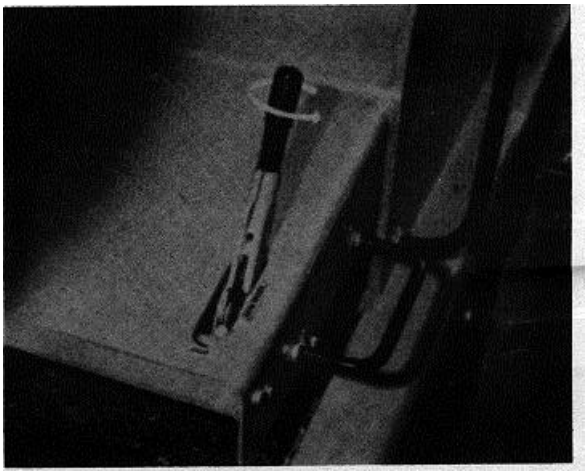
PARKING BRAKE

When the parking brake is engaged, the fuel solenoid shut off is activated. The engine will turn over but will not start.

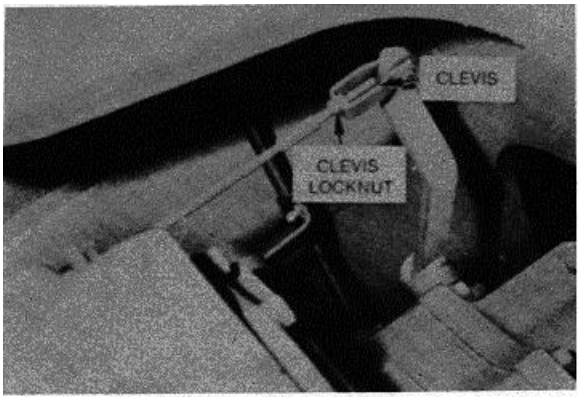


MAINTENANCE:

ADJUST PARKING BRAKE LEVER every 200 hours or as required by rotating lever handle or by adjusting parking brake cable. With the lever in the released position, minor adjustment of slack can be made by turning acorn on end of handle clockwise as shown. Further adjustment if required, can be made at the cable clevis.



Parking Brake Adjustment



Parking Brake Cable

STEERING COLUMN REMOVAL

1. Park machine on level ground and lower blade to ground level.

2. Remove horn wire contact plate on lower end of column. Remove horn button and base plate assembly.

3. Loosen steering wheel nut until It Is flush with top of steering shaft.

4. Install steering wheel puller to loosen wheel from shaft splines.

5. Remove puller, shaft nut and lift off wheel.

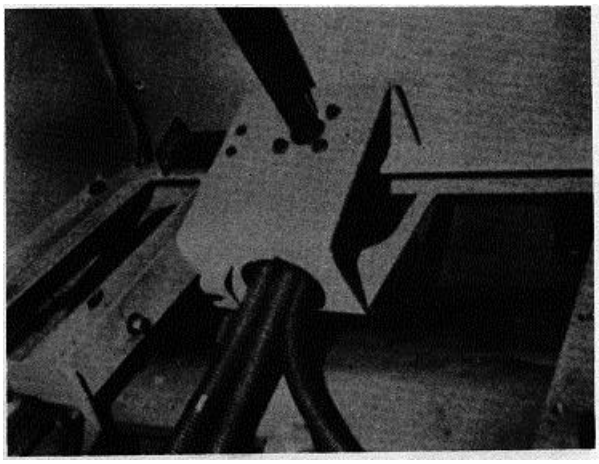
6. Remove steering column mounting bolts and move orbitrol valve to one side.

7. Remove the snap ring from the column jacket. The shaft and bearing assembly can now be removed from jacket by pushing on the lower end of the shaft.

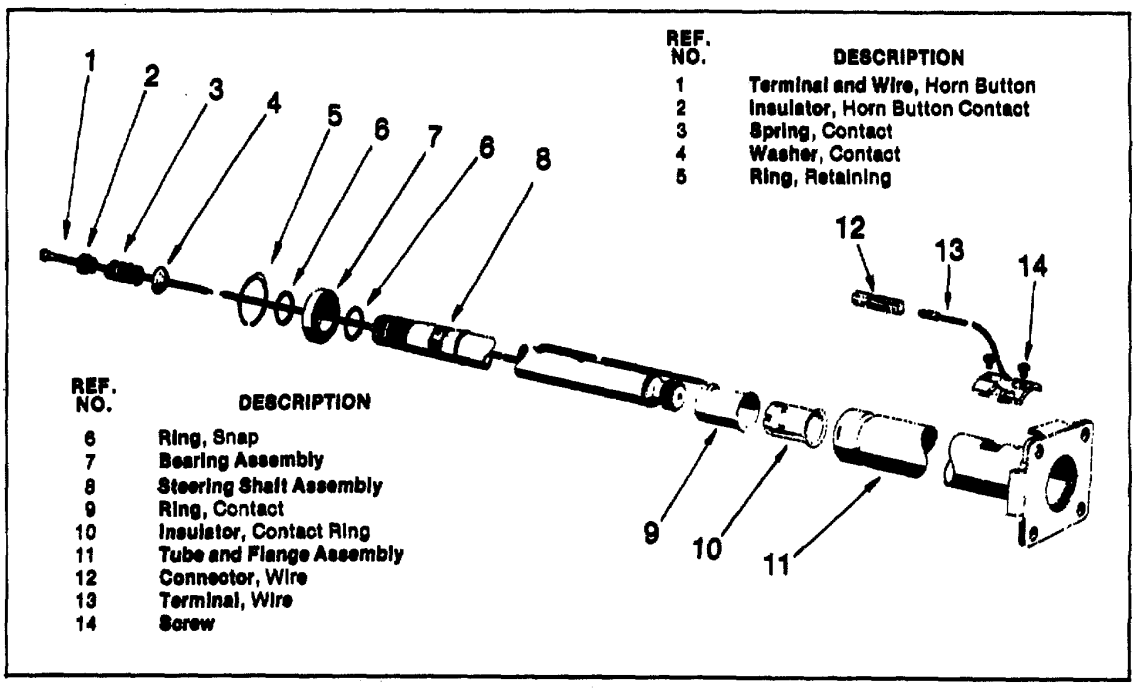
Note: *Do not use a hammer to pound the shaft free.*

8. When the shaft has been removed, the bearing and' second retaining ring can be removed. Clean all parts, replacing any that have been damaged.

9. Reverse procedure for Installation.

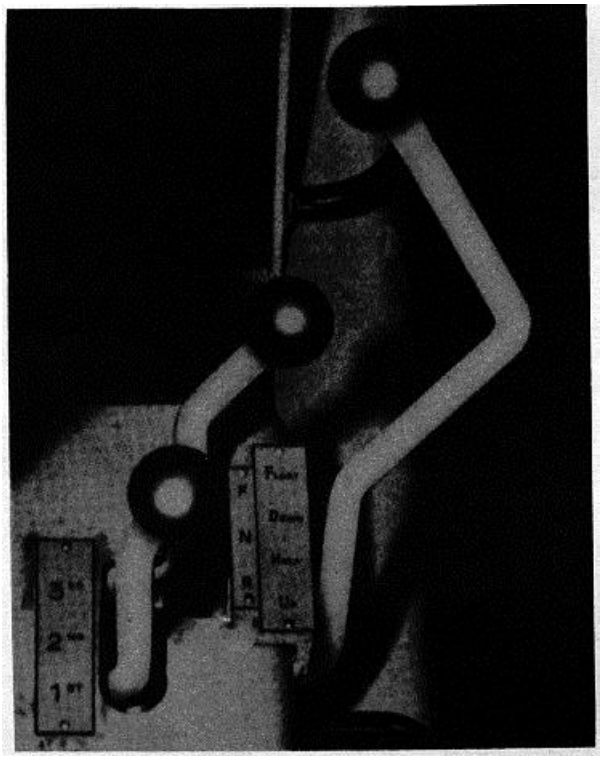


Steering Valve and Column Mounting



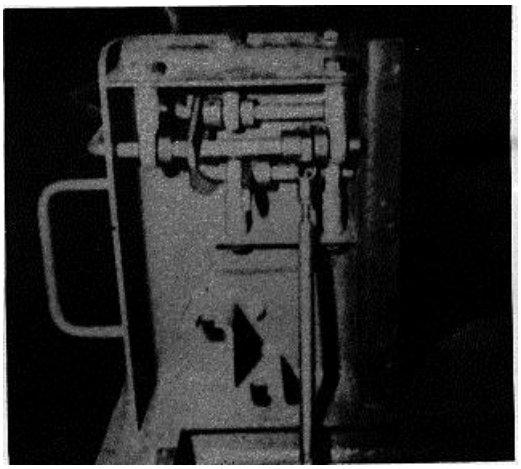
Steering Column Assembly

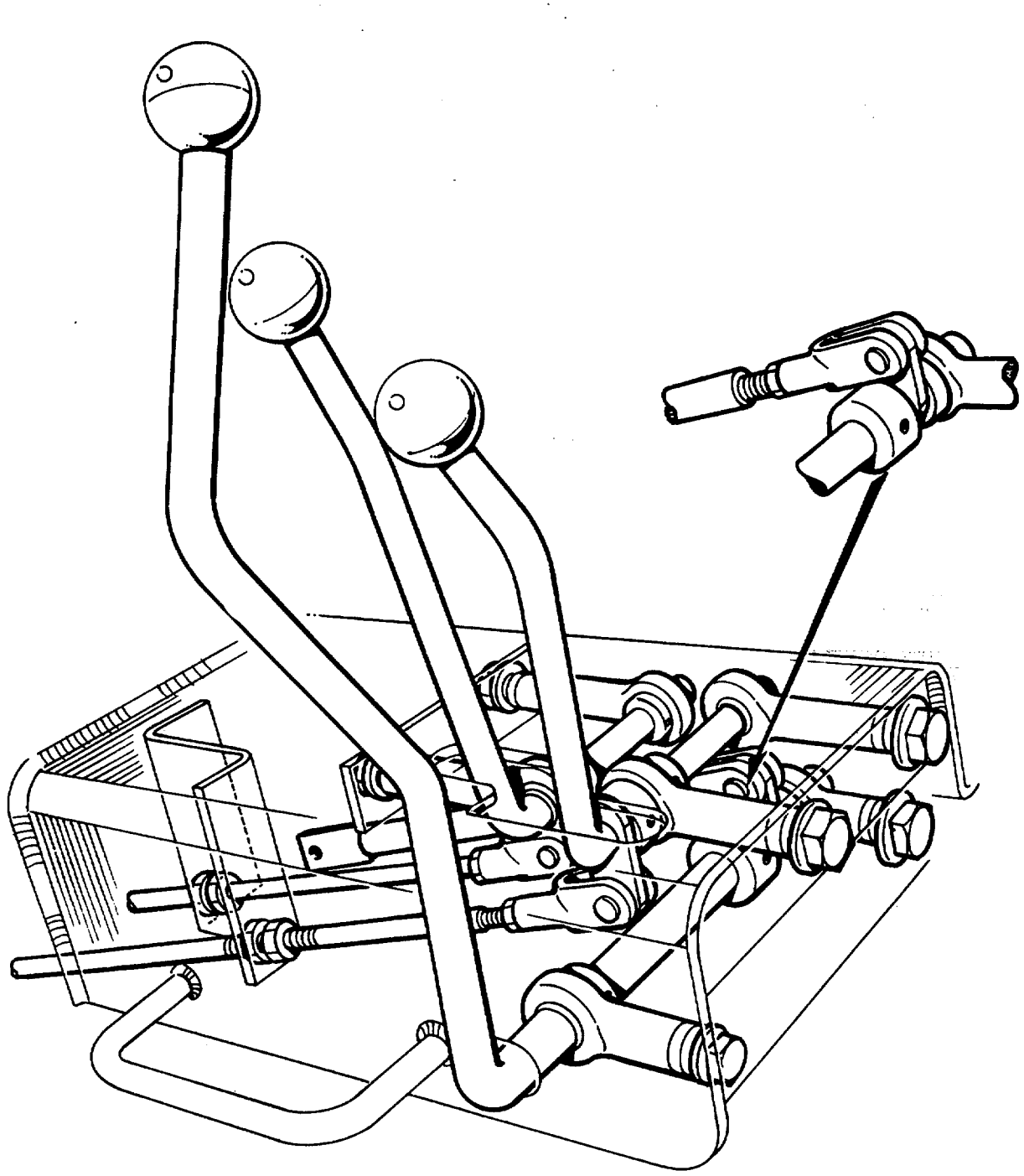
CONTROL LEVERS



MAINTENANCE:

CHECK AND ADJUST ALL CONTROL LEVERS, LINKAGES AND CABLES every 400 hours or as required. inspect and lubricate all mechanical controls to make sure they are In good operating condition. Adjustment can be made at the cable clevises.

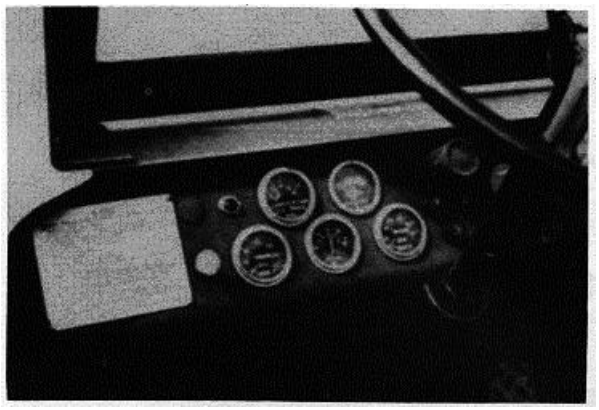




ELECTRICAL

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Electrical Maintenance..... 80-1.2
Console Wiring..... 80-1.4
Engine Wiring..... 80-1.6
Wiring Schematic 80-1.8



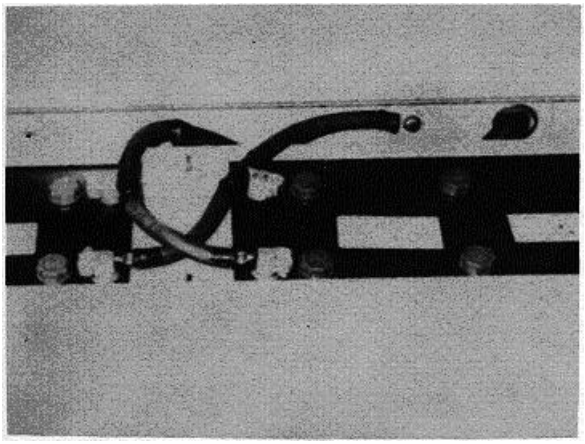
Control Console

To adjust hydrometer readings for temperature differences, subtract .004 (4 gravity points) from the specific gravity reading for every 10°F(5.5°C) the electrolyte temperature is below 80°F (27°C). The corrected reading is most important during cold weather. Test each cell in the same manner. If there is more than .050 (50 gravity points) variation between highest and lowest reading, replace the battery. If make up water is added, allow the battery to charge for 2 to 4 hours before taking hydrometer readings. If the battery requires cleaning, apply a solution of baking soda and water with a brush. Rinse the battery and tray with clean water and apply grease to terminals.

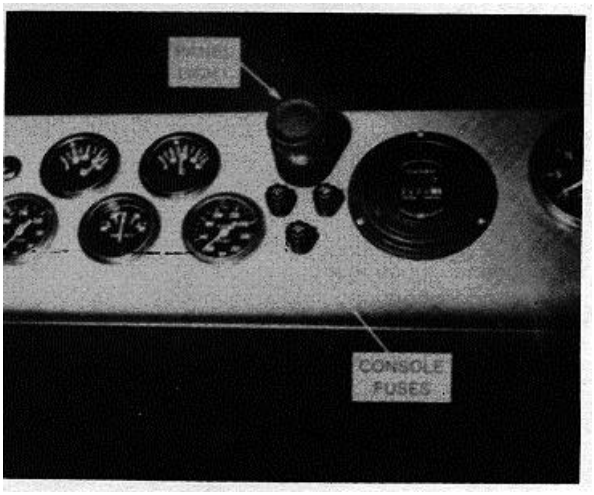
MAINTENANCE:

CHECK BATTERIES and connections every 50 hours. Terminals should be clean and tight and electrolyte level with the base of each vent well. Add distilled water as required but NEVER add acid or electrolyte. To test the electrolyte solution, measure the specific gravity with a hydrometer. At 80"F (27°C) hydrometer' readings are:

1.250 - up	fully charged
1.225 - 1.250	full to half charge
1.150 - 1.225	half to low charge
1.000- 1.150	dead cell
1.000	water



Battery Connections

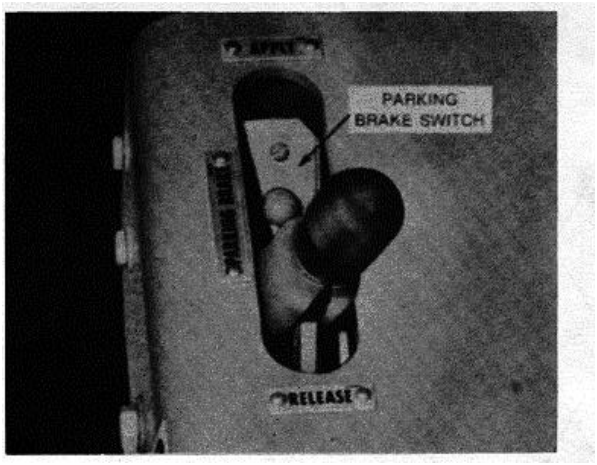


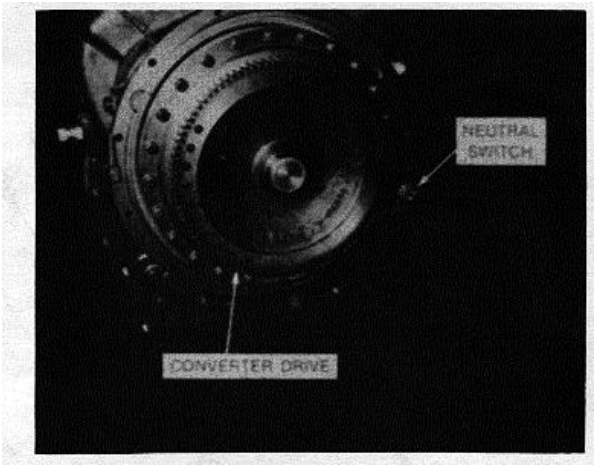
Console Fuses

INSPECT WIRING HARNESSES and connections every 400 hours for loose or damaged connections, chafed wire, etc.

FUSES:

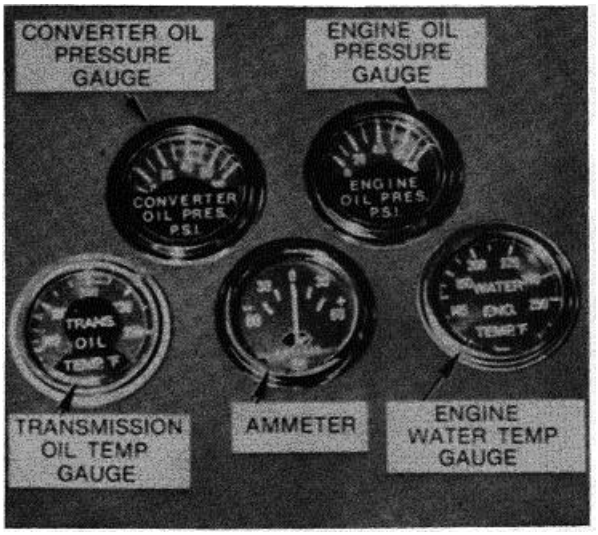
Machines are equipped with two 25 amp fuses mounted on the dash. There is also a 30 amp fuse self-contained in the light switch.



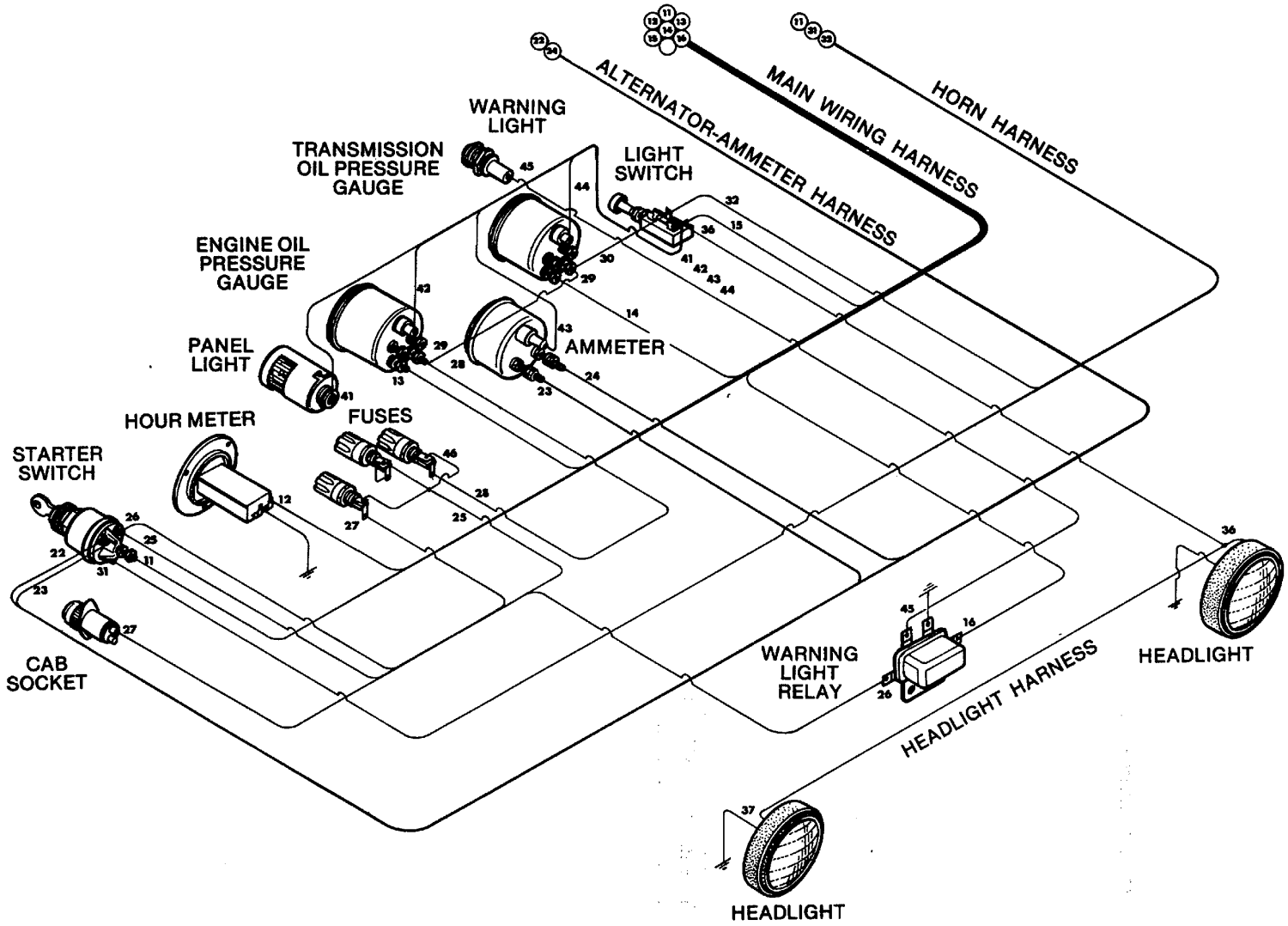


The parking brake switch is located in left side of hydraulic tank beneath the parking brake lever. This switch activates the fuel solenoid shut off when the brake lever is in the "APPLY" position.

The transmission neutral switch is connected by the main wiring harness to the engine start switch and the starter switch relay.



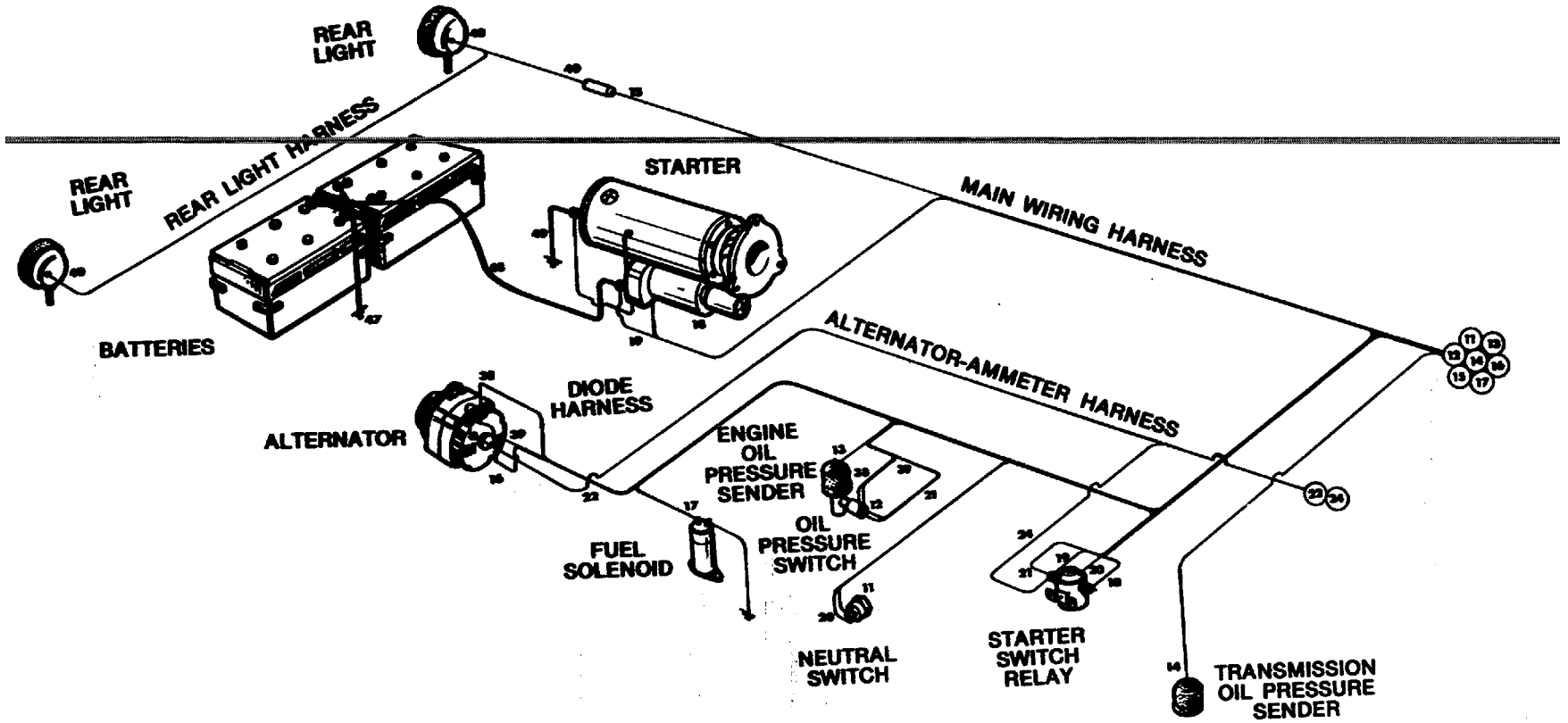
Console Gauges



Console Area Wiring

Console Area Wiring

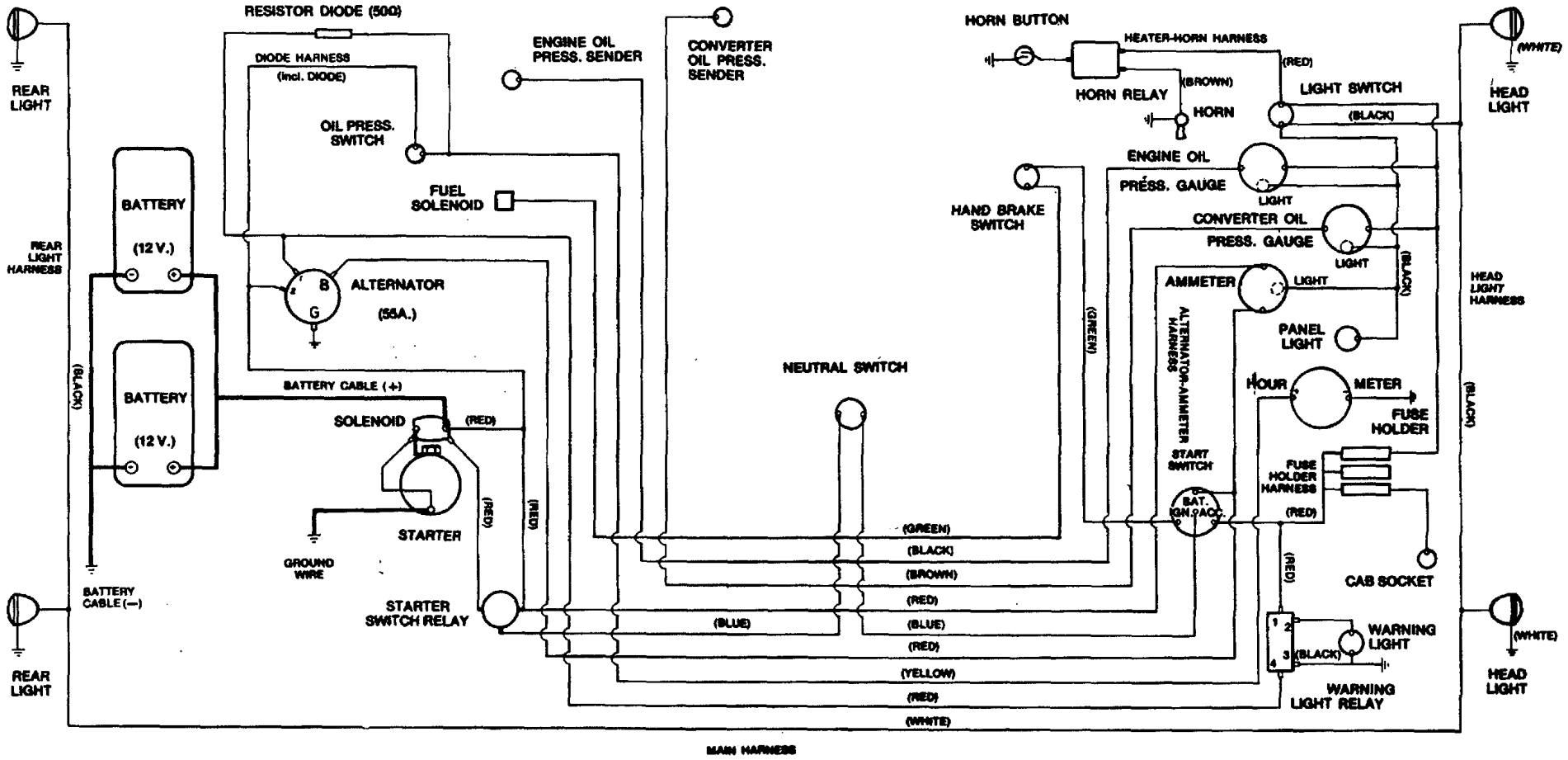
REF. NO.	DESCRIPTION	COLOUR	GAUGE
MAIN HARNESS			
11	Starter Switch -- Neutral Switch	Blue	12
12	Hour Meter - Engine Oil Pressure Switch	Yellow	12
13	Engine Oil Pressure Gauge - Engine Oil Pressure Sender	Black	12
14	Trans. Oil Pressure Gauge - Trans. Oil Pressure Sender	Brown	12
15	Light Switch - Rear Lights	White	10
16	Warning Light Relay - Alternator	Red	12
ALTERNATOR - AMMETER HARNESS			
22	Starter Switch - Alternator	Red	4
23	Starter Switch - Ammeter	Red	4
24	Ammeter - Starter Switch Relay	Red	4
FUSE HOLDER HARNESS			
25	Starter Switch - Fuses	Red	10
26	Starter Switch - Warning Light Relay	Red	14
27	Cab Socket - Fuse	Red	12
28	Fuse - Engine Oil Pressure Gauge	Red	12
29	Engine Oil Pressure Gauge - Trans. Oil Pressure Gauge	Red	12
30	Trans. Oil Pressure Gauge - Light Switch	Red	12
HORN HARNESS			
31	Starter Switch - Handbrake Switch	Green	14
32	Light Switch - Horn Relay	Red	14
HEADLIGHT HARNESS			
36	Light Switch - Headlight	Black	14
37	Headlight - Headlight	Black	16
MISCELLANEOUS			
41	Light Switch - Panel Light	Black	14
42	Light Switch - Engine Oil Press Gauge Light	Black	14
43	Light Switch - Ammeter Light	Black	14
44	Light Switch - Trans. Oil Press Gauge Light	Black	14
45	Warning Light Relay - Warning Light	Black	14
46	Fuse- Fuse	Red	12



Engine Area Wiring

Engine Area Wiring

REF. NO.	DESCRIPTION	COLOUR	GAUGE
MAIN HARNESS			
11	Neutral Switch.- Starter Switch	Blue	12
12	Engine Oil Pressure Switch - Hour Meter	Yellow	12
13	Engine Oil Pressure Sender - Englne Oil Pressure Gauge	Black	12
14	Trans. Oil Pressure Sender - Trans. Oil Pressure Gauge	Brown	12
15	Rear Light Harness - Light Switch	White	10
1is	Alternator - Warning Light Relay	Red	12
17	Fuel Solenoid - Handbrake Switch	Green	12
18	Starter Switch Relay -- Starter Solenoid	Red	10
19	Starter Switch Relay -- tarter Solenoid	Red	4
20	Starter Switch Relay - Neutral Switch	Blue	12
21	Starter Switch Relay - Engine Oil Pressure Switch	Red	12
ALTERNATOR - AMMETER HARNESS			
22	Alternator - Starter Switch	Red	4
24	Starter Switch Relay - Ammeter	Red	4
DIODE HARNESS88			
38	Alternator - Engine Oil Pressure Switch	Red	16
39	Alternator - Engine Oil Pressure Switch	Green	16
REAR LIGHT HARNESS			
40	Rear Lights - Main Harness	Black	14
MISCELLANEOUS			
47	Batteries - Ground	Black	4/0
48	Batteries - Solenoid	Black	4/0
49	Starter - Ground	Black	4/0


RESISTOR DIODE (50Ω)
DIODE HARNESS
(incl. DIODE)
ENGINE OIL
PRESS. SENDER
CONVERTER
OIL PRESS.
SENDER
HORN BUTTON
HEATER-HORN HARNESS
(RED)
HORN RELAY
(BROWN)
HORN
LIGHT SWITCH
(BLACK)
(WHITE)
HEAD
LIGHT
REAR
LIGHT
OIL PRESS.
SWITCH
ENGINE OIL
PRESS. GAUGE
LIGHT
FUEL
SOLENOID
HAND BRAKE
SWITCH
CONVERTER OIL
PRESS. GAUGE
LIGHT
REAR
LIGHT
HARNESS
BATTERY
(12 V.)
B
G
ALTERNATOR
(55A.)
AMMETER
LIGHT
(BLACK)
HEAD
LIGHT
HARNESS
(GREEN)
ALTERNATOR-AMMETER
HARNESS
PANEL
LIGHT
NEUTRAL SWITCH
BATTERY
(12 V.)
BATTERY CABLE (+)
SOLENOID
(RED)
HOUR
METER
FUSE
HOLDER
START
SWITCH
BAT.
IGN.
ACC.
FUSE
HOLDER
HARNESS
(RED)
(BLACK)
STARTER
(RED)
(RED)
GROUND
WIRE
(GREEN)
(BLACK)
(BROWN)
(RED)
CAB SOCKET
BATTERY
CABLE (—)
STARTER
SWITCH RELAY
(BLUE)
(BLUE)
(RED)
(YELLOW)
(RED)
(WHITE)
WARNING
LIGHT
(BLACK)
WARNING
LIGHT RELAY
REAR
LIGHT
(WHITE)
HEAD
LIGHT
MAIN HARNESS

OPERATION MANUAL

This manual contains complete information on components used in the manufacture of machine model K3QO, serial number range 9001-9075.

MODEL IDENTIFICATION

The machine model and serial number appear on a metal plate attached to the left hand side of the rear frame, located directly below the operator station.

MACHINE MODEL No. **K 300** *MACHINE SERIAL No.* **SPARE COPY**

ENGINE MODEL **CATERPILLAR 3208** *ENGINE SERIAL No.* -

BOOK PART No. **3682** *BOOK No.* **A 101**

LOCATION OF SERIAL NUMBERS

MACHINE: As described above and also stamped on the left rear frame structure, forward of the operator position, outlined in red.

ENGINE: Right rear (lower) corner of engine.

TRANSMISSION: Right front (lower) comer of transmission.

AXLE: Centre of differential housing.

PARTS ORDERING PROCEDURE

1. The terms 'right hand' and 'left hand' when referring to a machine component are determined by sitting in the operator's seat and facing toward front of machine.
2. Order parts from the BOMAG distributor in your territory.
3. Always provide the model and serial numbers of the machine and /or assembly.
4. Provide part number and complete description.
5. Provide complete address of destination and specify clearly preferred shipping method.
6. Confirm all telephone, telex or cable orders in writing.
7. Engine parts should be ordered from the engine manufacturers' authorized service dealers.
8. Credit will *not* be allowed on parts unless they are returned to the BOMAG distributor from whom they were purchased. Distributors please refer to BOMAG 'Parts Return Policy'.
9. Claims for shortages or errors will not be considered unless such claim is immediately reported on receipt of goods.
10. In the case of damaged items, a complete description of the damage is to be made by the carrier agent on the Bill of Lading whereupon full damage can be collected from the transport company.
11. We do not accept liability for delay or damage to merchandise while in transit. Liability ceases once the shipment is accepted by the transportation company from whom receipt is received, acknowledging the good condition of the shipment when received by them.

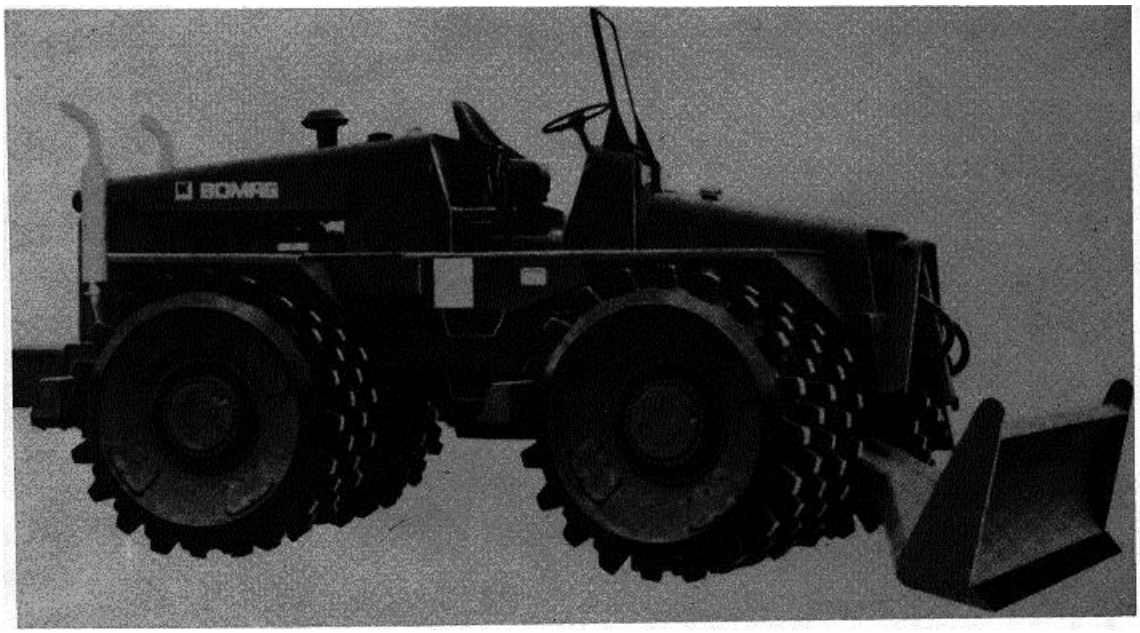
WARRANTY

Important: K-300's supplied under contract number DSA 700-76-C-8075, Serial Numbers 9001 to 9200 are covered under the standard Warranty (following page) for a period of one (1) year in lieu of the six (6) month Warranty stated.

FOREWORD
MACHINE INTRODUCTION

This OPERATION MANUAL contains operation instructions, and lubrication and maintenance information. Proper machine operation and maintenance are essential to its optimum life and performance.

Your BOMAG K300 is an all-purpose high performance earth compactor exhibiting man-euverability and stability to maximize high speed production.



Warranty

KOEHRING COMPANY certifies that new products sold by it are warranted to be free from defects in material or workmanship for a period of six (6) calendar months, or 1000 hours, whichever shall expire first, after date of delivery to the first user and subject to the following conditions:

Koehring Company certifies their obligation and liability under this Warranty is expressly limited to repairing or replacing at Koehring Company's option, any parts which appear to Koehring Company upon inspection to have been defective in material or workmanship. Such parts shall be provided at no cost to the user, at the business establishment of the authorized Koehring Company distributor of the product during regular working hours. This Warranty shall not apply to component parts or accessories of products not manufactured by Koehring Company and which carry the warranty of the manufacturer thereof, or to normal maintenance (such as engine tune-up) or to normal maintenance parts (such as oil filters).

Replacement or repair parts installed in the product covered by this Warranty are warranted only for the remainder of this Warranty as if such parts were original components of said product.

KOEHRING COMPANY MAKES NO OTHER WARRANTY, EXPRESS OR IMPLIED, AND MAKES NO WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE.

Koehring Company certifies their obligation under this Warranty shall not include any transportation charges, costs of installation, duty, taxes or any other charges whatsoever, or any liability for direct, indirect, incidental, or consequential damage or delay. If requested by Koehring Company, products or parts for which a warranty claim is made are to be returned transportation prepaid to the Koehring Company division from which product was originally shipped. Any improper use, including operation after discovery of defective or worn parts, operation beyond rated capacity, substitution of parts not approved by Koehring Company, or any alteration or repair by others in such manner as in Koehring Company's judgment affects the product materially and adversely, shall void this Warranty.

NO EMPLOYEE OR REPRESENTATIVE IS AUTHORIZED TO CHANGE THIS WARRANTY IN ANY WAY OR GRANT ANY OTHER WARRANTY UNLESS SUCH CHANGE IS MADE IN WRITING AND SIGNED BY AN OFFICER OF KOEHRING COMPANY AT ITS HOME OFFICE.

KOEHRING

Koehring (U.S.A.)
BOMAG Division

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GENERAL SPECIFICATIONS
K300 - Caterpillar 3208

ENGINE

Make / Model	Caterpillar 3208
Number of Cylinders	V-8
Bore	4.5" (114 mm)
Stroke	5" (127 mm)
Displacement	636 cu. In (10425 cc)
H.P@RPM	210@2800
Lubrication	Pressure feed
011 Capacity	2.5 Imp. gal (3 US gal) (11,4 lit)
Fuel Capacity	66.5 Imp. gal (80 US gal) (302 lit)
Weight	1225 lbs (558 kg)

ELECTRICAL

Battery	Two 12V-204 amp-hr
Alternator	12V-75 amp

COOLING

Radiator	Round tube, fin type
Coolant Capacity	12.5 Imp. gal (15 US gal) (57 lit)
Water Pump Capacity	60 Imp. gpm (72 US gpm) (273 lit min)
Type	Centrifugal
Drive	Belt
Fan Diameter	22" (559 mm)
Type	Blower - 4 blade

FILTERS

Engine Oil	Replaceable cartridge
Air	Replaceable cartridge
Transmission Oil	Replaceable cartridge
Hydraulic Oil	Replaceable cartridge
Fuel	Spin on cartridge

TRANSMISSION.(with integral torque converter)

Make / Series	Clark 28000
Speeds -- Forward	3
Reverse	3
Converter	13" SS
System 011 Capacity	8 Imp. gal (9.6 US gal) (36,4 lit)

SPECIFICATIONS:

AXLES

Make / Type ..... Clark / Hypoid, outside planetaries
Planetary Capacity (per planet) ..... 1.6 Imp. gal (1.9 US gal) (7,3 lit)
Differential Capacity..... 3.2 Imp. gal (3.8 US gal) (14,5 lit)
Total Lubricant per Axle ..... 6.4 Imp. gal (7.6 US gal) (28,2 lit)

DRIVELINES

Make / Type ..... Spicer Universal Joint
Size ..... 1650 Series

STEERING

Make ..... Char-Lynn
Type ..... Articulated, full hydraulic Orbitrol system
Pump CapacityQ2800 RPM ..... 11.8 Imp. gpm (14.2 USgpm) (53.7 lit / min)

THROTTLE

Control ..... Mechanical linkage over cable

BRAKE

Type ..... Hydro-mechanical
Cylinder Capacity ..... 0.13 Imp. gal (0.16 US gal) (0,6 lit)

FRAME

Separate front and rear frames connected by a center joint assembly providing 80° articulated steering and 300 oscillation.

WHEELS	**Front**	**Rear**
Width	38" (965 mm)	30" (762 mm)
Drum Diameter	48" (1219 mm)	48" (1219 mm)
Outside Diameter	64" (1626 mm)	64" (1626 mm)
Number of Teeth	100	80
Total Ballast	360 Imp. gal (432 US gal) (1636 lit)	

SPREADER BLADE

Control ..... Raise, hold, lower and float positions on lever
Width ..... 107.5" (2731 mm)
Height ..... 32.5"(826 mm)
Depth Below Ground Level ..... 3.25" (83 mm)
Height Above Ground Level .....36" (914 mm)
Edge ..... One piece, replaceable, self-sharpening

CLEANER TEETH

Type	Two-way, individual, adjustable, replaceable.
Construction	Cast manganese steel mounted on steel bars

HYDRAULICS

System Type	Open center
System Capacity	48 Imp. gal (57.6 US gal) (218,2 lit)
Dozer System Pressure	1500 psi (10335 kPa) (105 kg / sq. cm)
Steering System Pressure	2000 psi (13780 kPa1/3141 kg / sq. cam)
Pump Capacity32800 RPM	30 Imp. gpm (36 US gal) (136 lit / rein)
Valve	Gresen, double spool
Steering Cylinder	Two 3" (76 mm) x 23" (584 mm) stroke
Dozer Cylinder	4" (102 mm) x 23" (584 mm) stroke

GENERAL DIMENSIONS

Overall Length with Blade in Top Position	250" (6350 mm)
Overall Length with Blade at Ground Level	245.5" (6236 mm)
Overall Width - Front	107.5" (2731 mm)
- Rear	98" (2489 mm)
Height less Windshield:	100.75" (2559 mm)
Height with Windshield	121.5" (3086 mm)
Wheelbase	118" (2997 mm)
Ground Clearance	19" (483 mm)
Total Weight	35,000 Ibs. (15876 kg)
Steering Angle	40°, left and right
Oscillation Angle	30°
Turning Radius	108" (2743 mm) to inside wheel

SPEEDS

Forward and Reverse - 1st	3.5 MPH (5,63 km / hr)
- 2nd	5.5 MPH (8,85 km / hr)
- 3rd	7.0 MPH (11,3 km/ hr)

INSTRUMENTS

Transmission Oil Temperature Gauge
Converter Oil Pressure Gauge
Engine Oil Pressure Gauge
Engine Water Temperature Gauge
Alternator Warning Light
Tachometer
Hourmeter
Ammeter

LIGHTING

Double Seal Beams, Front and Rear
Dash Panel Light
Engine Oil Pressure Gauge Light
Ammeter Gauge Light
Converter Oil Pressure Gauge Light

SPECIFICATIONS:

MISCELLANEOUS ACCESSORIES

Seat	Heavy duty contoured foam rubber, with adjustable hydraulic suspension mechanism and seat belt.
Tool Box	Locking tool box with grease gun and tool kit.

Air Filter Restriction Indicator
Hydraulic Tank Level Gauge
Fuel Tank Level Gauge
Windshield
Fan Guard
Tow Hook
Horn

OPERATION

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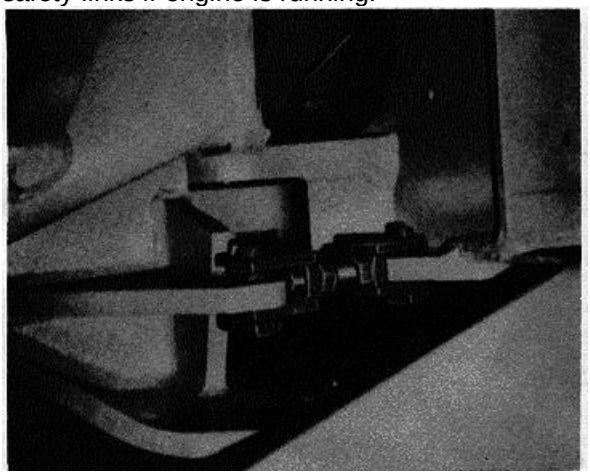
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SAFETY PRECAUTIONS

1. Do *not operate* machine unless completely familiar with controls and machine operation. Do not operate machine without properly functioning *Instruments.*

2. Do not leave machine unattended with engine running. Always put gear levers In neutral position, lower blade, set parking brake and shut down engine before leaving operator's seat.

3. Do not park or enter under machine with- o*ut setting* the parking brake. If on a grade, block the wheels. Connect safety links if engine is running.



Safety Links Installed

4. Make certain that no one Is In center Joint area between scraper bar and rear wheel before starting machine. Sound horn before moving machine.



Center Joint Area Warning Plate

5. Extreme caution must be used when backing up the machine to ensure that the path Is clear of personnel and equipment. Sound the horn before backing up.

6. Keep hands, floors and controls free from water, grease and mud.

7. Never get on or off the machine while In motion.

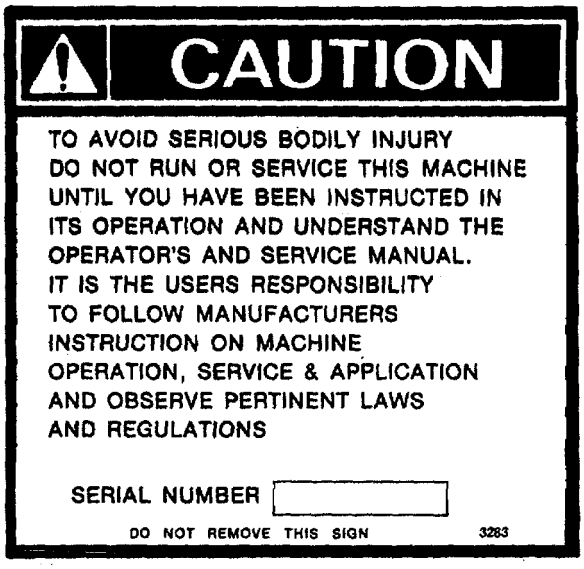
8. Never adjust or lubricate machine while engine is running. If machine Is malfunctioning or awaiting service, tie red WARNING tag on steering wheel.

9. Operate machine at speeds consistent with job conditions. Always give loaded equip- ment the right of way.

10. Do not use blade as a brake when going down a steep slope.

11. Observe all caution and warning decals and plates attached to the machine.

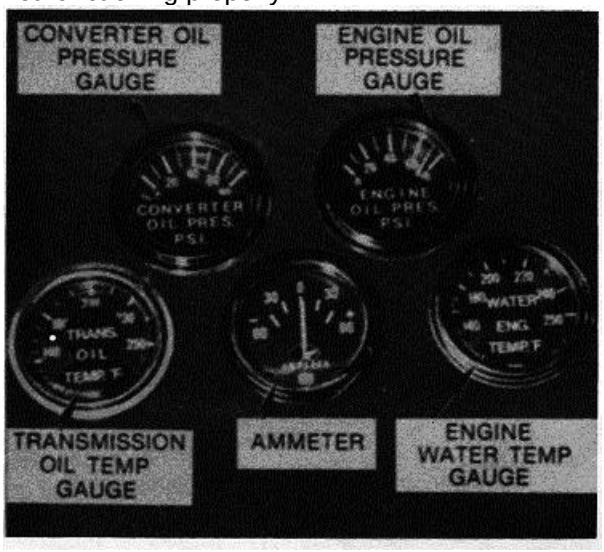
12. Ensure that machine Is clean of oil and Ignitable refuse at all times to reduce risk of fire.



Operator's Caution Plate

It is essential that the operator become thoroughly familiar with all instruments and controls before operating the machine. The terms "right hand" and "left hand" when refer- ring to a machine component are determined by sitting in the operator's seat and facing toward front of machine.

It is a good practice to observe gauges frequently. during machine operation. Do not operate machine if gauges are not functioning properly.



Console Gauges

INSTRUMENTS:

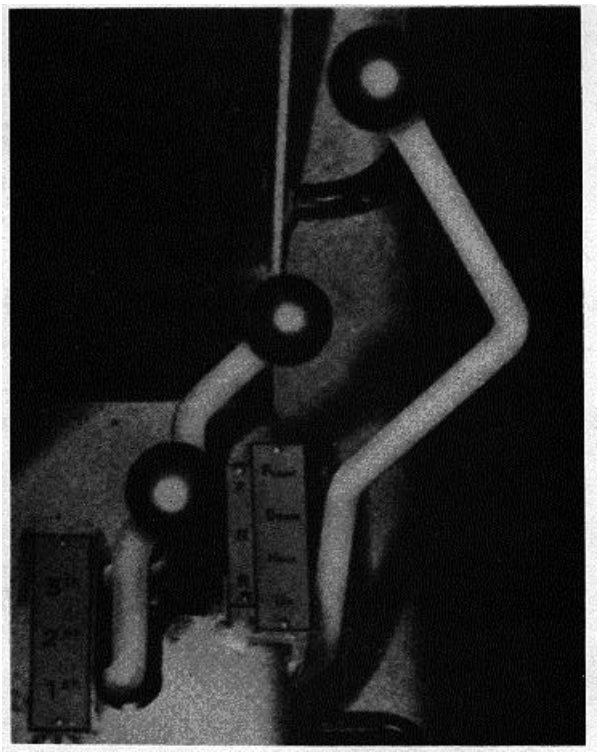
ENGINE WATER TEMPERATURE GAUGE should register between 165°F/74°C and 195°/91◦C under normal operating conditions. Engine coolant temperature must never exceed 200°F/93°C. If gauge reading exceeds 195°F/91°, shut down and determine cause of overheating.

ENGINE OIL PRESSURE GAUGE while engine Is at Idle (600 RPM) should read 10 to 25 psi (69 to 173 kPal 0,7 to 1,8 kg I sq cm), With engine at rated speed (2800 RPM), gauge readings should be 45 to 75 psi (310 to 517 kPa 13,2 to 5,3 kg/*sq* cm). 011 pressure readings should be made while engine Is warm.
Warning: *If gauge falls to register within 15 seconds of starting, stop engine Immediately and determine cause.*

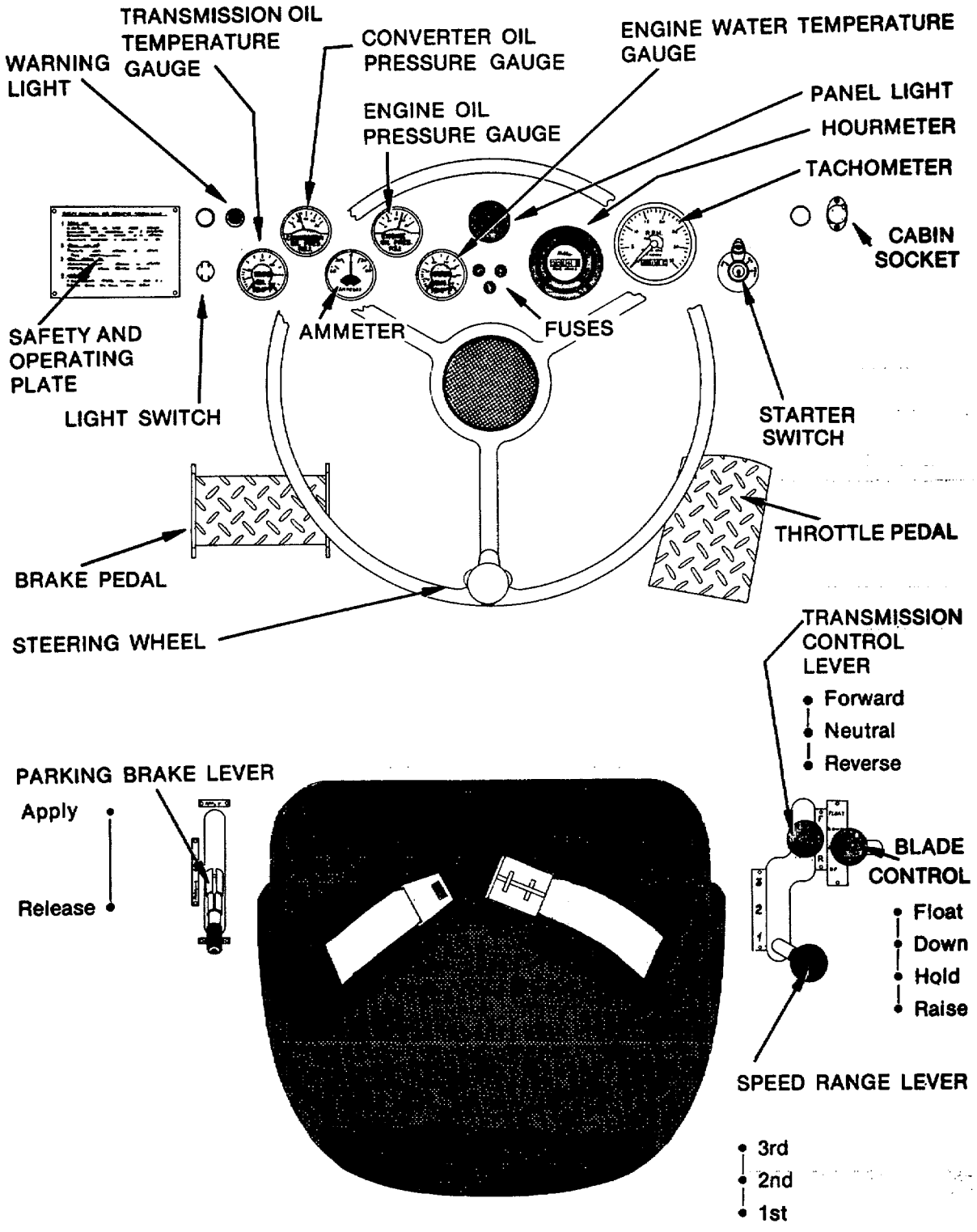
CONVERTER "OUT" OIL PRESSURE GAUGE should register a minimum of 25 psi (173 kPa/,8 kg/sq cm) with transmission oil at 200°F/93°C, engine at 2000 RPM and trans- mission gear shift lever in NEUTRAL position Maximum pressure is not to exceed 70 psi (482 kPa/4,9 kg/sq cm) with transmission oil at 200°F/93°C, transmission shift lever in NEUT RAL position and engine operating with no load at governed speed.

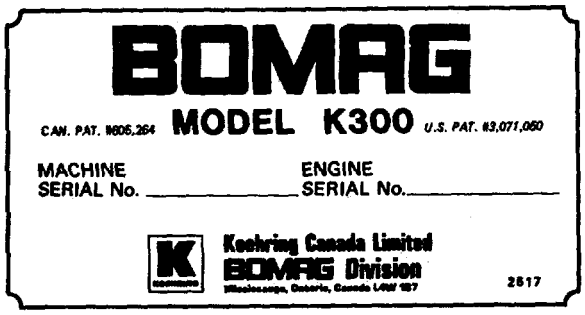
TRANSMISSION OIL TEMPERATURE GAUGE should register between 180°F/82°C and 250°F/121°C. When temperature approaches upper limit, shift to a lower operating speed range. Transmission and torque converter oil temperature must not exceed 250°F 121°C. If overheating persists, shut down and determine cause.

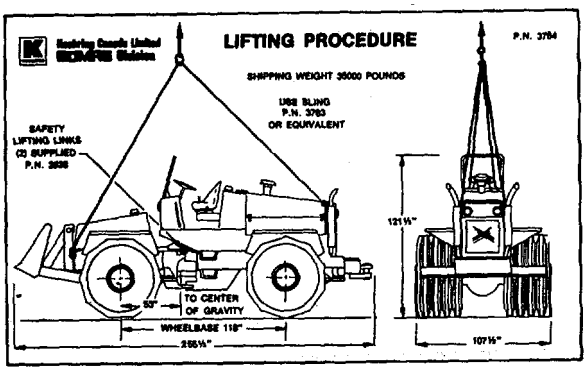
AMMETER should deflect slightly toward the negative during starting. With engine running and fully charged batteries, the ammeter should register at zero. A positive reading will occur if batteries are not fully charged. If a negative reading occurs, the red ammeter warning light will turn on. The ammeter warning light is activated if the engine is not running and the key is in the ACCESSORY or RUN position. The warning light will remain on after starting with engine at idle until throttle is depressed. If the ammeter warning light re- mains on, the operator should refer to TROUBLE SHOOTING GUIDE to correct mal-function.



Control Levers

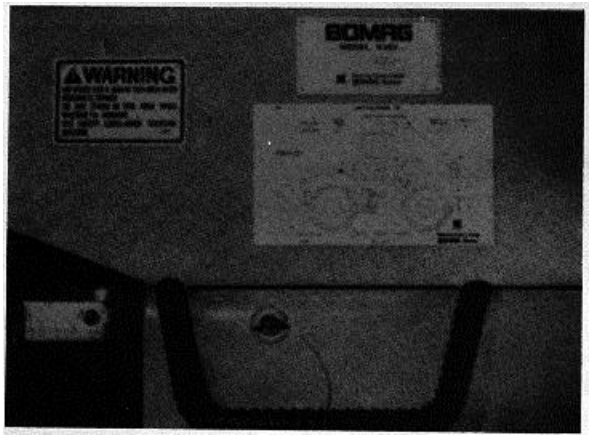

TRANSMISSION OIL TEMPERATURE GAUGE
WARNING LIGHT
CONVERTER OIL PRESSURE GAUGE
ENGINE WATER TEMPERATURE GAUGE
ENGINE OIL PRESSURE GAUGE
PANEL LIGHT
HOURMETER
TACHOMETER
CABIN SOCKET
SAFETY AND OPERATING PLATE
AMMETER
FUSES
LIGHT SWITCH
STARTER SWITCH
THROTTLE PEDAL
BRAKE PEDAL
STEERING WHEEL
TRANSMISSION CONTROL LEVER
Forward
Neutral
Reverse
PARKING BRAKE LEVER
Apply
Release
BLADE CONTROL
Float
Down
Hold
Raise
SPEED RANGE LEVER
3rd
2nd
1st





Decals and nameplates are used throughout the machine to give service or control instructions and aid in safe and efficient operation.

The operating instructions and safety precautions nameplate located on the left side of the control console should be read thoroughly before operating the machine. Further details are available in the OPERATION MANUAL.



The lubrication plate and machine Identification plate are located on the left side of the rear frame, directly below the operator station. The serial numbers are also stamped on the left side of the rear frame, below the control console.

The decal "WARNING - No space for a man in this area..." is located on both sides of the rear frame below the operator station. Personnel



Center Joint Area Warning Plate

must stay out of these areas when engine is running. Safety links should be attached between front and rear frames when servicing the machine.

Other decals and plates are used to remind the operator of various safety and service instructions.

PRESTART AND STARTING PROCEDURE

1. For first time starts after machine has been stored for a period of time, refer to OUT OF STORAGE SERVICE.

2. Check all oil levels according to MAIN- TENANCE SCHEDULE. Check fuel level.

3. Visually inspect machine for leaks or component damage.
4. Remove safety links.

5. Make certain that no one is in center joint area between scraper bar and rear wheel.
6. Release handbrake.

Note: *The handbrake switch is connected to the fuel solenoid shut off. If the handbrake is not released, the engine will turn over but will not start.*

7. Place gear lever in neutral position.
8. Depress throttle pedal.
9. Turn key to START position.

Caution: *Do not crank engine more than 30 seconds continuously.*

10. After engine starts, release throttle pedal and check engine oil pressure gauge. If pressure is not indicated within 15 seconds, shut off engine and determine cause.
11. Depress' throttle pedal to deactivate ammeter warning light.

COLD WEATHER STARTING

The best aid for cold weather starting is proper maintenance. Check cooling system anti-freeze protection; keep batteries fully charged and properly serviced; and use an engine oil suitable for anticipated temperatures.

If machine is not fitted with optional cold start- ing aid, the use of an ether spray or ether soaked rag may aid starting.

Caution: *Spray ether only while cranking engine. Do not inhale ether fumes.*

If machine is fitted with optional cold starting aid, activate pump while cranking engine.

WARM-UP CHECKS

Hold engine at idle speed for approximately two minutes after starting. Perform the following checks:

1. Engine oil pressure gauge
2. Converter oil pressure gauge
3. Transmission oil temperature gauge
5. Ammeter
6. Hydraulic oil level gauge
7. Fuel level gauge
8. Visually inspect machine for leaks
9. Lights
10. Horn
11. Operation of controls

Allow engine to reach operating temperature before operating machine.

PRELIMINARY OPERATING INSTRUCTIONS

After engine has been properly warmed up and all service checks, completed, raise dozer to traveling position by pulling back dozer control lever to UP position. Place transmission forward-reverse control lever in desired position, 'F' forward or 'R' reverse, and place trans- mission speed control lever in first '1' gear and apply throttle.

Gradually build up speed, shifting into a higher gear as required. The machine is equipped with a power shift transmission which means that the operator is able to shift to a higher speed range without slowing down. When rolling resistance is high or the machine is climbing an incline, a lower gear will often produce a higher speed. The operator will be aware of this if he notices a slowing down after shifting to a higher gear.

The dozer blade on the K300 should not be used for excavating or heavy dozing of undisturbed soils. Its proper function is in leveling off irregularities in grade left by the earth-moving equipment and leveling piles of dumped fill material. The operator should level the fill at a constant speed, making it easier to achieve uniform compaction. The type of fill will deter- mine the speed at which it is spread. Sandy soil, for example, can be laid down at a faster rate than clay. Speed is also an important factor in the compaction process. Higher speeds result in higher impact forces and thus, greater compaction densities are achieved.

In order to operate machine at maximum efficiency, maintain engine RPM above 2000, with transmission in appropriate gear. Observe gauges frequently during machine operation. Refer to INSTRUMENTS AND CONTROLS for normal gauge readings. Do not operate machine if gauges are not functioning properly.

SHUT-DOWN AND PARKING PROCEDUERE

It is important to idle an engine for 3 to 5 minutes before shutting it down to allow lubricating oil and water to carry heat away from engine components. Residual heat is very often the cause of engine damage. After idling the engine to reduce extreme temperatures, turn the ignition switch to the OFF position.

Put gear levers in neutral position, lower blade and set parking brake.

In cold weather, care should be taken to avoid freezing machine in mud, dirt or snow. If wheels are not properly cleaned, built up material may harden and damage cleaner teeth when machine is moved.

STORAGE PROCEDURE

If machine is to be stored for any period or indefinite length of time (MAXIMUM 6 months), perform the following service functions.

1. Store machine in dry area with wheels on blocks and blade lowered onto blocks. Put gear levers in neutral position.
2. Steam clean entire machine, paying special attention to engine and wheels. If wheels are not properly cleaned, built-up material may harden and result in broken cleaner teeth.
3. Complete full maintenance checks. Include checking all fluid levels, coolant anti- freeze protection, grease all fittings, and lubricate control levers, linkages and cables.
4. Drain any water from fuel system. Fill fuel tank to avoid formation of condensation.
5. Operate engine until thoroughly warm. Stop engine, shut fuel tank drain cock and disconnect fuel lines to engine fuel filter and injector drain line. Fill two containers, one with diesel fuel (refer to LUBRICANTS SPECIFICATION CHART) and a second with preservative oil US Military Spec MIL-L 644 Type P9. Pre- servative Oil to this specification is Daubert Chemical Co., Nox-Rust No. 518 or equivalent.

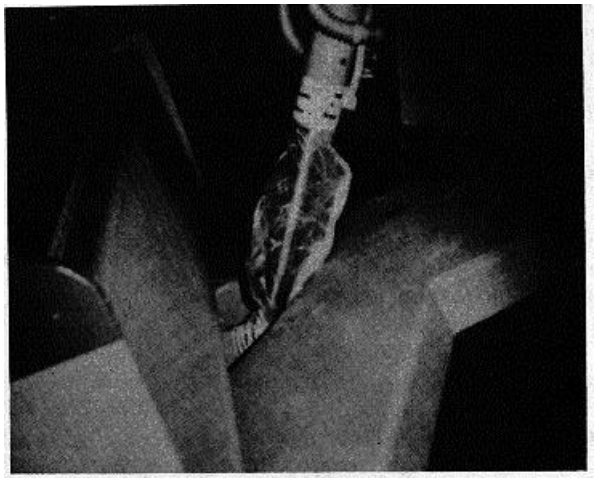
Start engine with fuel line to filter using diesel fuel with injector drainline flowing into same container. After engine is running smoothly, switch fuel line to container with preservative oil. Operate engine for five to ten minutes on preservative oil, then stop engine and reconnect fuel lines.

Brush or spray rust preventive compound conforming to Type P-2, Grade 1 or 2, US Military Spec MIL-C-16173C on all exposed, unpainted engine surfaces.

Spray lubricating oil into intake manifold while cranking engine slowly.

Cover all engine openings with heavy paper and tape. Bar engine crankshaft two or three revolutions each three or four weeks.

6. Set parking brake.
7. Remove batteries; store in warm place and recharge every 6 months.
8. Brush or spray rust preventive compound on chrome and polished surfaces - gauges, cylinder rods, etc.
9. Remove key and close starter switch protector cap. Cover seat and entire operator station with tarp if available.
10. Tag machine as "IN STORAGE" and include date.



Protecting Dozer Cylinder Rod

OUT OF STORAGE SERVICE

To prepare a stored machine for service:

1. Clean any accumulated dirt from exterior of engine. Remove covers and tape.
2. Use suitable cleaner to remove rust preventive compound from engine and machine surfaces.
3. Change engine oil and filter.
4. Flush and refill cooling system. Use a suitable antifreeze with rust inhibitor added if required. *Do not use antifreeze with antileak additives.*
5. Re-install and reconnect batteries.
6. Complete full maintenance checks. Include checking all fluid levels, grease all fittings and lubricate all control levers, linkages and cables.
7. Bleed fuel system. Open fuel tank drain cock.
8. Release handbrake. Start engine and warm up as recommended (refer to PRESTART AND STARTING PROCEDURE and WARM-UP CHECKS in OPERATION MANUAL).

COMPACTION

CONTENTS:

Compaction.....300-1.1

Soil.....300-1.1

Moisture Content.....300-1.1

Lift Thickness.....300-1.2

Number of Passes.....300-1.2

Compaction/Machine

Operation.....300-1.2

Compaction Terms.....300-1.3

COMPACTION

Soil compaction equipment has developed from the steam operated, smooth-wheel rollers of 19th century France to the modern specialized equipment of today. Compaction requirements have also progressed to complement modern technology. Vehicles using highways today may have six axles, 20,000 pound (9000 kg) axle loads and tire pressures of 150 psi (11 kg/ sq. cm). Increases in airline traffic and capacities also compounded the need for improved compaction procedures and stricter control.



There are three major purposes of compaction:

a) To Increase the potential strength and bearing capacity of the base. Studies have shown that the most Important stress Induced by a load on a pavement foundation Is the shear, and not the compressive stress,

b) To Increase the volumetric stability and avoid settling or localized compaction by future loads,

c) To minimize the permeability and prevent the deterioration of strength due to Infiltration and saturation of surface waters.

Compactability depends upon:

a) The soil-preparation, type and moisture content.
b) Compaction equipment-type and size.
c) Number and speed of passes.
d) Lift thickness.
e) Foundation characteristics.

SOIL:

The four basic types of soils with reference to compaction are gravel or rock fill, sand, silt and clay. Gravel and. sand are non-cohesive soils with high permeability. The shear strength of cohesionless materials is essentially controlled by five factors:

a) Mineralogical composition.
b) Size and gradation of the individual particles.
c) Shape of the individual particles.
d) Void ratio or dry density.
e) Confining pressure.

The shearing strength of a compacted cohesive soil is primarily affected by:

a) water content.
b) gradation.
c) dry density.
d) soil structure.

MOISTURE CONTENT:

The most significant factor influencing the compaction of a *soil* Is its moisture content. Optimum moisture content may range any- where from 4% for rock fill to 24% for a clay, depending upon soil type and specifications to be met. The moisture requirement is reduced for the higher density requirement of the Modified Proctor as compared to the Standard Proctor.

MOISTURE CONTENT vs SOIL TYPE

	Clay	**Sllt**	**Sllty Clay**	**Sllty Sand and Gravel**
Standard Proctor	17%	14%	12%	10%
Modified Proctor	14%	11%	9%	7%

Optimum moisture content Is that moisture at which the greatest density of a soil can be obtained through compaction. A soil's optimum moisture content should be determined by soil laboratory test using the selected Standard or Modified Proctor test procedures. To produce best field compaction results, experience has proven that when Standard Proctor densities are to be achieved field moistures should be at or slightly above optimum. Likewise best results when compacting to Modified Proctor densities may be achieved at or slightly below optimum. Care must be exercised in controlling moisture, as too high a moisture content will prevent

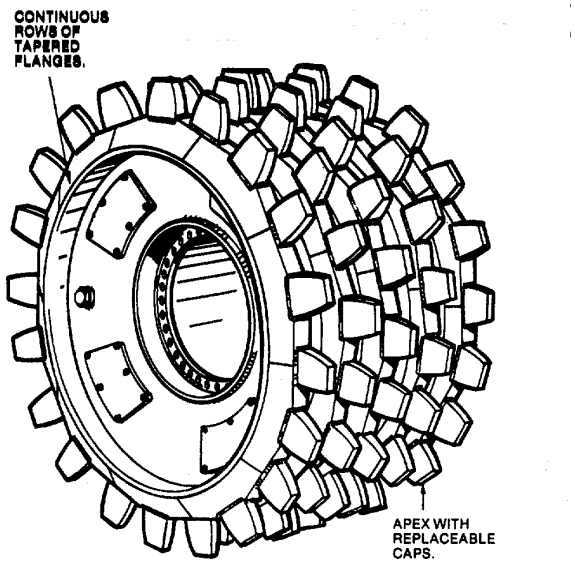
densities from being attained and the moisture content may have to be reduced by aeration prior to compaction.

LIFT THICKNESS / NUMBER OF PASSES:

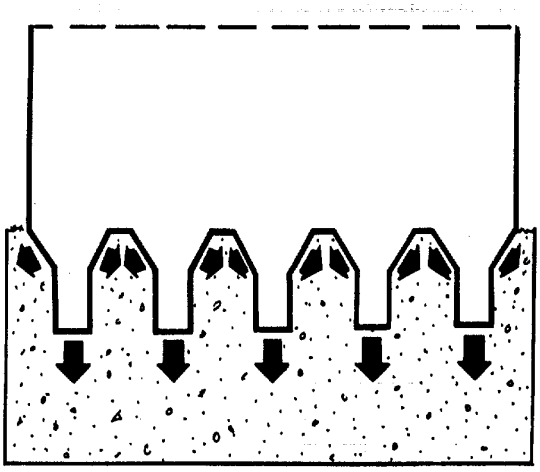
The greatest increases in density occur within the initial five passes, depending upon soil and field conditions. Additional passes may produce only slight gains, or even be detrimental. Generally, the lift thickness varies from 6 to 12 Inches (15 to 30 cm), depending upon conditions. While there are no set rules, we would recommend starting with a 6" (15 cm) lift and plotting achieved densities versus the number of passes. Increase the depth of lift in three inch (7,6 cm) Increments until you find the optimum combination of lift thickness and number of passes for the particular conditions. Care should be exercised in compaction to avoid selecting such a deep lift that bridging of the bottom of the lift occurs. When the proper combination has been determined, one must be on the lookout for changes In soil type and moisture content. If proper control is maintained, consistent compaction throughout the Job will be achieved.

COMPACTION / MACHINE OPERATION:

Segmented compaction wheels produce higher surface pressures and exert a combination of Impact and kneading action on the soil. The BOMAG K300 Pakall wheels provide great versatility In soil compaction. Soils ranging from sandy loams to heavy clay may be compacted with relative ease.

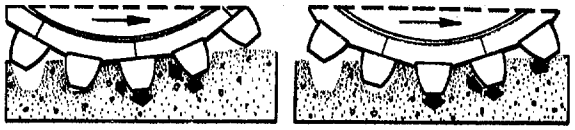


Responsible for this versatility is the shape of the wheel flanges. The tapered edges of these flanges exert pressure laterally as well as downward, allowing the machine to "walk out" in fewer passes.



The tapered flanges provide compaction both downwards and sideways. In this manner, material between them, as well as beneath them, is compacted.

As the wheel sinks Into uncompacted soil, the tapered flanges offer a large amount of bearing area to prevent over-stressing the soil when there Is low shear resistance. As soil density Increases, the wheel begins to "walk out", riding progressively higher on the wheel flanges, concentrating the compactive force on Its narrow ridges and finally on the apexes.



As the flanges turn, they penetrate the loose soil. Pressure is at first exerted both angularly on the leading load-bearing surface and downward on the trailing load-bearing surface. The compactor's full weight is applied downward when the apex reaches Its point of deepest penetration. When, upon further rotation, the apex is withdrawn, the compacted soil is left undisturbed. Shearing is kept to a minimum.

COMPACTION:

The flanges on the rear wheels are aligned to fall exactly in. between those on the front wheels, providing full coverage on each pass. The two wheels compact a total of 76 inches (193 cm) of width with 30 inches (76 cm) between, allowing the operator 8 inches (20 cm) of overlap to cover this area.

PERFORMANCE CHART

Hourly production is based on one machine pass, and ideal conditions at 100% efficiency.

SPEED		AREA COVERAGE		LIFT THICKNESS									
				6"	15,2 cm	9"	22,9 cm	12"	30,5 cm	15"	38,1 cm	18"	45,7 cm
M.P.H.	km/hr.	Yd^2	m^2	Yds^3	m^3	Yds^3	m^3	Yds^3	m^3	Yds^3	m^3	Yds^3	m^3
2.5	4,02	9270	7780	1545	1180	2317	1780	3090	2360	3863	2950	4635	3540
5.0	8,05	18540	15520	3090	2360	4635	3540	6180	4730	7726	5900	9270	7080
7.5	12,07	27810	23300	4635	3540	6952	5320	9270	7080	11587	8850	13905	10620
10.0	16,09	37080	31100	6180	4730	9270	7080	12360	9450	15450	11820	18504	14160

To determine actual cubic yard per hour production, divide the above figures, by the number of machines passes required to achieve the desired density.

To determine cubic yard per hour production at speeds and lift thickness other than those listed above, refer to the following equation.

$$\frac{\text{SPEED (M.P.H.)} \times 103 \times \text{LIFT (IN.)}}{\text{NUMBER OF PASSES}} = \text{cu. Yd./hr.} \qquad \frac{\text{SPEED (km/hr.)} \times 19{,}3 \times \text{LIFT (cm)}}{\text{NUMBER OF PASSES}} = m^3/\text{hr.}$$

The K300 is equipped with a power shift transmission. This means that the operator is able to start in a low gear and shift to a higher speed range without slowing down. When rolling resistance is high, or the machine is climbing an incline, a lower gear will often produce a higher speed. The operator will be aware of this if he notices a slowing down after shifting to higher gear.

The dozer blade on the K300 should not be used for excavating or heavy dozing of undisturbed soils. Its proper function is in leveling off irregularities in grade left by the earth-moving equipment and knocking down piles of truck-dumped fill material. It is also very helpful in leveling off and back-dragging the fill to minimize water penetration.

COMPACTION TERMS:

Proctor:
The generally accepted standards for the control of densities and moisture in soil compaction are the Standard and Modified Proctor. A container of known size is gradually filled with a stated number of layers of soil and a rammer of known weight is dropped from a definite height for a number of blows, usually 25 times the number of layers. The Standard Proctor uses three layers, a 5.5 pound (2,5 kg) rammer, and a 12 inch (31 cm) drop applying a 12,375 ft-lbs of compactive effort. The Modified Proctor uses five layers, a 10 pound (4,5) rammer, and 18 inch (46 cm) drop for a total of 56,250 ft-lbs of compactive effort. Obviously, the Modified Proctor density specifications are much more difficult to meet.

Water Balloon and Sand Cone Density Tests:
In-place soil density determination consists of removing a sample of the compacted soil from a 4 to 5 inch (10 to 12,7 cm) diameter hole. The moist soil is weighed and its moisture content determined. The volume of the hole is determined by measuring the amount of material of known weight required to fill the hole. This may be either water or sand and thus the name of the test. The dry weight of the material removed is then stated in pounds per cubic foot (kilograms per cubic meter).

Nuclear-Moisture Density Test:
An instrument is used employing gamma rays which are reflected by the soil density or neutron radiation reflected by the soil moisture,

MAINTENANCE

CONTENTS:

Maintenance Schedule.....400-1

Lubrication Diagram.....400-2

Lubricants Specification Chart.....400-3

Maintenance Instructions.....400-4

Trouble Shooting Guide.....400-5

Torque Specifications.....400-6

Vendor Manual Frontice Page.....400-7

MAINTENANCE SCHEDULE

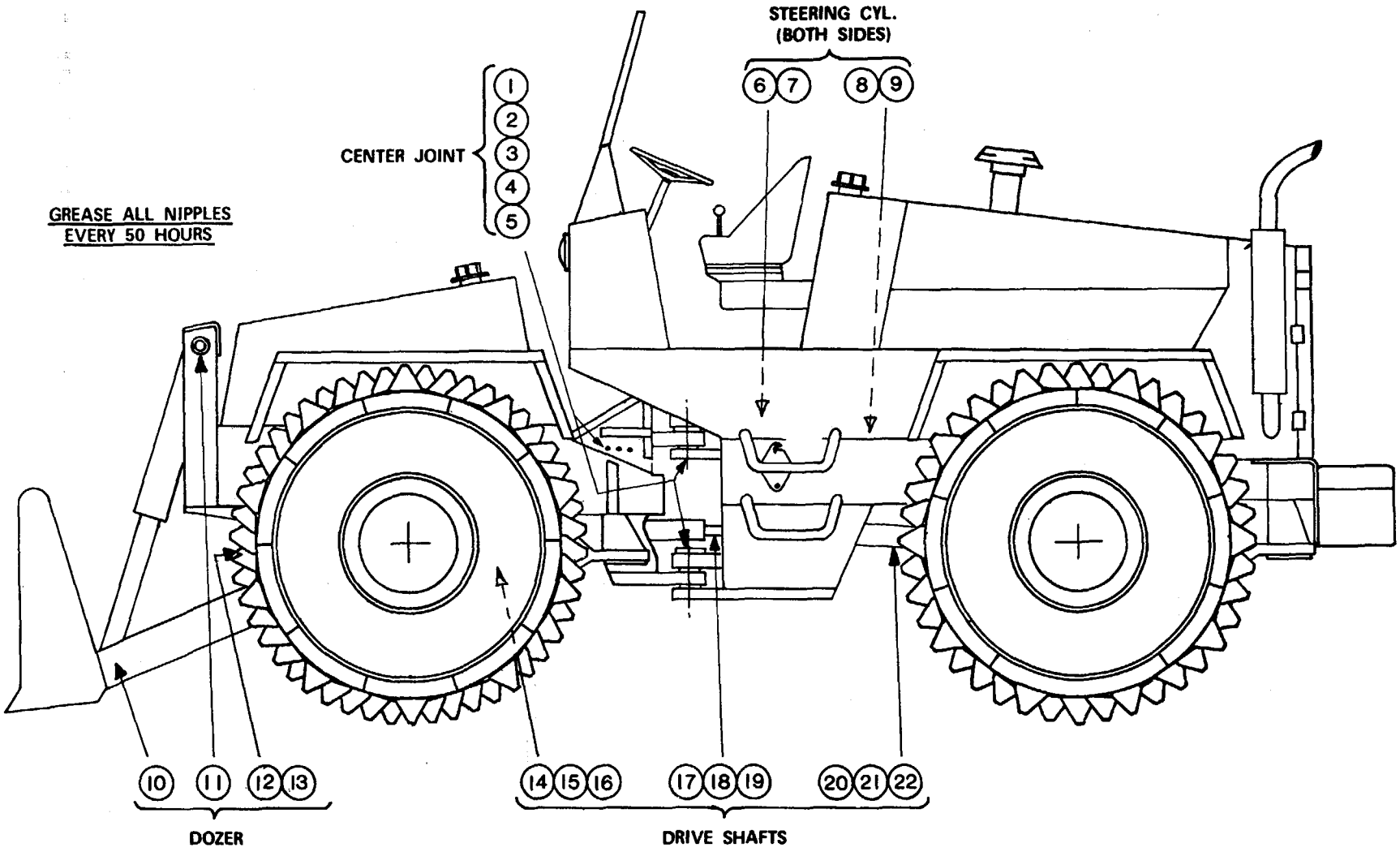
	DESCRIPTION	Daily	HOURS				
			50	100	200	400	800
ENGINE	CHECK OIL LEVEL	X					
	CHECK COOLANT LEVEL	X					
	CHECK AIR CLEANER RESTRICTION INDICATOR	X					
	FAN BELT ADJUSTMENT		X				
	CHECK BATTERIES		X				
	CHECK ANTI-FREEZE		X				
	CHECK AIR INLET HOSE AND CONNECTIONS		X				
	CHECK RAD HOSE AND CONNECTIONS		X				
	STEAM CLEAN RADIATOR		X	or A.R.			
	CLEAN AIR FILTER			X	or A.R.		
	OIL CHANGE				X		
	FILTER CHANGE				X		
	CHANGE AIR FILTER ELEMENT				X		
	CHANGE FUEL FILTER				X		
	CHECK THROTTLE LINKAGE				X		
	RECORD OIL PRESSURE				X		
	VALVE ADJUSTMENT						X
	CLEAN INJECTORS						X
	CHECK FAN HUB AND FAN MOUNTING						X
	CHECK ENGINE MOUNTS						X
	CHECK EXHAUST SYSTEM						X
	DRAIN AND CLEAN FUEL TANK						X
	COMPLETE ALL SERVICE FUNCTIONS AS INDICATED IN VENDOR ENGINE MANUAL						
TRANSMISSION	CHECK OIL LEVEL (at operating temperature)	X					
	CHANGE OIL FILTER				X		
	CHECK TORQ CONVERTER AND TRANSMISSION PRESSURE				X		
	OIL AND FILTER CHANGE					X	
	ADJUST BRAKE						X

	DESCRIPTION	Daily	HOURS				
			50	100	200	400	800
AXLES	CHECK DIFFERENTIAL AND PLANETARY OIL LEVEL		X				
	CHECK WHEEL MOUNTING NUTS (450 ft-lbs/62 m-kg)			X			
	CHECK AXLE MOUNTING NUTS (700 ft-lbs/97 m-kg)				X		
	CHANGE OIL						X
	ADJUST WHEEL HUB BEARING PRELOAD						X
	CHECK DIFFERENTIAL FLANGE BEARING END PLAY (if any, adjust preload)						X
HYDRAULIC	CHECK HYDRAULIC TANK LEVEL	X					
	REMOVE DEBRIS FROM DOZER CYLINDER RODS	X					
	CHECK HOSES AND CONNECTIONS		X				
	CHECK FOR CYLINDER LEAKAGE			X			
	CHANGE HYDRAULIC FILTER				X		
	CHECK PUMP MOUNTING BOLTS				X		
	DRAIN AND CLEAN HYDRAULIC TANK					X	
	CHECK HYDRAULIC PRESSURE					X	
GENERAL	VISUAL INSPECTION FOR LEAKS	X					
	GREASE ALL POINTS ACCORDING TO CHART		X				
	CHECK BRAKE CYLINDER FLUID LEVEL		X				
	CLEAN DEBRIS FROM UNDERCARRIAGE		X				
	INSPECT MOUNTED PARTS			X			
	INSPECT ROPS BUSHINGS AND PINS				X		
	CHECK FOR LOOSE NUTS AND BOLTS				X		
	ADJUST PARKING BRAKE LEVER				X or A.R.		
	ADJUST CONTROL LEVERS AND LINKAGES					X	
	STEAM CLEAN MACHINE					X	
	CHECK FRAME & DOZER WELDMENTS						X

NOTES:

1. **COMPLETE OIL AND FILTER CHANGE HAS TO BE DONE AFTER THE FIRST 50 HOURS.**
2. **Detailed instructions follow the schedule.**
3. **A.R. — As Required.**

LUBRICATION DIAGRAM



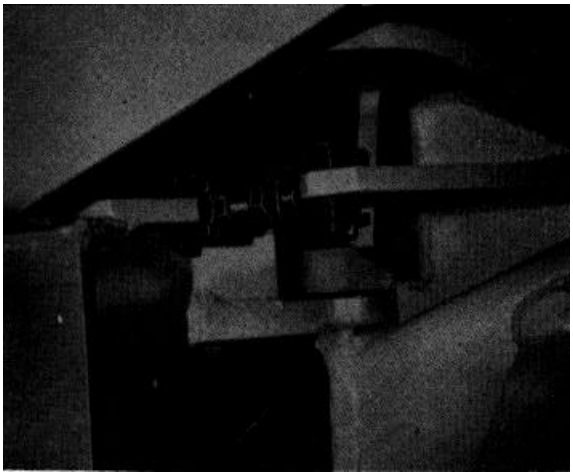
LUBRICANTS SPECIFICATION CHART

APPLICATION	CHANGE [HOURS]	CAPACITY			SPECIFICATIONS	VENDOR EQUIVALENTS					
		LITER	U.S. GAL.	IMP. GAL.		B.P.	ESSO	GULF	MOBIL	SHELL	TEXACO
ENGINE OIL	200	13,6	3.6	3	SUPERIOR LUBRICANTS (SERIES 3) MIL-L-2104B, MS 68-69 MIL-L-45 199A 1.85% MAX. ASH	BP ENERGOL DIESEL S3-30	ESSOLUBE XD-3	GULFLUBE XHB MOTOR OIL SAE 10W30	MOBIL DELVAC 1330	SHELL RIMULA CT-30	TEXACO URSA LA-3 SUPER DUTY SAE 30
ENGINE GREASE	50	—	—	—	NLG1 No. 2 W / CORROSION INHIBITOR MOLYBDENUM DISULFIDE 3-5% TO MIL-L-7866	BP LS-2 ENERGREASE	ESSO MP GREASE MOLY	GULFLEX MOLY No. 2	MOBIL GREASE MP No. 2	SHELL ALVANIA No. 2	TEXACO MOLYTEX No. 2
FUEL	—	302	80	66.5	No. 2 DIESEL FUEL — MIN. CETANE No. 40 (ASTM D-613) — MAX. 1% SULFUR BY WEIGHT						
ENGINE COOLANT	800	57	15	12.5	CLEAN WATER (LOW MINERAL CONTENT) WITH ANTI-FREEZE AND RUST INHIBITOR ADDITIVES — DO NOT USE ANTI-LEAK ADDITIVES.						
BATTERY WATER	A.R.	—	—	—	DISTILLED WATER IF AVAILABLE — CLEAN WATER WITH LOW MINERAL CONTENT						
TRANSMISSION AND TORQUE CONVERTER	400	32,7	8.6	7.2	AUTOMATIC TRANSMISSION FLUID TYPE A SUFFIX A OR DEXRON	BP DEXRON ATF	ESSO AUTOMATIC TRANSMISSION	GULF AUTOMATIC TRANSMISSION FLUID TYPE DEXRON	MOBIL ATF 220	SHELL DONAX T6	TEXOMATIC FLUID
MASTER BRAKE CYLINDER	400	0,55	0.15	0.12							
AXLE [DIFFERENTIAL] [per axle]	800	14,6	3.8	3.2	MIL-L-10 324 A SAE 90 EXTREME PRESSURE EP SCL SULFO-CHLORO-LEAD	BP ENERGOL MP 80-90 (SCP)	ESSO GEAR OIL LC-90	GULF 47-906 GEARLUBE SCL SAE 90	MOBILUBE 46 SAE90	SHELL HDR-90	TEXACO MULTIGEAR EP85W-90
AXLE [PLANETARY] [per planet]	800	7,3	1.9	1.6							
HYDRAULIC	400	218	57.6	48	HYDRAULIC OIL VISCOSITY 158-100°F SUV 43.5-210°F GRAVITY 32° API	BP ENERGOL HL 65	ESSO NUTTO H44	GULF HARMONY 44 HYDRAULIC OIL	MOBIL DTE OIL 24	SHELL TELLUX 27	TEXACO RANDO OIL HDA or HD 32 / 150
ARTICULATE BEARINGS AND DRIVE SHAFTS	50	—	—	—	NLG1 No. 2 D POINT 373°F TYPE L1-CA VISCOSITY 1183-100°F SUV 87-210°F	BP LS-2 ENERGREASE	ESSO GREASE BEACON No. 2	GULF CROWN GREASE EP-2	MOBIL GREASE MP No. 2	SHELL ALVANIA No. 2	TEXACO MULTI-PURPOSE GREASE No. 2

NOTE: Other suppliers may be used providing above specifications are met. Machine originally filled with TEXACO products.

SERVICE TIPS

1. Always park machine on level ground, set parking brake and lower blade unless other- wise stated.
2. When disassembling components, cleanliness is essential. Always place parts in order of disassembly for easier assembly. Use new gaskets and O ring seals when reassembling.
3. Always disconnect the batteries during service operations. NEVER weld on the ma- chine with batteries connected.
4. When welding on the machine, always ground on the same component (e.g. front frame, rear frame, wheel) as you are welding on. Grounding through bearings will damage them.
5. If service operation requires the batteries to be connected, remove the key from the start switch. If engine running is a requirement, block the wheels and connect safety links.



Safety Links Installed

6. The terms "right", "left", "front" and "rear" when referring to a machine component are determined by sitting in the operator's seat and facing toward front of machine.

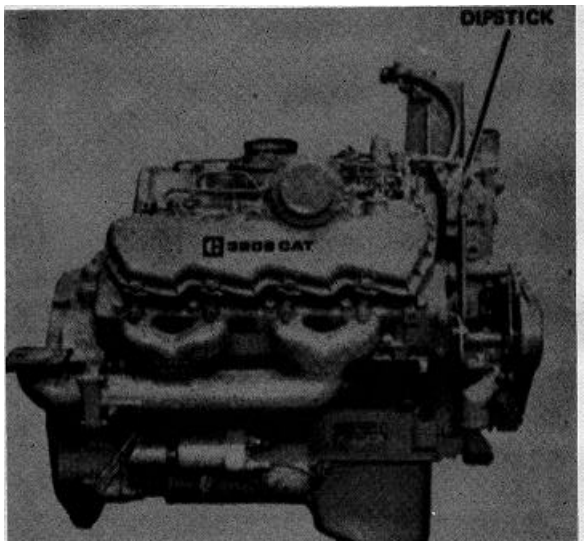
7. Refer to corresponding parts section for parts breakdown and assembly sequence. Component disassembly should be done in conjunction with component vendor manual, if available.

MAINTENANCE INSTRUCTIONS:

Daily:

ENGINE:

CHECK OIL LEVEL with dipstick oil level gauge with machine parked on level surface. Check should be made before starting or at least 15

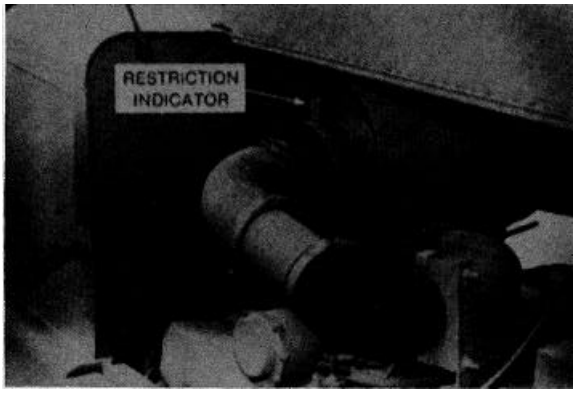


minutes after engine shutdown. Do not operate machine with oil level below the low mark or above the high mark. If necessary, add oil of the same quality and brand as already in engine (refer to LUBRICANTS SPECIFICATION CHART).

CHECK COOLANT LEVEL with engine cool and stopped. Maintain coolant level to within 1/2 inch (1,5 cm) below bottom of fill pipe. Do not fill completely as coolant will expand as it is heated. Add antifreeze, rust inhibitor or water as required, avoiding use of dirty water or water with high mineral content. Do not use anti-leak additives or antifreeze with anti-leak additives. Do not use 'DOWTHERM 209'. Causes of constant coolant loss should be investigated.

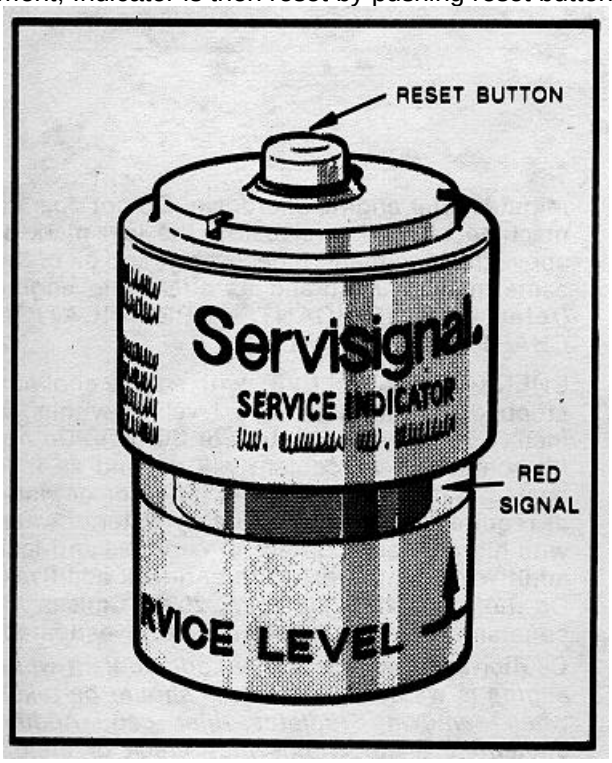
Caution: ***If it is necessary to add coolant while engine is warm, extreme care should be taken when removing radiator filler cap. Adding coolant to a hot engine may crack or distort engine components. If engine overheats, add coolant slowly with engine running.***

MAINTENANCE:

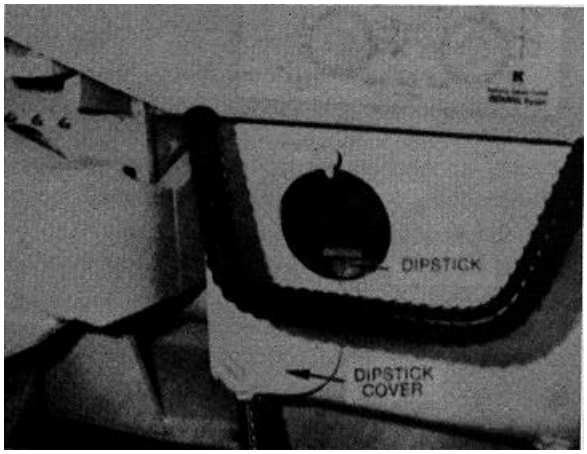


Air Inlet

CHECK AIR CLEANER RESTRICTION INDI- CATOR mounted on air cleaner inlet. The red flag in window rises as element loads with dirt. When the red flag reaches the top and is locked in position, clean or replace air cleaner element, Indicator is then reset by pushing reset button.



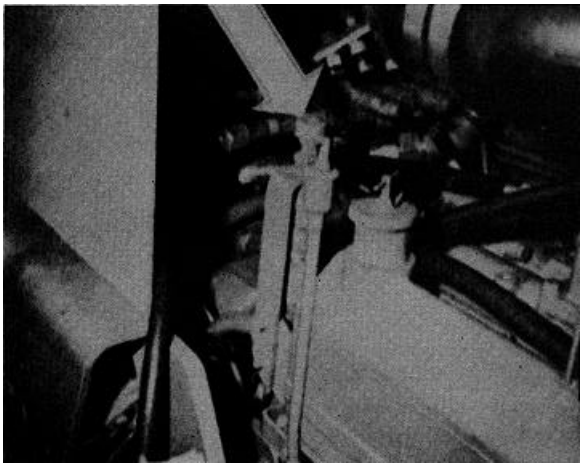
Air Cleaner Restriction Indicator



Transmission 0il Dipstick

TRANSMISSION:

CHECK OIL LEVEL daily on transmission ol.1 dipstick level gauge with engine idling and transmission oil at 180 to 200°F (82 to 93°C). Maintain oil level between dipstick markings, refilling as necessary, adding fluid (refer to LUBRICANTS SPECIFICATION CHART) through transmission fill plug.



Transmission 011 Filler-Breather Cap

HYDRAULICS:
REMOVE DEBRIS FROM AROUND DOZER CYLINDER to avoid damage to cylinder rod.

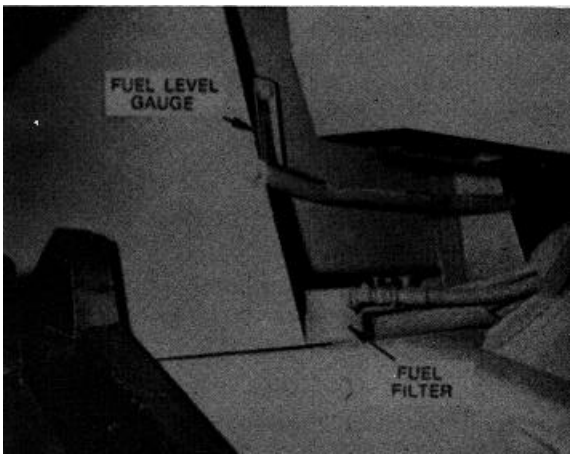
HYDRAULICS:

CHECK HYDRAULIC TANK LEVEL with ma- chine level, blade lowered and engine off. The level gauge Is mounted on the forward surface of the hydraulic tank on the operator's left. Refill as necessary, adding proper fluid (refer to LUBRICANTS SPECIFICATION CHART).



GENERAL:

CHECK FUEL LEVEL, filling as required with clean fuel handled In clean containers (refer to LUBRICANTS SPECIFICATION CHART), Fuel level gauge is located on rear side of fuel tank on operator's left.



VISUAL CHECK FOR LEAKS in hoses, cylinders, tanks, etc., should be made daily. Unexplained leaks or spills must be carefully investigated and corrected. Also inspect gen- eral machine for noticeable damage.

CHECK OPERATION OF ALL CONTROLS AND GAUGES. Do not operate machine if any are not functioning properly.

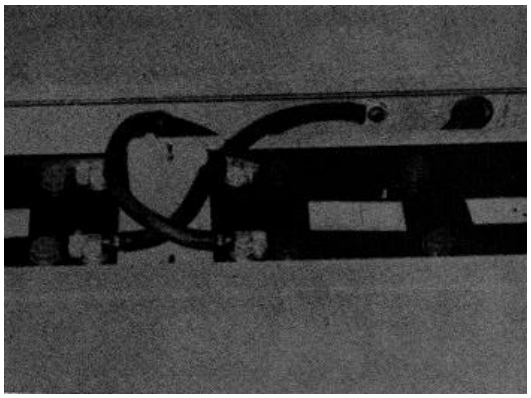
50 Hours:
ENGINE:
COMPLETE OIL AND FILTER CHANGE should be made after Initial 50 hours of operation and subsequently every 200 hours. Refer to vendor engine manual for detailed instructions.

CHECK AND ADJUST FAN BELTS, Check tension of each belt as described In vendor engine manual and check for excessive belt wear. If one belt In a set requires replacement, always install a new set of matched belts.

CHECK BATTERIES and connections, Termi- nals should be clean and tight and electrolyte level with the base of each vent well. Add distilled water as required but NEVER add acid or electrolyte, To test the electrolyte solution, measure the specific gravity with a hydrometer. At 80°F (27°C) hydrometer readings are:

1.250 - up	fully charged
1.225 - 1.250	full to half charge
1.150 - 1.225	half to low charge
1.000- 1.150	dead cell
1.00	water

To adjust hydrometer readings for temperature differences, subtract .004 (4 gravity points) from the specific gravity reading for every 10°F (5,5°C) the electrolyte temperature Is below 80°F (27°C). The corrected reading Is most Important during cold weather. Test each cell In the same manner. If there Is more than .050 (50 gravity points) variation between highest and lowest reading, replace the battery. If make up water Is added, allow the battery to charge for 2 to 4 hours before taking hydrometer readings. If the battery requires cleaning, apply a solution of baking soda and water with a brush. Rinse the battery and tray with clean water and apply grease to terminals,

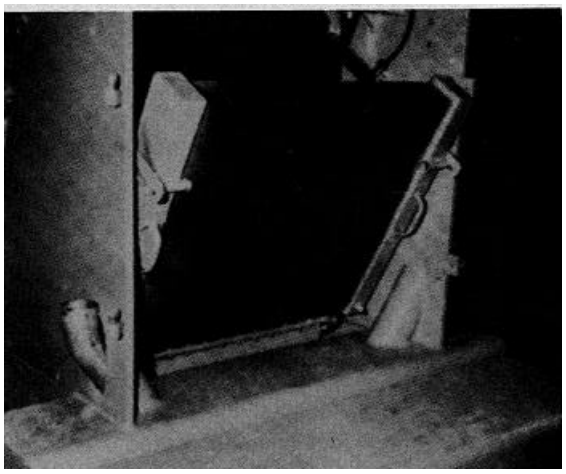


Battery Connections

MAINTENANCE:

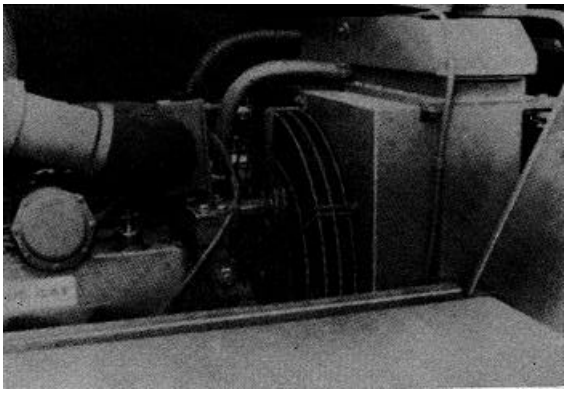
CHECK ANTI-FREEZE protection. Maintain readings well below anticipated temperatures, adding permanent type anti-freeze with rust inhibitors as required. Do not use anti-freeze with anti-leak additives. Do not use 'Dowtherm 209'

STEAM CLEAN RADIATOR every 50 hours or as required to maintain optimum cooling efficiency. The importance of a clean radiator cannot be overstressed. Remove air-oil cooler leaving hoses connected. Clean carefully and inspect core for bent or damaged fins.



Hinged Air-Oil Cooler

INSPECT RADIATOR HOSES and connections for leaks or damaged hoses.



Radiator Hose Connections

INSPECT AIR INLET CONNECTIONS for leaks or damaged tubing. If air by-passes the air filter and enters directly into the engine, serious damage may result.

TRANSMISSION:

OIL AND FILTER CHANGE should be made after initial 50 hours of operation, and there- after filter change every 200 hours and oil and filter change every 400 hours. Transmission oil should be at operating temperature. Remove sump screen, cleaning thoroughly and replace using new gaskets. Access to the filter can be made by removing rear floor plate' and seat mounting base, complete with seat. Using a chain or belt filter wrench, remove canister. Remove old element and check for foreign material deposits. Install new element and O ring. Install filter canister and torque to 20 to 25 ft-lbs (2,8 to 3,5 m-kg). Refill transmission to FULL mark (refer to LUBRICANTS SPECIFICATION CHART). Idle engine to prime converter and lines and recheck level, topping to FULL mark as required. When oil temperature is at operating temperature of 180 to 200°F (82 to 93°C) make final oil level check.

AXLES:

CHECK DIFFERENTIAL AND PLANETARY OIL LEVELS after machine operation but allow 5 minutes for all the oil to drain to its normal level. Planetary oil level is checked at filler plug on planetary end cap with filler hole at its lowest position, and differential oil level is checked at filler plug on differential housing. Add lubricant as necessary (refer to LUBRI- CANTS SPECIFICATION CHART).

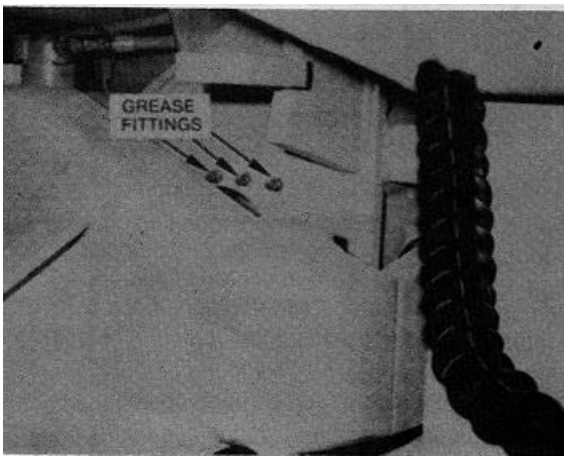
CHANGE OIL after initial 50 hours of operation with oil at operating temperature. Subsequent changes are made every 800 hours. Remove plug at bottom of axle housing and allow lubricant to drain. Replace drain plugs and fill with a light flushing oil. Operate axles for a short period of time, then drain. Inspect the magnetic drain plug for foreign particles indicative of wear or possible failure. Replace drain plugs

HYDRAULICS:

CHECK ALL HOSES AND CONNECTIONS for leaks, correcting where necessary. Damaged hoses should be replaced immediately to avoid further damage to other components.

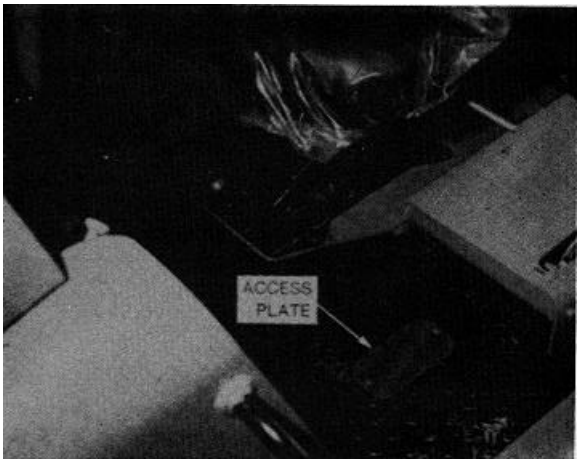
GENERAL:

GREASE ALL FITTINGS according to LUBRI- CATION DIAGRAM with proper lubricant (refer to LUBRICANTS SPECIFICATION CHART). Before servicing machine, always wipe dirt and foreign material from grease fittings.



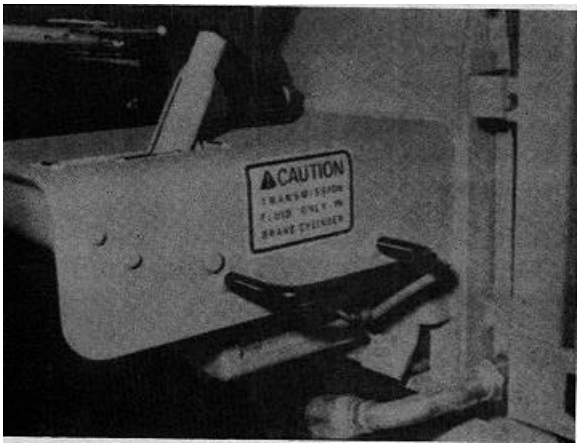
Center Joint Lubrication

CHECK MASTER BRAKE CYLINDER FLUID LEVEL by removing cover on rear floor plate.



Master Brake Cylinder Access

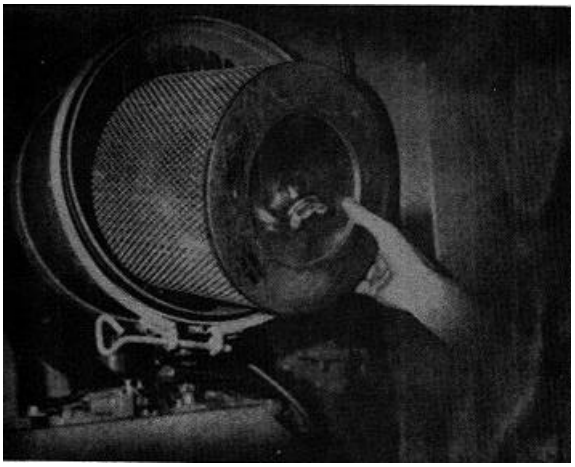
Note: *Use transmission fluid only [refer to LUBRICANTS SPECIFICATION CHART].*



100 Hours:

ENGINE:

CLEAN AIR FILTER ELEMENT every 100 hours or as indicated by air inlet restriction gauge. For cleaning procedure, refer to vendor air cleaner booklet.



MAINTENANCE:

AXLES:

CHECK WHEEL MOUNTING NUTS regularly and torque to 450 ft-lbs (62 m-kg). Loose wheel nuts will strain axle assemblies and affect steering and load distribution.

HYDRAULICS:

CHECK FOR CYLINDER LEAKAGE OR DAMAGE. Excessive leakage may require seal replacement.

GENERAL:

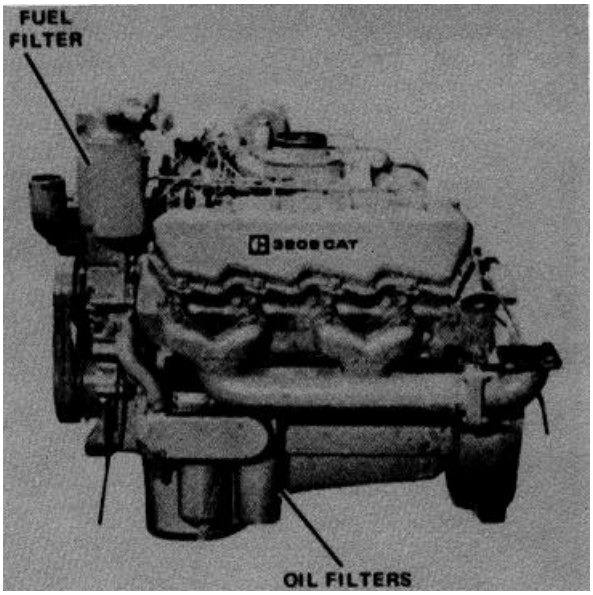
INSPECT ALL MOUNTED PARTS FOR looseness or noticeable damage.

200 Hours:

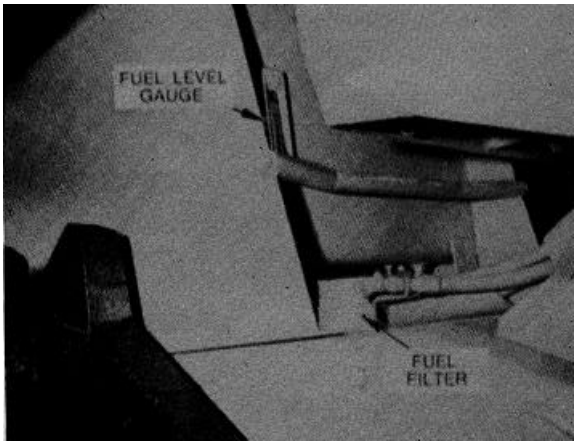
ENGINE:

CHANGE ENGINE OIL AND FILTER after machine operation as hot oil will drain away sediment. Refer to vendor engine manual for detailed instructions.

RECORD OIL PRESSURE after oil change with oil at operating temperature and engine at idle. Comparative readings will give an indication of progressive wear of engine components.



CHANGE FUEL FILTER every 200 hours, located on underside of fuel tank and on engine.



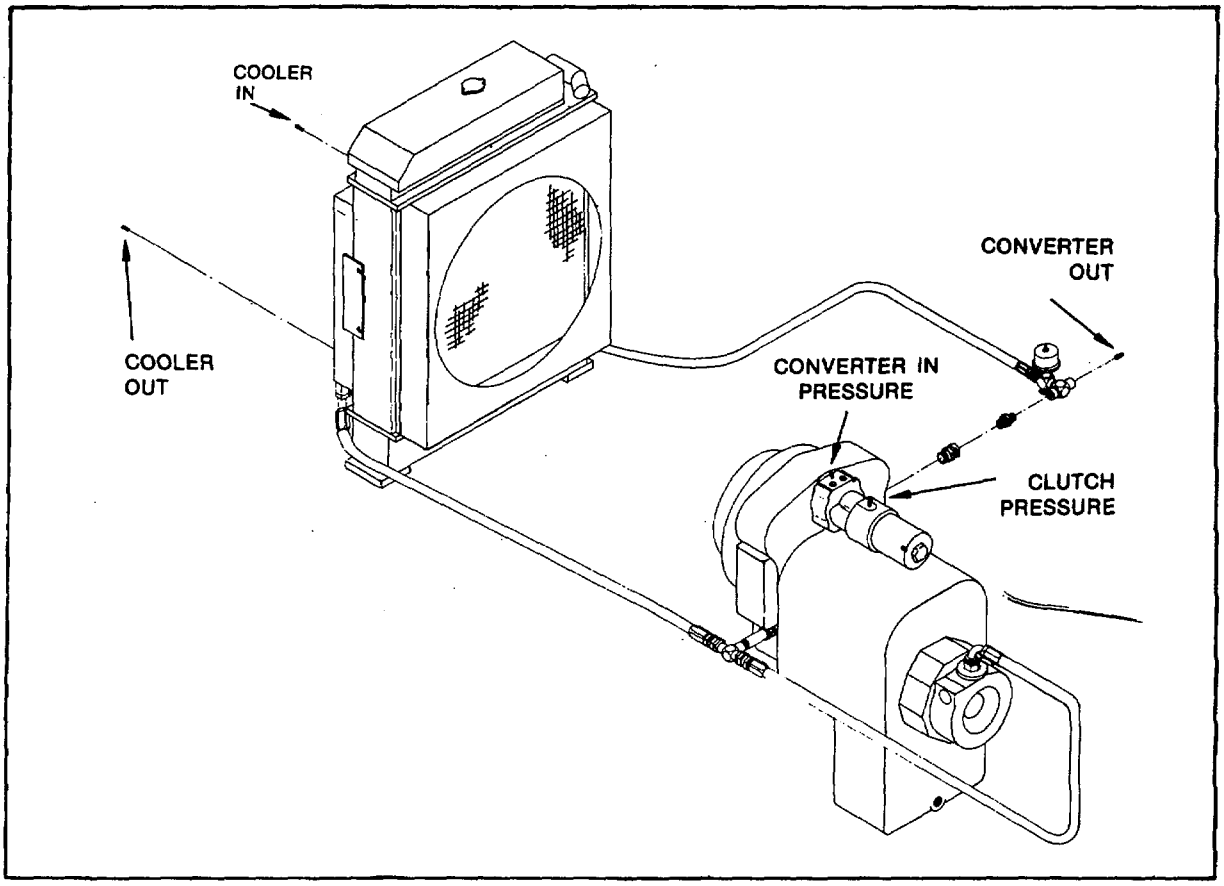
CHANGE AIR FILTER ELEMENT. Refer to vendor literature for recommended service procedure.

CHECK THROTTLE LINKAGE to see if in good operating condition. Make sure that linkage travel is free and unhindered.

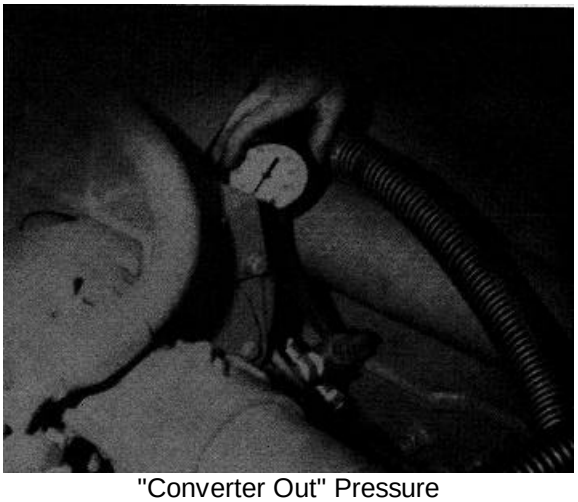
ADJUST VALVES after the first 200 hours of operation. Thereafter, valve adjustment is required only every 800 hours. Refer to vendor manual for detailed instructions.

TRANSMISSION:

CHANGE OIL FILTER every 200 hours with transmission oil at operating temperature of 180 to 200°F (82 to 93°C). Remove sump screen, cleaning thoroughly and replace using new gaskets. Access to the filter can be made by removing rear floor plate and seat mounting base, complete with seat. Using a chain or belt filter wrench, remove canister. Remove old element and check for foreign material de- posits. Install new element and O ring. Install filter canister and torque to20 to 25 ft-lbs (2,8 to 3,5 m-kg). Idle engine and check oil level, adding fluid as necessary (refer to LUBRI- CANTS SPECIFICATION CHART).



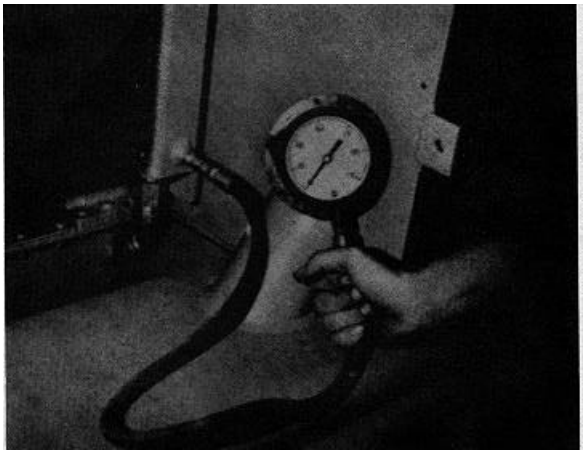
Transmission Oil System Pressure Testing



"Converter Out" Pressure

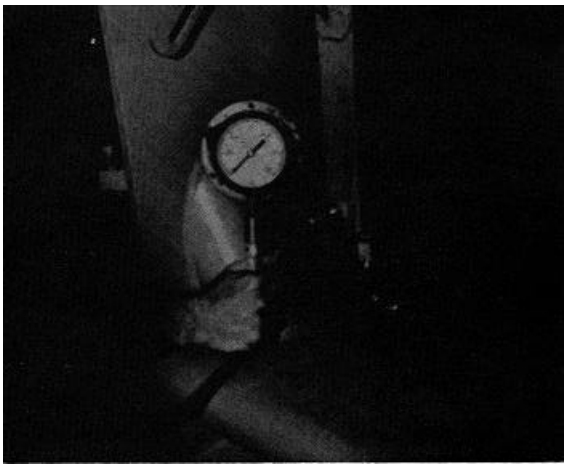
TRANSMISSION OIL PRESSURE TESTS should be made every 200 hours with transmission oil at operating temperature of 180 to 200°F (82 to 93°C).

1. "Converter Out" pressure reading is taken with a 150 psi pressure gauge installed in test port on tee fitting at transmission. Pressure reading should be a minimum of 25 psi (173 kPa/1,8 kg/sq. cm) with transmission shift lever in NEUTRAL and engine at 2000 RPM. Maximum pressure is not to exceed 70 psi (483 kPa14,9 kg/sq. cm) with transmission shift lever in NEUTRAL and engine operating with no load at governed speed (2800 RPM).



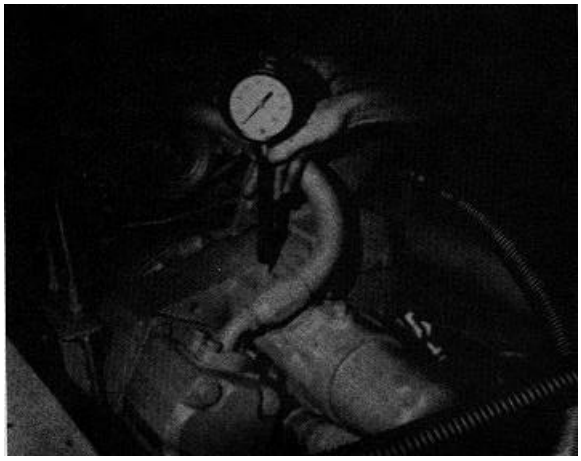
"Cooler out "Pressure Test

2. "Cooler Out" pressure reading is taken with a 150 psi pressure gauge at right hand test port at back of air-oil cooler. Reading should be 10 to 14 psi (69 to 96 kPalO,7 to 1,0 kg/sq. cm) less than "Converter Out" pressure with transmission shift lever in NEUTRAL and engine at 2000 RPM. If the pressure does not fall within the prescribed limits, a further check to localize the problem can be made at the left hand "Cooler In" test port at the back of the air-oil cooler.



"Cooler In" Pressure Test

3. "Converter In" pressure tested with a 150 psi pressure gauge should register 40 to 90 psi (276 to 620 kPa/2,8 to 6,3 kg /sq. cm) at test port on pump valve body. Pressure is checked with transmission shift lever in NEUTRAL and engine at 2000 RPM.



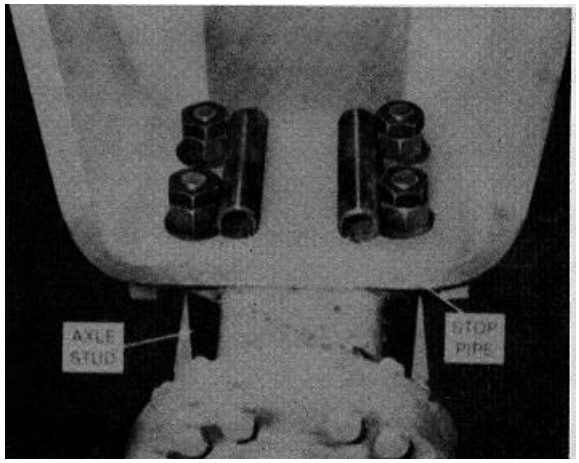
"Converter In" Pressure Test

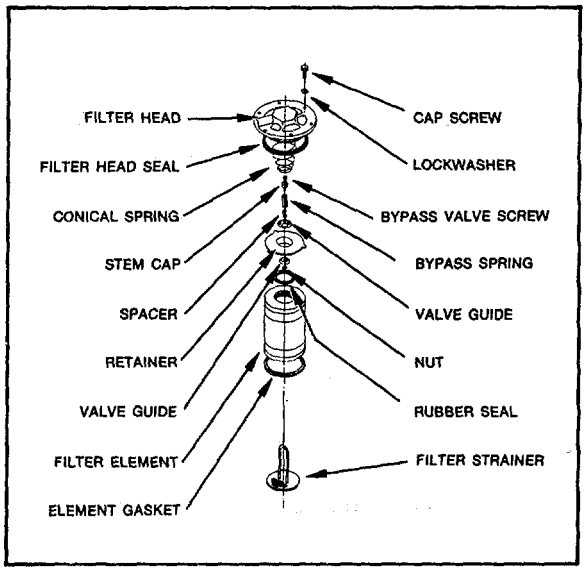
4. To test the "Clutch" pressure, the transmission oil should be at operating temperature of 180 to 200°F (82 to 93*C) and engine at idle (600 RPM). Shift through all direction and speed clutches with brake applied. With. a 300 psi pressure gauge installed in the test port on the filter housing, the clutch pressure should register 240 to 280 psi (1654 to 1930 kPa /16,9 to 19,6 kg /sq. cm). All clutch pressures must be equal within 5 psi (35 kPa/0,4 kg/sq. cm). If clutch pressure varies in any one clutch more than 5 psi, clutch requires repair.



"Clutch" Pressure Test

MAINTENANCE:





Hydraulic Filter

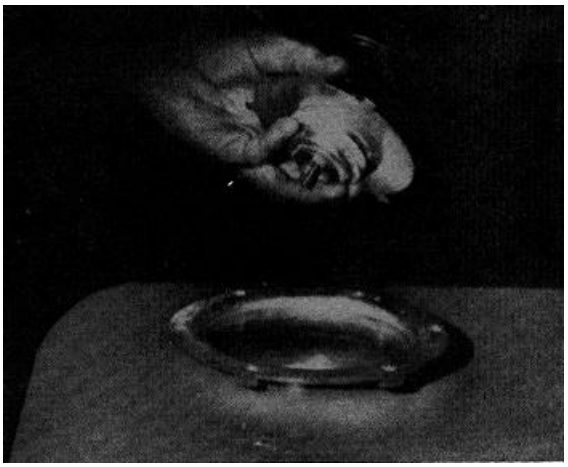
Note: *Care must be taken to replace all parts in proper sequence.*

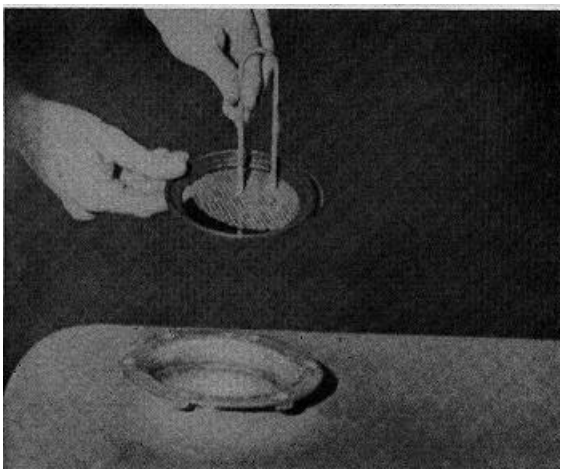
AXLES:

CHECK AXLE MOUNTING NUTS and torque to 700 ft-lbs (97 m-kg). Replace damaged nuts or axle mounting studs.

HYDRAULICS:

CHANGE HYDRAULIC FILTER. Clean all dirt from around the filter head and remove capscrews. Lift off filter head and remove coil spring.





Installing Filter Strainer

Remove filter by-pass valve assembly and filter element and check for foreign material. Remove the filter strainer, wash all parts in clean solvent and dry with lint-free cloth. Install strainer, new filter element and O rings. Install

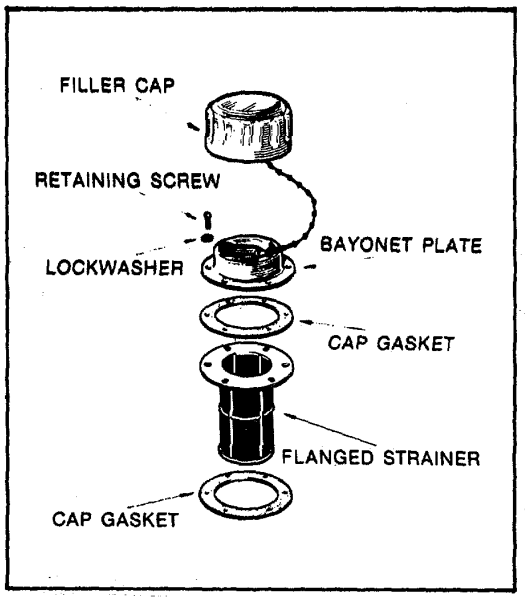
MAINTENANCE:



Installing Filter Element

by-pass valve assembly and replace head with large coil against filter head. Carefully place filter head and spring in housing. Care should be taken that the spring Is sitting properly on the by-pass valve. Install capscrews In filter head and torque to 20 ft-lbs (2,8 m-kg).

CLEAN FILLER-BREATHER CAP every 200 hours. Remove the hydraulic tank breather, located on the filler cap and wash In clean solvent. Blow dry and replace.



Hydraulic Oil Filler Cap

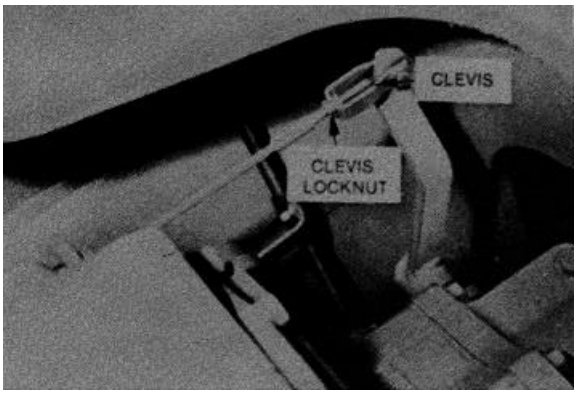
GENERAL:

CHECK FOR LOOSE NUTS AND BOLTS. Mounting bolts, especially on such components as engine, transmission, pump, steering gear and drive shafts will occasionally work loose and may cause unnecessary wear or even structural damage. Replace damaged or missing fasteners and tighten loose bolts according to TORQUE SPECIFICATIONS CHART.



Parking Brake Lever Adjustment

ADJUST PARKING BRAKE LEVER every 200 hours by rotating lever handle for minor adjustments or by adjusting parking brake cable.



Parking Brake Cable

MAINTENANCE:

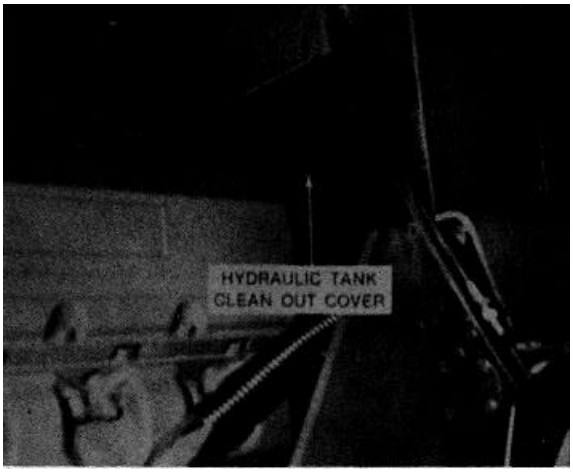
400 Hours:

TRANSMISSION:

CHANGE OIL AND FILTER after machine operation when oil is at operating temperature. Remove sump screen, cleaning thoroughly and replace using new gaskets. Access to the filter can be made by removing rear floor plate and seat mounting base, complete with seat. Using a chain or belt filter wrench, remove canister. Remove old element and check for foreign material deposits. Install new element and O ring. Install filter canister and torque to 20 to 25 ft-lbs (2,8 to 3,5 m-kg). Refill transmission to FULL mark (refer to LUBRICANTS SPECIFICA- TION CHART). Idle engine to prime converter and lines and recheck level, topping to FULL mark as required. When oil Is at operating temperature of 180 to 200°F (82 to 930C) make final oil level check.

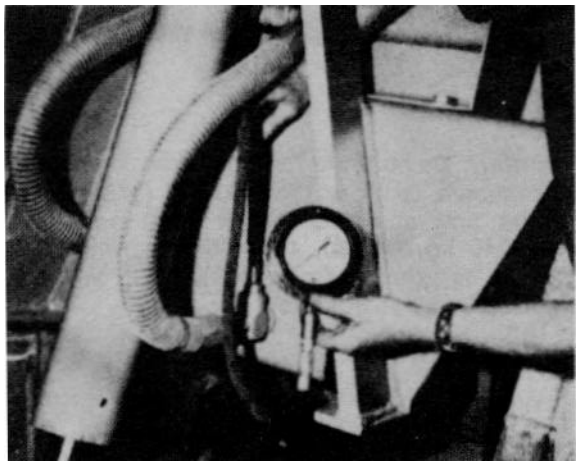
HYDRAULICS:

DRAIN AND CLEAN HYDRAULIC TANK every 400 hours. Park machine on level ground, set parking brake, lower blade and drain hydraulic oil into a 50 Imp. gallon (60 US gal /220 liter) container.



Remove the tank clean-out cover located on engine side of tank. Clean out all foreign material and flush with clean hydraulic fluid. Replace clean-out cover using new gasket. At this time it is advisable to replace the hydraulic filter element, detailed previously, clean the hydraulic filter strainer and clean filler- breather cap strainer. Refill the hydraulic tank with clean hydraulic fluid
(refer to LUBRI CANTS SPECIFICATION CHART).

DOZER SYSTEM PRESSURE TESTING AND ADJUSTMENT should be made every 400 hours after machine operation with hydraulic oil at operating temperature. Install a 3000 psi pressure gauge In dozer hydraulic system test port on front frame bulkhead at dozer cylinder hose. With engine RPM at 2000, check relief valve pressure by raising dozer blade to maximum height and taking gauge reading.

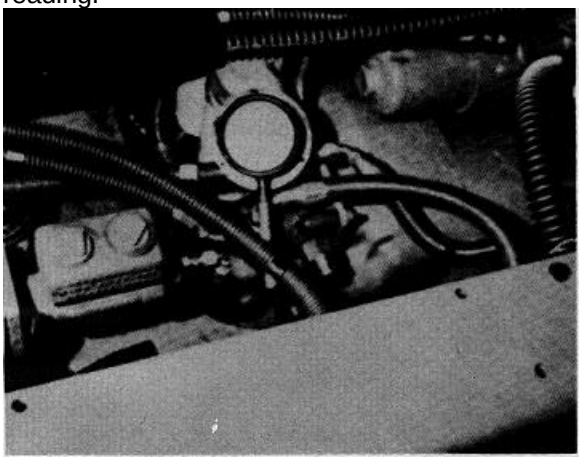


Dozer System Pressure Test

Caution: ***Do not hold for more than 30 seconds.*** If pressure is more than 50 psi (345 kPa/3,5 kg/sq. cm) above or below 1500 psi (10335 kPa 106 kg/sq. cm), the relief valve should be adjusted (refer to SERVICE MANUAL for detailed instructions).

MAINTENANCE:

STEERING SYSTEM PRESSURE TESTING AND ADJUSTMENT should be made every 400 hours after machine operation with hydraulic oil at operating temperature. Park machine on level ground, set parking brake and lower blade. Remove top bulkhead cover and rear floor plate. Install a 3000 psi pressure gauge in test port on bottom of steering relief valve. With engine RPM at 2000, check steering relief pressure by turning machine to a full lock (fully turned) position and taking gauge reading.



Steering System Pressure Test

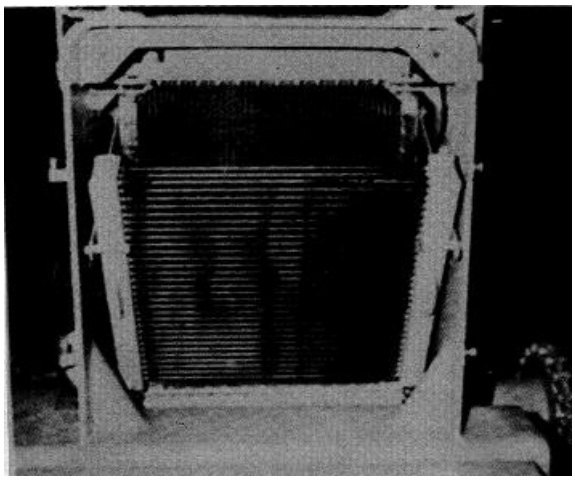
Caution: *Do not hold for more than 30 seconds.* **I**f pressure is more than 50 psi (345 kPa,3,5 kg/sq. cm) above or below 2000 psi (13780 kPal140 kg/sq. cm), the steering relief valve should be adjusted (refer to SERVICE MANUAL
for detailed instructions).

GENERAL:
CHECK AND ADJUST ALL CONTROL LEVERS, LINKAGES AND CABLES. Inspect and lubricate all mechanical controls to make sure they are in good operating condition.

STEAM CLEAN MACHINE every 400 hours or periodically as required. Dirt accumulation may become detrimental to machine operation. Protect alternator and starter motor by covering them before steam cleaning. Steam is recommended as the most effective method but if unavailable, use a spray of mineral spirits or similar solvent which is non-harmful to hoses or exposed electrical harnesses.

INSPECT WIRING HARNESSES and connections for loose or damaged connections, chafed wire, etc.

800 Hours:
ENGINE:
DRAIN AND FLUSH RADIATOR every 800 hours or twice yearly. Remove thermostat and reverse flush the system. Refill to within 1/2 inch (1,5 cm) below bottom of fill-pipe with required combination of anti-freeze (with rust inhibitor) and clean water.
Note: *Do not use 'DOWTHERM 209'.*



Radiator

MAINTENANCE:

CHECK FAN HUB AND FAN MOUNTING for damage and torque fasteners according to TORQUE SPECIFICATIONS CHART. For assembly and disassembly instructions, refer to vendor engine manual in SERVICE MANUAL.

INSPECT ENGINE MOUNTS for damage or deterioration, replacing if necessary.
CHECK EXHAUST SYSTEM AND CONNECTIONS for leaks or component damage.
DRAIN AND CLEAN FUEL TANK every 800 hours. After draining fuel into container, remove sediment from bottom of tank. Flush tank with diesel fuel and then refill with clean fuel (refer to LUBRICANTS SPECIFICATION CHART).
COMPLETE ALL SERVICE FUNCTIONS as indicated in engine vendor manual.

TRANSMISSION:
ADJUST BRAKE (refer to vendor transmission manual in SERVICE MANUAL).

AXLES:

CHANGE OIL after machine operation and oil is at operating temperature. Remove plug at bottom of axle housing and allow lubricant to drain. Rotate wheel until planetary filler hole is at the lowest position, remove plug and allow to drain. Replace drain plugs and fill with a light flushing oil. Operate axles for a short period of time, then drain. Inspect the magnetic drain plug for foreign particles indicative of wear or possible failure. Replace drains plugs and refill with clean oil (refer to LUBRICANTS SPECIFICATION CHART). Be sure thrust cap oil level is in proper position when refilling planetary.

ADJUST WHEEL HUB BEARING PRELOAD (refer to SERVICE MANUAL).

CHECK DIFFERENTIAL FLANGE BEARING END PLAY (refer to SERVICE MANUAL).

GENERAL:

INSPECT FRAME AND DOZER WELDMENTS for cracks or noticeable damage. Structural damage should be repaired immediately to prevent further damage.

TROUBLE-SHOOTING GUIDE

CAUSE	INDICATED BY	REMEDY
ENGINE FAILS TO CRANK OVER:		
1. Dead battery	Low electrolyte reading	Charge battery
2. Machine in gear	Forward-reverse lever not in neutral	Select neutral position
3. No electrical current to start switch	Electrical system inoperative	Check wiring from starter relay to ammeter for broken circuit
4. Defective neutral start switch	No electrical current to starter relay	Check by installing a jumper wire across neutral switch. Replace if defective.
5. Defective starter relay	Electrical current but no operation	Check for proper ground. Replace if defective.
ENGINE CRANKS OVER BUT FAILS TO START:		
1. Insufficient fuel	Low fuel level reading	Fill fuel tank
2. Restricted fuel flow	a) Dirty fuel filter b) Restricted or broken fuel lines c) Air in fuel system	Change fuel filter Blow out all fuel lines with compressed air Replace damaged lines Locate and correct leak Bleed fuel system
3. Water in fuel	-	Drain, clean and refill fuel tank
4. Insufficient air	Excessive black smoke while cranking engine	a) Check for intake restriction b) Change air filter element
5. Fuel solenoid not opening	No smoke while cranking engine	a) Release handbrake b) Check wiring from ignition switch to fuel solenoid *for* broken circuit c) Check fuel solenoid for proper operation
6. Low engine compression	a) Excessive black smoke b) Low compression reading	Refer to engine manual Refer to engine manual
ENGINE RUNS ROUGH:		
1. Air system	--	Check for air intake restriction
2. Fuel system	a) Dirty fuel filter b) Restricted or broken fuel lines c) Air in fuel system	Change fuel filter Blow out all fuel lines with compressed air Locate and correct leak Bleed fuel system
	d) Water in fuel	Drain, Clean and refill fuel tank

TROUBLE-SHOOTING GUIDE

CAUSE	INDICATED BY	REMEDY
EXCESSIVE ENGINE NOISE:		
1 Worn or damaged engine components	-	Inspect and replace damaged parts. Refer to engine manual
2. Engine mounts	-	Inspect and replace damaged engine mounts. Torque fasteners
3. Loose or worn fan belts	-	Replace or adjust belts
EXCESSIVE ENGINE VIBRATION:		
1. Faulty vibration mounts	-	Inspect and replace mounts if necessary
2. Unbalanced or loose flywheel	-	Tighten flywheel
ENGINE SMOKES:		
1. Insufficient air	Black or gray smoke	Check for intake restriction
2. Insufficient fuel	Black or gray smoke	a) Check for fuel line restriction b) Refer to engine manual
3. Restriction in exhaust	Black or gray smoke	Inspect and correct
4. Excess lubrication oil	White or blue smoke	Remove extra oil
LOW ENGINE OIL PRESSURE:		
1. Defective oil pressure gauge	-	Install new gauge
2. Insufficient oil flow	-	a) Check oil filter, changing if necessary b) Oil suction line restriction c) Low in crankcase oil d) Wrong grade of oil for weather conditions
3. Diesel fuel in lubrication oil	-	Locate and correct leak. Change lubrication oil and filter
4. Oil pump malfunction	-	a) Replace oil pump suction pipe b) Clean or repair oil pump relief valve c) Repair or replace oil pump
5. Cooling system malfunction	a) Insufficient coolant	Check coolant level, adding if necessary
	b) Dirty radiator	Steam clean radiator
	c) Dirty engine	Steam clean engine exterior
	d) Loose or worn fan belts	Replace or adjust fan belts

TROUBLE-SHOOTING GUIDE

CAUSE	INDICATED BY	REMEDY
COOLANT TEMPERATURE TOO HIGH		
1. Defective temperature gauge		a) Check gauge grounding b) Check if sender lead is shorted to ground c) Replace defective gauge
2. Defective thermostat	-	Replace thermostat
3. Defective water pump	-	Replace water pump
4. Restricted or damaged water line	-	Inspect rad hoses, changing if necessary
5. Restricted air flow through radiator	-	a) Remove restrictions b) Steam clean radiator c) Inspect and adjust fan belts
6. Insufficient coolant	-	Add coolant
COOLANT IN LUBRICATION OIL:		
1. Defective oil cooler	-	Replace oil cooler core
2. Failure of cylinder head gasket	-	Install new gasket
3. Cracked or defective cylinder head or block	-	Install new parts as necessary
OIL IN COOLING SYSTEM:		
1. Defective oil cooler	-	Replace oil cooler core
2. Failure of cylinder head gasket	-	Install new gasket
LOSS OF POWER:		
1. Air system	-	Check for air intake restriction
2. Fuel system	a) Air in fuel system	Locate and correct leak. Bleed fuel system
	b) Dirty fuel filter	Change fuel filter
	c) Restricted or broken fuel lines	Blow out all fuel lines with compressed air. Bleed fuel system
	d) Water in fuel	Drain, clean and refill fuel tank
	e) Cannot reach governed RPM	Check and adjust throttle linkage
3. Excess engine lubrication oil	High reading on dipstick	Remove extra oil
4. Insufficient transmission fluid	Low reading on dipstick	Fill transmission to proper level

TROUBLE-SHOOTING GUIDE

CAUSE	INDICATED BY	REMEDY
ENGINE RUNS BUT MACHINE WILL NOT DRIVE IN EITHER DIRECTION:		
1. Insufficient transmission fluid	Low reading on dipstick	Fill transmission to proper level
2. Faulty transmission control linkage	-	Check all linkage and cables for proper adjustment
3. Plugged charge pump suction line or filter	Low or zero charge pressure	Replace or clean suction line and filter
4. Defective charge pump or relief valve	Low or zero charge pressure	Replace defective assembly
5. Defective fiber ring gear Hydraulic system inoperative	Zero charge pressure. ring gear	Remove engine and replace
MACHINE OPERATES IN ONE DIRECTION ONLY:		
1. Defective control linkage	-	Check and adjust
2. Defective clutch pack	Low or zero clutch pressure	Refer to transmission service manual
TRANSMISSION OVERHEATS:		
1. Insufficient transmission fluid	Low reading on dipstick	Fill to proper level
2. Insufficient cooling	Dirty or plugged cooler	Remove transmission oil cooler and clean rad and cooler assembly
3. Insufficient oil flow thru cooler	Low gpm reading	Remove and flush oil cooler
4. Transmission brake not released	-	Check control and adjustment
5. Plugged charge pump suction line or filter	Low charge pressure	Replace or clean suction line and filter
6. Defective charge pump or relief valve	Low charge pressure	Replace defective assembly
TRANSMISSION PRESSURE SYSTEM ANALYSIS :		
1. Low oil level	Converter out pressure low Clutch pressure low	Fill to proper level
2. Cooler or system restriction Cooler out pressure drop low	Converter out, pressure high	a) Check cooler hoses for restriction b) Clean cooler c) Replace defective cooler
3. Defective pump or relief valve	a) Converter out pressure low Converter pressure low Clutch pressure low	Repair or replace defective pump or relief valve
	b) Converter pressure high Clutch pressure high	Repair or replace defective relief valve

TROUBLE-SHOOTING GUIDE

CAUSE	INDICATED BY	REMEDY
4. Defective control valve	Converter pressure low	Repair or replace defective control valve
5. Defective converter	Converter pressure low	Repair or replace converter
6. Plugged filter or suction screen	Converter and clutch pressure low	Clean or replace filter or suction screen
7. Worn or damaged clutch seal rings	Clutch pressure low	Replace clutch seal rings
TRANSMISSION OIL FLOW SYSTEM ANALYSIS:		
1. Cooler or system restriction	Flow reading low	a) Check cooler hoses for restriction b) Clean cooler c) Replace defective cooler
2. Defective pump	Flow reading low	Repair or replace pump
3. Plugged filter or suction screen	Flow reading low	Clean or replace filter or suction screen
DRIVELINE VIBRATION OR NOISE:		
1. Lack of lubricant	-	Grease drive line fittings
2. Backlash due to worn bearings	-	Replace bearings
3. Yokes not in line	-	Separate drive line and reassemble correctly
4. Out of balance drive line	-	Disassemble drive line, clean and replace defective parts
HYDRAULIC SYSTEM INOPERATIVE:		
1. Insufficient hydraulic fluid	Low level reading	Fill to proper level
2. Plugged suction line or filter	Low or zero pressure reading	Replace or clean suction line filter
3. Defective pump or relief valve	Low or zero pressure reading	Replace defective unit
4. Defective fiber ring gear	Machine will not drive	Remove engine and replace ring gear

TROUBLE-SHOOTING GUIDE

CAUSE	INDICATED BY	REMEDY
DOZER NOT OPERATING:		
1. Faulty control linkage	-	Check all linkages for proper adjustment
2. Worn or damaged control valve	Low or zero pressure to dozer cylinder	Replace defective unit
3. Defective dozer cylinder	Blade drops when the control lever is in the hold position	Replace or repair dozer cylinder
HYDRAULIC BRAKES INOPERATIVE:		
1. Insufficient fluid in master cylinder	-	Refill master cylinder and bleed brakes **Note:** *Use only* Type A trans. *fluid*
2. Defective master cylinder	Pedal goes slowly to floor and fluid level remains constant	Replace or repair master cylinder
3. Defective transmission cylinder seals	Pedal goes slowly to the floor and fluid level decreases (Note**:** No external leaks)	Remove transmission brake assembly and replace seals
4. Defective brake spool valve or seals	Pedal goes slowly to the floor and fluid level decreases (Note: No external leaks)	Remove brake spool valve and replace seals
STEERING DIFFICULT OR INOPERATIVE:		
1. Oil level Is low	Slow or hard steering	Fill to proper level
2. Dirt In system	a) Slow or hard steering b) Continuous steering wheel rotation	Drain, flush and refill with clean fluid
3. Plugged line	Slow or hard steering	Check lines
4. Worn sleeve, spool or orbit gear	Slow or hard steering	Check and replace
5. Defective pump or actuator	a) Slow or hard steering b) No response	Repair or replace defective pump or actuator
6. Linkage or valve binding	a) Steering wheel does not center b) Continuous steering wheel rotation	Realign linkage or valve
7. Lines hooked up Incorrectly	Wrong response to steering wheel	Reconnect lines
8. Orbit gear misaligned	Wrong response to steering wheel	Realign orbit gear

CAUSE	INDICATED BY	REMEDY
9. Defective steering cylinder	a) Slow steering operation b) Oil leaking from seals	Replace or repair cylinder
ALTERNATOR WARNING LIGHT ON :		
1. Key on - engine not running	-	-
2. Key on - engine not accelerated	-	Depress throttle pedal
3. Worn or damaged alternator belt		a) Adjust belt tension b) Replace worn belts
4. Charging circuit malfunction	Alternator not charging	Check charging circuit

TORSUE SPECIFICATIONS FOR FASTENERS

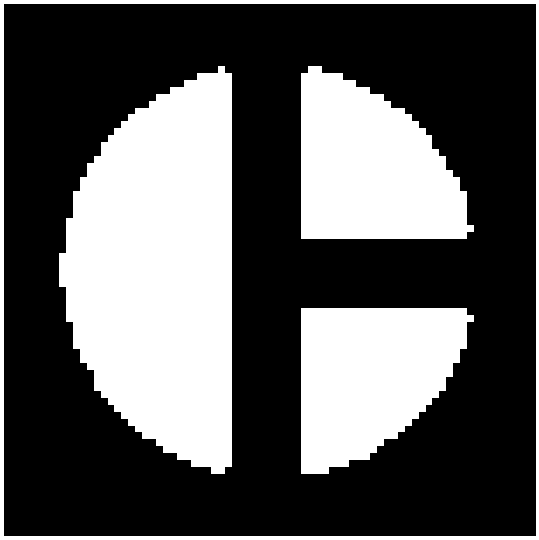
SAE GRADE NUMBER	 Grade 2		 Grade 5		 Grade 8	
NOMINAL THREAD SIZE	Torque Specifications in ft.-lbs. (m-kg)					
	DRY	LUBRICATED OR PLATED	DRY	LUBRICATED OR PLATED	DRY	LUBRICATED OR PLATED
1/4 - 20 UNC	5 (0,69)	4 (0,55)	8 (1,1)	5 (0,69)	–	–
28 UNF	6 (0,83)	5 (0,69)	10 (1,4)	6 (0,83)	–	–
5/16 - 18 UNC	11 (1,5)	8 (1,1)	17 (2,4)	11 (1,5)	–	–
24 UNF	13 (1,8)	10 (1,4)	19 (2,6)	15 (2,1)	–	–
3/8 - 16 UNC	18 (2,5)	13 (1,8)	31 (4,3)	22 (3,0)	45 (6,2)	30 (4,1)
24 UNF	20 (2,8)	15 (2,1)	35 (4,8)	25 (3,5)	50 (6,9)	35 (4,8)
7/16 - 14 UNC	28 (3,9)	19 (2,6)	49 (6,8)	35 (4,8)	70 (9,7)	50 (6,9)
20 UNF	30 (4,1)	22 (3,0)	55 (7,6)	40 (5,5)	80 (11,1)	60 (8,3)
1/2 - 13 UNC	39 (5,4)	27 (3,7)	75 (10,4)	60 (8,3)	105 (14,5)	80 (11,1)
20 UNF	41 (5,7)	28 (3,9)	85 (11,8)	65 (9,0)	120 (16,6)	90 (12,4)
9/16 - 12 UNC	–	–	110 (15,2)	80 (11,1)	155 (21,4)	115 (15,9)
18 UNF	–	–	120 (16,6)	90 (12,4)	170 (23,5)	130 (18,0)
5/8 - 11 UNC	–	–	150 (20,7)	115 (15,9)	210 (29,0)	160 (22,1)
18 UNF	–	–	170 (23,5)	130 (18,0)	240 (33,2)	180 (24,9)
3/4 - 10 UNC	–	–	270 (37,3)	200 (27,7)	375 (51,9)	285 (39,4)
16 UNF	–	–	295 (40,8)	225 (31,1)	420 (58,1)	315 (43,6)
7/8 - 9 UNC	–	–	395 (54,6)	295 (40,8)	605 (83,7)	455 (62,9)
14 UNF	–	–	435 (60,2)	325 (44,9)	675 (93,4)	500 (69,2)
1 - 8 UNC	–	—	590 (81,6)	445 (61,5)	910 (125,9)	685 (94,7)
14 UNF	–	–	660 (91,3)	485 (67,1)	990 (136,9)	745 (103,0)

NOTES:
1. Use torque values listed above unless otherwise noted.
2. Use of Loctite classes the fastener as lubricated.
3. Fasteners threaded into components of a softer material (e.g. aluminum, zinc) may require reductions in torque specifications.

VENDOR LITERATURE

CONTENTS:

Engine Maintenance Manual
Air Cleaner Service Booklet
Transmission Lubrication Care
Axle Lubrication Care



O P E R A T I O N
G U I D E

3208 INDUSTRIAL ENGINE

90N 1-UP

FOREWORD

This Operation Guide contains operation instructions, and lubrication and maintenance information. Application of this information should maximize performance and life of the engine; and minimize the costs of engine operation.

Caterpillar engines are found in many applications. Therefore, the illustrations in this Guide are typical and may not be of your specific engine or application.

Familiarize yourself with the components installed on your engine as described in the instructions. Some components described in the instructions may not be on your engine or installation.

Continuing improvement and advancement of product design may cause changes to your engine which may not be included in this publication. Each publication is reviewed and revised, as required, to update and include these changes in later editions.

Whenever a question arises regarding your Caterpillar product, or this publication, please consult your Caterpillar dealer for the latest available information.

The services of authorized Caterpillar dealers are recommended. Your dealer is staffed with trained personnel who are equipped with proper tools, necessary Caterpillar parts, and are trained in the latest service procedures.

ENGINE OPERATION

GENERAL

Proper engine operation and maintenance are essential to long engine life and maximum performance. The essentials for proper operation and normal periodic maintenance are outlined in this guide. However, your Caterpillar dealer is available for troubleshooting and/or repairs when required.

Before starting the engine, familiarize yourself with these procedures and apply the principles to your particular installation.

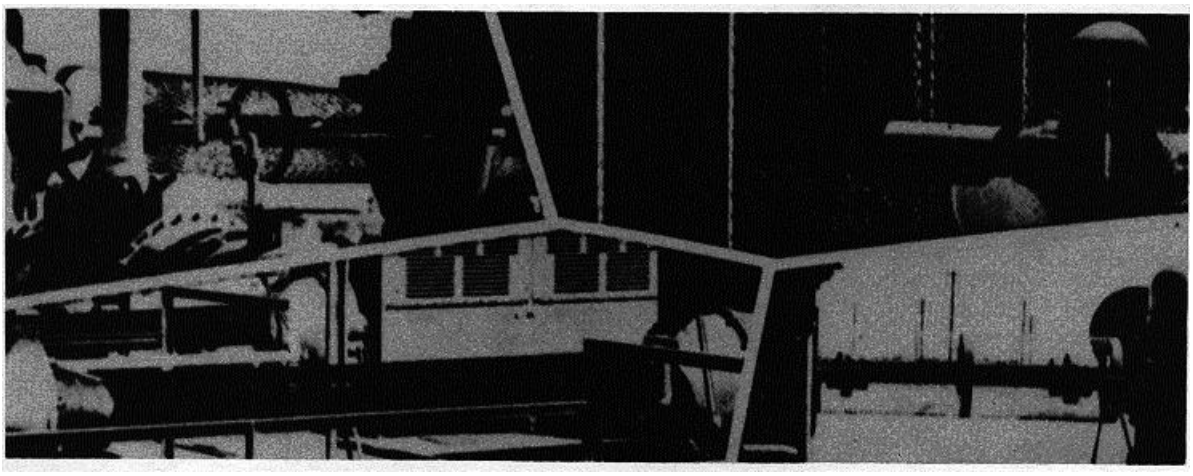
SAFETY PRECAUTIONS

Safety is basically common sense. There are standard safety rules but each situation has Its own peculiarities which cannot always be covered by rules. Therefore with your experience and common sense, you are in a position to do something about safety. Lack of attention to safety can result in: accidents, personal injury, reduction of efficiency and worst of all - loss of life. Watch for safety hazards. Correct deficiencies promptly.

Use the following safety precautions as a general guide to safe operation.

1. Never adjust or repair a machine while It is In operation.
2. Remove all tools and electrical cords before starting.
3. Keep the engine room and floor area clean.
4. Store oily rags in containers,
5. Never store flammable liquids near the engine.
6. Observe NO SMOKING signs.
7. Do not smoke around batteries. Hydrogen gas generated by charging is explosive. Keep batteries in a well ventilated area.
8. Do not wear loose clothing around machinery.
9. Be sure the engine room is properly ventilated.
10. Always disconnect and tape the ground battery lead before working on the electrical system.
11. All electrical equipment must be grounded according to local building ordinances.
12. Be sure an automatic tart-stop system is inoperative when the engine or generator Is being worked on. Disconnect and tape the ground battery lead.

Remember, safety Is everyone's business,



INSTALL GUARDS ON ALL EXPOSED ROTATING COMPONENTS

PERIODS OF LIMITED USE

A prolonged period without use is not good for any piece of machinery. Engines should be started and cycled every week. Load the engine every two weeks to the extent that it would be in normal operation. This is particularly important for standby power. Prolonged idling or running under a reduced load may cause oil consumption and carboning In the combustion chamber and result in poor performance and a loss of power. If long periods of Idling are neces**sary,** run the engine under load every four hours to clear carbon from the combustion chambers.

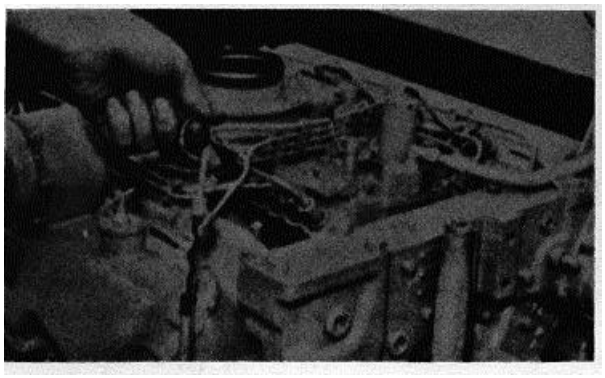
If an engine is going to be put in storage see your Caterpillar dealer for storage instructions.

STARTING

Perform required periodic maintenance before starting the engine. Make a "walk-around" check of the installation. It takes only a few minutes to correct minor discrepancies that can develop into major repair jobs.

PRE-START CHECKS

1. Correct any leaks, loose bolts or covers, and obstructions. The fan and radiator must be clear of restrictions.
2. Check the coolant level. Maintain coolant level to within 1/2 Inch (1 cm) below bottom of fill pipe.



OIL LEVEL

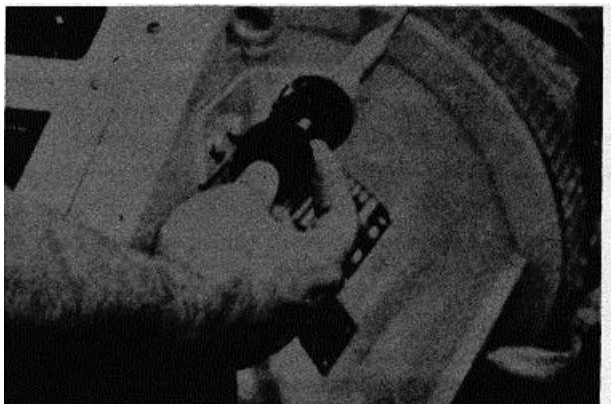
3. The crankcase oil level must be above the ADD mark on the dipstick.
4. Disconnect any battery chargers that are not protected against the starter current drain.
5. All guards must be in place. If guards are Inadequate or In need of repair, notify your supervisor.

If an engine has not been run for several weeks, fuel may have drained from or air accumulated in the filter housing. When fuel filters have been changed, some air space will be left In the housing. In these instances, prime the fuel system until pressure registers on the gauge.

STARTING PROCEDURE

ELECTRIC START

1. Open the fuel supply valve. The fuel return line must be open to prevent engine damage.
2. Disengage the clutch or open the circuit breaker. Do not start an engine under load.
3. Move the controls to half engine speed position. Push In on the center knob and simultaneously pull back the control knob.



OPERATING GOVERNOR CONTROL

4. Turn the start switch to START position. Start the engine using starting aids as necessary.

If the engine fails to start after 30 seconds of cranking, allow the starter to cool for two minutes before repeating the starting procedure.

CAUTION

Do not engage the starter when the flywheel is moving.

5. As the engine starts, release the start switch. It will return to the RUN position.

Clearances and tolerances are designed for operating conditions - including operating temperature. After the engine is started it takes several minutes to establish the lubricating oil film and allow the moving parts to heat up and expand. Loading a cold engine will cause shortened service life; i.e., broken rings, seized pistons, etc. This warm up period allows time for another "walk-around" check for leaks, etc.

WARNING

Do not attempt repairs or adjustments while the engine is running.

COLD WEATHER STARTING

These engines are designed to start at temperatures above 10 F without using starting aids. If temperature is below 10°F, a starting aid may be necessary and/or crankcase oil may need to be heated.

ETHER - Ether is much more volatile than diesel fuel and is used to start combustion of the fuel-air mixture.

WARNING

Ether is volatile and must be stored away from heat and direct sunlight. See the instructions on the container.

Engine mounted either dispensers are available commercially. Aerosol cans can also be used. Point the can opening at the air inlet and give a quick spray while cranking the engine. Too much ether will cause excessively high pressure and detonation. Liquid ether can be used by pouring a small amount on a cloth and holding the cloth in front of the air cleaner while the engine is cranking. Be sure the cloth is outside the air cleaner and cannot be drawn into the engine.

WARNING

DO NOT use ether after the engine has started. DO NOT inhale ether fumes.

In extremely cold climates, additional aids such as water heaters and battery heaters may be used. Contact your Caterpillar dealer before installing submersible crankcase oil heaters.

STOPPING

1. Remove the load from the engine.
2. Allow the engine to run at about half speed for five minutes. This allows internal temperatures to reduce gradually and prevents the loss of coolant by "afterboil"
3. Reduce speed to low idle for about 30 seconds.
4. Stop the engine by turning the START switch to OFF. The governor control will not stop the engine.

If an engine is going to be put in storage see your Caterpillar dealer for storage instructions.

ATTACHMENTS

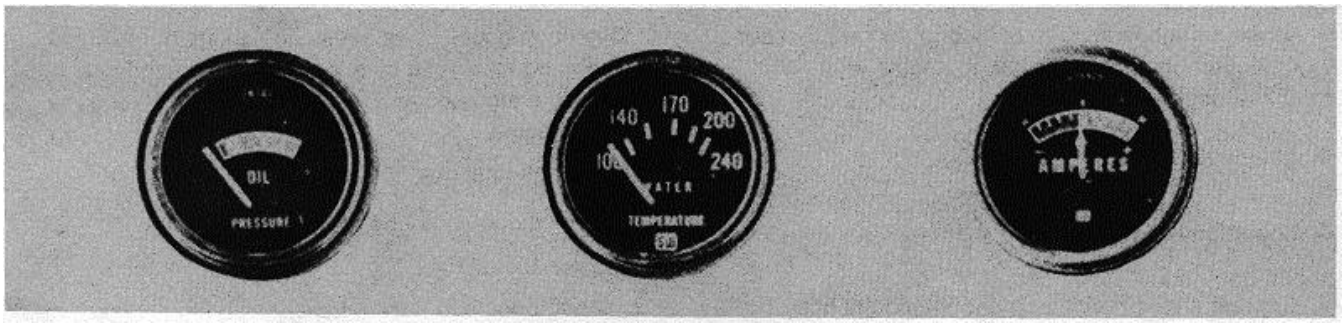
GAUGES

Gauges provide a "look" inside the engine. Be sure they are in good working order. You can determine what is "normal" operating range by observing the gauges over a period of time. The cause of any sudden or significant change in the readings should be determined and corrected.

OIL PRESSURE - Oil pressure is normally greatest after starting a cold engine. As the oil warms up the pressure drops. Oil pressure is greater at operating speeds than at low idle. Fluctuating readings can mean air in the oil or a sticking pressure relief valve. Stop the engine immediately if a sudden loss of oil pressure occurs.

WATER TEMPERATURE - The operating temperature is maintained by the water temperature regulator. High coolant temperatures mean the cooling system is not dissipating enough engine heat.

The minimum operating temperature should not be below 175°. If the temperature gauge continues to indicate below 175° while operating, have the gauge checked for accuracy and the thermostats checked for proper operation.



OIL PRESSURE **WATER TEMPERATURE** **AMMETER**

In cold weather the temperature-gauge may fluctuate in or near the cold range. This indicates the engine is being overcooled. In these instances the use of radiator louvers is suggested.

AMMETER - The ammeter should register in the charging range when the engine is running above low idle. If the gauge still registers a discharge as the engine speed is increased, determine the cause.

AUTOMATIC START-STOP

An automatic start-stop system ensures that power is supplied to a load when the normal power source is interrupted. The cranking panel is the heart of the system and consists of the failure warning system and relays to start and stop the engine. When a power failure occurs the system senses the failure, starts the engine and transfers the load to standby. When power is restored, it senses power restoration, transfers the load from standby and stops the engine. The major use of automatic start-stop systems is standby electric sets. This discussion is limited to that application.

The remote contacts close when a power failure occurs and completes the circuit to the cranking timer and the start *sla*ve relay. The start slave relay completes the circuit to the starter motor and the engine begins cranking.

As the engine starts and increases in speed, the frequency sensing relay turns off the cranking timer and starts the slave relay. This disconnects the starter motor circuit and protects the starter from overspeed damage. If the engine fails to start, the cranking timer will time out and lock the start circuit open, preventing the batteries from being discharged.

During the cranking cycle, the safety shutoffs are inoperative to prevent a low oil pressure shut down. When oil pressure reaches a safe level the safety circuit is armed by the arming relay, High water temperature or low oil pressure will now stop the engine and prevent major damage.

If an unsafe engine condition exists, a sending unit completes the circuit to the safety relay and locking relay. The safety relay de-energizes the fuel solenoid and stops the engine. The locking relay insures that the circuit to the safety relay is complete even if the remote contacts open.

The safety circuit must be reset by moving the start selector switch to the OFF position. Before restarting any unit which has been shut down by the safety circuit, the cause must be determined and corrected.

DETERMINING THE CAUSE OF SHUTDOWN

Anytime an engine is shut down by its safety circuit, the cause must be determined. In some cases the cause will be obvious but often an investigation will have to be made. Do not put the engine back into service without determining and correcting the cause of the shutdown.

HIGH WATER TEMPERATURE

Look for the obvious first.

1. Check for water on the floor from spilled or leaking coolant.
2. Check the water temperature gauge for accuracy.
3. Check air flow through the radiator.

WARNING

DO NOT remove the pressure cap of an overheated unit. The coolant is under pressure and relieving this pressure will cause the coolant to flash into steam. Serious bums and engine damage can result from the escaping coolant. Pressure in a radiator or surge tank may be reduced by pouring warm water on the top tank to condense the steam.

CAUTION

NEVER add cold water to an overheated engine.

4. Check air temperature to radiator. Few radiators can adequately cool a fully loaded engine with 125°F (52°C) ambient air.

5. Check for recirculating air currents.

6. Check fan and water pump belts for proper tension.

7. See that engine room vents and louvers are open.

8. Check water hoses for leaks. Is the water pump inlet hose collapsed. Hoses have been known-to peel off internally and restrict water flow.

9. If the engine is overloaded, overheating can result.

Overheating can cause seals and gaskets to relax and fuel nozzles to change their operating characteristics. If severe or prolonged overheating has occurred, have the engine checked.

LOW OIL PRESSURE

Look for the obvious first.

1. Check the oil level.

2. Check floor for oil from leaks.

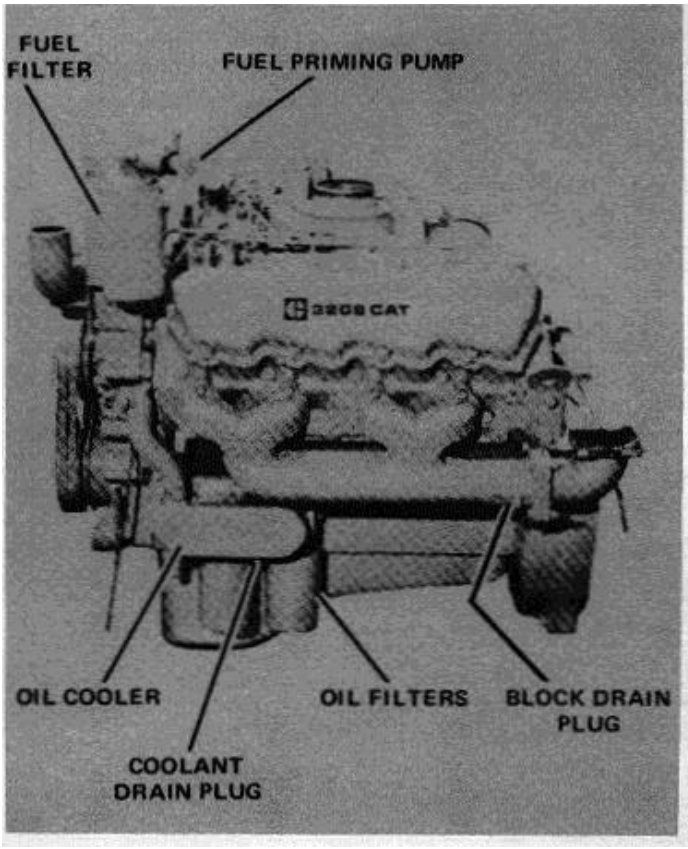
3. To determine if low oil pressure was the cause of the shut down, crank the engine with the fuel valve disconnected. If unusual noises come from the engine, discontinue cranking. If oil pressure fails to build up, and no external leaks are found, the problem is probably internal.

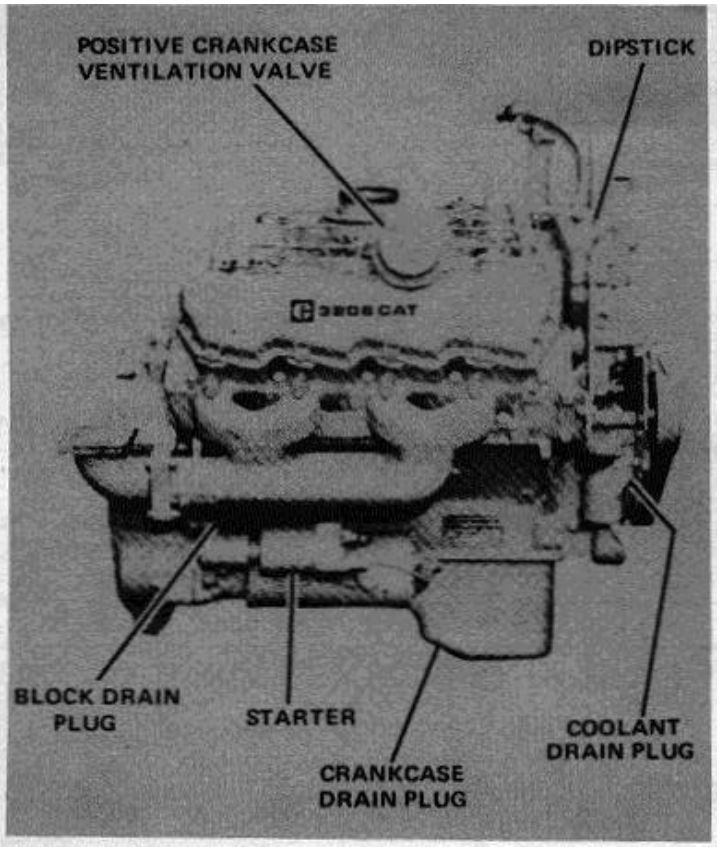
LUBRICATION AND MAINTENANCE CHART

The LUBRICATION AND MAINTENANCE CHART lists all serviceable items commonly ordered on this engine. The items are listed according to their frequency of maintenance, followed by those items needing only "As Required" maintenance.

Diesel fuels, lubricants, types of battery and the coolant make-up water to use are explained in the topic "Key to Fuels, Lubricants and Water" which follows this chart.

Page numbers refer to the LUBRICATION AND MAINTENANCE PROCEDURES where the detailed service instruction for that item can be found.





SERVICE INTERVALS

The service meter is the most reliable method of determining service intervals. The service meter shows the total number of units your engine has run. Perform the maintenance at multiple intervals of units shown. For example when the service meter shows "100" on the dial, all items listed under "EVERY 10 SERVICE METER UNITS" should be serviced now for the tenth time, and all items under "EVERY 50 SERVICE METER UNITS" should be serviced for the second time.

If your engine does not have a service meter, use the calendar interval. These figures are based on a 10 hour day and a 2000 hour year. If your operation differs from these limits, base your service intervals on actual running time. Keep an accurate record of operating time.

Items which do not pertain your engine may be lined out to customize your charts.

SERVICE ITEMS AND PROCEDURES		LUBE	PAGE
FREQUENTLY DURING OPERATION			
Check oil pressure gauge reading.	Observe all gauge readings. Note any change	–	11
Check water temperature gauge reading.	from the NORMAL reading and determine	–	17
Check ammeter reading.	the cause. Have necessary repairs made.	–	18
EVERY 10 SERVICE METER UNITS OR DAILY			
Check crankcase oil level.	Maintain between ADD and FULL mark on dipstick.	CD or CC	11
Fill fuel supply tank after stopping.	See "Key to Fuels, Lube & Water", Pg. 9	–	15
Check engine coolant level.	Maintain level 1/2" below fill pipe.	–	17
Check clutch adjustment.	Should engage with distinct snap.		21
EVERY 50 SERVICE METER UNITS OR WEEKLY			
Check electrolyte level of battery cells.	Fill only with make-up water, See "Key to Fuels, Lubricants and Water", Pg. 9	–	18
EVERY 100 SERVICE METER UNITS OR 2 WEEKS			
Check inlet and exhaust valve lash. (See Note 4)	Inital adjustment for new and reconditioned engines only. See valve lash setting, Pg. 10		12
Lubricate flywheel clutch lever bearings.	2 fittings – 2 strokes	MPGM	21
EVERY 150 SERVICE METER UNITS OR 3 WEEKS			
Change engine oil and oil filter. (See Note 2)	Drain and refill. Refill capacity 12 qts. (11.5 ltrs.)	CC (See Note 1)	11
Change air cleaner elements. (See Note 3)	Install a new or a cleaned element.		12
Check fan and drive belt wear and tension.	Maintain belt tension as indicated in chart		22
Check flywheel clutch oil level.	Keep at proper level.	CD or CC	21

SERVICE ITEMS AND PROCEDURES (Continued)

		LUBE	PAGE
EVERY 500 SERVICE METER UNITS OR 3 MONTHS			
Check inlet and exhaust valve lash. (See Note 4)	See valve lash setting, Pg. 10		12
Change oil in flywheel clutch housing.	Drain and refill. Refill capacity 1 qt. (1 ltr.)	CD or CC	21
EVERY 1000 SERVICE METER UNITS OR 6 MONTHS			
Check safety shutoff operation.	Check by authorized personnel only.		23
Drain water and sediment from fuel tank.			15
Clean primary fuel filter element (if equipped).			15
EVERY 2000 SERVICE METER UNITS OR 1 YEAR			
Change final fuel filters.	Change more often if loss of power is experienced.		15
PCV Valve	Check-replace diaphragm		14

Note 1: Oil period can be extended to 200 hours when CD type oil is used.

Note 2: Normal change interval when fuel sulphur is 0.4% or less.
When sulphur content is 0.4% to 1.0% reduce oil change interval one-half.
When sulphur content is above 1% reduce oil change to one-fourth the normal interval.
Regardless of hours, change oil and filters every six months.

Note 3: More often in dusty conditions. If after servicing the air cleaner, the exhaust smoke and/or loss of power continues, discard that element and install a new element at least once a year.

Note 4: Check valve lash after the first 80-100 hours of operation and then at least every 6 months regardless of service hours.

KEYS TO FUELS, LUBRICANTS AND WATER

FUEL: Use only distillate fuels (ASTM No. 1 or No. 2 Fuel Oil, or No. 1 D or No. 20 Diesel Fuel Oil are examples) with a minimum cetane number of 40. Heavier oil is generally preferable because of its higher energy content.

CD: Use oils which meet Engine Service Classification CD, or MIL-L-2104C, in Caterpillar diesel engine crankcases and gear compartments.

CC: Use oils which meet Engine Service Classification CC, MIL-L-2104B or MIL-L-46152 in these Diesel engine crankcases and/or gear compartments.

MPGM: Use Multipurpose-type Grease which contains both 3 to 5% molybdenum disulfide conforming to MIL-L-7866, and a suitable corrosion inhibitor. NLGI No. 2 Grade is suitable for most temperatures NLGI No. 1 or No. 0 are suitable for extremely low temperatures.

BATTERY: WATER Use either distilled water; or, odorless, tasteless drinking water. Do not use mineral water, water containing iron, salt water or softened water.

ENGINE: COOLANT Use clean water that is low in scale forming minerals not softened water. When the temperature is below 32°F (0°C), a sufficient amount of permanent type anti-freeze must be added to adequately protect your engine against freezing. Adding Caterpillar Coolant System Conditioner is recommended if protection is for temperatures above -20°F (-29°C).

RECOMMENDED VISCOSITIES AT VARIOUS STARTING TEMPERATURES

COMPONENT	ABOVE 32°F (ABOVE 0°C)	BELOW 32°F (BELOW 0°C)
Diesel engine crankcase	SAE 30 SAE 10W-30	SAE 10W(1) SAE 10W-30
Flywheel clutch rear bearing	SAE 30	SAE 10W

(1) SAE 1 OW oil may be used even if daytime ambient temperatures rise to 70°F (21°C).

In temperatures below 100F (-120C) it may be necessary to warm the oil so the engine can be cranked and the oil will circulate freely.

REFILL CAPACITIES (Approximately)

COMPONENT	U.S. Qts.	Imp. Qts.	Liters
Diesel engine lubrication system	12	10	11.5
Flywheel clutch rear bearing	1	1	1
Cooling system			
Engine only	26.0	21.5	24.5
High capacity radiator	40.0	33.5	38
Standard radiator	38.75	32.5	37.5

VALVE LASH

(Engine stopped and cold.)

Exhaust valves	.025 inch (0,63 mm)
Inlet valves	.015 inch (0,38 mm)

LUBRICATION AND MAINTENANCE PROCEDURES

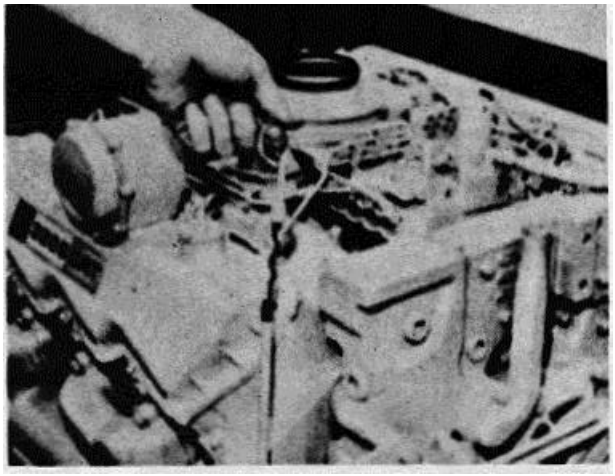
ENGINE LUBRICATION SYSTEM

CHECKING OIL PRESSURE GAUGE READING

Observe the oil pressure gauge frequently. If the indicator registers below NORMAL, or fluctuates, determine the cause and take the necessary corrective measures.

CHECKING OIL LEVEL

Check the oil level before starting. Maintain the oil level between the ADD and FULL marks on the dipstick. See the Lubrication and Maintenance Chart for proper oil.



CHECKING THE OIL LEVEL

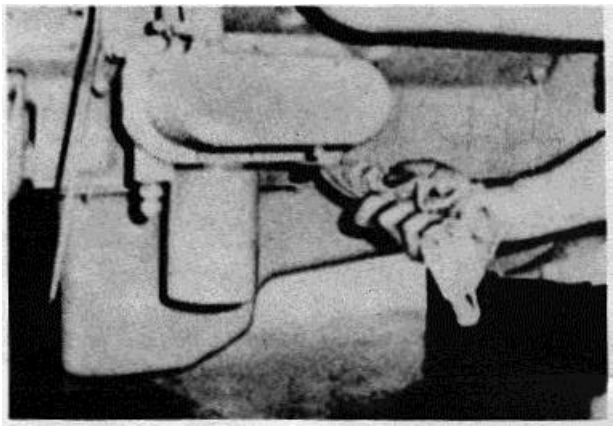
CHANGING CRANKCASE OIL AND FILTERS

Drain the crankcase with the engine stopped and oil warm.

1. Remove the crankcase drain plug.

2. Unscrew and remove the filters. Be sure the old filter gasket does not remain attached to the filter base: Leaking between the new and old filter gaskets will result.

3. Wipe the filter base.



WIPING THE FILTER BASE

4 Apply a thin coat of clean oil to the gasket of each new filter.

5. Install new filters. Hand tighten the filter 1/2 turn after the gasket contacts the filter base.

6. Install the drain plug. Fill the crankcase with clean oil. See the Lubrication and Maintenance Chart for refill capacity and proper oil to use.

7. Check oil level before starting.

8. Start and run the engine until it is warm; check for oil leaks.

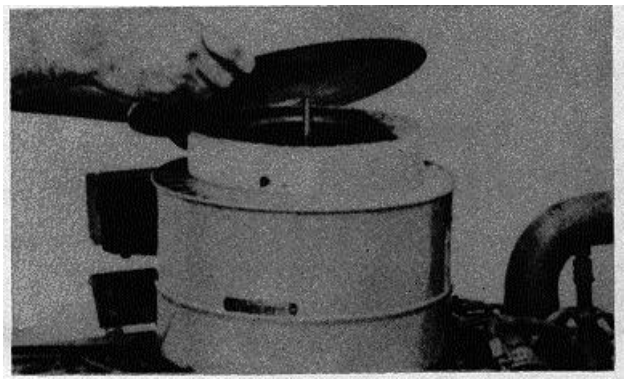
AIR INDUCTION AND EXHAUST SYSTEM

AIR CLEANER

1. Remove the wing nut, cover and element.

2. Clean the inside of the cover. The base should be clean. If the base is dusty, the air cleaner gasket leaked; discard the element.

3. Inspect the new element for damage and dirt.



REMOVING THE ELEMENT

4. Install the new element and cover.

The element removed may be cleaned or discarded, depending upon the apparent condition of the pleats. If a cleaned element is installed, and the exhaust smoke and/or loss of power continues, remove and discard that element and install a new element. Install a new element at least once a year.

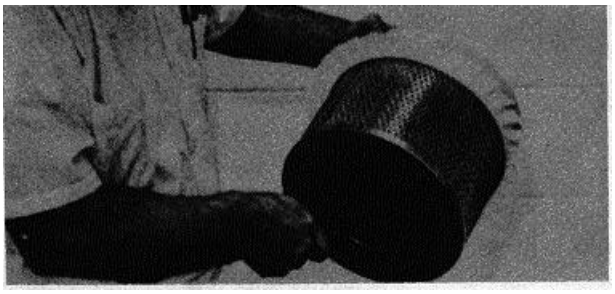
CLEANING WITH PRESSURE AIR

1. Use clean, dry-air - 30 PSI maximum. Hold the nozzle at least one inch from the element and at a slight angle. (A direct blast can rip the pleating.)

2. Direct the air stream along the complete length of each pleat on the CLEANEST side of the element. (This will loosen the dirt from the dirtier side.)

3. Blow the loosened dirt from the DIRTY side.

4. Direct the air from the CLEAN side through to the DIRTY side to remove any dirt blown into the pleats.



CLEANING THE ELEMENT WITH PRESSURE AIR

CLEANING WITH WATER

1. Use clean water - 40 PSI maximum. Do not use a nozzle.

2. Direct the water stream along the complete length of each pleat on the CLEAN side of the element.

3. Direct water along the complete length of each pleat on the DIRTY side of the element.

4. Rinse the CLEAN side of the element.

5. Allow the cleaned element to dry thoroughly.

CLEANING WITH DETERGENT

1. Wash both sides of the element in a solution of warm water and non-sudsing household detergent.

2. Rinse the CLEANEST side of the element with clean water (40 PSI maximum) along the complete length of each pleat.

3. Rinse the opposite side of the element along the complete length of each pleat.

4. Rinse the first side again to remove all loosened dirt.

5. Allow the cleaned element to dry thoroughly.

CHECKING CLEANED ELEMENT

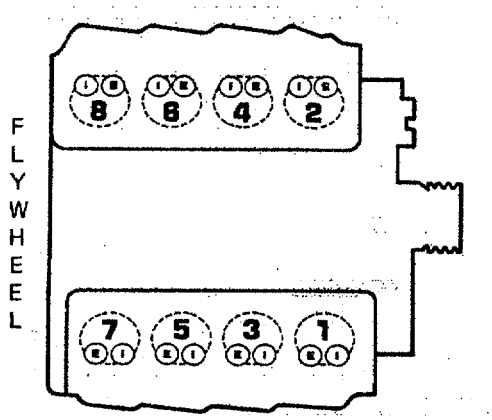
Hold the dried element in front of a lighted electric bulb. Carefully inspect the element for tiny, pin-points of light. Any light showing indicates a pleat has ruptured and will tear with further use. Discard the element.

1. Wrap usable elements in heavy paper.
2. Store the wrapped element in a dry, clean place.

VALVE LASH

PREPARING TO CHECK ADJUSTMENT

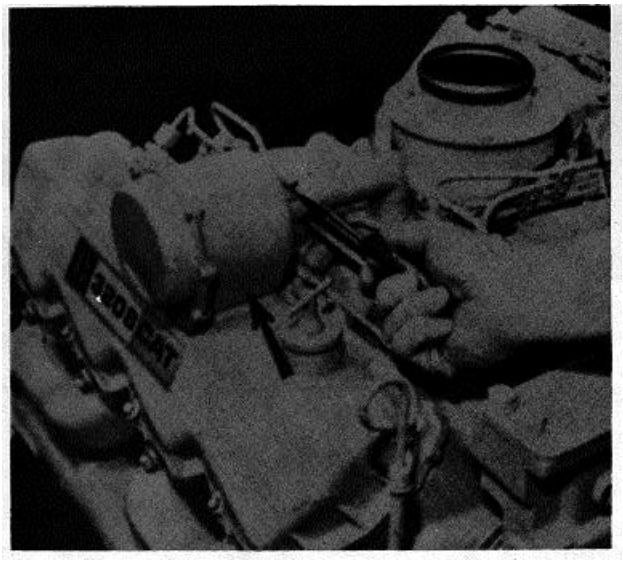
TDC of the No. 1 piston on the compression stroke is the reference point. The No. 1 piston is at TDC compression stroke when the timing mark on the damper or the pulley is aligned with the timing pointer, and No. 1 and No. 2. exhaust and inlet valves are closed. (The rocker arms are free and the push rod is at its lowest point.)



NUMBERING OF CYLINDERS AND VALVE LOCATION

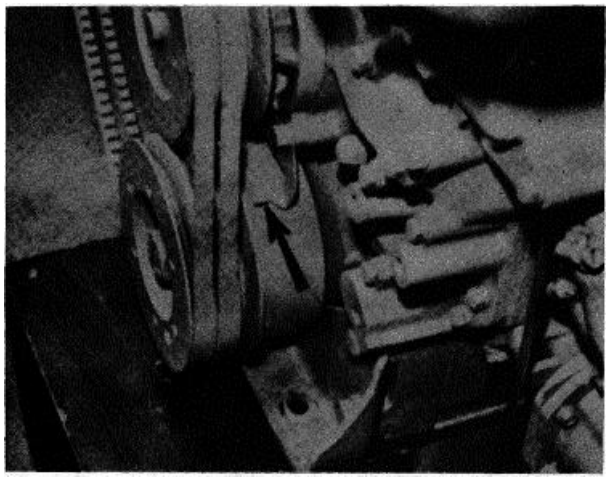
TO CHECK VALVE LASH

1. Stop the engine.
2. Clean around the valve covers.
3. Remove the crankcase ventilation valve.
4. Remove both valve covers.



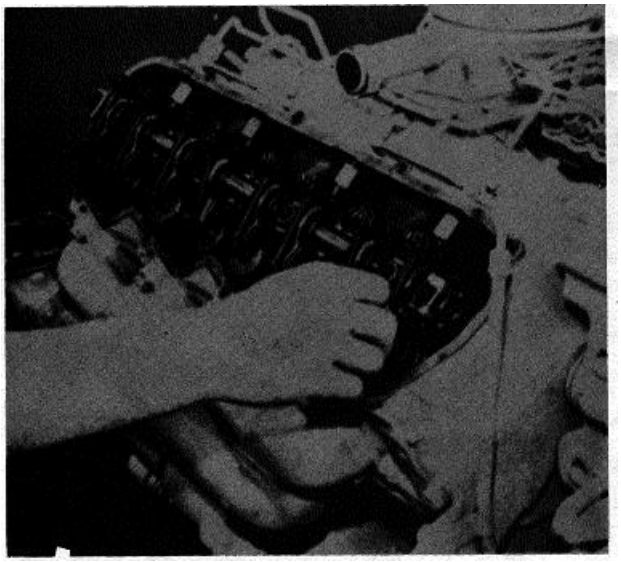
REMOVING CRANKCASE VENTILATION VALVE

5. Turn the crankshaft until No. 1 cylinder is on top dead center ("TC1") compression stroke. Align the ("TC1") timing mark on the damper with the timing pointer located on the front of the engine block.



TIMING MARK AND POINTER

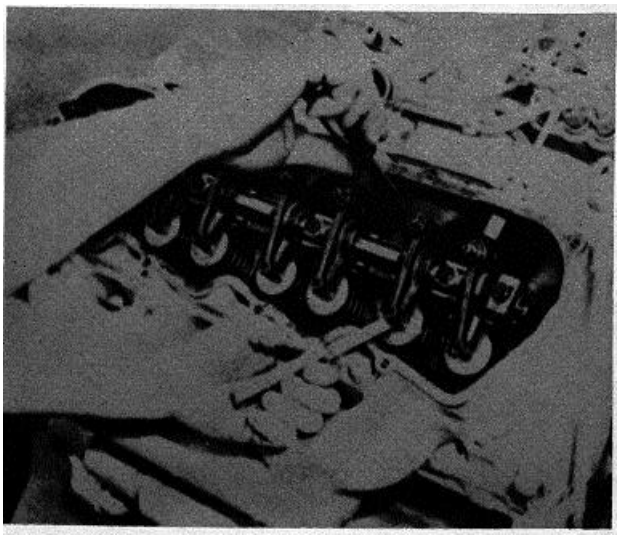
Both the exhaust and inlet valves for No. 1 and No. 2 cylinders will be closed: The four rocker arms will rotate with finger pressure.



ROTATING ROCKERS

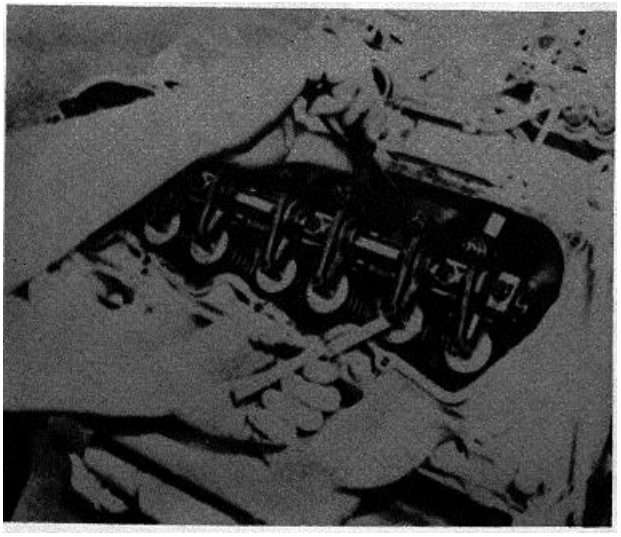
ADJUSTING VALVE LASH

1. Adjust the inlet and exhaust valve lash for No. 1 and No. 2 cylinders:
   a. Loosen the valve adjusting screw locknut.



LOOSENING LOCKNUT

b. Turn the adjusting screw to allow a clearance gauge to pass between the top of the valve stem and the valve rocker arm. See the LUBRICATION AND MAINTENANCE CHART for correct lash measurement.



ADJUSTING VALVE LASH

c. Tighten the adjusting screw locknut.
d. Check valve lash clearance.

2. Turn the crankshaft 180° clockwise (viewed from the front of the engine). On later engines, align the "VS" timing mark with the timing pointer. Adjust the inlet and exhaust valve lash for No. 3 and No. 7 cylinders.

3. Turn crankshaft 180° clockwise (viewed from front of engine), and align "TC1" timing mark with the timing pointer. Adjust the inlet and exhaust valve lash for No. 4 and No. 5 cylinders.

4. Turn crankshaft 1800 clockwise (viewed from front of engine); align "VS" timing mark with the timing pointer. Adjust the inlet and exhaust valve lash for No. 6 and No. 8 cylinders.

5. Inspect the valve cover gaskets. Install new gaskets if necessary. Install the valve covers and crankcase ventilation valve.

POSITIVE CRANKCASE VENTILATION VALVE

The PCV valve directs blow-by gases to the combustion chambers where they are burned. An oily accumulation around the cover could indicate the diaphragm has worn through. Replace diaphragm every 2,000 service hours, or annually.

Replacing Diaphragm:

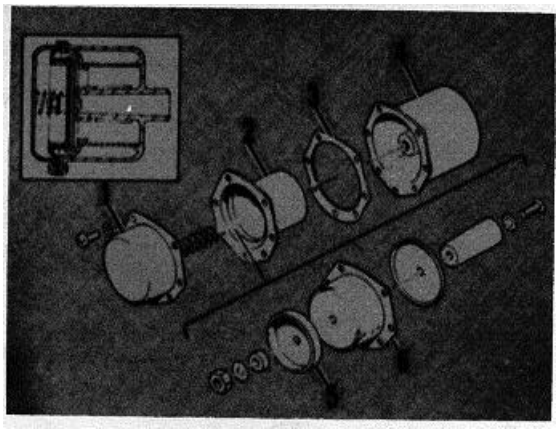
1. Clean area around PCV valve.

2. Remove series of bolts holding cover (1) in place on housing {4).

3. Clean and inspect all parts and replace as necessary. Always install new gaskets and diaphragm when disassembled for inspection.

4. When installing, coat both sides of the gasket (3) with gasket cement and install against rear face of inner sleeve (2).

5. To prevent diaphragm (6) from distorting and tearing during assembly, coat both flange sides of the diaphragm with gasket cement and install with face marked "piston side" facing piston (5).



FUEL SYSTEM

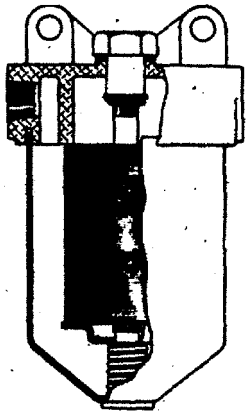
FUEL TANK

Open the fuel tank drain valve to drain water and sediment from the fuel tank. To minimize water contamination, fill the fuel tank in the late afternoon: As the fuel is consumed, air with some humidity must replace the fuel in the tank. By filling the tank in the late afternoon, this humid air is expelled before the moisture can condense on the cool inside walls of the fuel tank.

FUEL FILTERS

CLEANING PRIMARY FILTER ELEMENT

1. Stop the engine.
2. Close the diesel fuel supply valve.
3. Loosen the nut on the cover and remove the case and filter.
4. Clean the element and case in clean kerosene or diesel fuel.
5. Before installing the filter, inspect the gaskets. Install new gaskets if necessary.
6. Install the cleaned filter element and case.
7. Prime the fuel system.

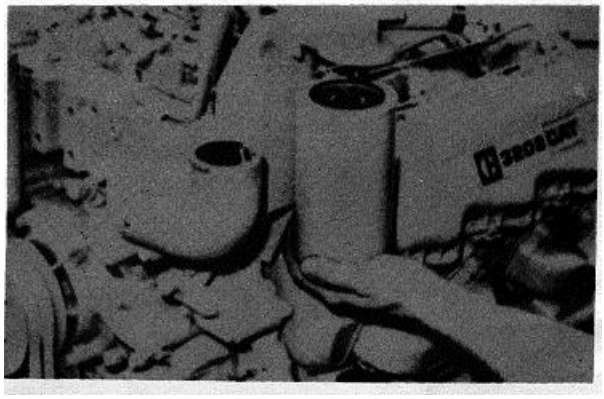


PRIMARY FUEL FILTER

PRIMARY FUEL FILTER

INSTALLING NEW FINAL FUEL FILTER ELEMENTS

1. Unscrew and remove the filter. Be sure the old filter gasket does not remain attached to the filter bun: Leaking between the new and old filter gaskets will result.



REMOVING THE FUEL FILTER

2. Clean the gasket sealing surface of the filter base.
3. Lubricate the new filter gasket with clean diesel fuel.
4. Tighten filter by hand until gasket contacts base;

then tighten 1/2 turn more.

5. Prime the fuel system.

NOTE

Do not pour fuel into the new filter element before installing.

PRIMING THE FUEL SYSTEMS

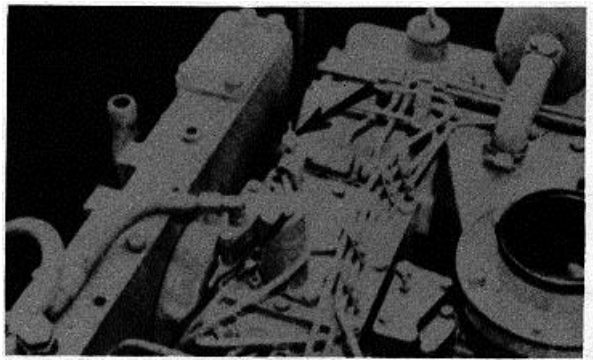
If air is trapped in the fuel system, the diesel engine will either not start, or will misfire.
To prime the system:

1. Stop the engine.
2. Loosen the vent valve on the fuel pump housing.

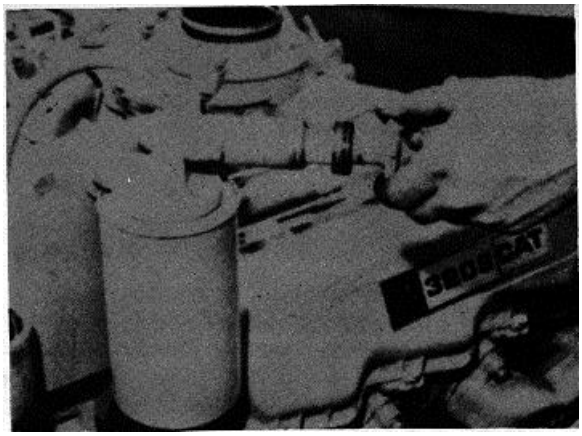
CAUTION

Operate the priming pump only when the bleed valve is open. Avoid bleeding excessive fuel.

3. Operate the electric starter, or the hand priming pump if so equipped, until the flow of fuel from the filter is continuous and free of bubbles.



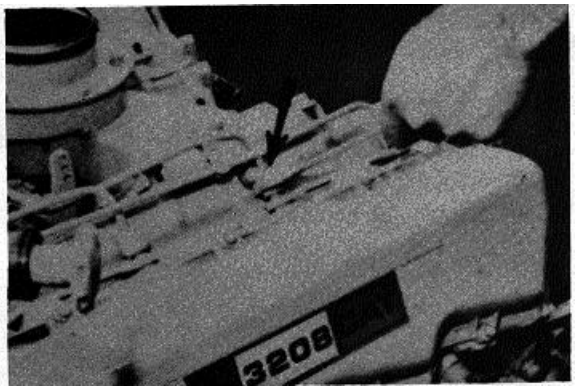
VENT VALVE



OPERATING THE PRIMING PUMP

4. Tighten the vent valve.
5. Start the engine. If the engine misfires or smokes, loosen a fuel injection line nut; allow the fuel to flow until free of air bubbles.

Tighten the line nut, open the next line nut and continue priming each successive line.



BLEEDING THE FUEL LINE

COOLING SYSTEMS

ENGINE JACKET WATER

CHECKING COOLANT LEVEL

Check coolant level with the engine cool and stopped:

1. Slowly loosen the filler cap and release pressure.

⚠ WARNING

Be careful if engine is warm; steam may spray. Avoid being burned.

2. Push downward and turn the cap until it is released.
3. Maintain coolant level to within 1/2 inch (1 cm) below bottom of fill pipe. The coolant will expand as it is heated.
4. Make-up coolant must be one of the following:
   a. Permanent anti-freeze and water solution.
   b. Drinkable water and rust inhibitor solution. For emergencies, and only as a "temporary fix" until the cooling system can be returned to either (a) or (b), use either:
   c. Drinkable water.
   d. Any available water.

"Drinkable water" is clean water that is low in scale forming minerals - not softened water. Never add coolant to an overheated engine; allow it to cool first.

Check specific gravity of anti-freeze solution frequently in cold weather to assure adequate protection.

CAUTION

Add coolant slowly to a hot engine to prevent possible cracking or distorting the cylinder head.

DRAINING RADIATOR

Whenever it is necessary to drain the cooling system for repairs:

1. Remove the filler cap.
2. Open the drain valve for the radiator.

DRAINING COMPLETE COOLING SYSTEM

1. Drain the radiator; see the topics above.
2. Remove front cover drain plug.
3. Remove both engine block drain plugs.
4. Remove the oil cooler coolant drain plug.
5. Remove the coolant; then install all drain plugs.

FLUSHING COOLING SYSTEM

To clean the cooling system, any good commercial radiator cleaning solution can be used. Follow the instructions included with the cleaner.

The cooling system can be cleaned using oxalic acid and sodium carbonate as follows:

1. Fill the cooling system with a solution consisting of one pound of oxalic acid or sodium bisulphate ($NaHSO_4$) with every 5 gallons of water (mix 0.4 kg. with every 10 liters of water).
2. Start the engine and operate at operating temperatures for 1/2 to 1 hour.
3. Stop the engine and drain the cooling system.
4. Flush the system with clean water until the draining water is clear.
5. Install all drain plugs.
6. Fill with a solution consisting of 1/2 pound of sodium carbonate crystals (Na_2CO_3, $10H_20$) with every 10 gallons of water (mix 0.06 kg with every 10 liters of water).
7. Start and run the engine for 10 minutes.
8. Stop the engine and drain the cooling system.
9. Flush the cooling system with clean water.
10. Install all drain plugs.

FILLING COOLING SYSTEM

1. Add anti-freeze, if required.
2. Fill to correct level with coolant which is free as possible from scale forming minerals. Do not use softened water.
3. Start and run engine for 10 minutes.
4. Remove the radiator cap and check the coolant level.
5. Add coolant, if needed, until coolant level is within 1/2 inch (1 cm) below bottom of the filler tube.
6. Install the radiator cap.

Most commercial antifreeze solutions contain rust inhibitors, however, it is recommended the adding of Caterpillar Coolant System Conditioner to glycol base antifreeze if protection is for temperatures above -20°F (-29°C). If protection is for temperatures -20°F (-20°C) or below, do not add conditioner. Follow instructions given on the container.

⚠ WARNING

Inhibitor contains alkali. Avoid contact with eyes. Avoid prolonged or repeated contact with skin.

BATTERY INSTALLATION

PREPARING DRY CHARGE BATTERIES

One day before installing a new dry charge battery, add the electrolyte solution to each cell.

1. Fill each cell to the bottom of the vent with electrolyte solution.

CAUTION

If the battery is initially filled with water by mistake, the battery is ruined and must be replaced.

2. Allow the battery to sit for several minutes to permit the battery plates to absorb the electrolyte.
3. Add make-up electrolyte solution until the level stabilizes. Once the level *st*abilizes, never *add* anything but water.
4. Install the vent caps.
6. Remove the tape covering the vent hole In each cap.
6. Slowly charge the battery on e battery charger until the specific gravity of the solution is at least 1.240 et a temperature of 80°F (27°C).

NOTE

If the electrolyte solution temperature nears 125°F (53°C) reduce the charging rate. Temperature in excess of 125°F (53°C) will ruin the battery.

PREPARING WET CHARGE BATTERIES

The electrolyte solution was added by the manufacturer. Make-up solution must be water; never add electrolyte or acid to a wet charge battery. If necessary, slowly charge the battery before using.

USING A BATTERY CHARGER

A desirable charging rate can be calculated by multiplying the amp-hour rating of the battery by .07 (7%). Shut off the battery charger before disconnecting the booster charger clamps from the battery terminals. While the battery is charging, hydrogen gas is being given off through each vent cap. When hydrogen gas is mixed with air, the mixture is highly explosive and will explode in the presence of a spark or small flame.

WARNING

Never smoke near the area where batteries are being charged.

INSTALLING BATTERY

1. Be sure the tray is free of objects which may puncture the battery case when the hold down traps awe tightened.
2. Be sure terminal posts and cable clamps are clean,
3. Place the battery in the tray. Tighten the hold downs evenly until the battery Is snug, Do not overtighten.
4. Connect the "hot" terminal first.
5. Connect the ground terminal last.

CAUTION

Always connect the "hot" terminal first.

When the "hot" terminal is connected first, no arcing can occur. If the wrench accidentally contacts both the terminal end the frame or tray. The part that is contacted will take the same polarity as the battery terminal.

By connecting the ground terminal first, the frame or tray is connected to ground. Then, if the wrench accidentally contacts the frame while connecting the "hot" terminal, a circuit is completed through the wrench. A hot spark will occur which could burn the person holding the wrench, or possibly explode the battery if an excess of hydrogen gas is present at any one of the vent holes.

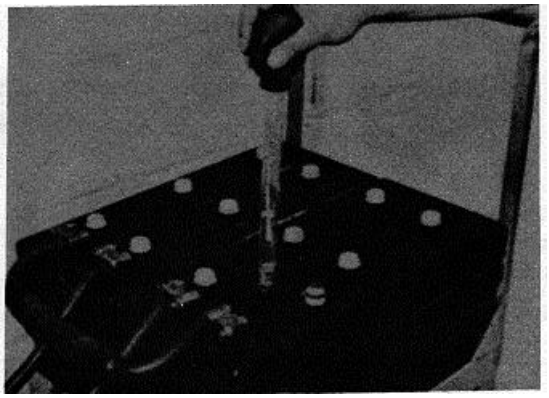
After connecting both cables, apply a thin coating of grease over the cable clamps, terminals and hold down fasteners.

BATTERY MAINTENANCE

TESTING THE ELECTROLYTE SOLUTION

The general condition of a battery can be determined by measuring the specific gravity of the electrolyte solution and adjusting the reading to 80°F (27°C). If the electrolyte level is too low to allow taking a hydrometer reading, add make-up water to the correct level and then charge the battery 2 to 4 hours before taking a reading.

1. Insert the hydrometer into a cell. Fill the hydra meter barrel while holding it vertically. The float must not drag on the wall of the barrel.
2. Read the hydrometer:
   1.250 or above - fully charged battery cell
   1.250-1.225 - full to half charged battery cell
   1.225-1.150 - half to low charged battery cell
   Below 1.150. dead cell
   1.000 - water
3. Test each cell in the same manner.



MEASURING SPECIFIC GRAVITY

4. If there is more than .050 (50 gravity points) variation between the highest and lowest reading, the battery should be replaced.
5. Adjust the readings to 80°F (27°C).
   a. For every 10F° (5.5C° the electrolyte temperature is above 80°F (27°C), add .004 (4 gravity points) to the specific gravity reading.

Example: Electrolyte temperature = 100°F; 38°C
Corrected temperature = 80°F; 27°C
Difference: = 20°F; 11°C
Increments: 10; 5.5
20÷ 10=2; 11 ÷5.5= 2
2 x 4 gravity points = 8 gravity points

Add 8 gravity points to your hydrometer reading to obtain the adjusted reading at 100°F. If the uncorrected hydrometer is 1.240 the corrected reading would be: 1.240 + 8, or 1.248

   b. For every 10F° (5.5C°) the electrolyte temperature is below 80°F (27°C), subtract .004 (4 gravity points) from the specific gravity reading.

Example: Electrolyte Temperature = 10°F; -13°C
Corrected temperature = 80°F; 27°C
Difference = 70°F; 40°C
Increments: 10; 5.5
70 ÷ 10= 7; 40÷ 5.5 = 7
7 x 4 gravity points = 28 gravity points

If the uncorrected hydrometer reading is 1.210 the corrected reading would be 1.210 - 28 = 1.182

The corrected reading is of most importance during cold weather when the hydrometer reading is always corrected to a lower specific gravity reading. A low reading signifies the battery has less available power to crank the engine and that booster batteries may be required.

ADDING MAKE-UP WATER

Check the electrolyte level of each cell and the general condition of the battery.

1. Maintain the electrolyte level to the base of each vent well.
2. The make-up water must be one of the following (in order of preference):
   a. Distilled water.
   b. Odorless, tasteless drinking water.
   c. Iron free water.
   d. Any available water.

WARNING

Never add acid or electrolyte.

READING THE AMMETER

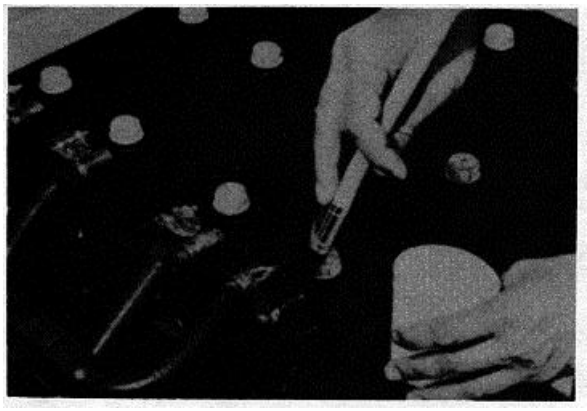
1. After starting the engine, the ammeter indicator should register to the right of zero, but should never be "pegged".
2. After the engine has been running, the indicator should be just to the right of zero.

If the indicator either "pegs" to the right, or remains to the left of zero with an increase of engine speed, have the electrical charging system checked.

The alternator charging rate maintains the battery's electrolyte specific gravity reading, and the battery's performance. An undercharge rate cannot maintain a desired 1.250 specific gravity reading. An overcharge rate will boil the water from the electrolyte solution. A proper charging rate should require no more than one ounce (30 cc) of water per cell per week to maintain a fully charged battery.

CLEANING BATTERY

1. Mix a weak solution of baking soda and water. Apply the solution with a bristle brush.



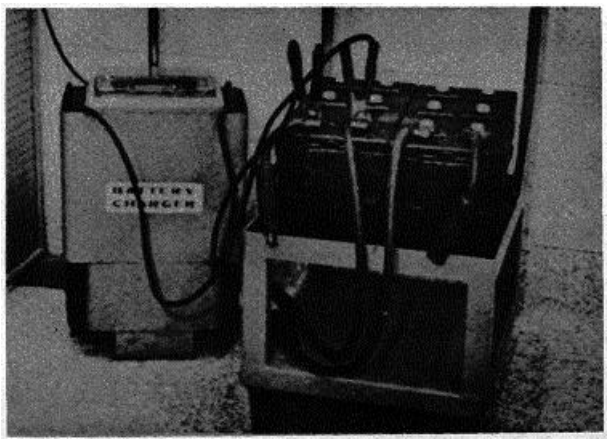
CLEANING BATTERY TERMINALS

2. Thoroughly rinse the battery and battery tray with clean water.
3. Apply grease to the battery cable clamps and terminals and to all threads.

COLD WEATHER BATTERY MAINTENANCE

The following instructions aid in obtaining maximum performance in cold weather:

1. After adding make-up water, charge the battery. The added water will dilute the electrolyte. This will lower the specific gravity of the solution, raise the freezing point of the solution and lower the charge of the battery.



CHARGING THE BATTERY

2. Keep the batteries fully charged either by operating the charging system or by using a battery charger.
3. Keep the electrolyte warm when the battery is not in use. The heat from an electric light bulb usually is sufficient.

CAUTION

Do not lay cloth or any flammable material in contact with a lighted bulb. Charring, or fire, can result.

4. Use starting aids as instructed when starting.
5. Use booster batteries as required. Connect as instructed below.

CONNECTING A BOOSTER BATTERY

1. Using a pair of jumper cables, connect the red jumper cable to the "hot" terminal of the 12 Volt booster battery.
2. Connect the black jumper cable to the ground terminal of the booster battery.

CAUTION

Keep the red and black cable terminals from touching each other.

3. Connect the other end of the red jumper cable to the "hot" terminal of the engine battery.
4. Connect the other end of the black jumper cable to the ground terminal of the engine battery.
5. Start the engine using starting aids as instructed.

REMOVING JUMPER CABLES

As soon as the engine starts:

1. Disconnect the black jumper cable from the engine battery ground terminal.
2. Disconnect the red jumper cable from the engine battery "hot" terminal.
3. Disconnect the black jumper cable from the booster batteries.
4. Disconnect the red jumper cable from the booster batteries.
5. Disconnect the booster batteries. Charge them to full capacity with a battery charger.

POWER COUPLING SYSTEM

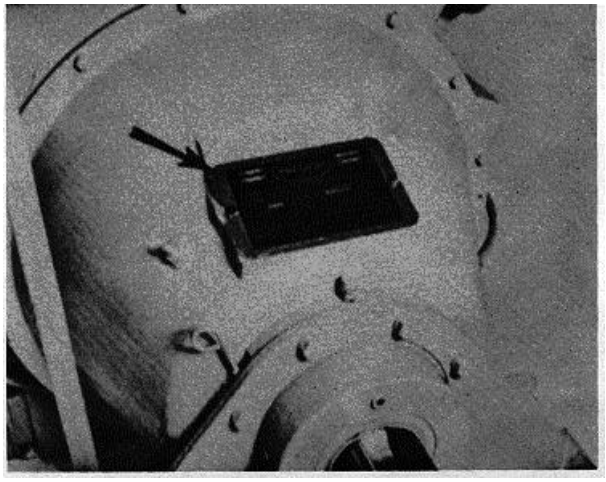
ENCLOSED CLUTCHES AND/OR FRONT POWER TAKE-OFF

CHECKING CLUTCH ADJUSTMENT

While engaging the clutch to pick up the load, check the clutch adjustment. The clutch should engage with a hard push and distinct snap. If engagement is "soft", adjust the clutch.

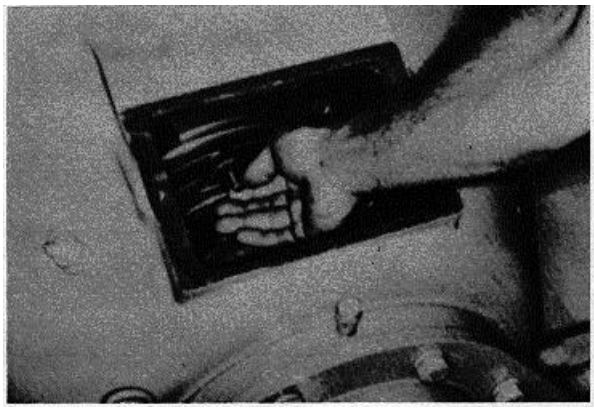
ADJUSTING CLUTCH

1. Stop the engine and remove the clutch inspection cover.



CLUTCH INSPECTION COVER

2. Turn the clutch until the lock pin, engaged in the locking ring, is visible.
3. Pull the lock pin out and rotate the locking ring clockwise until the lock pin pops into the next notch.



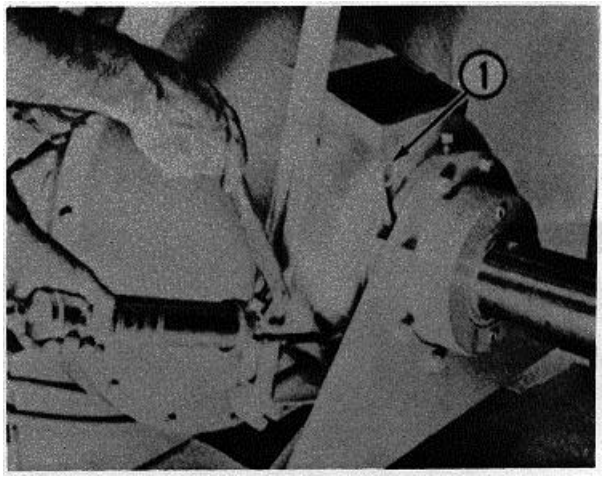
DISENGAGING LOCKING PIN

4. Test the clutch adjustment. If still too "soft", rotate the ring to the next notch. If the adjustment is too tight-turn the ring back one notch.
5. Install the cover.

LUBRICATING FLYWHEEL CLUTCH

The flywheel clutch bearings are grease lubricated, except the main shaft bearing. The main shaft bearing is oil lubricated.

1. Lubricate the shift lever bearings; 1 fitting on each side of clutch housing.



LUBRICATING SHIFT LEVER BEARINGS

1. Oil level gauge

2. Lubricate the pilot bearing; 1 fitting at the end of shaft. If this fitting is not accessible, remove the plug located on the circumference of the shaft near the rear of the housing, and install a fitting.
3. Lubricate the shift-collar bearings; 1 fitting at top-left of center.
4. Check the main shaft bearing oil reservoir level with engine stopped. Maintain the oil level at the FULL mark on the oil level gauge. Add oil through the filler tube on top of the bearing cage housing. See the Lubrication and Maintenance Chart for proper oil.
5. To drain the reservoir: Remove the drain plug located on the lower right side of the shaft bearing reservoir. Drain and install the drain plug. Fill to the FULL mark on the oil level gauge. Install filler cap.

MISCELLANEOUS MAINTENANCE

VEE BELTS

CHECKING BELTS

1. Check belt wear.
2. Check tension of each belt

If one belt in a set requires replacement, always install a new matched set of belts-never replace just the worn belt. If only the worn belt is replaced, the new belt will be carrying all of the load-as it will not be stretched as much as the older belts-and all of the belts will-fail in rapid succession.

In the following illustrations the pulley marked X is the adjusting pulley. The pulley marked C is the crankshaft. Force is applied at the arrow. See the chart for the force and belt deflection.

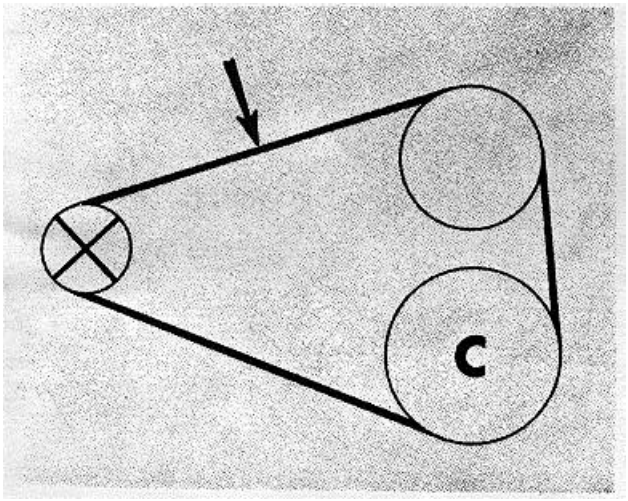


FIG. A ALTERNATOR DRIVE AND WATER DRIVE

ADJUSTING BELT TENSION

Alternator Drive (Fig. A)

1. Loosen the bolts on the alternator.
2. Move the alternator until the belt is properly adjusted. Tighten the adjustment bolt.
3. Check the adjustment.
4. Tighten the bolt.

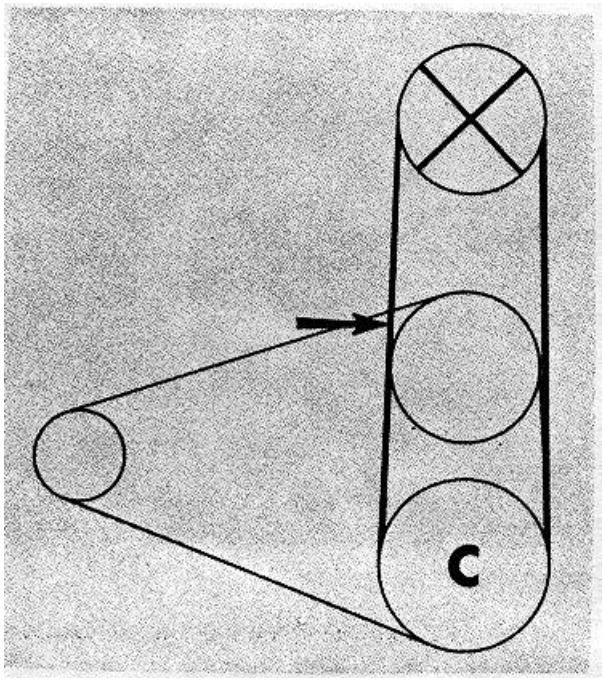


FIG. B HIGH MOUNT FAN DRIVE

ATTACHMENT	FORCE		BELT DEFLECTION		FOR SCHEMATIC SEE:
Alternator Drive	5 lbs.	227 gms.	0.25 in.	6.5 mm	FIG. A
Water Pump-Fan Drive	5 lbs.	227 gms.	0.25 in.	6.5 mm	FIG. A
High Mount Fan Drive	5 lbs.	227 gms.	0.25 in.	6.5 mm	FIG. B
Air Compressor Drive	6 lbs	272 gms.	0.25 in.	6.5 mm	FIG. C
Air Compressor Drive w/high mount fan	4 lbs.	182 gms.	0.12 in.	3.0 mm	FIG. D

Water Pump-Fan Drive (Fig. A), and Air Compressor Drive (Fig. C & D):

1. Loosen the adjusting bolt and pivot bolt on the idler.
2. Move the idler outward until the belt is properly adjusted. Tighten the adjustment bolt.
3. Check the adjustment.
4. Tighten the pivot bolt.

High-Mount Fan Drive (Fig. B)

1. Loosen the four bolts holding the adjustment plate.
2. Loosen the adjustment bolt locknut.
3. Turn the adjustment bolt to obtain correct bolt adjustment.
4. Tighten the four bolts holding the adjustment plate.
5. Tighten the adjustment bolt locknut.

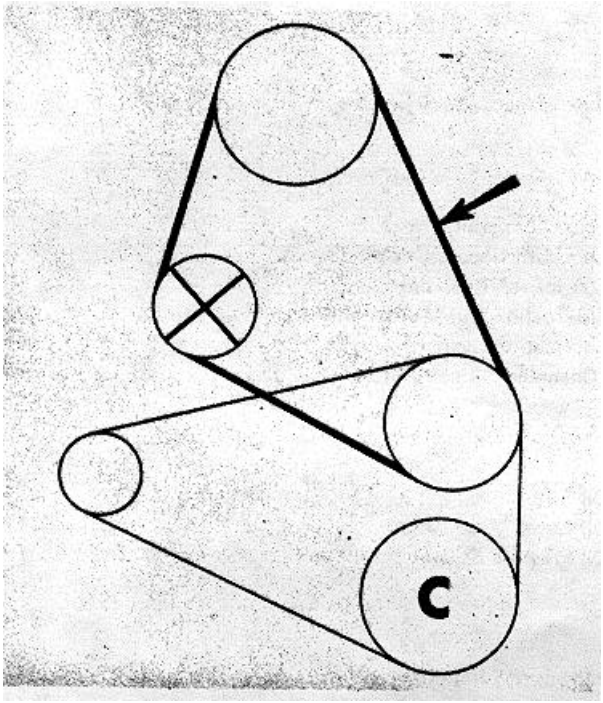


FIG. C AIR COMPRESSOR DRIVE

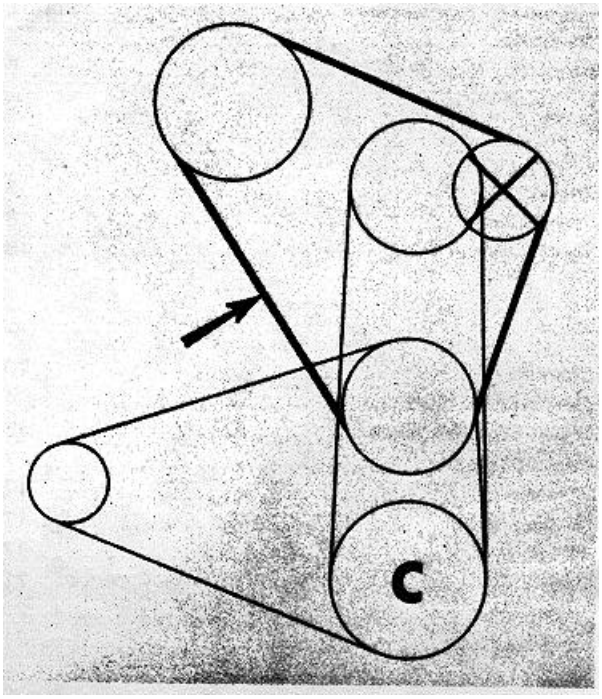


FIG. D AIR COMPRESSOR DRIVE WITH HIGH MOUNT FAN DRIVE

SAFETY SHUT-OFF CONTROLS

The shut-off controls must be checked to insure proper functioning if and when needed. To prevent damage to your engine while making the required tests, only authorized personnel should perform the checks. Contact your Caterpillar dealer.

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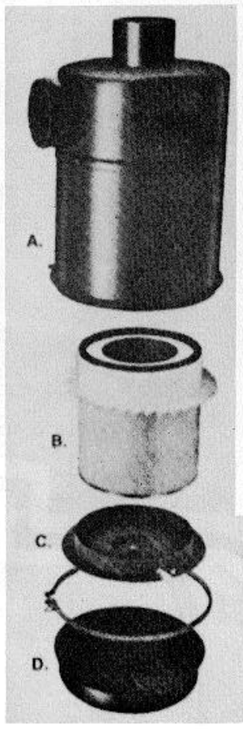
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Proper service improves performance– cuts operating costs



FW Series Cyclopac® Air Cleaners

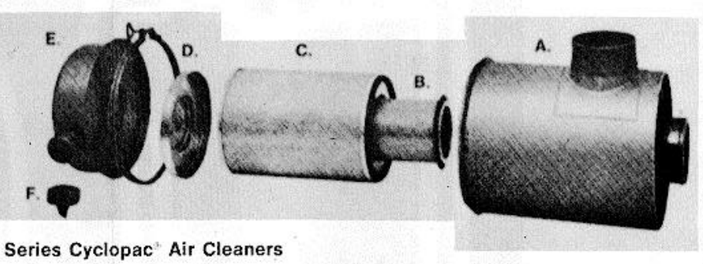
The Donaldson FW Series air cleaner has only a minimum number of parts. The heart of the air cleaner is the Duralife® II double-life element which can be cleaned and reused. The air cleaner is designed for fast, easy disassembly so that it may be serviced efficiently and quickly.

A. Body Assembly — This sturdy shell contains the ducting and sealing surface of the air cleaner.

B. Duralife® II Filter Element — The heart of the air cleaner consists of the initial separator (fins), the final filter and the sealing gasket in one cleanable and reusable part. Rigid manufacturing specifications and controls are the key to the built-in quality of this part.

C. Baffle Assembly — Retains the dirt in the dust cup.

D. Dust Cup is reservoir for dust separated from air stream by the integral separator. The slotted baffle is an integral part of the separator which forms a barrier to hold dust in the cup. Dust cup can be equipped with a vacuator valve to dump collected dust automatically.



FH Series Cyclopac® Air Cleaners

The FH Series air cleaner is a low-maintenance cleaner featuring built-in pre-cleaner fins, Duralife® II primary element, and a "back-up" safety filter element for extra protection.

A. Body Assembly — Rugged construction for long operating life.

B. Safety Element — An added insurance policy which protects the engine in case of damage to the primary filter — also guards engine during servicing of primary element.

C. Duralife® II Primary Element — The double-life element — provides much more filter surface in the same size cleaner, holds more dust — lasts much longer.

D. Baffle Assembly — Retains the dirt in the dust cup.

E. Dust Cup is reservoir for dust separated from air stream by the pre-cleaner.

F. Vacuator Valve (optional) — Ejects dust and water continuously. Eliminates regular cup servicing, cuts service time.

Service Procedure

Maximum engine protection against the ravages of dust is possible ONLY if the air cleaner is serviced at regular intervals. Over-servicing does not utilize the air cleaner features to the fullest. The procedure is simple — just follow these easy steps as shown.

1 Measure the restriction of the air cleaner with a Donaldson restriction indicator, service gauge, or a water manometer at the restriction tap provided in the air cleaner, the transfer pipe, or the blower intake. Replace or clean the element only when the restriction has reached the maximum allowed by the engine or equipment manufacturer.

2 Empty the dust cup as required. Dust should not be allowed to build up closer than one inch from the baffle. On vacuator valve equipped models, dust cup service is cut to a minimum; a quick check to see that the vacuator valve is not inverted, damaged, or plugged is all that is necessary.

3 **Element Servicing**
When restriction indicates that element servicing is required, loosen wing nut and remove primary element. Before installing new element, inspect the element and gasket for shipping or storage damage. Carefully install element and wing nut. Reset the restriction indicator to green.

For maximum vehicle downtime, replace dirty filter with a new or properly cleaned Duralife filter element. If element is to be serviced for immediate re-use, reinstall outer cover to protect induction system while cleaning element.

4 Reinstall the dust cup, making sure it seals 360° around the air cleaner body. Reset the restriction indicator to green.

5 Check all connections between the air cleaner and the engine to be certain they are tight and leak-free.

Safety Element Service

The safety element is not intended to be cleaned. For maximum engine protection and air cleaner service life, replace the safety element with a new safety element every third primary element change.

Element Cleaning Methods

Clean Duralife element by one of the following methods:

Compressed Air or Washing.

Compressed air is recommended when element will be re-used immediately because a washed element must be dried before re-use. However, washing does a better job and must be used when exhaust soot has lodged in fine pores of the filter media. Use Donaldson D-1400 detergent which contains a special additive for removing soot and carbon.

Replace element after 6 cleanings or annually, whichever occurs first.

Do not remove plastic fin assembly -- back-flowing with compressed air or washing will remove dust from beneath the fin assembly.

Request Form P45-7188 "How to Service Duralife® and Duralife® II Elements" for additional information.



Compressed Air

Direct air through element in the direction *opposite to normal air flow through the element.* Move nozzle up and down while rotating element. Keep nozzle at least one inch from pleated paper. Maximum air pressure to prevent damage of element is 100 P.S.I.



Washing

1. Soak element 15 minutes or more in Donaldson D-1400 and water solution. See carton for full instructions.
2. Rinse until water is clear (Maximum water pressure 40 P.S.I.)
3. Air-dry or use warm flowing air, max. 160°F. Do not use compressed air or light bulbs.



Inspection

Place bright light inside element and rotate element slowly. If any rupture, holes or damaged gaskets are discovered -- replace.

General Service Tips

The air cleaner should be inspected periodically to maintain maximum engine protection and maximum service life. These inspections should include the following points:

1— Inspect the air transfer duct between the air cleaner and the engine to be sure all clamps are tight, all flange joints are tight, and there are no cracks in the ducting.

2 — Air cleaner mounting bolts and clamps must be tight to hold the air cleaner securely.

3— Check the dust cup to make sure it is sealing 360° around the air cleaner body.

4 — Vacuator valve must be in place, not inverted or damaged, and free from obstruction.

5 — Check for dents and damage to the air cleaner which could mean a leak.

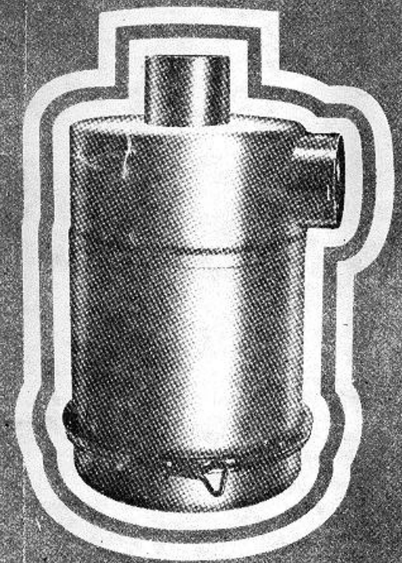
6 — Make sure all inlet accessories are free from obstructions and securely mounted.

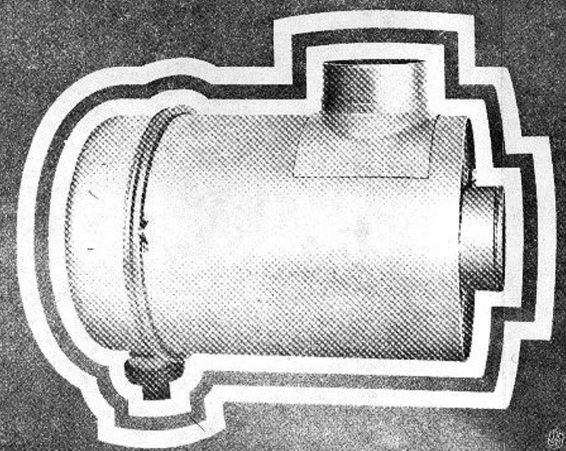
service bulletin

Service Instructions for Cyclopac® Series Air Cleaners

FH Series
FW Series

Construction, Service Procedure, Element Cleaning, General Service Tips





SUPPLEMENTAL OPERATING MAINTENANCE
AND REPAIR PARTS INSTRUCTIONS

FOR

COMPACTOR, HIGH SPEED, TAMPING, SELF-PROPELLED (CCE)

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*This publication supersedes USMP 5-3895-349, dated Jun 78

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GENERAL

1-1. Purpose. To provide User and Support personnel supplemental maintenance and repair parts instructions that have special application to Commercial Construction Equipment (CCE) items.

1-2. Scope. This publication applies to Department of the Army Units, Organizations and Activities that use and/or support the CCE High Speed, Self-Propelled Compactor.

1-3. CCE Item. The term "CCE Item" used in this publication applies to a standard commercial item of commercial equipment that has been approved for a specific TOE requirement and is procured and supported under the CCE System Plan. This plan permits maximum utilization of the civilian construction industry's competitive research and development, manufacturer's equipment publications and commercial sources for repair parts.

1-4. Description. The CCE Compactor is manufactured by Buffalo- Bomag, a division of the Koehring Company, Mississauga, Ontario, Canada. It is powered by a Caterpillar V-8 diesel engine (Model 3208). This engine is similar to those used in a number of construction equipment items currently in the military system. The transmission assembly consists of two basic components, an integral torque converter and a three-speed powershift transmission.

1-5. Operational Concept. The CCE Compactor can be deployed world- wide in all areas and altitudes where high volume compaction is feasible. The compactor is intended for use in construction operations for:

a. Compacting to a high density a full range of soils except clean sand.

b. Performing limited dozing or "striking off" functions. It will be issued as a replacement for towed sheepsfoot rollers (LIN S12438).

1-6. Procurement Status. The procurement contract number is DSA 700-76-C-8075 and was awarded on 26 September 1975.

1-7. Equipment Publications.

a. Initially two sets of the manufacturer's commercial publication will be overpacked and shipped with each compactor.

b. If additional assistance is required, contact the address in paragraph 1-11 of this publication.

1-8. Personnel and Training.

a. MOS Requirements:

(1) Operator: 62J20, General Construction Machine Operator.

(2) Organizational Maintenance: 62B20, Construction Equipment Repairman.

(3) Direct and General Support Maintenance: 62B30, Construction Equipment Repairman; 63G20, Fuel and Electrical Systems Repairman, 44B20 Metal Body Repairman.

b. New Equipment Training: New Equipment Training Teams (NETTs) are available to major field commands. Requests for NETTs should be forwarded to Commander, US Army Tank-Automotive Materiel Readiness Command (TARCOM), ATTN: DRSTA-MLT, Warren, MI 48090. Training teams should be requested only when trained personnel are not available in the command to operator and/or maintain the compactor.

1-9. Logistics Assistance.

a. Tank-Automotive Command Field Maintenance Technicians stationed at CONUS and OCONUS installations will be fully qualified and available to furnish on-site training and or assistance concurrent with receipt of the compactor.

b. Assistance can be obtained by contacting the Logistics Assistance Office listed in Appendix B of AR 700-4.

1-10. Warranty. The CCE Compactor contractor warrants the products furnished under this contract according to the terms and conditions described in the equipment publications and Appendix B of this publication. All warranties furnished to the compactor contractor by subcontractors of assemblies or components utilized in the manufacture of the end item will be extended to the Government. See Appendix B for warranty guidelines.

1-11. Reporting of Errors. You can improve this publication by recommending improvements, using DA Form 2028 (Recommended Changes to Publications and Blank Forms) or DA Form 2028-2 located in the back of the manual and mail the form direct to Commander, US Army Tank-Auto- motive Materiel Readiness Command, ATTN: DRSTA-MBS, Warren, MI 48090. A reply will be furnished direct to you.

MAINTENANCE

2-1. Maintenance Concept. The CCE Compactor will not require any new or special maintenance considerations. All maintenance functions can be accomplished within the current maintenance concepts established for construction equipment.

a. Operator/Crew Maintenance: Operator and crew maintenance is limited to daily preventive maintenance checks and services.

b. Organizational Maintenance: Organizational maintenance consists of scheduled preventive maintenance services, minor repairs and adjustments.

c. Direct support Maintenance: Direct support maintenance consists of repairs on-site or in a direct support units shops. Repairs are accomplished with a minimum of tools and test equipment; the assemblies and end items thus repaired are returned to their users.

d. General Support Maintenance: General support maintenance overhauls selected assemblies and repairs items designated by the area support command for return to stock.

e. Depot Maintenance: Depot maintenance overhauls end items and selected major assemblies when they are required to satisfy overall Army requirements. Overhaul of the end item may also be performed by contract with the manufacturer.

2-2. Maintenance Allocation Chart. Maintenance will be performed as necessary by the category indicated in the Maintenance Allocation Chart (MAC) (Appendix C) to retain or restore serviceability. All authorized maintenance within the capability of a using organization will be accomplished before referring the item to support maintenance. Higher categories will perform the maintenance functions of lower categories when required or directed by the appropriate Commanders. Using and support units may exceed their authorized scope and functions in the MAC when approval is granted by the next higher support maintenance Commander.

2-3. Modifications. Modifications will be accomplished by the end item manufacturer after TARCOM approves the field campaign or modification plan. See Appendix D.

2-4. Equipment Improvement Recommendations (EIR). Equipment improvement Recommendations will be submitted in accordance with TM 38-750,

2-5. Equipment Readiness Reporting. Readiness Reporting will be accomplished as required by current TM 38-750.

2-6. Maintenance Expenditure Limits. The average life expectancy for the compactor is 15 years.

PERCENT OF REPAIR	YEAR
50%	1982
45%	1985
40%	1987
35%	1989
30%	1991
20%	1993
10%	1994

2-7. Shipment and Storage.

a. Shipment and Storage. Refer to TB 740-97-2 for procedures covering preservation of equipment for shipment and storage.

b. Administrative Storage. Refer to TM 740-90-1 for instructions covering administrative storage of equipment.

2-8. Destruction to Prevent Enemy Use. Refer to TM 750-244-3 for procedures covering destruction of equipment to prevent enemy use.

2-9. Fire Protection.

a. A hand operated fire extinguisher may be installed at the discretion of the using unit.

b. Approved hand-portable fire extinguishers are listed in TB 5-4200-200-10.

2-10. Basic Issue Items List (BIIL). See Appendix E for a list of items which accompany the end item or are required for operation and/or operator 's maintenance.

2-11. Maintenance and Operating Supply List. See Appendix F for a list of maintenance and operating supplies required for initial operation.

2-12. Special Tools and Equipment. No special tools or equipment are required for operation and maintenance of the compactor.

2-13. Maintenance Forms and Records. Operational Maintenance and Historical Records will be maintained as required by the current TM-38-750.

2-14. Facilities. No special maintenance facilities are required for the compactor.

2-15. Safety Precautions.

a. Trained operators only.

b. Do not park or enter under machine without setting parking brake. If on a grade, block wheels. Connect safety links if engine is running.

c. Make certain no one is in center joint area between scraper bar and rear wheel before starting machine.

d. Never adjust or lubricate machine while engine is running. If machine is malfunctioning or awaiting service tie red warning tag on steering wheel.

e. Do not use blade as a brake when going down a steep slope.

REPAIR PARTS SUPPLY

3-1. General.

a. The basic policies and procedures in AR 710-2 and AR 725-50 are generally applicable to repair parts management for CCE items.

b. Manufacturer's parts manuals are furnished with CCE items instead of Department of the Army Repair Parts and Special Tool List (RPSTL).

c. National Stock Number (NSN's) are initially assigned only to PLL/ASL parts and major assemblies, i.e., engines, transmissions, etc. Additional NSN's are assigned by the supply support activities as demands warrant.

d. Automated Processing (AUTODIN) of Federal Supply Code Manufacturer (FSCM) part number requisitions, without edit for matching NSN's and exception data, is authorized.

e. Proper use of project codes and weapon systems designator codes on parts requisitions is essential.

f. Repair parts are available from commercial sources and may be purchased locally in accordance with AR 710-2 and AR 735-110.

g. Initial Prescribed Load List (PLL) and Authorized Stock List (ASL) will be distributed by US Army Tank-Automotive Materiel Readiness Command (TARCOM), ATTN: DRSTA-FHV.

3-2. Prescribed Load List (PLL). The PLL distributed by TARCOM is an estimated 15 days supply recommended for initial stockage at organizational maintenance. Management of PLL items will be governed by the provisions of AR 710-2 and local command procedures. Selection of PLL parts for shipment to CONUS/OCONUS units is based upon the receiving Command's recommendation after their review of the TARCOM prepared list. Organizations and activities in CONUS/OCONUS will establish PLL stocks through normal requisitioning process.

3-3. Authorized Stockade List (ASL). The ASL distributed by TARCOM is an estimated 45 days supply of repair parts for support units and activities. The ASL parts will be shipped according to the recommendations of the receiving commands, after they have reviewed the initial list distributed by TARCOM. Support units and activities in CONUS/OCONUS will establish ASL stocks through normal requisitioning process.

3-4. Requisitioning Repair Parts.

a. Using Units/Organizations: Requisitions (DA Form 2765 Series) will be prepared according to AR 710-2 and local command directives. All requisitions will have the Weapons System Designator Code "38" (interim Change 5-1, AR 710-2 per DA Message, DALO-SMS 091400Z June 78) entered in the 2nd and 3rd positions of block 18. Units in CONUS will use Project Code "BGW" in block 19. Units OCONUS will enter in block 19 Project Code "JZC", Appendix H.

b. Support Units and Activities:

(1) General: All MILSTRIP requisitions (DD Form 1348 Series) prepared for repair parts support of CCE items will include distribution and project codes, see Appendixes I, J, and K.

(2) Distribution Code: Supply customers in CONUS will use Code "F" in card column 54. Customers OCONUS will use the appropriate code from Appendix P, Paragraph P-3a(l) AR 725.50. Weapons System Designator Code "38". (DA Message DALO-SMS, 091*'4*QOZ,Jun 78), will be entered in card columns 55 and 56 of all requisitions for parts to support the Compactor.

(3) Project Codes: The Project Code “BGW”' will be used by CONUS customer when requisitioning part numbered parts. Supply customers OCONUS will use Project Code "JZC" for part numbered parts,.

3-5. Submitting Requisitions.

a. Using Units and Organizations will submit DA Form 2765 Series requisitions to designated support units or activities in accordance with local procedures.

b. Support units and activities will forward MILSTRIP requisitions for NSN parts through the Defense Automated Addressing System (DAAS) to the Managing Supply Support Activity. Requisitions for part numbered part will be forwarded through DAAS to the Defense Construction Supply Center (DCSC).

NOTE: When the manufacturer's part number and Federal Supply Code for Manufacturer (FSCM) exceed the space in card columns 8 through 22 of *AO2/AOB* requisitions, prepare an A05AOE requisition (DD Form 1348-6) and mail it to Commander, Defense Construction Supply Center, ATTN: DCSC-OSR, Columbus, Ohio 43215.

APPENDIX A

EQUIPMENT PUBLICATIONS

DA EQUIPE.NT PUBLICATIONS		
NOMENCLATURE	EQUIPMENT PUBLICATION NUMBER	DATE AVAILABLE
Utilization of Engineer Construction Equipment: Volume A, Earth moving, compaction, grading, and ditching equipment.	TM5-331A	Aug 67
NOTE.: Supervisors and operators' should refer to TM5-331A to get the most use from this equipment.		

APPENDIX B

WARRANTY GUIDELINES

1. A warranty period of 12 months or 1,OOQ hours applies to the Compactor, High Speed Model K300, Contract No. DSA700-76-C-8075, manufactured by Koehring Co., after delivery to the Government. This warranty applies to the end item, components and all supplies furnished under the contract.

2. Using units may not contact their local dealer. You must mail DA Form 2407 to the Maintenance Directorate, TARCOM, at the following address: US Army Tank-Automotive Materiel Readiness Command, ATTN: DRSTA-MVB, Warren Michigan 48090. To expedite actions you may call the information to AUTOVON 369-2434, 2982, or 2868 with the information from your DA 2407, Section 1, Block 1 through 11, Blocks 16, 17, 18 and 20.

3. General information:

a. DA Form 2407 (prepared in accordance with warranty claim actions in TM 38-750) will be used to submit warranty claims actions for end items when components, parts or assemblies are defective and are covered by a manufacturer's warranty. End items under warranty are identified by a decal plate and/or warranty statement included in the operator's and maintenance manual for the end item. All warranty actions settled or unsettled will be reported to the National Maintenance Point (NMP) on DA Form 2407. For warranties settled locally the DA Form 2407 will contain a statement "For Information Only" in block 35.

b. Maintenance activities in support of organizational maintenance are the responsible points of contact between the originator of warranty claims and the National Maintenance Point (US Army Tank-Automotive Materiel Readiness Command, DRSTA-[VB, AUTOVON 369-2434, 369-2982, 369-2668, Warren, Michigan 48090, which serves as. the DA Representative with the contractor in warranty matters.

NOTE: In certain instances, the originating organization and the support activity are one and the same.

c. Before you take your equipment to a dealer for repair, whether or not it was necessary for you to go through the NMP (TARCOM), check with your local procurement office to see if a funds commitment document is needed. Sometimes, even though the majority of the repairs are covered by the warranty, there may be a small charge for normal maintenance costs, i.e., oil filters, oil, etc. Further, the cause of damage could be determined by the dealer to be directly related to "operator abuse." In that case, the Government may be obligated to pay for teardown services even if the repairs are no longer desired, or for the complete cost if repairs are to be completed by the dealer.

d. When the equipment is given to the dealer for repairs, find out how long the work will taken the extent of the problem, if possible, and the charges, if any, which may be involved. Leave the name and telephone number of the person to be contacted for pickup of the equipment and specifically state that he should be called as soon as the repairs are finished. In addition, state he should be telephoned if unexpected problems, costs and/or delays are encountered. Get the name and telephone number of the service Manager, for any required follow-up purposes.

e. When you arrive to pick up your equipment after completion of services, make certain that you know exactly what repairs were performed and/or parts replaced. This is required for overall problem trend evaluation by the NMP and must be identified upon completion of warranty services.

f. Telephone the NMP at TARCOM, AUTOVON 369-2434, 369-2982, and/or 369-2668 if:

(1) Your equipment requires repairs and you cannot obtain there services using the procedures listed above.

(2) The length of time required for repairs may seriously namper your mission, or if the dealer's overall response to your requirements are not satisfactory.

(3) You have any questions regarding warranty procedures - either in general or about a specific Job. Do not wait until your problems become critical.

g. Do not attempt to conduct negotiations regarding a breach of warranty. This is a function of the Contracting Officer, through the NMP at TARCOM.

APPENDIX C

MAINTENANCE ALLOCATION CHART

FOR

COMPACTOR, HIGH SPEED TAMPING, SELF-PROPELLED (CCE)

Section I. INTRODUCTION

1. General: This Maintenance Allocation Chart designates responsibility for performance of Maintenance functions to specific Maintenance categories.

2. Maintenance functions:

a. Inspect: To determine the serviceability of an item by comparing its physical, mechanical and/or electrical characteristics with established standards through examination.

b. Test: To verify serviceability and detect incipient failures by measuring the mechanical or electrical characteristics of an item and comparing those characteristics with prescribed standards.

c. Service: Operations required periodically to keep an item in proper operating condition, i.e., to clean (decontaminate), to preserve, to drain, to paint, or to replenish fuel, lubricants, hydraulic fluids, or compressed air supplies.

d. Adjust: To maintain, within prescribed limits, by bringing into proper or exact position, or by setting the operating characteristics to specified parameters.

e. Align: To adjust specified variable elements of an item to bring about optimum or desired performance.

Calibrate**:** To determine and cause corrections to be made or to be adjusted on instruments or test measuring and diagnostic equipment used in precision measurement. Consists of comparisons of two instruments, one of which is a certified standard of known accuracy, to detect and adjust any discrepancy in the accuracy of the instrument being compared.

g. Install: The act of emplacing, seating, or fixing into position an item, part, or module (component or assembly) in a manner to allow the proper functioning of an equipment or system.

h. Replace: The act of substituting a serviceable like type part, subassembly, or module (component or assembly) for an unserviceable counterpart.

i. Repair: The application of maintenance services or other maintenance actions to restore serviceability to an item by correcting specific damage, fault, malfunction, or failure in a part, subassembly, module (component or assembly), end item, or system.

j. Overhauls: That maintenance effort (service/action) necessary to restore an item to a completely serviceable/operational condition as prescribed by maintenance standards (i.e., DMWR) in appropriate technical publications. Overhaul is normally the highest degree of maintenance performed by the Army. Overhaul does not normally return an item to like new condition.-

k. Rebuild: Consists of those services/actions necessary for the restoration of *unservic*e*able* equipment to a like new condition in accordance with original manufacturing standards. Rebuild is the highest degree of materiel maintenance applied to Army equipment. The rebuild operation includes the act of returning to zero those age measurements (hours/miles, etc) considered in classifying Army equipments/components.

3. Column entries: Columns used in the Maintenance allocation chart are explained below:

a. Column 1, Group Number: Column 1 lists group numbers, the purpose of which is to identify components, assemblies, subassemblies, and modules with the next higher assembly.

b. Column 2, Component/Assembly: Column 2 contains the noun names of components, assemblies, subassemblies, and modules for which maintenance is authorized.

c. Column 3, Maintenance Functions: Column 3 lists the functions to be performed on the item listed in Column 2.

d. Column 4, Maintenance Category: Column 4 specifies, by the listing of a "work time" figure in the appropriate subcolumn(s), the lowest level of maintenance authorized to perform the function listed in Column 3. This figure represents the active time required to perform that maintenance function at the indicated category of maintenance. If the number of complexity of the tasks within the listed maintenance function vary at different maintenance categories, appropriate "work time" figures will be shown for each category. The number of manhours specified by the "work time" figure represents the average time required to restore an item (assembly, subassembly, component, module, end item or system) to a serviceable condition under typical field operating conditions. This time includes preparation time, troubleshooting time, and quality assurance/quality control

time in addition to the time required to perform the specific tasks identified for the maintenance functions authorized in the Maintenance Allocation Chart.

e. Column 5, Tools and Equipment: Column 5 specifies by code those common tool sets (not individual tools) and special tools, test, and support equipment required to perform the designated function.

f. Column 6, Remarks: Column 6 contains an alphabetic code which leads to the remark in Section IV, Remarks, which is pertinent to the item opposite the particular code.

APPENDIX C

SECTION II. MAINTENANCE ALLOCATION CHART FOR COMPACTOR, HIGH SPEED TAMPING, SELF-PROPELLED (CCE)

(1) GROUP NUMBER	(2) COMPONENT/ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE CATEGORY					(5) TOOLS AND EQPT	(6) REMARKS
			C	O	F	H	D		
01	ENGINE							1,2,3,4	
0100	Engine Assembly	Test			1.5				
		Service	0.2						
		Replace			16.0				
		Repair			51.2				
		Overhaul				80			
	Engine Mounts	Replace			8.0				
0101	Cylinder Block	Repair				40		1,2,3,4	
		Replace				32.5			
	Cylinder Sleeve	Replace				2.0			
	Cylinder Head	Replace			4.0				
		Repair			6.7				
		Overhaul				16.8			
0102	Crankshaft	Replace				16.0		1,2,3,4	
	Main Bearings	Replace				6.0			
	Drive Pulley	Replace			3.0				
0103	Flywheel	Replace			8.0			1,2,3,4	
		Repair			2.0				
	Flywheel	Replace			8.0				
		Repair			2.0				
0104	Pistons and Connecting	Replace				2.0		1,2,3,4	
	Rods	Repair				1.5			
	Rings and Bearings	Replace				1.0			
0105	Rocker Arms	Replace			2.0			1,2,3,4	
	Valve Springs	Test			1.0				
		Replace			2.5				

*The Subcolumns are as follows:

C--operator/crew F--direct support D-depot
O--organizational H--general support

APPENDIX C

SECTION II. MAINTENANCE ALLOCATION CHART FOR COMPACTOR, HIGH SPEED TAMPING, SELF-PROPELLED (CCE)

(1) GROUP NUMBER	(2) COMPONENT/ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE CATEGORY					(5) TOOLS AND EQPT	(6) REMARKS
			C	O	F	H	D		
	Valves	Adjust			1.8				
		Replace			12.0				
		Repair			2.0				
0106	Engine Lubrication System							1,2	
	Oil Cooler	Replace			1.0				
		Repair			1.0				
	Oil Pan	Replace			1.0				
		Repair			1.5				
	Oil Pump	Replace			2.0				
		Repair				3.0			
	Oil Pressure Regulator	Adjust			0.2				
		Replace			0.5				
	Oil Filter Assembly	Service		0.2					
		Replace			0.5				
		Repair			0.5				
	Oil Filter Element	Replace		0.4					
0108	Exhaust Manifold	Replace			1.5			1,2	
		Repair			2.0				
03	FUEL SYSTEM								
0301	Fuel Injector	Test			1.0			1,2	
		Replace			1.0				
		Repair				1.0			
0302	Fuel Pump	Replace			2.0			1,2	
		Repair			3.0				
0304	Air Cleaner	Service	0.2					1	
		Replace		1.2					
		Repair		1.0					
	Air Cleaner Element	Replace		0.5					

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(1) GROUP NUMBER	(2) COMPONENT/ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE CATEGORY					(5) TOOLS AND EQPT	(6) REMARKS
			C	O	F	H	D		
0306	Fuel Tank	Service		0.5					
		Replace		1.5					
		Repair		2.0					
	Lines and Fittings	Replace		1.0					
		Repair		2.0					
0308	Governor Engine speed	Test			0.5			1,2	
		Adjust			0.6				
		Replace			1.8				
		Repair				2.0			
0309	Fuel Filters	Service		1.4				1	
		Replace		0.9					
		Repair		1.0					
	Elements	Replace		0.7					
0312	Throttle Control/ Linkage	Adjust		0.5				1	
		Replace		1.0					
		Repair		0.5					
04	EXHAUST SYSTEM							1	
0401	Mufflers and Exhaust Pipes	Replace		2.0					
		Repair		2.0					
05	COOLING SYSTEM								1,2
0501	Radiator	Test			0.5				
		Service	0.5						
		Replace		3.0					
		Repair			2.0				
	Radiator Shroud	Replace		1.2					1,2
		Repair			1.0				
0503	Thermostat	Test		0.5					1
		Replace		1.0					
	Hoses and Clamps	Replace		1.2					

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SECTION II. MAINTENANCE ALLOCATION CHART FOR COMPACTOR, HIGH SPEED TAMPING, SELF-PROPELLED (CCE)

(1) GROUP NUMBER	(2) COMPONENT/ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE CATEGORY					(5) TOOLS AND EQPT	(6) REMARKS
			C	O	F	H	D		
0504	Water Pump	Replace		2.0				1,2	
		Repair			2.5				
0505	Fan Assembly	Replace			1.0			1,2	
		Repair			1.0				
	Fan Belts	Inspect	0.1						
		Adjust		0.4					
		Replace		1.0					
06	ELECTRICAL SYSTEM							1,5	
0601	Alternator	Test		0.5					
		Replace		0.6					
		Repair			1.5				
	Alternator Drive Belt	Inspect	0.1						
		Adjust		0.4					
		Replace		0.5					
0603	Starting Motor	Test		0.5				1,2,5	
		Replace		1.0					
		Repair			1.6				
0607	Instrument Panel Accessories	Replace		0.5					1,5
		Repair		0.5					
0608	Miscellaneous Electrical Items (Switches, Circuit Breakers)	Replace		0.5					1,5
		Repair		0.5					
0609	Head Light Assembly	Replace		0.3					1,5
		Repair		0.5					
	Head Light Lamp Units	Replace		0.2					
0610	Sending Units/ Warning Switches	Replace		0.5					1, 5
0611	Horn Assembly	Replace		0.5					1,5
0612	Battery	Test		0.2					1, 5
		Service	0.3						
		Replace		0.5					

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(1) GROUP NUMBER	(2) COMPONENT/ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE CATEGORY					(5) TOOLS AND EQPT	(6) REMARKS
			C	O	F	H	D		
	Cables	Service	0.3						
		Replace		0.4					
		Repair		0.5					
	Battery Box	Service	1.0						
		Replace		1.0					
		Repair		0.5					
0613	Wiring Harness	Replace			2.0			1,2,5	
		Repair		1.0					
07	TRANSMISSION							1,2,3	
0700	Transmission Assembly	Test			3.0				
		Service		1.0					
		Replace			12.0				
		Repair			16.0				
		Overhaul				30.0			
0703	Control Valve	Replace			0.5				1,2
		Repair			1.0				
0708	Torque Converter (Integral)	Replace			8.0				1,2
		Repair			8.0				
	Transmission Oil Filter	Service		0.5					
		Replace			1.0				
		Repair			1.0				
	Oil Filter Element	Replace		0.5					
09	PROPELLER SHAFT								1,2,3
0901	Transmission Output to Axles	Service		0.5					
		Replace		2.0					
		Repair		1.0					
10	FRONT AXLE								1,2,3,4
1000	Front Axle Assembly	Service		1.0					
		Replace			10.0				
		Repair			10.0				

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(1) GROUP NUMBER	(2) COMPONENT/ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE CATEGORY					(5) TOOLS AND EQPT	(6) REMARKS
			C	O	F	H	D		
1002	Front Differential	Service		1.0				1,2	
		Replace			10.0				
		Repair			10.0				
1003	Planetary/Final Drive	Service		1.0				1,2	
		Replace			9.0				
		Repair			8.0				
11	REAR AXLE							1,2,3,4	
1100	Rear Axle Assembly	Service		1.0					
		Replace			10.0				
		Repair			10.0				
1102	Rear Differential	Service		1.0				1,2,3,4	
		Replace			10.0				
		Repair			10.0				
1103	Planetary/Final Drive	Service		1.0				1,2,3,4	
		Replace			8.0				
		Repair			8.0				
12	BRAKE SYSTEM							1	
1201	Parking Brake Linkage	Adjust		0.2					
		Replace		1.0					
		Repair		1.0					
1202	Service Brakes	Replace			2.0			1,2	
		Repair			3.0				
1204	Master Cylinder	Service		0.3				1	
		Replace		1.0					
		Repair			0.5				
	Lines and Fittings	Replace		2.0					
		Repair		1.0					
13	WHEELS							1,3,4	
1311	Wheel Assembly	Inspect		0.5					
		Replace			4.0				

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(1) GROUP NUMBER	(2) COMPONENT/ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE CATEGORY					(5) TOOLS AND EQPT	(6) REMARKS
			C	O	F	H	D		
	Wheel Shoe and Cap	Inspect Replace		0.1 0.5					
14	STEERING							1,2,3,4	
1401	Steering Wheel	Replace		1.0					
1405	Center Joint Assembly	Service Replace Repair		0.5	 4.0 2.0			1,2,3,4	
1407	Steering Control Unit	Replace Repair			2.0 2.0			1,2,3,4	
1410	Hydraulic Steering Pump	Replace Repair Overhaul			2.0 2.0	 4.0		1,2,3,4	
1411	Hoses, Lines and Fittings	Replace Repair			1.0 1.0			1,2,3,4	
1412	Hydraulic Steering Cylinders	Service Replace Repair		1.0	 1.5 2.0			1,2	
1414	Valve Assembly	Replace Repair			2.0 1.5			1,2	
15	FRAME							1,2	
1501	Frame Assembly	Repair			4.0				
18	HOOD, FENDERS, PANELS AND PLATES							1,2	
1801	Hood Assembly	Replace Repair		1.0	 1.5				
1802	Fenders	Replace Repair		0.5	 1.0			1,2	
1805	Floor Plates	Replace Repair		2.0	 1.0			1,2	

*The Subcolumns are as follows:
C--operator/crew F--direct support D-depot
O--organizational H--general support

APPENDIX C

SECTION II. MAINTENANCE ALLOCATION CHART FOR COMPACTOR, HIGH SPEED TAMPING, SELF-PROPELLED (CCE)

(1) GROUP NUMBER	(2) COMPONENT/ASSEMBLY	(3) MAINTENANCE FUNCTION	(4) MAINTENANCE CATEGORY					(5) TOOLS AND EQPT	(6) REMARKS
			C	O	F	H	D		
1806	Seat Assembly	Replace		1.0				1,2	
		Repair			1.0				
1808	Tool Box	Replace		0.5				1,2	
		Repair			0.5				
74	EARTH MOVING EQUIPMENT COMPONENTS							1,2,3	
7435	Dozer Blade Assembly	Replace		1.0					
		Repair			1.0				

*The Subcolumns are as follows:

C--operator/crew F--direct support D-depot
O--organizational H--general support

MAINTENANCE ALLOCATION CHART FOR

**COMPACTOR, HIGH SPEED TAMPING,
SELF-PROPELLED (CCE)**

SECTION III - TOOL AND TEST EQUIPMENT REQUIREMENTS

TOOL/TEST EQUIPMENT REF CODE	MAINT. CATEGORY	NOMENCLATURE	NATIONAL/NATO STOCK NUMBER	TOOL No.
		Unless otherwise noted, all maintenance functions can be accomplished with the tools contained in the following, common two sets.		
1	0, F, H	Shop Equip Contact Maint, TRK MTD (SC 4940-97-CL-EOI)	4940-00-294-9518	T10138
1	0, F, H	Shop Equip Org Repair, Light TRK MTD (SC 4940-97-CL-E04)	4940-00-294-9516	T13152
1	0, F, H	Tool Kit Automotive Maint, Org Maint Common #1 (SC 4910-95-CL-A74)	4910-00-754-0654	W32593
1	O, F, H	Tool Kit Automotive Maint, Org Maint Common #2 (SC 4910-95-CL-A72)	4910-00-754-0650	W32730
1	0, F, H	Tool Kit, Light Weight (SC 5180-90-CL-W26)	5180-00-177-7033	W33004
1	0, F, H	Shop Equip Auto Maint and Repair Org Maint Supp #1 (SC 4910-95-CL-A73)	4910-00-754-0653	W32867
1	O, F, H	Shop Equip Welding Field Maint (SC 3470-95-CL-A08)	3470-00-357-7268	T16714
1	O, F, H	Tool Set, Veh Full Tracked Sugg #2 SC 4940-95-CL-A08	4940-00-754-0743	W65747
1	F, H	Shop Equip Gen Purp Repair Semitrlr MTD (SC 4940-97-CL-E03)	4940-00-287-4894	T10549
2	F, H	Tool Kit Automotive, Fuel and Elec Sys Repair (SC 4910-95-CL-A50)	4910-00-754-0655	W32456
2	F, H	Tool Kit, Master Mechanic and Equip Maint and Repair (SC 5180-90-CL-E05)	5180-00-699-5273	W45060

MAINTENANCE ALLOCATION CHART FOR

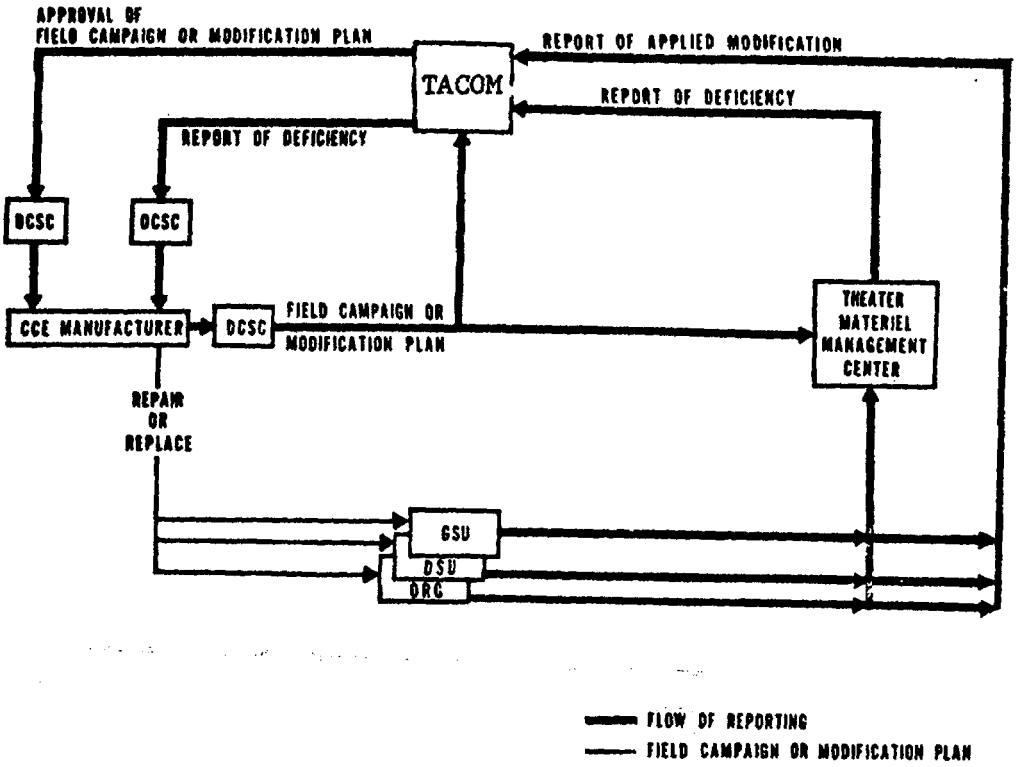
**COMPACTOR, HIGH SPEED TAMPING,
SELF-PROPELLED (CCE)**

SECTION III - TOOL AND TEST EQUIPMENT REQUIREMENTS

TOOL/TEST EQUIPMENT REF CODE	MAINT. CATEGORY	NOMENCLATURE	NATIONAL/NATO STOCK NUMBER	TOOL No.
2	F, H	Shop Set, Fuel and Elec Sys Field Maint Basic (SC 4910-95-CL-AO1)	4910-00-754-0714	T30414
2	F, H	Shop Set, Fuel and Elec Sys Field Maint Basic Sup #2 (SC 4910-95-CL-ASS)	4910-00-390-7775	T30088
2	F, H	Shop Equip Machine Shop, Field Maint Basic (SC 3470-95-CL-A02)	3470-00-754-0708	T15644
2	F, H	Measuring and Lay Out Tool, Set, Mach (SC 5280-95-CL-A02)	5280-00-511-1950	W44512
2	F. H	Tool Kit Body and Fender Repair	5180-00-754-0643	W33689
3	F. H	Wrench Set Socket, 3/4" Drive Hex Type	5310-00-754-0743	W65747
4	0, F, H	Wrench Torque, 3/4" Drive 500 lb Cap	5120-00-542-5577	Y84966
5	0, F, H	Multimeter	6525-00-999-7465	M80242

APPENDIX D

CCE MANUFACTURER FIELD CAMPAIGNS AND MODIFICATION PROCEDURES



APPENDIX E

BASIC ISSUE ITEMS LIST (CCE)

NOMENCLATURE:
MANUFACTURE:
SERIAL NUMBER RANGE:

DATE:

(1) MFR PART NO.	(2) MFR FED CODE	(3) DESCRIPTION	(4) UNITE OF ISSUE	(5) QUANTITY FURNISHED W/EQUIP
		N-O-N-E		

APPENDIX E

ITEMS TROOP INSTALLED OR AUTHORIZED LIST

(1) SMR CODE	(2) NATIONAL STOCK #	(3) DESCRIPTION REF NO. & MFR CODE USABLE ON CODE	(4) UNIT OF MEAS	(5) QTY AUTH
		NOTE: .The following items are overpacked with the compactor.		
	7520-00-559-9618	Case, Cotton Duck: MIL-B-11743 (81349)	ea	1
	7510-00-889-3494	Log Book Binder: MIL-B-43064	ea	1
		Tool Kit: Consisting of Six Open End Wrenches. 2500 (09605)	set	1
		Grease Guns 2055(09605)	ea	1
		Hose, flex grease: 2089 (09605)	ea	1
		NOTE: The following item is authorized but not issued with the compactor.		
	4210-00-889-2221	Extinguisher, Fire Dry Chemical	ea	1

APPENDIX F

PRESCRIBED LOAD LIST (PLL)
AUTHORIZED STOCKAGE LIST (ASL)

END ITEM: COMPACTOR, HIGH SPEED TAMPING, S/P (CCE)	MAKE: Koehring (BOMAG)	MODEL: k300

MFR PART NO:	NSN 3895-01-024-4064	SERIAL NO RANGE: ---------- TO ----------	DATE: Apr 79

SMR CODE	NAT'L STOCK NO.	PART NUMBER	FSCM	PART DESCRIPTION	U/M	QTY OF PARTS REQ'D FOR NO. OF END ITEMS PLL 1-5	ASL 1-5	ASL 6-20	ASL 21-50
PAOZZ	3030-00-609-9458	17491	73842	Belt, Water Pump	EA	1	1	2	2
PAOZZ	3030-00-689-6099	8272-2	24161	Belt Fan	EA	1	1	2	2
PAOZZ	2910-00-989-3388	9M-2341	11083	Element, Fuel Filter, Primary	EA	2	2	4	8
PAOZZ	2910-00-157-0650	1P2299	11083	Element, Fuel Filter, Secondary	EA	2	2	4	8
PAOZZ	4330-01-044-3143	3278-001	02249	Filter, Hydr. Element	EA	2	2	4	8
PAOZZ	2910-00-138-1782	P11-7331	18265	Element, Air Filter	EA	2	2	4	8
PAOZZ	2520-01-028-0082	230962	12603	Element, Trans.- Filter	EA	2	2	4	8
PAOZZ	2940-00-470-i238	9L9200	11083	Element, Oil Filter	EA	2	2	4	8
PAOZZ	3030-01-041-3120	2P4230	11083	Belt, Alternator	EA	1	1	2	4

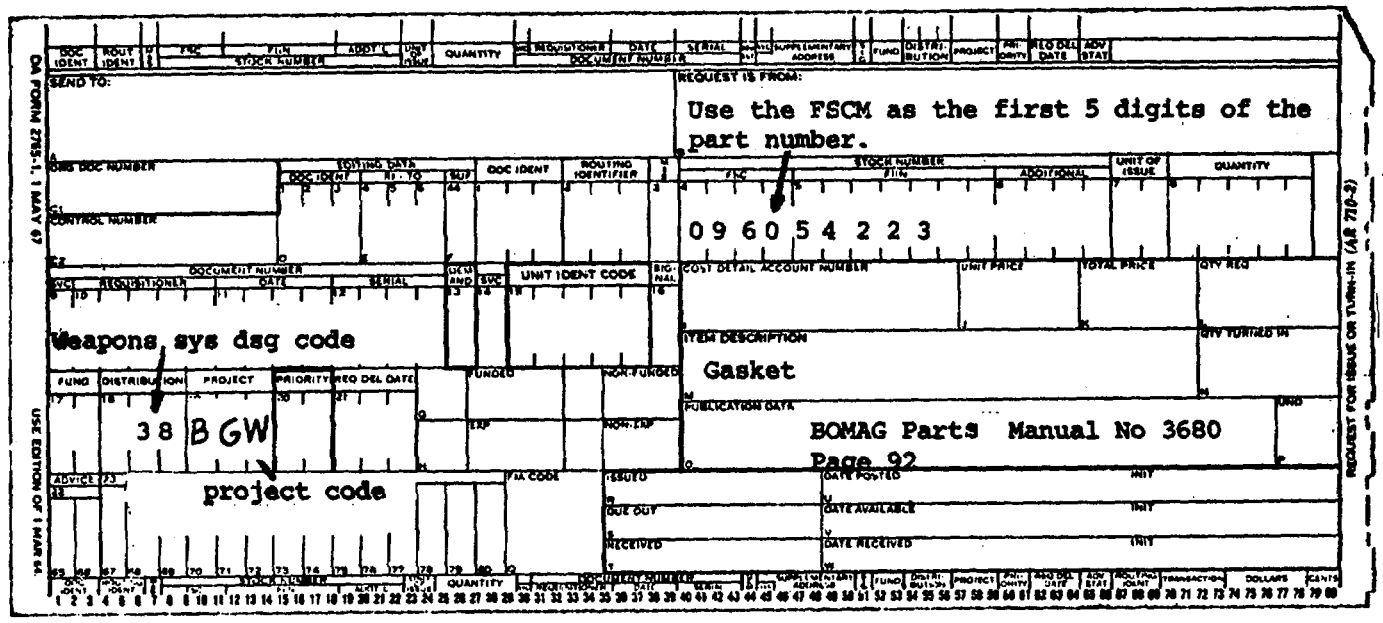
ADDITIONAL REPAIR PARTS

NSN	PART NUMBER	FSCM	DESCRIPTION
5920-00-142-4833	311025	75915	Fuse
5945-00-457-5345	1115834	16764	Relay, Wrng Light
5330-01-042-2819	185-8	97576	"O" Ring
2520-00-509-9686	570-18X	95019	Kit Brg Race Cap
5330-01-040-8661	111476	12603	Seal, Hub, Oil
5330-01-040-8662	118068	12603	Seal, Differential Pinion
5930-00-020-9535	9001	13445	Switch Emer Brake
6220-00-401-4689	M12745	74400	Light, Rear
6220-01-044-0006	M12327	74400	Headlights
2530-00-226-6413	5140	96151	Kit, Seal, Steer Valve
5330-01-020-0948	6OK40106	12603	"O" Ring
6685-00-881-3763	353-Z	57733	Sender, Oil Pressure
5330-01-018-5378	231080	12603	Packing preformed, converter Valve Body to Conv.
5330-01-043-1910	4223	09605	Gasket, Steer Pump

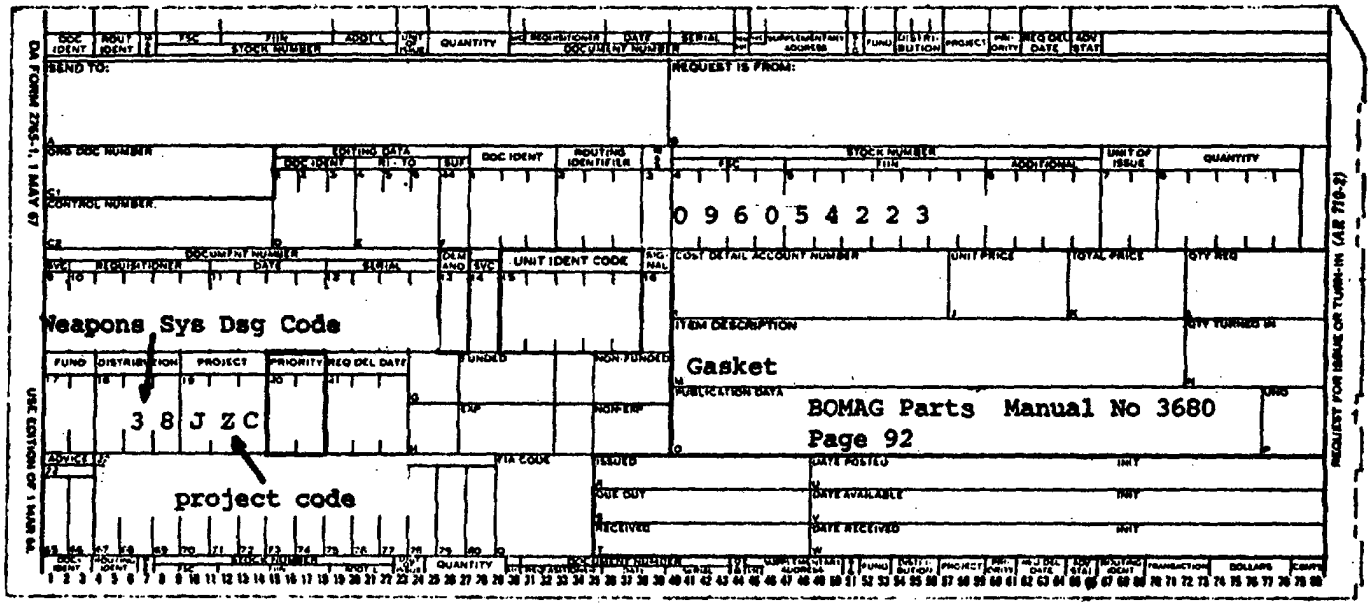
APPENDIX H

SAMPLE FORMAT- DA FORM 2765 PART NUMBER REQUEST

(CONUS REQUESTER)

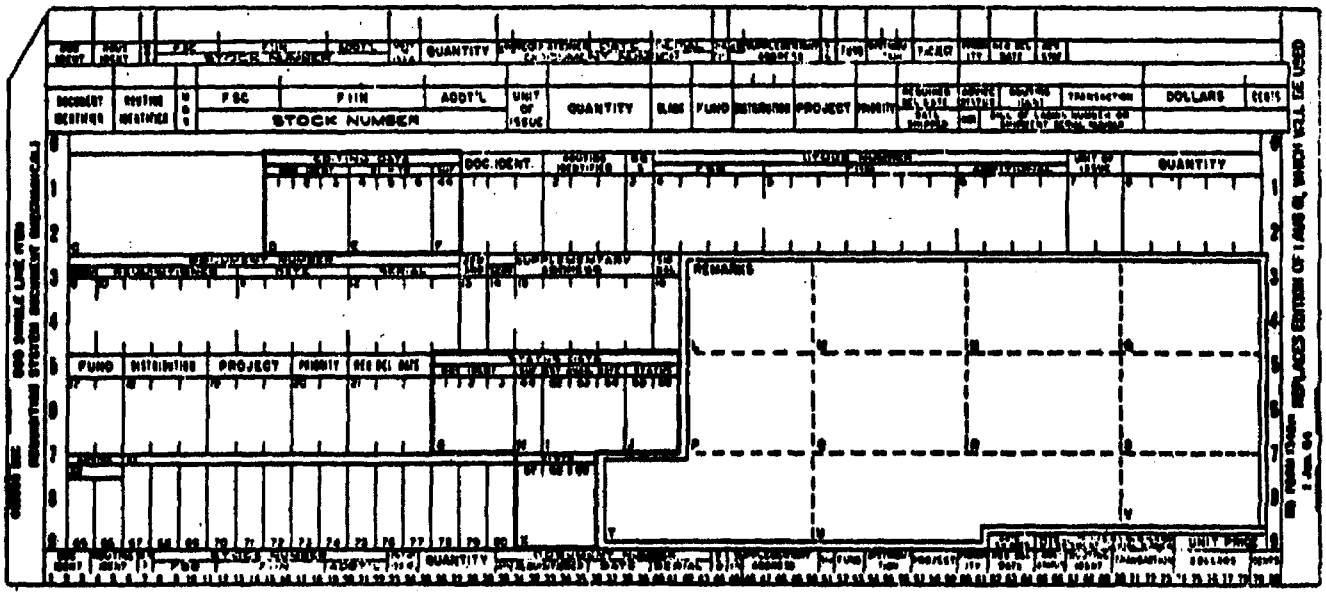


(CONUS REQUESTER)



APPENDIX I

SAMPLE FORMAT - MILSTRIP REQUISITION FOR CCE (NSN)



Card Column	Description of Data	Mandatory Entry for CCE
1-3	Document Identifier Code	AØA - CONUS AØ1 - Overseas
4-6	Routing Identifier Code	
7	Media/Status Code	
8-22	NSN	
23-24	Unit of Issue	
25-29	Quantity	
30-43	Document Number	
44	Demand Code	
45-50	Supplementary Address	
51	Signal Code	
52-53	Fund Code	
54-56	Distribution Code CC-54	"F" for CONUS; see AR 725-50 for OCONUS
	CC-55-56	Weapon System Code
57-59	Project Code	
60-61	Priority Code	
62-64	Required Delivery Date	
65-66	Advice Code	

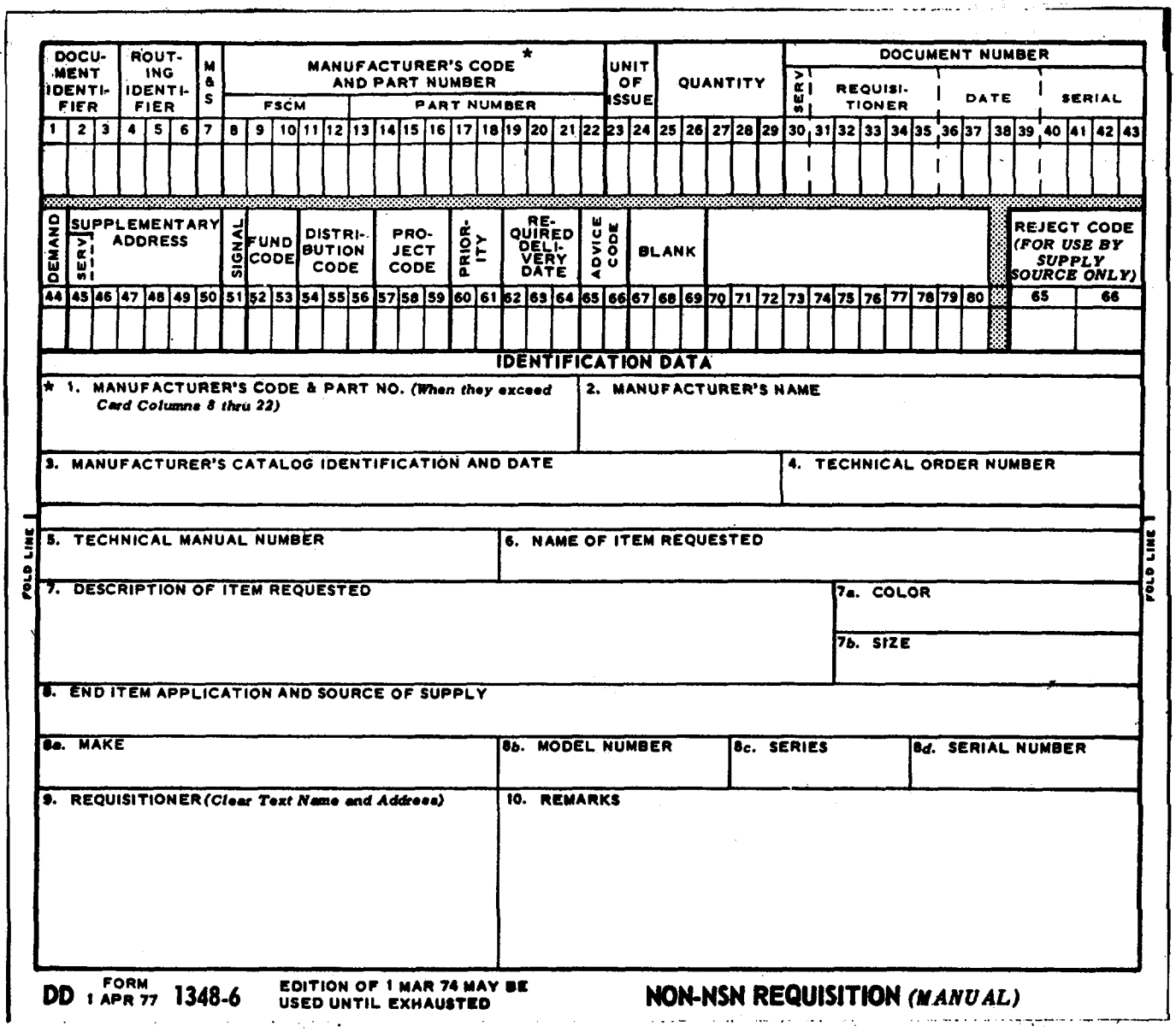
APPENDIX J

SAMPLE FORMAT - MILSTRIP REQUISITION FOR CE (NON-NSN)

Card Column	Description of Data	Mandatory Entry for CCE
1-3	Document Identifier Code	AØB - CONUS AØ2 - Overseas
4-6	Routing Identifier Code	Always S9C
7	Media/Status Code	
8-22	FSCM and Part Number	
23-24	Unit of Issue	
25-29	Quantity	
30-43	Document Number	
44	Demand Code	
45-50	Supplementary Address	
51.	Signal Code	
52-53	Fund Code	
54-56	Distribution Code CC-54	“F" for CONUS; see AR 725-50 for OCONUS
	CC-55-56	Weapon System Code
57-59	Project Code	
60-61	Priority Code	
62-64	Required Delivery Date	
65-66	Advice Code	

CARD COLUMN	DESCRIPTION OF DATA	MANDATORY ENTRY FOR COE
67-69	Blank	
70	Identification code applicable to entry in cc 71-80. A - Technical order or Technical Manual B - End Item Identification C - Noun Description D- Drawing or Specification No.	
71-80	Reference Identification	Identification of reference specified in cc 70

SAMPLE FORMAT - MILSTRIP REQUISITION FOR CCE (NON-NSN)(MANUAL)



DOCUMENT IDENTIFIER	ROUTING IDENTIFIER	M&S	MANUFACTURER'S CODE * AND PART NUMBER		UNIT OF ISSUE	QUANTITY	DOCUMENT NUMBER			
			FSCM	PART NUMBER			SERY	REQUISITIONER	DATE	SERIAL
1 2 3	4 5 6	7	8 9 10 11 12	13 14 15 16 17 18 19 20 21 22	23 24	25 26 27 28 29	30 31	32 33 34 35	36 37 38	39 40 41 42 43

DEMAND	SUPPLEMENTARY ADDRESS		SIGNAL	FUND CODE	DISTRIBUTION CODE	PROJECT CODE	PRIORITY	REQUIRED DELIVERY DATE	ADVICE CODE	BLANK		REJECT CODE (FOR USE BY SUPPLY SOURCE ONLY)	
	SERY												
44	45	46 47 48 49 50	51	52 53	54 55 56	57 58 59	60 61	62 63 64	65	66 67 68 69	70 71 72 73 74 75 76 77 78 79 80	65	66

IDENTIFICATION DATA

* 1. MANUFACTURER'S CODE & PART NO. *(When they exceed Card Columns 8 thru 22)*	2. MANUFACTURER'S NAME
3. MANUFACTURER'S CATALOG IDENTIFICATION AND DATE	4. TECHNICAL ORDER NUMBER
5. TECHNICAL MANUAL NUMBER	6. NAME OF ITEM REQUESTED
7. DESCRIPTION OF ITEM REQUESTED	7a. COLOR 7b. SIZE
8. END ITEM APPLICATION AND SOURCE OF SUPPLY	
8a. MAKE	8b. MODEL NUMBER / 8c. SERIES / 8d. SERIAL NUMBER
9. REQUISITIONER *(Clear Text Name and Address)*	10. REMARKS

FOLD LINE

FOLD LINE

DD FORM 1 APR 77 1348-6 EDITION OF 1 MAR 74 MAY BE USED UNTIL EXHAUSTED

NON-NSN REQUISITION *(MANUAL)*

APPENDIX K

INSTRUCTIONS

This form will only be used in those cases where the manufacturer's code and part number exceed the spaces allocated in card columns 8 - 22 of the requisition.

CARD COLUMN	DESCRIPTION DATA	MANDATORY ENTRY FOR CCE
1 - 3	Document Identifier Code	AØE - CONUS AØ5 - OCONUS
4 - 6	Routing Identifier Code	Always S9C
7	Media Status Code	
8 - 22	FSCM and Part Number	Leave Blank Enter In Block 1 under Identification Data
23-24	Unit of Issue	
25-29	Quantity	
30-43	Document Number	
44	Demand Code	
45-50	Supplementary Address	
51	Signal Code	
52-53	Fund Code	
54-56	Distribution Code CC 54	"F" for CONUS. (See AR 725-50 for OCONUS)
	CC 55-56	Weapon System Code
57-59	Project Code	
60-61	Priority Code	
62-64	Required Delivery Date	
65-66	Advice Code	
67-80		Blank

IDENTIFICATION DATA - Lower half of DD Form 1348-6. complete Blocks 1 thru 9.

APPENDIX L

MAINTENANCE AND OPERATING SUPPLY LIST

NOMENCLATURE: Compactor, High Speed, Tamping, Self Propelled	MAKE: Koehring (USA) Bomag Division	MODEL: K300
MFR PART NO:	NSN: 3895-01-024-4064	SERIAL NO RANGE: ---------- TO ----------	DATE: Apr 79

(1) COMPONENT APPLICATION	(2) MFR PART NO. OR NAT'L STOCK NO.	(3) DESCRIPTION	(4) QTY REQ F/INITIAL OPN	(5) QTY REQ F/8 HRS OPN	(6) NOTES
Engine Crankcase	9150-00-188-9858	Oil, Lubricating OE/HDO30 MIL-L-2104C	3.6 Gal	0	General Svc; NSN for 5 Gal drum
	9150-00-186-6668	Oil, Lubricating OE/HDO10 MIl-L-2104C	3.6 Gal	0	Low Temp; NSN for 5 gal pail.
Transmission & Brake	9150-00-186-6668	Oil, Lubricating OE/HD010 MIL-L2104C	9.6 Gal	0	Temperature Range: -30 degrees F and up.
	9150-00-242-7603	Oil, Lubricating MIL-L-10295	9.6 Gal	0	Temperature Range: -60 degrees F to 0 degrees F; NSN 5 gal drum
	9150-00-657-4959	Automotive Trans Fluid (Dexron)	9.6 Gal	0	NSN for 5 gal pail.
Final Drive	9150-01-035-5394	Lubricating Oil, Gear MIL-L-2105	15.2 Gal	0	General Svc and Low Temp, NSN 5 gal pail.
Hydraulic Fluid	9150-00-186-6668	Oil, Lubricating OE/HD010	56 Gal	0	Temperature Range: -30 degrees F and up.

APPENDIX L

MAINTENANCE AND OPERATING SUPPLY LIST

NOMENCLATURE: Compactor, High Speed, Tamping, Self Propelled	MAKE: Koehring (USA) Bomag Division	MODEL: K300
MFR PART NO:	NSN: 3895-01-024-4064	SERIAL NO RANGE: ---------- TO ----------	DATE: Apr 79

(1) COMPONENT APPLICATION	(2) MFR PART NO. OR NAT'L STOCK NO.	(3) DESCRIPTION	(4) QTY REQ F/INITIAL OPN	(5) QTY REQ F/8 HRS OPN	(6) NOTES
	9150-00-242-7603	Oil, Lubricating, MIL-L-10295	56 Gal	0	Temperature Range: -60 degrees F to 0 degrees F.
Lubrication Points	9150-00-190-0905	GAA Grease MIL-G-10924	0.5 lb	0	
Fuel Tank	9150-00-286-5296	Diesel Fuel, DF 2	80.0 Gal	40 Gal	NSN for 55 Gal drum.
Cooling System	6850-00-181-7933	Anti-Freeze, Permanent MIL-A-46153	7.5 Gal	0	50-50 Solution, 15 Gal Maximum System capacity

NOTE: Optional fuels and lubs listed in Service Manual.

APPENDIX M
PREVENTIVE MAINTENANCE CHECKS AND SERVICES

Maintenance Forms and Records

Every mission begins and ends with the paperwork. There isn't much of it, but you have to keep it up. The forms and records you fill out have several uses. They are a permanent record of the services, repairs, and modifications made on your vehicle. They are reports to organizational maintenance and to your commander. And they are a checklist for you when you want to know what is wrong with the vehicle after its last use, and whether those faults have been fixed. For the information you need on forms and records, see TM 38-750.

Preventive Maintenance Checks and Services

1. Do your before (B) PREVENTIVE MAINTENANCE just before you operate the vehicle. Pay attention to the CAUTIONS and WARNINGS.

2. DURING checks and services (D) of PREVENTIVE MAINTENANCE will be performed while the equipment and/or its component systems are in operation.

3. Do your after (A) PREVENTIVE MAINTENANCE right after operating the vehicle. Pay attention to the CAUTIONS and WARNINGS.

4. Do your weekly (W) PREVENTIVE MAINTENANCE weekly.

5. Do your monthly (M) PREVENTIVE MAINTENANCE once a month.

6. If something doesn't work, troubleshoot it with the instructions in this manual or notify your supervisor.

7. Always do your PREVENTIVE MAINTENANCE in the same order so it gets to be a habit. Once you've had some practice, you'll spot anything wrong in a hurry.

8. If anything looks wrong and you can't fix it, write it on your DA Form 2404. If you find something seriously wrong, report it to organizational maintenance RIGHT NOW.

9. When you do your PREVENTIVE MAINTENANCE, take along the tools you need to make all the checks. You always need a rag or two.

A - Keep it clean: Dirt, grease, oil, and debris only get in the way and may cover up a serious problem. Clean as you work and as needed. Use dry cleaning solvent (SD-2) on all metal surfaces. Use soap and water when you clean rubber or plastic material.

WARNING

Dry cleaning solvent, used to clean parts is potentially dangerous to personnel and property. Do not use near open flame or excessive heat. Flash point of solvent is 100°F - 138°F.

B - Bolts, nuts, and screws: Check them all for obvious looseness, missing, bent or broken condition. You can't try them all with a tool, of course, but look for chipped paint, bare metal, or rust around bolt heads. If you find one you think is loose, tighten it, or report it to organizational maintenance if you can't tighten it.

C - Welds: Look for loose or chipped paint, rust, or gaps where parts are welded together. If you find a bad weld, report it to organizational maintenance.

D - Electric wires and connectors: Look for cracked or broken insulation, bare wires, and loose or broken connectors. Tighten loose connectors and make sure the wires are in good shape.

E - Hoses and fluid lines: Look for wear, damage, and leaks, and make sure clamps and fittings are tight. Wet spots show leaks, of course. But a stain around a fitting or connector can mean a leak. If a leak comes from a loose fitting or connector, tighten it. If something is broken or worn out, report it to organizational maintenance.

10. It is necessary for you to know how fluid leakage affects the status of your vehicle. The following are definitions of the types/classes of leakage an operator or crew member needs to know to be able to determine the status of his/her vehicle. Learn, then be familiar with them and REMEMBER - WHEN IN DOUBT, NOTIFY YOUR SUPERVISOR!

Leakage Definitions for Crew/Operator PMCS

Class I	Seepage of fluid (as indicated by wetness or discoloration) not great enough to form drops.
Class II	Leakage of fluid great enough to form drops but not enough to cause drops to drip from item being checked/inspected,
Class III	Leakage of fluid great enough to form drops that fall from the item being checked/inspected.

CAUTION

EQUIPMENT OPERATION IS ALLOWABLE WITH MINOR LEAKAGES (CLASS I OR II), OR COURSE, CONSIDERATION MUST BE GIVEN TO THE FLUID CAPACITY IN THE ITEM/SYSTEM BEING CHECKED/ INSPECTED. WHEN IN DOUBT, NOTIFY YOUR SUPERVISOR.

B—Before D—During A—After W—Weekly M—Monthly

ITEM NO.	INTERVAL D	M	Q	A	AR	ITEMS TO BE INSPECTED PROCEDURE: Check for and have repaired, filled or adjusted as needed.	Equipment is not ready/ AVAILABLE IF:
						NOTE PERFORM WEEKLY AS WELL AS BEFORE PMCS's IF: a. You are the assigned operator but have not operated equipment since the last weekly. b. You are operating the equipment for the first time.	
1						GENERAL	
	•					a. Visually check for loose wiring, 4ds wed piping or hoses.	
	•					b. Look for evidence of fluid leakage (oil, fuel, coolant).	Class III leaks or any fuel leakages found.
2	•					ENGINE CRANKCASE Check dipstick for proper level. Add oil, as necessary, to Full mark. (At operating temperature, engine idling, 180-200° F).	
3		•				TRANSMISSION Check dipstick for proper level. Add oil, as necessary, to Full mark (At operating temperature, engine idling, 180-200° F).	
4						HYDRAULIC SYSTEM	
	•					a. Check hydraulic tank level sight gage (blade lowered and engine off). Add oil as required.	
				•		b. Check hoses and connections for condition and leaks.	Class III leaks found.

B—Before D—During A—After W—Weekly M—Monthly

ITEM NO.	INTERVAL B	D	A	W	M	ITEMS TO BE INSPECTED PROCEDURE: Check for and have repaired, filled or adjusted as needed.	Equipment is not ready/ AVAILABLE IF:
5	•					RADIATOR Check coolant level. Add coolant as required (Level should be 1/2 inch from bottom of filler neck).	
6				•		BRAKE MASTER CYLINDER Check brake cylinder fluid level. Add as required.	
7		•				AIR CLEANER a. Check air cleaner indicator. If red, clean or replace air filter element.	
				•		b. Inspect air cleaner element.	Element missing.
8					•	V BELTS Check for frayed, cracked, or broken belts	Broken belt.
9			•			AXLES Check differential and planetary oil level (allow 5 min for oil to settle).	
10		•				CONTROLS AND INSTRUMENTS a. Engine water temperature gauge (normal operating temperature 165-195°F).	If any are not within normal operating range.
		•				b. Engine oil pressure gauge (Idle 10-25 psi, rated speed 2800 RPM) 45-75 psi).	
		•				c. Converter "out" oil pressure gauge (25-70 psi).	
		•				d. Transmission oil temperature gauge (180-250° F).	

B—Before D—During A—After W—Weekly M—Monthly

ITEM NO.	INTERVAL B	D	A	W	M	ITEMS TO BE INSPECTED PROCEDURE: Check for and have repaired, filled or adjusted as needed.	Equipment is not ready/ AVAILABLE IF:
		•				CONTROLS AND INSTRUMENTS (Cont'd) e. Ammeter - slight (+) charge.	
		•				f. Controls - check for proper operation (i.e., steering, shifting, etc.).	
11					•	BATTERY Check electrolyte level. Fill as required to split ring. Inspect for obvious defects, such as, cracked case or loose terminals and cables.	One or more missing or defective will not crank engine.

Q—Quarterly S—Semiannually A—Annually B—Biennially H—Hours M—Miles

ITEM NO.	INTERVAL Q	S	A	B	H	MI	ITEM TO BE INSPECTED PROCEDURE: Check for and have repaired, filled or adjusted as needed.
1	•						ENGINE Check for leaks, loose mounts, and proper operation.
2					200		OIL FILTER Change oil and filter (after 50 hrs initially).
3					200		FUEL. FILTER Change fuel filter.
4	•						V BELTS (all belts) Check tension.
5							RADIATOR
	•						a. Check for leaks and clean exterior as required.
			•				b. Check antifreeze protection.
				•			c. Drain and flush radiator and engine.
6							AIR CLEANER
					100		a. Check filter element and clean as required.
					200		b. Change filter element.
	•						c. Inspect air inlet connections for leaks or damaged tubing.
7							BATTERY
					100		Check specific gravity of electrolyte in each cell.

Q—Quarterly S—Semiannually A—Annually B—Biennially H—Hours M—Miles

ITEM NO.	INTERVAL						ITEM TO BE INSPECTED PROCEDURE: Check for and have repaired, filled or adjusted as needed.
	Q	S	A	B	H	MI	
8							TRANSMISSION AND TORQUE CONVERTER
					200		a. Change oil filter (after 50 hrs initially) with transmission at operating temperature (180°-200° F).
					200		b. Check torque converter and transmission pressure with transmission at operating temperature (180-200° F).
					400		c. Oil and filter change with transmission at operating temperature (180-200° F).
					300		d. Adjust brake.
9							AXLES
					100		a. Check wheel mounting nuts for proper torque (450 ft lbs/62 m-kg).
					200		b. Check axle mounting nuts for proper torque (700 ft lbs/97 m-kg).
		•					c. Change oil.
					800		d. Adjust wheel hub bearing preload.
					800		e. Check differential flange end play (if any, adjust preload).
10							HYDRAULIC SYSTEM
					200		a. Change hydraulic filter.
					400		b. Drain and clean hydraulic tank.
					400		c. Check hydraulic pressure.
11							PARKING BRAKE
		•					Check adjustment.

Q—Quarterly S—Semiannually A—Annually B—Biennially H—Hours M—Miles

ITEM NO.	INTERVAL						ITEM TO BE INSPECTED PROCEDURE: Check for and have repaired, filled or adjusted as needed.
	Q	S	A	B	H	MI	
12		•					CONTROL LEVERS, LINKAGES, AND CABLES Inspect and lubricate.
13		•					FRAME AND DOZER WELDMENTS Inspect for cracks or noticeable damage.
14		•					FAN HUB AND FAN MOUNTING Check for damage and torque fasteners IAW Torque Specifications Chart.
15		•					EXHAUST SYSTEM Inspect for leaks or component damage.
16		•					FUEL TANK Drain and clean.

By Order of the Secretary of the Army

E. C. MEYER
General, United States Army
Chief of Staff

Official:

J. C. PENNINGTON
Major General, United State Army
The Adjutant General

Distribution:
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