

*5. Army Tank*

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3. Aust. Tank Workshop Coy  
A.E.M.E.  
No. *T/43/1*

**HANDBOOK**  
**ON**  
**M2A4, M3 AND M3A1 LIGHT TANKS**

**NOT TO BE PUBLISHED**

The information given in this document is not to be communicated, either directly or indirectly, to the Press or to any person not holding an official position in His Majesty's Service.





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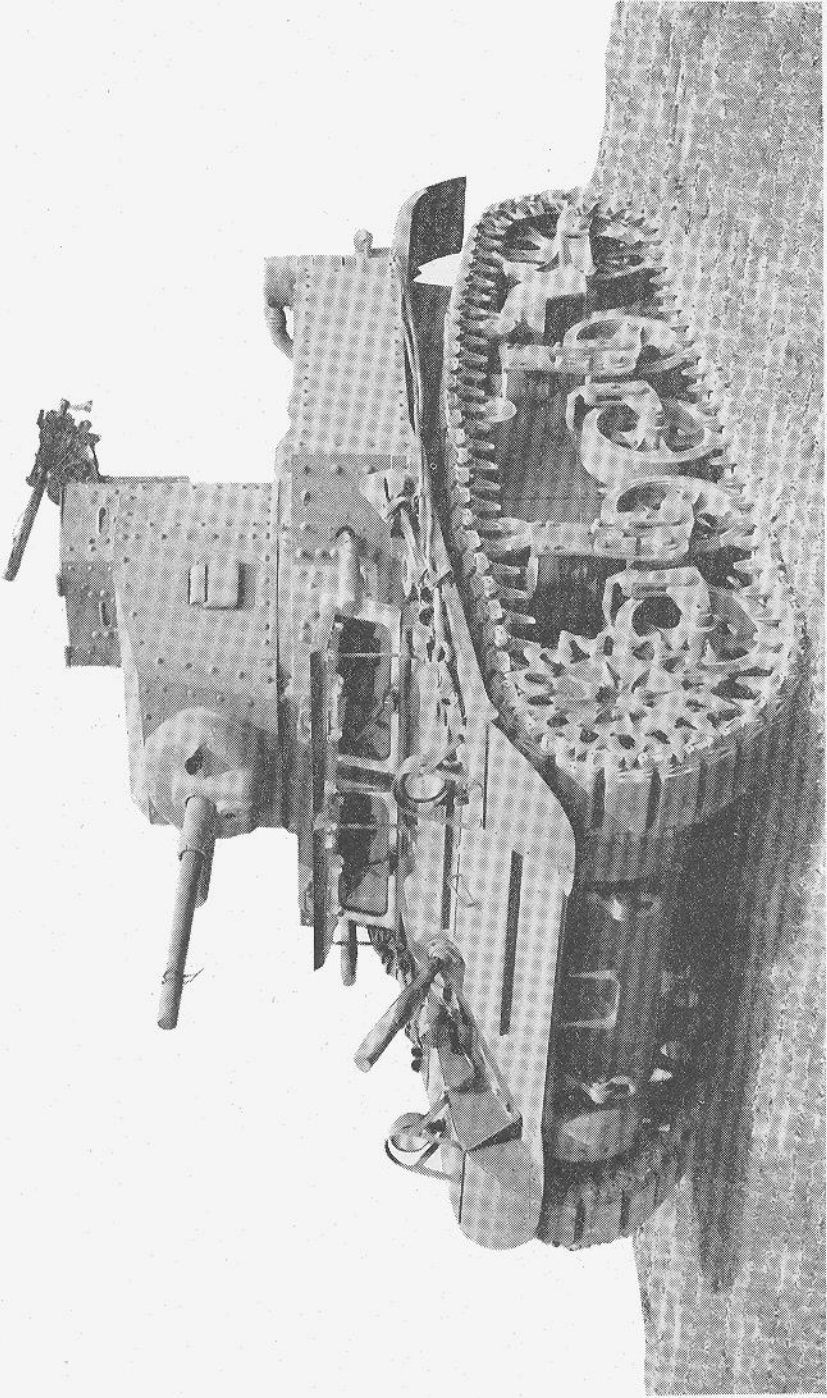


PLATE A  
M3 LIGHT TANK



## CHAPTER I

### PARTICULARS

#### A. General Description (Plate A)

The M2A4, M3 and M3A1 Light Tanks are all basically of the same design. The M3 is different from the M2A4 in that it has thicker armour, a trailing idler and different turret which may be riveted or welded. The M3A1 Light Tank is similar to the M3 but has a power operated turret with rotating platform and a gyro-stabiliser installed to steady the 37 mm. gun. The cupola has been removed and periscopes and periscopic sights substituted. The crew consists of four, composed of the driver, the machine gunner alongside the driver, the gunner and the commander-loader. In the M3 Light Tank the commander is also the gunner. In the sponsons on either side of the tank are .30 machine guns which are fired by the driver.

*The hull* of all these tanks is built up of flat plates which are welded and/or riveted together. It is supported on rubber-tired wheels.

*The fighting chamber* is situated between the transmission chamber, which is at the forward end, and the engine compartment at the rear. The engine propeller shaft runs through the fighting chamber.

*The engine*, a 250 H.P. radial aircraft engine, is air cooled and mounted in the rear of the vehicle. The power is transmitted through a multiplate clutch and propeller shaft to the gear box and controlled differential located in the front end of the vehicle. To steer, it is only necessary to pull back the lever on the side to which it is desired to turn. This causes one track to slow down and the speed of the other track to be increased. Thus, at no time is one track transmitting no power at all. It is quite impossible to lock either track even though the steering lever may be pulled full back. The track sprockets are each driven by spur gear final drive units coupled to the steering units. Two alternate types of links are provided, one type having rubber blocks forming both the tread and roller path, and the other having a rubber roller path, but with a spudded steel tread.

#### B. General Specification

##### *Armament:*

1—37 mm. Gun M5 or M6, and 1-.30 Browning Machine Gun in co-axial mounting in the turret. (Gun mount in M2A4 is M20; in M3, M22 and in M3A1, M23.)

1—Browning Machine Gun in a ball mounting alongside the driver.

1—Browning Machine Gun in the sponson either side of the tank.

1—Browning Machine Gun for the anti-aircraft mounting on the back of the turret.

1—Sub-machine Gun.

*Lookouts and Sighting:*

Slits, Protectoscopes and Periscopes.

*Ammunition:*

100 rounds	37 mm.
8000 "	.30 cal.
600 "	.45 cal.

*Turret Rotation:*

By hand. In later models, M3A1, there will be power traverse.

*Internal Communication:*

Nil. May be fitted at a later date.

*Wireless Receiver and Transmitter:*

U. S. set SCR No. 245 or SCR 508.  
No. 11 set or No. 19/24 set.

*Performance:*

Maximum speed: 30 to 35 mph.

Fording depth:

Ground clearance—16½".

Minimum turning circle—42' diameter.

*Tracks:* Each 68 blocks, which may be

12" wide rubber blocks, with rubber bushed joints; or

12" wide rubber-coated blocks with metal treads and rubber bushed joints.

*Suspension:*

Two bogie assemblies on each side of the vehicle, each with double vertical volute springs.

*Gear Box:*

5 speeds forward and one reverse, synchro-mesh.

*Overall Gear Reductions:*

Reverse speed	39.19.
First "	33.96.
Second "	17.86.
Third "	10.87.
Fourth "	6.89.
Fifth "	4.68.

*Steering:*

Controlled differential.



*Petrol Tank Capacity:*

44 gallons. (Br.)

*Fuel Rating:*

82 Octane. 75 octane is permissible.

*Range of Operation:*

70 Miles.

*Oil Supply:*

Capacity: Engine oil cooler	8 qts.
Engine oil tank	16 qts.
Transmission and Differential	32 qts.
Final drive units, each	4 qts.

<i>Leading Dimensions:</i>	M2A4	M3	M3A1
Height	8' 3"	8' 4"	7' 6"
Width	7' 4"	7' 4"	7' 4"
Length	14' 7"	14' 5"	14' 5"

*Weight of Tank:*

M2A4	11½ tons (Br.)
M3	12½ tons (Br.)
M3A1	13 tons (Br.)

**Engine Specification**

*Make:* Continental Motors Corporation.

*Model:* W-670—9A.

*Type:* Radial—Air Cooled No. 707.

*Bore and Stroke:* 5<sup>1</sup>/<sub>8</sub> x 4<sup>5</sup>/<sub>8</sub> inches.

*Firing Order:* 1-3-5-7-2-4-6.

*H.P.:* Maximum, 250 at 2400 R.P.M.

*Compression Ratio:* 6.1 : 1.

*Fan:*

Make: Continental 8 or 12 blades.

*Pistons:*

Make: Continental—Waffle.

*Cylinders:*

Block not integral with upper crankcase.

*Valves:*

Located in cylinder head—two per cylinder, Poppet type.  
Clearance, 10/1000-in. cold.

*Governor:*

Make: Pierce—Centrifugal. Model: A-1589.

*Lubrication:*

Pressure fed throughout.

*Oil Cooler:*

Harrison—Type A.F. 11.

*Petrol Pump:*

Make: Candler Hill Corp. Model: 9151—Vane type.

*Fuel Filter:*

Make: Cuno—Type D.

*Fuel Primer:*

Make: Lunkenheimer—Hand operated.

*Air Cleaner:*

Two King Seely Corporation—Model T-6.

*Carburetor:*

Stromberg—Model NA-R6B—Size No. 6.

*Battery:*

12 volt—168 ampere.

*Starter:*

Eclipse Aviation—Model No. 1, type 404.

*Dynamo:*

Eclipse Aviation—Model 36—Type 310.

*Voltage Regulator:*

Eclipse Aviation—Model CB-68A1E.

*Dynamo Filter:*

Eclipse Aviation—Model M2892.

*Magneto:*

2 Scintilla—Model VMN7-DFA-CLW, Automatic ignition control to 17°—Gap .012.

*Sparking Plug:*

B.G. Model 314 G.S.

*Auxiliary Generator (in M3A1):*

Delco Model. 750-Watt, 12 volt.

## CHAPTER II

### TRANSMISSION

#### A. Gear Box (Plate B)

The synchro-mesh gear box has five speeds forward and one reverse speed. Ball and needle bearings are employed throughout.

Spring actuated poppets engage gears in the shift rod to hold the rods in their shifted position; and a large ball is provided to inter-lock the shift rods and to ensure that only one speed is engaged at a time.

To prevent any accidental engagement of first or reverse gear, a

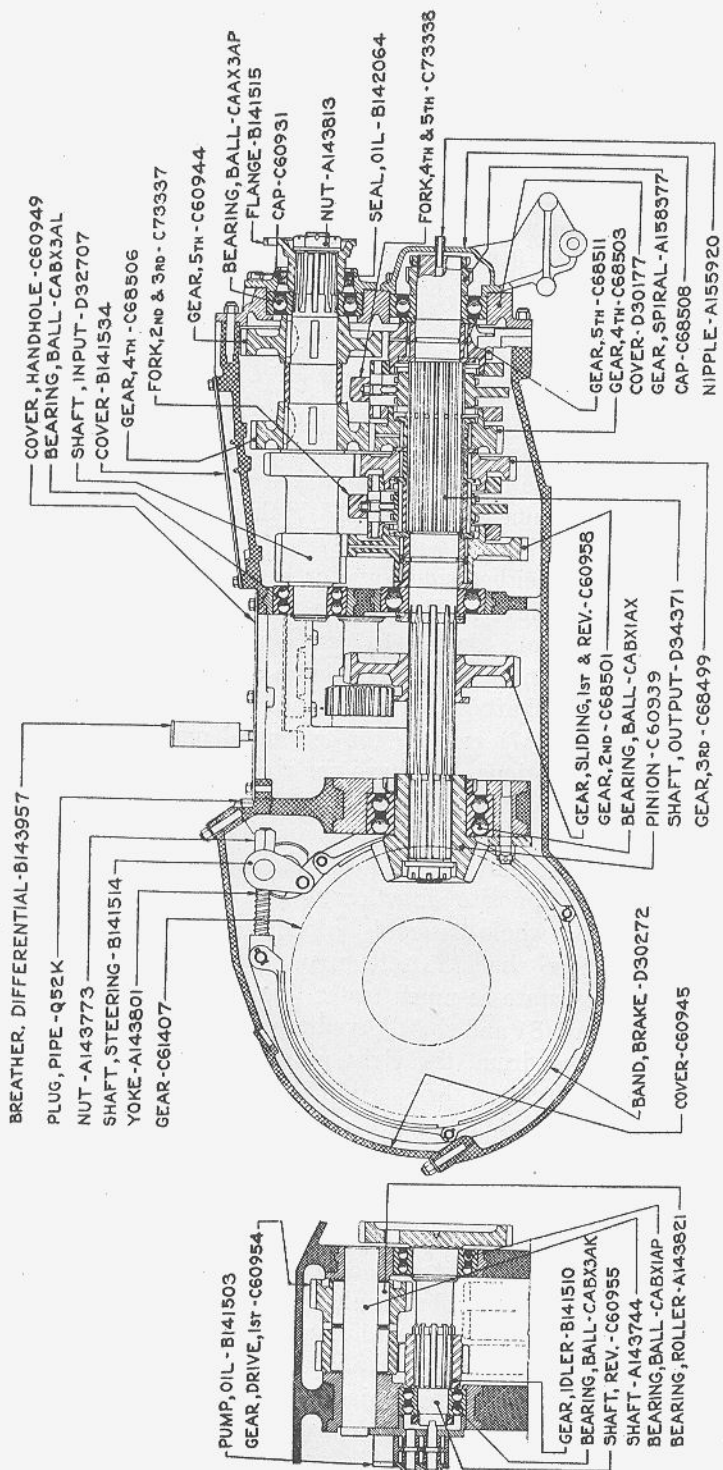


PLATE B  
 GEAR BOX

spring loaded button on the top of the gear shift lever must be depressed.

## **B. Controlled Differential Steering and Brakes**

### *1. Controlled Differential Steering (Plates C & D)*

On the front end of the gear box the bevel pinion on the output shaft meshes with the crown wheel of the controlled differential. This differential is the same as fitted to any car, except that the differential pinions carry at their outer end further external pinions of larger diameter which mesh with an additional gear on either side to drive a hollow shaft on which is mounted the brake drum. The main drive shaft runs through the hollow shaft to the final drive.

When the tank is going straight ahead the whole assembly driven by the bevel pinion rotates as a unit. The differential pinions do not turn in their bearings, and the main drive shaft gears both turn at the same speed. The steering drum gears, and the brake drums turn as a unit with the whole differential.

To turn the tank to either side, say for example, to the right, pull back the right steering lever. This causes the brake band to contract, and holds the right brake drum (10) stationary, preventing it from rotating with the differential. The right hand external (4) and internal pinions (2) with their shafts in their bearings are then made to rotate with the crown wheel, (7) causing the left hand pinions (1, 3) to be driven in opposite directions. Because the right hand external pinions (4), are now rotating around the stationary brake drum gear (6) and turning in the same direction, the right main drive shaft gear (8) and shaft are turning more slowly. The left differential pinions (1) are now rotating in the opposite direction to the rotation of the crown wheel (7) while the whole assembly continues to turn in the same direction as before so that the left main drive shaft gear (9) and shaft are caused to rotate as much faster than the crown wheel as the right main shaft gear (8) and shaft have been retarded. So by stopping the right hand brake drum, the right main drive shaft is caused to turn more slowly, decreasing the speed of the right track, while the left has been speeded up.

### *2. Brakes (Plate B)*

The brake bands, consisting of three bands linked together around the brake drum, are of the external contracting type. The bands are lined with either a special fabric lining with heat resisting elements impregnated, or an asbestos type of lining. The brakes are applied by means of a two-way cam operated through the brake arm, which is splined onto the pivot of the cam projecting through the brake drum casing on the inside of the tank. The brakes are adjusted by a nut A 143773.





PLATE C  
TRANSMISSION AND FINAL DRIVE

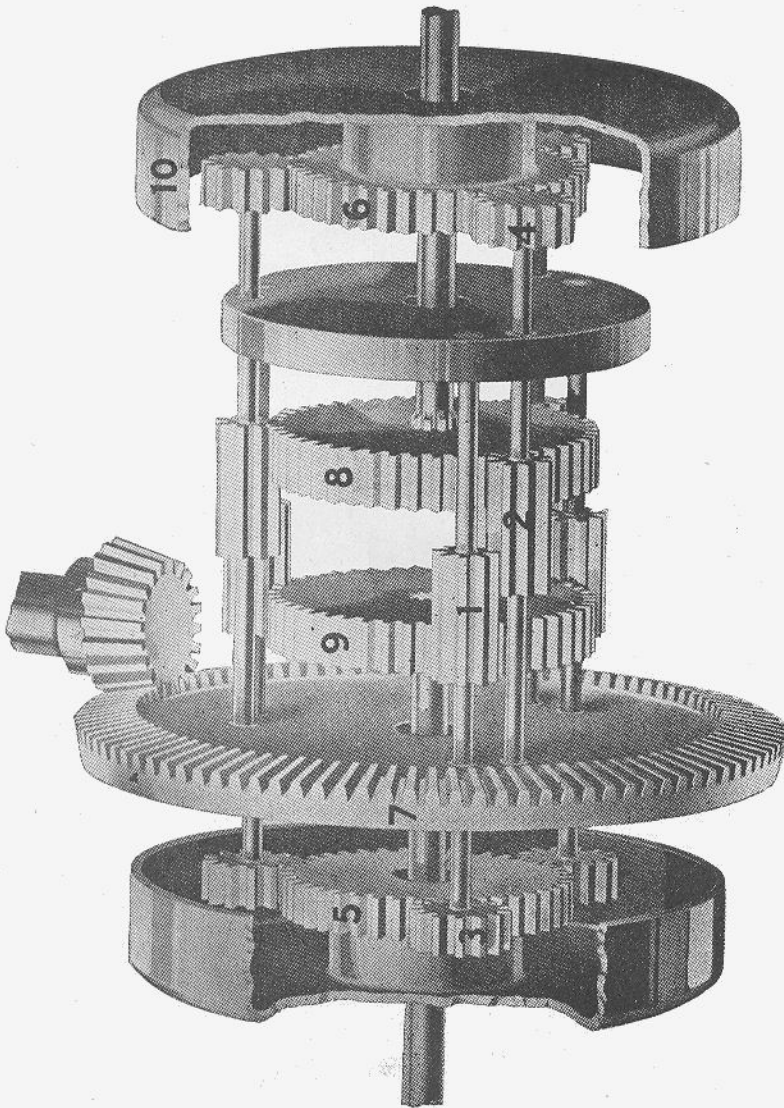


PLATE D  
CONTROLLED DIFFERENTIAL

C61407  
 C61410  
 D27413  
 B141509  
 C60917  
 C60923  
 C60918  
 C60924  
 D30272

B141058  
 D27413  
 B140800  
 B145161  
 A17212F  
 { B141514  
 B145583  
 B151693  
 B151692

1. Gear, Bevel Drive
2. Cover, left
3. Shaft (same as 13)
4. Pinion, External
5. Case, Compensating
6. Gear, Compensating
7. Flange
8. Rim
- 9.
10. Band, Brake
- 11.

12. Pinion, Internal
13. Shaft (Same as 3)
14. Pipe, Filler
15. Gauge, Oil Level
16. Plug, Pipe (Drain)
17. Shaft, Steering
18. Screen, Oil, left
- Screen, Oil, right

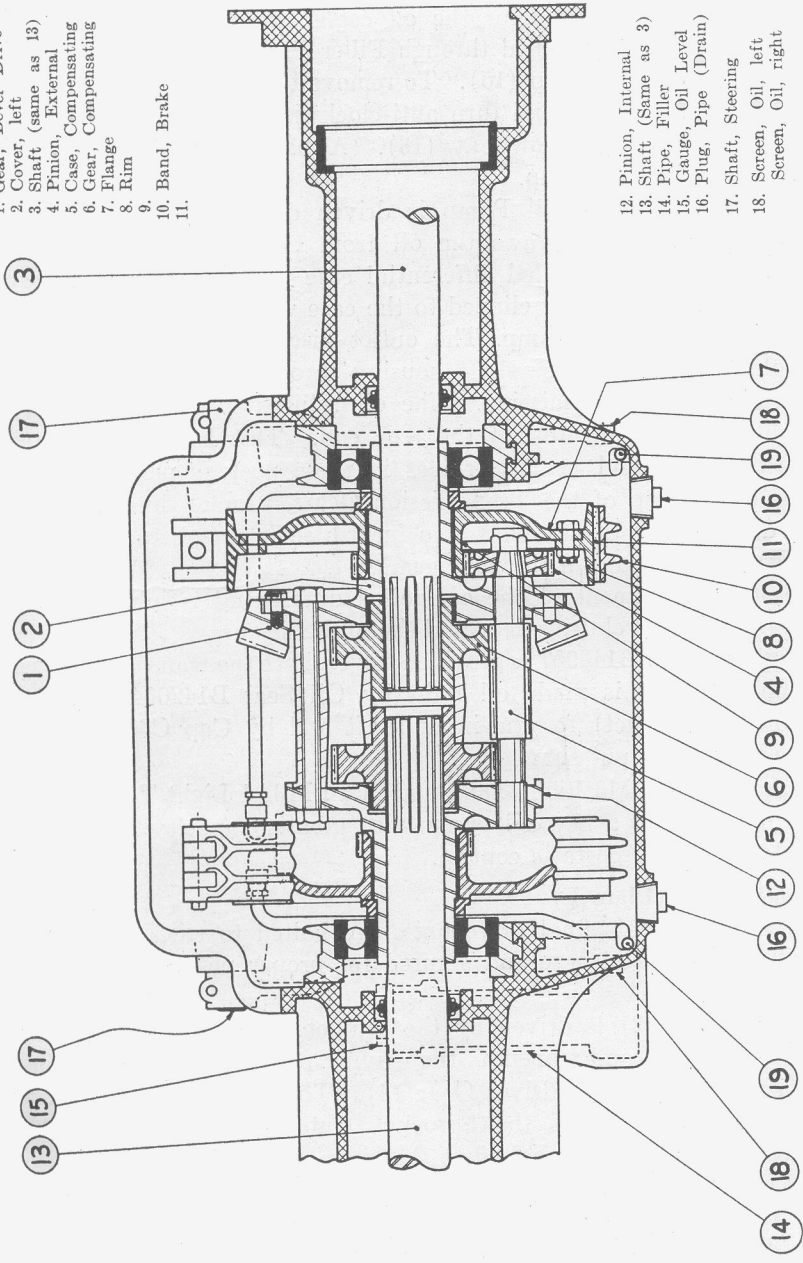


PLATE E  
 CONTROLLED DIFFERENTIAL

Access to this is obtained through a hole in the case opposite each nut and closed by the plugs Q52K which assemble the breather. To park, pull back both steering levers simultaneously and engage the quadrant on each lever.

### **C. Lubrication of the Transmission (Plates E & B)**

The oil capacity of the transmission case is about  $3\frac{1}{4}$  gallons, with an additional  $2\frac{1}{2}$  gallons for the oil cooler which is located at the engine bulkhead. It is filled through Filler Pipe (14) which is closed by the threaded Filler Cap (15). To remove the latter, insert a screwdriver between the lugs and turn anti-clockwise. Drain Plugs for the transmission case are shown at (16). A bayonet type oil gage is assembled to the filler cap.

A double gear type Oil Pump is driven direct from the Reverse Shaft. The oil pump draws the oil from two screened pockets at the bottom of the controlled differential case (Plate E (19)) through two suction lines, securely clipped to the case wall, to two inlets which are on top of the oil pump. The outlet discharges the oil into the oil cooler in the propeller shaft housing through an opening on the right side of the transmission. The oil returns to the transmission through a hole at the top of the rear end. This hole is connected to Pockets (18) and (19). Orifices in these pockets permit the oil to flow on the top of the Transmission Gears. An oil line is drilled in the driven shaft of all vehicles to furnish sufficient oil to the needle bearings of fourth and fifth speed gears.

The steering element of the controlled differential is lubricated by splash from the bevel drive gear and the brake drums.

An Oil Breather B143957 is provided to ventilate the transmission case and the assembly is made oil tight by Oil Seal B142064 and Cap C60931 (with gasket) for the input shaft and by Cap C68508 (with gasket) for the output shaft.

On the modified M3 Light Tank and in all M3A1 Light Tanks, there are being installed a new oil pump with greater capacity and a new oil cooler with thermostatic control.

### **D. Final Drive (Plate F)**

The right and left final drive units are bolted to each end of the controlled differential case and secured for proper position by dowels (1).

Splined Shaft (2) is driven by the compensating Gear of the controlled differential and transmits the driving power to Gear (3) which in turn meshes into and drives Gear (4). The latter is assembled to Shaft (5) which mounts the Sprocket Hub (6) secured by bolts. Sprockets (7) are in turn bolted to the hub.

The assembly is made oil tight by Oil Retainer (8) assembled in Cover (9).

The final drive units are lubricated through holes on the outside



- 7. Sprocket .....D27468
- 8. Retainer, Oil... B132705AD
- 9. Cover .....B132935

- 4. Gear ..... D32854
- 5. Shaft ..... D27406
- 6. Hub, Sprocket. D36962

- 1. Dowel .....
- 2. Shaft .....D27413
- 3. Gear .....C66170

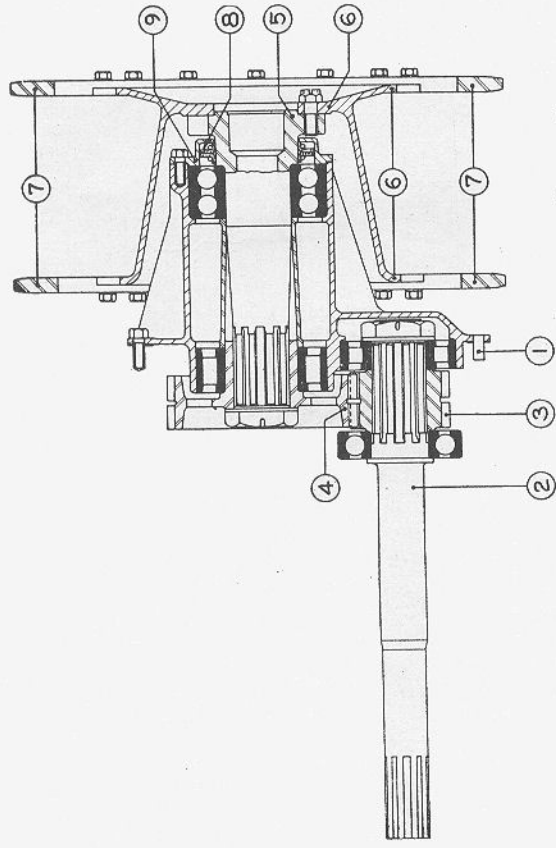
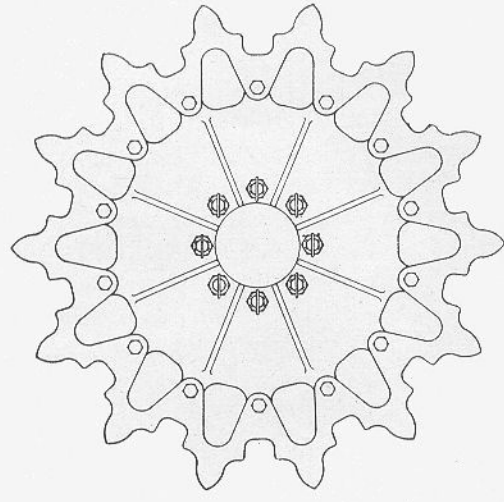


PLATE F  
FINAL DRIVE



front end of the hull. These holes are closed with Hexagon Head Plugs locked with locking wire. The upper Plug opens the filling hole, the lower one the drain hole.

#### **E. Track (Plate G)**

The tracks are composed of rubber block units which are reversible and each block consists of a forged steel frame (2) covered with rubber (1). Rubber is vulcanized to the frame and two track pins (3) having rubber bushings (4) vulcanized on the pins are pressed into the blocks under high pressure. The holes in the track pins are used to secure grousers to the track.

Each pin is assembled to the pin of the adjacent track link by connecting ends (5) and are held in position by wedge (6) engaging flats (9) on the end of each pin. The wedge is secured by a nut (8).

For slippery cross-country travel, grousers (10) are provided and they should be assembled on every shoe to get a comfortable ride. One in four is adequate for soft ground work. To assemble them the steel pins of the grousers fit in the ends of the track pins, and are held in place by a screw (11) which secures the grouser end connection. Two special socket wrenches are provided for assembling and removing the grousers.

### CHAPTER III ENGINE

The Continental engine is a seven cylinder single row static radial air-cooled engine. It is mounted in a frame at the back and supported in the front by a transverse hollow tube.

#### **A. Particulars of Engine (Plate H)**

##### *(1) Cylinders*

Heat treated aluminum alloy cylinder heads are screwed and shrunk to forged steel barrels. Closely spaced cooling fins are provided on barrels and cylinder heads to provide ample and efficient radiation surface. Cylinder bores are ground to mirror finish and held within extremely close limits. Aluminum bronze spark plug inserts and valve seats are shrunk in the cylinder heads. Rocker boxes are cast integral with the heads and provided with oil-sealed covers. Drains are provided on each cylinder for the scavenging of the rocker boxes.

##### *(2) Crankcase*

The crankcase consists of two aluminum alloy castings bolted together on the centerline of the cylinders. Into the front and rear portions of the case are pressed bearing liners which are accurately align-reamed. Ball bearings fit these liners and furnish support for

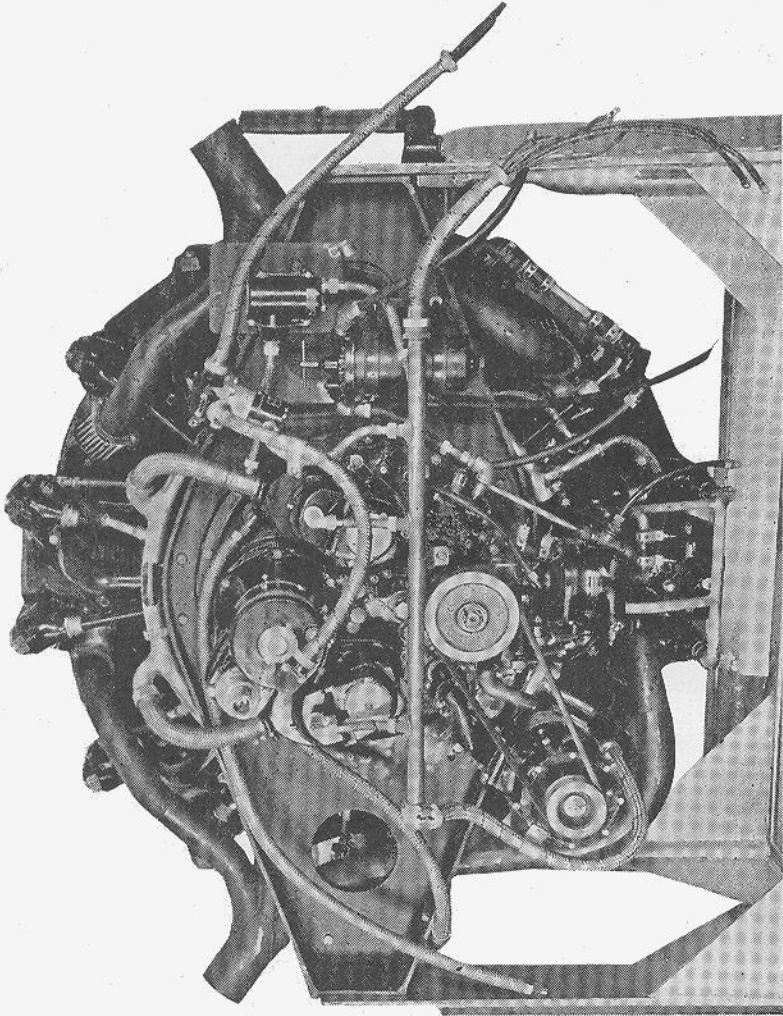


PLATE H  
ENGINE



the crankshaft. Intake manifolding and valve tappet guide bosses are cast into the rear case. A system of drilled oil lines provide pressure oiling to the valve tappets. Engine lifting eyes are attached to the crankcase.

### *(3) Pistons*

Heat treated aluminum alloy forged pistons are provided with three compression rings and one oil ring. The heads are internally finned to dissipate heat, and the skirts are exceptionally long to minimize scuffing. Floating gudgeon pins are retained by aluminum plugs.

### *(4) Connecting Rods*

Master and link rods of "H" section are chrome vanadium steel forgings completely machined. The crankpin bearing of the internal type master rod is a diamond-bored, steel-backed, lead-bronze lined bushing. Link rods are attached to the master rod by knuckle pins which are secured by Woodruff keys and circlips. Gudgeon pin and knuckle pin bronze bushings are pressed into the rods and are diamond-bored. The master rod is drilled to provide pressure lubrication to the knuckle pin bushings.

### *(5) Crankshaft*

The crankshaft is a two-piece, heat-treated chrome-nickel steel forging drilled throughout for lightness and plugged to form oil passages. The shaft is of one-throw design and completely machined. The crankpin is accurately ground to size and fitted to a ground hole in the rear cheek where it is clamped in place. Steel counterweights are straddle-fitted to the crankcheeks and riveted in place. The shaft is supported by two ball bearings. A ball bearing at the forward end provides end location. Bearings are held by clamping action of nuts, spacers and sleeves. The driving end of the shaft is machined to a No. 20 S.A.E. spline, except for length.

### *(6) Cam Ring and Valve Gear*

The cam ring is a nickel steel forging, completely machined and hardened. Intake and exhaust cam surfaces are side by side with three cam lobes each. The cam ring is riveted to a heat-treated forged aluminum alloy hub which is carried on the sleeve of the cam drive gear and turns at one-sixth engine speed in opposite direction to crankshaft. On the inside rim is an internal gear which meshes with the cam drive intermediate gear which in turn is driven from the cam drive crankshaft gear.

Rollers and tappets fit aluminum alloy guides so sealed as to positively prevent leakage. Tappets are drilled in such a manner that an oil passage is provided from the tappets to the push rods, rocker arm bearings and rocker rollers. Push rods are made of light steel tubing with welded ball ends, hardened and ground, and drilled their entire

length to provide an oil passage to the overhead mechanism. The push rod is fully enclosed and the outer end fits into an adjustable socket in the rear of the valve rocker. The rocker acts directly on the valve through the roller and effectually prevents side thrust on the valve stem. Rockers are mounted on double row replaceable ball bearings and are completely enclosed. Push rods are withdrawn through the rocker arms by removing the adjusting screw sockets from the rockers.

#### (7) Accessory Case

The accessory case is a light alloy casting which is attached to the rear of the crankcase. It contains the entire accessory gear train and provides standard flanged mountings for two magnetos, starter and generator and fuel pump. It also carries a double rev-counter drive, pressure oil pump, separate scavenge pumps for engine sump and rocker boxes, pressure oil filter, scavenge oil strainer, oil pressure relief valves and oil temperature connection.

#### B. Lubrication (Plates I and J)

The W670 is a dry sump engine. Oil is drawn from the oil tank, filtered, and delivered under pressure through drilled passages in the accessory case to all drive bearings and through the crankshaft to the crankpin and knuckle pin bearings. Engine oil from the main pressure pump under reduced pressure is carried through drilled passages in the crankcase to the tappets. After entering the tappets, it travels out to the overhead mechanism through the hollow push rods, and is spilled over the rocker arm bearings and rollers. As it drains away, it thoroughly oils the valve stems and valve guides. From the upper three cylinders, the oil is returned to the crankcase by the push rod housing; while from the four lower cylinders, it is drained to the lowest point and there picked up by a special scavenge pump, mounted on the accessory case, and returned to the engine sump.

Cylinder walls, crankshaft thrust and main bearings and piston pin bearings are lubricated by a spray. Gear type feed and scavenge oil pumps are provided. Scavenge pump picks up excess oil in the crankcase sump and returns it through a coarse mesh screen to the oil tank. The pressure relief valve is set to give approximately 70 pounds oil pressure at 2000 r.p.m. The oil tank has a capacity of about 7 gallons and is filled with 5 gallons of lubricating oil. *It must never be filled above the 6 gallon level.*

A thermostatic oil temperature regulator was fitted to the first two tanks sent to England and may be included on later tanks. Its purpose is to regulate automatically the temperature of the oil entering the engine to a pre-determined setting, thus obviating the radiator shutters or other means of controlling oil temperatures. Furthermore, it also reduces the warming up period to approximately half the time over engines not equipped with this device.

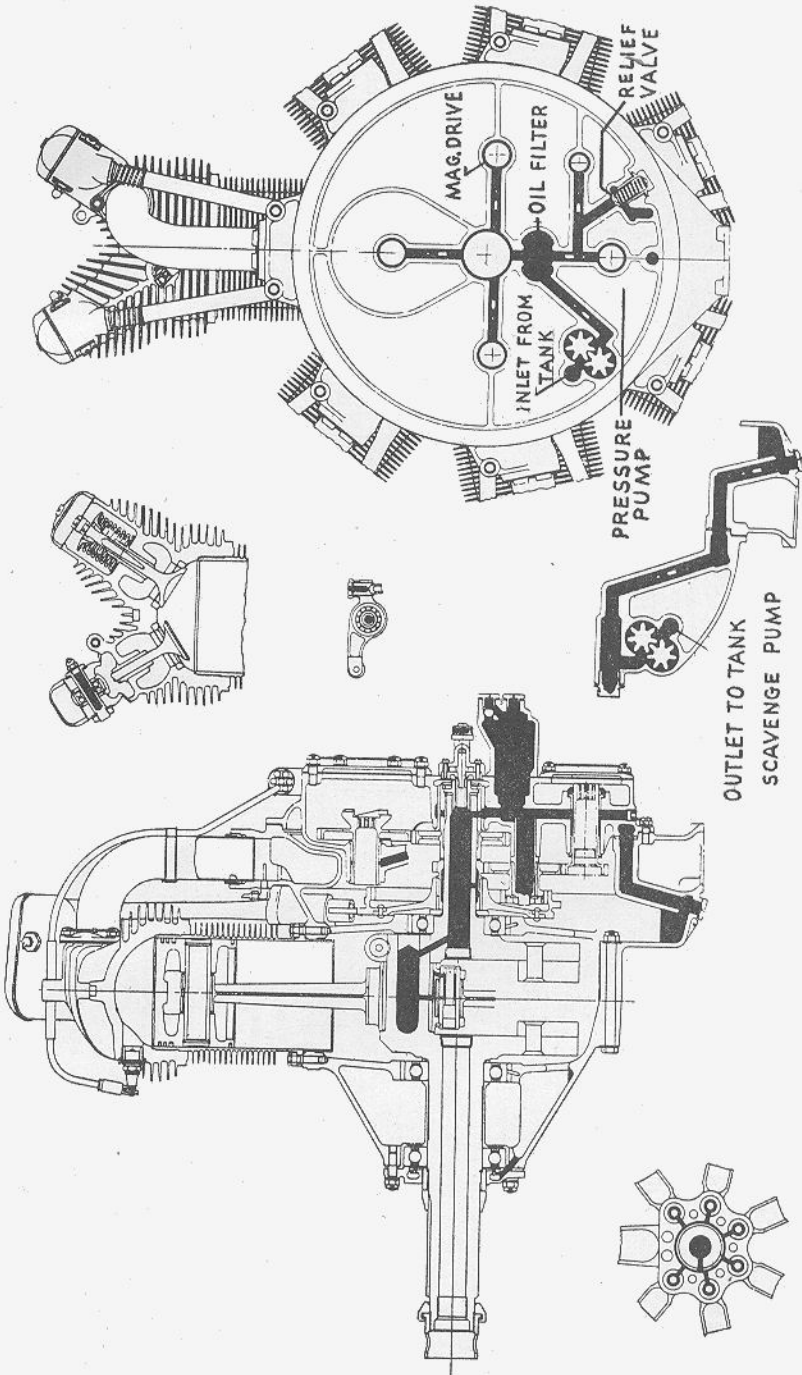


PLATE I  
 ENGINE LUBRICATION

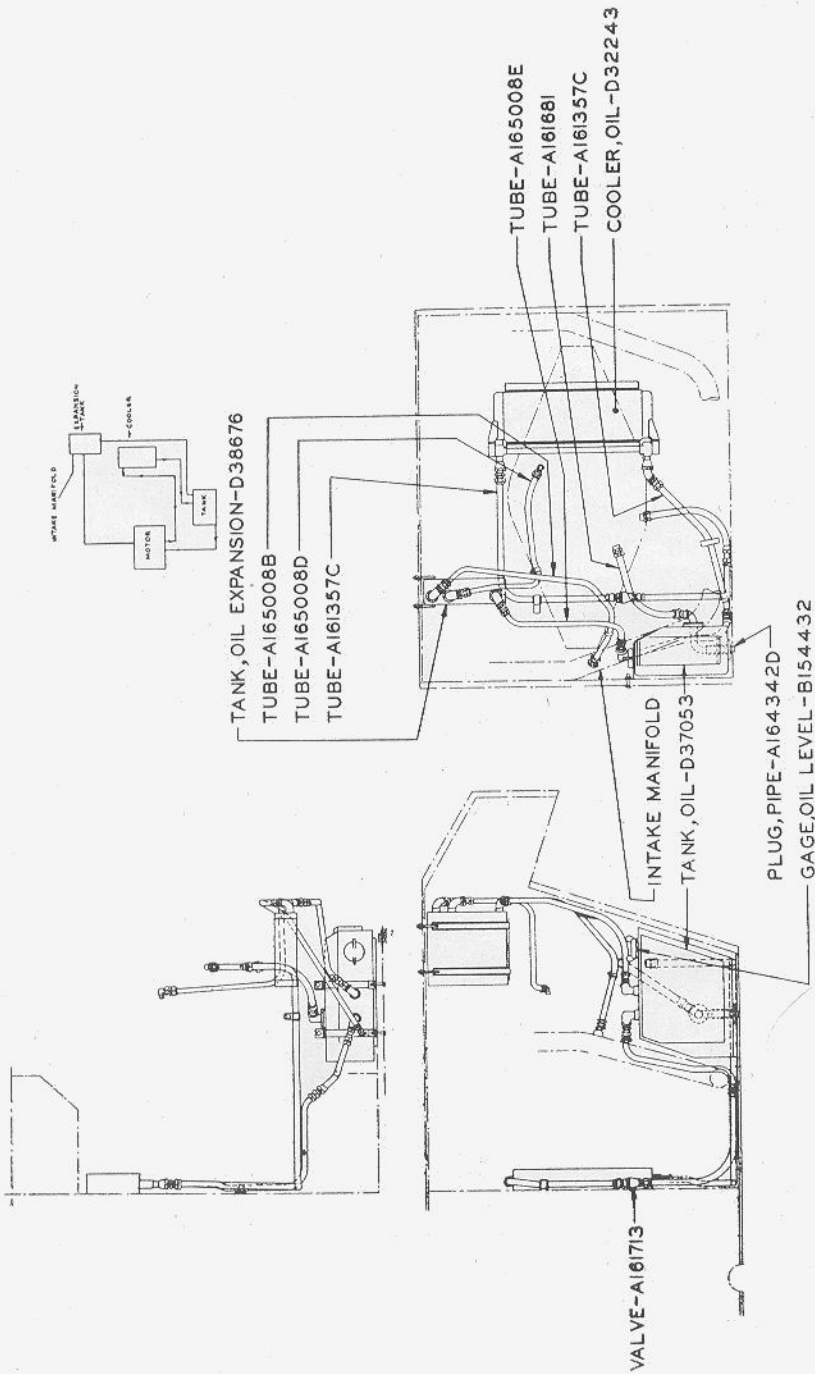


PLATE J  
 OIL TANK AND COOLER



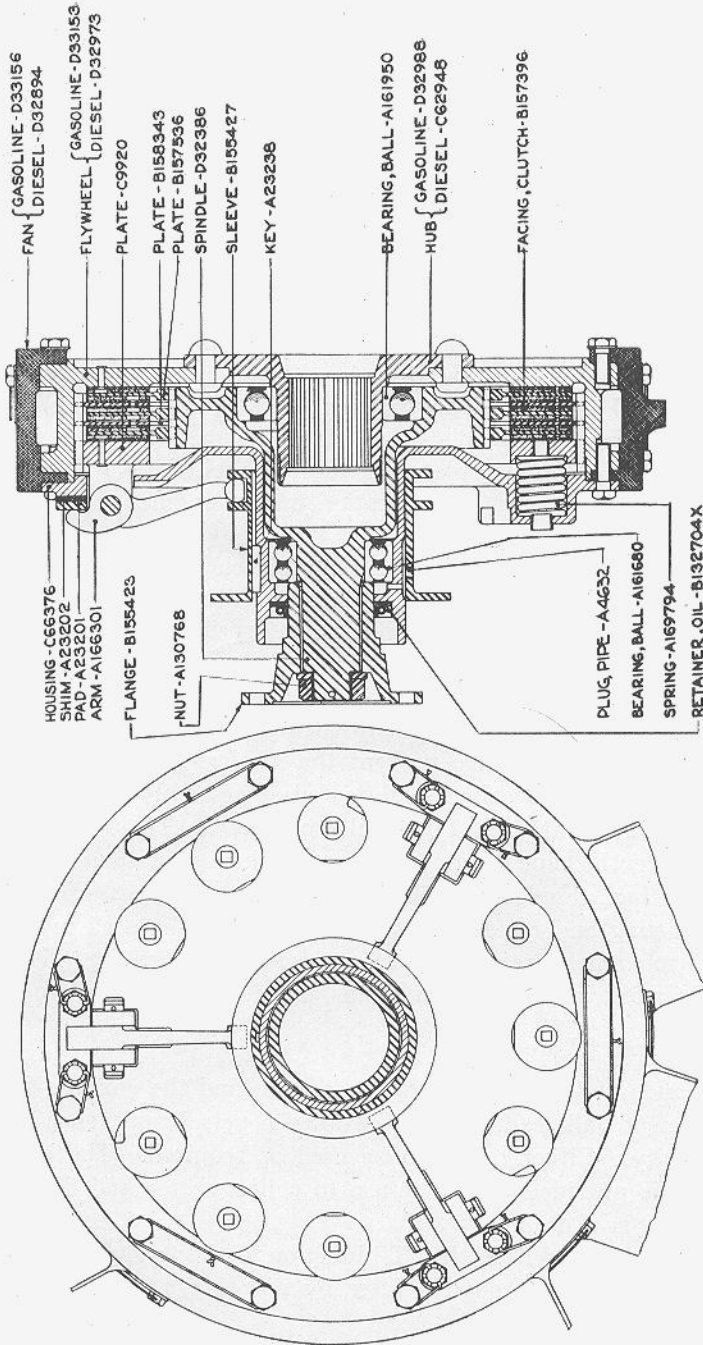


PLATE K  
 ENGINE CLUTCH

When the oil is cold, the valve automatically directs the outlet oil from the engine to the bottom of the oil tank in close proximity to the suction line. Consequently, the warm oil coming from the engine will be turned into the suction line feeding the oil pressure pump. This process continues until the oil entering the engine reaches the desired temperature at which time the automatic valve directs sufficient oil through the engine's external oil cooler (oil radiator) and thence to the top of the oil tank to maintain the desired inlet temperature.

This unit normally requires no attention between overhaul periods.

#### C. Engine Clutch, Flywheel and Fan (Plate K)

A fan consisting of eight or twelve blades is bolted to the flywheel at its outer edge. The flywheel, which incorporates the clutch, is bolted to the flywheel hub, and this is splined onto the crankshaft.

When the clutch is engaged, the springs A169794 seated in the housing act against the pressure plate and force the metallic lined plates on the spindle to contact the plates on the flywheel, thereby revolving the spindle and transmitting the rotation of the engine, through the propeller shaft, to the transmission.

The clutch is released by depressing the clutch pedal which forces the sleeve forward by means of the clutch throw-out yoke. This movement forces the arms A166301 to compress the springs, thereby releasing the grip on the clutch plates and allowing the engine to run idle.

The clutch assembly rotates on anti-friction bearings A161950 and A161680. Oil retainer B132704X is provided to seal the assembly, and bearing A161680 is shielded to prevent the lubricant from getting on the clutch plates. The bearing is lubricated at assembly and does not require attention for at least 1,000 miles of travel. To lubricate the bearing, remove the pipe plug A4632 and replace it with a pressure lubricating fitting. Force a small amount of grease into the bearing, remove the fitting and replace the plug. Care must be used in lubricating that too much grease is not forced into the bearing. Excess grease might work into the clutch plates and cause the clutch to slip.

#### D. Petrol System (Plate L)

On either side of the engine compartment, behind the engine—fighting compartment bulkhead, there is installed a petrol tank, each of 25 gallons capacity. Either tank can be used as required. The bottom of each tank is provided with a screen to collect water and dirt, and alongside there is a drain plug.

The petrol is pumped from the "T" junction of the two pipes leading from the petrol tanks, through a filter by a rotary vane type pump to the carburetor.

A petrol primer pumps petrol into the main induction manifold. The primer is mounted on the instrument board and is provided with

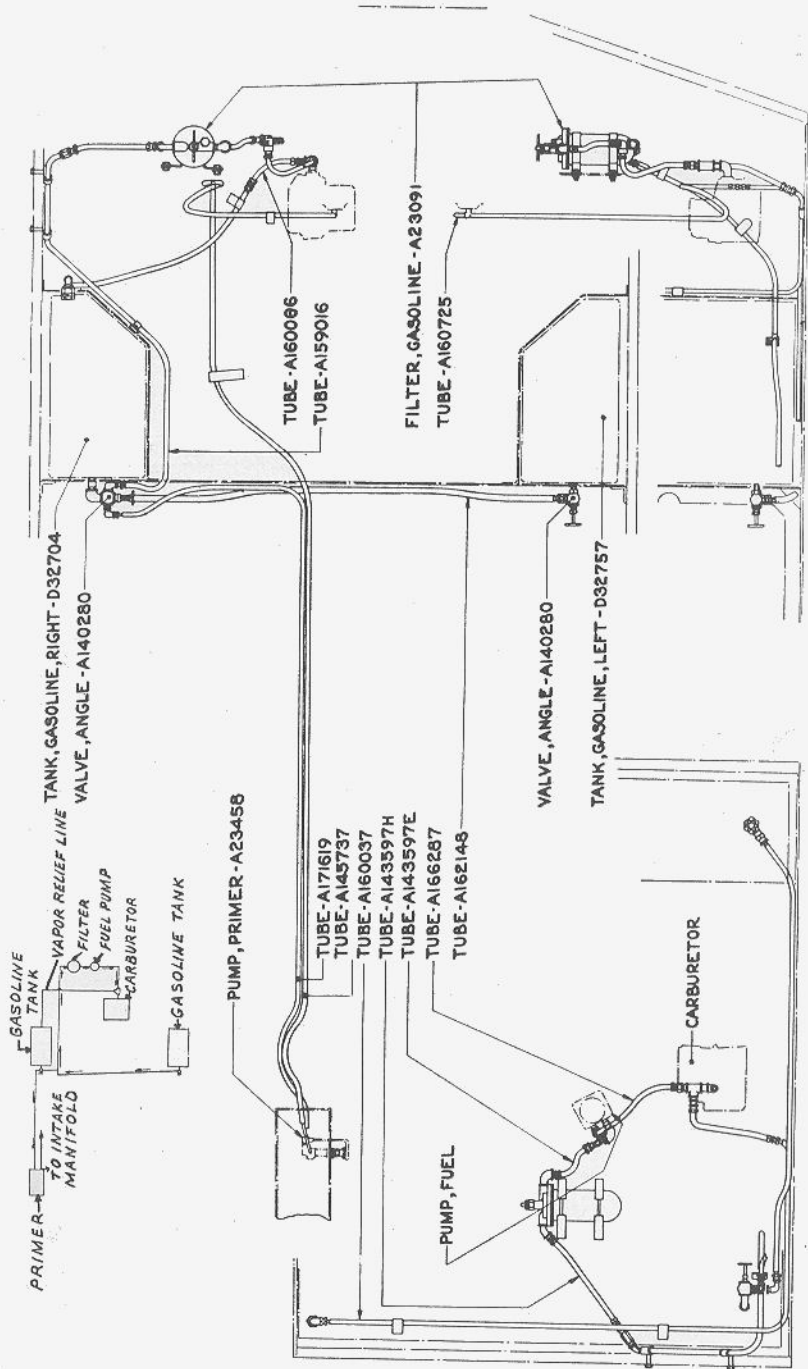


PLATE L  
FUEL LINES

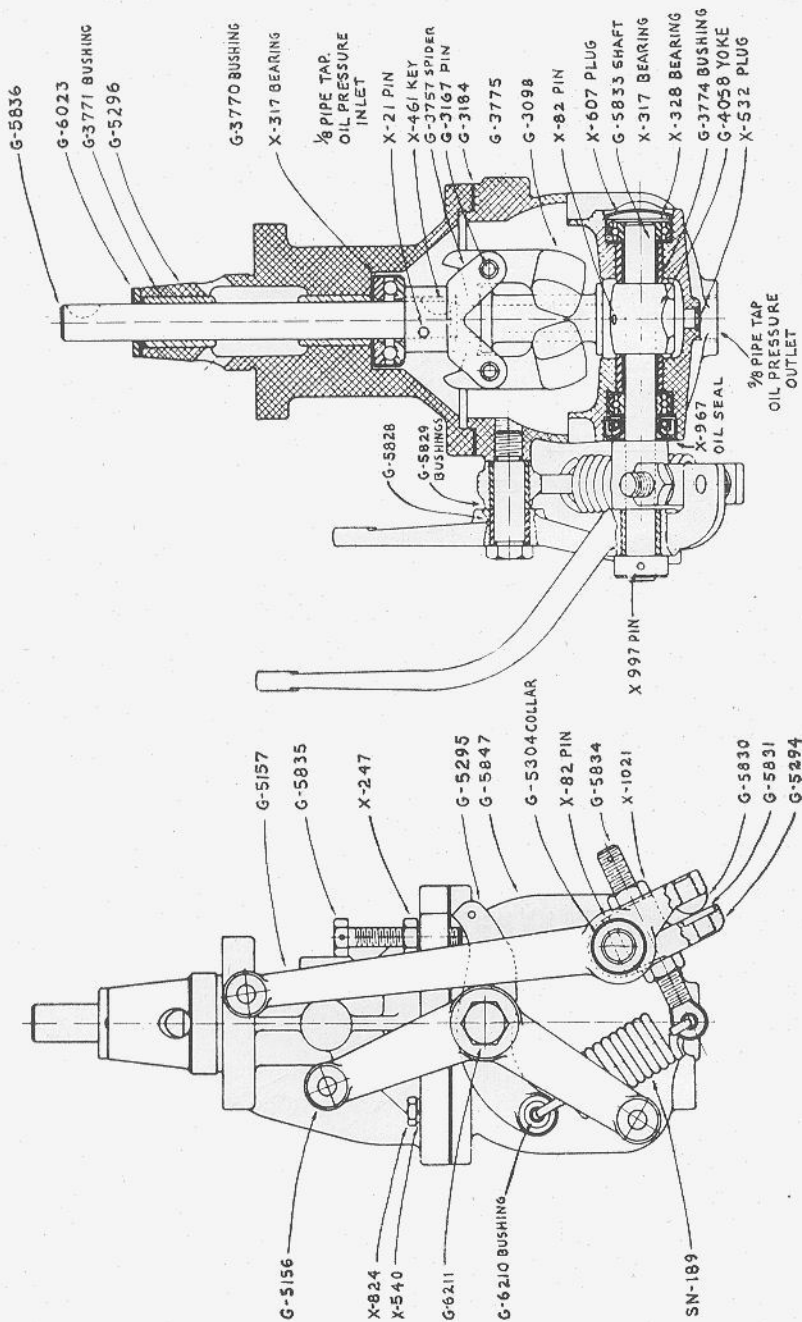


PLATE M  
ENGINE GOVERNOR

a shut off to prevent fuel from entering the engine when the primer is not in use.

The carburetor is a Stromberg NA-R6B. The principles of operation of this carburetor are quite similar to those used in all Stromberg aircraft and motor car carburetors. It is a single barrel up draft model having an accelerating pump, hinge type float assembly, idle cut out and needle type economizer. The float needle valve and seat require a fuel pump that will maintain 3 lbs. sq. in. pressure at the fuel inlet. No mixture control is provided. The metering system is of the plain tube type with an air bleed to the main discharge jet which is secured in a boss in the air intake with a discharge hole near the centre of the venturi. The main air bleed consists of a tube screwed into the main discharge jet boss. This tube has a hole drilled through the centre and a side hole which acts as a restriction near the upper end. As the main metering system will not function at very low engine speeds, an idling system is provided, which operates up to an engine speed of approximately 900 to 1,000 r.p.m. This consists of an idle tube with idle metering orifice near the bottom and air bleed holes in the side, an idle air bleed and an adjustable idle discharge jet. This jet may be rotated by means of an idle adjustment lever. A quadrant is fastened to the carburetor body behind this lever and indicates by the letters "R" and "L" the direction to move the lever for richer or weaker mixture. For smooth and quick acceleration a fuel pump operated by the throttle is incorporated in the carburetor, and this is provided with a separate discharge jet. Below the fuel inlet of the carburetor is a petrol strainer which may be removed by undoing a square head nut. Both the throttle stop and idle adjustment should be set with the engine hot.

#### **E. Pierce Engine Governor (Plate M)**

The purpose of the Governor assembly on the Continental W670 Radial Engine is to regulate and control the speed of the engine at approximately the peak horsepower speed after the motor has been manually accelerated up to that speed point. This not only prevents damaging or destructive engine overspeeds, but enables the vehicle operator to shift gears more easily.

The Governor mechanism is enclosed in a suitable housing. The main Governor Shaft, G-5836, is driven by a suitable gear. On the Governor shaft is a weight holder or spider, G-3757, which supports the two Governor Weights, G-3098. The Weight Noses (dotted in sketch) rest against the hardened Thrust Sleeve, G-3775, on each end of which is a high grade Thrust Bearing, X-317. (Sketch shows upper but not lower Thrust Bearing.)

When the engine is being operated below the governed speed the Weights are collapsed (position as shown in sketch) and the Lever, G-5157, floats on the Rocker Shaft, G-5833. As the engine is acceler-

ated to the point of governed speed, however, the centrifugal energy developed in the two whirling weights is sufficient to counterbalance the tension of the Governor Spring, SN-189, and the weights swing outward on their pivots, G-3197.

When this occurs the weight noses force the Thrust Sleeve, G-3775, and the Lower Thrust Bearing, X-317, against the Rocker Shaft Yoke, causing the Rocker Shaft to turn which moves the governor control Lever G-5294, which is attached to the Rocker Shaft. The action transfers movement to the outside of the governor, bringing Rivet, G-5831 (a part of Lever, G-5294) in contact with Rivet, G-5830, (a part of Lever, G-5157) moving Lever, G-5157, which, in turn, moves the governor control rod to close or open the carburetor to satisfy the power requirement while holding the engine speed at a near constant.

The lower end of Lever, G-5156, is attached to the manually operated throttle rod, while to the upper end is connected a spring loaded Barrel and Rod Assembly. The opposite end of the Barrel and Rod Assembly is connected to the carburetor bellcrank. When the operator has fully depressed the accelerator pedal, and the engine comes up to governed speed, the governor Lever, G-5157, in regulating the position of the carburetor valve, has sufficient energy to overcome, when necessary, the tension in the spring of the Spring Loaded Rod.

It can be said, therefore, that when engine speeds are below the governed point, Lever G-5157 is inoperative and is floating on the Rocker Shaft of the Governor. Under these conditions the engine is under the control of the operator through the accelerating rod and Lever, G-5156. But when the engine reaches the point of governed speed the Lever, G-5156, under the pressure of Lever G-5294, takes charge of the carburetor valve, and due to the flexing of the spring in the barrel and rod assembly, renders Lever G-5156 inoperative. The moment, however, the engine speed falls below the governed point, Lever G-5156, subject to the control of the operator, again takes charge of the throttle.

### Adjustments

1. The Governor should be installed with Levers to the left as the rear of the Tank is faced.

2. The Carburetor Bellcrank should be installed so that it points down 90° from horizontal when the Carburetor Valve is in the idle position.

3. Attach Spring Loaded Rod and Barrel Assembly to upper hole in Lever G-5156. Attach other end of Rod and Barrel Assembly to Carburetor Bellcrank.

4. Hook up foot throttle rod to lower hole in Lever G-5156. Adjust this foot throttle rod so that carburetor will be wide open *without extending the Rod and Barrel Assembly* and when the foot pedal stop



is against the transmission housing. *This adjustment is very important.*

5. Put some tension on governor by turning down Screw G-5835. Attach other end of Rod to carburetor bellcrank. Adjust this rod length so that when carburetor is in wide position the governor lever Rivet, G-5830, will be solid against lever Rivet G-5831. *This adjustment is important.*

6. Make sure that oil lubrication line to governor is restricted to 1/16", and that oil drain at bottom of governor is adequate. Provision has been made for 3/8" oil drain from governor.

7. Secure maximum high motor speed of 2400 r.p.m. by adjusting Screw G-5835. After adjustment always lock adjusting screw securely with locknut X-247.

8. Adjusting springeye Screw G-5834 to the right makes governor more sensitive. Adjusting to the left makes governor less sensitive, and screw should be screwed out one turn at a time in the event of an engine surge. After adjustment securely lock Screw in place with Locknuts X-1021.

Provision is made in Screws G-5835 and G-5834 and in Lever, G-5295 for sealing adjustments with a wire seal.

#### F. VMN7DFA Magneto (Plate Y)

The VMN7DFA magneto is a single, flange mounted, seven cylinder type driven at  $\frac{7}{8}$  engine crankshaft speed. It has a four-pole automatic advance rotor with a four-lobe cam actuating the lever type breaker.

The large distributor gear is mounted on an axle which is adjustable for obtaining the proper backlash between the larger gear and the pinion gear. Oilers are provided for lubricating all bearings.

The primary and secondary windings of the coil are enclosed in a hard rubber case which protects the coil chiefly from the effects of moisture. The condenser is similarly encased in hard rubber and is mounted on top of the coil.

The distributor cylinder is clamped to the large distributor gear by a snap ring and secured in proper position with a dog screw. The cylinder carries two high tension segments, two booster segments, and a booster collector ring. The distributor blocks are secured between the coil cover and front end plate by the clamp at the top of the magneto. Radio shielding is secured by two clamping springs which engage suitable latches, and are locked with engine speed.

The small distributor drive gear mounted on the magnet shaft has forty-four teeth and meshes with the large seventy-seven tooth distributor gear carrying the distributor cylinder. Therefore, the distributor cylinder turns at  $\frac{7}{8} \times \frac{4}{7}$ , or one half engine speed.

One end of the primary winding is connected to the ground. The other end is connected to the insulated contact point. When the con-

tact points are closed, the primary current passes to ground. The condenser is connected across the contact points.

One end of the secondary winding is also grounded to the magneto. The other end terminates at the high tension insert of the coil. High tension current in the secondary winding is then conducted to the central insert of the distributor cylinder by means of a carbon brush. From here it is conducted to the high tension segments on the cylinder and across a small air gap to the electrodes of the distributor blocks. High tension cables then carry it to the spark plugs where the discharge or spark occurs for ignition purposes.

The booster segments are located so that they trail the high tension segment on the distributor cylinder to give a retarded spark for starting the engine.

## CHAPTER IV

### HULL AND SUSPENSION

#### A. Hull

The hull structure consists of riveted, bolted, or welded plates, of a varying thickness. The engine compartment is completely separated from the fighting compartment by a bulkhead which is sufficiently rigid to provide support between the two sides of the tank hull.

The driver sits in front of the tank on the near side. To his right sits the forward machine gunner. This machine gun is mounted in a ball mounting. On either side are the two sponsons and in each is fixed one flexible machine gun. These are fired by the driver. Either or both of these guns can be easily removed and mounted on a tripod in case the tank is knocked out or breaks down.

(1) Control steering levers are fitted in the usual position—one on each side of the driver with a gear lever and parking brake on his right, level with his shoulder. There are only two foot controls—clutch and accelerator.

(2) The instrument panel is situated directly in front of and on the right hand side of the driver and includes the following:

Booster and starter switches	Ignition switch.
Speedometer.	Rev. Counter.
Ammeter.	Volt-meter.
Oil pressure gauge.	Oil temperature gauge.
Petrol Primer.	

#### (3) *Vision arrangements*

Both the driver and the forward gunner are provided with hinged armoured flaps, each approximately two feet by one foot, which can

be opened at will. In the center of these flaps is a small slit through which both the driver and the gunner look.

In the M3 and M3A1 Light Tanks, protectoscopes are provided for both the driver and the gunner.

#### *(4) Engine compartment*

Access to the engine compartment may be obtained either through the rear door or by removing one of the armoured plates on top.

The air intake is next to the fighting compartment but, in order to prevent splash entering, an armoured anti-splash plate has been placed a few inches down under the wire grill.

In the M3 the air outlet has been covered over and hot air is forced out through a protected exit at the rear of the tank.

Petrol tanks are shut off from the engine compartment by a metal partition.

A fixed fire extinguisher has been installed which can be operated from the fighting compartment.

### **B. Suspension (Plate N)**

Two identical suspension assemblies on either side carry the weight of the tank. On the top of each assembly there is a steel skid to prevent the track fouling the suspension bracket. Two rollers carry the weight of the track along the top to the rear of the tank. On either side there is a large idler wheel which enables the tension to be adjusted. In the M3 and M3A1 Light Tanks this idler wheel is trailing.

#### *(1) Suspension and bogie assemblies*

The assembly consists of two bogie wheels (3) located by two arm assemblies (1) and (2) which are free to pivot about the axle (4). A floating lever (5) pivots about gudgeon pin (7) which is free to slide up and down in guides (8) in the main bracket, bolted to the hull.

The gudgeon pin (7) mounts two plugs (9) which form the seat for the volute springs (10).

At either end of levers (5) is a connecting link (6) to arm assemblies (1) and (2). The up and down movement of the track when striking obstructions is transferred to the wheels and arms and from there through the connecting link (6) to the volute springs.

The wheels (3) are alloy steel castings mounted with heat resisting solid rubber tyres (17) vulcanized to a steel rim (18) which is a press fit on the wheel.

The wheels are mounted on ball bearings (19) and (20) which are kept in proper alignment by distance tubes (21) and (22) and made oil tight by Oil Retainers (23).

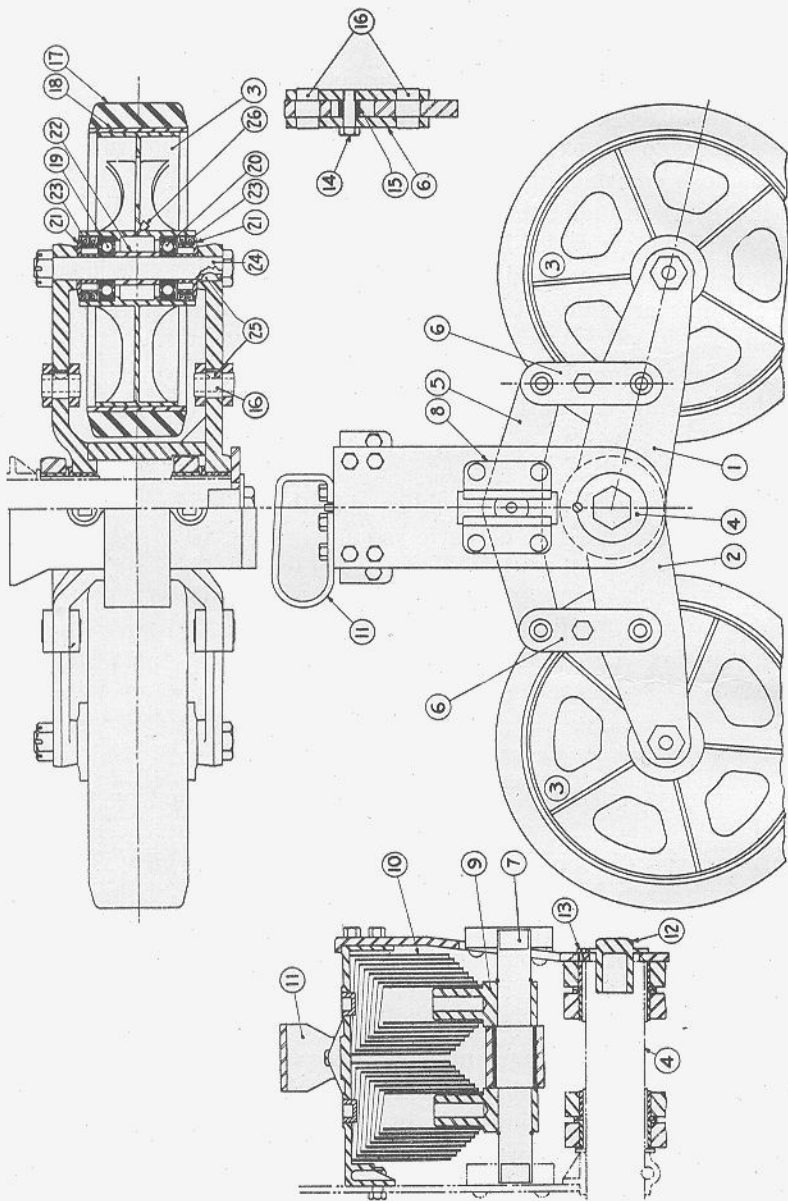


PLATE N  
 SUSPENSION

Gudgeon pin (24) assembles the wheels to the arms and is prevented from turning by Woodruff Key (25).

### C. Top Roller and Idler Wheel (Plate O for M2A4, Plate P for M3)

The top rollers are mounted on brackets (1) which are fitted to each side of the hull. The assembly consists of solid heat resisting rubber tyres (2) vulcanized to steel frames (3) which are mounted on bracket (1) on ball bearings (4) and (5). These bearings are located on the bracket by distance tube (6) with bearing (4) sealed against the shoulder on the bracket arm and the entire assembly secured by threaded plug (7) contacting bearing (5). The plug (7) is locked by screw (8). An oil retainer (9) is provided to seal the back end while the front cover (10) with gasket (11) seals the front end of the assembly.

The idler assembly is composed of a steel idler wheel (13) which revolves on ball bearings (16) and (17) mounted on spindle (18). The wheel is secured on the spindle by washer (20) and nut (25) with a cotter pin.

The outer end of spindle (18) which mounts the idler is machined eccentric with the inner or bearing end. The inner end of the spindle rotates in bracket (26) bolted to the hull. The spindle is secured in place by nut (27) and washer (28) locking the serrations on the flange (29) or spindle (18) to mating serrations on bracket (26).

For M3 and M3A1 Light Tanks see Plate P. The idler assembly is of the trailing type constructed to give additional support to the rear end of the tank. The idler wheel D-34910 is mounted on the arm C-69303, which by reason of the design of the volute spring C-63342 seated in bracket D-38552 holds the wheel in contact with the roller. The wheel is mounted on ball bearings on shaft B158853 secured by the ends A-172286.

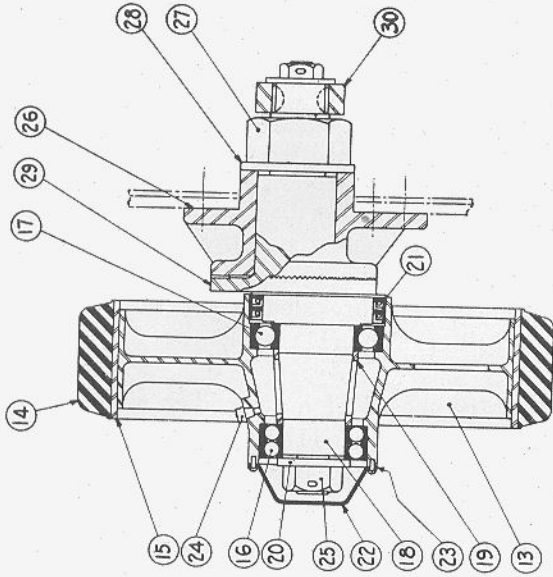
## CHAPTER V

### TURRET, POWER TRAVERSE AND GYRO-STABILISER

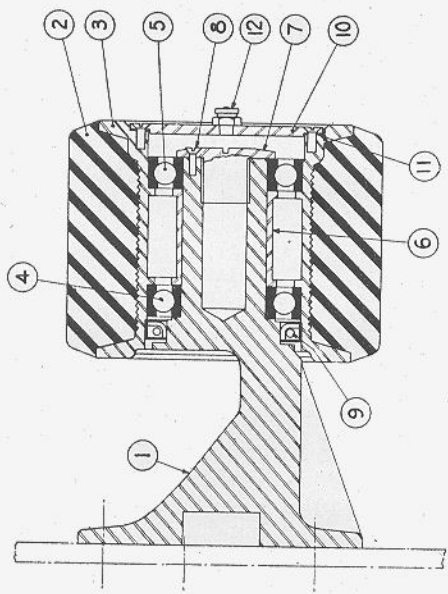
#### A. Turret

The turret in the M2A4 and M3 Light Tanks, mounted on three equally spaced rollers, is built up of vertical plates riveted, bolted or welded together, and has a fixed cupola. In each plate of the turret and of the cupola, apertures have been cut to provide lookouts. These lookouts can be closed by a sliding plate on the inside. In these tanks the tank commander is also the gunner. In addition to the turret rotation, a certain amount of lateral movement is provided in the gun mount itself. Both free and geared elevation are provided. A telescopic sight is fitted.

In the M3A1 Light Tank, the turret, which is circular in shape,



IDLER



TRACK SUPPORTING ROLLER

PLATE 0



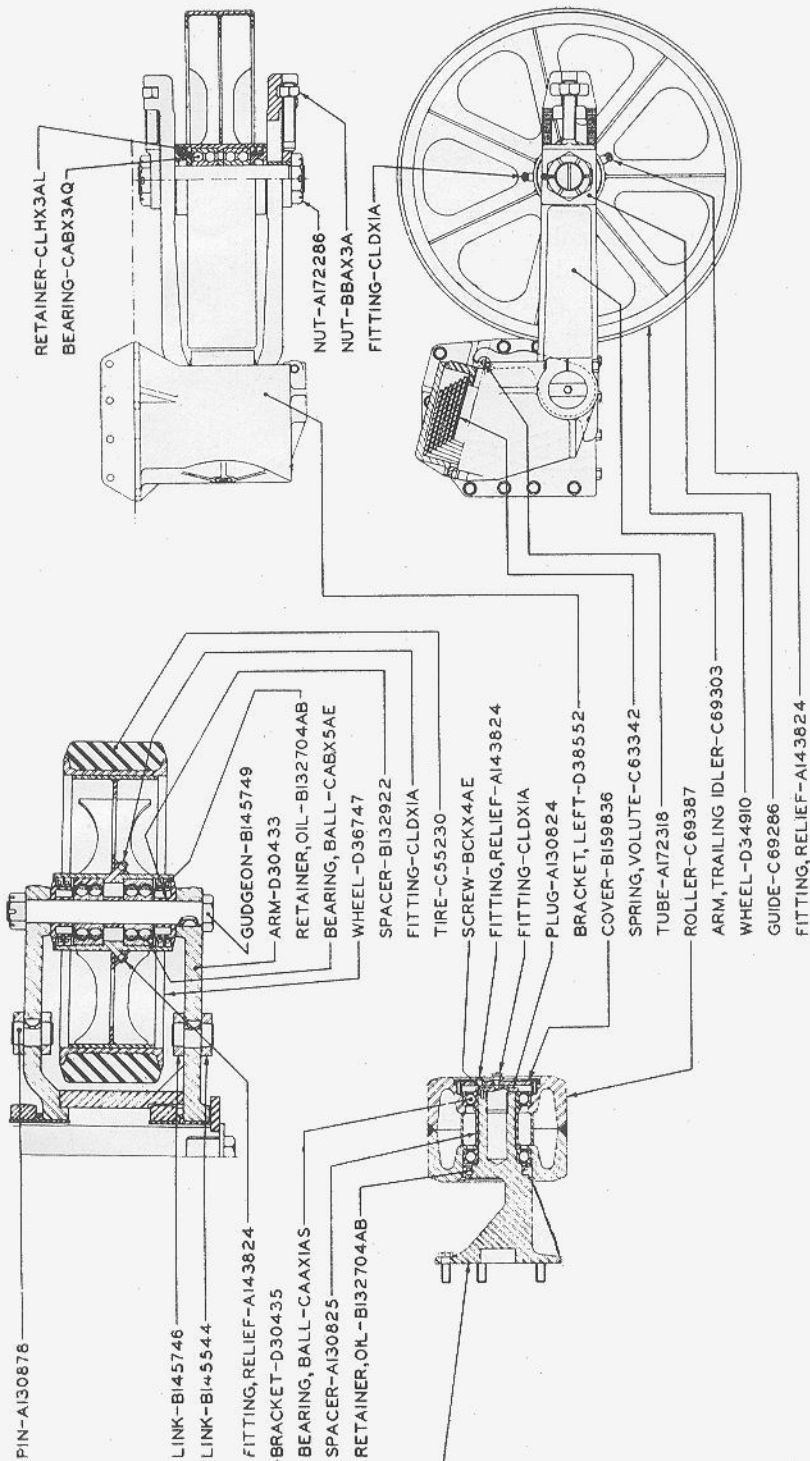


PLATE P  
 TOP ROLLER AND IDLER WHEEL

supports a basket, in which are located the gunner and the tank commander, who is also the gun loader. The cupola has been removed, and instead periscopes have been substituted. The gun is sighted by means of a periscopic sight. A gyro-stabiliser is fitted. This stabilises the gun in elevation.

Entrance to the turret is obtained by opening up the turret lid or cupola flap. In some models of the M3 tank a periscope is fitted in this flap for use by the tank commander.

Outside the tank, behind the cupola on the M2A4 and M3 Light Tanks, is fitted a machine gun mount for use against air-craft.

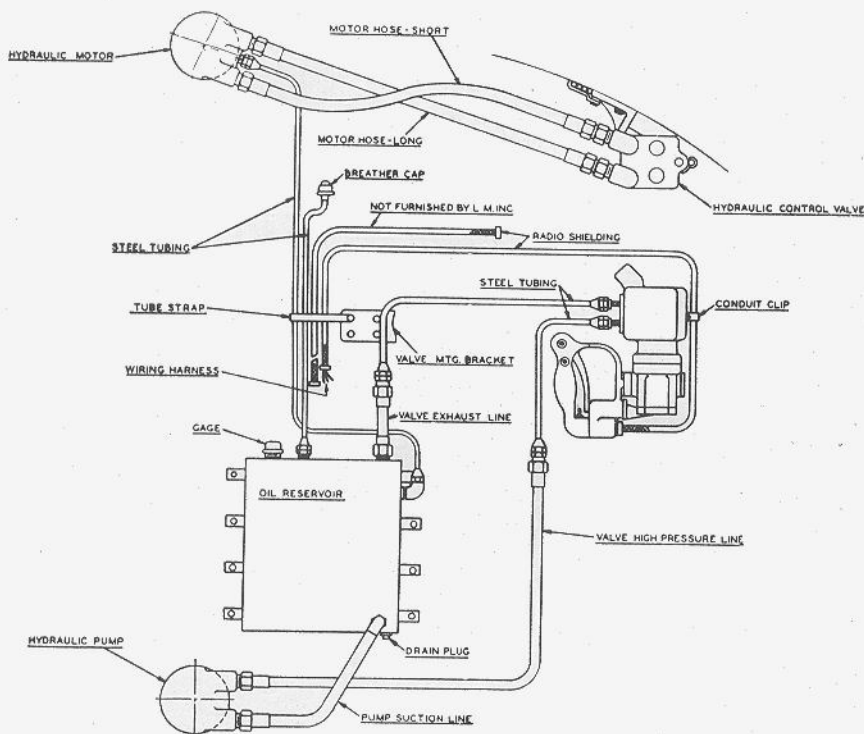


PLATE Q

## LOGANSPORT POWER TRAVERSE

### B. Turret Traversing Gear

The turret may be traversed either by hand or by power. The object of the power equipment is to provide a mechanical means of traversing the turret with the greatest accuracy of control and the least fatigue to the gunner. It is also designed to eliminate drive-back shocks to the gunner and to provide a wide range of traversing speed.

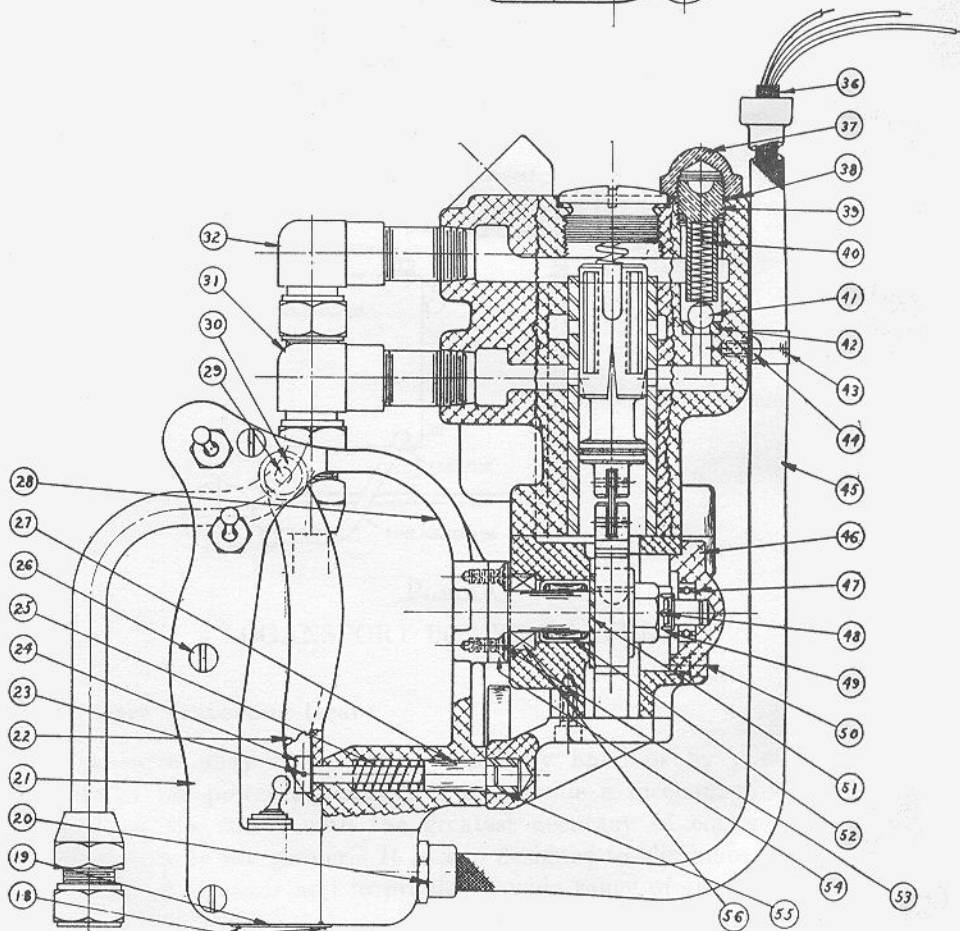
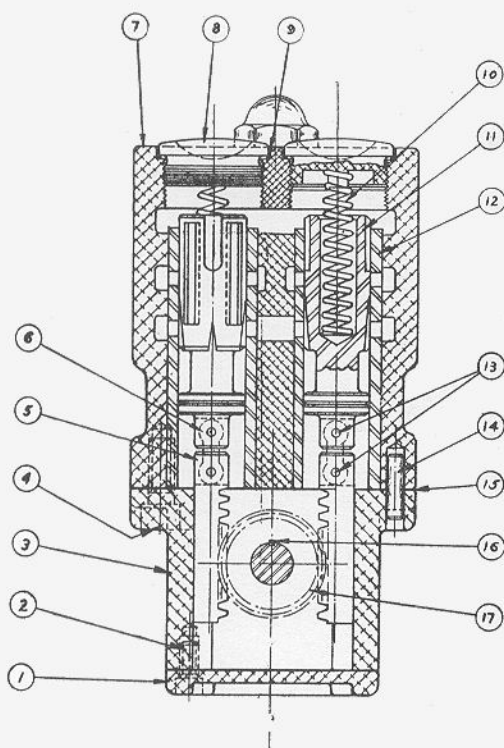
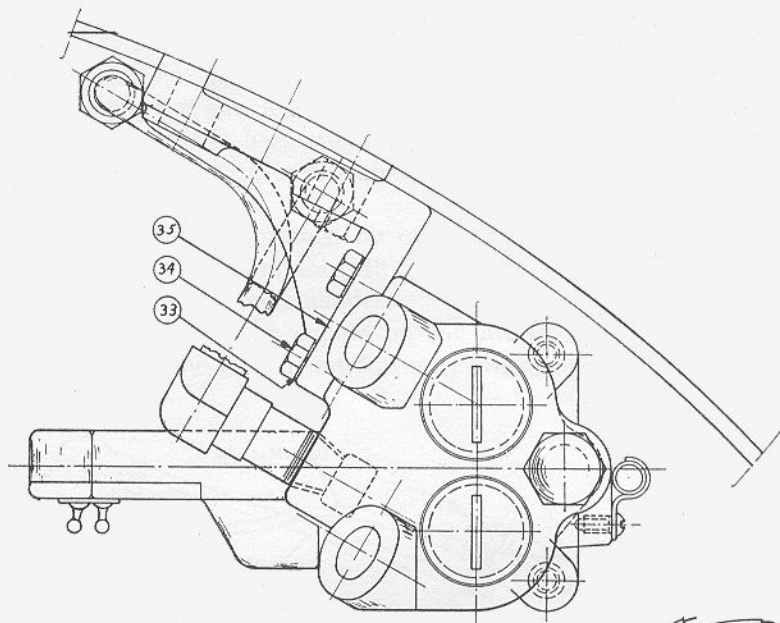
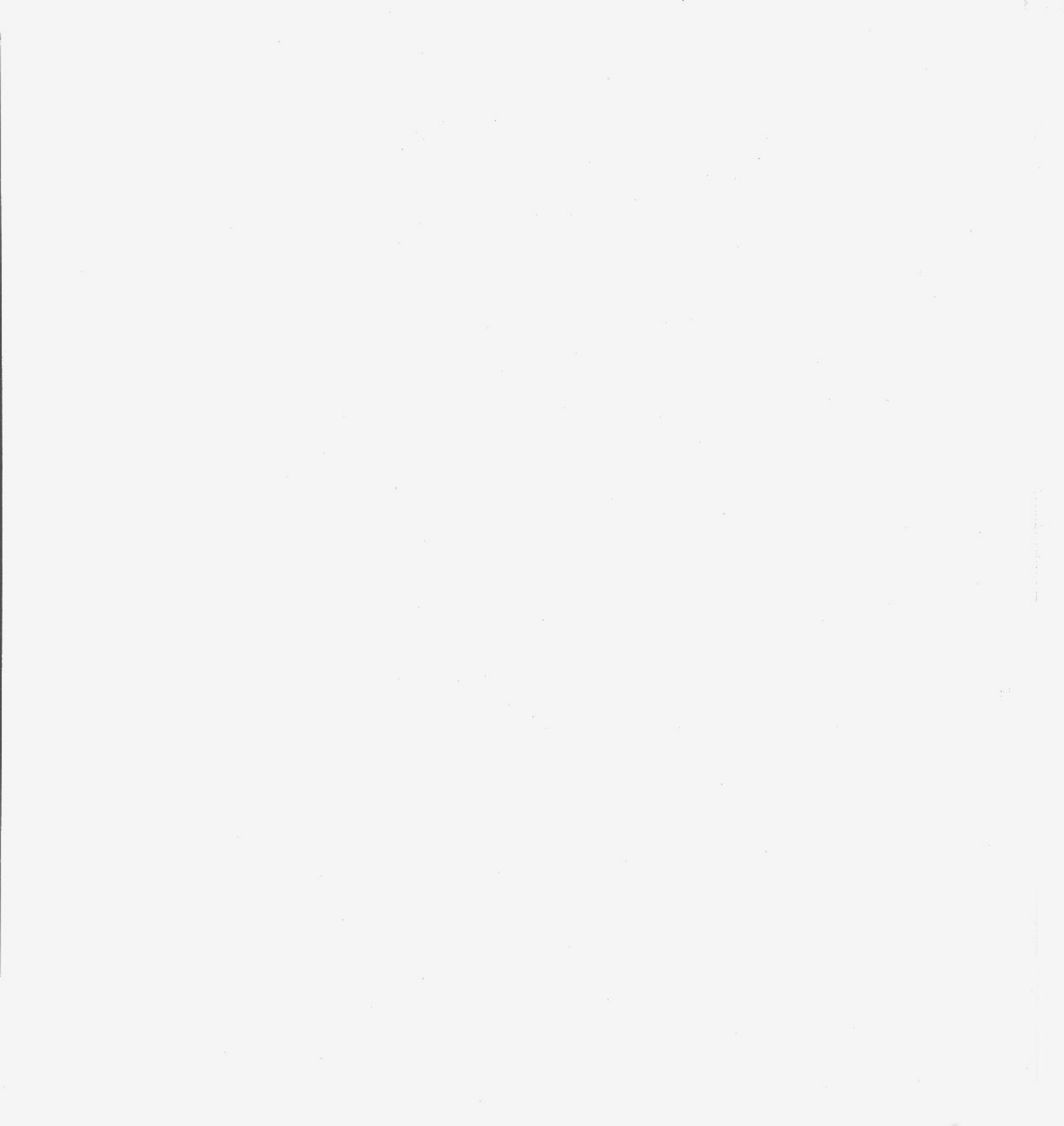


PLATE R  
LOGANSFORT POWER TRAVERSE VALVE ASSEMBLY



This allows both fine laying and a rapid engagement of targets separated by wide angles of training.

(1) *Hand Traverse Gear.*

Final design of the hand traverse gear is not yet settled, but it is believed that it will be similar to that installed in the M2A4 and M3 Light Tanks.

(2) *Power Traverse.*

Two types of power traverse may be employed in the existing production of M3A1 Light Tanks—the one made by Logansport and the other by Oilgear. That made by Logansport (Plates Q and R) consists of:

(a) A 12-volt D.C. electric motor which drives the hydraulic pressure pump. The pump consists of an external gear revolving inside of an internal gear. The opening and closing of the spaces between the gear provide the pumping action.

(b) The pump obtains its oil from a small oil reservoir which has a capacity of approximately two gallons, to which must be added the oil contained in the system, approximately one-half gallon.

(c) Oil from the pump is discharged under pressure to the inlet port of a manually operated control valve. This is essentially a two piston valve in which the two pistons move in opposite directions.

This motion is produced by means of the gear (17), and the racks (5). The gear shaft (54) is carried on needle bearing (52) and ball bearing (47) making for easy rotation. The pistons (11) slide inside lines (12) covering or uncovering holes drilled in them. These holes communicate with cast-in ports which in turn are connected to the various ports of the hydraulic system.

The lower row of holes connect with the high pressure line; the center row of holes connect with cores leading to the motor ports; the upper end of the liner is exposed to a core which connects with the valve return port. With the piston in the neutral position (See Plate R), the lower holes communicate with grooves milled into the pistons which do not extend completely to the end of the piston (by-pass grooves). In this position the oil entering the high-pressure line (31) passes through the lower row of holes, thence through the by-pass grooves into the top core, and thence through valve return line (32) back to the reservoir.

The center core communicates with the motor ports and also communicates with the center row of holes. In the neutral position these holes are blocked off and, therefore, the hydraulic motor cannot rotate. Hence the turret also remains stationary regardless of the effort exerted on it by means of the unbalanced weight of the turret on a slope.

When handle has been turned counter clock-wise, the right piston will ascend and the left piston will descend. The right piston is ascending

will first disrupt the communication between the lower row of holes and the by-pass grooves. Therefore, pressure will build up and be trapped, and the amount of pressure will be regulated by means of the check valve assembly. In further ascending, the sharp pointed metering grooves will begin opening into the center row of holes and, therefore, will admit oil to one side of the hydraulic pump.

The left piston in descending will first close off the by-pass grooves on top so that oil will here also be trapped. In further descending, the exhaust grooves milled into the piston from the top to near the center will uncover the center row of holes and, therefore, oil coming from the hydraulic motor will be permitted to pass through them and into the exhaust core. From there the oil will return through line (32) to the reservoir.

(d) The relief valve built into the control valve is of the spring loaded ball type. Pressure is adjusted by turning the adjusting screw (39) which raises or lowers the tension in the spring (40). This screw is locked in place by a nut (37).

(e) The hydraulic motor is essentially the same as the hydraulic pump except that it is running in reverse.

The alternative type of power traverse is made by Oilgear (Plates S, T, T<sub>1</sub>, U). It operates as follows:

An electric motor drives a variable displacement pump which pumps oil under pressure to a constant displacement motor. Assisting the variable displacement pump is another geared pump which maintains the pressure in the system. The direction of rotation of the turret is determined by the flow of oil and this is controlled by the hand control unit. This consists of a series of valves which open and close allowing oil to pass so that the control cam moves and according to the direction of movement displaces the slide block race. This displacement is sufficient to change the direction of a flow of oil.

The complete unit consists of:

(a) A 12-volt electric motor which develops  $1\frac{1}{4}$  H.P. at 2200 R.P.M. On the M3A1 Light Tank this drives two pumps—one at each end; the one for the gyro-stabiliser and the other for the power traverse. It is connected to the pump through a jaw coupling.

(b) A variable displacement oil pump and control valve. This consists of a stationary flat valve (105) and ported shaft (90) with integral cylinder barrel (101) having 14 closely fitted pistons (60) and special roller bearings (84), a slide block race (61) and a hydraulic servo-motor control mechanism. The drive shaft (90) and cylinder barrel rotate on two ball bearings (93 and 102) and owing to the resultant centrifugal force the convex surfaces of the rolling pistons are kept at all times in contact against the inner race (84) of the roller bearing (61) which rotates with the cylinder barrel owing to the resultant action of the rolling pistons.



# OILGEAR MOTOR

VIEW FACING DRIVE SHAFT END.

DIRECTION OF ROTATION:  
CONTROL AT "B"

# OILGEAR HIGH PRESSURE PUMP

VIEW FACING DRIVE SHAFT END  
WITH SLIDE BLOCK IN PUMPING  
POSITION AND PRESSURE  
AT PORT NO. 1.

PUMP CONTROL  
MECHANISM

CONTROL  
LEVER

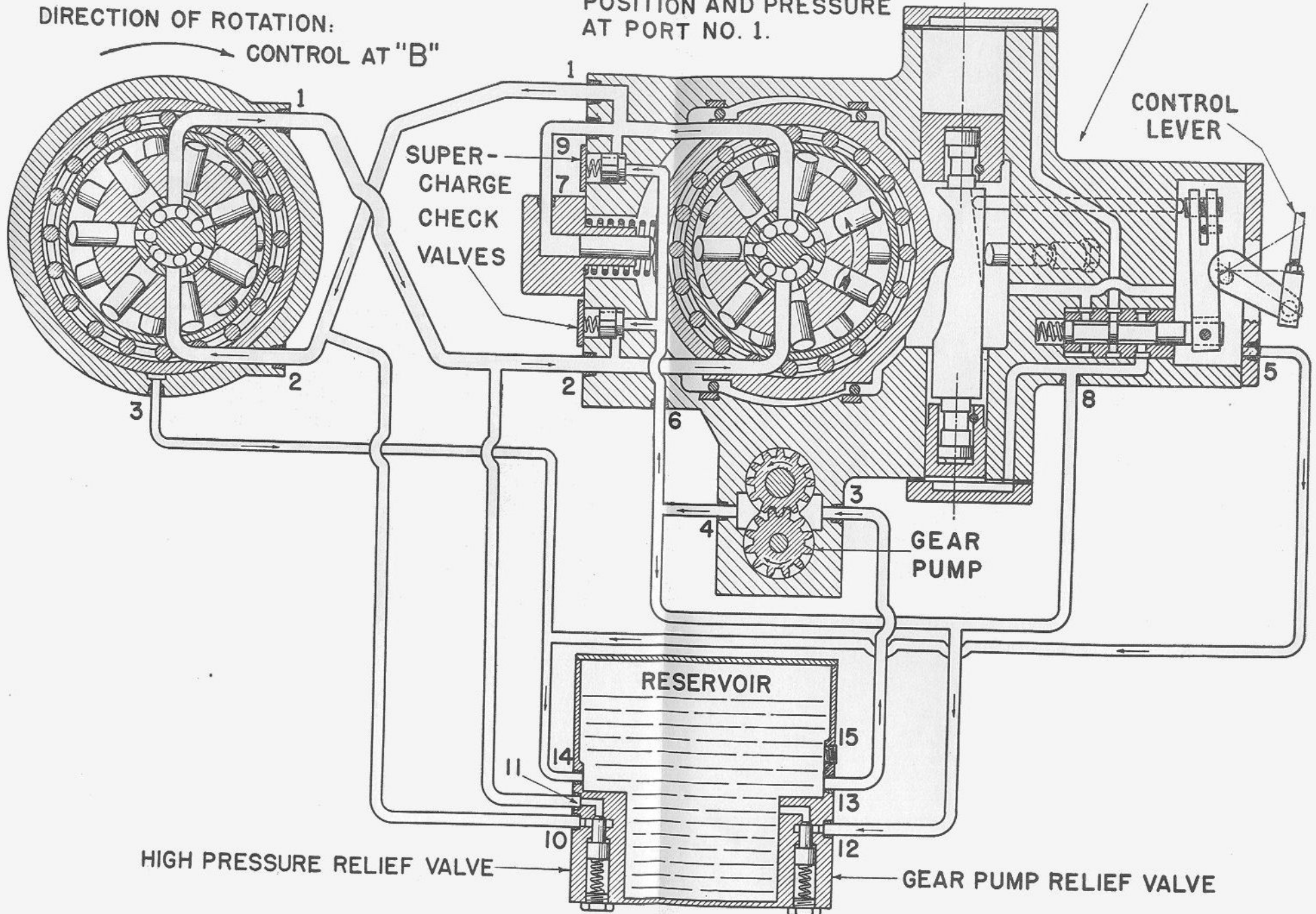
SUPER-  
CHARGE  
CHECK  
VALVES

GEAR  
PUMP

RESERVOIR

HIGH PRESSURE RELIEF VALVE

GEAR PUMP RELIEF VALVE





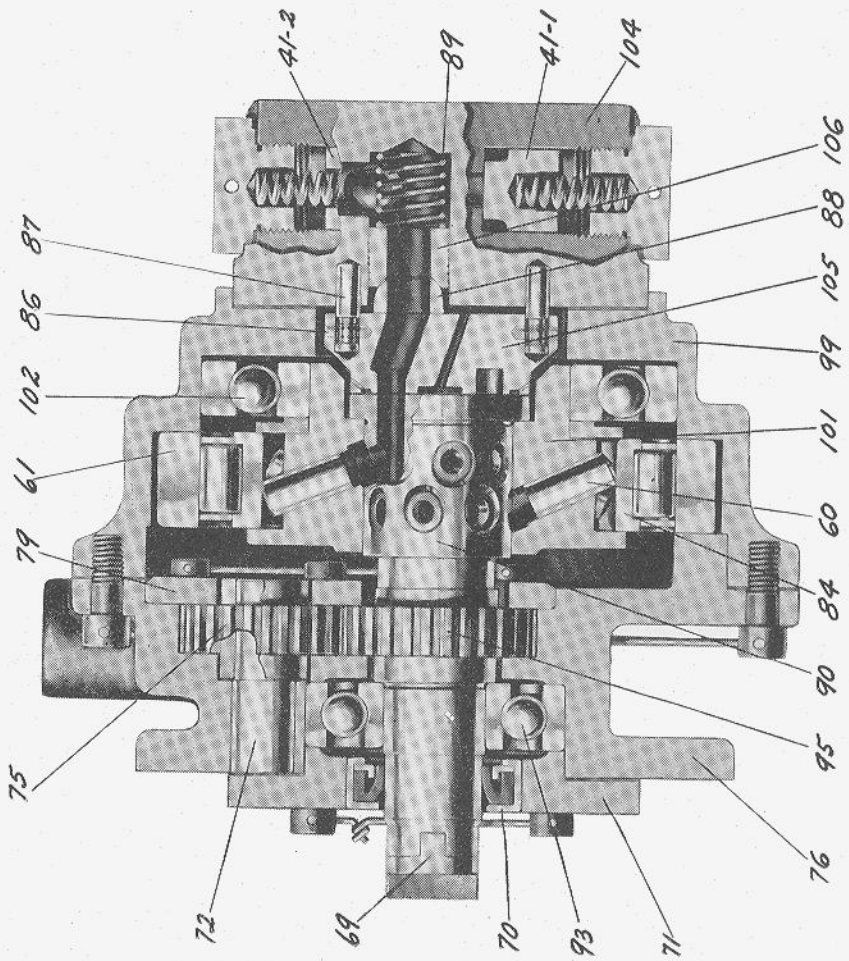


PLATE T  
 OILGEAR VARIABLE DISPLACEMENT PUMP

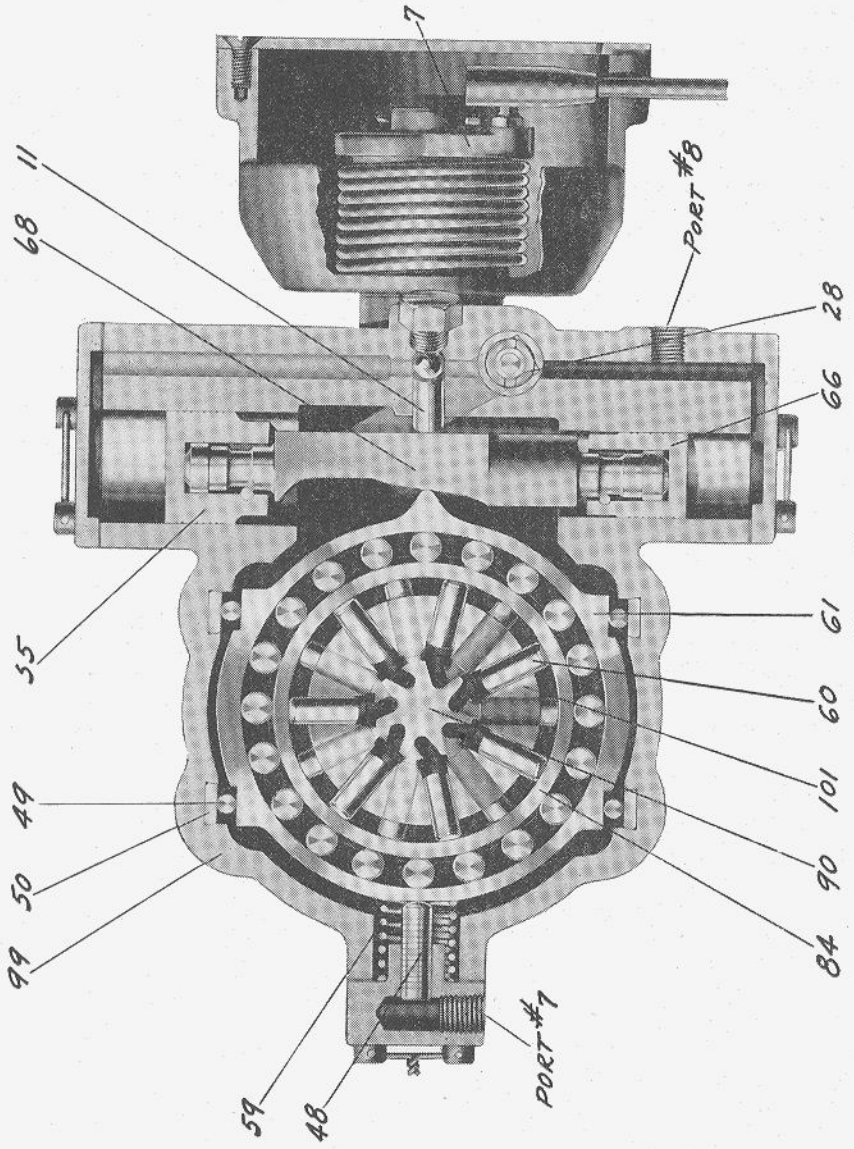


PLATE T<sub>1</sub>  
OIL-GEAR VARIABLE DISPLACEMENT PUMP

The slide block outer race is mounted on rollers (49) between four horizontal ways (50) in the pump case (99). This is actuated to the right or left of the drive shaft axis by the control cam (68), piston (48) and spring (59) to change the direction of oil flow and vary the stroke of the pistons (60).

(c) A hydraulic servo-motor control mechanism (Plate L). This consists of the following:

- A spring centered operating lever (7)
- Eccentric control shaft (3)
- Equalizing bar (22)
- Equalizing pin (21)
- Pilot valve (28)
- Hydraulically operated control cam (68)
- Piston (48)
- Spring (59)

Springs (89) in the end head (104) combined with the pressure on the back-up pistons (106) and the tumblers (88) hold the balanced bronze flat valve (105) against the end of the drive shaft (90). This pump flat valve is similar to the motor flat valve. Built into the front housing (76) is a gear pump (75 and 95) which supercharges the main radial rolling piston pump system and operates the hydraulic servo-motor control. Two spring loaded plunger type check valves (41-1 and 41-2) are built into the end head. (104)

(d) A constant displacement motor, which consists essentially of a stationary flat valve and ported drive shaft with integral cylinder barrel having fourteen closely fitted pistons. Oil is delivered under pressure from the pump to one of the two ports of the motor, and a pressure of this oil causes the drive shaft to rotate. The direction is dependent upon pressure of oil at either port. Any oil leakage lubricates the working parts and drains back into the oil reservoir.

(e) A gear box adapter and gear box which are bolted to side of the turret basket.

(f) The oil reservoir. This with its control leakage is mounted in a vertical position and fastened to the side of the turret basket. In it there are incorporated two pressure relief valves. The one is set at 1500 pounds per square inch and protects the main system if ever it is necessary suddenly to change the direction of the movement of the turret; the other is set at 50 pounds per square inch and prevents overloading of the control system which is operated by the gear pump. To adjust the pressure for either of these relief valves remove the cap of the valve concerned and either add or remove more thin shims in the spring chamber in the cap.

### Mode of Operation

- (1) Before starting make sure that the unit is supplied with oil.

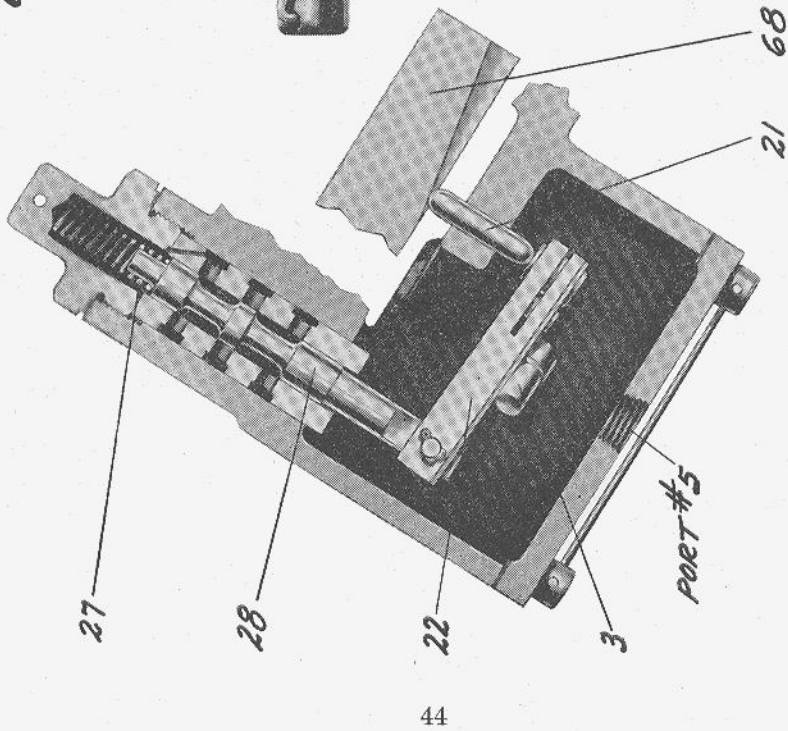
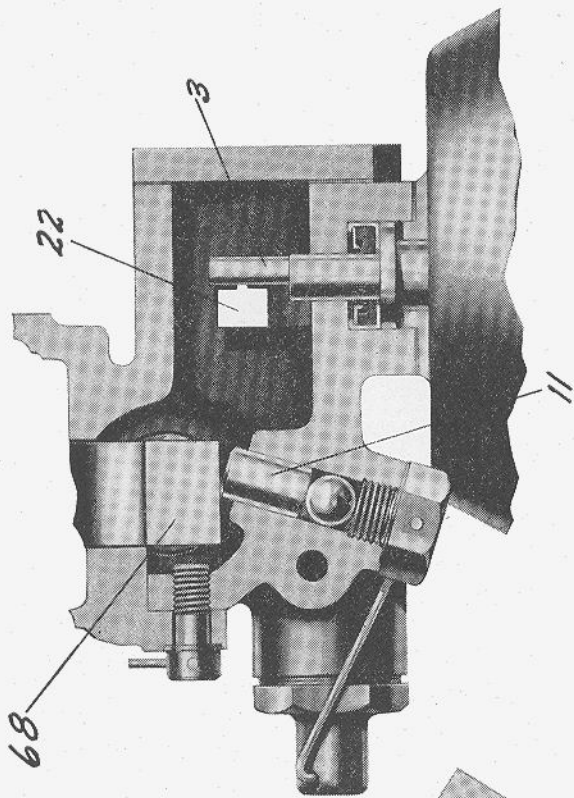


PLATE U  
OILGEAR CONTROL MECHANISM



If any part of the unit is run without oil serious damage is liable to occur. The oil should be perfectly clear, free from grit, contaminants and chemically inert.

(2) If the tank engine is not running start the auxiliary generator.

(3) Switch on the electric motor. Pressure will build up almost immediately in the system.

(4) Disengage the hand traverse gear and engage the power traverse gear.

(5) Grasp the handle firmly with the left hand squeezing the latchet grip. To traverse the turret left move the handle counter-clockwise. In order to make the turret traverse to the right turn handle clockwise. The further the handle is turned, the faster the turret will move. In the case of the Oilgear system the volume of oil delivered is increased or decreased proportionately with the increase or decrease in eccentricity of the slide block.

(6) The guns are fired by depressing either one of the two toggle or thumb switches with the left thumb.

### C. Gyro-Stabiliser (Plate V)

The elevating mechanism of the 37 mm. and .30 machine guns may be free or controlled either by hand or by gyro-stabiliser. The object of the latter is to maintain the position of the 37 mm. and .30 machine guns so as to assist the gunner in aiming and firing the gun accurately when the tank is on the move, but it must be remembered, however, that the stabiliser only controls the gun in a *vertical* plane.

The hand elevating mechanism operates through a pair of helical gears and drives a worm gear which meshes into the elevating arc, bolted to the rear end of the recoil cylinder, to elevate or depress the gun.

The gyro-stabiliser operates as follows:

In order to maintain its set angular position the gun must move with respect to the turret when the tank is pitching. This movement of the gun is controlled by a double acting piston and cylinder assembly. If the oil, fed under pressure to each side of the piston, is controlled properly, the gun can be made to maintain a set angular position.

In order to elevate or depress the gun, it is only necessary to change the relation between the gyro control unit and the gun; and for this reason it is attached to the gun through suitable gearing. On turning the elevating handwheel, therefore, in the normal manner the relationship between the gyro and gun is changed; and since the gyro tends to maintain itself vertical, the gun moves to a new position automatically so as to restore the gyro to its vertical position.

The gyro-stabiliser will be installed on all M3A1 Light Tanks and may be installed in some models of the M3 Light Tanks, but in either case it consists basically of the same components.

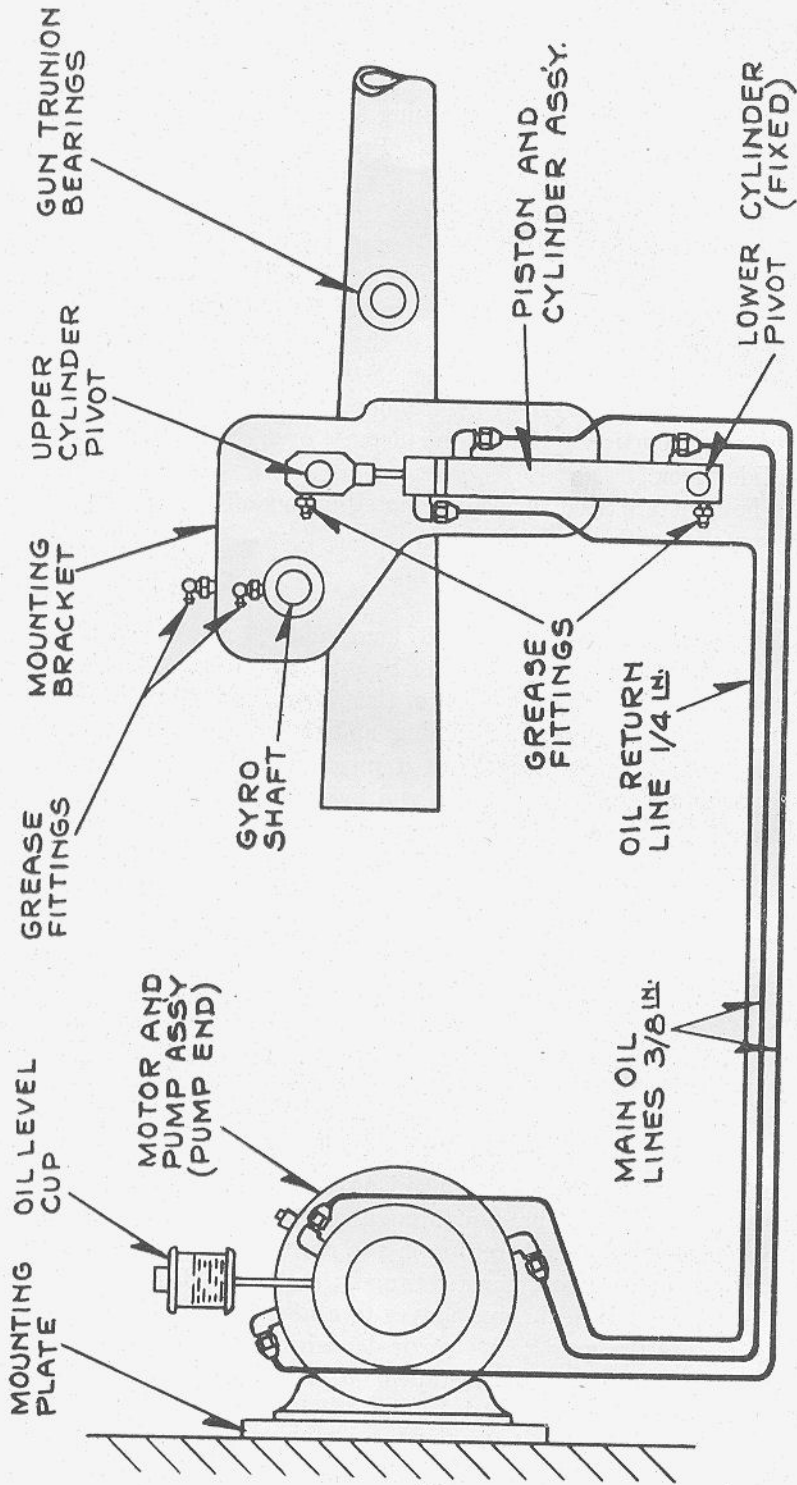


PLATE V  
 GYRO-STABILISER OIL LINES AND GREASE FITTINGS

(a) A 12-volt electric motor developing  $1\frac{1}{4}$  H.P. at 2200 R.P.M., which drives both the pump for the stabiliser and the pump for the hydraulic power traverse except in the case of the first 100 M3 Light Tanks when a different type electric motor (developing  $\frac{1}{4}$  H.P.) only drives the pump for the stabiliser.

(b) The pressure pump consists of a driving pinion and two other pinions each of which pass oil under pressure to the piston cylinder.

(c) The piston cylinder is fastened at the one end to the top of the turret and at the other end to the gun mount. There are two oil lines from the oil pump, one at the bottom of the piston cylinder and the other at the top. A close machined fit between piston rod guide and piston rod minimizes oil leakage around piston rod. Oil that does leak past this fit enters a return pipe leading back to the main reservoir on the pump housing.

(d) From this housing there is a pipe taken to the oil level cup located as high as possible in the turret which must be above the top of the piston cylinder. This cup must be kept full of oil to enable the gyro-stabiliser unit to work satisfactorily.

(e) The gyro control unit is attached to the gun mount, but by turning elevating handwheel in the normal manner it is possible, owing to the flexible drive shaft connecting the handwheel drive to the gyro control unit to alter the relationship of the gyro control unit to the gun mount, and so elevate or depress the gun.

The gyro control unit is sealed on leaving the factory and should never be touched except by specially trained personnel of the R.A.O.C.

(f) The control box consists of two rheostats and a warning light. One of the rheostats controls the stiffness of the stabilising action. The other controls the recoil mechanism.

(g) There are two switches to this unit; the one the master switch for the electric motor and the other a push and pull switch in the control box to work the gyros.

### Mode of Operation

(1) Ensure that the unit is fully charged with oil. For working temperatures in the range  $-20^{\circ}$  F. to  $+120^{\circ}$  F. use Univis 47 oil.

(2) If the tank engine is not running, start auxiliary generator.

(3) Release the hand elevating gear so that the gun is free to elevate or depress.

(4) Turn the handwheel until the gyro control unit is approximately in the vertical position.

(5) Set the stiffness control at zero.

(6) Close the master switch which causes the electric motor to drive the oil pump, and build up pressure on either side of the piston in the piston cylinder.

(7) Allow the oil to warm up.

(8) Switch on the gyros and allow them to run for 30 seconds before attempting to use the gyro-stabiliser.

(9) Correct the gyro for stiffness and turn the knob of the stiffness adjuster in the direction of the arrow. The gun will hunt (vibrate) when it is too stiff. If not stiff enough, there will not be sufficient force to stabilize the gun properly.

(10) Do not allow the gun to remain either at maximum high or low elevation longer than is absolutely necessary as this causes a strain on the mechanism and a considerable drain on the tank batteries.

**Maintenance. (Full details in special handbook.)**

(1) Check that the gun is balanced. If it is unbalanced, satisfactory performance of the stabiliser cannot be expected. When checking, the 37 mm gun must be loaded with a dummy round and the .30 machine gun have its normal supply of ammunition. If unbalanced consult unit fitters.

(2) Check trunnion friction and ensure that all parts are well lubricated and move freely.

(3) Check all connections to ensure there is no oil leak.

(4) Check and ensure that there is no air in the system. To do this it may be necessary to recharge the system, in which case proceed as follows:

Heat the oil to approximately 200° F. and disconnect the oil return pipe at the pump.

Remove the cap and add oil to the level cup. When the oil runs from the open connection, attach the oil return line and continue to fill the cup about  $\frac{1}{2}$  full.

Loosen the two main oil line connections on the cylinder.

Remove the multi-prong plug from the gyro unit and switch the pump on.

Ensure the elevating gears are out of mesh. When a flow of oil is observed at the lower cylinder connection, depress the breech of the gun as far as it will go and tighten the connection.

Next raise the breech as far as it will go and tighten the connection, when the flow from the upper connection seems steady. If necessary, add more oil to keep the level in the oil cup about  $\frac{1}{2}$  full.

Stop the pump, and move the breech of the gun up and down slowly until all signs of air coming from the oil in the cup have disappeared.

CHAPTER VI  
ELECTRICAL SYSTEM

(PLATE W)

The Tank is fitted with a 12-volt dynamo charging a 12-volt battery. For starting purposes a 12-volt starter motor is fitted.

(1) The starter motor is an Eclipse Aviation Model I, Type 404, and consists of an electric motor, reduction gearing, multiplate clutch, automatic engaging and disengaging mechanism and driving jaw.

(2) The dynamo is Eclipse Aviation model 36, Type 310, and is fitted with voltage control and cut out.

(3) The Booster Coil is furnished completely enclosed in a shield housing with threaded spouts for attachment of shielding conduit. The Booster Switch is of riveted construction, and contains a spring loaded plunger to which a cable is attached.

(4) The auxiliary generator, 750 watts, 12-volt, is made by Delco.

#### Radio and Interphone Facilities

1. The radio and interphone facilities provided differ according to the different types of tanks and also according to the availability or non-availability of radio equipment at the time of issue of the tanks. They may be summarized as follows:

Type	Radio Set	Interphone	Aerial
M2A4 and M3	SCR-245	RC-61	Whip
M2A4 and M3 *	No. 11	RC-61	Whip
M2A4 and M3	No. 19	No. 19	No. 19
M3A1	No. 19	No. 19	No. 19

Detailed descriptions of the various sets and interphone equipment can be obtained from the relevant handbooks or Signal Training Pamphlets; this chapter will only indicate the facilities provided.

2. *SCR-245*. This is a U. S. designed and built equipment and has only been provided on M2A4 and M3 Light Tanks. It is used in conjunction with the RC-61 interphone equipment to provide crew control, and is mounted on the rear bulkhead of the tank where it is readily accessible to the operator.

The receiver and transmitter are separate units connected by flexible plug in connectors.

The antenna used is a 15¾ foot rod antenna made up from 5 high tensile steel sections and mounted on a helical spring mast base.

3. *RC-61 Interphone Equipment*. This consists of an amplifier unit, 3 control boxes, 2 jackboxes and sundry interconnecting cables, head-

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\* No. 11 Set and RC-61 installations will probably be replaced by No. 19 Sets.

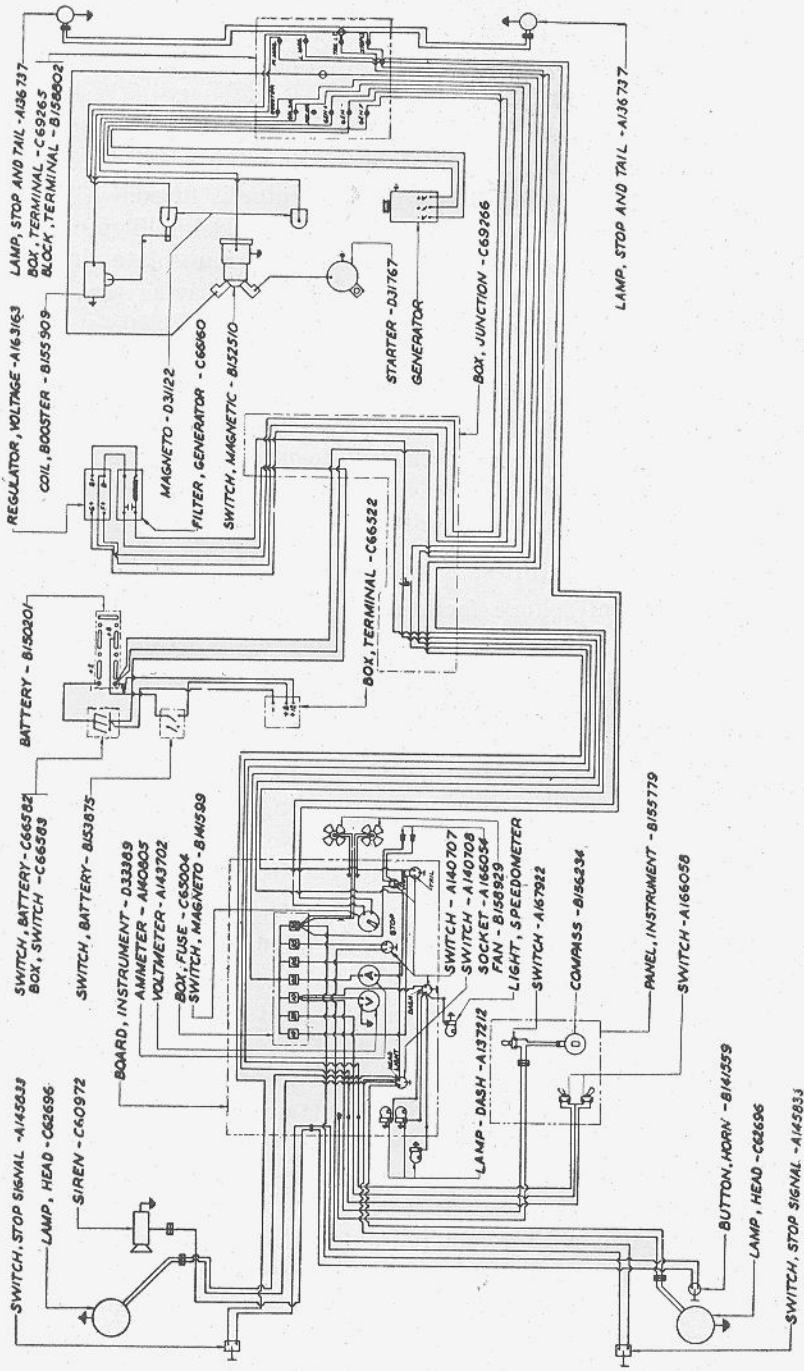


PLATE W  
WIRING DIAGRAM M3 LIGHT TANK



phones, etc. The amplifier is mounted on the rear bulkhead while the other units are conveniently disposed about the tank, as indicated later in this section.

When used in conjunction with the SCR-245, the RC-61 offers radio control on two of the outlets as well as crew intercommunication. When used in conjunction with other radio equipment such as the No. 11 set only crew control facilities are available. It should be noted that, when used with the No. 11 set, separate microphones and headphones must be used, owing to the difference in output impedance of the two equipments. If, therefore, the commander or operator has been speaking on the No. 11 set, he must change his headphones and microphone before he can speak on the interphone equipment. It is definitely not possible to plug the No. 11 set microphones and headphone into the RC-61 or vice versa.

The following gives the disposition of the various units of the RC-61:

One jack box providing two microphone and two headphone outlets is mounted on a bracket placed centrally between the driver and forward gunner on the front of the tank. The driver's control box is mounted on the transmission housing in front of the tachometer. Two control boxes, each providing one microphone and one headphone output and catering for the commander and radio operator respectively, are mounted on brackets on the roof of the hull, one on the left and one on the right forward of the cupola ring. In addition a jack box is provided on the hull roof to the rear of the cupola ring providing one microphone and one headphone outlet.

The control units provided for the commander and operator are both fitted with a switch to give control of the radio sets SCR-245 when this is fitted. With both switches in these units on "interphone," pressing any microphone button and speaking into that microphone enables communication to be made with all the other members of the crew. Note that the driver's microphone is controlled by the toggle switch on his control unit, whereas the other three microphones are controlled by switch buttons in the connecting cords.

On the driver's jack box are two lights, one red and one green, which will be alight when the commander and operator are switched to interphone but if either or both are switched to radio their respective lights will be extinguished. The green light indicates the commander and the red the radio operator. In the event of an emergency, if the driver wishes to attract the attention of the commander when the latter is switched to radio, he presses the signal button in his control box and the signal will be heard in the commander's earphones.

4. *No. 11 Set.* This set is well known and requires no description here. It is mounted on the rear bulkhead in place of the SCR-245. As indicated heretofore, when used with the RC-61 interphone certain shortcomings are evident but there are no means of overcoming these.



5. *No. 19 Set.* This set also is well known and only a description of the installation will be given here. The M2A4 and M3 installations will be given first and then that for the M3A1.

(a) *No. 19 Set in M2A4 and M3 Light Tanks.*

The set is mounted on the rear bulkhead with Control Unit No. 2 (operator) immediately below and Control Unit No. 1 Mk. II (commander) on the right hand end of the set at about the center of the tank. The driver and forward gunner are provided for by a Junction Distribution No. 3 situated between them on the front of the tank. A driver's alarm signal is provided with this unit to attract the attention of the commander. Both the commander and the operator are able to switch themselves to the A Set, the B Set, or interphone.

(b) *No. 19 Set in M3A1 Light Tank.*

Note: the installations described in this section must be treated as provisional only as they had not been finalized at the time of writing.

The set is situated in the right sponson as far forward as possible. A Control Unit No. 3C situated just to the right of the forward gunner-radio operator provides an outlet for the driver on interphone only and for the operator which he can switch to the A Set, the B Set, or interphone as required. The commander and gunner are provided for by a Junction Distribution No. 3 on the turret roof. This unit is connected directly through the slip rings to the Control Unit No. 3C. It is provided with an alarm buzzer, the output of which is connected to the operator's headphones. By means of a prearranged signal code, the operator switches the commander to the A Set, the B Set or interphone, according to his signal. Since the commander and gunner's headphones in the turret are both in parallel so that they will always be connected to the same outlet, the gunner is not on interphone at all times as is usual with other No. 19 set installations.

## CHAPTER VII

### INSTRUCTIONS FOR RUNNING INSPECTION LUBRICATION AND MAINTENANCE

#### A. Starting up and Stopping

##### (1) *Daily before starting*

Check the oil in the oil tank. See that the oil taps are open. Check the fuel and turn the taps on. Make sure that all joints and connections are tight and that there are no leaks. See that the earth wires are properly connected from the magnetos to the ignition switch, and the point marked "Grd." on the ignition switch is connected to the engine crankcase.

*(2) To start up from cold*

Make sure that the engine is switched off.

Put the gear lever in neutral.

Give the engine several strokes of the priming pump. Four should be sufficient.

*NOTE:* (1) Excessive priming will wash the oil off the cylinder walls, and cause scoring or seizing of the barrel and pistons. Do not prime through the spark plug holes with liquid petrol, nor while the engine is being turned over by the starter motor. (2) Do not start the engine by coasting or towing the vehicle as to do so may cause serious damage to the engine or transmission.

*Turn the engine over by hand four revolutions to ascertain that everything is clear and that no oil has leaked into the bottom cylinder. This is very important* and if particular attention is not paid to this point it may result in a piston being broken or a cylinder head being blown off. If it is impossible to turn the engine over by hand, remove the sparking plug from the bottom cylinder, as probably that cylinder is full of oil, and allow the oil to drain out. Replace the sparking plug, and continue to turn the engine over by hand.

Move the throttle lever almost to the closed position, or about 1/10 open.

Fully depress the engine clutch.

Switch on and press down on the starter and booster switches simultaneously, until the engine fires. Release the two switches.

As soon as the engine fires, open the throttle very slowly until the rev. counter registers 800 r.p.m. and advance the spark to full advance. Allow the engine to warm up for five to ten minutes, so that the engine oil is at 80° before you move off.

Check the oil pressure and ammeter readings. Do not let the engine idle under 800 r.p.m. unless you intend to switch off.

If the engine fails to start prime again and repeat the above procedure.

If the engine is overprimed, it should be turned over a few revolutions by hand with the throttle open and the engine switched off.

*(3) To start up when hot*

Switch on and press down on the starter and booster switches; as soon as the engine fires, release both switches.

*(4) To stop the engine*

Let the engine idle for five minutes at 400 to 500 r.p.m. and then switch off. Turn off the petrol.

Do not race the engine and then switch off as this will cause a great deal of oil to accumulate in the sump, which will not be pumped out by the scavenge pump. This oil will then seep past the piston rings of the bottom piston, into the bottom cylinder, and will neces-

sitate the removal of the bottom cylinder sparking plug before the engine can be started.

## **B. Running Notes**

Remember that this engine was designed primarily for aircraft use and, after initial warming, should be operated at appreciable engine speeds. *Do not therefore allow the engine to idle or the engine to labor under load*; keep the engine revolutions above 800 r.p.m., unless it is intended to stop the engine.

The engine should not be raced while cold. It should also be remembered that any rapid movement of the accelerator pedal causes a jet of petrol to be injected into the cylinders, and if the engine is cold, this petrol will leak past the pistons into the sump and dilute the oil.

When driving, use the steering levers as little as possible, and so save wear on the brake bands. Unlike other British tanks, it is impossible to lock either track. If it is necessary to stop suddenly, pull both steering levers back firmly; the engine will stall, however, if the engine clutch is not disengaged.

Take an occasional glance at the various gauges and especially at the oil pressure gauge and the oil temperature gauge. If the oil pressure drops below 65 pounds at 1,000 r.p.m., check the lubricating system.

## **C. Crew Inspection (Plate X)**

### *(1) Inspection at halts*

Attend to any points noted as a result of the Tank's running, i.e., brake adjustment, oil level, etc.

Inspect tracks for tension, and check all nuts clamping the end-connections and wedges together.

Make certain that no suspension springs are broken.

### *(2) Inspection after running or weekly*

Clean down as necessary, and inspect as "at halts".

Fill up with petrol, and top up the oil tank. Check the final drive oil level.

Lubricate according to mileage done. If the tank has been running in mud or sand, lubricate the suspension.

Turn oil filter handle and petrol filter handle.

Check the air cleaners if dust conditions have been severe.

Check the battery.

Check the oil level in the power traverse and gyro-stabilizer systems.

Note mileage, petrol and oil, and any work done in the driver's note book. In case of doubt, consult the unit fitters.

### *(3) Inspection every 50 hours or monthly*

Check valve clearance (10/1000-in.) with the engine cold, and inspect the push rod housing hoses for signs of leaks.

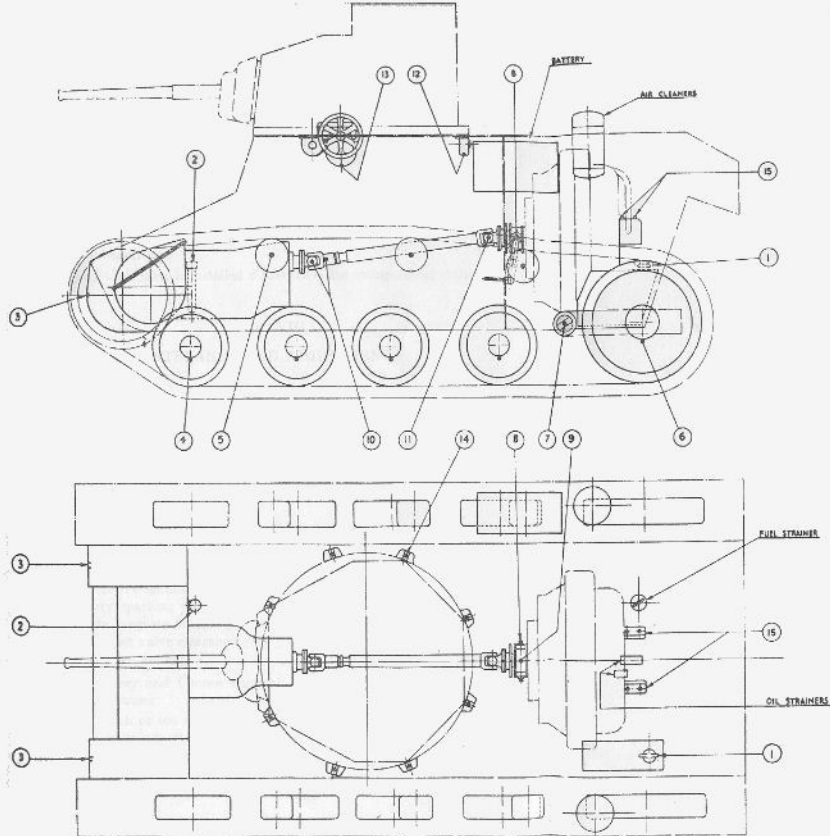


PLATE X  
LUBRICATION CHART, M3 LIGHT TANK

LOCATION OR PART	PART	NUMBER OF POINTS	LUBRICANT	REMARKS
			EVERY 100 MILES OR DAILY	
1	ENGINE	1	M. 400	CHECK OIL LEVEL; TOP UP; CHANGE OIL EVERY 500 MILES.
			EVERY 100 MILES OR WEEKLY	
2	GEARBOX AND DIFFERENTIAL	1	M. 400	CHECK OIL LEVEL; TOP UP; CHANGE OIL EVERY 2000 MILES.
3	FINAL DRIVES	2	M. 400	CHECK OIL LEVEL; TOP UP; CHANGE OIL EVERY 1000 MILES.
4	BOGIE WHEELS	8	GREASE, GS	
5	TOP ROLLERS	6		
6	IDLER WHEELS	2		
7	IDLER WHEEL ARM FULCRUM PINS	2		
8	CLUTCH THROW-OUT ROLLERS	2		
			EVERY 250 MILES OR FORTNIGHTLY	
	CONTROL RODS - LEVERS - LINKAGES		M. 400	OIL CAN
	DOOR AND SHIELD HINGES - DOOR LATCHES			
	PROP HOLE PROTECTORS - PISTON PORT COVERS			
	GUN MOUNTING PINS			
			EVERY 1000 MILES	
9	CLUTCH SLEEVE	1	GREASE, GS	
10	PROPELLOR SHAFT SWIP JOINT	2	M. 400	REMOVE PLUG - INSTALL GREASE FITTING - REPLACE PLUG.
11	PROPELLOR SHAFT UNIVERSAL JOINT	1		
12	TURRET SUPPORT ROLLERS	5		
13	TURRET TRAVERSING GEAR	1		
14	TURRET HOLD-DOWN AND TURRET ROLLERS	8		
15	MAGNETOS	4	M. 160	OIL CAN - DO NOT OVER-LUBRICATE. 15-DROPS IN BREAKER END OILER. 15-DROPS IN DRIVER END OILER.

AIR CLEANER --- NORMAL CONDITION --- FILL TO "OIL LEVEL" LINE WITH M. 90. CHANGE OIL, AND WASH ELEMENT IN PETROL EVERY 250 MILES.  
 --- DIRT CONDITIONS --- CHANGE OIL, AND CLEAN ELEMENT EVERY 100 MILES.  
 FUEL STRAINER --- TURN HANDLE ONE FULL TURN DAILY --- DRAIN EVERY 250 MILES.  
 OIL STRAINERS --- REMOVE AND CLEAN EVERY 500 MILES.  
 BATTERY --- WEEKLY --- TOP UP WITH DISTILLED WATER, AND SMEAR TERMINALS WITH PETROLEUM JELLY.

LOANSFORT - POWER TRAVERSE - M. 80  
 OILMAN - POWER TRAVERSE  
 GYRO-SEALERER, UNIVIS 47



Check sparking plug gaps (.015"). Do not disassemble the sparking plugs unless absolutely necessary.

Examine the magneto brushes and check the magneto points (.012").

Check the ignition wiring for defective insulation.

Check that there is at least 1/16" play between the clutch bearings and sleeve.

Check and clean the carburetor.

Clean the oil filter and the petrol filter.

Ensure that all exhaust and inlet manifold nuts are tight.

Check the engine mounting bolts and accessory flange nuts.

Check the oil in the final drive.

Check the fan for loose cap screws.

Lubricate all round.

#### D. Fire Precautions

In every tank there is installed a fixed CO<sub>2</sub> fire extinguishing system.

### CHAPTER VIII

## MAINTENANCE AND ADJUSTMENTS

### A. ENGINE

(1) *Failure of the Engine to Start* may be due to any, or a combination, of the following conditions:

(a) Lack of fuel—check fuel supply and filter.

(b) Throttle opening incorrect—should be about 1/10 open. If the accelerator pedal has been pumped, the induction manifold is probably flooded with petrol.

(c) Water in the carburetor.

(d) Under-priming or over-priming.

(e) Cold oil in very cold weather, or run-down battery.

(f) Defective booster coil.

(g) Defective ignition wiring.

(h) Dirty sparking plugs or incorrect setting of the gap.

(i) Dirty magneto breaker points.

(j) Incorrect valve clearance.

(k) Incorrect timing.

(2) *Low Power and Uneven Running* may be traced to any of the following causes:

(a) Too rich or too weak a mixture.

(b) Leaks in induction system.

(c) Faulty sparking plugs.

(d) Faulty magneto.

(e) Valves sticking or incorrectly adjusted.

- (f) Poor fuel.
- (g) Defective ignition wiring.
- (h) Carburetor leakage.
- (i) Engine overheating.

(3) *High Oil Consumption* may be due to:

- (a) Insufficient oil cooling. The cooling should be checked to ascertain that the cylinders are receiving sufficient cooling.
- (b) Insufficient oil supply.
- (c) Low grade oil.
- (d) Dirty oil.
- (e) Worn piston rings, or incorrectly installed piston rings.
- (f) Scavenging oil pump failure or leak in oil lines. The pump may need priming.

(4) *Loss of Oil Pressure* may be due to:

- (a) Lack of oil. There must be at least four gallons of oil in the oil tank.
- (b) Dirt in the oil strainer.
- (c) The improper setting of the pressure relief valve, or weak valve spring in the oil pump.
- (d) Dirt on the oil pressure relief valve (which is most unlikely).
- (e) A bearing having run, or worn badly.
- (f) High oil temperature which will have reduced the viscosity of the oil, which then passes the bearing more freely and tends to drop the oil pressure.
- (g) Low outside temperature which may cause the oil to congeal in the suction line from the oil tank and then prevent it from reaching the pump.
- (h) It should be remembered that the pressure will vary with the varying engine speed and oil temperature, and due allowance should be made for the pressure drop to be expected with increased temperature.

(5) *To Adjust the Pressure Relief Valve*

The valve should only be removed and adjusted if the oil pressure gauge shows less than 65 pounds at 1,000 r.p.m. of the engine with all oil line fittings and connections tight and with the proper oil supply. Permission to do this must first be obtained from the Battalion Technical Adjutant, and the work must be done by a fitter.

Start up the engine and, with the engine running at 1,000 r.p.m., turn the adjusting screw in the oil pump, which is located to the rear of the engine. This raises or lowers the tension in the spring; and will alter the pressure accordingly.



(6) *To Change the Engine Oil* (Every 500 miles or every 25 hours).

The oil should be changed when the engine is hot. Remember to allow the engine to idle for five minutes before switching off. This will ensure that the oil in the crankcase is pumped out.

Remove the cover in the hull floor and drain the oil tank by removing the plug. At the same time drain the oil cooler.

Refill the oil tank to the correct level. Start up the engine and check the oil pressure. After running for five minutes switch off and check the oil level.

(7) *To Remove the Sparking Plugs*

(a) Remove hood and grill over intake chute.

(b) Remove transmission oil cooler from bulkhead.

(c) Adjust all points to .015 inch.

(8) *Sequence of Events for Lifting out Engine*

(a) *Preliminary steps to be taken:*

1. Disconnect the battery and turn off all petrol taps.
2. Remove the rear floor and top plates and the engine cowling.
3. Remove the cowling over propeller shaft by the engine bulkhead, and disconnect the propeller shaft flange.
4. Remove the clutch withdrawal rollers.
5. Disconnect the exhaust pipes and remove the silencers.
6. Remove the pipes leading from the air cleaners to the carburetor.
7. Now disconnect:
  - (a) The thermometer lead.
  - (b) The oil delivery and return pipes.
  - (c) The oil pressure gauge lead.
  - (d) The electrical leads at the engine junction box.
  - (e) Both petrol pipes at the pump.
  - (f) The priming line.
  - (g) The revolution counter drive cable.
  - (h) The engine fire extinguisher pipes.
  - (i) Throttle rods from the carburetor.

NOTE: All petrol and oil pipes should be plugged at their open ends to prevent any entry of dirt.

(b) *Removal of the Engine*

1. Attach lifting hooks.

NOTE: Improper use of the hoisting equipment may result in serious damage to the engine. Do not try to attach it to any part of the engine except where it was designed to be attached.

2. Place a rope around the clutch withdrawal bearing to take the weight of the front part of the engine.

3. Remove the four bolts at either end of the engine frame, and the two vertical bolts.
4. Remove the two vertical bolts holding the front support tube to the side of the tank.
5. Now check that all connections have been broken and lift the engine out.

NOTE: To get the engine clear of the engine compartment it will have to be tilted forward 5 to 10 degrees.

### *(9) Valve Timing*

Slip the timing disc over the front end of the crankshaft and attach the pointer. Insert the top dead center indicator in Number 1 cylinder front spark plug hole and check the accuracy of the pointer setting.

Adjust the valve tappet clearance to approximately .015 inch on all valves regardless of the position of the cam. In this way the possibility of bending the push rod for lack of clearance when turning the crankshaft during the timing operation will be eliminated and at the same time there will be tension all around the cam. Now tighten the rear crankshaft locking nut so that the serrations engage in the cam drive gear serrations and the cam will turn with the crankshaft.

Turn the crankshaft until the inlet valve of cylinder No. 7 and the exhaust valve of Cylinder No. 2 are open about the same amount. (These valves are the ones nearest cylinder No. 1.) Then on No. 1 cylinder set the clearance between rocker roller and valve stem to .124 inch, using the feeler gauge and adjusting wrenches found in the Maintenance Tool Kit.

When the clearance has been adjusted, rotate the crankshaft in an anti-clockwise direction, by small movements, to the exhaust valve closing position until the rocker roller is just released. The rear crankshaft nut should then be loosened to disengage the cam, and the crankshaft rotated in anti-clockwise direction to top center position.

The rear crankshaft nut may then be tightened, taking care that the teeth of the serrations in the crankshaft cam drive gear engage as the nut is drawn up. It is possible for the teeth to ride on their points without engaging and allowing the timing to change after the engine is in operation. This may be checked by stopping as soon as the nut is snug and working the crankshaft back and forth. If the serrations are not in mesh, the nut may be turned up about one turn further. After tightening up the rear crankshaft nut, the point of closing the exhaust valve should be checked by turning the crankshaft in anti-clockwise direction and determining if the rocker roller is released as the desired position on the timing disc passes the pointer. The serration tooth pitch allows 6 degrees of crankshaft rotation per tooth so that if the pointer is more than 3 degrees from the zero line at the point of exhaust valve closing, the crankshaft rear nut should be loosened and the tim-

WHEN REASSEMBLING MAGNETO, APPLY KEYSTONE #44 GREASE OR ITS EQUIVALENT EVENLY ON TEETH OF GEAR.

BACKLASH OF GEARS  
NEW - .002 TO .003  
SERVICE - .007 MAX.

ROTATING MAGNET SHAFT BEARINGS ARE SHIMMED TO .001 PRELOAD. USE GAUGE # 4-7823.

CHECK CONDENSER WHEN HEATED TO 200°F WITH 4-17049 400 VOLT D.C. MEGGER. READING MUST NOT BE LESS THAN 50,000 OHMS.

CHECK PRIMARY CURRENT AT 400 R.P.M. WITH 4-4676Z AMMETER. MUST BE 1.7 AMPS. OR MORE.

CHECK COMING-IN SPEED (7 MM. 3 POINT GAPS)  
FULL ADVANCE - 135 R.P.M.  
FULL RETARD - 250 R.P.M.

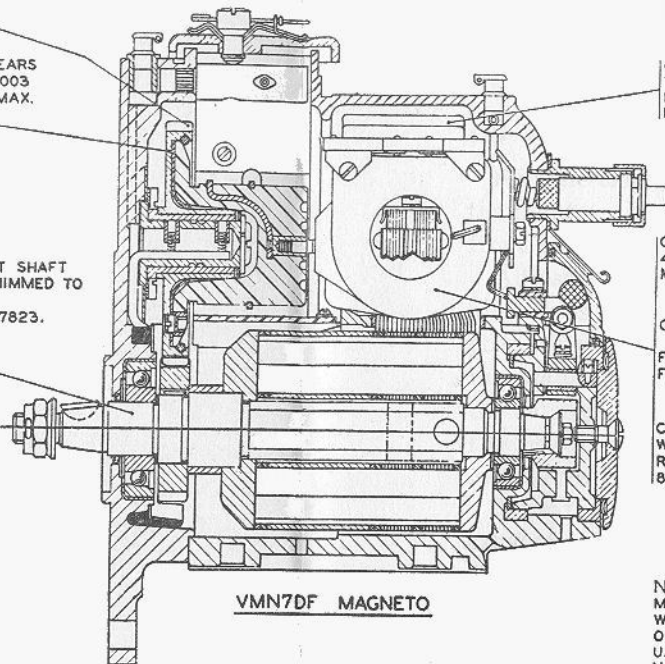
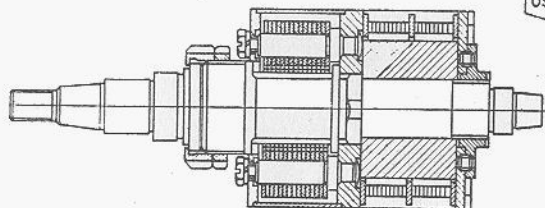
CHECK RESISTANCE OF SECONDARY WINDING WITH 4-12933Y OHMMETER. RESISTANCE SHOULD BE 5,000 TO 8,000 OHMS.

NOTE. WHEN REASSEMBLING MAGNETO, PACK BALL BEARINGS WITH KEYSTONE #44 GREASE OR ITS EQUIVALENT.  
U.S. ARMY SPEC. # 3560, GRADE 295  
NAVY SPEC. E-100.

ROTATING MAGNET IS 7°±2° PAST NEUTRAL WHEN CONTACT POINTS BEGIN TO OPEN.

CLEARANCE .0015 MIN.

THE VMN7DFA MAGNETO IS EXACTLY LIKE THE VMN7DF MAGNETO EXCEPT AN AUTOMATIC ADVANCE ROTOR, WHICH IS SHOWN BELOW, IS USED. BEARINGS ON AUTOMATIC ADVANCE ROTOR SHAFT ARE SHIMMED TO .0005 END PLAY.



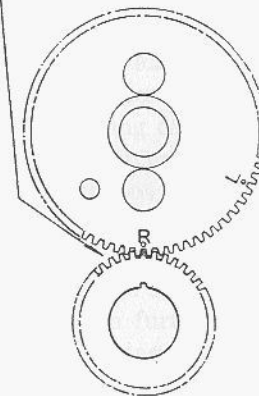
VMN7DF MAGNETO

**TIMING VMN7DFA**

SET CONTACT POINTS TO .012 CLEARANCE AND ADJUST BREAKER SO THAT THEY OPEN WHEN ROTATING MAGNET IS 7°±2° PAST NEUTRAL. TURN ROTOR BACKWARDS FROM CONTACT POINT OPENING POSITION THE NUMBER OF DEGREES OF AUTOMATIC ADVANCE AT WHICH POSITION TIMING MARKS "A" & "B" LINE UP AND REPRESENT THE FULL ADVANCED FIRING POSITION OF MAGNETO FOR NO.1 CYLINDER.

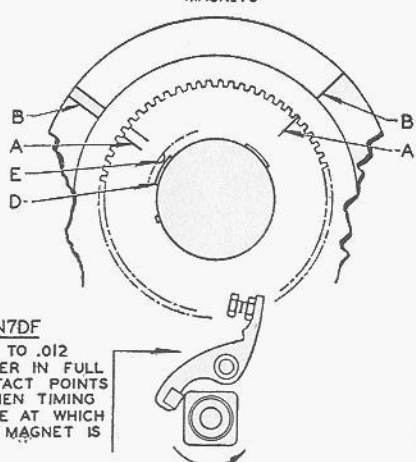
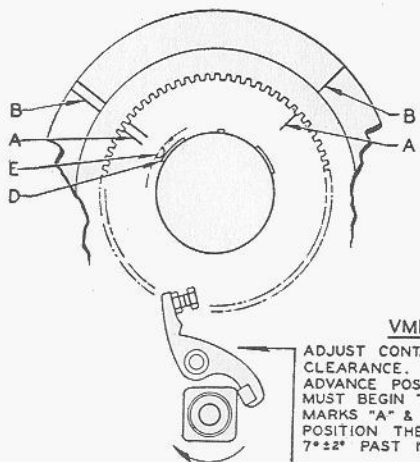
**RELATION OF TIMING MARKS WHEN MESHING GEARS**

THE MARKED TOOTH ON SMALL GEAR ENGAGES TOOTH ON LARGE GEAR MARKED "R" FOR CLOCKWISE MAGNETOS AND "L" FOR ANTI-CLOCKWISE MAGNETOS.



ANTI-CLOCKWISE MAGNETO

CLOCKWISE MAGNETO



**TIMING VMN7D & VMN7DF**

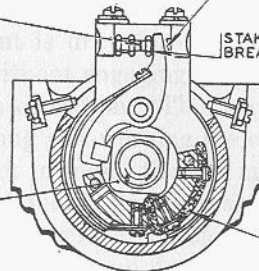
ADJUST CONTACT POINTS TO .012 CLEARANCE. WITH BREAKER IN FULL ADVANCE POSITION, CONTACT POINTS MUST BEGIN TO OPEN WHEN TIMING MARKS "A" & "B" COINCIDE AT WHICH POSITION THE ROTATING MAGNET IS 7°±2° PAST NEUTRAL.

CONTACT POINT CLEARANCE  
.010 MINIMUM  
.012 DESIRED  
.014 MAXIMUM.

WHEN CONTACT POINTS ARE WIDE OPEN, FIBRE STOP CLEARANCE MUST BE .002 TO .010.

CAM CONCENTRIC WITHIN .001 FULL INDICATOR READING.

KEEP FELT WICK MOIST WITH OIL.





ing corrected. With .124 inch clearance, the exhaust valve must close within three degrees of top dead center.

The rear crankshaft nut may now be locked with the tongued lockwasher and new circlip, making sure that the circlip covers four points of the nut. The lockwasher engages in slots in the rear of the crankshaft starter gear. The rev.-counter assembly is then bolted in place, the squared end of its drive shaft engaging with a similarly shaped opening in the rear crankshaft nut. Valve adjusting screws and lock nuts are screwed into place and the clearance of all valves set at .010 inch.

#### *(10) To adjust the tappets*

Turn the crankshaft until No. 1 cylinder is on top dead center of its firing stroke. The clearance, 10/1000 in., should be checked with the engine cold in rotation in accordance with the firing order of the engine, that is Cylinders 1-3-5-7-2-4-6, each time having the piston on top dead center of the firing stroke of the cylinder being checked. Replace the rocker covers, using new gaskets throughout and making sure that all covers are in their proper positions.

#### *(11) To Time the Magnetos (Plate Y)*

Set the magneto contact breaker points at .012-.015. When the cam is in position to give maximum breaker point opening, turn the engine crankshaft until the piston of No. 1 cylinder is in its full advanced position. Now with the right hand magneto points properly set remove the distributor blocks and turn the magneto drive shaft until the engraved marks on the teeth of the large distributor gear are approximately opposite the corresponding marks on the inside of the front end plate. Install the magneto in this position to the engine, making sure that the face of the magneto flange and the corresponding face on the mounting surface of the engine are clean and free from burrs or scratches.

Move the body of the magneto through the range provided in the elongated slots on the mounting flange until the timing marks "A" on the large distributor gear are exactly opposite the corresponding marks "B" on the inside of the front end plate. The above relation will place the high tension segment of the distributor cylinder opposite the electrode of the distributor block firing No. 1 cylinder. However, the contact points will not be opening as the automatic rotor is on the retard side. When the above timing is obtained, tighten and lock the mounting flange hold-down bolts.

It should be noted above that it is recommended to time VMN7DFA magnetos to the engine at the full advance position. The full advance position is preferable as any variations in the advance curve will occur on the retard side and not on the advance side, thus maintaining the original full advance firing setting specified by the engine manufacturer.

Repeat the same procedure for the left hand magneto and synchronize.

### **B. CARBURETOR**

The carburetor should not require much attention. Before any maintenance is done the carburetor should be removed as a complete unit.

The halves of the carburetor may be separated by the removal of the fillister head screws at the parting surface. The mixture control needle and the pump sleeve are held in the upper half or throttle valve body, and will be drawn out of the lower half as the upper half is lifted off. The venturi is held in the lower half by a hexagon head screw. Remove the float fulcrum screw and the float and needle valve. Also remove the plugs in the air intake flange under the main and economizer jets.

If there is any indication of dirt or foreign matter in the float chamber it is advisable to remove the main discharge jet so that it may be thoroughly cleaned. Remove the pump valve and piston and also the fuel strainer. The removal of the above parts will permit a thorough inspection and cleaning of the carburetor and unless replacements are necessary, further disassembly is not recommended.

### **C. AIR CLEANER**

An oil bath is located at the bottom of the cleaner and all air to the carburetor is drawn in through this bath, and through the oil-washed filter and prefilter. All that is needed to clean it, is to remove the cup at the bottom and take out the vortex chamber. The cup can then be emptied of oil and the accumulated sediment.

Replace the vortex chamber and fill the cup to the level indicated on the disc with a light grade of oil.

It should not be necessary to wash out the filter, but the prefilter should be inspected periodically and all chaff of fibres cleaned off.

### **D. REMOVE TRANSMISSION, CONTROLLED DIFFERENTIAL AND FINAL DRIVE**

Drain oil from differential and final drive units, and disconnect wires at siren and headlights; remove siren and headlights.

Now remove front fenders and front plate.

Disassemble both tracks, and remove tunnel cover.

Undo the universal joint at front end of drive shaft, disconnect inlet and outlet lines to oil cooler at transmission, and all oil lines.

Remove right and left brackets holding transmission to tunnel, and gear shift lever and cap on out put shaft from transmission.

Now disconnect

(a) speedometer cable and speedometer.

(b) springs, brake linkage, accelerator and clutch control rod.

Remove

(a) clutch shaft bearing bracket from hull floor.

(b) four bolts holding instrument panel to transmission.

- (c) final drive sprockets.
- (d) final drive shafts.
- (e) bolts holding controlled differential to hull side.
- (f) cap screws in front end of controlled differential.
- (g) filling and drain plugs.

Lift out the transmission and controlled differential from the vehicle by means of a hoist and sling with two loops placed under the controlled differential and one under the transmission.

## CHAPTER IX GUN MOUNTS

### PLATE Z

A. The two sponson mounts are mounted, one in the front end of each sponson and assemble the .30 Browning machine gun M1919A4. The mounts consist of a frame, which supports the machine gun, and a slow motion elevating mechanism, connected between the frame and the bottom plate of the sponson. The guns are fired by a solenoid firing mechanism controlled by trigger switches assembled to the steering levers.

B. The turret mount is a co-axial mount M22 for the 37 mm. gun and .30 Browning machine gun M1919A4. The mount has both elevating and traversing mechanism and is equipped with a telescopic sight. Two separate firing mechanisms are provided, one for the 37 mm. gun and the other for the .30 machine gun.

The mount is assembled to the turret as follows: Yoke D37188 is assembled to the turret by trunnions A187161 which form the pivot for the movement of the gun in traverse. Trunnions C72973 and C73022 are assembled to the recoil cylinder with the trunnion portion secured to the yoke D37188 by caps A173973. These trunnions form the pivot for the movement of the gun in elevation. No recoil cylinder protector is required with this mount.

The worm gear elevating mechanism is assembled to the lower end of yoke D37188 and engages the gear sector C72996, secured to the recoil cylinder. The traversing mechanism is connected by a bolt A173675 to yoke D37188 and engages a rack which is secured to the side of the turret by bracket C73067.

The machine gun is secured to brackets on the right hand side of the mount, by two bolts. The telescopic sight is assembled on the left hand side of the mount with the ball portion of the sight assembled in bracket B160017, and the rear end held in the sight adjuster D37248.

NOTE: (1) The turret mount for the M3A1 Light Tank is similar to the M22 mount in the M3 Light Tank and is known as the M23 mount. The chief difference is that there is no means of traverse in the mount itself.

- (2) Either the 37 mm. M5 or M6 gun may be fitted.



- (f) Poor fuel.
- (g) Defective ignition wiring.
- (h) Carburetor leakage.
- (i) Engine overheating.

(3) *High Oil Consumption* may be due to:

(a) Insufficient oil cooling. The cooling should be checked to ascertain that the cylinders are receiving sufficient cooling.

(b) Insufficient oil supply.

(c) Low grade oil.

(d) Dirty oil.

(e) Worn piston rings, or incorrectly installed piston rings.

(f) Scavenging oil pump failure or leak in oil lines. The pump may need priming.

(4) *Loss of Oil Pressure* may be due to:

(a) Lack of oil. There must be at least four gallons of oil in the oil tank.

(b) Dirt in the oil strainer.

(c) The improper setting of the pressure relief valve, or weak valve spring in the oil pump.

(d) Dirt on the oil pressure relief valve (which is most unlikely).

(e) A bearing having run, or worn badly.

(f) High oil temperature which will have reduced the viscosity of the oil, which then passes the bearing more freely and tends to drop the oil pressure.

(g) Low outside temperature which may cause the oil to congeal in the suction line from the oil tank and then prevent it from reaching the pump.

(h) It should be remembered that the pressure will vary with the varying engine speed and oil temperature, and due allowance should be made for the pressure drop to be expected with increased temperature.

(5) *To Adjust the Pressure Relief Valve*

The valve should only be removed and adjusted if the oil pressure gauge shows less than 65 pounds at 1,000 r.p.m. of the engine with all oil line fittings and connections tight and with the proper oil supply. Permission to do this must first be obtained from the Battalion Technical Adjutant, and the work must be done by a fitter.

Start up the engine and, with the engine running at 1,000 r.p.m., turn the adjusting screw in the oil pump, which is located to the rear of the engine. This raises or lowers the tension in the spring; and will alter the pressure accordingly.

APPENDIX A

LIST OF TOOLS AND EQUIPMENT FOR M3 LIGHT TANK

<i>Part Number</i>	<i>Designation</i>	<i>Quantity per Tank</i>
B150925	Axes, c/w handle	1
B150201	Batteries, 12 volt	1
B154723	Belts, safety	2
C72717	Brackets, fire extinguisher	1
B108777	Cables, towing	1
WA219	Cases, Map	1
WA220	Cookers, Petrol	1
C74887	Covers, Headlamp (Sunglare)	2
D47448	Cranks, Starting	1
	Crowbars, 40-in. w/Chisel and Claw Ends	1
	Cushions:	
C64412	Bow Gunner	1
C69226	Gunner 37mm	1
C64412	Driver	1
C64425	Loader	1
D37127	Extinguishers, fire	1
	Goggles (prs.)	4
C73265	Grousers	32
	Guards, head lamp	2
	Gunsights: Telescopic Sight—37mm Gun—M5A1	1
TFHX1A	Handles, mattock pick	1
C76072	Helmets, tank	4
WA225	Kits, first aid	1
	Lamps:	
C62696	Head	2
	Bulb	2
C84919	Blackout	2
A213667A	Bulb	2
A136737	Tail and Stop	2
	Bulb No. 64	2
	Bulb No. 1141	2
C69204	Levers, door	1
B101907	Mattocks, pick	1
SLAXIA	Padlocks, c/w 2 keys—1-1/2-in.	1
	Protectoscopes (complete)	2
A173332	Mirrors, bottom (spare)	2
A173333	Mirrors, top (spare)	6

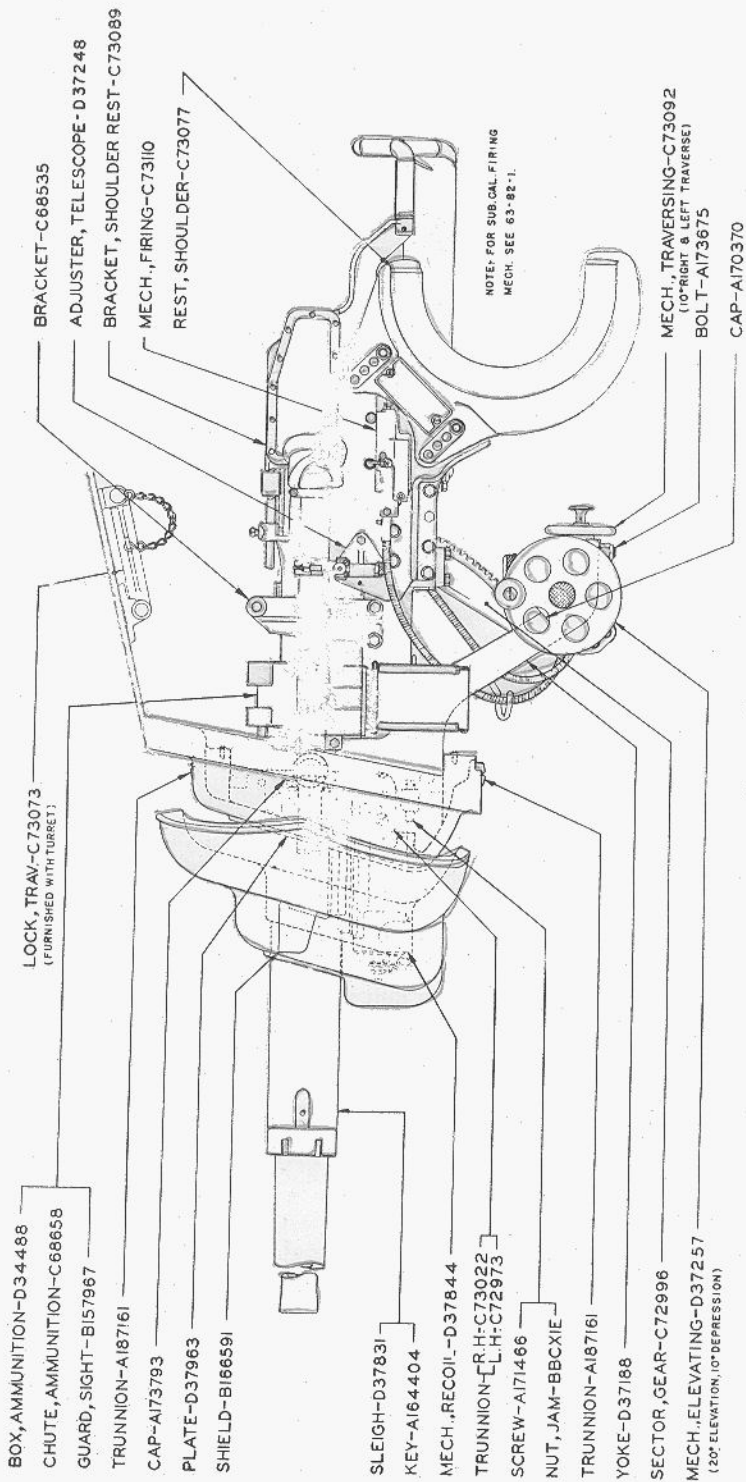


PLATE Z  
 M22 GUN MOUNT FOR M3 LIGHT TANK

APPENDIX A

LIST OF TOOLS AND EQUIPMENT FOR M3 LIGHT TANK

<i>Part Number</i>	<i>Designation</i>	<i>Quantity per Tank</i>
B150925	Axes, c/w handle	1
B150201	Batteries, 12 volt	1
B154723	Belts, safety	2
C72717	Brackets, fire extinguisher	1
B108777	Cables, towing	1
WA219	Cases, Map	1
WA220	Cookers, Petrol	1
C74887	Covers, Headlamp (Sunglare)	2
D47448	Cranks, Starting	1
	Crowbars, 40-in. w/Chisel and Claw Ends	1
	Cushions:	
C64412	Bow Gunner	1
C69226	Gunner 37mm	1
C64412	Driver	1
C64425	Loader	1
D37127	Extinguishers, fire	1
	Goggles (prs.)	4
C73265	Grousers	32
	Guards, head lamp	2
	Gunsights: Telescopic Sight—37mm Gun—M5A1	1
TFHX1A	Handles, mattock pick	1
C76072	Helmets, tank	4
WA225	Kits, first aid	1
	Lamps:	
C62696	Head	2
	Bulb	2
C84919	Blackout	2
A213667A	Bulb	2
A136737	Tail and Stop	2
	Bulb No. 64	2
	Bulb No. 1141	2
C69204	Levers, door	1
B101907	Mattocks, pick	1
SLAXIA	Padlocks, c/w 2 keys—1-1/2-in.	1
	Protectoscopes (complete)	2
A173332	Mirrors, bottom (spare)	2
A173333	Mirrors, top (spare)	6

<i>Part Number</i>	<i>Designation</i>	<i>Quantity per Tank</i>
A173330	Windows, auxiliary—peep hole (spare)	4
A173331	Windows, bottom (spare)	2
A169699	Windows, top (spare)	6
B150926	Shovels	1
C60972	Sirens	1
	Straps:	
QBDX2DA	Type "D", 1-1/4 W x 10-in. long	3
QBDX2DB	Type "D", 1-1/4 W x 13-in. long	4
QBDX2DE	Type "D", 1-1/4 W x 25-in. long	2
QBDX2DG	Type "D", 1-1/4 W x 40-in. long	2
O8456Z	Tanks, water, 5 gal.	3
D37589	Tarpaulins, 12-ft. x 12-ft.	1
	Torches, hand (flashlite)	1
	Tool Kits:	
B169931	Cans, oil, trigger type, 1 pt.	1
B169987	Guns, lubricating, lever type, high pressure (1 lb. cap with heavy duty 15-in. hose, button head type—CLCX1A)	1
TAAXID	Hammers, ball peon, 2 lb.	1
THCXIA	Pliers, combination, slip joint, 8-in.	1
D5103	Rolls, tool, M-4	1
TGBXIA	Screwdrivers, machinist's	1
TGAX2B	Screwdrivers, special purpose, 1-3/4-in. blade	1
C74747	Windshields, left	1
C74748	Windshields, right	1
	Wrenches:	
TKAX3A	Adjustable, single end, 8-in.	1
TKKX2B	Double Ended, 1/2 x 9/16-in.	1
TKKX2F	Double Ended, 5/8 x 3/4-in.	1
TKKX3A	Double Ended, 3/4 x 13/16-in.	1
TKKX4C	Double Ended, 15/16 x 1-in.	1
B144496	Grouser	1
	Set comprising:	1
A189962	Bar, cross (1)	
B169933	Handle, hinged, 15-in. 1/2-in. sq. (1)	
TKEX3D	Socket, wrench, 1/2-in. sq. drive, dbl. hex, 9/16-in. (1)	
TKEX3H	Socket, wrench, 1/2-in. sq. drive, dbl. hex, 3/4-in. (1)	
TKEX3N	Socket, wrench, 1/2-in. sq. drive, dbl. hex, 15/16-in. (1)	
	Socket, double hex, 19/32-in.	1

<i>Part Number</i>	<i>Designation</i>	<i>Quantity per Tank</i>
	Socket, double hex, 5/8-in.	1
	Socket, double hex, 3/4-in.	1
	Socket, double hex, 25/32-in.	1
	Socket, double hex, 7/8-in.	1
	Socket, double hex, 15/16-in.	1
	Socket, draglink, 1/2-in. sq. drive	1
A166884	Spark Plug, complete comprising: Extension (1)	1
	Ratchet, reversible, 1/2-in. sq. drive, 20-in. (1)	
	Socket, single hex, 11/16-in. (snap-on Y2) (1)	
	Socket, single hex, 1-in. (snap-on Y4) (1)	

#### PUBLICATIONS

##### Handbooks:

Running and maintenance  
 Tank Spare Parts  
 Continental Engine Spare Parts  
 Log, driver's, A. B. 413  
 Lubrication Guide

APPENDIX B

LIST OF ARMAMENT AND ACCESSORIES FOR  
M3 LIGHT TANK

NOTE:—(1) U. S. designations and Part Numbers are used throughout (words in brackets are explanatory only).

(2) In all cases American (S. A. E.) Threads are used.

\*First dimension = diameter of thread.

Third dimension = type of fit.

Second dimension = threads per inch.

Fourth dimension = length of screw.

37-mm., TANK GUN, M5

<i>Piece Mark</i> or <i>Stock No.</i> ( <i>Part No.</i> )	<i>List of Parts (Designation)</i>	<i>Quantity</i> <i>per</i> <i>Tank</i>
	Q.F. 37-mm. Tank Guns, M5 on Mounts M22	1
	Comprising:—	
D37847 } or D50088 }	Q.F. 37-mm., Guns M5, complete (1) Mounts, M22, complete (1)	
	SIGHTING EQUIPMENT*	
	Periscopes, M1	
	or	
91-85	Telescopes, M5 A1	1
	ACCESSORIES	
D50082	Bags, empty cartridge, 37-mm.	1
B157305	Brushes, bore, M8	1
B101420	Cans, 1/4 gallon	1
D38617	Covers, muzzle	1
B156647	Guns, oil with cap and hose	1
TAAX1B	Hammers, machs., ball-peen, 8 ozs.	1
THCX1A	Pliers, combination, slip joint 8-in. (prs.)	1
TCFX1A	Punches, drive pin, 3/32-in. point	1
D5274	Rolls, tool, M6	1
	Sights, bore complete	1
	Comprising:—	
A170991	Sight, bore breech (1)	
A130627	Sight, bore muzzle (1)	
TGAX1A	Screwdrivers, regular, 3-ins.	1
B154621	Staffs, cleaning, M5 A2	1
B167254	Targets, testing sights (Set of 6 in envelope)	6
BCTX1G	Wrenches, socket head, set screw, 3/32-in. hexagon	1
BCTX1H	Wrenches, socket head, set screw, 1/8-in. hexagon	1

\*NOTE:—If MOUNT, M22, D37847 is fitted TELESCOPE, M5A1 is used.

If MOUNT, M22, D50088 is fitted, PERISCOPE, M1 is used.



<i>Piece Mark or Stock No. (Part No.)</i>	<i>List of Parts (Designation)</i>	<i>Quantity per Tank</i>
BCTX1L	Wrenches, Socket head, set screw, 3/16-in. hexagon	1
TKKX1E	Wrenches, engineers, double headed, 3/8-in. x 1/2-in.	1
TKAX3A	Wrenches, adjustable, 8-in.	1

SPARES

A25201	Pins, firing	1
A25204	Springs, firing	1

PUBLICATIONS

Check Chart	Lubrication Charts	1
OF5B-6-A-45	Lubrication Instructions	1
FM23-80	Field Manuals (Unit Instructional Handbook)	1

GUNS, M/C, CAL: .30, BROWNING, M1919 A4

<i>Drawing No.</i>	<i>Designation</i>	<i>Quantity per Tank</i>
51-83	Guns, M/C, Cal. .30 Browning, M1919 A4—Fixed	
51-84	and Flexible	4

ACCESSORIES

D38703	Bags, empty cartridge, bow guns	1
D37854	Bags, empty cartridge, sponson guns	2
D47447	Bags, empty cartridge for turret mtgs. D47373	1
C64943	Belts, ammunition M3 (100 rnds.)	80
B108828	Brushes, chamber cleaning M6	1
C4035	Brushes, cleaning cal. .30 M2	2
B147310	Cans, tubular	1
C6573	Cases, cleaning rod cal. .30 M1	1
C59656	Cases, spare bolt M2	1
D35395	Chests, packing Browning belt filling m/c	1
D38631	Covers, muzzle, cal. .30 M.G.	1
D38629	Covers, muzzle, left sponson	1
D38627	Covers, muzzle, right sponson	1
D31496	Covers, receiver M10	3
D30653	Covers, tripod mount M2	2
C3854	Extractors, ruptured cartridge Mk. IV	1
C84823	Grips, firing	1
D1262	Machines, belt filling Browning Cal. .30 M1918	1
C7327	Machine Gun Tripod Mounts cal. .30 M2	2
C59737	Oilers, oval 3 oz. w/cap & chain	1

<i>Drawing No.</i>	<i>Designation</i>	<i>Quantity per Tank</i>
TCFX2K	Punches, drive pin .18 pt.	1
TCFX2F	Punches, drive pin .08 x 3/4 pt.	1
TCFX2H	Punches, drive pin .12 pt.	1
THBX1A	Pliers, sidecutting parallel jaw 6-in.	1
D8237	Rods, cleaning jointed cal. .30 M1	1
D7389	Rolls, tool M12	1
C68338	Screwdrivers, combination M1	1
B47352	Trays, ammunition assem. B183096 (250 rnds.)	
C84825	Trays, ammunition assem. (100 rnds.)	
C68334	Wrenches, combination M6	1
B147277	Wrenches, socket front barrel bearing plug	1
SPARES		
Guns, M/C, Cal. .30 Browning, M1919 A4—		
Fixed and Flexible		
B147299	Bolts, assembly	1
C64135	Extractors, assembly	2
B131317	Levers, cocking	1
B17503	Levers, feed belt	1
A20567	Pins, cocking lever	1
C9186	Pins, firing assembly	2
Guns, Machine, Cal. .30 Browning, M1919 A4—		
Fixed and Flexible		
B147222	Rods, driving spring assembly	1
C64137	Sears	1
A135057	Springs, barrel plunger	1
B147224	Springs, belt feed pawl .032 wire	1
B147225	Springs, belt holding pawl	1
B17513	Springs, cover extractor	1
B147227	Springs, driving .047 wire	1
B147230	Springs, locking barrel .208 pt.	1
B131265	Springs, sear assembly	2
B147231	Springs, trigger pin	1
PUBLICATIONS		
FM23-50	Field Manuals	1

CARBINES, SUB-MACHINE, THOMPSON

<i>Piece Mark or Stock No. (Part No.)</i>	<i>Drawing No.</i>	<i>List of Parts (Designation)</i>	<i>Quantity per Tank</i>
	B108828	Brushes, chamber cleaning M6 (Brush, cleaning breech)	1
	C4036	Brushes, cleaning, Cal. .45, M5	2
51-63		Carbines, sub-machine, Thompson, Cal. .45, M1928A1, w/com- pensator, w/o magazine	1
	AOC15-18-98	Cases, accessory and spare parts, M1918 (empty)	1
	AOC-132	Cases, 50 round, mag. w/shoulder strap	1 (a)
	AOC15-18-102	Envelopes, fabric, one button, 3-in. x 3-1/8-in. (empty)	1
		Magazines, 20 rounds assem. (box type)	5
		Magazines, 50 rounds assem. (drum type)	10 (a)
	AOC-81	Oilers, sub-machine gun (cans, oil)	1
	C64183	Rods, cleaning, sub-machine gun	1
	C7791	Slings, gun M1923 (Slings, rifle web)	1
	C64175	Thongs (Pull throughs)	2
SPARES			
		Carbines, sub-machine, Thompson, cal. .45, M1928A1	
6 D	AOC45-1-6	Disconnectors, (lever, trigger)	1
4 B	AOC45-1-4	Ejectors	1
15 A	AOC45-1-17	Extractors	1
14 A	AOC45-1-16	Pins, firing	1
16 D	AOC45-1-18	Rockers, (lever trip)	1
9 A	AOC45-1-9	Springs, disconnecter, (Spring, lever trigger)	1
14 C	AOC45-1-16	Springs, firing pin	1
9 D	AOC45-1-9	Springs, magazine catch, (Spring, catch, magazine)	1
17 C	AOC45-1-21	Springs, recoil (Spring, return)	1
9 B	AOC45-1-9	Springs, sear	1
PUBLICATIONS			
FM23-40		Field Manuals	1 (b)
A-32		Standard Nomenclature Lists	(c)

(a) Issued for tank use only.

(b) 1 per 2 equipments (for use in tanks).

(c) 1 per 50 equipments.













