UNCLASSIFIED

TM 9-1750D

WAR DEPARTMENT

TECHNICAL MANUAL

ORDNANCE MAINTENANCE

ACCESSORIES FOR WRIGHT R975—EC2 ENGINES FOR MEDIUM TANKS M3 AND M4

AUGUST 12, 1942

RESTRICTED

TECHNICAL MANUAL
No. 9-1750D

WAR DEPARTMENT
Washington, August 12, 1942

ORDNANCE MAINTENANCE

ACCESSORIES FOR WRIGHT R975-EC2 ENGINES FOR MEDIUM TANKS M3 AND M4

Prepared under the direction of the Chief of Ordnance

CONTENTS

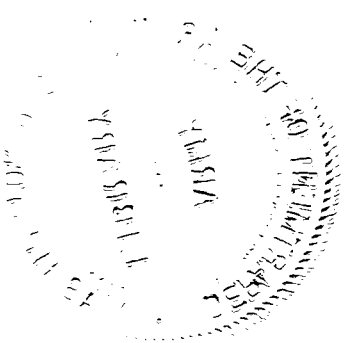
ORDNANCE MAINTENANCE—ACCESSORIES FOR WRIGHT R975-EC2 ENGINES FOR MEDIUM TANKS M3 AND M4

Chapter 1

INTRODUCTION

1. SCOPE.

This manual is published for the information and guidance of ordnance maintenance personnel. It contains detailed instructions for disassembly, inspection, maintenance, repair, and assembly of the accessories for the Wright Whirlwind R-975-EC2 Tank Engine, supplementary to those in TM 9-750 and in Field Manuals prepared for the using arm. Additional descriptive matter and illustrations are included to aid in providing a complete working knowledge of the materiel. All the components in the fuel system, governor, governor valve, ignition system, engine electrical system, and engine lubricating system are discussed in this manual.



Chapter 2

ENGINE TROUBLE SHOOTING

2. GENERAL.

This section is devoted to a discussion of the most common engine troubles and their causes. Its purpose is to minimize, in so far as possible, the time wasted in ascertaining the source of a given trouble. Difficulty in determining the exact cause of an engine trouble may be encountered at times, due to the number of sources to which a given symptom can be attributed. The best method of trouble shooting is to isolate the troubles as general troubles, local troubles, and unit troubles. A general trouble is one affecting all cylinders alike. This will limit the probable cause to some accessory which affects all cylinders. A local trouble affects only one cylinder or a few cylinders; that is, if the cylinder is missing, the trouble is to be determined in the ignition system, spark plugs, and spark plug leads, and not in the magneto. It is assumed that if the magneto will fire eight cylinders, it will fire the ninth. A unit trouble affects a mechanism which is not a part of the basic engine, such as generator, control box, booster coil, etc.

3. FAILURE OF AN ENGINE TO START.

If the engine fails to start, determine whether the fault is with the fuel system or ignition system. The delivery of a priming charge to the engine is ascertained by the resistance felt to the pressure stroke of the priming pump. If the engine is receiving a priming charge, notice whether there is any firing at all or whether the engine is completely dead. If there is slight firing, as evidenced by coughing or sputtering, the ignition system is operative and the fuel system is unable to supply the fuel requirements after the priming charge has been consumed. If there is no evidence of firing at all, investigate the ignition system first.

a. Fuel System Troubles.

(1) LACK OF FUEL. Examine the fuel supply, the shut-off cocks,

the traps, and the line condition. Check the sump fuel strainer and the carburetor fuel strainer for clogged condition.

(2) THROTTLE OPENING INCORRECT. Keep the throttle almost closed or about one-tenth open until the engine starts to fire.

(3) RAW FUEL IN AIR SCOOP. Remove the air scoop from the bottom of the carburetor. If this is found to be partially filled with gasoline, remove the carburetor to check for sticking of the float needle valve. Besides checking the needle valve, check to insure that the needle valve seat has not been tampered with so as to leave a gap between the lower end of the seat and the seating gasket. If adjustment of the float level is necessary, insert gaskets until proper adjustment is obtained. These gaskets may be obtained in various thicknesses from $\frac{1}{64}$-inch to $\frac{1}{16}$-inch. NOTE: In many installations, the air scoop is provided with a ⅛-inch drain cock in the bottom so that removal of the air scoop will not be necessary.

(4) WATER IN CARBURETOR. Remove the float chamber drain plug and the strainer, and drain off.

(5) UNDERPRIMING AND OVERPRIMING.

(a) Underpriming. If the engine is underprimed, check the functioning of the primer pump and further load the engine by turning it over with the starter, with the ignition off and the throttle closed. Attempt to start the engine again.

(b) Overpriming. If the engine is overprimed, shut off the fuel at the tanks and turn the engine over by the starter with the ignition switch off and throttle open wide to remove the extra fuel produced by overpriming.

b. Ignition System Troubles.

(1) DEFECTIVE BOOSTER COIL. To check the operation of the booster coil, station one man in the engine compartment while another operates the booster coil switch. A buzzing sound will be heard by the man in the engine compartment if the booster coil is operating. If it is not operating, attempt to adjust the booster coil to draw 1¼ to 1½ amperes. In the absence of an ammeter, adjust the booster coil to sustain a spark ⅜-inch long. Test by removing the booster wire from the magneto and holding it ⅜ inch from the engine while operating the booster coil. If a spark fails to jump the gap, the booster and/or booster wire is defective and should be replaced.

(2) FAULTY MAGNETO.

(a) See that the magneto breaker points are clean and free from excessive oil. Remove a spark plug terminal and hold it ¼ inch from a ground while rotating the engine. If a spark is emitted, the magneto

is operative and the trouble is in the spark plug. If there is no spark at the terminal, remove the terminal blocks at the magneto and hold a ground about ⅛ inch from the distributor segments while rotating the engine. If there is a spark, the magneto is functioning and the defect is in the ignition harness.

(b) To prevent faulty operation of the magnetos during conditions of high humidity, treat the dielectric parts against moisture absorption. Pay particular attention to the distributor block, distributor cylinder, booster and coil terminal blocks, booster collector ring, condenser, and coil. If the dielectric parts have previously been treated with lacquer and if the lacquer is in good condition, merely wipe the parts carefully with a clean cloth. When the lacquer is flaked or in otherwise poor condition, magnetos should be removed and overhauled. For dielectric parts that have been treated with oil, wipe the parts with a clean cloth, and then rub them for a few minutes with a cloth moistened with OIL, engine, SAE 30.

(3) SPARK PLUGS. Remove and inspect the spark plugs. Clean and set the gap to 0.012 inch if necessary. After cleaning and setting the gaps, test the spark plugs under a pressure of 120 pounds per square inch to see that they fire correctly. Spark plugs covered (1) with wet oil, indicate the cylinder is not firing; (2) with carbon, indicate the cylinder has been firing but not correctly; (3) with white powder, indicate that they have been operating too hot. Inspect core for tightness, and inspect the ignition wire and terminals for failure.

(4) DEFECTIVE IGNITION WIRING. Test all ignition wires by placing them in a circuit with a lamp and source of power. The lamp will light if the ignition wire is serviceable.

c. Mechanical Troubles.

(1) LOW COMPRESSION. Check the compression of each cylinder by removing all the rear spark plugs and noting the compression of each cylinder as the engine is rotated. The compression pressure reading should be 105-110 pounds per square inch. If a cylinder is found to have no compression, check the valve clearance. Remove all cylinders having more than ten pounds per square inch variation and check the following:

(a) Broken, worn, or weak piston rings.

(b) Broken or weak valve springs.

(c) Gummed, sticking, broken, or burnt valves.

(d) Excessive cylinder wear.

(e) Leaking, or improperly seated spark plugs.

(f) Cracks in the cylinder head, barrel, or piston.

(g) Warped, pitted, or burnt valve seat inserts.

(2) INCORRECT TIMING.

(a) Check the valve timing to see that it is within its limits. If the valve timing cannot be adjusted to within its limits, check the following:

1 Valve clearance for correct setting, which is 0.010 inch.

2 Push rods for correct length and excessive wear.

(b) See that the ignition timing is correct. If not, check the following:

1 Breaker point gap, which should be 0.012 inch.

2 To see that the points are breaking at 1½ degrees after top dead center.

(3) MECHANICAL FAILURE. Mechanical failures are caused by high temperatures or defective parts.

(a) High temperatures are caused by friction, which also causes wear. Friction can be minimized by lubricating the parts, therefore some mechanical failures can be traced to poor lubrication.

(b) Failures due to defective parts can be partially eliminated by an effective inspection at the time of assembly.

(c) If mechanical failures are suspected, make a more comprehensive check after removing the engine from the vehicle.

4. ENGINE STARTS BUT STOPS.

If the engine starts but stops with sputtering and backfiring, the trouble is in the fuel system. Check the fuel system as outlined in paragraph 3 **a**. If, when testing the operation of the engine on each magneto separately, the engine stops abruptly, as is ordinarily the case when there is a defective magneto, then the fault is in the ignition system. Check the ignition system (par. 3 **b**).

5. LOW POWER AND UNEVEN RUNNING.

Low power and uneven running may be attributed to any of the following causes:

a. Incorrect Governor Setting. If the engine appears to operate satisfactorily but cannot attain full power output, check to see that the governor setting is correct. This check can be made by observing the movement of the butterfly valve control arm on the governor throttle box. The butterfly valve should not close until the engine speed reaches 2375 revolutions per minute. Any change in the governor setting should be made under the guidance of an authorized inspector.

b. Rich or Lean Mixture. Too rich a mixture is shown by uneven running and continuous black smoke from the exhaust. Too lean a mixture is shown by uneven running, overheating, backfiring, and detonation. Detonation will cause black smoke to come from the exhaust in intermittent bursts. When rich or lean mixture is evidenced, check the fuel pressure at the carburetor float bowl. The fuel pressure regulator may be at

fault through mechanical defects or misadjustments. The fuel supply pressure should be between 3 and 4 pounds per square inch. A pressure above this will raise the gasoline level in the float bowl, causing a rich mixture, while a pressure below that specified will cause a low fuel level and result in a lean mixture.

c. Fuel Line Restrictions. A restriction in the fuel line, such as a partially clogged strainer, kinked fuel lines, or dirty fuel passage, may result in the engine operating normally up to half or even three-quarter load, but when fully loaded it will miss, cut-out, and backfire (a symptom that can be mistaken for ignition trouble) due to the lack of sufficient fuel when maximum power is demanded.

d. Leaks in Induction System. Examine the intake pipes for cracks and for leaks at the cylinder and crankcase connections. Examine the carburetor and intake manifold flanges for tightness. Examine the cast elbow between the carburetor and rear section for cracks which may develop from vibration and rough usage. A crack in this section would result in an extremely lean mixture.

e. Spark Plugs. To locate a faulty spark plug, determine first whether it is in the front or rear set. Do this by running the engine first on the left magneto, then on the right magneto. An abnormal drop in engine speed while running on one magneto would indicate in which set the faulty plug is located, since that cylinder would stop firing completely. If operation of the engine on eight cylinders is continued the exhaust stack of the missing cylinder will soon cool below the temperature of those in operation and can be located by placing a few drops of water on the exhaust stack and observing the rapidity with which it evaporates. CAUTION: Do not attempt to test the temperature of the exhaust stacks with bare hands as a severe burn will result.

f. Valve and Valve Gear Trouble. Check the valve tappet clearance, springs, washers, rocker arms, and push rods. Make sure the valves are not sticking. Valve clearances are 0.010 inch on all valves and must be checked and set when the engine is at room temperature. Take care to insure that the valve is completely closed and the valve tappet roller is completely off the cam ring lobe.

g. Poor Fuel. Use only the recommended grade of gasoline and see that it flows freely to the carburetor.

h. Magneto Breaker Points. See that the magneto breaker points are clean and check the operation of the magneto.

i. Ignition Wiring Deteriorated or Burned. Check the condition at the terminals. Drill a $\frac{3}{32}$-inch hole $\frac{1}{8}$ inch above the bottom of each blank end of the main ignition manifold to allow any moisture to escape that might collect therein.

j. Engine Overheating. This condition may be caused by any reasons indicated in paragraph 5 **a, c, d,** and **f** and it is easily recognized by the fact that the engine will run at normal speed just after idling and then the speed will slowly fall off. Continued running of an engine exhibiting this symptom is likely to cause considerable damage; investigate the cause immediately. Other causes of engine overheating include improper cowling, excessive air temperatures, thin oil, and insufficient oil cooling.

k. Carburetor Leakage. See paragraph 11.

6. ENGINE RUNS BUT WILL NOT STOP.

If this occurs, the trouble is in the system that controls the ignition of the fuel charge in the cylinders. Turn the magneto switch to the "off" position and if the engine continues to run smoothly, the switch did not ground either one or both magnetos. Close the automatic fuel cut-off valve and the engine will stop. Check the magneto switch and grounding to both magnetos. If the engine continues to fire irregularly after the magneto switch has been turned off, the firing is attributable to autoignition; follow the cooling off procedure.

7. LOSS OF OIL PRESSURE.

a. CAUTION: Stop the engine immediately and determine the cause of the pressure drop before restarting. Make sure the engine is not operated for any length of time without oil pressure.

b. Loss of oil pressure is usually an indication of one or more of the following conditions. Perform the inspections and follow the remedies outlined below:

(1) Inspect the oil tank for adequate supply.

(2) Inspect the oil inlet line to the pump for proper connections.

(3) Air leaks in a flexible oil line are difficult to find because of chafing or rupturing of the inner lining, which is not visible from the outside. Often these lines will allow air to enter when a suction is applied to the line but will hold when tested under pressure. The lack of oil around a connection is not always an indication that the connection is tight. A slight air leak may cause low oil pressure and often necessitate the priming of the oil pump after the engine has stood for awhile.

(4) Inspect oil pressure gage line for proper connections.

(5) Remove the oil pressure relief valve and check the following:

(a) Spring tension. The spring compressed to 1¼ inches in height should register 4.95 pounds on the scale. If the spring is not within limits and a new spring is not available, add shims behind it to increase the tension.

(b) Valve seat. Check the seat of the pressure relief valve to insure that no obstruction is interfering with its seating.

ENGINE TROUBLE SHOOTING

(c) *Free movement of valve in its housing.* It is not uncommon for faulty operation of the high pressure relief valve to express itself as subnormal pressure at low speeds and abnormal pressure at high speeds. This indicates that the valve is stuck in a halfway position, which results in insufficient restriction at low speeds and too much restriction at high speeds.

(6) Remove the section of the exhaust manifold directly beneath the sump oil strainer plug and remove the strainer. Since the strainer is at the entrance of the scavenger system, it would have no direct effect upon the oil pressure. If it is clogged, it will allow oil to collect in the sump, which will result in excessive smoking and a sluggish engine. Make close inspection of any foreign material found in the sump strainer to detect metal particles. These might indicate bearing wear which, in turn, will result in low oil pressure.

(7) Remove the Cuno filter and inspect for metal particles, which may come from worn bearings. Subnormal oil pressure is caused by worn bearings.

(8) If the oil strainer and Cuno filter are free of foreign material, prime the oil pump. To do so, break the line at the coupling joint between the short length of flexible tubing leading to the pump and the stationary oil line in the tank hull. Lift the end of the flexible tubing to the highest point possible, then pour oil into the line while turning the engine over with the starter until a quart or so has been sucked into the pump. See that there are at least four gallons of oil in the main tank.

(9) A leak in the oil dilution system may dilute the lubricating oil to such an extent that the pressure will fall. If the oil is exceptionally thin, check the oil dilution system.

(10) Foaming is a frequent cause of fluctuating oil pressure and loss of pressure. The presence of air in the scavenged oil is normal, but in order to eliminate excessive foaming, the return oil from the engine should be directed into the supply tank in such a manner as to produce a minimum of splashing, and to permit air in the return line to separate from the oil as readily as possible. Oil foaming may also result from the use of water-mixed cleaning solutions, most of which contain either soap compounds or caustic soda.

(11) EXCESSIVE BEARING CLEARANCE. A bearing may be worn enough to reduce the pressure. If this is the case, an overhaul is necessary.

(12) HIGH OIL TEMPERATURES. Excessive temperatures reduce the viscosity of the oil, which then passes the bearings more freely. Such a condition tends to decrease the oil pressure.

(13) Remember that the pressure will vary with the varying engine speed and make due allowance for this variation. During normal oper-

ation, the pressure should be between 60 and 80 pounds per square inch, but at idling speed the pressure may drop as low as 15 pounds per square inch.

8. EXCESSIVE OIL TEMPERATURE AND HIGH OIL CONSUMPTION.

This trouble may exist as a result of one of the following conditions:

a. Insufficient Oil Cooling.

(1) Check the oil cooler to see that it is not blocked by clothing or equipment in the crew compartment.

(2) Check to see if the oil bypass valve is stuck open and allows the oil to bypass the cooler.

b. Insufficient Oil Supply. The capacity of the oil reservoir is 9⅔ gallons which is necessary to lubricate and cool this engine.

c. Low Grade Oil. See that the oil used complies with the specifications.

d. Oil Scavenger Pump Failure. Failure of the scavenger pump will be indicated by the engine's becoming sluggish and by excessive smoke from the exhaust mufflers. Replace the pump and prime the new one before installing.

e. Over Diluted Oil. A high oil consumption will result if there is a leak in the oil dilution system or if the oil dilution valve has been operated for too long a period.

f. Dirty Oil.

g. Worn Piston Rings.

h. Piston Rings Incorrectly Installed.

i. The clogging or improper installation of the oil system and crankcase vent lines will result in oil reservoir pressure and crankcase pressure. This will cause abnormal oil consumption.

j. Insufficient oil cooling, in many cases, has been traced to an accumulation of sludge or other foreign material in the external oil system. Instructions pertaining to the cleaning of the external oil system are in paragraph 72.

k. Incorrect ignition timing results in higher oil temperatures.

l. Improper functioning of the oil seal at the impeller shaft allows oil to get into the diffuser section.

m. Worn Valve Guides.

n. Bearings. If the trouble is not found after an investigation of the foregoing, it may be necessary to dismantle the engine to determine

whether or not a bearing is overheating or whether any bearing clearance is excessive, causing oil scavenging difficulties.

9. COLD WEATHER DIFFICULTIES.

Unless certain precautions, such as operation of the oil dilution system, are taken, difficulties in cold weather operation of the engine may result.

a. Cold Oil. Unless the vehicle is parked in a warm place, drain the oil after stopping the engine. Before starting, fill the oil system with pre-heated oil.

b. Low Oil Temperature. If the oil does not attain a sufficient temperature to flow freely, lag the lines running to and from the external oil tank. A layer of asbestos cord wrapped with friction tape and then shellacked makes an excellent lagging. If asbestos is not available use several layers of ordinary packing cord. Partial covering of the oil cooler during severe cold weather operation is sometimes necessary in order to keep the oil temperature up to normal.

c. Inaccurate Pressure Readings. To obtain accurate oil pressure readings in cold weather, large size pressure gages and oil lines are essential.

10. CARBURETOR AIR CLEANER.

Although the carburetor air cleaner will handle very heavy concentrations of dust, it will not function properly if the oil in the oil reservoir is allowed to become too thick with dust to wash the filter element properly. Service the cleaner frequently. To service Vortox air cleaners, remove the cups from the cleaners and the flute assembly from the cups. Empty dirt and oil from the cup and refill with OIL, engine, SAE 50. Select an oil that will not evaporate, the quality is unimportant. Used crankcase oil may be used. Heavy or dirty oils will not effectively wash the dust from the filter element. Do not use heavy oils diluted with solvents, since the solvents evaporate very quickly. The filter elements, being self-washing, should require no attention if the oil in the cups is kept reasonably clean. However, inspect the filters occasionally and wash in SOLVENT, dry cleaning, if they appear to be clogging. An air cleaner can clean only the air passing through it. The air connections between the air cleaner and engine must be kept airtight. Small leaks no larger than a pin hole will allow a surprising amount of dust to pass through.

11. CARBURETOR LEAKAGE.

a. Because of the fire hazard, do not run the engine if the carburetor leaks gasoline. Leakage may be caused by:

(1) Leaky or stuck float.

(2) Excessive fuel supply pressure.

(3) Poor seating of the needle valve.

(4) Wear of the float fulcrum pin.

(5) Improper float level.

b. In any case remove and check the carburetor. If the float has been leaking, remove the gasoline, and solder the hole. Immerse the float in hot water to test for tightness. Check the float level.

Chapter 3

FUEL SYSTEM

Section I

GENERAL DESCRIPTION

12. GENERAL (fig. 1).

The fuel system consists of the following components: tanks, strainer, pump, pressure regulator, carburetor, air cleaners, fuel lines and primer. There are four fuel tanks, one in each sponson and one in each forward corner of the engine compartment, each controlled by a separate shut-off valve. There are also two main shut-off valves, with handles on the front of the bulkhead beneath the oil tank, each one controlling the flow of fuel from the two tanks on its particular side into the common block or header. The fuel flows from the tanks into the common block, thence through the fuel filter, the fuel pump and into the carburetor, where it mixes with air which has been cleaned by passing through the two air cleaners. Fuel not required by the carburetor flows past the carburetor, through the pressure regulator or relief valve and back into the common block. The air cleaners are located on the right and left inside walls of the engine compartment. The fuel primer, located on the instrument panel, draws fuel from the common block and delivers it to the intake manifold pipes of the top five cylinders.

13. TANKS.

The four tanks give a total fuel capacity of 175½ gallons, sponson tanks 60 gallons each and vertical tanks 27¾ gallons each. The shut-off valves for the two sponson tanks are controlled by handles projecting from the plate over the engine compartment and the valves for the vertical tanks are controlled by the handles at each forward corner of the grille over the engine compartment. The filling caps are beneath the four heavy-hinged covers on top of the tank, two at each side near the ends of the engine compartment grille. The drain plugs for the sponson tanks are located above the removable plates on the bottom of the sponsons near the rear ends. The drain plugs for the vertical tanks are located above the 1½-inch pipe plugs in the floor of the tank directly beneath the filling caps.

ORDNANCE MAINTENANCE—ACCESSORIES FOR WRIGHT R975-EC2 ENGINES FOR MEDIUM TANKS M3 AND M4

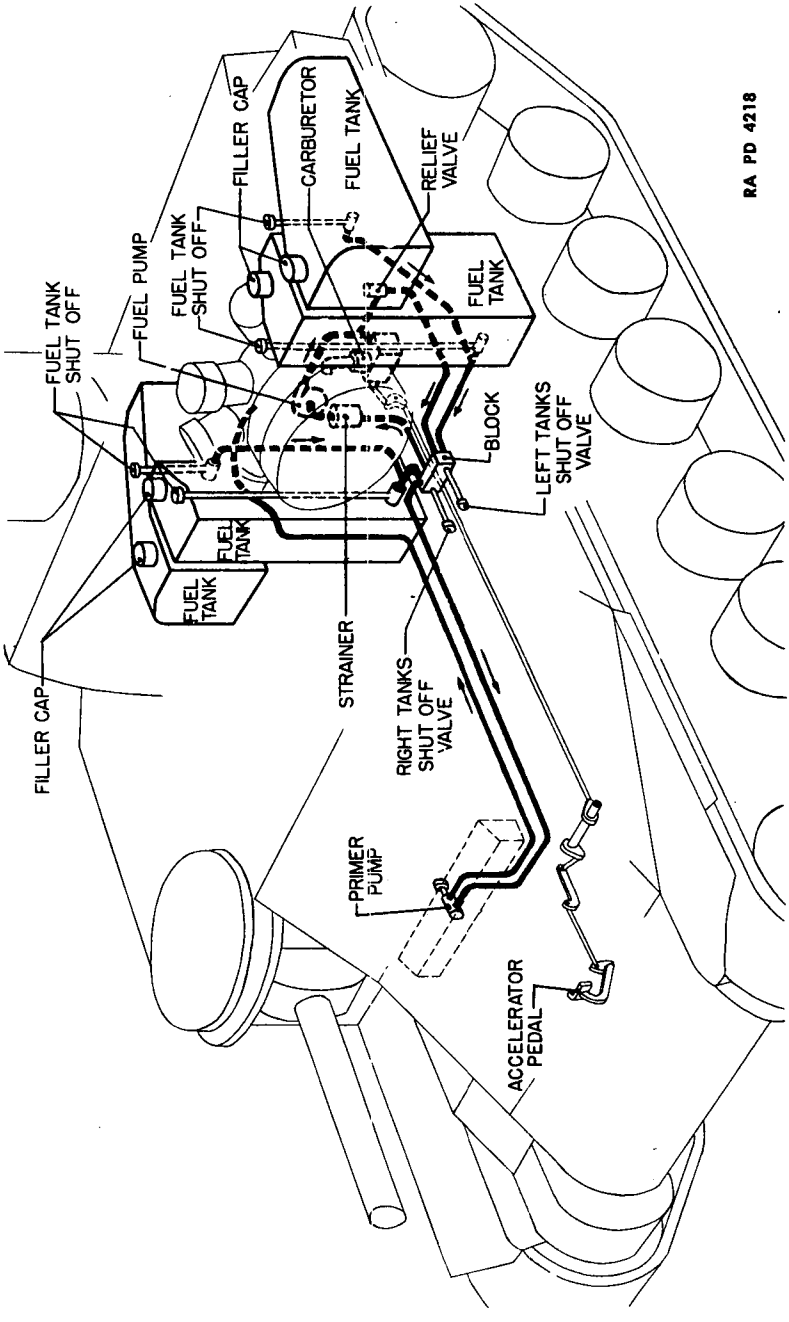


Figure 1—Fuel System

GENERAL DESCRIPTION

14. STRAINER.

The fuel strainer is of the sediment bowl type, and is attached to a bracket just inside the right rear door, close to the floor. If the strainer is to be cleaned or removed, close the four shut-off valves before starting the operation. Remove the screen for cleaning by unscrewing (wrench, ½-in.) the plug from the left side of the strainer, being careful not to loosen the gasket. Drain the bowl by opening the valve at the bottom. This is about the only maintenance. If it is necessary to remove the strainer, unscrew the two coupling nuts fastening the fuel lines to the front and rear of the strainer and remove the two screws fastening the strainer to the bracket. Install a new strainer by reversing the above procedure.

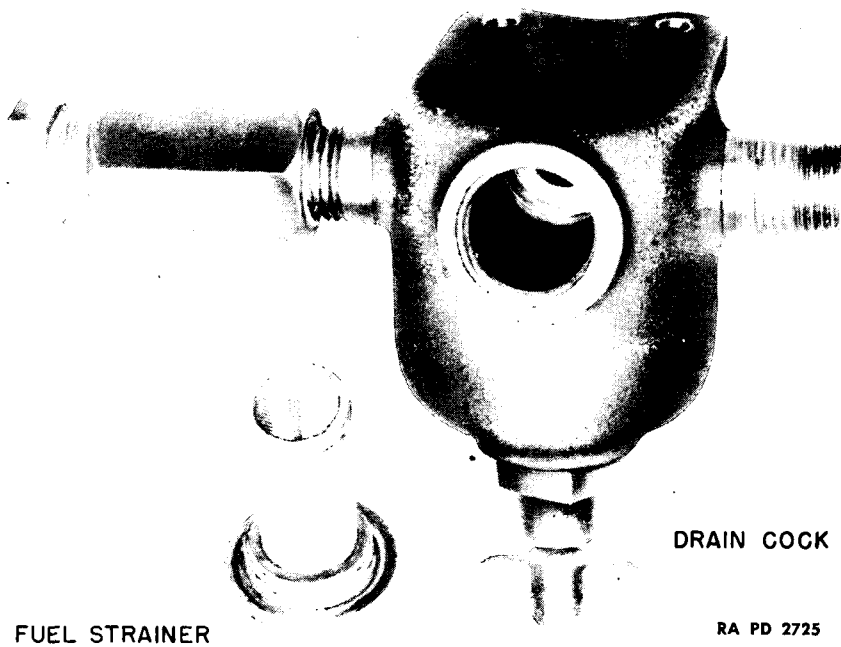


Figure 2—Fuel Strainer

15. PUMP.

The pump is of the positive displacement, rotary-vane type and is located on the engine accessory case to the right of the carburetor elbow.

16. PRESSURE REGULATOR.

The fuel pressure regulator is located just inside the right rear door above the strainer and is fastened to the hull by the same bracket. The regulator is adjustable, and maintains a constant pressure on the fuel

feed to the carburetor. It also serves as a relief valve and allows fuel that is pumped and not used by the carburetor to return to the block.

17. CARBURETOR.

The carburetor is a Stromberg model NA-R9D. It is of the single-barrel, up-draft type, and has an accelerating pump hinge-type float assembly, idle cut-off and needle-type economizer. It also incorporates a spring loaded needle valve for stopping the engine. This valve is operated by a solenoid connected to a toggle switch on the instrument panel. The valve diverts the suction of the intake manifold through the idle discharge nozzle from the idle tube to the space in the carburetor bowl above the fuel, and stops the fuel through the idle discharge nozzle.

18. AIR CLEANERS.

There are two air cleaners of the oil-bath type, one is located at the right- and the other at the left-rear of the engine compartment. Directions for maintenance and replacement are given in TM 9-750.

19. PRIMER.

The primer is used to inject fuel into the intake manifold to facilitate starting. Operation and maintenance are covered in TM 9–750.

Section II

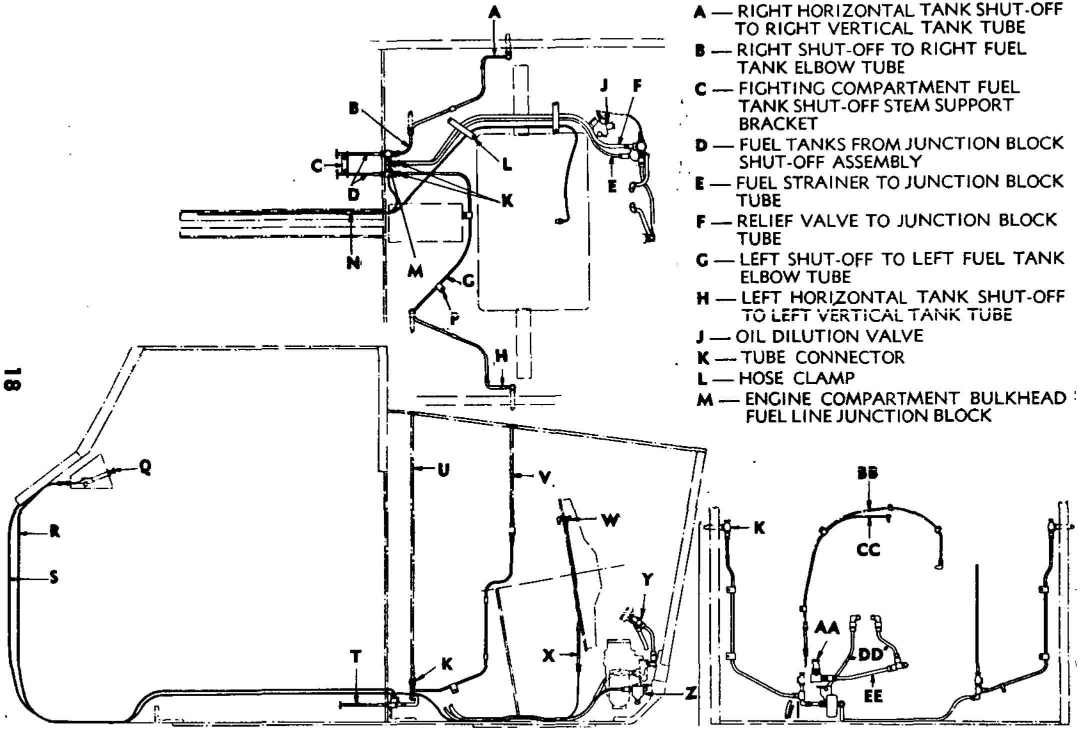
FUEL LINES AND TANKS

20. FUEL LINES (fig. 1).

a. General. Fuel lines connecting the various units of the fuel system are made up of copper and rust-proofed steel tubing with connector fittings of two types: compression and flared tube fittings and their connectors. A protector loom covers these lines. In places of excessive movement short lengths of fire-resistant hose with suitable connectors are used. The lines are attached to the hull and other units so that the effect of vibration is minimized and so that they are free of contact with sharp edges which might cause wear.

b. Inspection. Inspect the fuel lines and replace if leaks develop, or if they are dented to the extent of restricting the free flow of fuel. Keep fittings and connectors tight; if leaks appear at fittings check for marred or crossed threads, and replace when necessary.

c. Repair and Replacement. The method of making up new fuel lines for replacement is as follows: from the proper size roll of tubing cut off a length a little longer than the line to be replaced; if a protector loom is used, cut loom three inches shorter than the new piece of tubing. Blow out tubing, remove burs and square tube ends; then slide on protector loom and install fittings. When installing flared tube fitting nuts, use proper size flaring tool. In bending tube assembly use suitable bending tool and bend to conform with the line that has been removed. The flexible hose connectors are manufactured with fittings attached and should be replaced as an assembly.



A — RIGHT HORIZONTAL TANK SHUT-OFF TO RIGHT VERTICAL TANK TUBE
B — RIGHT SHUT-OFF TO RIGHT FUEL TANK ELBOW TUBE
C — FIGHTING COMPARTMENT FUEL TANK SHUT-OFF STEM SUPPORT BRACKET
D — FUEL TANKS FROM JUNCTION BLOCK SHUT-OFF ASSEMBLY
E — FUEL STRAINER TO JUNCTION BLOCK TUBE
F — RELIEF VALVE TO JUNCTION BLOCK TUBE
G — LEFT SHUT-OFF TO LEFT FUEL TANK ELBOW TUBE
H — LEFT HORIZONTAL TANK SHUT-OFF TO LEFT VERTICAL TANK TUBE
J — OIL DILUTION VALVE
K — TUBE CONNECTOR
L — HOSE CLAMP
M — ENGINE COMPARTMENT BULKHEAD FUEL LINE JUNCTION BLOCK
N — PROPELLER SHAFT HOUSING CLIP BRACKET
P — FUEL TANK TUBE CLIP
Q — FUEL PRIMING PUMP ASSEMBLY
R — GASOLINE PRIMER LINE FROM PRIMER PUMP INLET TO JUNCTION BLOCK TUBE
S — GASOLINE PRIMER LINE FROM PRIMER PUMP OUTLET TO HOSE AT ENGINE BEAM TUBE
T — FUEL TANKS FROM JUNCTION BLOCK SHUT-OFF ASSEMBLY
U — VERTICAL FUEL TANK SHUT-OFF ASSEMBLY
V — HORIZONTAL FUEL TANK SHUT-OFF ASSEMBLY
W — GASOLINE PRIMER LINE FROM ENGINE BEAM TO TOP OF ENGINE TUBE
X — ENGINE BEAM PRIMER LINE HOSE ASSEMBLY
Y — ROMEC GASOLINE PUMP ASSEMBLY
Z — REAR ENGINE COMPARTMENT FUEL LINE FUEL STRAINER ASSEMBLY
AA — FUEL PRESSURE RELIEF VALVE MOUNTING BRACKET
BB — OIL GAUGE TUBE TO ENGINE BEAM
CC — PRIMER PUMP TUBE TO ENGINE BEAM
DD — FUEL PUMP TO CARBURETOR HOSE ASSEMBLY
EE — CARBURETOR TO RELIEF VALVE HOSE ASSEMBLY

RA PD 10882

Figure 3—Installation of Fuel Lines

d. Removal of Fuel Lines (fig. 3).

(1) EQUIPMENT:

Wrench, open-end, $\frac{7}{16}$-in.
Wrench, open-end, ½-in.
Wrench, open-end, $\frac{9}{16}$-in.
Wrench, open-end, $\frac{11}{16}$-in.
Wrench, open-end, ¾-in.
Wrench, open-end, ⅞-in.
Wrench, open-end, 1-in.
Wrench, open-end, $1\frac{1}{16}$-in.
Wrench, open-end, 1⅛-in.

(2) PROCEDURE:

(*a*) Remove main fuel line, tube assembly, junction block (header) to strainer.

Wrench, open-end, $\frac{11}{16}$-in. Wrench, open-end, ¾-in.

Disconnect main fuel line nuts from fitting at fuel line junction block (header) and at fuel strainer inlet fitting, and remove line assembly.

(*b*) Remove return fuel line, tube assembly, check valve to junction block (header).

Wrench, open-end, 1-in. Wrench, open-end, $1\frac{1}{16}$-in.

Disconnect fuel return line nuts from fittings at junction block (header) inlet fitting and at check valve outlet fitting and remove tube assembly.

(*c*) Remove hose assembly strainer to fuel pump.

Wrench, open-end, ⅞-in. Wrench, open-end, 1⅛-in.

Disconnect compression fitting nuts from fitting at strainer and fuel pump and remove hose assembly.

(*d*) Remove return fuel line, tube assembly, carburetor to check valve.

Wrench, open-end, ⅞-in.

Disconnect return fuel line fitting nuts at carburetor and check valve fittings and remove line assembly.

(*e*) Remove primer discharge line, priming pump to engine.

Wrench, open-end, $\frac{7}{16}$-in. Wrench, open-end, ¾-in.

Disconnect priming tube fitting nut at engine hose connector and at priming pump and remove tube assembly.

(*f*) Remove primer intake line, tube assembly, block (header) to priming pump.

Wrench, open-end, $\frac{7}{16}$-in.

Disconnect primer intake tube fitting nut at block (header) connector and at priming pump and remove tube assembly.

(*g*) Remove oil dilution fuel line, tube assembly, check valve to dilution valve.

Wrench, open-end, ½-in. Wrench, open-end, $\frac{9}{16}$-in.

Disconnect dilution line fitting nut at check valve and dilution valve connectors and remove tube assembly.

(*h*) Remove fuel line, tube assembly, horizontal tank to vertical tank.

Wrench, open-end, $\frac{11}{16}$-in. Wrench, open-end, ¾-in.

Disconnect fuel line fitting nuts from fittings at horizontal tank outlet valve tee and at vertical tank outlet valve tee and remove tube assembly.

(i) Remove fuel line, tube assembly, vertical tank to junction block (header).

Wrench, open-end, $\frac{11}{16}$-in. Wrench, open-end, ¾-in.

Disconnect fuel line fitting nut from fittings at vertical tank outlet valve tee and at junction block (header).

e. Installation of Fuel Lines.

(1) EQUIPMENT:

Wrench, open-end, $\frac{7}{16}$-in.
Wrench, open-end, ½-in.
Wrench, open-end, $\frac{9}{16}$-in.
Wrench, open-end, $\frac{11}{16}$-in.
Wrench, open-end, ¾-in.
Wrench, open-end, ⅞-in.
Wrench, open-end, 1-in.
Wrench, open-end, $1\frac{1}{16}$-in.
Wrench, open-end, 1⅛-in.

(2) PROCEDURE:

(a) Install primer intake line, tube assembly.

Wrench, open-end, $\frac{7}{16}$-in.

Connect primer intake tube fitting nut at block (header) and at priming pump.

(b) Install primer discharge, tube assembly.

Wrench, open-end, $\frac{7}{16}$-in. Wrench, open-end, ¾-in.

Connect priming tube fitting nut at engine hose connector and at priming pump fitting.

(c) Install return fuel line tube, assembly, carburetor to check valve.

Wrench, open-end, $\frac{7}{16}$-in.

Connect return line fitting nuts at carburetor and check valve fitting.

(d) Remove hose assembly, strainer to fuel pump.

Wrench, open-end, ⅞-in. Wrench, open-end, 1⅛-in.

Connect hose assembly fitting nuts to fittings at fuel pump and at strainer.

(e) Install return fuel line, tube assembly, check valve to junction block (header).

Wrench, open-end, 1-in. Wrench, open-end $1\frac{1}{16}$-in.

Connect fuel return line fitting nuts to fittings at junction block (header) and at check valve outlet fitting.

(f) Remove main fuel line, tube assembly, junction block (header) to strainer.

Wrench, open-end, $\frac{11}{16}$-in. Wrench, open-end, ¾-in.

Connect fuel line fitting nuts to fittings at junction block (header) and at strainer.

(g) Install fuel line, tube assembly, horizontal tank to vertical tank.

Wrench, open-end, $\frac{11}{16}$-in. Wrench, open-end, ¾-in.

Connect fuel line tube nuts to fittings at horizontal tank outlet valve tee and at vertical tank outlet valve tee.

(h) Install fuel line, tube assembly, vertical tank to junction block (header).

Wrench, open-end, $\frac{11}{16}$-in. Wrench, open-end, 3/4-in.

Connect fuel line tube fitting nuts to fitting at vertical tank outlet valve tee and at junction block (header).

(i) Install oil dilution fuel line, tube assembly, check valve to dilution valve.

Wrench, open-end, 1/2-in. Wrench, open-end, $\frac{11}{16}$-in.

Connect dilution valve fuel line fitting nut to fitting at check valve and dilution valve.

21. CONSTRUCTION OF FUEL TANKS (figs. 4 and 5).

The right and left sponson tanks have a capacity of 60 gallons each, while the right and left vertical tanks hold 27 3/4 gallons each. The body, top and bottom are made from 12 gage (0.109-inch thickness) copper bearing steel with a basic welded construction. The sponson tanks are equipped with a float assembly which is used in conjunction with an indicator located at the bulkhead to indicate electrically the amount of fuel in the tanks. The float assembly is riveted to the top of the tank. The drain plug flange and the inlet and outlet flange are made of bronze and they are riveted and soldered to the tank body. A plate is riveted to the interior side of the top of the tank to which the flame arrester assembly is attached by six 1/4-inch cap screws. The flame arrester assembly consists of two screen tubes of different diameters, the smaller one placed inside the larger one, and a cast bronze flange threaded on the exposed end to receive the tank filler cap. The fuel tank is vented by means of a small hole in the filler cap. This hole is closed by means of a ball operated by a cork float when the fuel level rises high enough in the tank to operate the float.

22. REASONS FOR REMOVAL OF FUEL TANKS.

a. A leak between the tank and any of the flanges which are riveted and soldered to the tank.

b. A leak in the top, bottom, or body of the tank in the copper bearing steel from which these parts are fabricated.

c. An unusual amount of foreign matter in the bottom of the fuel tank, which will cause corrosion and rupture of the section. Use the following method to make the inspection. The vertical tanks may be inspected thoroughly by this method, but only a limited portion on the sponson tanks, due to their construction.

(1) Remove plate covering the fuel tank drain plug.

(2) Drain the fuel tank until about one inch of fuel remains in the tank. Install drain plug.

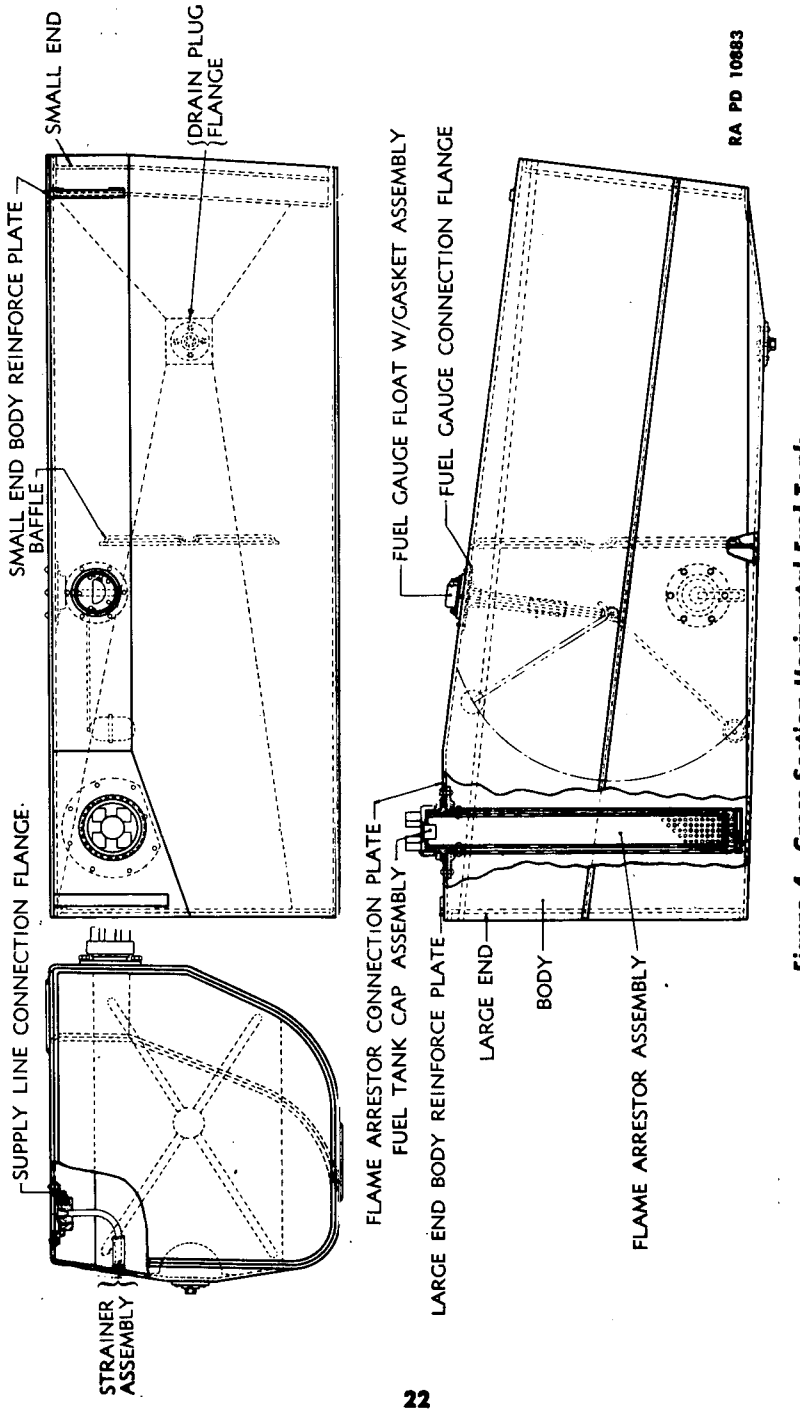


Figure 4—Cross Section Horizontal Fuel Tank

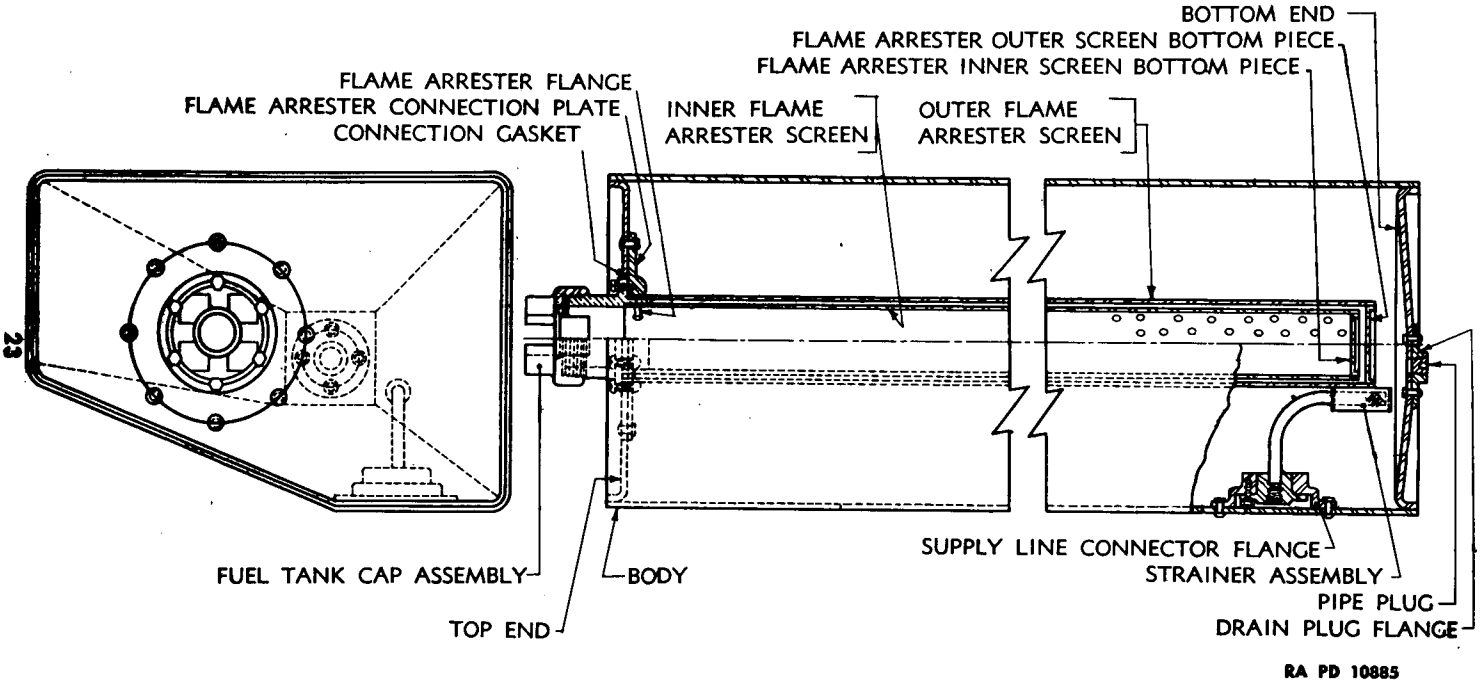


Figure 5—Cross Section Vertical Fuel Tank

(3) Remove the filler cap.

(4) Remove the six ¼-inch cap screws holding the flame arrester assembly to the fuel tank. Remove the flame arrester assembly.

(5) Insert a metal rod (¼-in. to ½-in. in diameter and approximately 5 ft. long) through the filler hole and tap the bottom of the tank. CAUTION: To preclude the possibility of igniting the fuel vapor in the tank by a static discharge from the metal rod, ground the rod to the vehicle before inserting it in the tank. If any portion of the bottom of the tank is corroded or dangerously thin, the rod will puncture the metal sufficiently to start a leak. This will be indicated by fuel leaking from the opening made by removing the plate which covers the drain plug. If a leak develops, remove and repair the tank.

(6) Drain all the fuel from the tank, and with a flashlight which has been switched on before being exposed to the vapor remaining in the tank, inspect the bottom of the tank for dirt. CAUTION: If the flashlight has a metal case, ground the metal case with a wire to the vehicle before exposing the flashlight to the vapor of the fuel tank. A spark would ignite the vapor in the fuel tank, causing an explosion and fire. If this dirt cannot be flushed out and has accumulated to the point where a possibility exists that some of it might clog or impair the fuel outlet of the tank, remove the fuel tank from the vehicle.

23. REMOVAL OF LEFT- AND RIGHT-HAND VERTICAL FUEL TANKS (fig. 6).

NOTE: Follow identical procedure for removal of the right- or left-hand tank. Two men are required to complete the removal operations.

a. Equipment.

"A" frame with block and chain or equivalent
Pliers
Rope, length of, ½-in.
Wrench, Allen, $\frac{11}{16}$-in.
Wrench, Allen, 1-in.
Wrench, box, $\frac{7}{16}$-in.
Wrench, open-end, ⅜-in.
Wrench, open-end, $\frac{9}{16}$-in.
Wrench, open-end, $\frac{11}{16}$-in.
Wrench, open-end, ¾-in.
Wrench, open-end, 1-in.
Wrench, socket, with 12-in. extension handle, $\frac{11}{16}$-in.
Wrench, socket, with ratchet, $\frac{7}{16}$-in.

b. Procedure.

(1) Remove engine. Refer to TM 9-1751.

(2) Drain fuel tank.

Wrench, Allen, $\frac{11}{16}$-in.
Wrench, Allen, 1-in.

Close fuel shut-off valve on horizontal tank. Remove pipe plug located beneath the drain plug; this is reached from the under side of the tank. Then remove the fuel drain plug and drain fuel.

(3) Remove channel bracket from bulkhead.
Wrench, socket, with ratchet, $\frac{15}{16}$-in.

Remove two cap screws that attach channel bracket, with set screws, to bulkhead, then lift clamping plate from the top of the tank.

(4) Remove vertical fuel tank shut-off stem.
Pliers
Wrench, open-end, $\frac{3}{8}$-in.

Pull cotter pin from stem universal joint and remove two bolts with nuts and lock washers from each of the two clips attached to the brackets. Then remove stem and clips assembly.

(5) Remove vertical tank upper cover plate.
Wrench, open-end, $\frac{9}{16}$-in.
Wrench, socket, with 12-in. extension handle, $\frac{9}{16}$-in.

Remove six cap screws that attach tank cover plate to tank and one bolt and nut, holding bolt head on outside of tank with open-end wrench. Then remove five bolts that attach cover plate to bulkhead, using an open-end wrench to hold the bolt heads on the tank compartment side of the bulkhead, and lift out cover plate.

(6) Disconnect horizontal tank fuel line.
Wrench, box, $\frac{7}{16}$-in.
Wrench, open-end, $\frac{3}{4}$-in.
Wrench, open-end, $\frac{11}{16}$-in.

Remove three cap screws and lock washers from the three clips that attach fuel line to lower cover plate. Then disconnect fuel ferrule fitting nut at vertical tank outlet tee.

(7) Disconnect vertical tank line.
Wrench, open-end, $\frac{11}{16}$-in.
Wrench, open-end, $\frac{3}{4}$-in.
Disconnect tank to header fuel line ferrule fitting nut at outlet tee.

(8) Remove fuel outlet nipple with tee and shut-off valve assembly.
Wrench, open-end, $\frac{11}{16}$-in.
Disconnect nipple with tee assembly from tank fuel outlet flange.

(9) Remove fire extinguisher tube assembly.
Wrench, open-end, 1-in.
Disconnect fire extinguisher line flared tube nuts at tee and nozzle and remove tube assembly.

(10) Remove vertical fuel tank.
"A" frame with block and chain or equivalent
Rope, length of, $\frac{1}{2}$-in.

Remove filler cap, tie rope around filler plate neck, making a short sling, and screw on filler cap. Then position "A" frame, place chain block into sling and pull out tank, at the same time pulling out the three wooden wedges from around the tank.

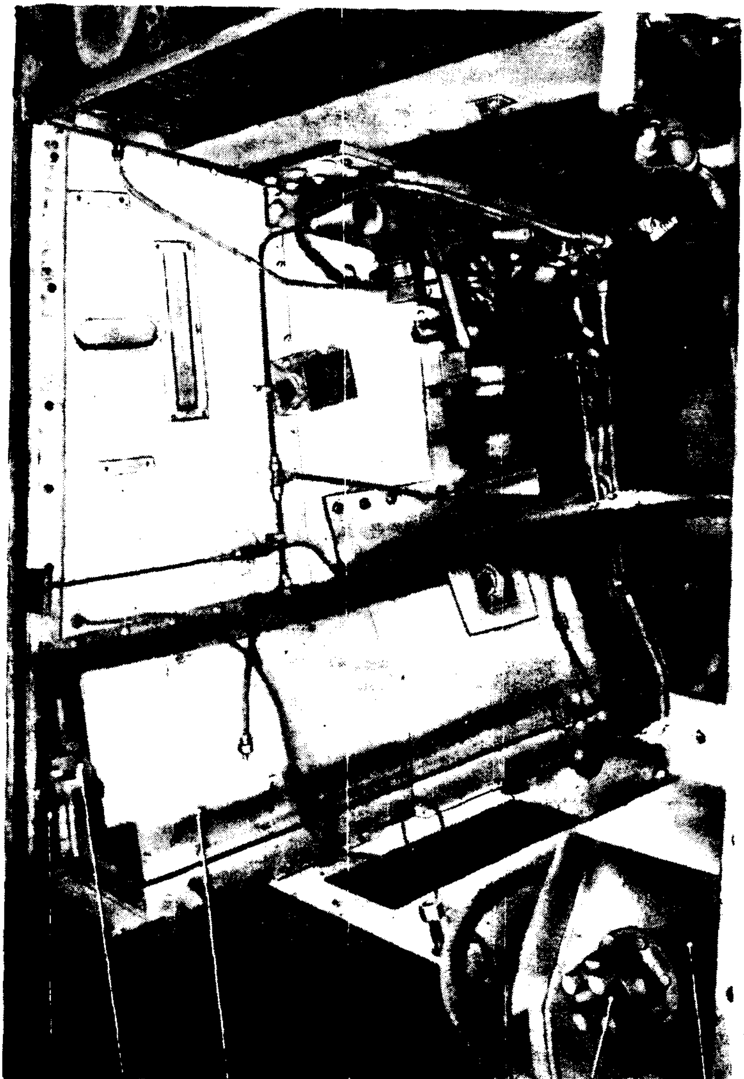


Figure 6—Installation of Fuel Tank—Right Side

FUEL LINES AND TANKS

24. REMOVAL OF LEFT- AND RIGHT-HAND HORIZONTAL FUEL TANKS (fig. 6).

NOTE: Follow identical procedure for removal of left- or right-hand tank. Two men are required to complete the removal operations.

a. Equipment.

Link, drag, with 10-in. extension
Pliers
Screwdriver
Wrench, Allen, $\frac{5}{16}$-in.
Wrench, Allen, 1-in.
Wrench, open-end, $\frac{7}{16}$-in.
Wrench, open-end, $\frac{9}{16}$-in.
Wrench, open-end, 1-in.
Wrench, socket, with ratchet, $\frac{9}{16}$-in.
Wrench, socket, with 10-in. extension handle, $\frac{9}{16}$-in.

b. Procedure.

(1) Remove engine.

Refer to TM 9-1751.

(2) Drain vertical and horizontal fuel tanks.

Link, drag, with 10-in. extension
Wrench, Allen, $\frac{5}{16}$-in.
Wrench, Allen, 1-in.

Remove pipe plug located beneath vertical tank and remove drain plug. Then remove three screws from plate under horizontal tank and remove drain plug.

(3) Remove vertical fuel tank.

Follow procedure for removal of vertical tank (par. 23).

(4) Remove spacer blocks.

Lift out two wooden blocks that position the vertical tank.

(5) Remove shut-off valve stem.

Pliers

Pull cotter pin from shut-off valve universal joint and pull out stem.

(6) Remove fire extinguisher tube assembly.

Wrench, open-end, $\frac{7}{16}$-in.
Wrench, open-end, 1-in.

Remove cap screws from two clamping brackets that attach line to cover plate. Then disconnect flared tube nut from fitting at rear spray nozzle and lift out tube assembly.

(7) Remove taillight conduit union connector.

Pliers
Wrench, open-end, 1-in.

Remove conduit from union and pull out light plug, then remove union fitting nut and pull out union from inside engine compartment.

(8) Remove cover plate.

Link, drag, with 10-in. extension
Pliers
Wrench, open-end, $\frac{9}{16}$-in.
Wrench, socket, ratchet, $\frac{9}{16}$-in.
Wrench, socket, with 10-in. extension handle, $\frac{9}{16}$-in.

Remove thirteen cap screws and three slotted head machine screws from cover plate. Then remove the five bolts from cover plate that extend through hull. Hold bolt head on outside with wrench. Disconnect

fuel gage conduit knurled fitting at cover plate. Pull cover plate out from top of tank and cut the fuel gage wire. Pull wire through hole and lift off cover plate.

(9) Remove horizontal fuel tank.

Screwdriver

Remove four machine screws from the two strap assemblies that attach them to the sponson. Then remove the front and rear wooden spacers from under tank and slide tank out from sponson.

25. CLEANING TANKS.

Use the following methods to clean the tanks thoroughly. The methods are listed in the order of preference.

a. First Method. Fill a five-gallon can with heavy-duty alkaline cleaner, Quartermaster Corps Specifications Es-No. 382a compound. Dissolve the cleaner in fifty gallons of water. Bring the solution to the boiling point in a large vat heated by steam. Take the fuel tank off the vehicle. Remove the caps, plugs, and inspection hole covers, place everything in the vat, and boil them for at least thirty minutes. This should eliminate all inflammable substances. Flush the tank with cold water and dry out with compressed air.

b. Second Method. Flush the tank for fifteen minutes with boiling water admitted at the bottom of the tank and allow the water to overflow at the top. Then steam the fuel tanks for three hours and the oil tanks for one hour, admitting live steam at the top of the tank and allowing it to escape through the bottom outlets. If live steam is not available, flush with boiling water continuously for at least three or four hours, and dry the tank thoroughly with compressed air. This process is not positive and should be used only when it is not feasible to use the first method. Use great caution in this process. Flush the tank with cold water and dry out with compressed air.

c. Third Method. Drain tank thoroughly. Pour approximately one gallon of carbon tetrachloride into the tank and flush thoroughly. Allow some of the fluid to remain in the tank while repairs are being made.

d. Preparing Tanks for Repair.

(1) Repair work must be accomplished as soon as possible after the tank has been prepared. In no case should the tank be allowed to stand more than thirty minutes before being repaired.

(2) When repairs can be accomplished by soldering, normally it will not be necessary to prepare tanks as indicated above. The tank, however, must be thoroughly drained, and as a precaution blow it out with compressed air to remove all volatile residue. Do not make the soldering iron "red hot," as hot or adhering particles of dirt or dust may ignite any explosive mixture remaining in the tank.

(3) Care must be taken when handling fuel tanks to avoid producing sparks that may ignite the volatile mixture of air and fuel. The use of power sanding machines and similar equipment that produce sparks is prohibited.

26. TESTING TANKS.

a. Test the fuel tank before and after repairing it. Use either of the two methods outlined below.

(1) THE WET METHOD.

(a) Plug all openings except the filler neck.

(b) Dry the entire outer surface of the tank thoroughly with compressed air and with a clean dry rag.

(c) Place the tank on a bench on top of blocks so that the under side can be seen easily with the aid of an electric light.

(d) Fill the tank with water.

(e) Insert the end of the air hose in the filler neck and cover the rest of the opening with the palm of one hand.

(f) Apply air pressure against the water by opening the air valve with the other hand for a few minutes.

(g) Examine the entire tank for moist spots where the water was forced through.

(2) THE AIR PRESSURE METHOD.

(a) Plug all openings except the fuel outlet connection.

(b) Attach the loose end of the air supply hose to the fuel outlet connection by a short-threaded tube.

(c) Submerge the fuel tank in a tank of clean water or cover the tank with soapy water.

(d) Turn on the air pressure, but not more than 15 pounds.

(e) Draw a ring around each spot on the fuel tank where bubbles appear. The bubbles indicate leaks.

27. REPAIR.

a. Leak Through the Steel Shell. If a leak occurs in the coffer bearing steel of the body, top, or bottom of the tank, weld or braze the leak if the material of the tank is in good condition. CAUTION: In the welding or brazing process do not allow the portion of the tank adjacent to a bronze casting or the bronze casting to reach the melting point of solder. If this occurs, the tank may leak between the shell and the casting.

b. Leak Between the Steel Shell and a Bronze Casting. In this case remove the bronze casting from the tank, retin the contacting surfaces, rivet the bronze casting in place, and solder the rivet heads to the casting and the casting to the steel shell. If a leak occurs between the top of the tank and the cast plate to which the flame arrester is attached, remove the top of the tank (refer to par. 27 **b** (2)) from the body in

order to retin the surface of that portion of the top which contacts the cast plate. If a leak occurs between the cast flange used to attach the screen outlet assembly and the body of the tank, remove the bottom of the tank from the body in order to retin that portion of the tank contacting the cast flange. If a leak occurs between the bottom of the tank and the cast flange into which the drain plug is screwed, do not remove the bottom of the tank from the body.

(1) REPLACEMENT OF A BRONZE CASTING. Use the following procedure to replace a bronze casting on the fuel tank.

(a) Grind or file the exposed ends of the rivets flush with the surrounding surface.

(b) Heat the casting and the portion of the tank shell adjacent to it hot enough to melt solder. With a hammer and punch, drive out the rivets that attach the bronze casting to the shell of the tank. Separate the bronze casting from the steel shell of the tank. If it is necessary to remove an end of the tank from the body, perform the step described in paragraph 27 b (2) before proceeding with the next step.

(c) Retin and solder the surfaces of the bronze casting and shell of tank that contact each other. Clean out the rivet holes in the casting and the steel shell.

(d) Rivet the retinned casting in place. When the drain plug flange is being worked on, use a long bar with a square end, working through the flame arrester opening to upset the end of the rivet.

(e) Solder the rivet heads to the casting, and the casting to the steel shell of the tank.

(f) Treat the surface exposed to soldering flux with a solution of washing soda.

(g) Weld the end of the tank to the body if it has been removed and test the repaired tank for leaks (par. 26).

(2) REMOVING TOP OR BOTTOM OF TANK. Use the following procedure to remove the top or bottom of the tank from the body.

(a) With a portable grinder, grind the bead, welding the end of the tank to the body, to a depth sufficient to remove the weld, but first be sure the tank is empty of liquid and volatized fuel.

(b) Slip a ½-inch diameter round bar five or six feet long through the hole in the opposite end of the tank. With the bar as a hammer, drive against the inside of the tank end to be removed, as close as possible to the body of the tank. Remove the end of the tank from the body.

(c) If the material of the tank end is not in good condition, replace it with a new one. Rivet and solder the bronze casting in place as outlined in paragraph 27 b (1) before welding the end of the tank to the body.

(d) Test the tank for leaks as outlined in paragraph 26.

c. **Treatment After Repair.** Wash the interior of the tank with OIL, lubricating, preservative, medium, as protection against rust. Drain excess OIL from tank.

28. INSTALLATION OF LEFT- AND RIGHT-HAND VERTICAL FUEL TANKS.

NOTE: Follow identical procedure for the installation of left- and right-hand tanks. Two men are required to complete the installation operations.

a. Equipment.

Bar, long
Hammer
Pliers
Rope, length of, ½-in.
Wrench, Allen, $\frac{9}{16}$-in.
Wrench, Allen, 1-in.
Wrench, box, $\frac{7}{16}$-in.
Wrench, open-end, ⅜-in.
Wrench, open-end, $\frac{9}{16}$-in.
Wrench, open-end, $\frac{11}{16}$-in.
Wrench, open-end, ¾-in.
Wrench, open-end, 1-in.
Wrench, socket, with ratchet, $\frac{5}{16}$-in.
Wrench, socket, with 12-in. extension handle, $\frac{9}{16}$-in.

b. Procedure.

(1) Replace vertical tank.

Bar, long
Hammer

Place tank in lower cover plate socket and replace two wooden spacer blocks between vertical and horizontal tanks. Then drive in three wooden wedges between tank and cover plate on engine compartment side.

(2) Install vertical tank cover plate.

Wrench, open-end, $\frac{9}{16}$-in.
Wrench, socket with 12-in. extension handle, $\frac{9}{16}$-in.

Place cover plate in position and replace six cap screws and six bolts that attach plate to hull and bulkhead.

(3) Replace fire extinguisher tube assembly.

Wrench, open-end, 1-in.

Connect flared tube nuts at T fitting on cover plate and at nozzle.

(4) Install shut-off valve.

Wrench, open-end, $\frac{11}{16}$-in.

Replace shut-off valve with nipple in tank fuel outlet fitting flange.

(5) Install shut-off valve stem.

Pliers
Wrench, open-end, ⅜-in.

Insert shut-off stem in universal joint collar and replace cotter pin. Then place two stem clips in position on brackets and secure with two bolts, nuts and lock washers.

(6) Install channel bracket on bulkhead.

Wrench socket, with ratchet, $\frac{5}{16}$-in.

Replace channel bracket with two tank clamping set screws on bulk-

head and secure with two cap screws. Then place clamping part in position on top of fuel tank and tighten set screws to secure tank.

(7) Install horizontal fuel tank tube assembly.

Wrench, box, $\frac{7}{16}$-in.
Wrench, open-end, $\frac{3}{4}$-in.
Wrench, open-end, $\frac{11}{16}$-in.

Connect fuel line flared tube nut to fitting at horizonal tank outlet valve tee and vertical tank outlet valve tee. Then secure three tube clips to lower cover plate with cap screws and lock washers.

(8) Install vertical fuel tank tube assembly.

Wrench, open-end, $\frac{11}{16}$-in.
Wrench, open-end, $\frac{3}{4}$-in.

Connect vertical tank fuel line flared tube at outlet tee fitting.

29. INSTALLATION OF LEFT- AND RIGHT-HAND HORIZONTAL FUEL TANKS.

NOTE: Identical procedure should be followed for installing left- and right-hand tanks. Two men are required to complete installation operations.

a. Equipment.

Link, drag, with 10-in. extension
Pliers
Screwdriver
Wrench, Allen, $\frac{5}{16}$-in.
Wrench, Allen, 1-in.
Wrench, open-end, $\frac{7}{16}$-in.
Wrench, open-end, $\frac{9}{16}$-in.
Wrench, open-end, 1-in.
Wrench, socket, with ratchet, $\frac{9}{16}$-in.
Wrench, socket, with 10-in. extension handle, $\frac{9}{16}$-in.

b. Procedure.

(1) REPLACE HORIZONTAL FUEL TANK.

Screwdriver

If clamping straps have been removed, replace and tighten straps. Slide tank in sponson and replace front and rear wooden spacers. Then replace four machine screws that attach clamping strap to bottom of sponson.

(2) INSTALL COVER PLATE.

Link, drag, with 10-in. extension
Wrench, open-end, $\frac{9}{16}$-in.
Wrench, socket ratchet, $\frac{9}{16}$-in.
Wrench, socket, with 10-in. extension handle, $\frac{9}{16}$-in.

Place cover plate on sponson ledge and thread fuel gage wire through hole in cover plate and join the wire that was cut for removal of plate by soldering and taping or with a suitable connector. Then reinstall thirteen cap screws, three slotted head screws, and five bolts and safety nuts that attach cover plate to sponson.

(3) INSTALL TAILLIGHT UNION CONNECTOR.

Position union in hole in rear armor plate and replace locking nut. Then insert wire plug and connect conduit to union.

(4) INSTALL FIRE EXTINGUISHER TUBE ASSEMBLY.

Wrench, open-end, $\frac{7}{16}$-in. Wrench, open-end, 1-in.

Put the two tube clamping brackets in place and install attaching screws. Then connect tube flared tube nut to fitting on spray nozzle.

(5) INSTALL SHUT-OFF VALVE.

Pliers Wrench, open-end, $\frac{3}{8}$-in.

Replace shut-off valve with nipple in fuel outlet fitting.

(6) REPLACE FUEL TANK DRAIN PLUG COVER PLATE.

Link, drag, with sliding T handle

If drain plug has been removed, position drain plug cover plate and replace three attaching screws.

(7) REPLACE VERTICAL FUEL TANK.

Follow procedure for installation of vertical tank (par. 28 b).

(8) INSTALL ENGINE.

Refer to TM–9–1751.

Section III

FUEL PUMP

30. DESCRIPTION (fig. 7).

The Romec F-8 fuel pump is of the positive displacement, rotary-vane type with a capacity of 150 gallons per hour at 1750 revolutions per minute. It has an inlet depression of 4 inches of mercury and a discharge pressure of 10 inches of mercury (about 5 pounds per square inch). The pumping unit comprises a liner, rotor, blade or vane, two rockers, and bottom and top bearings. The rotor is mounted eccentrically within the special-shaped bore of the liner and the sliding blade passes completely through it. Both tips of the blade carry sealing rockers which contact the inside of the bore at all times. The lower bearing and liner

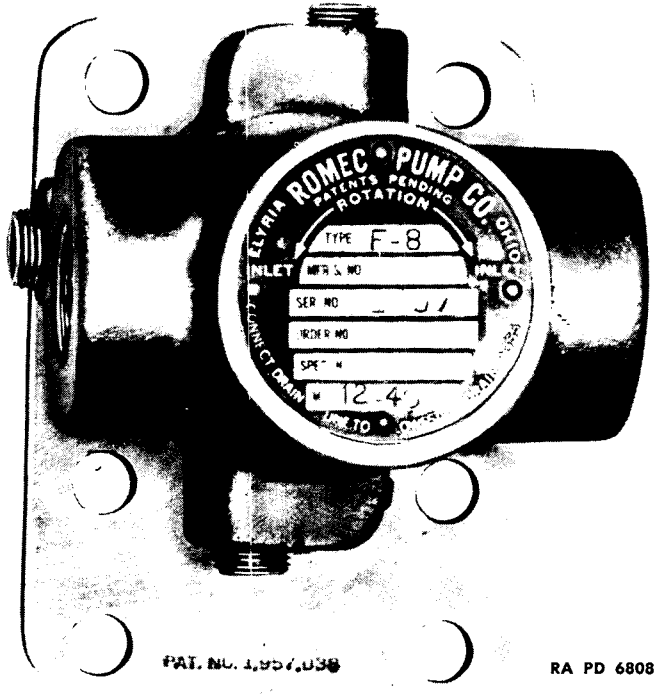


Figure 7—Romec Fuel Pump F-8, Wright Engine R975-EC2

are shrunk into the pump body and the upper bearing is locked in place by a threaded lock nut. The drive shaft seal is cushioned, self-lubricated, and pressure-compensated to prevent fuel leakage along the shaft. This seal compensates for both axial and angular misalinement of the shaft. An oil seal is incorporated to prevent OIL, engine, from leaking into the pump along the drive shaft. The adapter plate is detachable and may be secured to the pump body in four positions. Install the name plate with its top toward the short end of the adapter plate to bring the inlet and outlet into correct position.

31. REMOVAL.

Disconnect the fuel lines from the ells on the top and bottom of the pump by unscrewing the coupling nuts (⅞-in. wrench). Plug the ends of the lines to prevent entrance of dirt. Remove the palnuts, nuts (½-in. wrench) and plain washers holding the pump to the accessory case and pull the pump off the studs.

32. OVERHAUL.

A list of the tools necessary to overhaul the Romec F-8 fuel pump follows: (Two of the special ones are shown in fig. 8.)

- Bath, oil, with facilities for heating to 350-400 F
- Calipers, inside
- Mallet, rawhide, small
- Micrometer
- Puller, upper and lower bearing, RE-T4
- Screwdriver, 6-in.
- Screwdriver, 10-in.
- Scriber or other pointed tool
- Vise, bench, with hardwood or fiber jaws
- Wrench, bearing lock nut, RE-T5

a. Disassembly (fig. 9).

(1) REMOVE BEARING LOCK NUT AND COUPLING PARTS FROM PUMP.

- Vise, bench, with wood or fiber jaws
- Screwdriver, 6-in.
- Wrench, special, RE-T5

Secure the pump in a vise with the drive shaft up. Use wood or fiber jaws between the vise jaws and the adapter plate. Remove the screw holding the lock plate and remove the lock plate. Remove the lock ring with a small screwdriver and lift out the retainer and the oil seal. Unscrew the bearing lock nut (special wrench RE-T5) and lift it out of the pump. Remove the lock nut gasket, seal plate, oil seal, engine seal coupling, sealing spring and pump seal coupling from the end of the pump by hand.

(2) REMOVE LEAD GASKET.

- Scriber or other pointed tool

Lift out the lead gasket with a scriber or other pointed tool. The gasket forms a seal between the upper bearing and the inside of the body bore. It will be damaged by removal and a new one must be used for assembly.

ORDNANCE MAINTENANCE—ACCESSORIES FOR WRIGHT R975-EC2 ENGINES FOR MEDIUM TANKS M3 AND M4

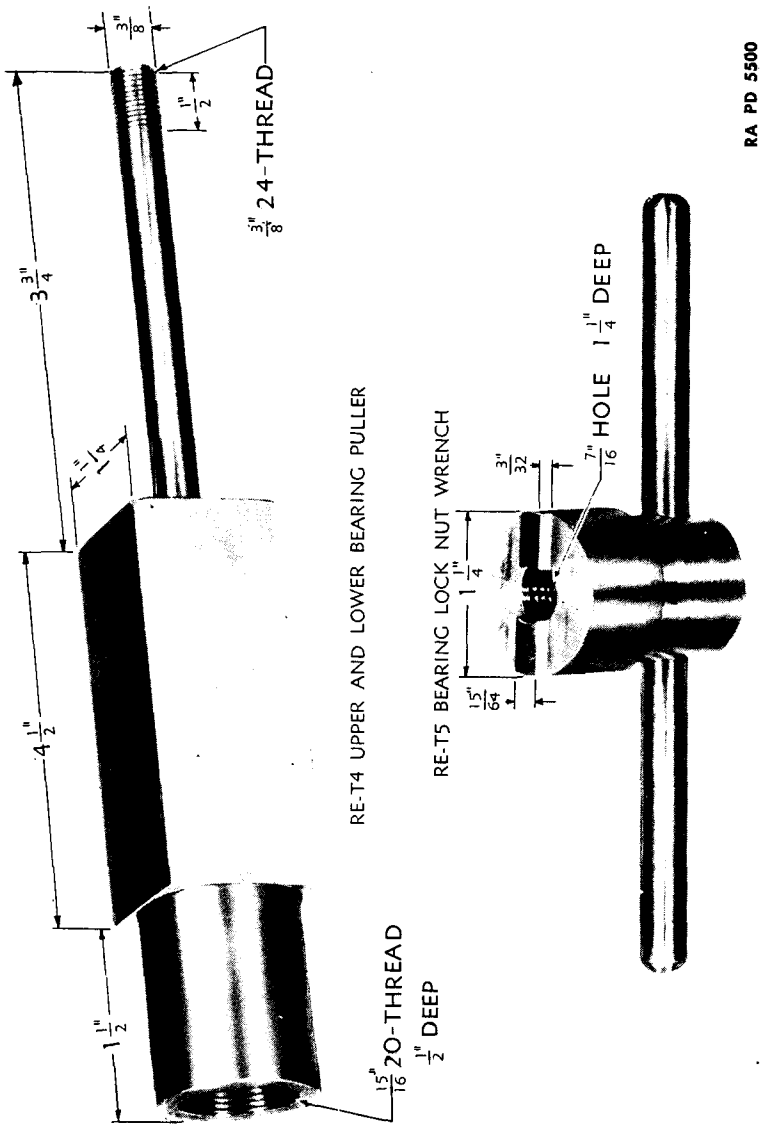
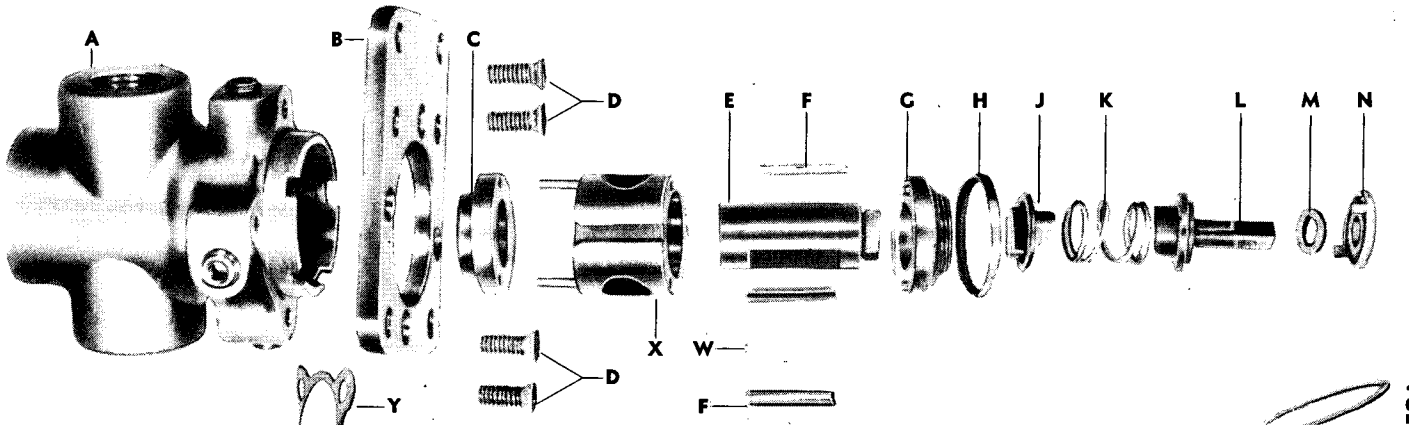


Figure 8—Overhaul Tools for the Romec F-8 Fuel Pump



A — PUMP BODY
B — ADAPTER PLATE
C — LOWER BEARING
D — ADAPTER PLATE SCREWS
E — ROTOR
F — ROCKER
G — UPPER BEARING
H — LEAD GASKET
J — PUMP SEAL COUPLING
K — SEALING SPRING
L — ENGINE SEAL COUPLING
M — SYNTHETIC RUBBER OIL SEAL
N — SEAL PLATE
P — LOCK NUT GASKET
Q — BEARING LOCKNUT ASSEMBLY
R — LOCK PLATE
S — SCREW
T — SEAL DISK
U — RETAINER
V — LOCK RING
W — BLADE
X — LINER
Y — BODY GASKET

Figure 9—Romec F-8 Pump

(3) REMOVE UPPER BEARING, ROTOR BLADE AND ROCKERS.
Puller, bearing, RE-T4

Screw the large end of the bearing puller (fig. 8) onto the end of the upper bearing and lift the bearing out of the pump body by hand. Lift the rotor, blade, and rockers out of the body by hand and separate them.

(4) CLEAN AND INSPECT PARTS.
Calipers, inside Micrometer

Clean all the parts and remove any burs that may have been caused by the disassembly process. However, be careful not to remove any of the sharp corners from parts of the jumping mechanism as this might result in an internal slip in the pump. Check the parts of the internal assembly and see that the clearances come within the limits specified (fig. 10). Replace any parts that do not give these fits. If these clearances cannot be obtained by changing the rotor, blade, or rockers, it will be necessary to remove the liner and lower bearing from the pump body.

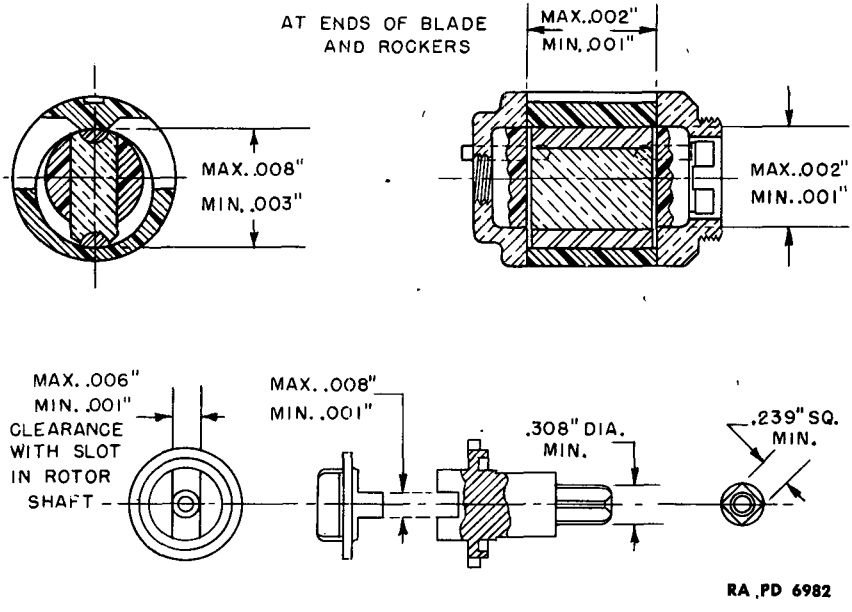


Figure 10—Clearances for Parts of Romec Pump F-8

(5) REMOVE LINER AND LOWER BEARING FROM THE BODY.
Bath, oil, with facilities for heating to 350 F-400 F
Puller, bearing, RE-T4
Screwdriver, 10-in.

Remove the four screws holding the adapter plate to the body, remove the body from the plate and the plate from the vise. Close the inlet and

outlet of the pump with plugs (½-in. NPT), and screw the small end of the bearing puller into the tapped hole in the lower bearing. Heat the oil bath to 350 F to 400 F and lower the body into it just deep enough so that the oil will not over run over the top and into the inside. After five minutes remove the body quickly from the oil, clamp the puller in a vise and pull the body off the liner and lower bearing by hand, being careful to protect the hands. If necessary, tap the body lightly with a rawhide mallet, working against the bosses to prevent any damage to the bore. Unscrew the lower bearing from the puller and separate the bearing and liner by hand.

(6) CLEAN AND INSPECT LINER AND LOWER BEARING.

Calipers, inside — Micrometer

Clean the liner and lower bearing thoroughly and check to see that the clearances are within the limits specified (fig. 10). Replace such new parts as are necessary to obtain these clearances.

h. Assembly (fig. 9).

(1) INSTALL THE LOWER BEARING AND LINER IN THE PUMP BODY.

Bath, oil, with facilities for heating to 350 F-400 F
Mallet, rawhide, small
Puller, bearing, RE-T4

Close the inlet and outlet of the pump body with plugs (½-in. NPT), heat the oil bath to 300 F, and lower the body into it just deep enough so that the oil will not run over the top and into the inside. (The body must stay in the hot oil for about five minutes.) Slide the lower bearing onto the pins of the liner and screw the small end of the puller (RE-T4) into the upper end of the bearing. The keyway in the outside of the liner is for manufacturing purposes only but may be used as a guide in assembling the liner and bearing with the body in such a position that the ends of the pins projecting from the lower side of the bearing enter the clearance holes provided for them at the bottom of the body bore. Remove the body from the oil bath, place in an upright position, and with the keyway as a guide, quickly lower the bearing and liner into correct position. A few light taps with a rawhide mallet on the end of the puller will seat the bearing firmly in place. Be sure the liner is seated firmly on the bearing. This operation must be performed quickly or the body may freeze onto the bearing or liner before it is in correct position. Remove the bearing puller. Allow the assembly to cool.

(2) ASSEMBLE ADAPTER PLATE WITH BODY.

Screwdriver, 10-in.

Place the adapter plate on the body in such a manner that the top of the name plate on the body is toward the narrow end of the plate and secure it with four screws. Stake the screws to prevent loosening.

(3) INSTALL ROTOR, BLADE, ROCKERS, AND UPPER BEARING.

Puller, bearing, RE-T4
Vise, bench, with wood or fiber jaws

Clamp the adapter plate in the vise, open end of the pump up, and use wood or fiber blocks to protect the edges of the plate from the jaws. Slide the blade into the slot in the rotor, put the rockers in place on the ends of the blade and slide the assembly into place in the liner and lower bearing. Put the upper bearing into place and make sure the two dowel pins fit into the holes in the upper end of the liner. (The bearing puller may be used if necessary to handle the upper bearing.)

(4) INSTALL LEAD GASKET.

Install the lead gasket (always use a new one) above the upper bearing.

(5) INSTALL COUPLING PARTS, LOCK NUT, AND SEALS.

Screwdriver, 6-in.
Wrench, special, RE-T5
Vise, bench, with wood or fiber jaws

Put the pump seal coupling, sealing spring, engine seal coupling, oil seal (new one), and seal plate into the open end of the pump in that order. Put the lock nut gasket (new one) onto the lock nut and screw the lock nut into the open end of the pump over the parts just installed. Tighten the nut with wrench RE-T5, leaving a pair of slots in the body and lock nut in alinement. Install the oil seal (new one) in the upper end of the nut, put the seal plate in place, and secure it with the lock ring. Put the lock plate in place and secure it with the screw. Remove the assembly from the vise.

33. TEST BEFORE INSTALLATION.

a. Run In. After assembly the moving parts should turn over easily by hand without pronounced tight spots. Mount the pump on a test stand and run at 1750 revolutions per minute for two hours using kerosene, after which it should be run, using gasoline, for ten minutes, and dried out by disconnecting the lines and running for five minutes.

b. Dry Vacuum Test. If an accurate vacuum gage or a mercury manometer is available a dry vacuum test will give a more accurate indication of the condition of the pump than capacity readings. The vacuum readings on the inlet side with the pump running dry should equal or exceed the following:

250 revolutions per minute	0.8 inch of mercury
500 revolutions per minute	2.0 inches of mercury
1000 revolutions per minute	4.5 inches of mercury
1500 revolutions per minute	6.8 inches of mercury
2000 revolutions per minute	9.0 inches of mercury

c. Shaft Seal Leakage With the pump operating on gasoline at 2500 revolutions per minute against pressures increasing in 5 pounds per square inch increments from 5 pounds per square inch to 25 pounds per square inch the leakage, as checked by removing the lowest drain plug, should not exceed 5 drops per minute. If this leakage is exceeded check the seals.

34. INSTALLATION.

Install the pump by reversing the operations listed in paragraph 31.

Section IV

PRESSURE REGULATOR

35. INSPECTION AND ADJUSTMENT (fig. 11).

The entire working mechanism of the pressure regulator or relief valve is enclosed within the cast body and there is little chance of malfunction unless the whole assembly is damaged. To test the relief pressure remove the plug (3/8-in. wrench) from the left side of the carburetor just above the screen and temporarily install a pressure gage. The pressure should be between 2.5 and 3.5 pounds per square inch, preferably 3 pounds per square inch. If the pressure is not correct, adjust as follows: remove the cap (1 3/8-in. wrench) from the top of the valve, lift out the locking clip or plate, unscrew the threaded adjusting plug, and remove the plug and spring. If the spring is clean and apparently in good condition, put it back into place and screw in the adjusting plug until its upper end is about flush with the end of the cage. Start the engine and screw the adjusting plug in or out until a pressure of 3 pounds per square inch is secured. Install the locking clip or plate which holds the plug in a fixed position in the cage. Install the screw cap (1 3/8-in. wrench), using a new lead washer if the old one has been damaged, and new locking wire. Stop the engine, remove the pressure gage, and install the plug (3/8-in. wrench). If proper adjustment cannot be secured by this pro-

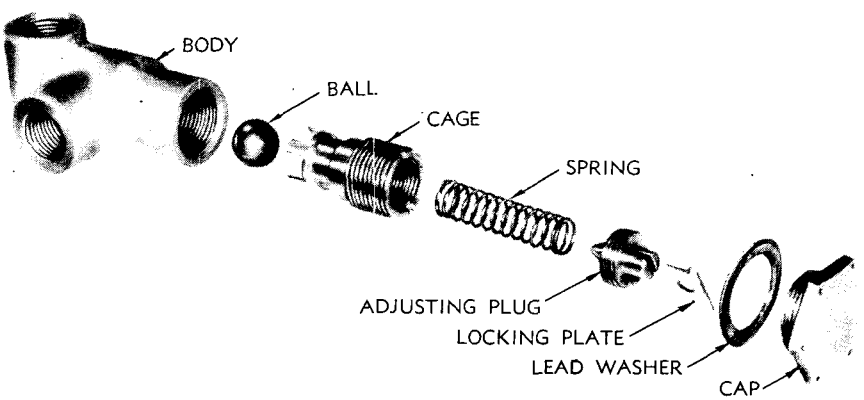


Figure 11—Fuel Pressure Regulator or Relief Valve

cedure and the pump is known to be functioning properly, remove and overhaul the regulator.

36. REMOVAL.

Close the fuel shut-off valves. Unscrew the hose coupling nut (5/8-in. wrench) from the left or inlet side of the regulator. Unscrew the outlet line coupling nut (3/4-in. wrench) from the front connector. Unscrew the primer line coupling nut (7/16-in. wrench) from the right side connector. (Plug the open ends of the lines to prevent entrance of dirt.) Remove the two nuts (7/16-in. wrench) and lock washers from the front ends of the U bolt, remove the U bolt from the regulator and bracket, and remove the regulator.

37. OVERHAUL.

The following tools are used in overhauling the pressure regulator.

Pliers
Screwdriver, 6-in.
Screwdriver or drag link with blade, 7/8-in. x 3/32-in.
Vise, bench
Wrench, 1 3/8-in.

a. Remove Cap and Lead Sealing Washer.

Vise, bench
Wrench, 1 3/8-in.

Clamp the assembly in a vise (cap up), unscrew the cap (1 3/8-in. wrench) and remove the lead sealing washer.

b. Remove Locking Clip or Plate, Adjusting Plug and Spring.

Screwdriver, 6-in.

Lift the locking clip or plate out of the cage and plug with the fingers or the end of the screwdriver. Unscrew and remove the adjusting plug and lift out the spring.

c. Remove Cage and Ball.

Screwdriver or drag link, 7/8-in. x 3/32-in.
Vise, bench

With the body of the regulator held in the vise, unscrew and remove the cage. Remove the body from the vise and turn it upside down to remove the ball.

d. Clean and Repair. Clean the body by compressed air and the other parts with SOLVENT, dry cleaning. There is little repair other than the replacement of damaged parts.

e. Assembly. The regulator is assembled by reversing the procedure given in paragraphs 37 **a**, **b**, and **c**.

38. INSTALLATION AND ADJUSTMENT.

a. Installation. Install regulator by reversing the procedure given in paragraph 36.

b. Adjustment. Adjust the regulator as instructed in paragraph 35 but do not remove the adjusting plug and spring for inspection.

Section V

CARBURETOR

39. DESCRIPTION (fig. 12).

The Stromberg carburetor, Model NA-R9D, is a single barrel updraft model having an accelerating pump, hinge type float assembly, idle cut-off, and needle type economizer. The principles of operation as de-

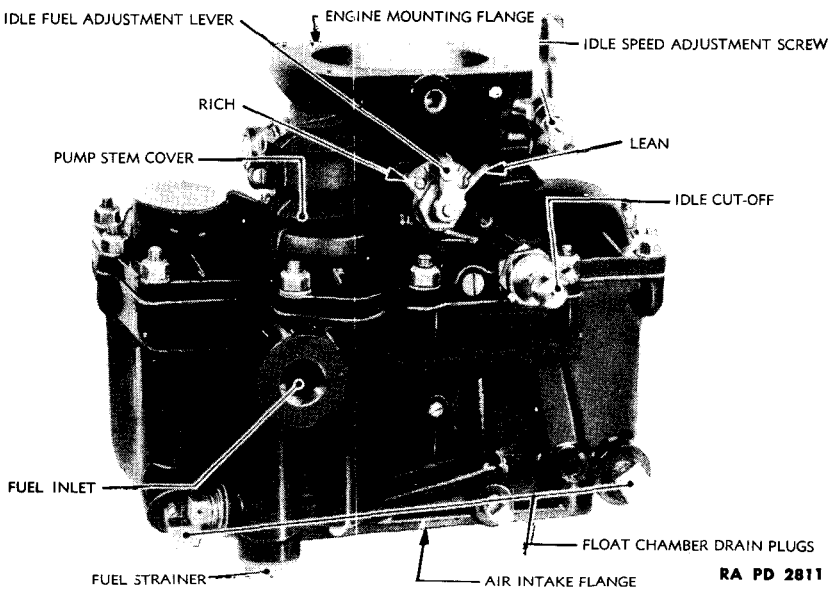


Figure 12—Stromberg Carburetor NA-R9D

scribed in these instructions are quite similar to those used in all aircraft and motor car carburetors. The setting of the carburetor as described herein is vital to the performance of the engine and should be strictly complied with.

40. SPECIFICATIONS AND CONSTRUCTION.

a. Specifications. Table of specifications for NA-R9D carburetor used on Wright Whirlwind R-975-Ec 2 engine:

Venturi	2⅝ in.
Main metering jet	No. 27
Economizer metering jet	No. 47
Main metering air bleed	No. 55
Economizer needle seat	No. 34
Economizer setting	28°
Throttle valve angle	18°
Idle tube assembly	No. 48
Idle air bleed	No. 60
Idle discharge jet	A-60, B-70, C-60, D-56
Pump valve	4-No. 45
Pump discharge nozzle	No. 50
Fuel level in float bowl (.710 sp. gr.)	⅞ inch below parting surface

b. Construction.

(1) ACCELERATING PUMP SYSTEM (figs. 13 and 15). For smooth and quick acceleration of an aircraft engine a quantity of fuel in addition to that supplied by the regular metering system is required. A fuel pump operated by the throttle has, therefore, been incorporated in the design of the carburetor. The fuel pump consists of an inverted cylinder or sleeve connected to the throttle in such a way that it is depressed as the throttle is opened; a piston, free to slide on a valve; and the necessary drilled passages to the pump discharge nozzle. When the throttle is closed or in any fixed position, the piston is held at the top of the pump valve by a spring, thus closing off the holes in the valve. The fuel enters the space above the piston through the clearance space between the piston and sleeve. As the throttle is opened and the pump sleeve depressed, the pump piston is forced down by the gasoline, thus opening the holes in the valve and allowing the gasoline to be forced out of the pump discharge nozzle. Fuel leaving the pump valve enters the vertical passage in the main body (fig. 14). Passing through a hole in the gasket, fuel reaches the discharge nozzle. The discharge nozzle is pressed into the throttle body via a vertical hole in the throttle body that matches the corresponding hole in the main body.

(2) FLOAT MECHANISM. A float mechanism of the Y type is used to maintain a constant fuel level at the main discharge nozzle (fig. 18). This consists of two stainless steel floats connected by means of a forked float

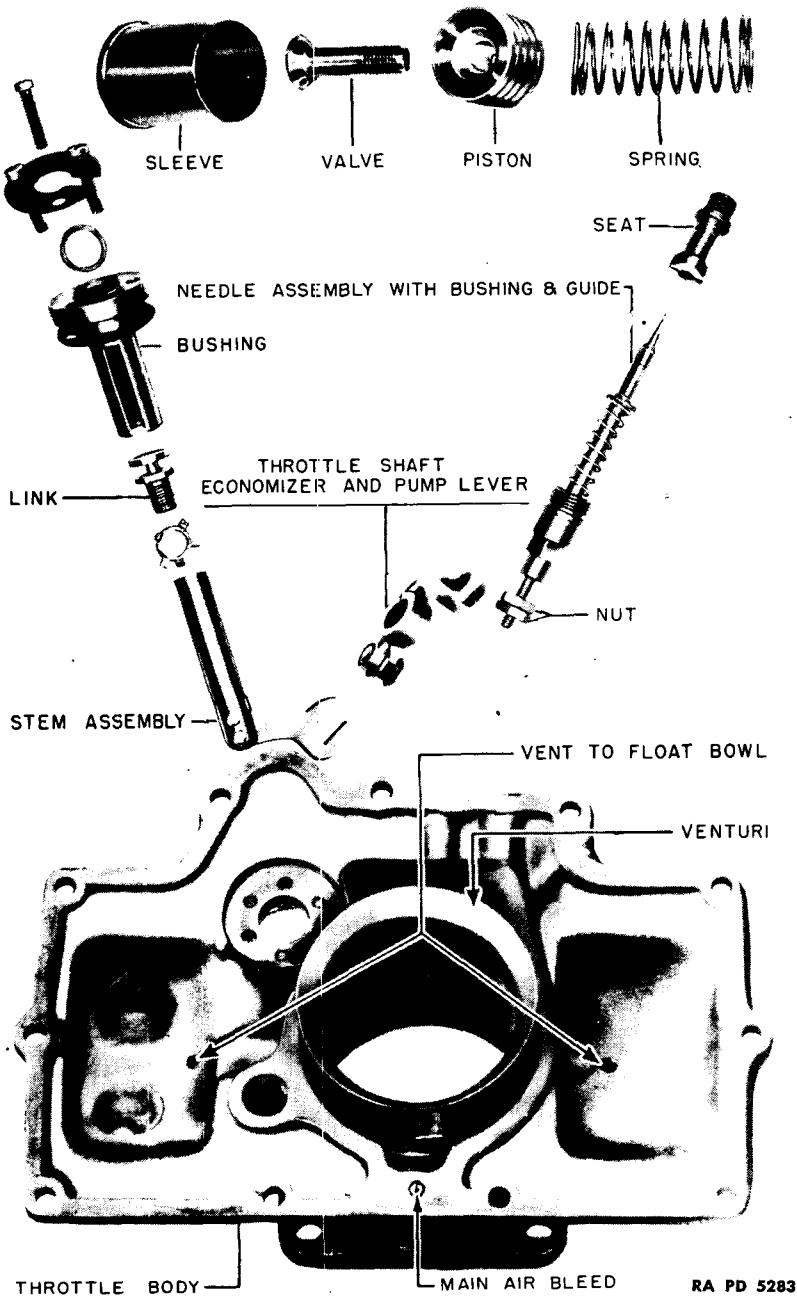


Figure 13—Economizer and Acceleration Pump Assemblies

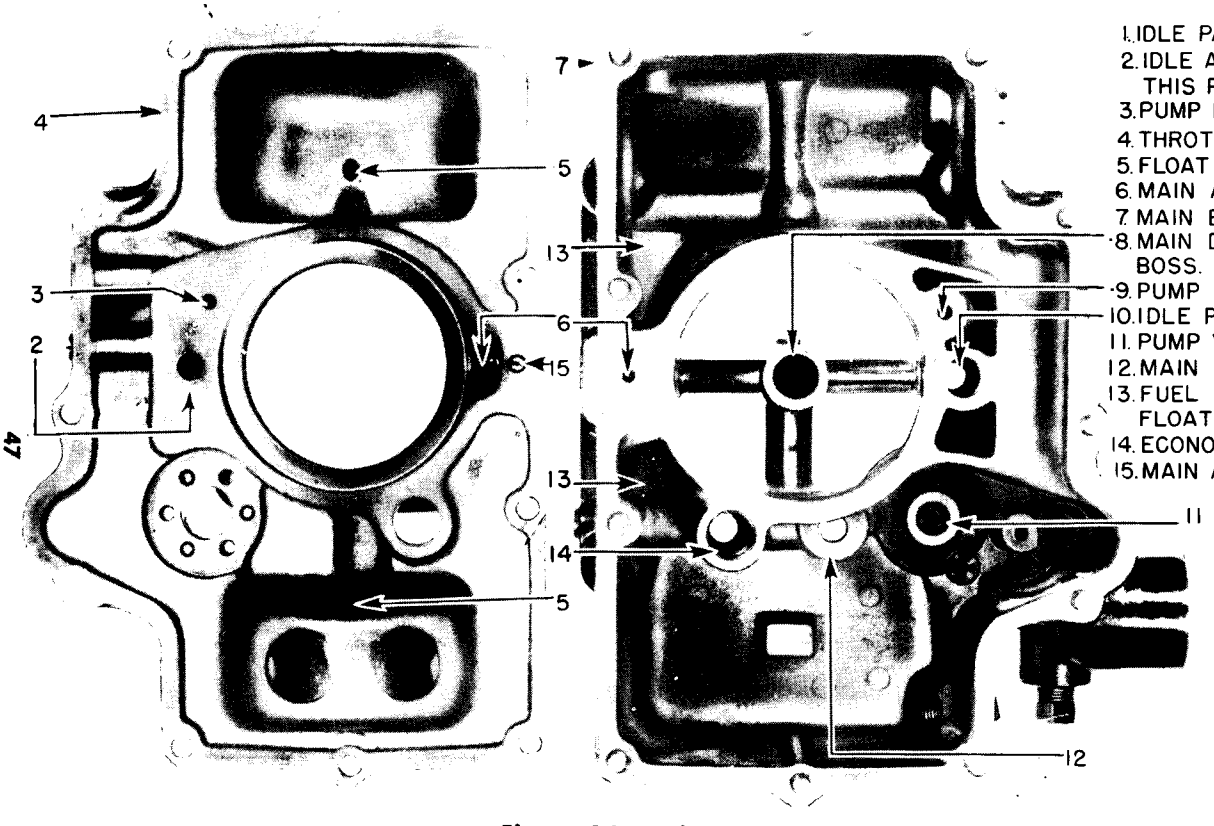
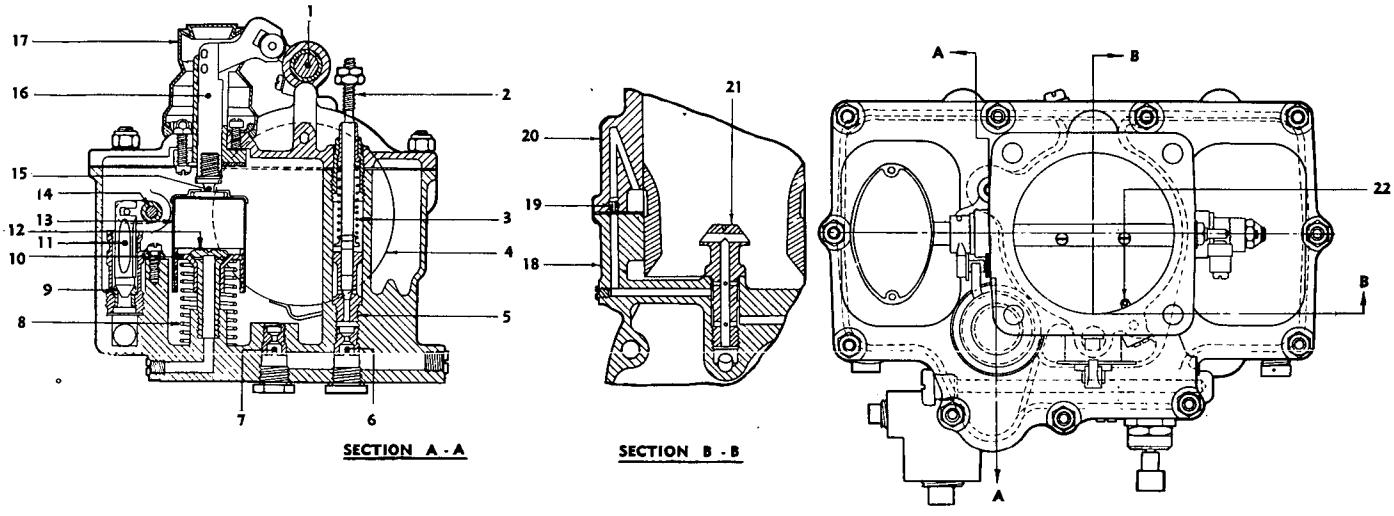


Figure 14—Main and Throttle Bodies



1 — THROTTLE SHAFT
2 — ECONOMIZER NEEDLE
3 — SPRING
4 — FLOAT
5 — SEAT
6 — ECONOMIZER METERING JET
7 — MAIN METERING JET
8 — SPRING
9 — FLOAT VALVE SEAT
10 — PISTON
11 — FLOAT VALVE
12 — VALVE
13 — SLEEVE
14 — FLOAT FULCRUM SCREW
15 — LINK
16 — STEM & FORK ASS'Y
17 — PUMPSTEM COVER
18 — MAIN BODY
19 — MAIN AIR BLEED
20 — THROTTLE BODY
21 — MAIN DISCHARGE NOZZLE
22 — PUMP DISCHARGE NOZZLE

RA PD 2819

Figure 15—Stromberg Carburetor Assembly—Cross Section

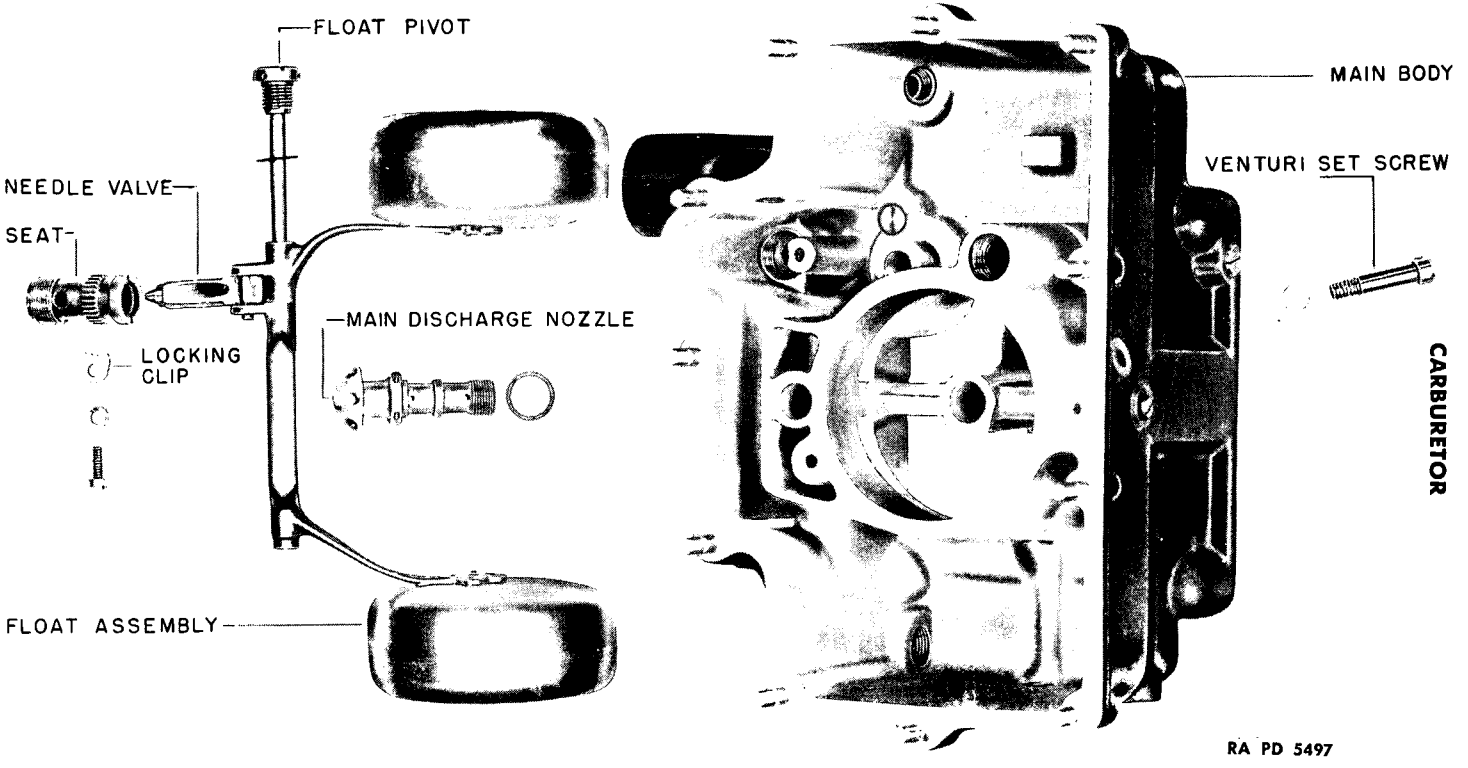


Figure 16—Float Assembly

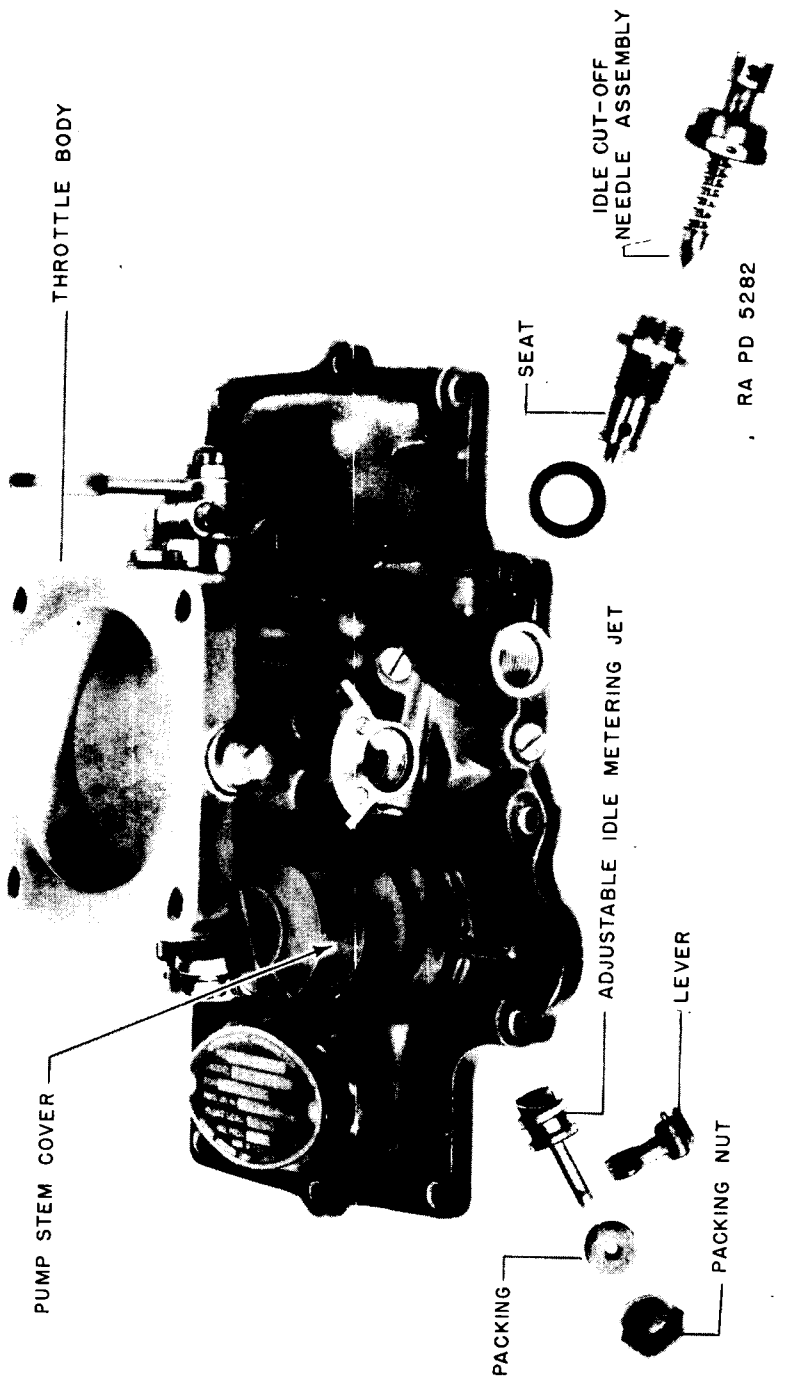


Figure 17—Idle Cut-Off Valve and Idle Jet Assemblies

CARBURETOR

hanger, which operates a single float needle valve. Each float operates in a float chamber having ample fuel capacity to function properly in all ordinary maneuvers. The two float chambers are connected by a fuel passage cast in the main body and an air vent passage in the throttle valve body (fig. 14).

(3) MAIN METERING SYSTEM. The main metering system used in this carburetor is of the type which uses an air bleed to the main discharge nozzle (fig. 15). The main discharge nozzle, of the rosette type, located at the center of the venturi, is screwed into a boss projecting into the air intake (figs. 16 and 18). The main air bleed, a small headless screw plug with the proper size hole drilled through it, is located in a passage in the throttle body so that air can be drawn from behind the venturi through the bleed and then into the main discharge nozzle through holes in the wall of the nozzle. The actual metering of the fuel is accomplished by the main metering jet located in a passage between the main discharge nozzle and the float chambers.

(4) IDLING SYSTEM. Inasmuch as the main metering system will not function at very low air flows (low engine speeds), an idling system is provided. This consists of an idle tube with an idle metering orifice near the bottom and several air bleed holes in the wall, an idle air bleed, and adjustable idle discharge nozzle (fig. 17). Fuel for the idle system is

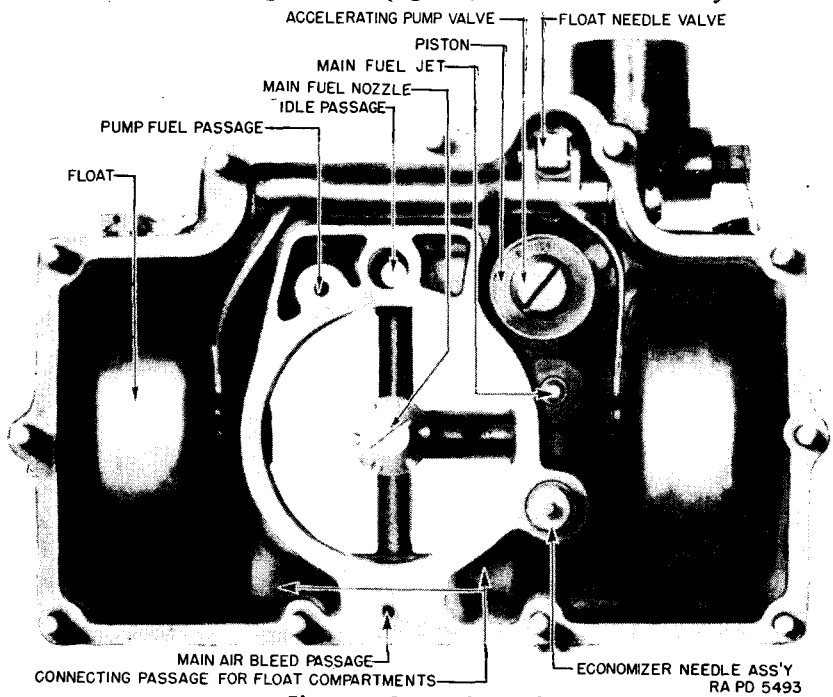


Figure 18—Fuel Bowl

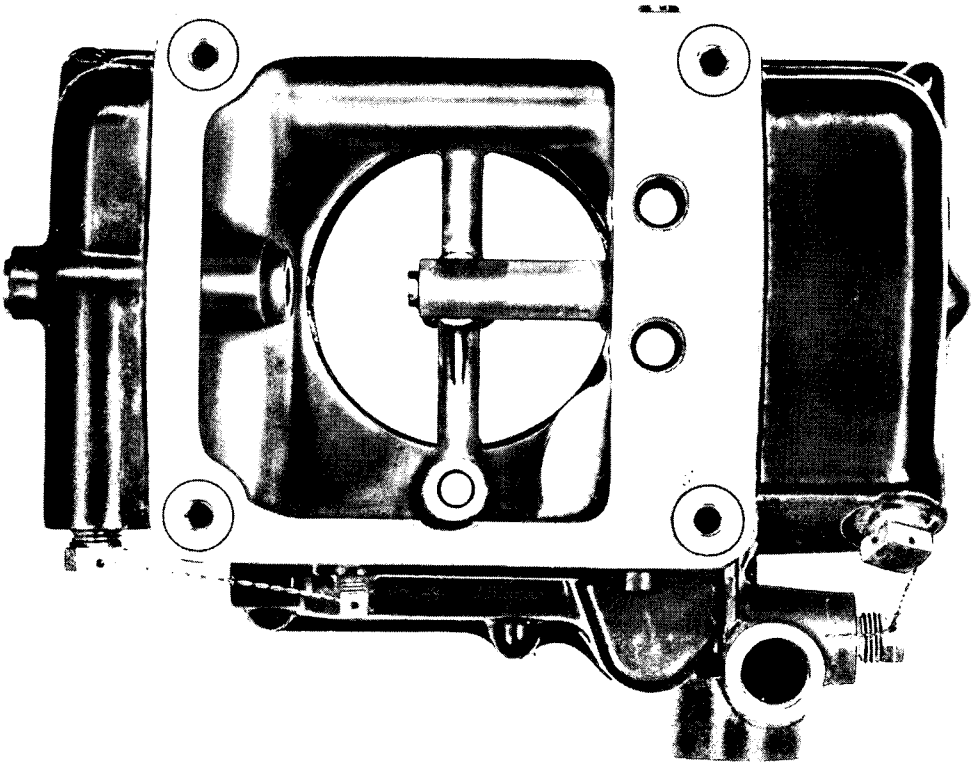
taken from the annular space around the main discharge nozzle and passes through the idle metering jet (a hole in the idle tube holder between the threads and the head). Air from the annulus around the venturi is drawn through an idle air bleed (fig. 14) and enters the annulus formed by the vertical idle passages of the throttle and main bodies and the idle tube (fig. 19). The air passes into the idle tube by means of two cross holes drilled in the tube near the end which is pressed into the holder. The fuel and air in the idle tube pass through an adjustable idle metering jet (fig. 17) before being released in the throttle bore. The idle system operates up to an engine speed of about 900 to 1000 revolutions per minute (no load on engine).

(5) ECONOMIZER METERING SYSTEM. The economizer system as applied to this carburetor is in reality an enriching device, which provides a rich mixture at full throttle for maximum power and permits a leaner mixture at part throttle for maximum economy. This device consists of a needle valve and seat located in a passage between the main discharge nozzle and the float chamber (figs. 13 and 15). The needle valve is held on its seat by a spring at idling and part throttle so that no fuel can flow past the needle valve seat. At about 46 degrees throttle valve opening, a lever fastened to the throttle shaft engages a nut on the needle valve stem and raises the needle off its seat so that fuel is then drawn past the needle valve and into the main metering system. An economizer metering jet is provided directly below the needle valve seat to insure accurate metering of the fuel passing through the economizer system (fig. 19).

(6) IDLE CUT-OFF. The idle cut-off as used on this carburetor consists of a spring-loaded needle valve located in such a position that when it is open the suction from the idle discharge nozzle is diverted from the idle tube to the space behind the venturi. This causes the flow of fuel from the idle discharge nozzle to stop, which immediately causes the engine to cease firing (fig. 17).

41. PREVENTIVE MAINTENANCE.

Once the carburetor is properly installed and the idle adjustments made very little maintenance is required. A fuel strainer is located at the lower right side of the carburetor and may be removed after removal of the large square head plug at the lower right side of the carburetor. A small square head plug is provided as a drain in the bottom of each float chamber. Remove the strainer and drain plugs frequently to remove any dirt or water which may have accumulated in the strainer chamber or the float chambers. Inspect the entire carburetor to see that all parts are tight and properly made safe, and put a small quantity of oil on the pump operating mechanism (fig. 13). This carburetor is equipped with a float



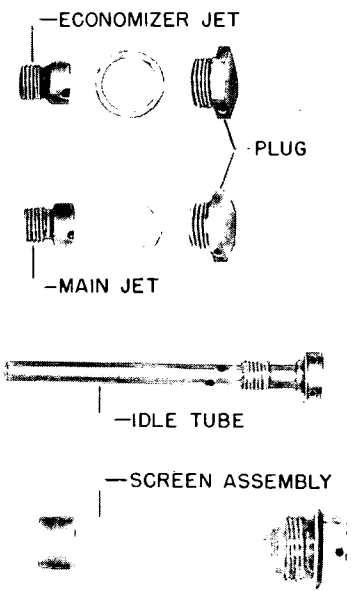


Figure 19—Air Horn Flange of Main Body

needle valve and seat which requires a fuel pump that will maintain three pounds per square inch pressure at the fuel inlet.

42. POSSIBLE CAUSES OF TROUBLE.

If the carburetor fails to deliver the proper fuel mixture for maximum power at open throttle, the trouble may be attributed to one or a combination of the following causes:

a. The Fuel Pressure to the Carburetor Is Too High or Low. This pressure, measured at the carburetor, should read between two and three pounds, depending upon the speed of the engine. The ¼-inch pipe plug on the carburetor strainer boss connects to the outside of the strainer screen. If the strainer screen is plugged, the fuel pressure to the float valve needle will not be sufficient to supply fuel to the carburetor bowl and the mixture will go thin at open throttle rated speed.

b. The Idle Cut-Off Needle Does Not Seat Properly. This will cause the mixture ratio to thin out, especially at high engine speeds and open throttle.

c. Float Needle Held Open. A broken or punctured float may hold the needle open so that the float level rises and makes the mixture ratio too rich.

d. If the accelerating pump piston does not seat and close off the holes in the pump valve, fuel will flow out of the pump discharge nozzle at the throttle openings beyond governed idle speed and make the mixture ratio too rich.

e. Plugged or restricted passages to the air bleed of the main fuel jet will enrich the fuel mixture.

f. The volume above the fuel in the bowl is connected to the air horn by the tortuous passages. Any restriction in these passages will cause the mixture ratio to vary. This variation will be especially noticeable between cool and hot engines.

43. POSSIBLE CAUSES OF TROUBLE AT IDLE SPEED.

If the idle mixture fails to adjust or is not stable, the following list shows the places in the carburetor in which to look for trouble.

a. The position of the economizer jet and main fuel jet may be reversed.

b. The idle adjustment lever may be installed on the adjustable idle jet 180 degrees from the correct position.

c. A float mechanism that drags or binds will cause a variation in fuel level.

d. The idle air bleed or passages may be restricted or plugged.

e. The gasket may leak between the carburetor throttle body and the inlet manifold.

f. The idle cut-off valve may not be seating.

CARBURETOR

44. REMOVAL.

If necessary to remove or replace the carburetor, proceed as follows:

a. Check to see that fuel shut-off valves are closed.

b. Disconnect the fuel line and drain lines.

c. Disconnect the fuel cut-off and accelerator linkage.

d. Disconnect air intake connections at flexible connector.

e. Remove the locking wire and the four bolts holding the carburetor to the intake manifold flange and remove carburetor. Disconnect air intake pipes.

45. DISASSEMBLY.

Disassemble the carburetor for cleaning and inspect it each time the engine is overhauled. Use the following procedure for disassembly of the carburetor.

a. Disassembly of Throttle Body.

(1) EQUIPMENT:

Hammer
Pliers
Plug, wooden
Punch
Screwdriver
Screwdriver, metering jet
Wrench, box or socket, $\frac{7}{16}$-in.
Wrench, open-end, $\frac{7}{8}$-in.
Wrench, open-end, box or socket, $\frac{1}{2}$-in.
Wrench, special socket, $\frac{3}{4}$-in.

(2) PROCEDURE.

(a) Remove air horn. Remove locking wire. Remove four cap screws ($\frac{1}{2}$-in. open-end, box or socket wrench) attaching air horn to main body of carburetor.

(b) Remove venturi set screw. Remove locking wire. Remove set screw (screwdriver).

(c) Separate throttle body from main body. Remove eleven $\frac{1}{4}$-in. hexagon head safety nuts from studs of main body attaching throttle body to main body ($\frac{7}{16}$-in. box or socket wrench). Remove washers. Separate throttle body from main body. Do not damage gasket or pump sleeve.

(d) Remove pump sleeve. Remove sleeve from pump link. Do not distort or drop sleeve.

(e) Remove pump link. Fold locking ears of washer away from link (screwdriver). Remove link and washer ($\frac{1}{2}$-in. open-end wrench).

(f) Remove pump stem bushing and pump stem assembly with cover. Separate pump stem cover and plate. Remove three cotter pins from screws holding pump stem bushing to throttle body. Remove screws,

plate, and pump stem bushing. Remove pump stem assembly with cover.

(g) Remove idle cut-off assembly. Remove locking wire from packing nut. Remove packing nut with idle cut-off valve (⅞-in. open-end wrench). Remove idle cut-off seat (⅞-in. open-end wrench).

(h) Remove throttle shaft. Drive out tapered pin locking pump stem lever to throttle shaft (hammer and punch). Loosen clamp screw. Remove lever. Remove two screws with lock washers holding throttle valve to throttle shaft. Mark shaft before removal. Remove throttle shaft.

(i) Remove adjustable jet assembly. Remove packing nut, lever and adjustable idle jet assembly (¾-in. special socket wrench).

(j) Remove idle air bleed. Remove exterior plug (screwdriver). Remove jet exposed by removal of plug (special screwdriver).

(k) Remove main jet air bleed. Remove bleed.

(l) Remove venturi (fig. 12). Drive venturi out of throttle body, using wooden plug.

b. Disassembly of Main Body.

(1) EQUIPMENT.

Pliers	Wrench, box or socket, $\frac{11}{16}$-in.
Screwdriver	Wrench, open-end, ½-in.
Screwdriver, metering jet	

(2) PROCEDURE.

(a) Remove parting surface gasket. Remove gasket.

(b) Remove economizer needle assembly. Remove bushing (½-in. open-end wrench). Lift out assembly.

(c) Remove economizer needle seat. Remove seat.

(d) Remove metering jets and plugs. Remove locking wire from plugs over jets ($\frac{11}{16}$-in. box or socket wrench). Remove plugs (metering jet screwdriver, fig. 23) and jets.

(e) Remove idle tube assembly. Remove locking wire. Remove idle tube assembly (screwdriver).

(f) Remove main nozzle. Remove locking wire. Remove main nozzle (screwdriver).

(g) Remove floats and float valve. Remove locking wire. Remove float fulcrum screw assembly (screwdriver). Remove floats with needle.

(h) Remove pump valve, piston and spring. Remove pump valve (screwdriver), piston and spring. Do not damage exterior surface of valve or piston.

(i) Remove float valve seat assembly. Remove screw holding locking clip. Remove clip. Using a special screwdriver, remove seat assembly.

CARBURETOR

46. REPAIR.

a. Cleaning and Inspection.

(1) CLEANING. Clean the bodies and all parts thoroughly in SOLVENT, dry cleaning, and blow out all passages with compressed air.

(2) INSPECTION. Inspect all moving parts to see that they do not have excessive clearance and that they are in agreement with the limits established by the table of clearances.

b. Throttle Shaft Bushings. Should the throttle shaft bushings require replacing, remove the old bushings with the BS-T19492 bushing remover. Upon removing the old bushings and pressing in the new bushings aline ream with the new bushings with BS-P-14498-T-18 (.5023-in. diameter) reamer and use a new throttle shaft on assembly (fig. 20). Use a new throttle shaft stop and pump and economizer lever with a new throttle shaft. Pin the throttle shaft stop on the throttle shaft as shown in figure 21 and figure 22. Insert the throttle shaft in the throttle body and clamp the economizer lever in the correct position, allowing about .030-inch end play between the throttle bushings and the throttle stop. Mark the pump and economizer lever, remove it from the shaft, and drill and ream it as instructed in figure 21.

(NOTE: In the following table and in all "Tables of Clearances" which appear hereafter in this manual, the symbol L denotes a "loose fit," i.e., undersized; the symbol T denotes a "tight fit," i.e., oversized.)

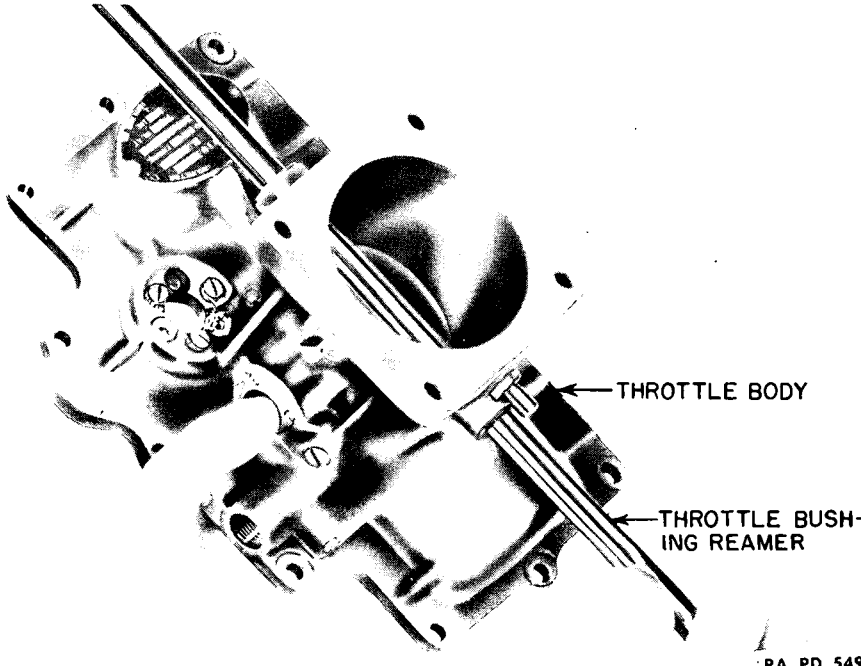
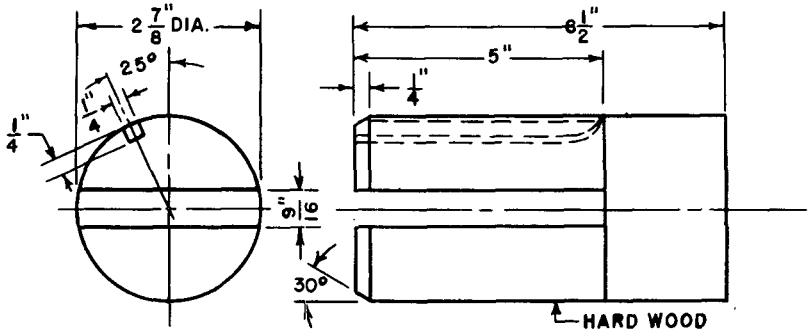
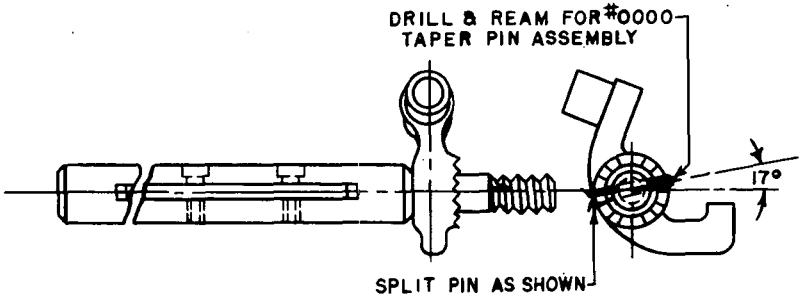


Figure 20—Aline Reaming Throttle Shaft Bushing

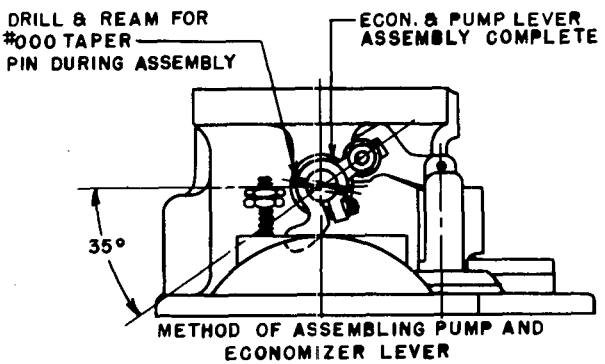
ORDNANCE MAINTENANCE—ACCESSORIES FOR WRIGHT R975-EC2 ENGINES FOR MEDIUM TANKS M3 AND M4



NA-R9D VENTURI REMOVAL PLUG



THROTTLE STOP & SHAFT ASSEMBLY



METHOD OF ASSEMBLING PUMP AND ECONOMIZER LEVER

RA PD 4891

Figure 21—Venturi Removal Tools and Throttle Stop Assembly

CARBURETOR

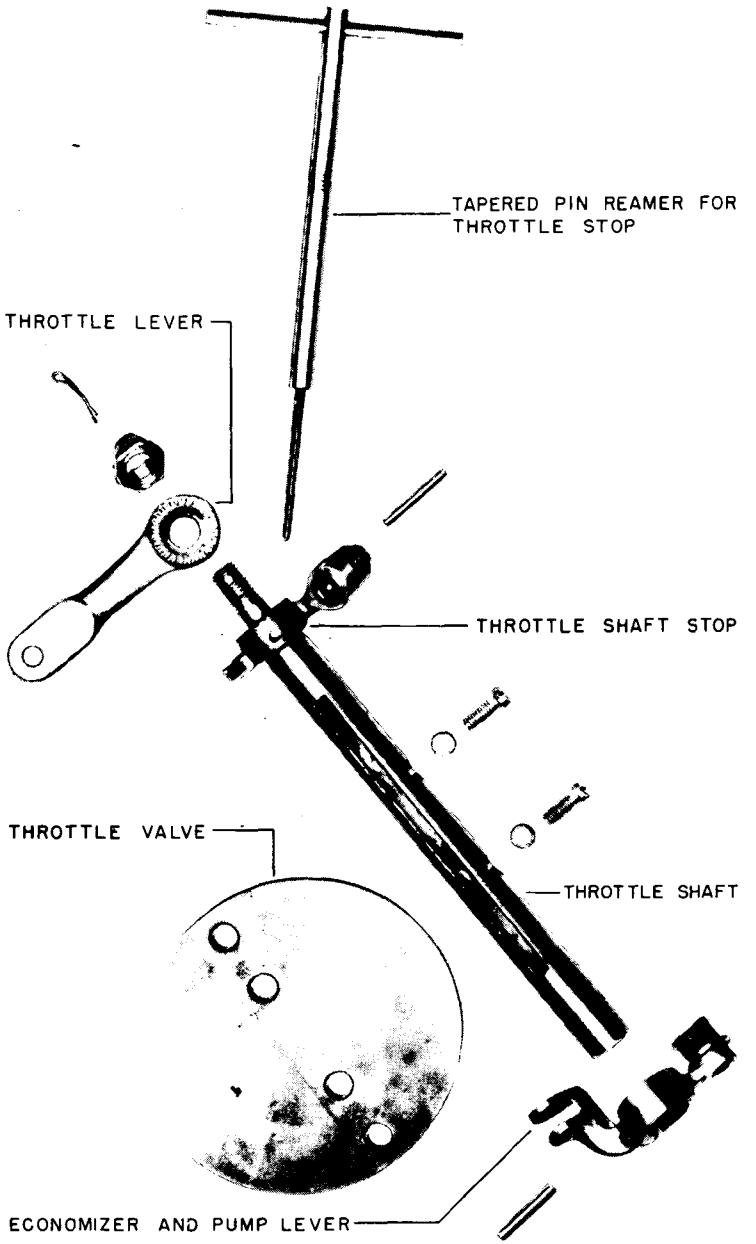


Figure 22—Throttle Shaft Assembly and Taper Reamer

c. Table of Clearances.

	Min.	*Desired*	*Max.*	*Correction*
Float fulcrum pin in float bearing.	0.001 -in. L	0.0025-in. L	0.009 -in. L	Replace float and/or fulcrum pin.
Float bearing end play	0.005 -in. L	0.015 -in. L	0.024 -in. L	Change thickness of gasket under fulcrum pin.
Float pin in needle slot	0.007 -in. L	0.014 -in. L	0.020 -in. L	Replace float if pin is worn or needle if it is worn.
Throttle shaft and bushings	0.001 -in. L	0.0015-in. L	0.007 -in. L	Replace bushings and/or shaft if worn.
Accelerating pump piston and sleeve	0.0025-in. L	0.0040-in. L	0.0085-in. L	Replace worn parts.
Accelerating pump stem and bushing	0.001 -in. L	0.002 -in. L	0.010 -in. L	Replace worn parts.
Accelerating pump fork and block..	0.0005-in. L	0.0035-in. L	0.010 -in. L	Replace worn parts.
Float level	Minus $\frac{3}{64}$-in.	as specified	Plus $\frac{1}{64}$-in.	Change gasket thickness under needle seat.

d. Refer to table of specifications in paragraph 4.

47. UNIT ASSEMBLY OPERATIONS.

a. Headless Screws.

Assemble all headless screw plugs below the fuel level with shellac, being careful not to get it on the end of the plug where it will come off and be carried by the fuel into one of the metering orifices. Headless screw plugs above the fuel level and all other threaded parts screwed into the bodies should have a compound of graphite and castor oil put on the threads.

b. Venturi Tube. Use a new packing to reassemble the venturi tube. Also, when fitting the throttle body over the venturi tube, put a small amount of OIL, engine, SAE 10, on the venturi packing so that the throttle body will not cut it.

c. Throttle Assembly. To replace the throttle shaft, pump lever or throttle stop, assemble the lever and stop as shown in figure 21. Fit the throttle valve so that it excludes practically all light when in the closed position.

d. Float Mechanism. In replacing a float needle valve or a needle valve seat, replace these two parts at the same time, as it is very difficult to fit a new needle to an old seat or a new seat to an old needle. The float level should be 1 inch below the parting surface and is adjusted by the thickness of the gasket under the float needle valve seat. Check the level under the conditions encountered in service as regards the fuel used and the fuel pressure or head at the carburetor. The fuel level was set at the factory using 1½ pounds per square inch fuel pressure (60-in. gasoline head at 0.710 sp. gr.). If after assembling, the level is not correct, remove the needle valve seat and put in thicker gaskets

to lower the level and thinner gaskets to raise it. A change in gasket thickness of $\frac{1}{64}$ inch will change the level approximately $\frac{5}{64}$ inch.

e. Economizer Setting. The position of the economizer needle adjusting nut determines the engine speed at which the needle is lifted off its seat, and it is, therefore, important that this be set correctly so that the engine will not be operating on too lean a mixture near full throttle or too rich a mixture at part throttle. The throttle opening at which the economizer should come in is given on the specification sheet as the economizer setting. This is the travel in degrees of the throttle valve from closed position to that point where the forked lever on the throttle shaft engages the economizer needle adjusting nut. To find the angle which the valve makes with the horizontal flange surface when the economizer comes in, add the throttle valve angle (given on the specification sheet) to the economizer setting. If the setting is 33 degrees and the throttle valve angle is 20 degrees, the angle which the throttle valve will make with the horizontal flange surface when the forked lever engages the economizer needle is 53 degrees. When the final adjustment is made, use another nut to lock or to jam the adjusting nut, being careful, however, not to change the setting (fig. 21).

48. ASSEMBLY OF CARBURETOR.

Use the following procedure in assembling the carburetor, observing the precautions and methods outlined in paragraph 46.

a. Equipment.

Hammer	Wrench, box or socket, $\frac{11}{16}$-in.
Pliers	Wrench, open-end, $\frac{7}{16}$-in.
Plug, wooden	Wrench, open-end, $\frac{1}{2}$-in.
Press, arbor	Wrench, open-end, $\frac{7}{8}$-in.
Screwdrivers	Wrench, socket, special, $\frac{3}{4}$-in.
Screwdrivers, special	Wrench, special, $\frac{3}{4}$-in.

b. Throttle Body Assembly.

(1) INSTALL VENTURI (fig. 21).

Plug, wooden — Press, arbor, or hammer

Line venturi up and press or drive into position. Install with hammer and wooden plug.

(2) INSTALL MAIN AIR BLEED.

Screwdriver

Install main bleed jet in throttle body.

(3) INSTALL IDLE AIR BLEED.

Screwdrivers, two

Install idle bleed jet in throttle body passage. Then install jet passage plug.

(4) INSTALL ADUSTABLE IDLE JET.

Wrench, socket, special, $\frac{3}{4}$-in.

Install adjustable idle jet assembly.

(5) INSTALL THROTTLE SHAFT ASSEMBLY.

Install shaft. Install pump stem lever, tightening clamp screw when holes in lever are lined up with hole in shaft. Install tapered pin locking pump stem lever to throttle shaft. Install throttle valve.

(6) INSTALL IDLE CUT-OFF ASSEMBLY.

Wrench, open-end, 7/8-in.

Install seat. Install valve assembly. Do not tighten pack nut sufficiently to cause the valve to stick.

(7) INSTALL PUMP STEM BUSHING AND PUMP STEM ASSEMBLY.

Pliers Screwdriver

Install pump stem cover on pump stem assembly. Insert pump stem through hole in casting and hook fork of pump stem over pump lever. With gasket on pump stem bushing, insert through hole in casting. Place packing, washer, and plate over end of pump stem bushing. Install three nuts and screws holding pump stem bushing in place. Install cotter pins to lock nuts in place.

(8) INSTALL PUMP LINK.

Wrench, open-end, 1/2-in.

Install locking washer. Install pump link. Lock link in place with two ears of the locking washer.

(9) INSTALL SAFETY WIRE.

Pliers

Safety wire all parts drilled for the use of safety wire.

(10) INSTALL PUMP SLEEVE.

Install sleeve on link.

c. Main Body Assembly.

(1) INSTALL FLOAT VALVE SEAT ASSEMBLY.

Screwdriver Screwdriver, special

Install seat. Install locking clip. Using screw and lock washer to secure clip to main body.

(2) INSTALL PUMP PISTON.

Screwdriver

Place coil spring in position. Slip valve through hole in piston, entering shallow counterbored end of piston first. Install valve with piston in main body.

(3) INSTALL FLOAT VALVE AND FLOAT ASSEMBLY.

Screwdriver

Hang needle on float valve lever. Install float and needle. Install float fulcrum screw.

(4) INSTALL MAIN NOZZLE.

Screwdriver

Install main nozzle and secure with locking wire.

(5) INSTALL IDLE TUBE.
Screwdriver
Install idle tube assembly and secure with locking wire.

(6) INSTALL METERING JETS AND PLUGS.
Screwdriver, special Wrench, box or socket, $\frac{11}{16}$-in.
Install jets, making certain the correct jet goes in each passage. Install plugs.

(7) INSTALL ECONOMIZER NEEDLE ASSEMBLY AND SEAT.
Screwdriver, special Wrench, open-end, ½-in.
Install needle seat. Then install needle assembly.

(8) INSTALL SAFETY WIRE.
Pliers.
Safety wire all parts drilled for the use of safety wire.

(9) INSTALL PARTING SURFACE GASKET.
Place gasket on main body parting surface, with studs passing through correct holes in gasket.

(10) JOIN THROTTLE BODY WITH MAIN BODY.
Wrench, box or socket, $\frac{7}{16}$-in.
Join the two castings together, making certain the piston enters the pump sleeve and the pump lever is beneath the nuts on the economizer needle. Install eleven safety nuts to main body studs.

49. TEST.

a. Description. Before attaching the throttle body to the fuel bowl, test the behavior of the float mechanisms provided that equipment is available. This test may be accomplished by connecting the fuel inlet to a gasoline line having a pressure of 1½ pounds per square inch. If the specific gravity of the fuel being used on this test is not 0.710, the fuel level varies within small limits, according to the following formula:

$$\frac{1 \times \text{Specific gravity of fuel used}}{0.710} = \text{distance in inches below parting surface for desired float level of the fuel being used in testing float level.}$$

b. Testing. After checking to make certain the float needle valve does not leak and that the float mechanism has no drag or sticky places throughout its range of operation, let the carburetor bowl stand for ½ hr., and keep pressure on the fuel inlet all the while. Check the exterior of the bowl for leaks.

50. INSTALLATION.

a. Using a new gasket, attach carburetor with air horn to intake manifold flange, using four bolts and nuts. Install safety wire.

b. Connect hoses attaching carburetor air horn to air intake air pipes and tighten clamps.

c. Connect the idle cut-off and accelerator linkage.
d. Connect the fuel and drain lines.
e. Open the fuel tank valves.
f. Check all connections for leaks.

51. ADJUSTMENT.

A small lever at the rear of the throttle valve body may be moved to control the richness of the mixture at idling speeds. A quadrant behind this lever indicates by the letters R and L the direction in which to move it to obtain a rich or lean mixture. To aid in setting the idle mixture on installations where the quadrant is not visible, the stop on the lean side of the quadrant has been made longer than that on the rich side. This arrangement enables the mechanic to adjust the idle mixture correctly. The quadrant is also notched in the adjustment range so that the adjustment lever will remain in place after being correctly set. To obtain the desired idling speed, adjust the throttle stop on the throttle shaft next to the throttle lever. Set both the idle speed adjustment and idle mixture adjustment with the engine hot to maintain the proper idling speed and smooth operation.

52. SPECIAL TOOLS.

Name	Overhaul Tools Size	Tool No.
Bar, extension	5-in. long	BX-T31946
Handle, sliding offset	8-in. long	BX-T19279
Reamer, taper pin	No. 0000	BX-T24957
Reamer, throttle bushing	0.5023	BX-P14498-T-18
Remover, bushing	3/8-in. to 5/8-in.	BX-T19492
Screwdriver, socket	0.048-in. x 0.547-in.	BX-T20199

Name	Overhaul Tools Size	Tool No.
Screwdriver, metering jet	Types "A" and "B"	BX-T24923
Screwdriver, socket	0.062-in. x 0.672-in.	BX-T19272
Screwdriver, socket float needle valve seat	0.068-in. x 3/4-in.	BX-T19276
Socket, double hex.	7/16-in.	BX-T25061
Socket, double hex.	1/2-in.	BX-T24942
Socket, double hex.	11/16-in.	BX-T21425
Socket, double hex.	3/4-in.	BX-T20198
Socket, key release		BX-T24949
Socket, square	11/16-in.	BX-T24963
Wrench, end	11/16-in. x 7/8-in.	BX-T18160
Wrench, end	3/4-in. x 13/16-in.	BX-T20222

CARBURETOR

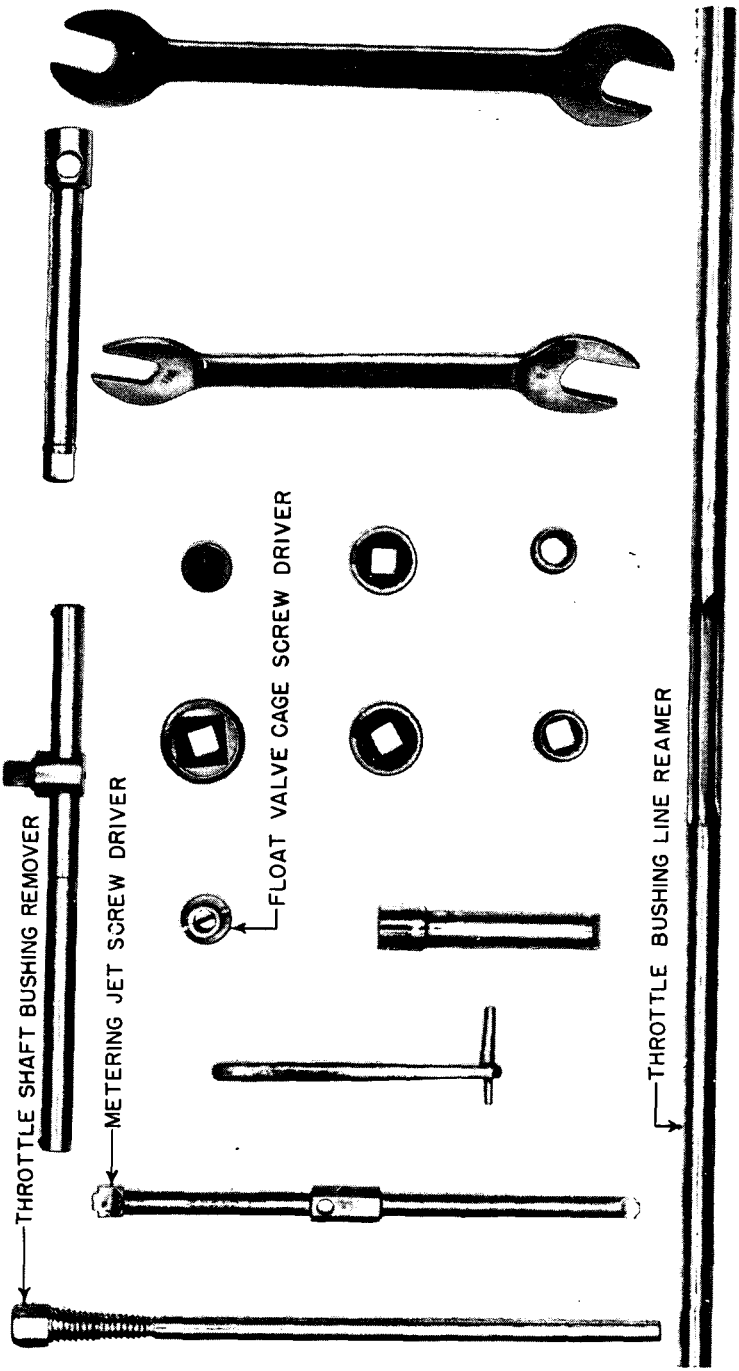


Figure 23—Overhaul Tools for Stromberg Carburetor

Section VI

PRIMER

53. DESCRIPTION AND OPERATION.

The priming system consists of a Dole PR-16 pump (fig. 24) mounted on the instrument board, a distributor mounted on the inlet tube of No. 1 cylinder, and the necessary connecting lines. When the pump plunger stem is pulled out, fuel is drawn from the block or header, through the suction line, past the inlet valve and into the pump barrel. The inward stroke of the plunger stem forces the fuel past the outlet and diaphragm valves, through the pressure line, distributor and distribution lines, and sprays it into the intake manifold pipes of the upper five cylinders. The diaphragm valve is so constructed that a comparatively small pressure by the pump will open the valve, allowing fuel to pass for priming. However, if the engine backfires, the extreme pressure required to open the valve from the outlet side prevents the pressure backing up into the pump, protects the springs of the ball-valves and prevents the balls from being driven down into their seats. The diaphragm valve also prevents fuel siphoning from the tanks into the engine.

54. PUMP.

a. Maintenance.

(1) PACKING. If the pump fails to deliver priming fuel to the engine, there may be a leakage between the plunger stem and the packing. To remedy this, tighten the packing nut (5/8-in. wrench) just in front of the plunger stem cap by half turns until the leakage is stopped.

(2) PISTON WASHER. To inspect or replace the leather cup washer on the piston, unscrew the packing nut, and pull the plunger, packing, packing ring, and the piston assembly out of the pump barrel. Remove the lock nut (1 1/32-in. wrench), plain washer, leather cup washer, and metal cup washer from the end of the plunger. Replace new parts as necessary and assemble by reversing the above procedure, being careful to install the leather and metal cup washers with the concave sides towards the forward end of the plunger.

b. Removal. Disconnect the two fuel lines by unscrewing the two coupling nuts (3/8-in. wrench). Unscrew the pump cap using a 5/16-inch wrench on the flat on the plunger and be careful not to lose the lock washer between the end of the plunger and the cap. Loosen the lock nut (1-in. wrench) on the inside of the instrument panel, unscrew the

cap from the end of the pump barrel and remove the pump through the inside of the panel.

c. Overhaul. Very little overhaul or repair is possible, except the replacement of damaged parts.

(1) PLUNGER ASSEMBLY. The overhaul of the plunger assembly is described in paragraph 54.

(2) INLET VALVE. Unscrew the connector ($\frac{7}{16}$-in. wrench) from the pump casting and be careful not to lose the ball and spring which are loose within it. Install by reversing the procedure. Make sure the spring is placed between the ball and the casting.

(3) OUTLET VALVE. Unscrew the outlet check plug (screwdriver) from the end of the pump casting and remove the spring and ball. Install by reversing the procedure. Make sure the spring is placed between the ball and the plug.

(4) DIAPHRAGM VALVE. Unscrew the diaphragm cap ($\frac{9}{16}$-in. wrench) and remove; be careful not to lose the spring and spring guides. Remove the diaphragm and the diaphragm gasket. Unscrew the outlet connector ($\frac{3}{8}$-in. wrench). Clean these parts and be particularly careful not to injure the small end of the outlet connector where it contacts the diaphragm, or the diaphragm itself. Use a new fiber gasket, if necessary. Make sure the hole in the small end of the diaphragm is open. Assemble the valve by reversing the disassembly procedure. Make sure that the spring guide is between the spring and the diaphragm.

d. Installation. Install the pump by reversing the operations as given in paragraph **b** above.

ORDNANCE MAINTENANCE—ACCESSORIES FOR
WRIGHT R975-EC2 ENGINES FOR MEDIUM TANKS M3 AND M4

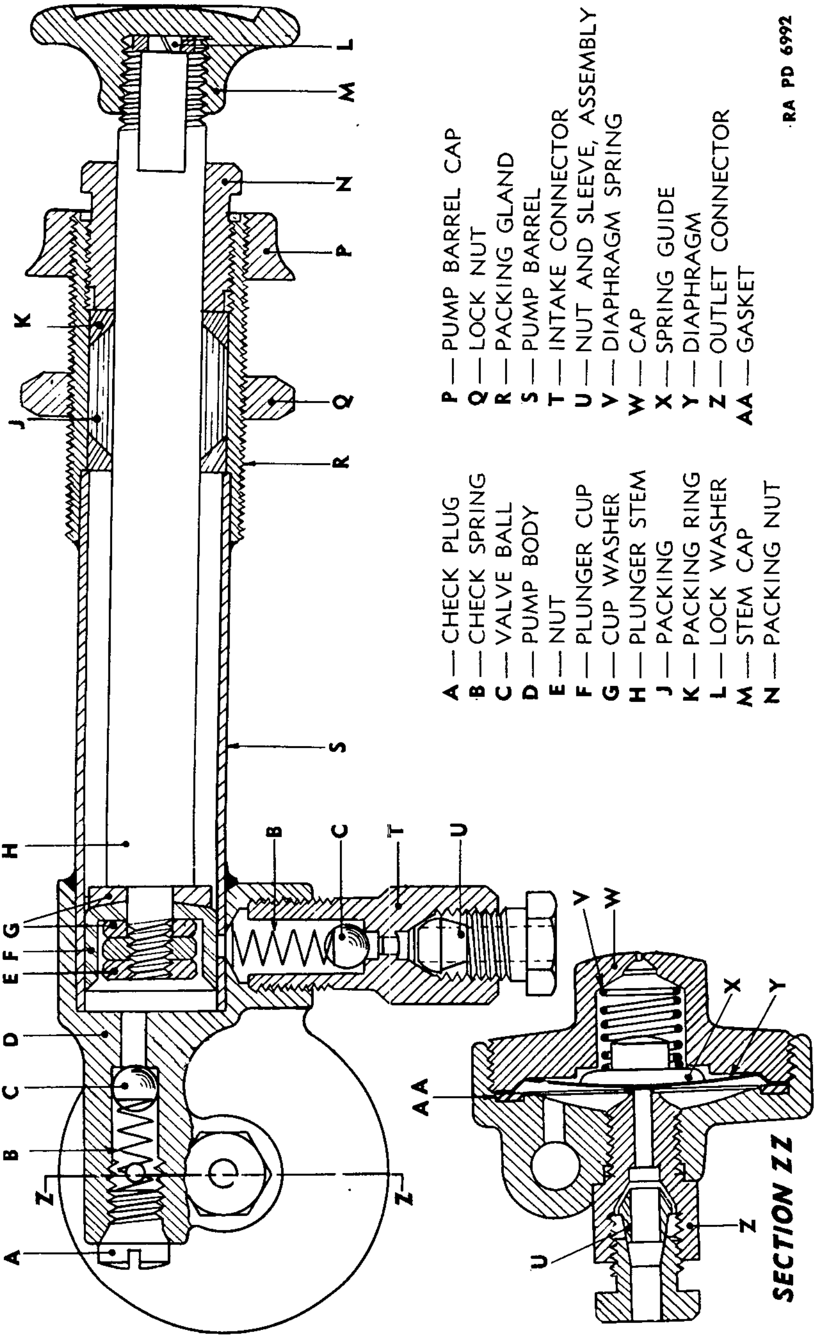


Figure 24—Cross Section of Primer Pump

Chapter 4

GOVERNOR AND GOVERNOR VALVE BOX

Section I

GOVERNOR

55. DESCRIPTION.

The Pierce governor (fig. 25) is mounted on the rear of the accessory case to the left of the carburetor elbow and serves to prevent excessive engine speeds. The governor shaft is driven by the engine and

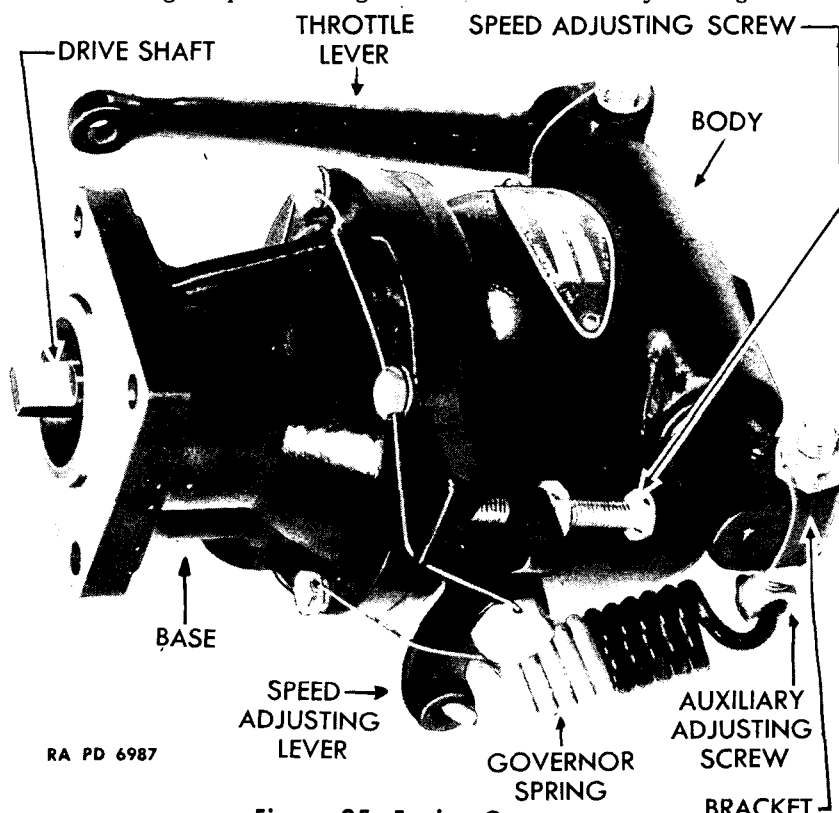


Figure 25—Engine Governor

carries a spider to which are hinged two weights. When the engine is being operated at speeds below that for which the governor is set, the tension of the spring exceeds the centrifugal force exerted by the weights and the throttle lever remains in open position (fig. 26). Inasmuch as the butterfly valve in the valve box (fig. 27) is connected to the governor throttle lever, it also remains wide open. When the engine reaches the speed for which the governor is set, the centrifugal force of the weights exceeds the tension of the spring and the weights move out, carry the thrust sleeve and yoke to the rear, move the throttle lever and the butterfly valve towards the closed position and reduce the amount of fuel being delivered to the engine. The whole governing system is entirely separate from the carburetor throttle and is not connected to it in any way. The governor simply serves to restrict the flow of explosive mixture to the cylinders and to limit the speed of the engine when the manually operated throttle valve is opened to a point that will give an excessive engine speed under existing load conditions.

56. REMOVAL.

To remove the governor from the accessory case proceed as follows: remove the cotter pin and washer from the clevis pin which connects the throttle lever and the throttle rod, then remove the clevis pin. Disconnect the oil drain line by unscrewing the coupling nut just below the governor. Remove the cotter pins, nuts ($\frac{7}{16}$-in. wrench) and washers holding the governor to the case and pull the governor off the studs. Discard the old gasket.

57. DISASSEMBLY.

Use the following tools to disassemble the governor:

Block, wood, 1¾-in. x 1¾-in. x 3-in.	Punch, pin, $\frac{5}{64}$-in.
	Punch, pin, $\frac{1}{32}$-in.
Blocks, wood, two, 8-in. high	Screwdriver, 6-in.
Hammer, ½-lb	Scriber
Pliers	Wheel, grinding
Press, arbor	Wrench, ⅜-in.
Puller, bearing	Wrench, $\frac{7}{16}$-in.
Punch, pin, $\frac{7}{64}$-in.	Wrench, two, ½-in.
Punch, pin, $\frac{9}{64}$-in.	Wrench, $\frac{1}{32}$-in.

a. Remove All Safety Wire.

Pliers.

Remove the safety wire from the speed adjusting lever screw and the four cap screws that hold the body and base together, the throttle lever cap screw, the auxiliary adjusting screw nuts, and the speed adjusting screw.

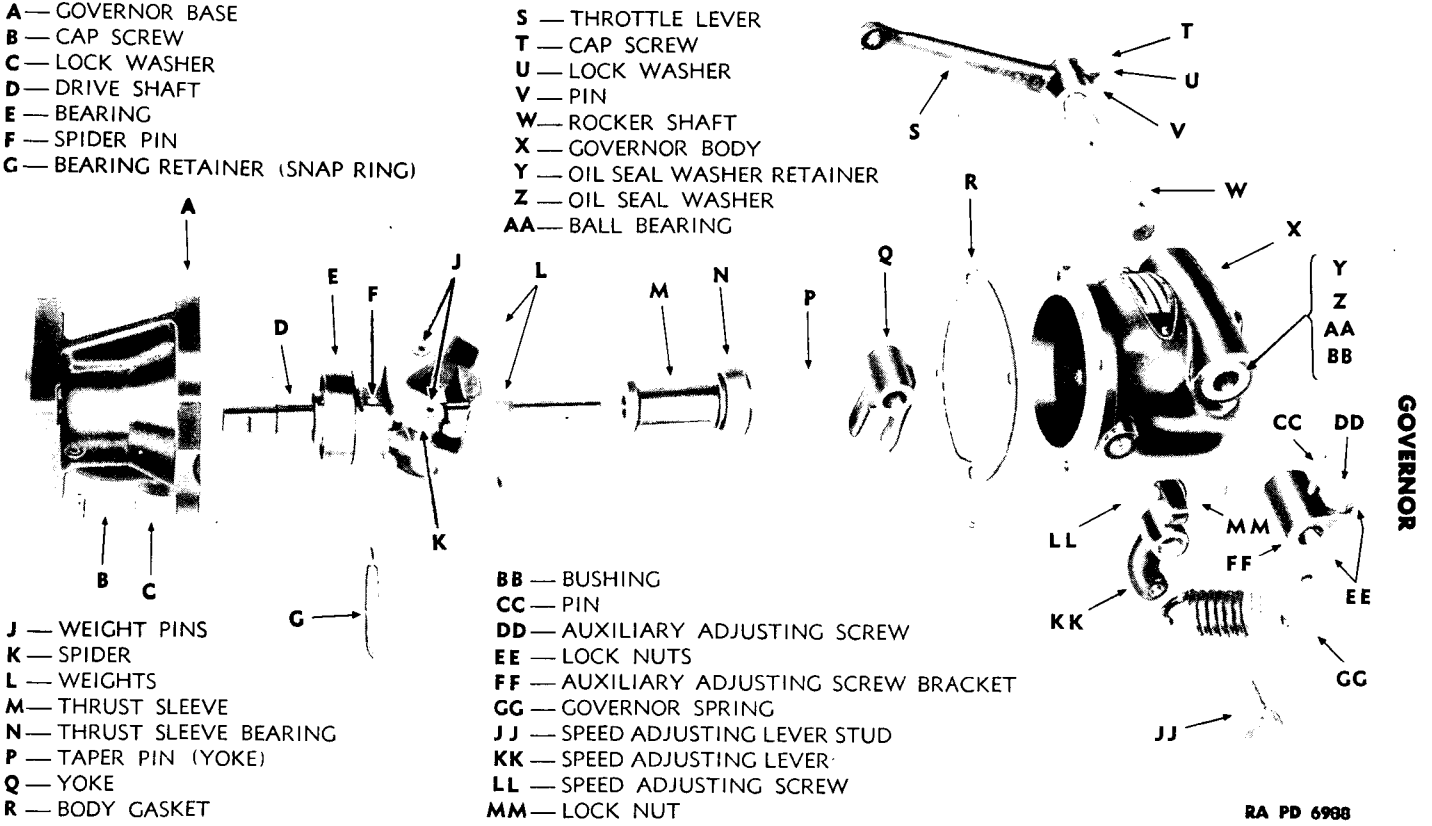


Figure 26—Partially Exploded View of Pierce Governor

b. Remove Governor Spring.

Wrench, 3/8-in.
Wrench, 7/16-in.
Wrench, two, 1/2-in.

Loosen the lock nut (7/16-in. wrench) on the speed adjusting screw and unscrew the speed adjusting screw (3/8-in. wrench) until all tension is taken from the governor spring. Loosen the nuts (1/2-in. wrench) on the auxiliary adjusting screw. Remove the governor spring from the auxiliary adjusting screw and the speed adjusting lever with the hands.

c. Separate Governor Body from Base.

Scriber
Wrench, 3/8-in.

Mark the body and the base with a scriber so that these two units may be reassembled in the same position. Remove the four cap screws (3/8-in. wrench) and lock washers, and lift the base and weight assembly as a unit from the body with the hands. Remove the gasket.

d. Remove Weight and Shaft Assembly from Base.

Blocks, wood, two, 8-in. high
Hammer, 1/2-lb.
Screwdriver, 6-in.

Move the weights outward as far as possible and slide the thrust sleeve and bearing assembly off the small end of the drive shaft. With a screwdriver pry the bearing retainer (snap ring) out of its slot in the inside of the governor base. Place the base, large end down, on two wood blocks each eight inches high and drive the drive shaft and weight assembly down and out of the base, protecting the tongue on the drive shaft with a wood block.

e. Remove Spider Assembly and Thrust Bearing from Drive Shaft.

Hammer
Pliers
Press, arbor
Punch, pin, 7/64-in.

Drive out the pin holding the spider to the shaft with a pin punch (7/64-in.) and hammer. Press the drive shaft out of the spider and weight assembly and remove the Woodruff key. (The spider slides off the small end of the shaft.) Press the bearing off the shaft (over the small end).

f. Remove Thrust Bearing from Thrust Sleeve.

Press, arbor

Press the thrust sleeve out of the bearing with an arbor press.

g. Remove Governor Weights from Spider.

Block, wood, 1 3/4-in. x 1 3/4-in. x 3-in.
Hammer, 1/2-lb
Punch, pin, 1 5/64-in.
Wheel, grinding

GOVERNOR

The weights are fastened to the spider by two pins which are peened over on both ends. These pins will be damaged if removed and new ones must be installed. If removal is necessary, grind one peened end off each pin, being careful not to damage the weights or the spider. Place the spider and weight assembly on a wood block (1¾-in. x 1¾-in. x 3-in. with a ½-in. hole bored through one of the 1¾-in. faces), and with a pin punch ($\frac{5}{64}$-in.) and hammer, drive the pins out of the weights and spider down into the hole in the block. The weights will drop out.

h. Remove Auxiliary Adjusting Screw from Bracket.

Wrench, two, ½-in.

Unscrew the nut (½-in. wrench) from the end of the auxiliary adjusting screw and slide the screw out of the auxilitary adjusting screw bracket.

i. Remove Rocker Shaft from the Body.

Hammer, ½-lb
Punch, pin, $\frac{9}{64}$-in.
Punch, pin, $\frac{7}{64}$-in.

Drive out the pin holding the auxiliary adjusting screw bracket to the shaft with a pin punch ($\frac{7}{64}$-in.) and hammer. Pull the auxiliary adjusting screw bracket off the rocker shaft. Drive a small punch through the small expansion plug in the rear end of the body and pull the plug out of the body. Working through the open end of the body with a $\frac{9}{64}$-inch pin punch, drive the taper pin holding the yoke to the rocker shaft out of the yoke and out through the hole in the body from which the expansion plug was removed. Push the rocker shaft out of the governor body and yoke, and remove the yoke from the inside of the body.

j. Remove Speed Adjusting Lever.

Wrench, $\frac{9}{32}$-in.

Unscrew the hexagon head screw or stud ($\frac{9}{32}$-in. wrench) from the body and slide the lever off the screw.

k. Remove Rocker Shaft Oil Seal Retainers, Seal Washers, Ball Bearings, and Bushings from the Governor Body.

Puller, bearing
Screwdriver, 6-in.

Insert a screwdriver into the hole in the oil seal retainer and pry the retainer out of the body. Lift out the oil seal washer. Pull the ball bearing out of the body with a bearing puller. Do not remove the bushing unless necessary as it may be damaged in removal. If necessary pull the bushing out of the body with a bearing puller. Repeat these operations to remove the oil seal retainer, oil seal washer, ball bearing, and bushing from the other rocker shaft boss.

1. Remove Expansion Plug, and Bushing from the End of Governor Body.

Press, arbor — Punch, pin, $\frac{11}{32}$-in.
Hammer, ½-lb

Do not remove the bushing unless damaged or worn. With a $\frac{11}{32}$-inch pin punch, punch through the open end of the body and the drive shaft bearing, drive the expansion plug out of the body. Press the bushing out of the body with an arbor press.

m. Remove Bushing from Governor Base.

Hammer, ½-lb — Punch, pin, $\frac{7}{64}$-in.
Press, arbor

Do not remove this bushing unless damaged or worn. The bushing is pressed and pinned into the governor base. Drive the pin in through the base and the bushing with a pin punch ($\frac{7}{64}$-inch), and press the bushing out of the base with an arbor press.

n. Remove Throttle Lever from Rocker Shaft.

Hammer, ½-lb — Scriber
Punch, pin, $\frac{9}{64}$-in.

Do not separate these parts unless damaged or worn. Mark the shaft and lever so that they may be reassembled in the same position. Drive out the pin connecting the lever and shaft with a pin punch ($\frac{9}{64}$-in.), remove the cap screw ($\frac{7}{16}$-in. wrench) and lock washer from the lever and drive the shaft out of the lever.

58. REPAIR AND REPLACEMENT.

Very little actual repair of parts is feasible. Replace any parts showing undue wear. Clean all parts thoroughly with SOLVENT, dry cleaning, and inspect for wear. The parts most subject to wear are the shafts, bushings, and bearings. Make sure the shafts are straight. Discard any cotter pins, expansion plugs, oil seals or locking wire that have been removed and install new ones. Discard any weight pins removed and install new ones. Because the groove pins are slightly tapered, take care to install them the same way as originally installed. Clean the oil hole in the drive shaft thoroughly with compressed air, and make sure the plug in the small end of the drive shaft is securely in place.

59. ASSEMBLY.

These instructions apply only where the original drive shaft, spider, yoke, rocker shaft, throttle lever, and auxiliary adjusting screw bracket are reassembled. If any of these are replaced, a different method of

GOVERNOR

assembly is necessary (par. 60). The following tools are used in assembling the governor:

Block, riveting or anvil
Drill, 1/8-in. and method of driving
File
Hammer, 1/2-lb.
Hammer, ball peen, 1/4-lb
Pliers
Press, arbor
Punch or expansion plug tool, 1/2-in.
Screwdriver, 8-in.
Wrench, 3/8-in.
Wrench, 7/16-in.
Wrench, two 1/2-in.
Wrench, 19/32-in.

a. Assemble Throttle Lever and Rocker Shaft.

Hammer, 1/2-lb

Push or drive the throttle lever onto the end of the throttle shaft as marked at disassembly, aline the pin holes in the shaft and lever and drive in the groove pin in the same position as in the previous assembly.

b. Install Bushing in Governor Base.

Drill, 1/8-in. and method of driving
Drill, No. 48 and method of driving
Hammer, 1/2-lb
Press, arbor

Press the bushing into the base with an arbor press leaving both ends of the bushing flush with the ends of the bore in the base. Insert a drill (1/8-in.) through the pin hole in the base and drill through the bushing. Drive in the pin securing the bushing to the base, and take care that the end of the pin does not project into the bore. Insert a No. 48 drill in the oil hole in the base and drill the oil hole through the bushing. Remove any burs left by the drills.

c. Install Bushing and Expansion Plug in Governor Body.

Hammer, 1/2-lb
Press, arbor
Tool, punch or expansion plug, 1/2-in.

Press the bushing into the rear end of the body until the forward end of the bushing is flush with the inside surface of the body. Insert a new expansion plug in the bore behind the bushing, and secure it by expanding with a punch, or expansion plug tool, and a hammer.

d. Install Bushings, Ball Bearings, Seal Washers, and Oil Seal Retainers for Rocker Shaft.

Hammer, 1/2-lb
Press, arbor

Press the two bushings into place in the housing with an arbor press, each bushing being pressed in from the outside until its outside end is flush with the outside end of the bore into which it is pressed. Press the two ball bearings (maker's name outside) into the housing with an arbor press until they seat on the shoulders provided. Install a new oil seal

outside of each ball bearing, and secure in place with the oil seal retainers which are tapped into the outside ends of the bore (concave side in) with a hammer. Try the rocker shaft in the bearings to see that it turns freely.

e. Install Speed Adjusting Lever.

Wrench, $\frac{1}{32}$-in.

Slide the adjusting lever screw or stud ($\frac{1}{32}$-in. wrench) through the lever and screw into the threaded hole in the left side of the body. The lever goes on in such a position that the threaded hole for the adjusting screw is up and on the side next to the body (fig. 25). Screw the lock nut onto the speed adjusting screw. Screw the speed adjusting screw (head to the rear) into the lever.

f. Install Rocker Shaft.

Hammer, ½-lb
Punch, pin, $\frac{7}{64}$-in.
Tool, plug-seating, ½-in.

Push the rocker shaft and lever assembly into the right body boss (fig. 25) just far enough so that the shaft projects through the boss into the inside of the body. Place the yoke in position inside the body with the long prong on the yoke next to the boss through which the shaft projects, and slide the shaft through the yoke and the other boss. With the throttle lever pointing forward, aline the hole in the rocker shaft with the hole in the yoke, and insert the taper pin. (The pin must be inserted through the small expansion plug hole in the rear end of the body.) Drive the pin all the way in with a pin punch and hammer. Install a new expansion plug and expand in place with a plug-seating tool and hammer. Push the auxiliary adjusting screw bracket onto the rocker shaft with the boss for the adjusting screw outside and to the rear. Aline the hole in the shaft with the holes in the bracket, and drive in the groove pin in the same position it previously occupied.

g. Install Auxiliary Adjusting Screw in Bracket.

Wrench, two, ½-in.

Insert the auxiliary adjusting screw in the auxiliary adjusting screw bracket with the eye towards the center of the governor body and a nut on each side of the bracket. Tighten the nuts in such a position that the distance from the center line of the shaft to the center of the hole in the end of the screw is 1⅛ inches (fig. 29). The hole in the screw should be parallel to the rocker shaft.

h. Assemble Spider and Weights.

Block, riveting, or anvil
File
Hammer, ball peen, ¼-lb

Put a weight in position in the spider and insert a weight pin through the spider and weight. Rest one end of the pin on a riveting block or

anvil, and flare the upper end of the pin where it projects above the surface of the spider with a ball peen hammer. Invert the spider and weight, and flare the other end of the weight pin. Repeat the above operations in attaching the other weight to the spider. It is important that the weights move freely after the weight pins have been flared. Make sure that the spider arms have not been drawn against the weights. New weights are not prefitted to the spider. It is imperative that the weights have equal "lift" when the stops are against the spider. This can be checked after the thrust sleeve is in place. If necessary, material can be removed from the stops with a file. It is also important that the weights move sufficiently between closed and open positions to give the sleeve a travel of at least ¼ inch. Travel can be increased by removing material from the ends of the stops with a file.

i. Assemble Thrust Bearing and Thrust Sleeve.

Press, arbor

Press the sleeve into the bearing, the shouldered end of the sleeve going into the square-cornered face of the bearing.

j. Assemble Bearing and Spider with Drive Shaft.

Hammer, ½-lb
Punch, pin, $\frac{7}{64}$-in.
Press, arbor

Slide the bearing over the small end of the drive shaft and press into place against the shoulder with an arbor press. Place the Woodruff key in position in the drive shaft. Slide the spider and weight assembly (hub end first) onto the drive shaft, aline the key slot in the spider with the key in the shaft, and press the spider onto the shaft and against the bearing. Drive the retaining pin through the spider and shaft, and head over slightly on both ends.

k. Install Weight and Shaft Assembly in Base.

Screwdriver, 8-in.

Insert the weight and shaft assembly into the large end of the base, the shaft going through the bushing, and the bearing going into its seat. Lock the assembly in place by installing the bearing retainer (snap ring) in the slot in the base. Separate the weights and slide the thrust sleeve and bearing assembly onto the drive shaft flanged end first. Check the weight travel as explained in paragraph 59 **h.**

l. Assemble Body and Base.

Wrench, ⅜-in.

Install a new gasket on the body. Place the base assembly on the body, alining the marks made during disassembly so that the two units go back together in the same position they were in before being separated. Fasten the body and base together with four cap screws (⅜-in. wrench), and lock washers.

m. Install Spring.

Wrench, 3/8-in. Wrench, 7/16-in.

Hook one end of the governor spring into the eye of the auxiliary adjusting screw and the other end into the end of the speed adjusting lever. Tighten the speed adjusting lever screw (3/8-in wrench) until tension is started on the governor spring. Tighten the lock nut (7/16-in. wrench) on the speed adjusting lever screw.

n. Install All Safety Wires.

Pliers

Install the four safety wires, speed adjusting lever screw and the four cap screws holding the body and base together, throttle lever cap screw, auxiliary adjusting screw nuts, and speed adjusting screw and nuts (fig. 25).

o. Adjust the Governor.

Adjustment can only be made after the governor is installed on an engine.

Directions for adjustment are given in TM 9-1751, paragraph 213 c (58).

60. ASSEMBLY WHEN CERTAIN NEW PARTS ARE USED.

Certain new parts when received from stores are not drilled for the taper or groove pins used to connect them and this necessitates a somewhat different method of procedure. The parts on which drilling or reaming is necessary are: drive shaft, spider, yoke, rocker, shaft, throttle lever, and auxiliary adjusting screw bracket.

a. Assembly When New Rocker Shaft Is Used. Proceed with the assembly as outlined in paragraph 59 **b, c, d,** and **e.** Before installing the rocker shaft, slide the yoke onto the shaft (long end of the shaft as measured from the hole in the center goes to the left (fig. 29)), aline the holes in the yoke and shaft, ream the holes with a No. 1 taper reamer inserted from the rear of the yoke and remove the yoke from the shaft. The bare rocker shaft is installed as in paragraph 59 **f,** except that the long end of the shaft, as measured from the hole in the center, is assembled on the left side of the governor (fig. 29). Do not install the auxiliary adjusting screw bracket on the shaft at this time. Continue with operations as described in paragraph 59 **g, h, i, j, k,** and **l.** Drill the shaft for the pins securing the throttle lever and auxiliary adjusting screw bracket. With the rocker shaft turned to swing the yoke forward against the thrust bearing, push the throttle lever, hub first, onto the right end of the shaft, adjust it to the position shown in figure 29 (forward and 10 degrees down from the line of the drive shaft), and tighten the clamping screws. Push the lever onto the shaft far enough to eliminate about half of any end play in the shaft. Drill a 5/32-inch hole through

the shaft in line with the holes in the lever and drive in the groove pin. Push the auxiliary adjusting screw bracket, hub first, onto the left end of the rocker shaft, adjust it to the position shown in figure 29 (the adjusting screw at right angles to the line of the throttle lever), drill a ⅛-inch hole through the shaft in line with the holes in the bracket and drive in the groove pin. The lever should be on the shaft far enough to eliminate appreciable end play on the shaft but not far enough to cause binding. Continue with operations as described in paragraph 59 **m, n,** and **o.**

b. Assembly When New Throttle Lever or Auxiliary Adjusting Screw Bracket Is Used. If it is necessary to replace the throttle lever or the auxiliary adjusting screw bracket, it is advisable to replace the rocker shaft also, as it is very difficult to drill holes in the lever or bracket to aline with the hole in the shaft. In this case, follow the assembly procedure outlined in paragraph 60 a except that the holes for the pins will have to be drilled through the lever or bracket and the shaft, instead of just through the shaft.

c. Assembly When a New Yoke Is Used. Slide the new yoke into correct position on the old shaft, aline the holes in the yoke and shaft, and ream with a No. 1 taper reamer. Remove the yoke from the shaft and proceed with the assembly as outlined in paragraph 59.

d. Assembly When a New Drive Shaft or Spider Is Used. If a new drive shaft or spider is used, the shaft bearing and spider are assembled the same as in paragraph 59 **j,** except that before the spider pin is driven into place, it will be necessary to drill a ⅛-inch hole through the hub of the spider and the shaft. This hole is located ¼ inch from the end of the spider hub and $\frac{5}{32}$ inch off the center of the shaft and is drilled through from one boss to the other on the hub. This position locates the hole through the side of the shaft and keeps the pin from restricting the oil hole in the shaft.

61. INSTALLATION.

Install the governor on the engine by reversing the procedure outlined in paragraph 56.

Section II

GOVERNOR VALVE BOX

62. DESCRIPTION.

The governor valve box assembly (fig. 27) consists essentially of a tube-shaped casting containing a butterfly valve operated by a lever on the left side. The casting is flanged on the top and bottom and is located between the support bracket at the top of the carburetor air funnel and the bottom of the carburetor elbow.

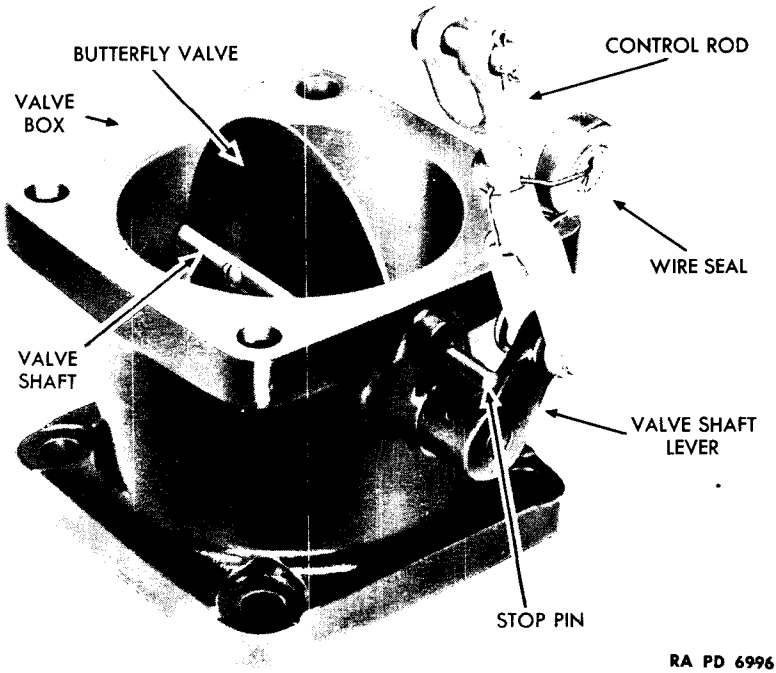


Figure 27—Governor Valve Box

63. REMOVAL.

To remove the governor valve box proceed as follows: remove the cotter pin and washer from the clevis pin, and remove the clevis pin

connecting the throttle rod with the throttle lever on the governor. Remove the nuts, ($\frac{9}{16}$-in. wrench, two) plain washers, and bolts connecting the carburetor air horn to the support bracket and valve box, then drop the carburetor to the floor of the tank. Remove the gasket from the top of the air horn. Loosen the bolts ($\frac{9}{16}$-in. wrench, two) holding the support bracket to the motor support, allowing the rear end of the bracket to drop away from the valve box. Remove the gasket between the box and the support. Remove the locking wire, nuts ($\frac{9}{16}$-in. wrench), and plain washers from the studs holding the valve box to the carburetor elbow and remove the box and gasket.

64. **DISASSEMBLY** (fig. 28).

The following tools are used in the disassembly of the governor valve box:

Extractor, bushing	Punch, pin, $\frac{7}{64}$-in.
Hammer, ½-lb	Screwdriver, 8-in.
Pliers	Scriber

a. Remove Throttle Rod from Valve Shaft Lever.

Pliers

Remove the cotter pin and washer from the clevis pin connecting the throttle rod to the valve shaft lever; remove the clevis pin, and the throttle rod will drop off.

b. Remove Butterfly Valve and Shaft from Valve Box.

Screwdriver, 8-in. Scriber

Mark the butterfly valve and the valve shaft so that they may be assembled in the same position. This is important, as the butterfly valve is beveled around the edge to fit the valve box when the butterfly is closed. Remove the two screws securing the butterfly valve in the shaft. Push the butterfly valve out of the slot in the valve shaft, and pull the shaft out of the valve box.

c. Remove Bushings from the Box.

Extractor, bushing

Pull the valve shaft bushings out of the valve box with a bushing extractor. (Do not remove the bushings unless damaged or worn.)

d. Remove Stop Pin from Box.

Pliers

If necessary the stop pin can be removed with pliers. However, the pin may be damaged in removal necessitating a new one for assembly.

e. Remove Valve Shaft Lever from Valve Shaft.

Hammer, ½-lb. Punch, pin, $\frac{7}{64}$-in.

Drive the groove pin out of the shaft and lever, and drive the shaft out of the lever. (These parts need not be separated unless damaged or worn.)

1 — VALVE BOX
2 — VALVE SHAFT BUSHING
3 — BUTTERFLY VALVE
4 — STOP PIN
5 — VALVE SHAFT BUSHING
6 — VALVE SHAFT
7 — VALVE SHAFT SCREW
8 — COTTER PIN
9 — PLAIN WASHER
10 — LEVER PIN
11 — VALVE SHAFT LEVER
12 — THROTTLE CONTROL ROD
13 — YOKE PIN

RA PD 6989

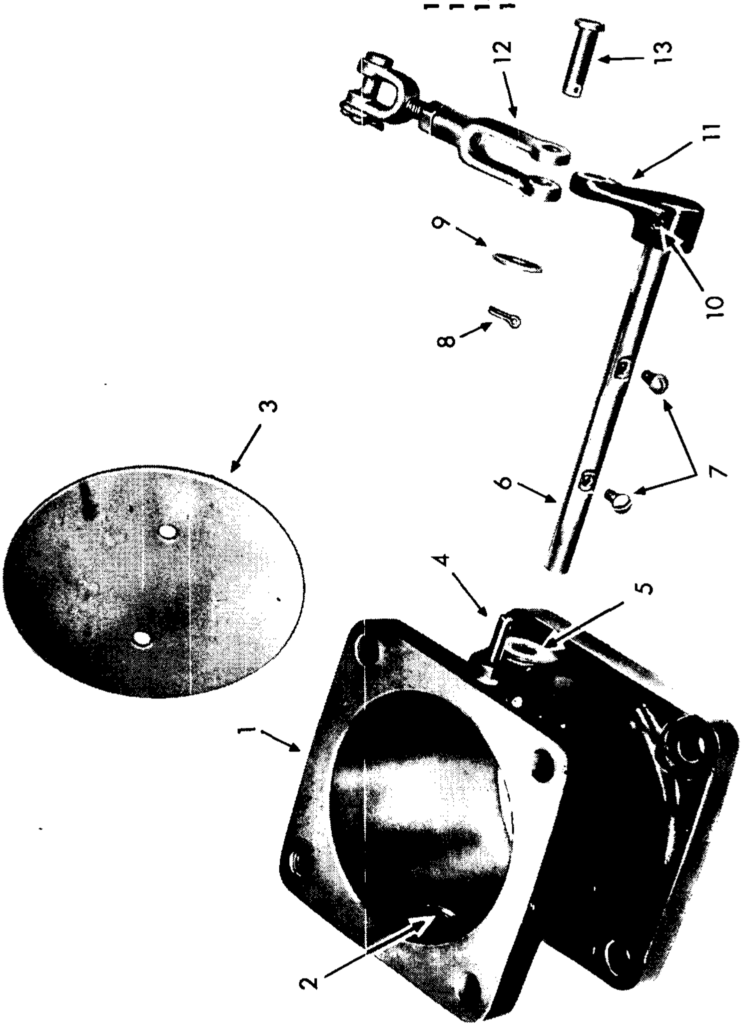


Figure 28—Parts of Governor Valve Box

GOVERNOR VALVE BOX

65. REPAIR AND REPLACEMENT.

Clean all parts thoroughly with SOLVENT, dry-cleaning, and inspect for wear. Very little actual repair of parts is feasible, but replace any parts showing undue wear.

66. ASSEMBLY.

The following tools are used in assembly of the governor valve box:

Hammer, ½-lb.	Press, arbor
Pliers	Screwdriver, 8-in.

a. Assemble Valve Shaft and Valve Shaft Lever.

Hammer, ½-lb.

Drive the lever onto the drilled end of the shaft, line up the holes in the lever with the hole in the pin, and drive the groove pin in the same position as previously installed. NOTE: With the shaft held with the counterbores facing the operator and the drilled end to the right, the lever goes on the shaft hub end first, with the lever pointing up and slightly away from the operator.

b. Install Stop Pin in Valve Box.

Hammer, ½-lb

Drive the pin into the hole in the boss on the left side of the box.

c. Install Valve Shaft Bushings in Box.

Press, arbor

With an arbor press press the bushings into place in the bores in the sides of the governor box. Press in the left bushing until the outside end of the bushing is flush with the outside end of the boss; and press in the right bushing until it bottoms in the bore. Take great care not to distort the valve box while pressing the bushings into place.

d. Install Shaft and Butterfly Valve in Box.

Screwdriver, 8-in.

Push the valve shaft into the valve box by hand. With the box right side up, turn the shaft until the lever is at the rear of the stop pin as shown in figure 27. Push the butterfly valve into place in the slot in the valve shaft, determining the proper position by the marks made during disassembly. Install the two screws that hold the valve in place in the shaft. Be sure the shaft and valve turn freely without binding.

e. Connect Throttle Rod to Valve Shaft Lever.

Pliers

Put the long yoke in place straddling the lever as shown in figure 27, push the clevis pin through the holes in the yoke and lever, and secure the pin with a plain washer and a cotter pin.

ORDNANCE MAINTENANCE—ACCESSORIES FOR WRIGHT R975-EC2 ENGINES FOR MEDIUM TANKS M3 AND M4

67. INSTALLATION (fig. 29).

To install the governor valve box proceed as follows: place gasket on flange, insert governor valve box on four studs of the carburetor adapter elbow. Install plain washers, nuts ($\frac{9}{16}$-in. wrench), and locking wire. Tighten the bolts ($\frac{9}{16}$-in. wrench, two) connecting the rear end of the motor support bracket to the valve box support bracket. Place gasket on top of carburetor air horn, fasten carburetor to governor valve box studs, and insert plain washers, nuts ($\frac{9}{16}$-in. wrench, two). Connect the throttle rod with the throttle lever on the governor by inserting clevis pin, washer, and cotter pin.

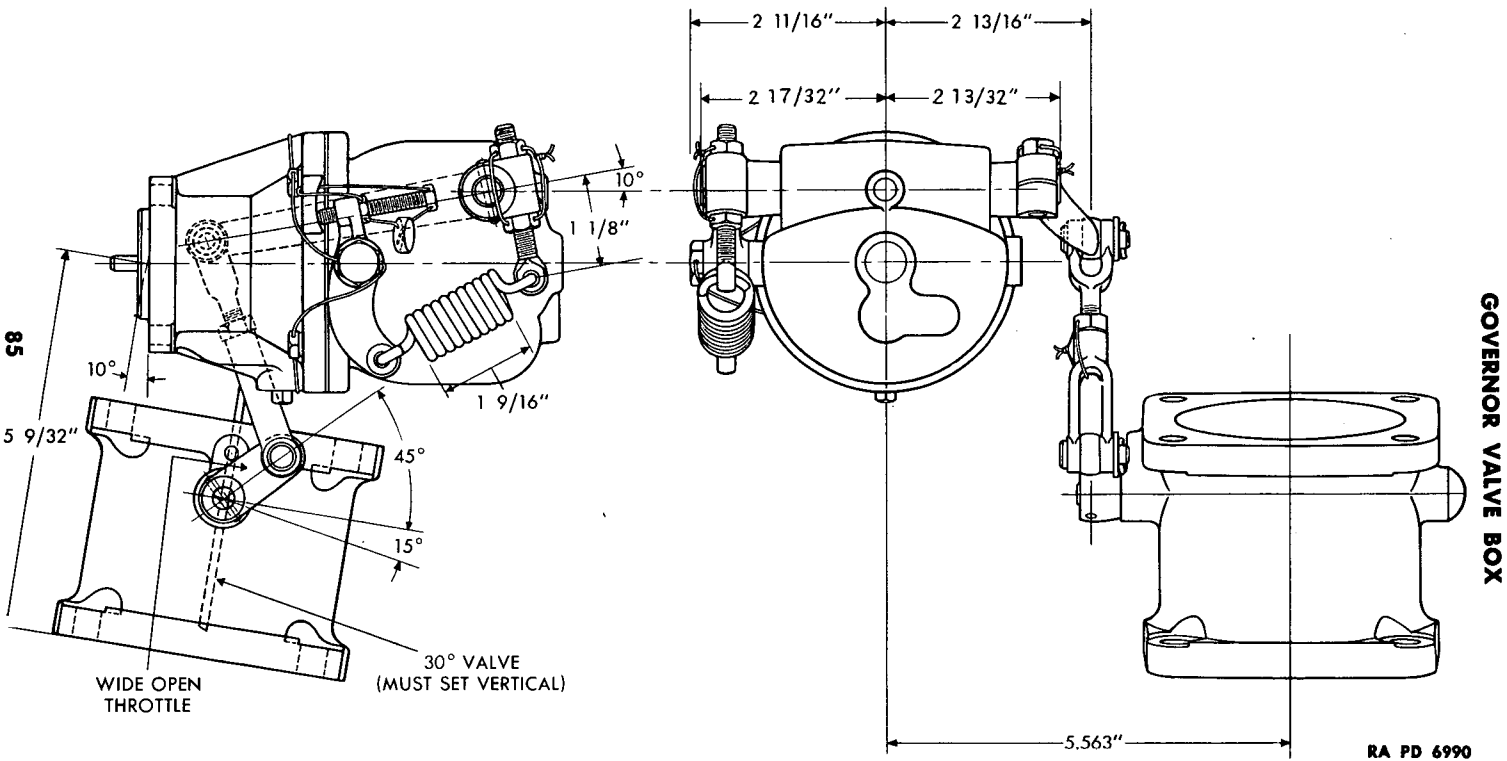


Figure 29—Installation of Governor and Valve Box

ORDNANCE MAINTENANCE—ACCESSORIES FOR WRIGHT R975-EC2 ENGINES FOR MEDIUM TANKS M3 AND M4

Chapter 5

ENGINE IGNITION SYSTEM

Section I

GENERAL DESCRIPTION OF SYSTEM

68. GENERAL DESCRIPTION OF SYSTEM (fig. 30).

The ignition system consists of the following units: spark plugs, two magnetos, a booster coil, and the ignition harness. Dual ignition is furnished by the two magnetos: the right magneto fires the front spark plugs, and the left magneto, the rear spark plugs. The magnetos, type VAG9DFA, are equipped with automatic spark advance and shielded

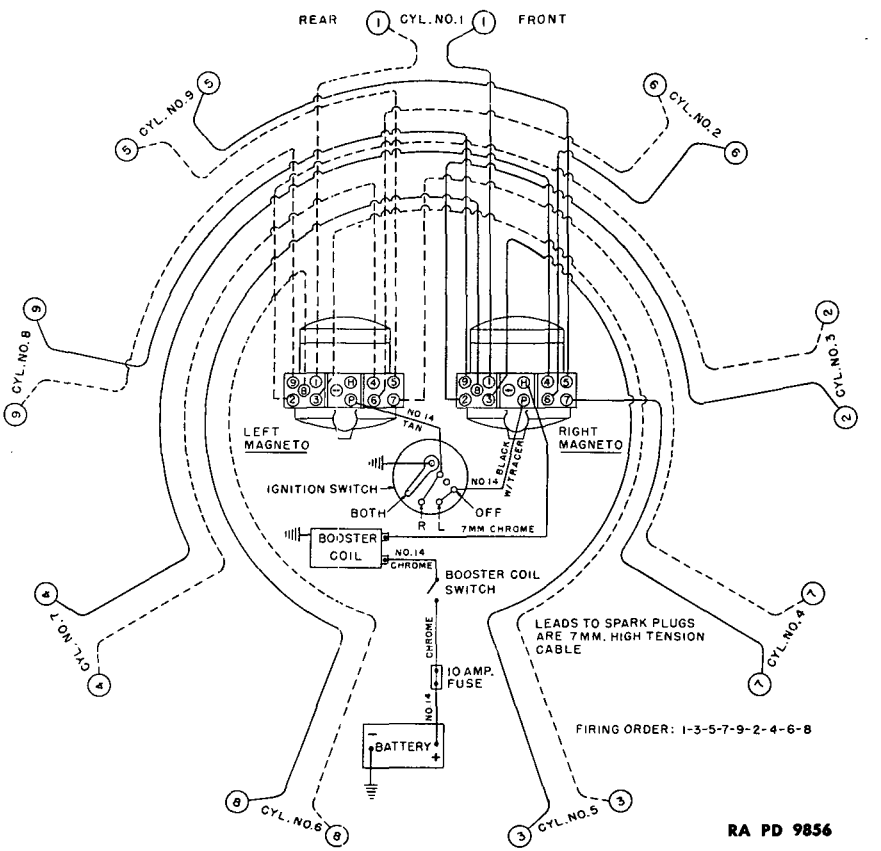


Figure 30--Engine Ignition System

to prevent radio interference. The booster coil, model 3, style "A" type 513, is used in series with the right magneto to provide an intense auxiliary spark across the points of the front spark plugs to facilitate starting. The engine ignition system is completely shielded to prevent radio interference. The schematic wiring diagram (fig. 30) shows the connections in the ignition circuit. No. 14 wire is used between the fuse and booster coil switch and booster, also from the magneto switch to the magnetos. High tension ignition cable 7-mm outside diameter 7 strands, corrosion resistant, is used from the booster coil to the magneto and from both magnetos to the spark plugs. In the text which follows, carbon tetrachloride is recommended as a cleaner. However, use this solvent very carefully. Do not immerse insulated parts of electrical equipment in carbon tetrachloride, because it will destroy the insulation if kept in contact for an appreciable length of time. When carbon tetrachloride is sprayed on such parts or applied with a cloth, it evaporates so fast and completely that it is not in contact with the insulating material long enough to attack it. Other solvents, such as SOLVENT, dry cleaning, are unsatisfactory because they do not evaporate rapidly and completely enough to prevent damage to insulating materials.

Section II

BOOSTER COIL

69. DESCRIPTION AND OPERATION (figs. 31 and 32).

The Eclipse Model 3, Style A, Type 513 battery booster coil is of the one-wire shielded type which provides additional ignition spark during the starting period. It consists of a vibrator type coil in a separable housing which serves as a shield as well as a means of attaching the complete unit to the right side of the generator and starter supporting bracket. When the booster coil switch is closed, the battery supplies 24 volts to the primary winding and a potential is induced in the secondary. The potential in the primary magnetizes the core, and causes the

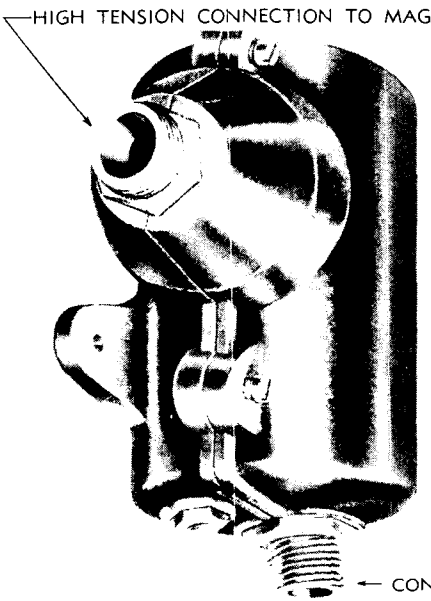
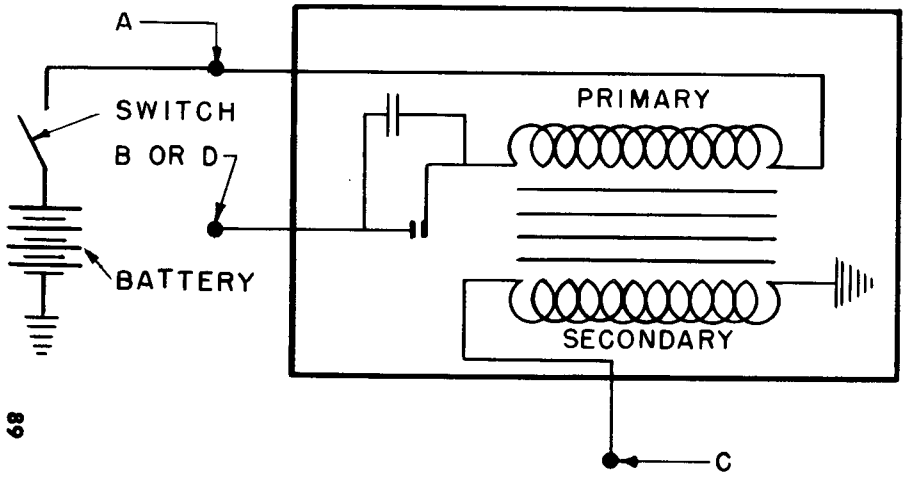
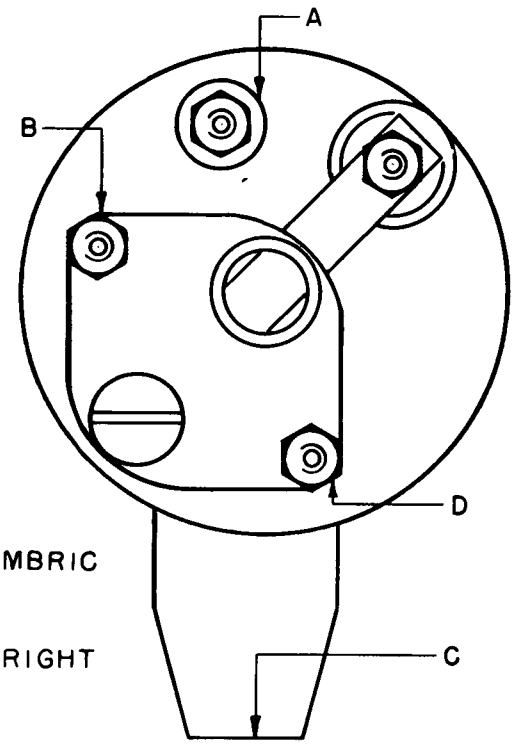


Figure 31—Booster Coil RA PD 16862



NOTE—

1. CONNECT BATTERY WIRE TO TERMINAL "A" WITH NO.16 CAMBRIC CABLE.
2. TERMINAL "B" IS OPEN AND TERMINAL "D" IS GROUNDED.
3. CONNECT TERMINAL "C" TO BOOSTER TERMINAL ON THE RIGHT HAND MAGNETO WITH 7 MM HIGH TENSION CABLE.



BOOSTER COIL

Figure 32—Wiring Diagram and Connections on Top of Booster Coil

contact points to separate, thereby breaking the circuit. The secondary now discharges its potential across the spark plug gap. With the circuit broken, the core is demagnetized. The contact spring reestablishes the circuit by making contact with the gap adjusting screw. NOTE: This booster coil will operate on a 12-volt (Light Tank M3) or 24-volt (Medium Tank M3) supply. The only difference between the booster coil on each of the tanks is in the setting of the gap adjusting screw (par. 75 a).

70. INSPECTION ON THE VEHICLE.

The using arm is responsible for inspecting the booster coil once each week to make sure the coil buzzes when current is admitted to the coil. To make this inspection, one man closes the battery switch and holds the booster coil toggle switch closed, another man is stationed at the engine compartment to listen for the buzzing sound originating from the coil. If the coil does not buzz, remove it and install one that operates.

71. REMOVAL.

Open the battery switch and unscrew the two knurled nuts (pliers) holding the cable conduits to the sprouts. Loosen the two nuts ($\frac{5}{16}$-in. wrench) locking the two spouts to the housing assembly, and pull the high tension cable out of its spout. Remove the locking wires (pliers) and four screws (screwdriver) with plain and lock washers holding the cover to the box, and remove the cover. Remove the low tension cable from the terminal post on top of the coil. Loosen the interior nut ($\frac{3}{8}$-in. wrench) locking the coil in place and unscrew the exterior nut ($\frac{3}{8}$-in. wrench) from the locating stud. Remove the two sprouts from the box. Lift coil out of the box.

72. DISASSEMBLY AND REPAIR (fig. 33).

a. Disassembly. The only disassembly other than that performed in paragraph 71 will be the removal of the vibrator contacts. Remove the two nuts ($\frac{3}{8}$-in. wrench) and lock washers holding the bracket assembly to the top of the coil, and lift off the bracket assembly. Remove the nut ($\frac{3}{8}$-in. wrench) and lock washer securing the spring assembly to the top of the coil, and lift off the spring assembly.

b. Repair.

(1) No repair beyond the cleaning of the contact points is practical. Replace all defective parts.

(2) CLEANING OF THE CONTACTS.

(a) To reface dirty or slightly pitted contact points, first use a fine India oilstone FB14, or the equivalent, and then a hard Arkansas oilstone HB13.

(b) After refacing, wash the bracket and spring assemblies in carbon tetrachloride, and install on top of the coil.

73. ASSEMBLY (fig. 33).

a. Place the high tension spout and coil in the box aligning the high tension cable hole in the coil with the hole in the spout. Secure the coil in place by tightening the nut (3/8-in. wrench) on the negative terminal post against the inside of the box. NOTE: This operation has been performed during the adjustment of the core gap.

b. Put the low tension spout in place and connect the low tension cable to the terminal post.

c. Put the cover in place over the box and the two spouts and secure in place with the four screws (screwdriver) with the plain and lock washers and install the locking wires on the screw.

d. Tighten the nuts (15/16-in. wrench) securing the two spouts to the housing assembly.

74. CONVERSION OF STYLE "A" TO STYLE "B" BOOSTER COIL.

In order to obtain a hotter spark during the starting period, the booster coil has been modified to provide increased output with improved operation. This has been done by increasing the core gap and reducing the thickness of the contact spring for greater flexibility. Accordingly, it is recommended that all style "A" booster coils be reworked at the next overhaul to duplicate the performance of the style "B" coils, as shown in the table, paragraph 75. To rework the style "A" booster coils, remove the present contact spring assembly, and install the new contact spring assembly (EC85224), placing shim (EC91345) under the contact spring to increase the core gap from 0.020 inch to 0.055 inch. Adjust the core gap (par. 75 a) using the values in table for style "B" and stencil the new voltage and current data on the coil housing with durable ink. When ordering replacement parts to convert to style "B," order as follows:

Old Part	Replacement
EC18949 Contact spring assembly	EC85224 Contact spring assembly with EC91345 shim
EC39235 Coil, housing and contact assembly	EC91798 Coil, housing and contact assembly or EC85223 Coil and housing with EC85224 Contact spring assembly

1 - BOX
2 - COVER
3 - HIGH TENSION CONNECTOR PLUG
4 - GROUNDED TERMINAL POST BUSHING
5 - GAP ADJUSTING SCREW
6 - COIL SECURING NUTS
7 - SPOUT
8 - GLAND
9 - PLAIN WASHER
10 - KNURLED NUT
11 - SPOUT RETAINING NUT
12 - LOCATING STUD
13 - COVER PLUG
14 - BRACKET RETAINING NUT
15 - CONTACT SCREW ASSEMBLY
16 - BRACKET ASSEMBLY
17 - CONTACT SPRING ASSEMBLY
18 - COIL ASSEMBLY
19 - {CEMENT RUBBER PADS TO BOX AND {COVER WITH RUBBER CEMENT
20 - GROUNDING STRIP

RA PD 9855

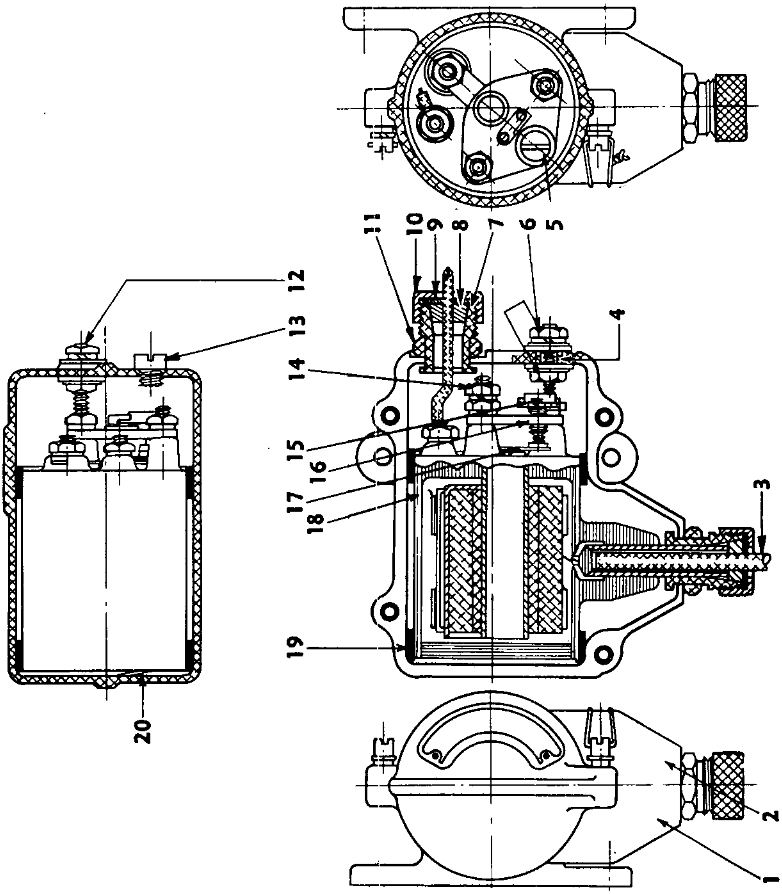


Figure 33—Cross Section of Booster Coil Type 513, Model 3, Style A

BOOSTER COIL

75. ADJUSTMENT OF CONTACT GAP AND TEST OF COIL.

a. Adjustment of Core Gap. Place the coil, bracket assembly, and high tension spout in the box, and aline the high tension cable hole in the coil with the hole in the spout. Secure the coil in place in the box by means of the interior nut (⅜-in. wrench) on the locating stud. Connect the primary terminals of the booster coil in series with an ammeter and control switch to a battery supply and insert a three-ampere fuse in the line to protect the ammeter. Use the required number of standard cells to produce the desired voltage (see chart below). **Do not under any circumstance place a resistor in the circuit to obtain the proper input voltage.** Connect the high tension terminal to a spark plug having a gap of 0.022 inch. A return line from the spark plug case to the booster coil housing must be made. Starting from the extreme outward position, close contact gap until the current drain shown on the ammeter equals the value shown in the chart below for style "A" or style "B" booster coils. With the proper voltage being delivered, the coil should fire the spark plug under atmospheric pressure. If the coil does not fire the spark plug at all, check all the connections. If the connections are found secure, install a new coil assembly and proceed as outlined in paragraph 75 **a.**

Type	Model	Style	Battery Voltage	Input Voltage	Current Drain (Amperes)	Reed Thickness (In.)	Core Cap (In.)
513	3	A	24	24	0.50 – 0.75	0.022	0.020
513	3	B	24	18	1.80	0.015	0.055

76. INSTALLATION.

a. Secure the low tension conduit to the low tension spout by screwing the knurled nut (pliers) onto the spout.

b. Push the high tension cable connector plug into its spout, and secure the conduit to the spout by screwing the knurled nut (pliers) onto the high tension spout.

c. If the box has been removed from the generator and starter support bracket, place the box on the right side of the bracket and secure with the two bolts (⅜-in. wrench).

Section III

MAGNETO

77. DESCRIPTION.

a. The Scintilla VAG9DFA magneto is a flange-mounted, nine-cylinder magneto of clockwise rotation. The magneto is driven at 1⅛-engine crankshaft speed.

b. The four-pole rotating magnet used is made of a high-grade magnet steel which enables a stable magnetic field to be maintained, producing adequate energy output for long periods of time. The magnet turns on two annular ball bearings, one located at the breaker end, and the other at the drive end. These bearings are packed with a high temperature grease, and may be lubricated at regular inspection intervals through conveniently located oilers.

c. An automatic advance mechanism is incorporated on the magnet shaft. As the magneto speed increases throughout the advance range, this mechanism advances the spark automatically without changing the "E" gap, which is the rotating magnet position measured in degrees from neutral to the position where the contact points just begin to open. On the

automatic advance magnet shaft is secured a four-lobe breaker cam which actuates a lever type breaker assembly.

d. 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 of the flat type is similarly encased in hard rubber and is mounted on top of the coil.

e. A laminated brush on the coil primary bridge provides a contact with the insulated contact point support. There is no manual means of advancing the spark range of the magneto, as the breaker assembly is maintained in a fixed position in the breaker compartment of the magneto housing.

f. A distributor driving gear located on the rotating magnet shaft drives the large distributor gear and distributor cylinder. The relation between these gears is such that the high tension current is conducted from the coil to the distributor cylinder, to the distributor block electrodes, and thence through the high tension cables to the spark plugs at the correct firing intervals of the engine. The high tension current is conducted from the coil, through the medium of a carbon brush, to the distributor cylinder electrodes.

g. The distributor cylinder is secured to the distributor driven gear by means of a lock ring, and is located in the proper position with a dog screw. The cylinder carries four high tension electrodes; one for the booster current, another for the booster current collector ring.

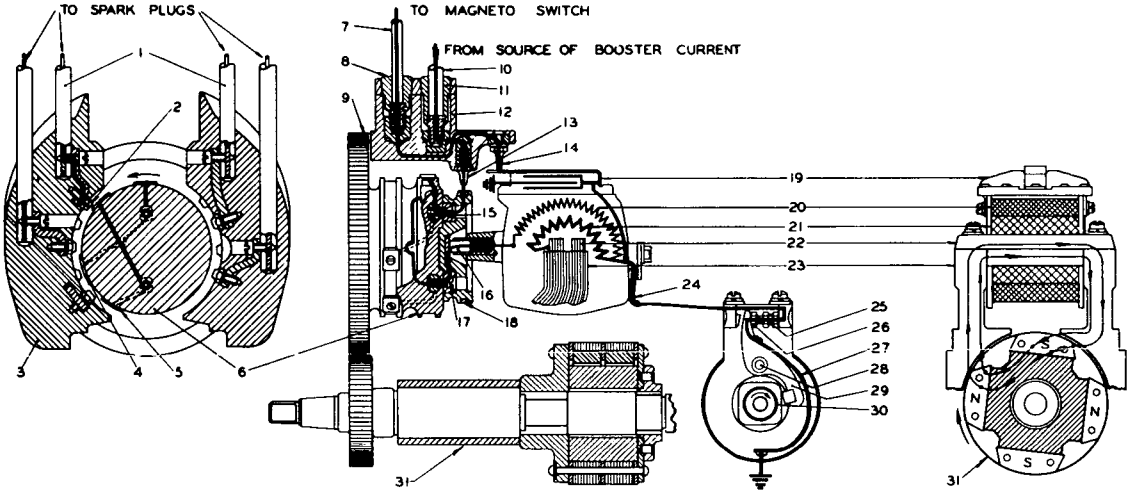
h. The ground and booster terminals are conveniently located at the top of the coil cover which is secured to the magneto housing. The distributor blocks are secured between the coil cover and the front end plate and are totally encased by the radio shield. This shield is secured by two clamping springs which engage suitable latching hooks locked with safetypins.

78. OPERATION.

a. The poles of the rotating magnet are arranged in alternate polarity (fig. 34), so that the flux can pass from a north pole through the coil core and back to a south pole. As the magnet is turned, the polarity continually changes, thereby producing flux reversals in the coil core. The number of flux reversals during one complete revolution of the magnet is equal to the number of poles on the magnet.

b. The flux reversals induce current in the primary winding while the contact points are closed. The flow of current in the primary winding stores energy which is released later by the opening of the contact points, thereby producing high voltage in the secondary winding.

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



1 IGNITION CABLES
2 ELECTRODE IN DISTRIBUTOR BLOCK
3 DISTRIBUTOR BLOCK
4 SEGMENT IN DISTRIBUTOR CYLINDER CARRYING BOOSTER CURRENT
5 SEGMENT IN DISTRIBUTOR CYLINDER CARRYING SECONDARY CURRENT
6 DISTRIBUTOR CYLINDER
7 GROUND CABLE
8 GROUND TERMINAL CABLE SCREW
9 LARGE DISTRIBUTOR GEAR
10 BOOSTER CABLE
11 BOOSTER TERMINAL CABLE SCREW
12 BOOSTER & GROUND TERMINAL BLOCK
13 ELECTRODE FOR BOOSTER CURRENT
14 STUD FOR GROUND CONTACT
15 FASTENING SCREW FOR COLLECTOR RING (IN BOOSTER CIRCUIT)
16 HIGH TENSION CARBON BRUSH
17 FASTENING SCREW FOR COLLECTOR RING (IN SECONDARY CIRCUIT)
18 COLLECTOR RING – BOOSTER CURRENT
19 CONDENSER
20 SECONDARY WINDING
21 PRIMARY WINDING
22 COIL CORE
23 POLE SHOES
24 PRIMARY CONTACT BRUSH ASS'Y
25 LONG CONTACT POINT (INSULATED)
26 SHORT CONTACT POINT
27 BREAKER LEVER MAIN SPRING
28 BREAKER LEVER AXLE
29 BREAKER LEVER
30 BREAKER CAM
31 ROTATING MAGNET

RA PD 5269

Figure 34—Schematic Diagram of Electric and Magneto Circuits

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

d. The ground terminal of the magneto is electrically connected to the insulated contact point. A wire is connected between the ground terminal and the switch. When the switch is in the "off" position, this wire provides a direct path to ground for the primary current. This prevents the production of high voltage in the secondary winding.

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

f. The booster segment is located so that it trails the high tension segment on the distributor cylinder to give a retarded spark for starting the engine.

79. PREVENTIVE MAINTENANCE.

a. Inspection of Breaker Contacts. At regular inspection intervals, remove the breaker cover and check the clearance between the contact points when held wide open by the cam lobe. The clearance should be from 0.010 inch to 0.014 inch; the most desirable being 0.012 inch.

b. Adjust Clearance of Breaker Contacts. Loosen the lock nut on the long contact screw with contact point wrench SCI-11-490. Adjust the long contact screw so that there is 0.012-inch clearance between the contact points; then tighten the lock nut.

c. Oiling.

(1) Each magneto has two oil cups; one located on the top of the front end plate, the other on the magneto coil cover. The front end plate oiler lubricates the bearing at the drive shaft end of the rotating magnet. The magneto coil cover oiler lubricates the breaker end bearing of the rotating magnet and the felt attached to the breaker assembly for lubrication of the cam follower.

(2) At regular inspector intervals, put 20 to 30 drops of OIL, engine, SAE 30, into the oil cup on the front end plate, and only five to eight drops into the oil cup on the magneto coil cover.

(3) Avoid overoiling at the coil cover, as excess oil in the breaker end bearing will enter the breaker compartment and cause fouling of the contact points.

(4) Examine the felt wick at the bottom of the breaker housing to make sure it is moist with oil. If oil appears on the surface of the felt when it is squeezed with the fingers, no oil is needed. If the felt is dry, add a few drops of OIL, engine, SAE 30. Do not saturate the felt with oil, as any excess will reach the contact points and will cause fouling.

80. REMOVAL OF MAGNETO FROM ENGINE.

a. For removal instructions see TM 9-750, page 61, paragraph 42 e.

b. If magneto is to be disassembled or exchanged, remove the coupling. Remove the cotter pin, nut, and washer and pull the coupling off the shaft with a gear puller.

81. DISASSEMBLY OF RADIO SHIELD, DISTRIBUTOR BLOCKS, AND COIL COVER (figs. 35, 36, and 37).

a. Remove the safetypins from the distributor block clamps. Disengage the radio shield outlet adapter, and remove the shield clamping screws. The shield halves and the distributor blocks may then be lifted off. Remove the two long screws which hold the coil cover to the magneto housing. Take off the coil cover and the breaker cover.

b. Clean the electrodes of the distributor blocks with a piece of fine emery cloth. If the electrodes are burned or worn, replace with new ones. Use socket wrench SCI-11-989 for the electrodes, and check the electrode height with template SCI-11-978. Figure 38 shows template being placed in position. If the new electrodes are too high, machine with electrode cutting tool SCI-11-118 or milling fixture SCI-11-1157. The milling fixture is best suited when electrodes are to be machined in a large quantity of blocks, as all the electrodes in the block are cut at the same time. The SCI-11-118 cutting tool accommodates only one electrode at a time and, therefore, should be used only when a small quantity of electrodes is to be machined.

c. Examine the cable holes, and remove any foreign particles. Examine all parts of the distributor blocks for cracks.

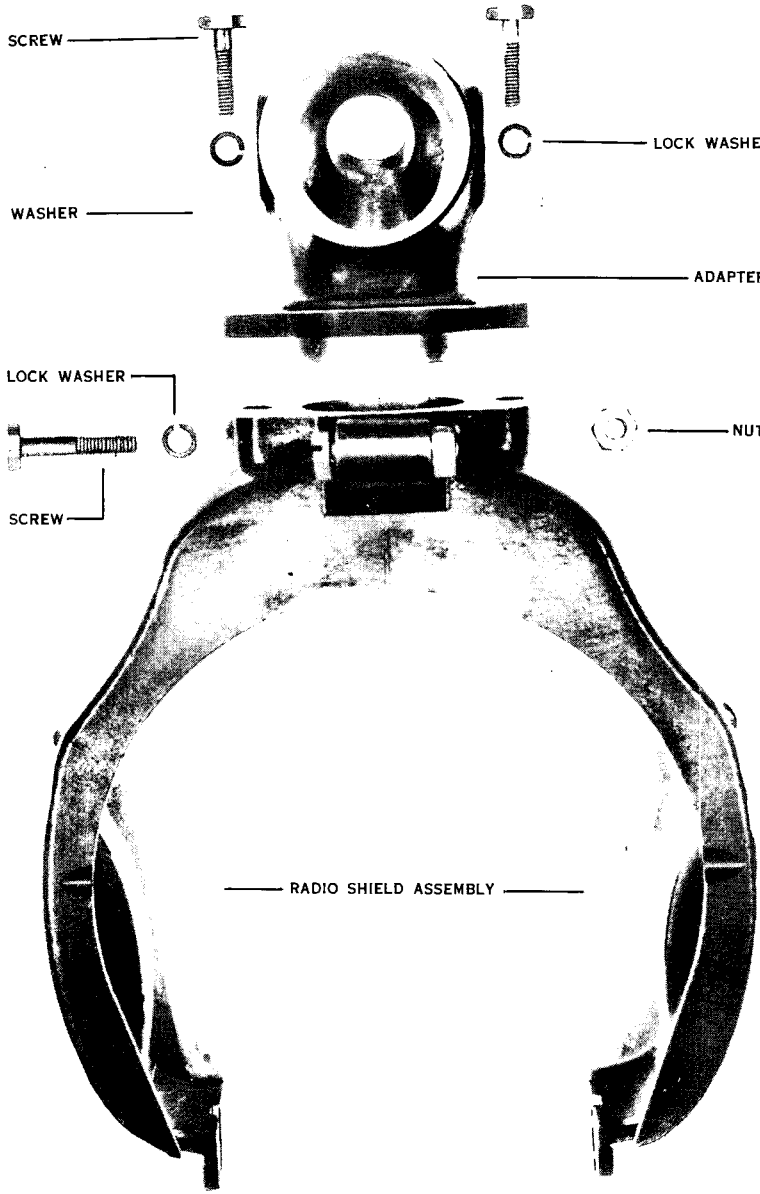
d. Inspect the booster and the ground-terminal block for defects or cracks. Clean the booster electrode and primary current stud with a piece of fine emery cloth. Inspect the booster and ground terminals for cracks. Make sure the felt strips at the parting surfaces of the coil cover are in good condition and tightly secured.

82. DISASSEMBLY OF BREAKER (fig. 39).

a. Release the breaker bayonet lock, and take out the breaker assembly and the spring ring. Clean the assembly thoroughly. Inspect the contact lever and axle for excessive wear. If either the lever is loose on the axle or if the cam follower on the contact lever is badly worn, replace both the lever and the axle.

b. Examine the contact points. If the wear seems to be excessive or if the surfaces are rough or pitted, clean and polish the contact points. Contacts can be dressed with contact point dressing block SCI-11-1248, special cut file SCI-11-1256, and polishing stone SCI-11-1269. Use socket wrench SCI-11-1033 to remove the contact point from the contact lever. Remove the long contact screw from the support with wrench

MAGNETO



RA PD 5267

Figure 35—Radio Shield

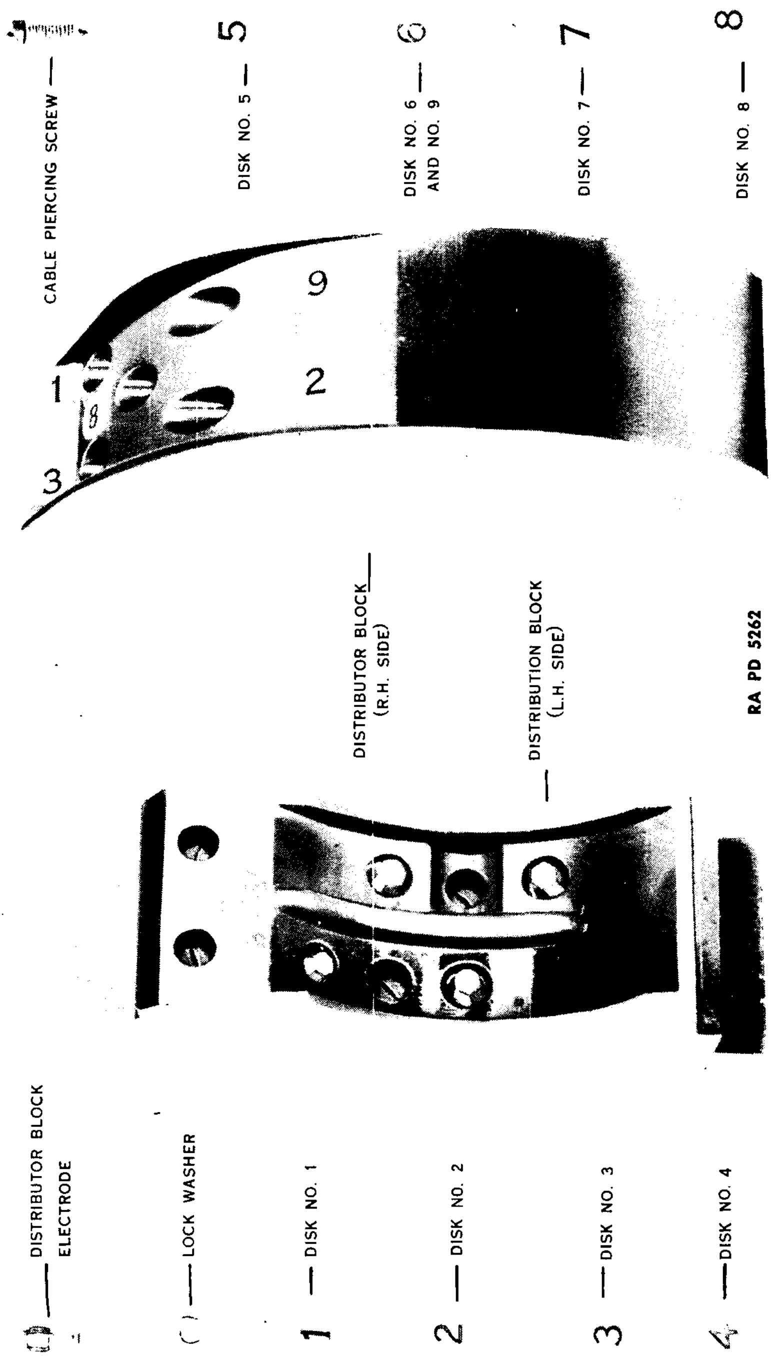


Figure 36—Distributor Blocks

1 - ECCENTRIC STUD
2 - PIN
3 - CAP ASSEMBLY
4 - ROTATION PLATE
5 - DISK NO. 1
6 - ROTATION DISK
7 - DISK NO. 3
8 - FELT STRIP
9 - BOOSTER TERMINAL SCREW
10 - GROUND TERMINAL SCREW
11 - RUBBER LOCK
12 - TERMINAL BLOCK GASKET
13 - TERMINAL BLOCK
14 - BLOCK FASTENING SCREW
15 - LOCK WASHER
16 - ELECTRODE
17 - STUD
18 - DISK P
19 - DISK NO. 6
20 - DISK NO. 4
21 - DISK H
22 - COIL COVER
23 - PLATE FASTENING SCREW
24 - SPRING
25 - BREAKER COVER
26 - NUT

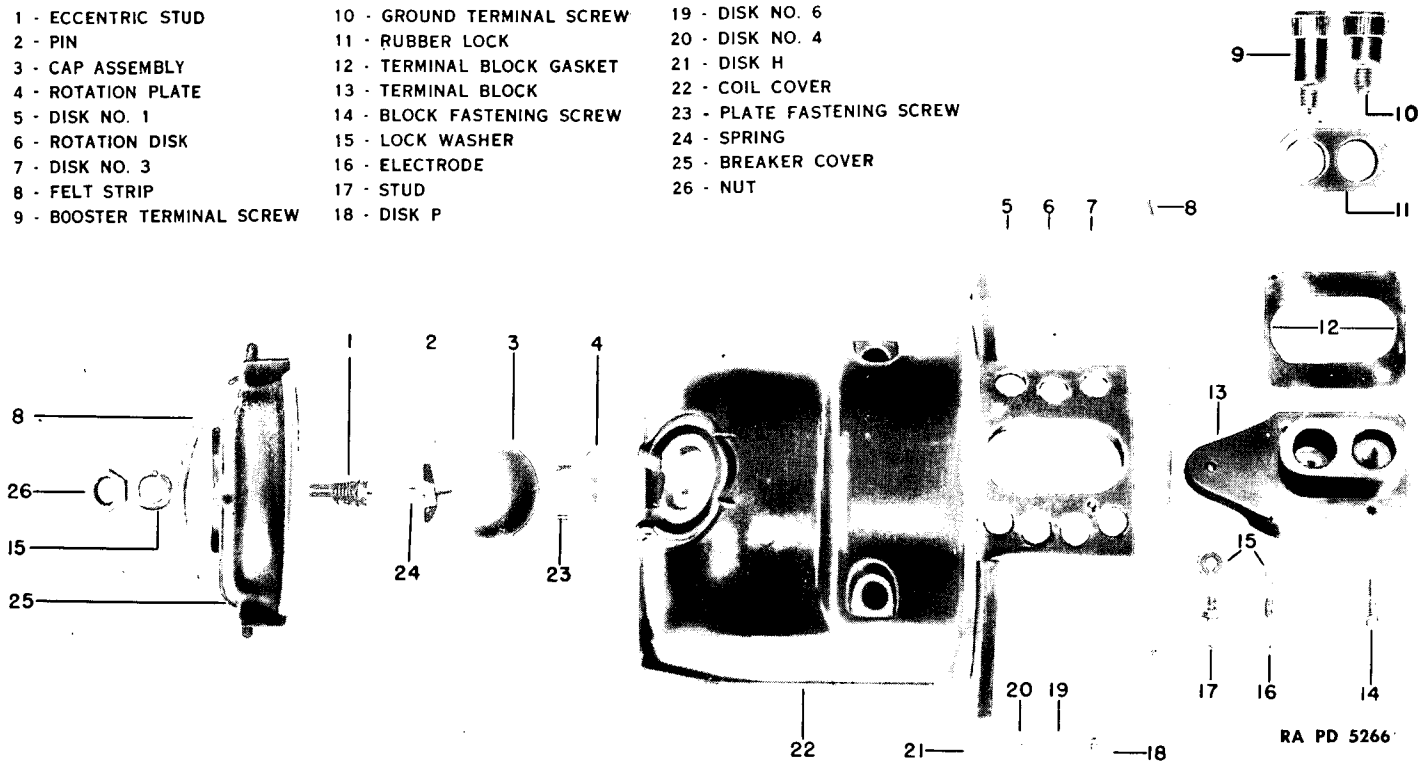


Figure 37—Magneto Coil Cover

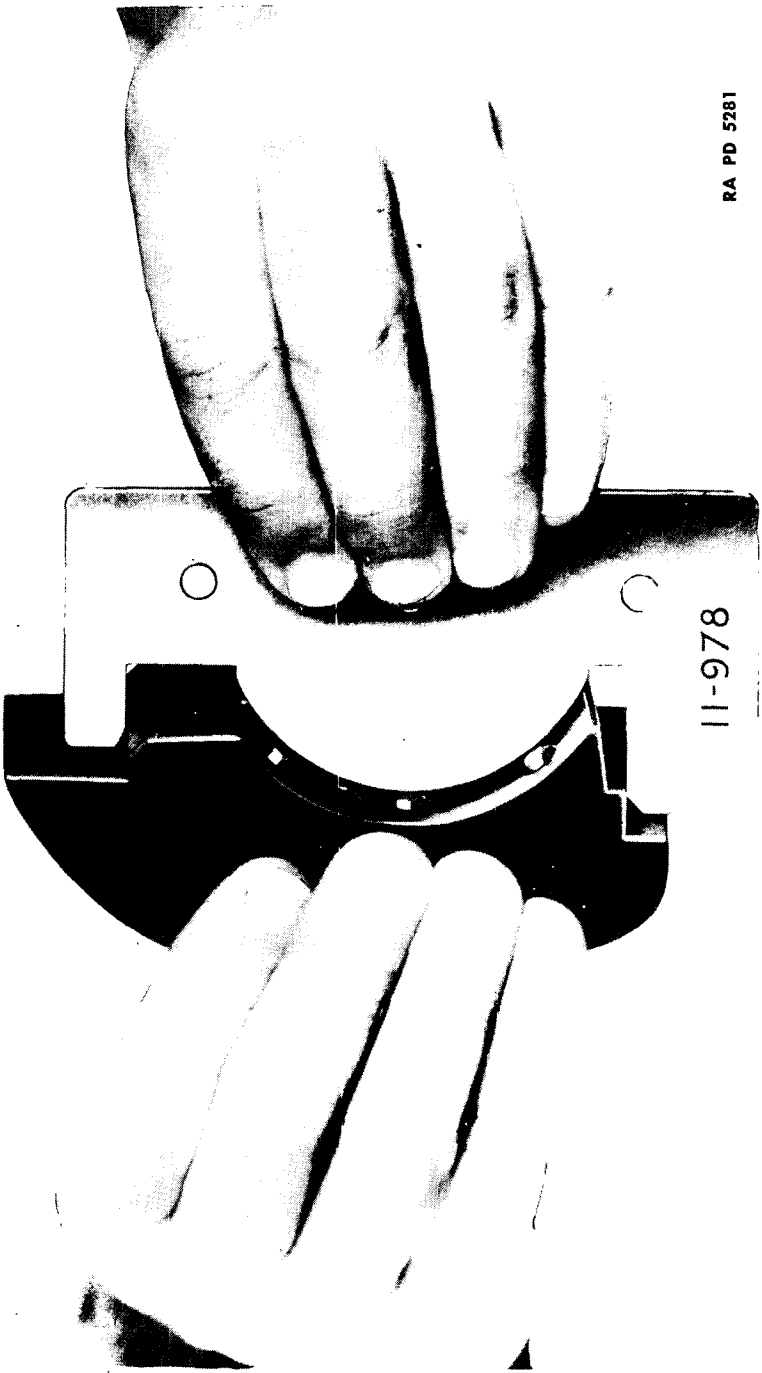
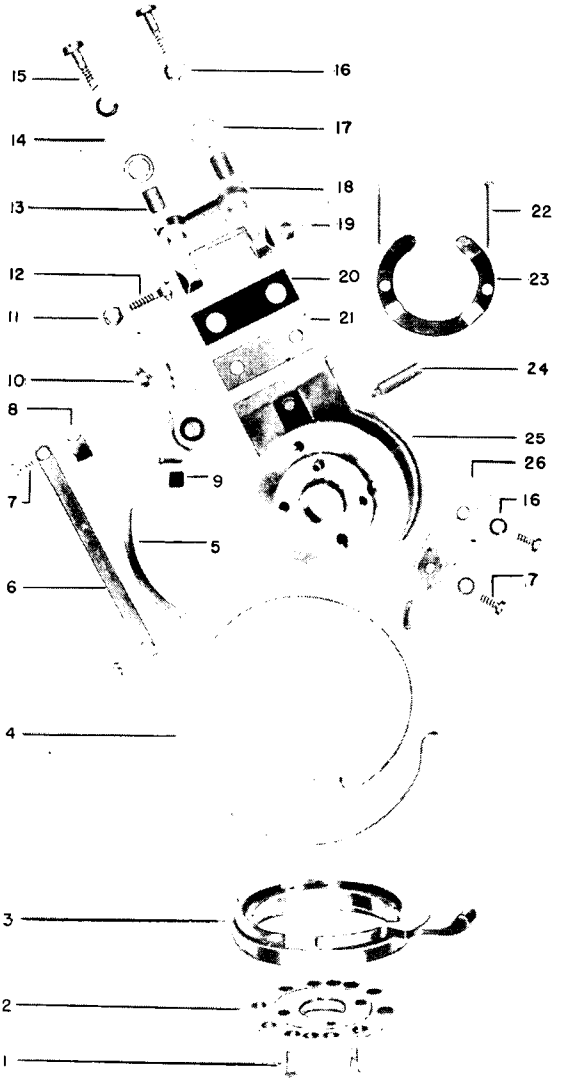


Figure 38—Method of Using Template for Distributor Block Electrodes

MAGNETO



8 - REINFORCING MAIN SPRING (SHORT)

9 - BREAKER CONTACT LEVER

10 - BREAKER CONTACT SCREW (SHORT)

11 - ADJUSTING NUT

12 - BREAKER CONTACT SCREW (LONG)

13 - INSULATING BUSHING

14 - PLAIN WASHER

15 - CONTACT SUPPORT FASTENING (SCREW)

16 - LOCK WASHER

17 - INSULATING WASHER

18 - CONTACT SUPPORT

19 - FIBER STOP

20 - INSULATING PLATE (CONTACT SUPPORT)

21 - INSULATING PLATE (CONTACT SUPPORT ADJUSTING)

22 - RIVET

23 - BREAKER GROUND SPRING

24 - CONTACT LEVER AXLE

25 - BREAKER HOUSING

26 - CAM OIL WICK

1 - ADVANCE LEVER PLATE FASTENING SCREW

2 - ADVANCE LEVER LOCATING PLATE

3 - ADVANCE LEVER LATCH

4 - ADVANCE LEVER LATCH SPRING

5 - REINFORCING MAIN SPRING (LONG)

6 - CONTACT LEVER MAIN SPRING

7 - FASTENING SCREW

RA PD 5268

Figure 39—Contact Breaker

SCI-11-490. When reassembling the short contact screw to the contact lever, stake with locking tool SCI-11-1058.

c. Examine the felt in the bottom of the breaker housing. If oil appears when felt is squeezed, do not add oil. However, if felt is dry, moisten it with a few drops of OIL, engine, SAE 30. Do not overoil.

d. Reassemble contact breaker. Check the contact lever tension with gage SCI-11-1217. Apply gage adjacent to the contact point on the side facing the end of the lever. Tension should be from 16 ounces to 32 ounces. If tension is low, replace the spring.

83. DISASSEMBLY OF COIL AND CONDENSER (fig. 40).

a. Remove the two screws, lock washers, and clamps which secure the coil to the pole shoes. Remove the coil, and take out the felt cushion.

b. Examine the coil and condenser carefully for cracks or defects. Replace carbon brush if it is worn excessively or damaged. Also make sure that the carbon brush does not stick when depressed. For electrical test of the coil and condenser, see paragraph 19.

84. DISASSEMBLY OF FRONT END PLATE (fig. 41).

a. Remove the front end plate after taking out its two securing screws and four lock nuts. Use socket wrench SCI-11-1072 for the lock nuts. Tap each side of the front end plate lightly with a rawhide mallet to remove it from the housing. See that the felt strips are in place. Examine the outer ball race of the drive shaft bearing. If it is unsatisfactory for further service, replace the complete ball bearing assembly, according to instructions in paragraph 86.

b. Remove the distributor cylinder after prying out the lock ring with a small screwdriver. Examine the dielectric material for defects or cracks. Clean and then check the height of the distributor cylinder segments with gage SCI-11-1133. Replace segments burned away 0.015 inch as indicated on the gage.

c. Remove the brass cap from the distributor gear with puller SCI-11-1123. Remove the two nuts from the distributor gear axle with wrench SCI-11-1072, and lift off the large gear. Do not loosen the two screws which secure the distributor gear axle to the front end plate unless the axle must be replaced, as the original adjustment of the gear will be maintained if the position of the axle is not disturbed. The top ball and cage assembly and the spacer with the shim washers will come out as loose parts when the distributor gear is lifted from the axle. Use the same spacer and shim washers when reassembling, as they determine the correct adjustment between the gear and axle. Press out the remaining bearing and retainer with a piece of fiber rod (fig. 42).

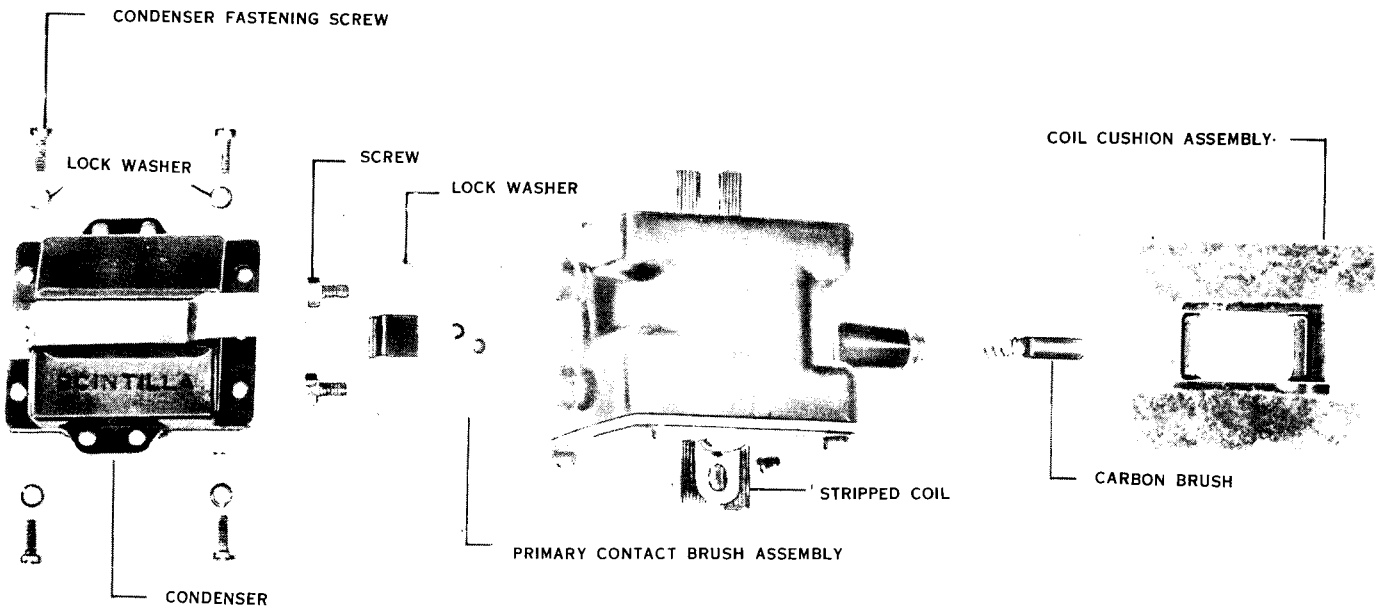
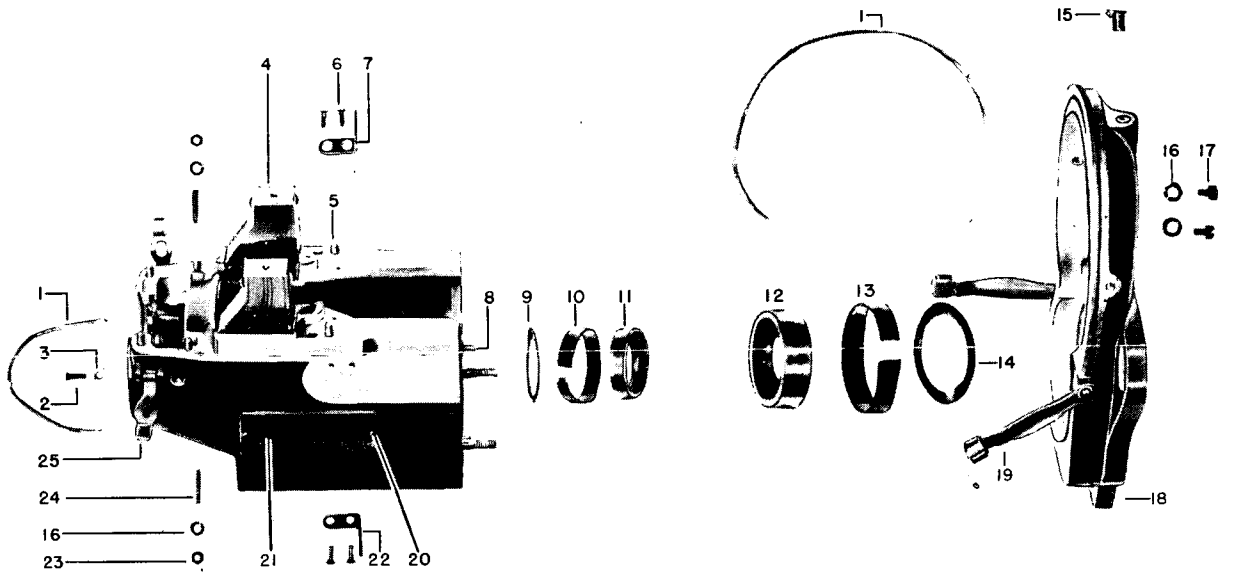


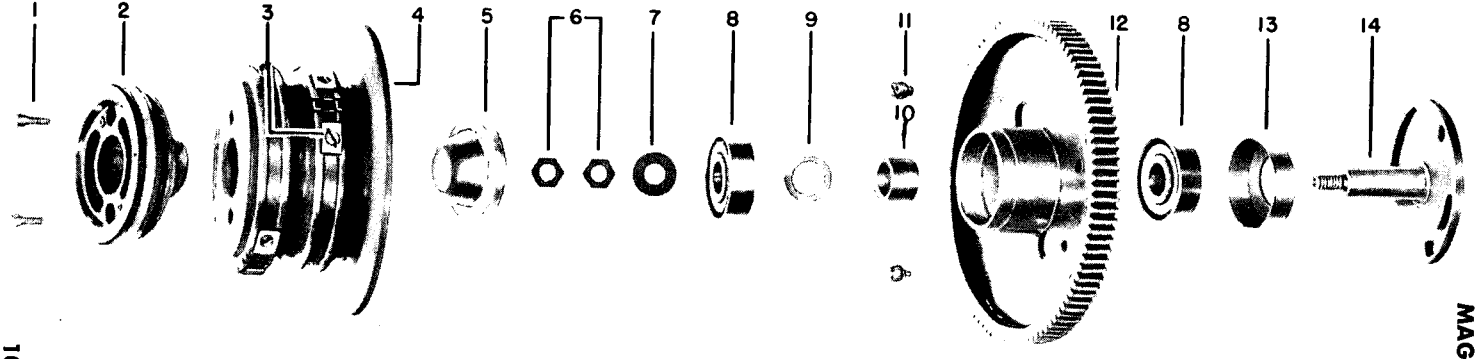
Figure 40—Coil and Condenser



1 - FELT STRIP
2 - MAGNETO BREAKER STOP FASTENING SCREW
3 - MAGNETO BREAKER STOP
4 - MAGNETO STRIPPED HOUSING
5 - MAGNETO HOUSING DOWEL
6 - CLAMPING HOOK FASTENING SCREW
7 - CLAMPING HOOK (RIGHT)
8 - MAGNETO END PLATE MOUNTING STUD
9 - MAGNETO DRIVE SHAFT BREAKER END GASKET
10 - MAGNETO MAGNET SHAFT BREAKER END STRIP
11 - RACE
12 - BEARING RACE
13 - MAGNETO MAGNET SHAFT DRIVE STRIP
14 - MAGNETO DRIVE SHAFT GASKET
15 - MAGNETO FRONT END PLATE OIL CUP
16 - LOCK WASHER
17 - PLUG SCREW
18 - MAGNETO FRONT END PLATE
19 - MAGNETO RADIO SHIELD CLAMP
20 - MAGNETO IDENTIFICATION PLATE DRIVE SCREW
21 - MAGNETO IDENTIFICATION PLATE
22 - CLAMPING HOOK (LEFT)
23 - MAGNETO BREAKER RANGE AND CONTACT LOCK NUT
24 - MAGNETO BREAKER ADJUSTING SCREW
25 - MAGNETO BREAKER COVER LOCKING SPRING AND PIN

RA PD 5278

Figure 41—Front End Plate and Housing



1 - BOOSTER COLLECTOR RING FASTENING SCREW
2 - BOOSTER COLLECTOR RING
3 - MAGNETO DISTRIBUTOR CYLINDER ELECTRODE AND SCREW
4 - DISTRIBUTOR MAGNETO CYLINDER
5 - OIL RETAINING CAP
6 - MAGNETO DISTRIBUTOR AXLE NUT
7 - SPACING WASHER
8 - MAGNETO DISTRIBUTOR AXLE BEARING
9 - ADJUSTING WASHER
10 - MAGNETO DISTRIBUTOR GEAR BEARING SPACER
11 - LOCATING SCREW
12 - MAGNETO DISTRIBUTOR DRIVEN GEAR
13 - AXLE BEARING RETAINER
14 - MAGNETO DISTRIBUTOR AXLE

RA PD 5280

Figure 42—Distributor and Distributor Gear

d. Examine the distributor driven gear for burs or excessive wear of the teeth. If this gear is replaced, also replace the distributor driving gear. Clean bearings and examine for roughness, wear, or looseness. If any part of a bearing is defective, replace the complete bearing assembly.

85. DISASSEMBLY OF ROTATING MAGNET AND MAGNETO HOUSING (fig. 43).

a. Remove the rotating magnet from the housing. Clean and inspect the bearings for noticeable wear, roughness, or looseness. Examine the distributor driving gear for burs or excessive wear of the teeth. If a new distributor driving gear has to be installed, also install a new driving gear. The driving gear can be removed with puller SCI-11-1037, and the new one installed with pressing tool SCI-11-1032.

b. Do not disassemble the automatic advance rotating magnet at overhaul periods unless absolutely necessary, in which case, proceed as follows: Remove the inner bearing race, shims, and small gear from the drive end of the magnet. Remove the spindle lock ring with a small screwdriver. (Early rotors have the spindle secured with two lock nuts which can be loosened and removed with two $\frac{5}{16}$-inch spanner wrenches.) Take out the flyweight cover securing screws, and remove the flyweight cover. Lift off the flyweights, and remove the spindle and springs. Clean all parts thoroughly, and examine them for excessive wear. Fill recess in magnet body half full of GREASE, special high temperature, also applying it to the inside of the sleeve. Insert the spindle and springs into the magnet body, making sure that the ends of the springs are properly seated in the grooves in the magnet recess and spindle. Also make sure the spindle and springs are greased thoroughly. Install the flyweights, cover assembly, and screws. Secure spindle with its lock ring. (For spindles secured with lock nuts, first run securing nut down tight, then back off $\frac{1}{8}$ turn and lock with lock nut.) Check the spindle to see that it turns freely. Replace the distributor driving gear, shims, and inner bearing race.

c. Remove insulating plate from the housing after taking out the two securing screws which also hold the safety gap bridge. Inspect the outer bearing race for wear or rough spots.

86. REPLACEMENT OF DRIVE SHAFT AND BREAKER END BALL BEARINGS.

a. If any one part of a ball bearing is defective and needs replacement, replace the complete bearing. When installing new bearings, use the original steel spacing washers in back of the inner race on the magnet shaft.

b. The outer ball races are insulated from the magneto by insulating

strips and also backed by washers of the same material as used in the insulating strips.

c. Remove the outside ball race from the front end plate with puller SCI-11-1002 (fig. 44), and remove the inside race from the magnet with puller SCI-11-1065 (fig. 45).

d. Remove the outside ball race from the housing with puller SCI-11-992, and the inside race from the magnet with puller SCI-11-1049. Before removing this inside race, remove the cam with puller SCI-11-1060. Remove cam securing screw with socket wrench SCI-11-1033.

e. Before installing new races in the front end plate and housing, put the flat insulating washer on the bottom of the recess for the bearing so that the cut will line up with the oil recess. Then spread a few drops of oil evenly over one side of the insulating strip. Bend the strip into a circular form with the oiled side inside, and overlap the ends enough to allow the strip to fit loosely into the recess for the outer race. When it is released, it will expand against the walls and the ends will overlap slightly in the recess cut for them. Install pressing tool SCI-11-976 in an arbor press, and press the outside ball race for the front end plate into position. Similarly install the outside ball race for the housing with pressing tool SCI-11-970 in conjunction with support SCI-11-975, which must be inserted into the breaker compartment in order to support the magneto housing. Cut off the surplus insulating strip with cutting tool SCI-11-705.

f. Press the inside ball race for the drive end bearing onto the rotating magnet shaft with pressing tool SCI-11-1032. Similarly, press the inside ball race for the breaker end bearing onto the rotating magnet shaft with pressing tool SCI-11-1036.

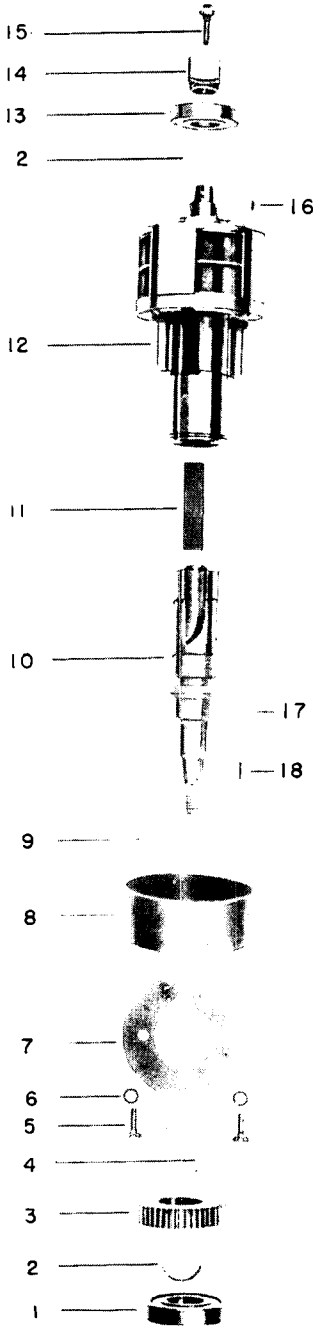
87. ASSEMBLY GENERAL (fig. 46).

Before reassembling the magneto, make sure that all parts are clean and free from chips or foreign particles.

88. ASSEMBLY OF FRONT END PLATE (fig. 41).

a. Install a new felt strip in drive shaft hole in front end plate.

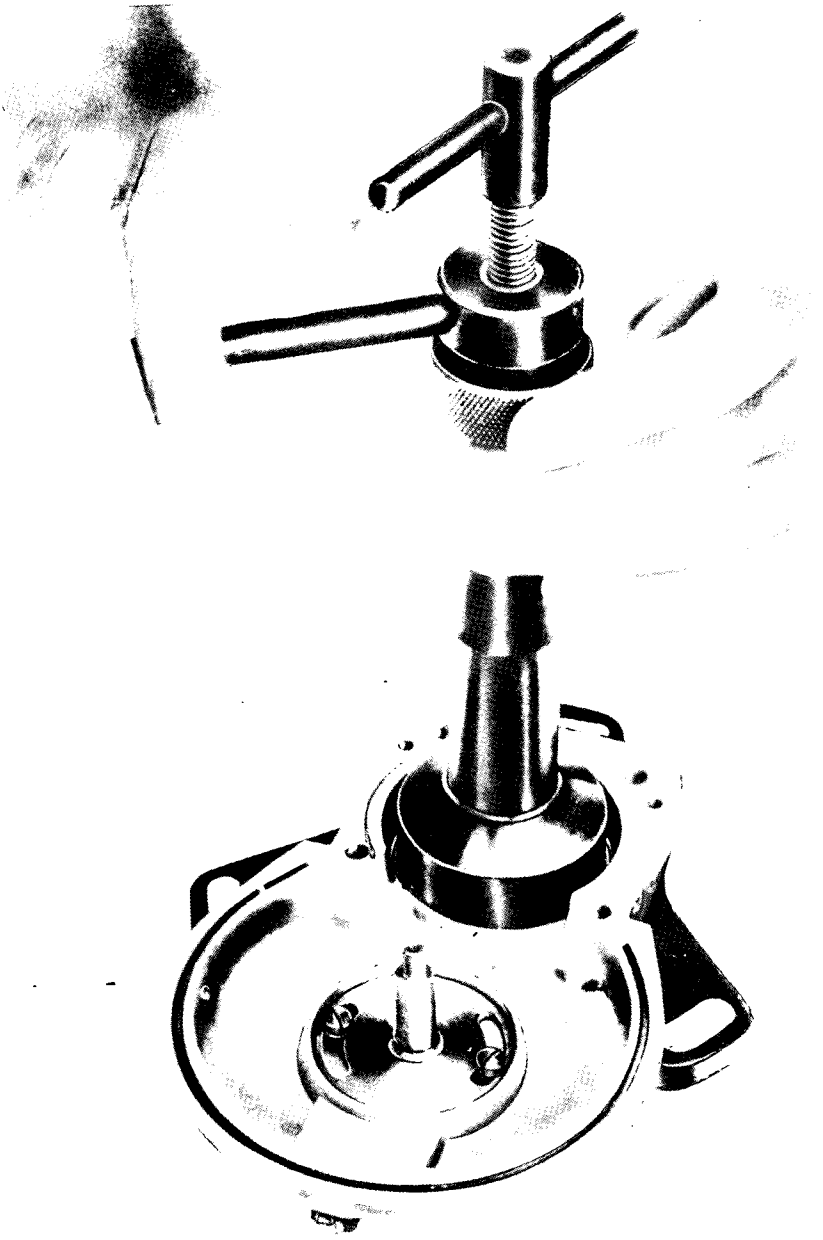
b. Press the complete bearing and retainer into the front end plate side of the distributor gear, and also press the outside race of the other bearing into the other side of the gear hub. Place the gear on the axle and install the original spacer and shim washers, and also the remaining cage and ball assembly. Secure gear with its plain washer and two lock nuts. Do not grease the bearings at this time, as it is necessary to test the gear for end play. Do this by pressing on the outside diameter of the gear with the thumbs, first applying pressure on one side and



1 - BALL BEARING (DRIVE END)
2 - WASHER
3 - DISTRIBUTOR GEAR (SMALL)
4 - DRIVE SHAFT SECURING RING
5 - FASTENING SCREW
6 - LOCK WASHER
7 - RETAINER
8 - COVER (FLYWEIGHT)
9 - AUTOMATIC ADVANCE FLYWEIGHT
10 - DRIVE SHAFT
11 - AUTOMATIC ADVANCE SPRING
12 - ROTATING STRIPPED MAGNET
13 - BALL BEARING (BREAKER END)
14 - BREAKER CAM
15 - CAM FASTENING SCREW
16 - WOODRUFF KEY (CAM)
17 - WOODRUFF KEY (SMALL GEAR)
18 - WOODRUFF KEY (DRIVE SHAFT)

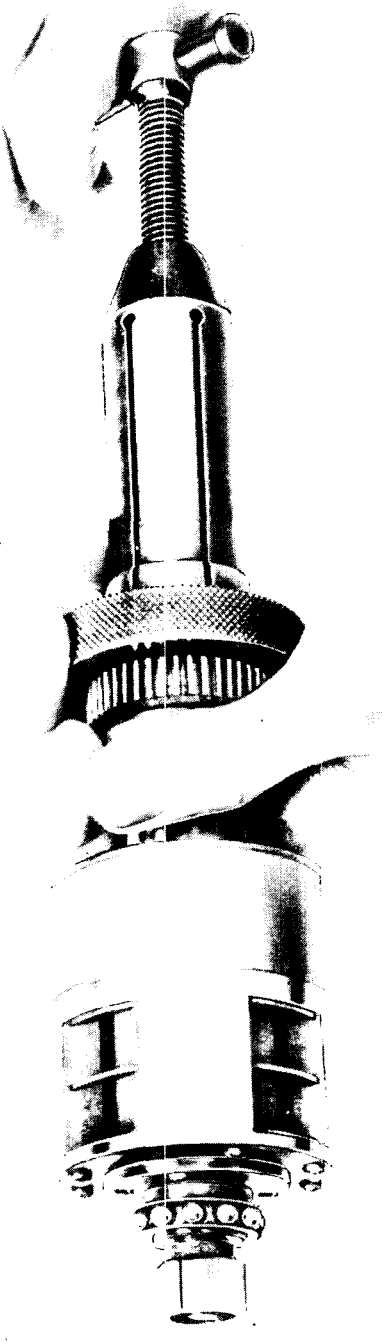
RA PD 5264

Figure 43--Rotating Magnet



RA PD 5263

Figure 44—Removal of Outside Ball Bearing Race From Front End Plate



RA PD 5260

Figure 45—Removal of Inner Race from Rotating Magnet

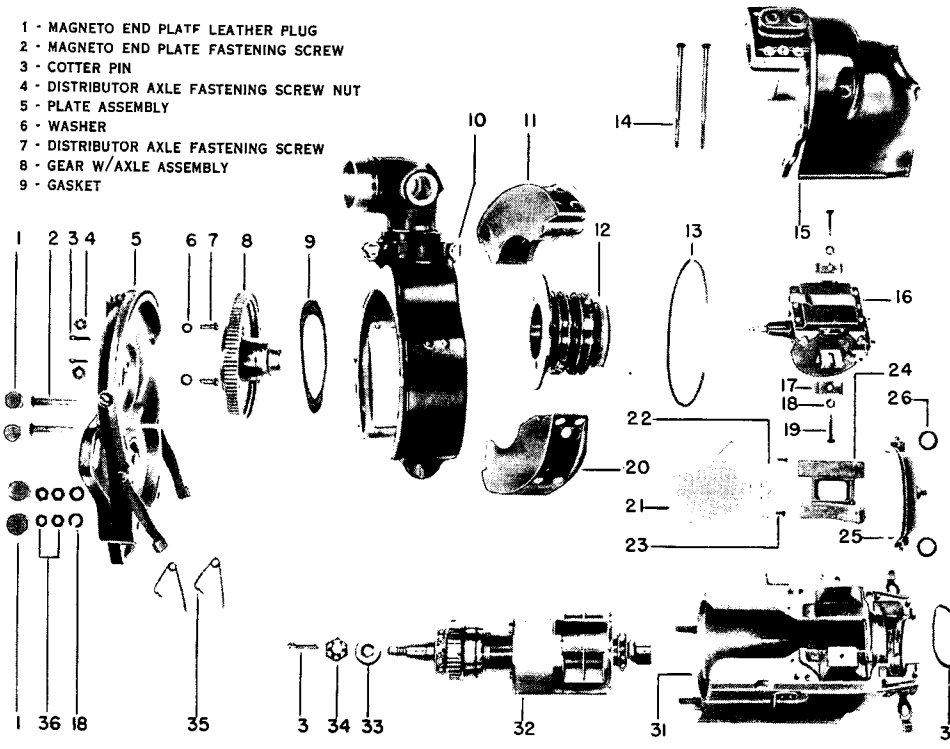


Figure 46—Disassembled Scintilla Magneto

them the other. The gear should turn freely with the least possible end play between it and the axle. If the end play is too great, remove shim washers next to the spacer.

c. After the correct adjustment for end play has been made, remove the two lock nuts and take out the first cage and ball assembly. Pack high temperature GREASE, special, into the hub of the gear around the axle, and reinstall the cage and ball assembly after first packing with grease. Reinstall the two lock nuts and washers, and then press on the brass cup, after having placed a small amount of grease in it.

d. Moisten all felt strips with OIL, engine, SAE 30.

89. ASSEMBLY OF ROTATING MAGNET (fig. 43).

a. Place the cam key in the keyway on the magnet shaft. Index the key with the keyway on the cam marked "D," and secure with the hexagon head screw. Use socket wrench SCI-11-1033 for this screw.

b. Charge the magnet in magnet charger or SCI-14-217. The SCI-14-217 charger is for use on 36 volts direct current. Pack both bearings with high temperature GREASE, special. Make sure that all chips or foreign particles have been removed from the magnet and the inside of the magneto housing.

c. Engage the rotating magnet with the front end plate so that the chamfered tooth on the distributor drive gear indexes with the timing mark "D" on the distributor driven gear (fig. 47).

d. Place a light coating of OIL, engine, SAE 30, on the pole pieces of the rotating magnet, and insert the rotating magnet into the housing.

e. Secure the front end plate to the housing with its two screws, lock washers, and four lock nuts.

f. Make sure the rotating magnet turns freely and does not bind at any place. Check clearance between each pole piece and the pole shoes of the housing. The clearance must not be less than 0.0015 inch for any pole piece of the magnet.

90. ADJUSTMENT OF ROTATING MAGNET BEARINGS (fig. 48).

a. Adjust end play by placing steel spacing washers back of the inner ball races of the magnet shaft. These washers are available in thicknesses of 0.0025 inch, 0.004 inch, 0.005 inch, 0.008 inch, 0.010 inch, and 0.012 inch. If the inner races are removed, always keep the spacing washers, which are already installed, in the same position. If the original spacing washers are kept in place, it will rarely be necessary to adjust the rotating magnet bearings.

b. If either or both of the bearings have been removed or replaced, adjust them as follows: remove one of the inside bearing races and remove about one-half of the steel spacing washers. Replace the race,

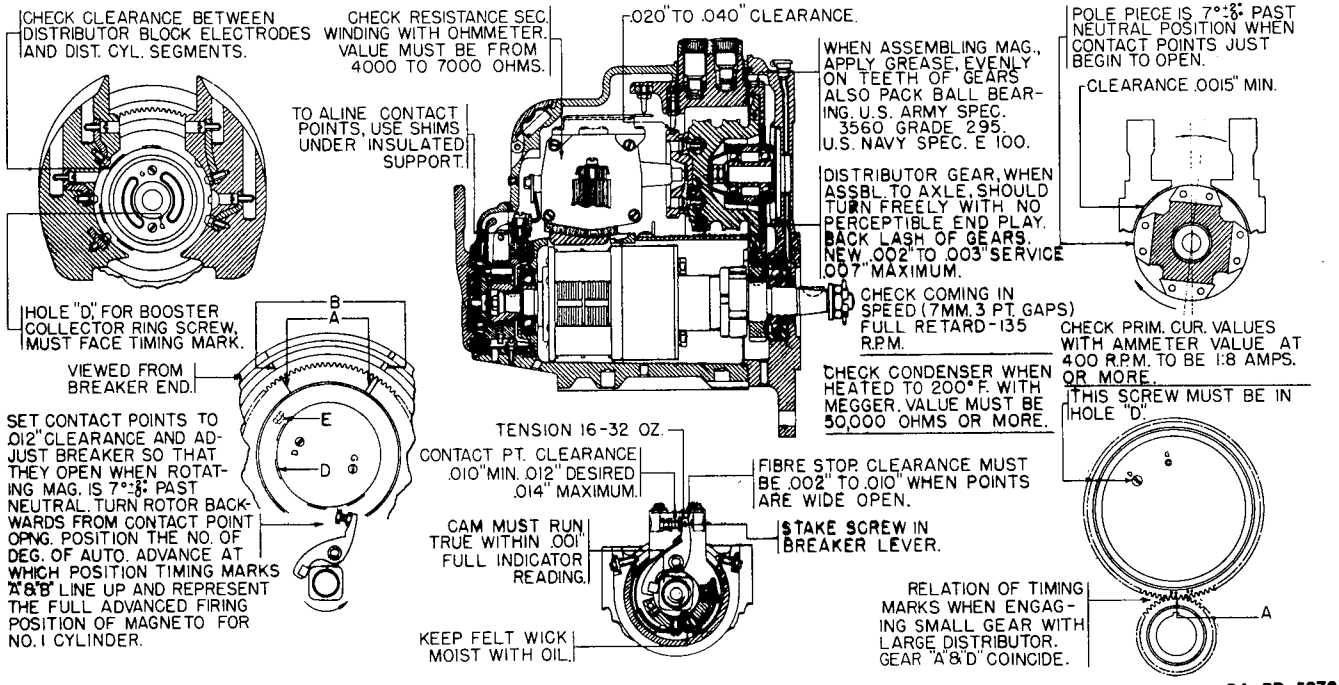


Figure 47—Service Chart for Scintilla Magneto

and install the rotating magnet in the housing and front end plate. Determine the amount of end play with tool SCI-11-1138. Install steel spacing washers equal to the amount of end play minus 0.001 inch. (For example, rotating magnet end play 0.004 inch−0.001 inch=0.003 inch or amount of steel spacing washers to be added in back of the inner bearing race.) This adjustment gives the bearings the correct amount of end play which should be from 0.0005 inch to 0.0015 inch. Do not preload the bearings.

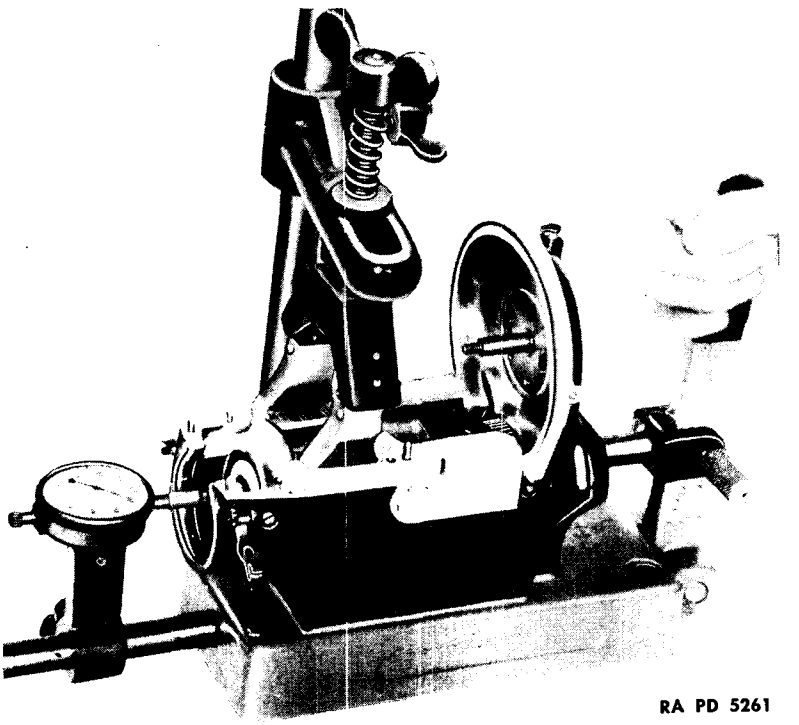


Figure 48—Determining Amount of End Play in Rotating Magnet Bearings

91. ADJUSTMENT OF MESH OF DISTRIBUTOR GEARS.

a. Rarely will it be necessary to adjust the mesh of the gears if the position of the distributor driven gear axle has not been changed.

b. If new gears are installed, adjust the mesh of the gears. This is done by loosening the two screws and lock nuts which hold the distributor driven gear axle to the front end plate. Turn the gear until the round hole in the gear axle flange can be seen through one of the holes in the

face of the gear. Place a drift in the hole in the axle flange, and turn the flange slightly to the right to raise the driven gear (loosen mesh) or to the left to lower the driven gear (tighten mesh). Lock the rotating magnet in a fixed position, with locking tool SCI-11-1225. Then with gage SCI-11-1221, check the backlash of the gears. Do this at several positions to insure that there are no tight spots. A backlash of 0.002 inch to 0.003 inch is desired for new gears, although a maximum of 0.007 inch backlash is allowed. After adjustment is made, tighten and lock the two screws and nuts holding the distributor driven gear axle and apply high temperature GREASE, special, evenly in the teeth of the distributor driven gear.

92. ASSEMBLY OF CONTACT BREAKER (fig. 39).

a. Check the eccentricity of the cam with gage SCI-11-1221. The cam should run true within 0.001 inch full indicator reading. It is permissible to tap the cam lightly with a fiber drift, to fulfill eccentricity requirements.

b. Insert the spring tension ring in the recess provided in the breaker end of the housing. Install the breaker assembly in the magneto housing, and secure with the bayonet lock. Aline contacts, if necessary, by shimming under contact support (fig. 47). Check the clearance between the contact lever and the fiber stop on full contact opening. A clearance of 0.006 inch is desirable. Replacement of the fiber stop is not necessary, however, unless the clearance exceeds 0.010 inch, nor is it necessary to file the stop down unless the clearance is less than 0.002 inch.

93. INTERNAL TIMING.

a. Set the clearance between the contact points to 0.012 inch using contact wrench and feeler gage SCI-11-490.

b. Check the "E" gap of the magneto. The "E" gap is the number of degrees the magnet has turned past its neutral position when the contacts begin to open. Check this gap with timing disk SCI-11-1100 in conjunction with a suitable fixed pointer to be used as an index for the degree markings on the disk. Place the timing disk on the rotating magnet shaft, and turn the magnet to its neutral position. Then note the number of degrees the disk must be turned in the direction of normal rotation to the position where the contacts are just opening. This number of degrees is the actual "E" gap of the magneto, and should be seven degrees to nine degrees. If the reading is outside this tolerance, adjust the breaker stop screw to give the correct reading. Socket wrench SCI-11-1033 is used for the breaker stop screw lock nuts.

c. The opening of the contact points can be conveniently determined with the timing light. If the timing light is not available, the opening of the contact points can be determined by placing a 0.0015-inch shim stock

between them. When the shim stock is released with a slight pull, the points are just opening.

d. Install the magneto in the test stand and determine the exact number of degrees of automatic advance as described in paragraph 95 **e.** Remove magneto from test stand, after recording the exact number of degrees of advance. Place timing disk SCI-11-1100 on the magnet shaft, and turn the shaft in the direction of normal rotation until the contacts are just opening. At this point the timing marks "A" and "B" are approximately in line (fig. 47). (The marks will not line up exactly when the contacts are just opening, since the automatic advance mechanism is in full retard position.) Then turn the shaft in the direction opposite forward rotation the number of degrees of advance as recorded on the stroboscope. Timing marks "A" and "B" (fig. 47) should then line up, as they denote full advance firing position for No. 1 cylinder.

e. If timing marks "A" and "B" do not line up exactly, the "E" gap can often be changed slightly so that the necessary correction can be made. If the tolerance of the "E" gap (seven degrees to nine degrees) does not permit this, remove the timing marks from the front end plate and inscribe new ones opposite the timing marks on the gear. It is essential that timing marks "A" and "B" be accurate, as they are used to time the magneto to the engine at the full advance firing position.

94. COMPLETION OF ASSEMBLY (fig. 47).

a. Make sure that the dog screws are tight and locked in the holes marked "D," located in the face of the distributor driven gear. Secure the booster collector ring to the distributor cylinder with two screws. One screw hole is marked "D" and the other "G." The hole marked "D" must face toward the timing mark on the distributor cylinder.

b. Place the paper gasket in position on the distributor driven gear. Install the cylinder on the gear, with the dog screws in the face of the gear engaging corresponding holes located on the flat surface of the distributor cylinder, and secure with lock ring.

c. Install the insulating plate and the safety gap bridge on the magneto housing with its two securing screws. These screws must be staked after they have been tightened.

d. Remove the contact assembly. Place the felt pad between the pole shoe extensions under the coil. Place the coil in position and secure with its two screws, clamps, and washers. Make sure the high tension carbon brush is not broken or damaged while installing the coil.

e. Secure the coil cover with its two screws, and install distributor blocks. Moisten all felt strips on the main cover and front end plate with oil.

f. Install the radio shield halves and clamp together with the two screws, washers, and nuts. Secure the radio shield in position with two spring clamps and safetypins. Install the radio shield outlet adapter.

g. Reinstall the contact assembly and the breaker cover. Secure the breaker cover with the two spring clamps and lock rings. Adjust the fixed spark locking screw to hold the breaker advance lever in the full advance position.

95. TEST PROCEDURE.

a. Complete Magneto.

(1) Mount the magneto on the magneto test stand. Use a drive shaft pulley which is calibrated in degrees for use in conjunction with the stroboscope when checking the operation of the automatic advance mechanism.

(2) Connect the high tension cables to the 7-mm three point spark gaps. Operate the magneto for several minutes at various speeds to observe mechanical operation. Hold contact points open, and listen to gears and bearings at declining speeds.

(3) Check the coming in speed, or the lowest speed at which the magneto will produce consistent sparking at all the gaps. The magneto should spark consistently at 160 revolutions per minute or less.

(4) Increase the speed to 2500 revolutions per minute, and observe the spark closely. If missing occurs, it may be caused by: improper breaker adjustment, dirty contact points, defective coil, or defective condenser (if contacts arc excessively).

(5) Check the ground connection. No spark should occur at the spark rack when the magneto is shorted through the ground wire terminal screw.

(6) Connect the cable from the source of booster current to the booster connection in the magneto. Run magneto at about 150 revolutions per minute and observe the booster spark to make sure it is being properly distributed. The booster spark always trails the magneto spark.

b. Rotating Magnet. Operate the magneto for about five minutes at 2500 revolutions per minute. During this run, short circuit the primary current through the magneto ground terminal several times. Then reduce the speed to 400 revolutions per minute. (This speed must not vary more than 10 revolutions per minute.) Hold contact points open by hand and connect the ammeter across the open contact points. The primary current at 400 revolutions per minute should not be less than 1.8 amperes. If the reading is below 1.8, recharge the magnet. If the reading is still below 1.8, repeat the test with a new coil before rejecting magnet.

c. Coil.

(1) Before installing the coil in the magneto, check the resistance of the secondary winding with the ohmmeter. The reading must be from 4000 to 7000 ohms.

(2) The final test of a coil must be made by an actual running test of the magneto on the test bench. As heat from the engine affects the insulation materials of the coil, the final test should be made at an elevated temperature. This is done by directing a reflector type heater on the magneto while it is being run on the test bench. When the temperature of the coil has reached approximately 165 F, increase the spark gaps by means of the adjustable panel from 7-mm to 9-mm. At 2000 revolutions per minute the coil must spark consistently at this temperature and spark gap. Increase the gaps to 10-mm. If consistent sparking occurred with the 9-mm gap, intermittent missing with the 10-mm gap will not be sufficient cause to reject the coil. It may be found that the coil produces consistent sparking at room temperature with 7-mm gaps; however, if the coil does not spark consistently at the elevated temperature with 9-mm gaps, it should not be used for further service.

d. Primary Circuit Condenser. Test the condenser before installing it on the magneto. The recommended test is made at an elevated temperature with the four hundred volt direct current megger. Heat the condenser to 200 F in an oven. If the reading of the megger for the condenser at 200 F is less than 50,000 ohms, the condenser is not satisfactory for further service.

e. Automatic Advance Mechanism.

(1) Place the stroboscope over the rim of the graduated pulley. Remove the No. 1 cable from the test gap panel and connect it to the stroboscope. Ground the stroboscope by mounting it to the metal base casting of the test stand, or by a suitable ground wire.

(2) Run the magneto at about 500 revolutions per minute, and look into stroboscope. Shift stroboscope until the hair line corresponds with any degree marking on the calibrated pulley. Gradually increase the speed of the magneto until the advance mechanism just starts to advance, which is evidenced by a slight shifting of the degree mark from under the hair line of the stroboscope. The spark advance mechanism should begin to advance at a speed somewhere between 700 revolutions per minute and 900 revolutions per minute. Increase the speed of the magneto until the spark ceases to advance, and note the number of degrees through which the spark advances. The spark should advance 28 degrees to 31 degrees when the magneto speed is increased to 1250-1450 revolutions per minute. Record the actual number of degrees of advance as read on the pulley. If the spark advance mechanism does not

function properly, it can often be corrected by cleaning the advance mechanism, which may be sticking.

96. TIMING TO THE ENGINE.

a. Make sure that the magneto has been properly checked and inspected. Replace the coupling on the shaft.

b. Turn the engine crankshaft in the direction of normal rotation until the piston of No. 1 cylinder is in its full advance firing position. This position is obtained by rotating the crankshaft in its normal direction until the timing disk indicates 25 degrees before top dead center on the compression stroke of No. 1 piston.

c. Remove the radio shield and distributor blocks. Rotate the magneto drive shaft in the direction of normal rotation until the engraved timing marks on the teeth of the distributor driven gear are approximately opposite the corresponding timing marks engraved on the inside of the front end plate. With the magneto in this position, install it on the engine, making sure that the face of the magneto mounting flange and the corresponding face on the mounting surface of the engine are clean and free from burs.

d. Move the magneto through the range provided in the elongated slots on the mounting flange until the timing marks "A" engraved on the distributor driven gear (fig. 47) are **exactly** opposite the corresponding timing marks "B" engraved on the inside of the front end plate. This relation will place the high tension electrode "D" of the distributor cylinder opposite the electrode "E" of the distributor block firing the No. 1 cylinder; however, the contact points will not be opening, as the automatic advance rotating magnet is on the retard side. Tighten and lock the magneto mounting hold-down bolts.

e. It is recommended that the VAG9DFA magnetos be timed 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 as specified by the engine manufacturer.

97. WIRING.

a. Remove the cable piercing screws from the distributor blocks to avoid any possibility of the high tension cables not being fully seated on the bottoms of the cable holes.

b. Insert the spark plug cable for No. 1 cylinder into the distributor block cable hole marked "1," and secure it with the cable piercing screw. See that the piercing screw is tight. Insert the spark plug cable for the next cylinder to fire (No. 3) in the distributor block cable hole marked "2," etc. The numerals on the distributor blocks denote the order in

which the sparks are delivered by the magneto, and have no bearing whatsoever on the engine cylinder numbers. Apply talcum powder to that part of the cable inserted in the distributor block cable holes to prevent it fusing to the walls of the distributor block cable holes. The numerals on top of the coil cover are for the purpose of locating the right and left distributor blocks in their correct positions.

c. Connect the cable from the booster source to the terminal marked "H" located on top of the coil cover.

d. Connect the ground cable from the magneto switch to the terminal marked "p" located on the top of the coil cover.

e. Before installing the radio shields, check the connections for any short or open circuit and to ascertain whether or not the cables lead to the proper cylinders from the magneto. Either a buzzer, light system or a booster magneto can be used. When using a buzzer or light system, touch the distributor block electrode with one point and the spark plug end of the cable for the proper cylinder with the other. The circuit is complete when the buzzer gives a signal or the lamp lights. If the circuit is not complete, check for a possible open circuit or wrong connection of the cable. Use a booster magneto to check for a short circuit due to faulty insulation of the cable. The high-tension terminal of the booster magneto is connected to the distributor block electrode. The spark plug end of the cable is held about ¼ inch from a grounded object. If no spark occurs, check the cable for faulty insulation.

f. Install the radio shields over the distributor blocks, allowing enough slack in the cables to prevent extreme sharp bends. Install the radio shields, distributor blocks, and main cover on the magneto.

98. MAJOR OVERHAUL TOOLS.

Numbers with Prefix "SCI"—Scintilla Magneto Company

Drg. No.	New Piece Mark	Old Piece Mark		Quantity
	SCI–11–1248	SCI–4–12176	Block, contact point, dressing	1
		SCI–4–8143	Cutter (used with 11–1157 Tool)	1
		SCI–4–149	Die, contact screw and breaker stop screw, threads	1
	SCI–11–1100	SCI–4–2512	Disk, timing, "E" gap checking	1
		SCI–4–225	Drift, axle, oil cover removing (3 lengths)	1
		SCI–4–227	Drift, axle, spring clamp removing	1
	SCI–11–1256	SCI–4–12177	File, contact point, dressing	1
	SCI–11–1133	SCI–4–7264	Gage, distributor cylinders segment, checking	1
	SCI–11–1138	SCI–4–7823	Gage, magnet end play, checking	1

MAGNETO

Numbers with Prefix "SCI"—Scintilla Magneto Company

Drg. No.	New Piece Mark	Old Piece Mark		Quantity
	SCI-11-1217	SCI-4-9713	Gage, Main Spring Tension, Measuring	1
		SCI-4-145	Handle, rotor, drive shaft turning	1
	SCI-11-1221	SCI-4-9886	Indicator, distributor gear backlash checking (with 11-1225)	1
		SCI-4-148	Keeper, pole shoe extensions	1
	SCI-11-1060	SCI-4-241	Puller, cams, lobe breakers, 2 and 4, remove	1
	SCI-11-1123	SCI-4-4390	Puller, distributor gear hub cap removing	1
	SCI-11-1037	SCI-4-233	Puller, gears, small distributor	1
	SCI-11-1049	SCI-4-235	Puller, inside ball race, 15-mm ball bearing, remove	1
	SCI-11-1065	SCI-4-243	Puller, inside ball race, 17-mm ball bearing, remove	1
	SCI-11-992	SCI-4-218	Puller, outside ball race, 15-mm ball bearing, remove	1
	SCI-11-1002	SCI-4-222	Puller, outside ball race, 17-mm ball bearing, remove	1
		SCI-4-236	Reamer, Breaker, Lever Bushing	1
		SCI-4-224	Screwdrivers, set of four (4)	1
	SCI-11-1269	SCI-4-12868	Stone, contact point, polishing	1
	SCI-11-975	SCI-4-134-1	Support (used with 11-970 pressing tool)	1
		SCI-4-14325	Tap, distributor block electrode hole, cleaning	1
		SCI-4-150	Tap, contact screw and breaker stop screw, threads	1
	SCI-11-978	SCI-4-140	Template, distributor block electrode, height, check	1
		SCI-4-2183	Template, distributor cylinder segments, height, check	1
	SCI-11-705	SCI-4-2510	Tool, cutting outside ball races, insulating strip	1
	SCI-11-118	SCI-4-4295	Tool, distributor block electrode cutting	1
	SCI-11-1157	SCI-4-8092	Tool, distributor block electrode milling (used with 4-8143)	1
		SCI-4-237	Tool, locking, 2 sizes: 11-1058—locking, all screws except holding screws on main cover, front end plate and mounting flanges. 4-237-2—holding, screws on main cover, front end plates and mounting flanges	1
	SCI-11-1225	SCI-4-9886-1	Tool, locking, rotating magnet (used with 11-1221 indicator)	1
		SCI-4-226	Tool, mounting, axle, oil cover drive	1
		SCI-4-228	Tool, mounting, axle, spring clamp, drive	1

ORDNANCE MAINTENANCE—ACCESSORIES FOR WRIGHT R975-EC2 ENGINES FOR MEDIUM TANKS M3 AND M4

Numbers with Prefix "SCI"—Scintilla Magneto Company

Drg. No.	New Piece Mark	Old Piece Mark		Quantity
	SCI-11-1036	SCI-4-232	Tool, pressing, inside ball race, 15-mm bearing installing	1
	SCI-11-970	SCI-4-134	Tool, pressing, outside ball race, 15-mm bearing, install (used with 11-975 support)	1
	SCI-11-976	SCI-4-136	Tool, pressing, outside ball race, 17-mm bearing, install	1
	SCI-11-1032	SCI-4-229	Tool, pressing, small distributor gear and inside ball	1
		SCI-4-2580	Wrench, radio shielding housing spring clamps	1
		SCI-4-2209	Wrench, cam holding (when removing fastening screw)	1
		SCI-4-168	Wrench, socket, drive shaft nut	1
	SCI-11-989	SCI-4-181	Wrench, socket, distributor block electrodes	1
	SCI-11-1033	SCI-4-230	Wrench, socket, cam fastening screw, ground contact stud auxiliary breaker stop screw lock nuts, short contact screw and contact assembly fastening screw	1
		SCI-4-234	Wrench, socket, distributor block spring clamp studs	1
	SCI-11-490	SCI-4-490	Wrench, includes a 0.012-in. feeler gage	1
	SCI-11-1072	SCI-4-1337	Wrench, socket, front end plate lock nut on bottom studs and breaker hold-down springs, removing	1

Section IV

SPARK PLUGS

99. INFORMATION ON SPARK PLUGS WILL BE ISSUED WHEN AVAILABLE.

Section V

IGNITION HARNESS

100. DESCRIPTION.

The horseshoe shaped radio shielded ignition harness Breeze E-593-19P-2M is secured to the rear section parting flange by four nuts and serves to prevent radio interference by providing a continuous grounded circuit of the ignition wiring system. The harness consists of a two section cadmium plated seamless brass manifold ring and spark plug ignition cable conduits from the manifold ring to the front and rear spark plugs; and two main conduits from the manifold ring to the magnetos.

101. REMOVAL.

a. Remove the engine from the vehicle and mount on disassembly stand. See TM 9-1751, paragraph 48.

b. With a lug wrench, (tool No. WR 80171), loosen the intake pipe packing nut at the crankcase end of all intake pipes. Remove the three cap screws from the intake pipe flange at the cylinder end of all intake pipes. Pull the flange back from the intake port and withdraw the intake pipes from the crankcase rear section. Install a cover over the intake ports of all cylinders, and install a cover in all intake pipe packing nuts in the crankcase rear section.

c. Separate the contact sleeve from the ignition cable by straightening the strands of the cable bent over the sides of the hollow rivet in the contact sleeve. Take the sleeve off the cable.

d. Remove all the spark plug terminal elbows by unscrewing the coupling nuts (¾-in. wrench) securing the elbows to the spark plug conduits.

e. With a ⅜-inch wrench, unscrew the two cap screws that secure the adapter elbows to the radio shields. Remove the bolts and nuts (⅜-in. wrench) that hold the two sections of the radio shield together and lift off the radio shields. Loosen the lock screw and lift the distributor blocks out of the magneto.

f. Unscrew the four nuts ($\frac{7}{16}$-in. wrench) attaching the manifold ring to the rear section parting flange. Loosen the knurled nut holding the two halves of the manifold ring together and lift out the harness.

102. DISASSEMBLY.

a. Remove all the piercing screws from each distributor block and withdraw the ignition cables from the distributor blocks.

b. Unscrew the knurled nut securing the adapter elbow to the magneto conduit. Unscrew the coupling nuts ($\frac{3}{4}$-in. wrench) at each end of the cross-over ground conduit, and first, slide the adapter elbows off the ignition cables, then slide the ground conduit off the ground wire.

c. With a $\frac{3}{4}$-inch wrench, unscrew the coupling nut attaching the spark plug conduit to the manifold ring, and slide the conduit and rubber gasket off the cable.

d. Repeat steps a to c for all spark plug cables.

e. Unscrew the knurled nuts securing the magneto conduits to the manifold ring and slide the magneto conduits off the cables.

f. Unscrew the knurled nut holding the two halves of the manifold ring and start withdrawing the ignition cables from the magneto outlet lugs in reverse of the wiring order.

103. INSPECTION, CLEANING, AND REPAIR.

a. Inspection.

(1) Examine the inside surfaces of all parts, particularly at the connections, for nicks, burs, and abrasions which may tear, or otherwise damage, the cable insulation during the wiring of the harness.

(2) Inspect the two halves of the manifold ring for cracks and punctures.

(3) Inspect the conduit for abrasions or a break in the braiding wire. Replace if necessary.

(4) Examine the threads of all outlets and coupling nuts.

b. Cleaning.

(1) Clean dirty conduits with SOLVENT, dry cleaning, if carbon tetrachloride is not available.

(2) With a wire brush, clean the threads of aluminum couplings to remove oxidation which sometimes forms on the threads. This oxidation breaks the grounded circuit and causes radio interference.

c. Repair.

(1) Silver solder or braze cracks in the manifold ring.

(2) Silver solder to the manifold ring any mounting clips that have become loose.

(3) Dress up damaged threads.

(4) Replace defective conduits.

(5) Replace outlet lugs by removing the defective lugs; use a torch having a wide flame (or two torches if necessary) to heat the circum-

ference of the joint uniformly, and with a pair of pliers lift off the outlet lug. Silver solder a new outlet lug to the manifold rings. At times it may be more economical to replace half the manifold ring rather than to replace several outlet lugs.

(6) To replace a single ignition cable, proceed as follows: remove the spark plug terminal elbow and spark plug conduit and withdraw the cable from the distributor block. To the spark plug end of the cable, solder a six-foot length of No. 14 wire. Withdraw the cable from the magneto outlet lug, and unsolder the defective cable from the stringer wire, which is now in the manifold ring in place of the cable. Cut a length of cable equal to the one just removed and solder it to the stringer wire at the magneto end. Apply powdered talcum to the cable and pull the cable through the manifold ring by the stringer wire.

104. ASSEMBLY.

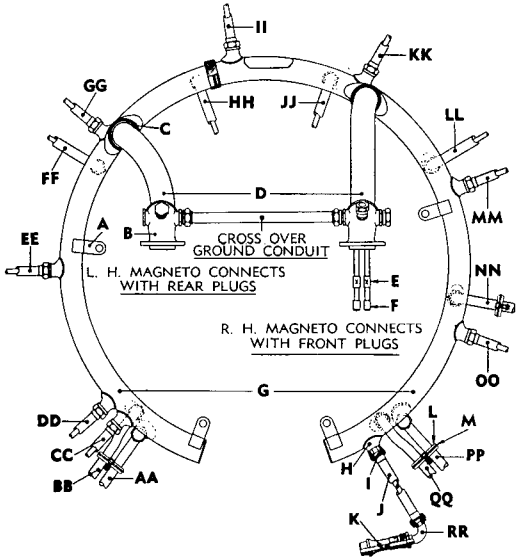
a. At each overhaul, replace all rubber gaskets and ignition cables.

b. Cut the ignition cables to the lengths shown in figure 49.

c. To facilitate the wiring of the manifold, apply powdered talcum or mica to each cable before feeding it through the manifold ring. Start feeding the cables into the manifold ring through the spark plug outlet lugs and follow the wiring order shown on figure 30. To aid in withdrawing the cables from the magneto outlet lug, sharpen the end of a $\frac{1}{16}$-inch drill rod and bend it in the form of a hook. Insert one finger into the magneto outlet lug and feed the cable through the manifold ring until it is felt at the magneto outlet lug. "Fish" the cable out with the hook. When it becomes difficult to wire the last few cables, start feeding the cable through the magneto outlet lug and use the hook to withdraw it at the spark plug outlet lug. Feed the cable through the manifold ring until the length, shown in figure 49, extends beyond the spark plug outlet lug. As each cable is withdrawn from the manifold ring, install a cotton marker on the magneto end of the cable denoting the position of the cable in the distributor block (fig. 49).

d. Install a rubber washer over the spark plug end of each cable with the cone of washer toward the manifold ring and push it into position in the spark plug outlet lug. Slide the proper conduit over the cable and secure the conduit to the manifold ring with the coupling nut ($\frac{3}{4}$-in. wrench). Install another rubber washer over the spark plug end of each cable with the cone of the washer toward the spark plug end of the cable.

e. Before installing the spark plug terminal elbow, cut each cable to a length of 3¼ inches measured from the face of the ferrule on the conduit. Slide the elbow over the cable and secure the elbow to the conduit with the coupling nut ($\frac{3}{4}$-in. wrench). Strip about $\frac{3}{8}$ inch of the insula-



A — MOUNTING CLIP
B — ADAPTER ELBOW
C — METAL GASKET
D — MAIN CONDUITS
E — COTTON MARKER
F — FERRULE
G — MANIFOLD RING
H — SPARK PLUG OUTLET LUG
I — RUBBER WASHER
J — SPARK PLUG IGNITION CABLE CONDUIT
K — CONTACT PROTECTOR
L — RUBBER GROMMET
M — AIR DEFLECTOR DISC

CODE FOR MANIFOLD RING	CYL. NO. & PLUG LOCATION	WIRING ORDER	LENGTH BEYOND MAGNETO ADAPTER ELBOW	CUTTING LENGTH OF CABLE	SPARK PLUG CONDUIT LENGTH	LENGTH BEYOND SPARK PLUG OUTLET LUG	MAGNETO TERMINAL NO. (COTTON MARKER)
J J	F-1	13	4-3/4	51	14	19	1
L L	F-2	12	4-3/4	46	14	19	6
N N	F-3	11	6-1/2	55	14	19	2
P P	F-4	10	6	62	14	19	7
Q Q	F-5	9	4-3/4	65	14	19	3
A A	F-6	2	7-1/2	77	14	19	8
B B	F-7	4	4-3/4	70	14	19	4
F F	F-8	6	6	60	14	19	9
H H	F-9	8	6-1/2	56	14	19	5
I I	R-1	14	4-3/4	38	4-7/8	10	1
K K	R-2	7	4-3/4	45	4-7/8	10	6
M M	R-3	5	6-1/2	53	4-7/8	10	2
O O	R-4	3	6	60	4-7/8	10	7
R R	R-5	1	4-3/4	66	4-7/8	10	3
C C	R-6	15	7-1/2	53	8-3/4	14	8
D D	R-7	16	4-3/4	47	4-7/8	10	4
E E	R-8	17	6	40	4-7/8	10	9
G G	R-9	18	6-1/2	33	4-7/8	10	5

RA PD 33609

Figure 49—Ignition Shielding Harness

tion from the end of the cable. Slide the contact sleeve over the cable and thread the stripped end of the cable through the hollow rivet of the contact sleeve. Separate the strands and bend them radially over the sides of the hollow rivet. Attach a bakelite contact protector to each spark plug elbow.

f. Replace the metal gasket, slide the magneto conduit over the cables, and secure the conduit to the manifold ring by the knurled nut. Thread the cables through the adapter elbow and attach the adapter elbow to the conduit by the knurled nut. Cut each cable so that the length measured from the face of the adapter elbow is as specified in figure 50. Remove about ½ inch of the insulation of each wire. Separate the strands, space them evenly, and fold them back over the insulation. Install the proper ferrule stamped with a number denoting its position in the distributor block and swage the ferrule in place.

g. Insert the cables in the distributor block so that the ferrule number corresponds with the number on the distributor block and secure the cables in the distributor block with the piercing screws. If the extending ends of the cables are too long, feed them back into the manifold, so that the extra length will be available for future repairs.

105. TESTS.

To test the ignition harness, remove from engine and test with B. G. Corporation harness test set M-534B. Attach the instrument to 110 volts alternating current and adjust variac knob so that meter reads 110 volts. Attach wire marked "ground" to suitable ground. Attach wire marked "engine ground" to harness manifold; spread ends of all wires to eliminate possibility of spark jumping at metal connectors. Fasten test lead clip to wire terminal sleeve and press control button. NOTE: DO NOT TOUCH THE EXPOSED END OF THE TEST LEAD OR WIRE BEING TESTED. If no moisture or defective wire is present, the light on the panel will remain dark; if wire is defective or moisture present, the light will flash. Test each wire in the above manner. Replace defective wires. NOTE: To eliminate possible damage to magneto due to excessive high voltage do not test the ignition harness on the engine with this instrument unless the magneto manufacturer's voltage test charts are available. Never permit the voltmeter to read more than 110 volts, as with an input of 110 volts the output is 10,000 volts. The output voltage is approximately 91 times the voltmeter reading. Example: variac adjusted so that voltmeter reads 70 volts output—voltage 91 x 70 = 6370 volts. For complete maintenance and instruction on the use of this instrument refer to the instruction chart attached to the cover of the instrument.

106. INSTALLATION.

To install the ignition harness reverse the procedure given in paragraph 101.

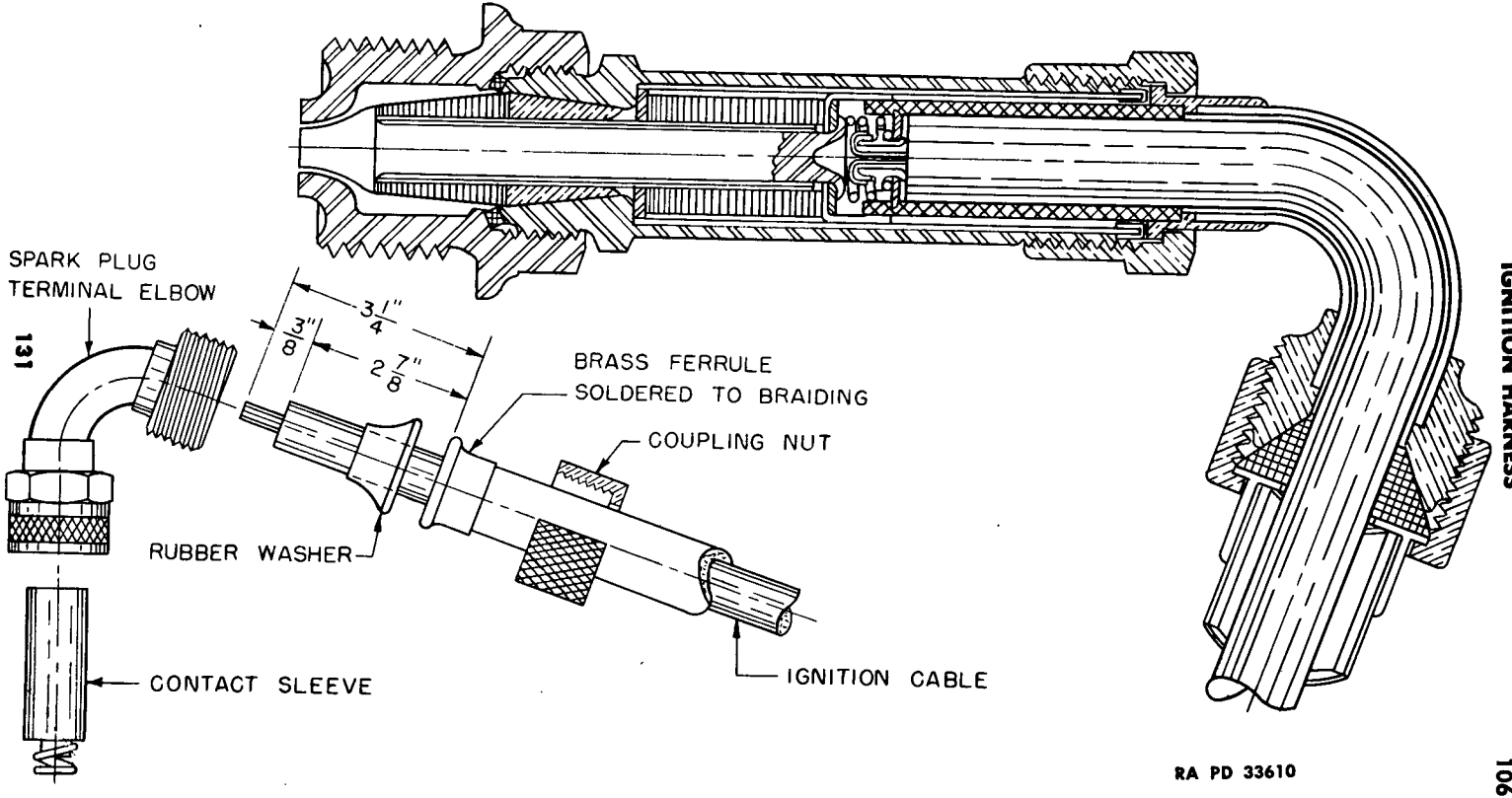


Figure 50—Cross Section of Spark Plug Terminal Elbow and Contact Sleeve

Chapter 6

ENGINE ELECTRICAL SYSTEM

Section I

GENERAL DESCRIPTION OF SYSTEM

107. GENERAL DESCRIPTION (fig. 51).

The engine electrical system consists of the following units: direct electric starter, starter solenoid switch, generator, two generator filters, two voltage regulators, and the fuel cut off solenoid. The negative side of the circuit is grounded. The wiring diagram (fig. 51) shows the connections between the various units. The starter, Eclipse type 817-1A, is operated through the toggle switch as the instrument panel which energizes the starter solenoid switch, Eclipse type 518-21-A. The starter is equipped with a hand starting attachment which is used to turn the engine over before starting the engine. The voltage control unit maintains the output of the generator to specified limits while the generator filter, Eclipse type 349-1-A, in this circuit reduces radio interference. The voltage control units consist of a voltage regulator which maintains a constant voltage across the generator terminals within the normal speed range of the generator, a current limitator which limits the current output and a reverse current cut-out. The reverse current cut-out prevents discharge of the battery through the generator when the generator is not operating or operating below normal speed. The fuel cut-off solenoid, Eclipse type 500-15-A, is operated by the toggle switch on the instrument panel and automatically stops the flow of fuel to the engine. The generator and starter circuits are shielded to reduce radio interference.

GENERAL DESCRIPTION OF SYSTEM

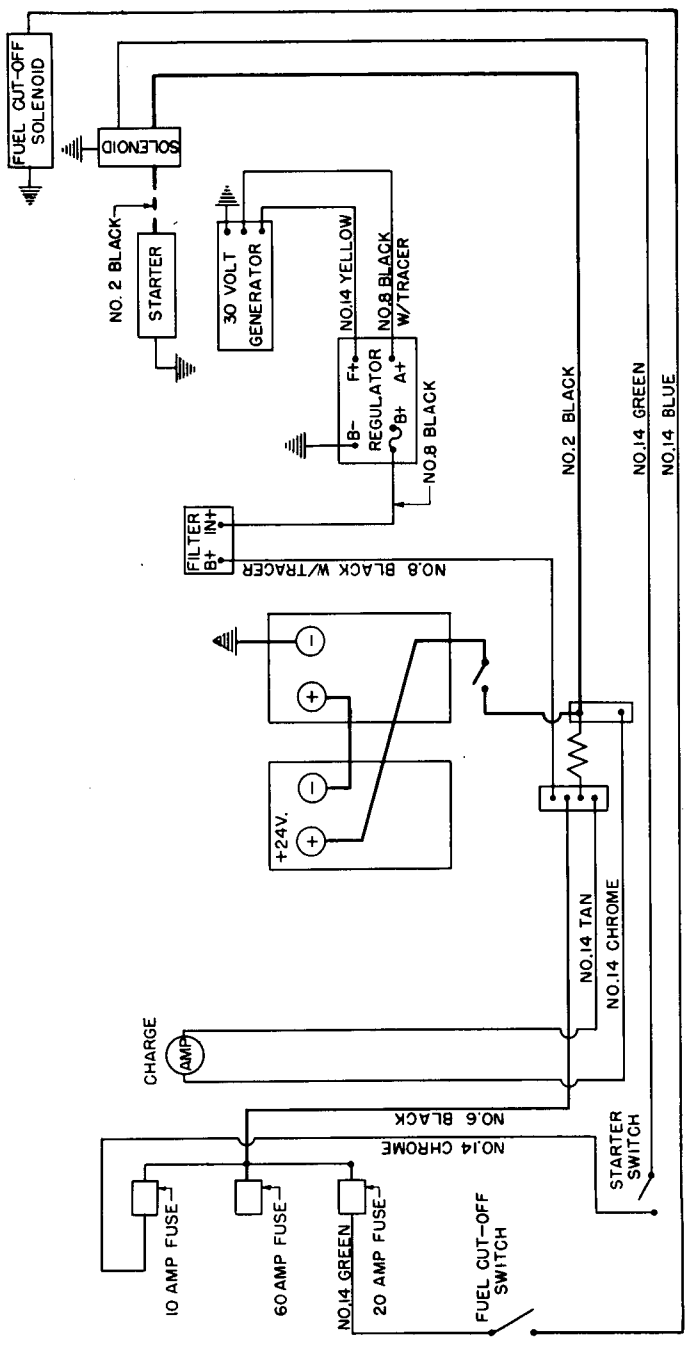


Figure 51—Wiring Diagram Engine Electrical System

Section II

GENERATOR

108. DESCRIPTION.

The Eclipse Model 31, Type 314 generator is of the flange-mounted type designed for use on a 24 volt direct current system in connection with an Eclipse Model 2, Model 4, Style A, Type 667 voltage control. The shaft carries a fan which circulates cooling air through the unit to prevent overheating. The rated capacity of the generator is 50 amperes, 30 volts. A schematic wiring diagram is shown in figure 52.

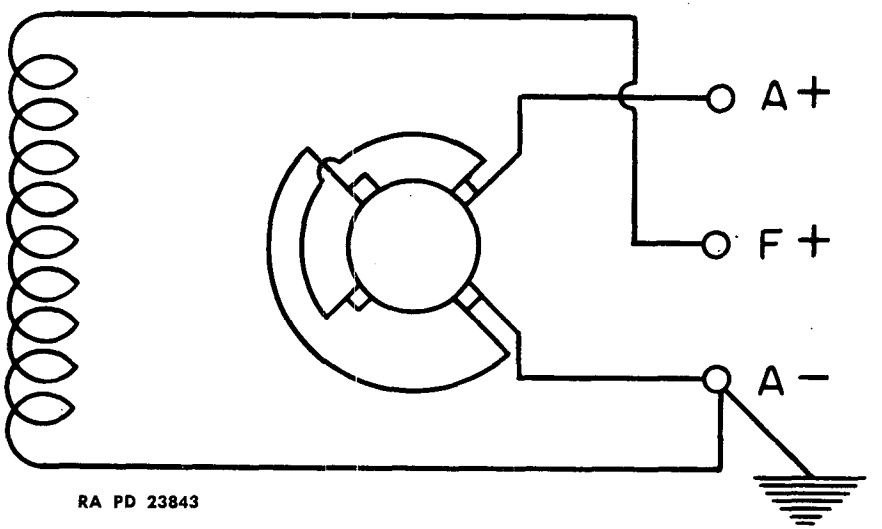


Figure 52—Wiring Diagram for Generator—Eclipse Generator, Model 31, Type 314

GENERATOR

109. REMOVAL FROM ENGINE.

Open the battery switch. Remove the generator and starter supporting assembly. Disconnect the conduit from the terminal shield on the rear end of the generator, remove the shield cover, and disconnect the cables from the terminals; tag these for correct assembly. Remove the locking wires, nuts, and washers from the studs holding the generator to the engine, and remove the generator. Preserve the Vellumoid gasket if still in a usable condition.

110. DISASSEMBLY (fig. 53).

Remove the two window straps, raise the brush springs, and lift the brushes out of the holders. CAUTION: To avoid injury to the brushes, remove them from the holders before other disassembly operations. Remove the flanged head, and lift the housing and drive shaft assembly off the end of the armature shaft. Remove the nut and lock washer, and pull the drive plate assembly, intermediate head with liner and bearing, and fan off the armature shaft. Remove the cap from the front head, remove the cotter pin and nut from the end of the armature shaft, press the shaft out of the bearing, and remove the armature from the yoke, and field coil assembly. Disconnect the terminals of the field coils and tag them for correct assembly. Remove the front head assembly.

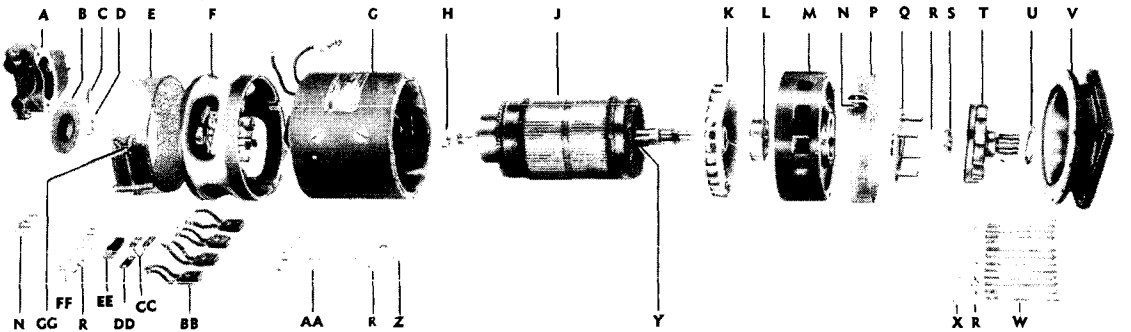
111. MAINTENANCE.

After the generator has been dismantled, clean all parts thoroughly with carbon tetrachloride and compressed air except where otherwise specified. Examine and check the parts for wear in accordance with the clearance chart (par. 112).

a. Ball Bearings. Wash ball bearings thoroughly in clean SOLVENT, dry cleaning. The bearings may be strung on a wire and sloshed in the solvent to remove oil and grease. Afterward they may be rotated by hand in solvent to complete the removal of old lubricant and dirt. Finish the cleaning with clean, dry compressed air as follows: Hold inner and outer bearing rings against rotation and direct the air squarely at the side, or face, of the bearing; that is, so that the air hose nozzle is parallel to the bearing bore. When thoroughly clean, oil each bearing with clean new OIL, engine, and rotate to distribute the lubricant to all surfaces. Following this, the bearing may be examined for serviceability. Replace rough turning or excessively loose bearings. Pack with GREASE, special, high temperature, after cleaning and before reassembling. Do not pack the bearing cap with grease. Do not wash new bearings removed from factory sealed boxes; simply lubricate and use.

b. Oil Seal Felts. Install new oil seal felts in the front and mounting heads at each overhaul. Soak in clean oil before assembling.

c. Armature Assembly. Dip the armature in a container of carbon tetrachloride and scrub thoroughly with a stiff brush. Do not allow



A — TERMINAL SHIELD, ASSEMBLY
B — FRONT BEARING CAP
C — COTTER PIN
D — FRONT ARMATURE SHAFT NUT
E — WINDOW STRAP, ASSEMBLY
F — FRONT HEAD, ASSEMBLY
G — YOKE W/FIELD COIL, ASSEMBLY
H — FRONT SPACER
J — ARMATURE, ASSEMBLY
K — FAN
L — BALL BEARING
M — INTERMEDIATE HEAD, ASSEMBLY
N — SCREW
P — STRAP, ASSEMBLY
Q — DRIVE PLATE, ASSEMBLY
R — LOCK WASHER
S — REAR COUPLING NUT
T — HOUSING AND DRIVE SHAFT COUPLING W/RUBBERS, ASSEMBLY
U — THRUST WASHER
V — BACK HEAD, ASSEMBLY
W — BACK HEAD TO YOKE SCREW
X — WASHER
Y — WOODRUFF KEY
Z — FRONT HEAD HOUSING BOLT WASHER
AA — FRONT HEAD TO YOKE SCREW
BB — BRUSH, ASSEMBLY
CC — JUMPER STRAP
DD — GROUND STRAP
EE — JUMPER STRIP
FF — JUMPER STRAP TERMINAL POST SCREW
GG — WING NUT

RA PD 23840

Figure 53—Parts of Generator, Eclipse Generator, Model 31, Type 314

armature to soak. Dry and smooth the commutator with No. 000 sandpaper. Do not use coarse sandpaper or emery cloth. Clean the armature thoroughly to remove sand particles before assembly. If the commutator is extremely rough or burned, mount the armature in a lathe and take a light cut across the face of the commutator. When mounting the armature, make certain that the centers are true and clean. The minimum diameter to which a commutator may be turned is 2⅛ inches. After turning, carefully undercut the mica insulation between the commutator bars to a depth equal to the width of the mica or approximately 0.030 inch. Use a cutting tool slightly wider than the mica to insure complete removal of the mica to the required depth. Smooth and polish the commutator after undercutting to remove any burs. NOTE: If the commutator is turned, reseat the brushes.

d. Drive Coupling. Replace all worn or non-resilient rubbers. Check all splines for rough service or scuffing.

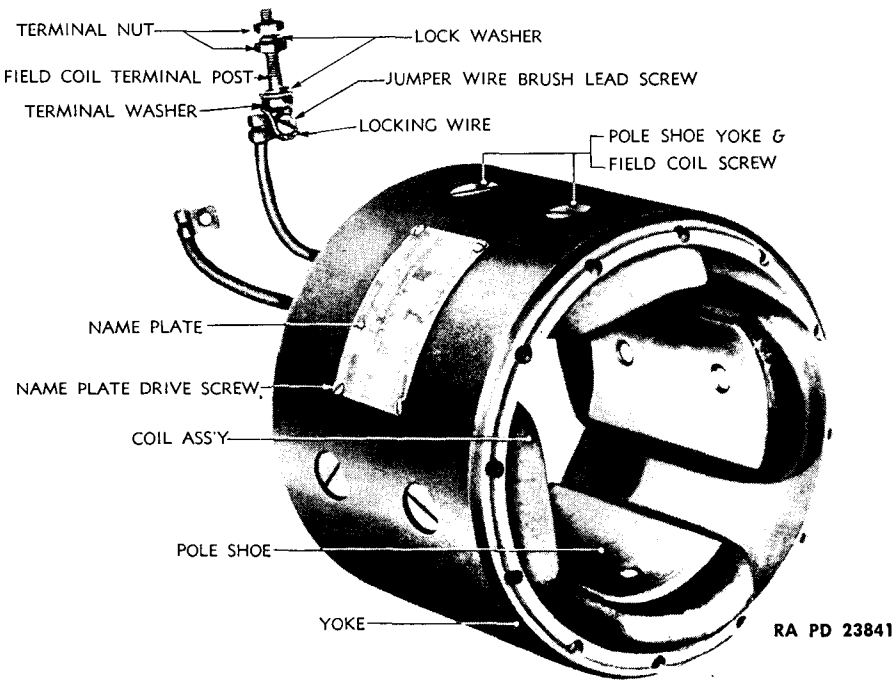


Figure 54—Yoke W/Field Coil Assembly—Eclipse Generator, Model 31, Type 314

e. Yoke and Field Coil Assembly (fig. 54). Do not remove pole shoes and field coils unless defective. Test the field coils for a grounded or open circuit, as outlined in paragraph 113. If the coils must be replaced, remove the pole shoe screws, pole shoes, and field coils.

CAUTION: When removing the pole shoes, mark each one so that it may be reassembled in the same position. Assemble the new coils into the yoke, pull up the pole shoes sufficiently to hold the coils in place, and insert the three insulating pieces between the three field connections. After tucking in the three insulating pieces under the coils, pull up the pole shoes tightly with a plug gage as specified in the clearance chart, to assure proper alinement of the pole shoes and prevent interference with the armature windings. Place the complete assembly of yoke, field coils, insulating pieces, and pole shoes in an oven and bake at 260 F for a period of two hours. As replacement field coils have been dipped in varnish and partially baked before shipment, the two hour baking causes the varnish first to soften and flow into the crevices in the assembly, and then to harden during the remainder of the baking process. This procedure results in a well bonded assembly which prevents the field coils from loosening during service.

f. Front Head Assembly (fig. 55). Clean the front head assembly thoroughly with carbon tetrachloride and compressed air to remove all foreign material such as copper chips, solder, or carbon dust. After cleaning, inspect for weakened or burnt insulation, and test for grounds as instructed in paragraph 113. Replace the brush board if the insulation is cracked or burnt (par. 117).

g. Brushes. The maximum permissible wear of brushes is $\frac{5}{16}$-inch from a new length of $\frac{7}{8}$-inch, or when the amount of brush remaining is $\frac{9}{16}$-inch. However, replace brushes before their maximum wear limit is reached in order to assure proper operation until the next inspection period.

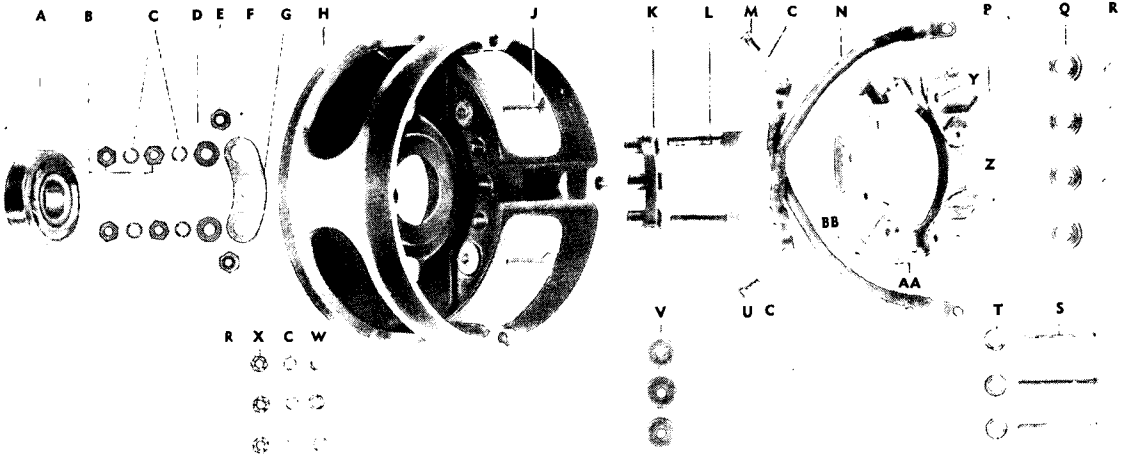
h. Intermediate Head Bearing Liner. In the event that replacement of the liner is required install a new intermediate head.

112. CLEARANCE CHART.

The following chart is provided as an aid in checking clearances when inspecting or reassemblying generators at overhaul.

Description	Clearance
Yoke assembly ID (as measured between pole shoes)	3.678—Plug gage "Go"
Front head ball bearing OD	0.0004T*-0.0004L*
Front head ball bearings ID	0.0002T*-0.0005L*
Intermediate head ball bearing OD	0.0005T*-0.0000L*
Bushing in drive coupling	Press fit
Drive coupling thrust washer (thickness)	0.040-in. min

L*—Loose. T*—Tight.



A — BALL BEARING
B — TERMINAL NUT
C — LOCK WASHER
D — BOOSTER COIL AND GENERATOR TERMINAL WASHER
E — SAFETY NUT
F — WASHER
G — FRONT HEAD TERMINAL POST INSULATOR
H — FRONT HEAD, ASSEMBLY
J — TERMINAL HOUSING BOLT
K — TERMINAL INSULATING PLATE
L — TERMINAL POST
M — JUMPER WIRE BRUSH REST SCREW
N — JUMPER WIRE, ASSEMBLY
P — BRUSH BOX
Q — BRUSH SPRING
R — COTTER PIN
S — BRUSH BOARD SCREW
T — FRONT HEAD SCREW WASHER
U — JUMPER WIRE BRUSH LEAD SCREW
V — SPACER
W — BRUSH BOARD WASHER
X — NUT
Y — RIVET
Z — BRUSH BOARD
AA — BRUSH SPRING POST
BB — BRUSH REST

RA PD 23842

Figure 55—Front Head Assembly—Eclipse Generator, Model 31, Type 314

113. TEST AT DISASSEMBLY.

Test the armature, the yoke and the field coil assembly for short ground, and open circuits before assembling, with a 220-volt alternating current having a lamp in series. If a 220-volt line is not available, 110 volts will do.

a. Open Field Circuit. Connect the two terminals of lamp circuit to the two field terminals of the yoke assembly. The lamp will light if the circuit is continuous.

b. Grounded Field Circuit. Connect one terminal of the lamp circuit to one of the field terminals of the yoke assembly, the other field terminal being free. Touch the other terminal of the lamp circuit to the yoke. The lamp will light if the field is grounded. NOTE: If an ohmmeter is available, the field coils may be tested for short, ground, and open circuits by measuring the resistance of the field coil winding. This should be 13.7 ohms plus or minus five percent.

c. Shorted Armature. To test for a shorted armature, use a growler.

d. Grounded Armature. Connect one side of the lamp circuit to the armature shaft. Connect the other terminal of the lamp circuit to the commutator bars. If the armature is grounded, the lamp will light.

e. Open Armature. Examine the commutator for black or burnt commutator bars, and be sure that all conductors are firmly soldered to the risers. Loose conductors or blackened commutator bar indicate the possibility of an open circuit.

f. Front Head Assembly. Test for grounds between the brush boxes and the front head by replacing the terminal of the lamp circuit on the brush board and the other terminal on the head. The lamp will light if the board is grounded.

114. ASSEMBLY.

In assembling the generator, observe the following precautions:

a. Armature. Wipe the armature shaft with an oil-dampened cloth to prevent rust.

b. Front Head. Take care to assemble the front head in correct position. Connect field leads in the same positions as noted before assembly (par. 117).

c. Brushes. The brushes should be a free fit without excessive side play in the brush boxes. Wipe binding brushes clean with a cloth moistened in carbon tetrachloride and bake at 200 F for two to four hours. The brush springs should bear centrally against the top of the brushes so that full spring pressure will be transmitted. To insure

proper seating of new brushes, place a thin strip of No. 000 sandpaper under the brushes with the sanded side of the paper in contact with the brush surface. CAUTION: Do not use coarse sandpaper or emery cloth. Turn the armature slowly in the proper direction of rotation until the brushes are completely seated. Remove all sand or metal particles with compressed air.

d. Brush Springs. Test the brush springs with a small spring balance for required tension. If the tension is less than 26 ounces or more than 30 ounces when spring leaves the top of a new brush, replace the springs.

e. Pole Shoe Screws. Wipe the pole shoes with an oil-dampened cloth to prevent rust. As a precaution against possible seepage of OIL, engine, into the generator, ground the pole shoe screws, and coat the under sides of the screw heads with lacquer just before assembling screws. When the lacquer dries it will form a seal between the screw head and the counterbore in the yoke.

f. Field Coils and Pole Shoes. To be sure that the field yoke and pole shoes are properly magnetized after assembly, flash the field by connecting the positive field terminal (F+) to the positive side of a 12-volt battery, and momentarily touch the negative side of the battery to the negative terminal of the generator (A −). However, if the generator is connected to the control box, lift off the brushes before flashing the field. Refer to wiring diagram (fig. 52).

g. Replace all locking devices and safety wire.

115. TEST.

Mount the generator on a test bench and connect with a voltage control (Eclipse Type 667, Model 2 or 4, Style A) and a load as shown in figure 56. Connections are made with No. 8 *B. and S.* gage flexible insulated wire except the field lead (F + generator to F + control box) which may be of No. 18 wire. Remove the bearing retainer cap at the commutator end of the generator in order to determine the armature revolutions with a hand tachometer. Replace two of the retainer cap screws using washers sufficiently large to lock the outer bearing race in place. CAUTION: Do not operate the generator with the bearing retainer cap removed until the outer bearing race has been locked in place as described above.

a. Heat Run. Drive the generator with the window strap in place at its rated minimum speed (2600 revolutions per minute) and full load (30 volts, 50 amp.) for a period of ½ hour. The temperature rise of the generator yoke at the end of the ½-hour heat run should not exceed 112 F. If the temperature rise exceeds this value, disassemble the generator and recheck the clearances.

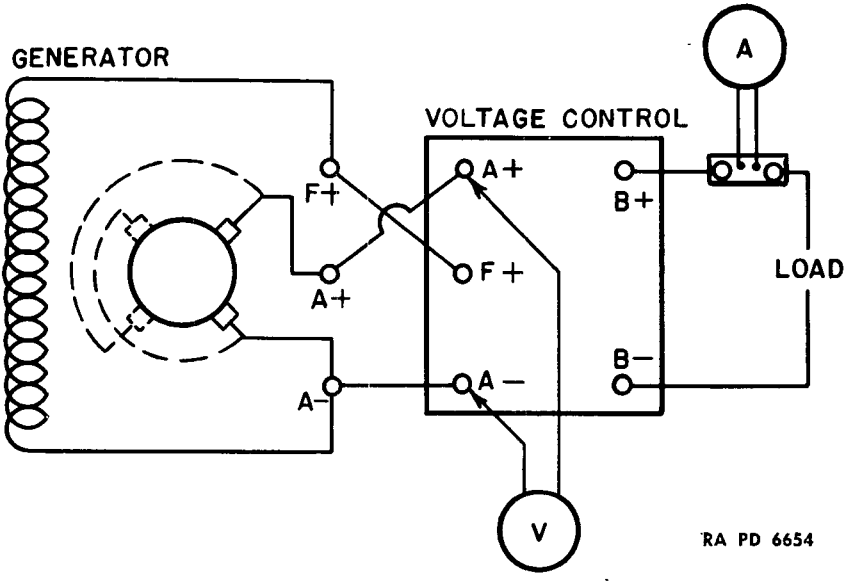


FIG.5 WIRING DIAGRAM FOR TESTING
THE ENGINE GENERATOR AND VOLTAGE CONTROL

Figure 56—Schematic Wiring Diagram for Testing the Engine Generator and Voltage Control

b. Ground Test. While still hot, after the completion of the heat run, subject the generator to a 220-volt or 110-volt alternating current ground test using a lamp in series. CAUTION: Remove the A–terminal grounding washer before the ground testing. Place one terminal of a 220-volt or 110-volt lamp circuit on the yoke and touch the other terminal to each of the three terminal posts in turn. The lamp will light if the unit is grounded.

116. INSTALLATION.

Install the $\frac{1}{64}$-inch Vellumoid on the generator mounting pad at the rear of the engine, and slide the generator into place over the studs. Install the generator with the conduit opening in the terminal shield pointing to the left, and slightly downward. Install the washers and nuts on the studs and secure the nuts with locking wire. Install the generator and starter supporting assembly. Connect the cables to the proper terminals, connect the conduit to the terminal shield and install the cover on the shield securing the screws with locking wire. Refer to wiring diagram (fig. 51).

GENERATOR

117. CONVERSION OF FRONT AND BACK HEAD ASSEMBLIES TO LATEST DESIGN.

a. Front Head Assembly. The front head bearing has been redesigned to incorporate a grease seal, thereby eliminating the necessity of an external seal consisting of felt washer EC-16487, retaining washer EC-16419, and felt washer cup EC-54581. In addition to simplifying generator construction, this bearing provides a more effective grease seal. However, due to the dimensional similarity of the new type bearing to the old bearing, the liner had to be redesigned, as shown in figure 57, to compensate for the elimination of retaining washer EC-16419 and felt washer cup EC-54581. In order to insure proper replacement of front heads and bearings, observe the following points:

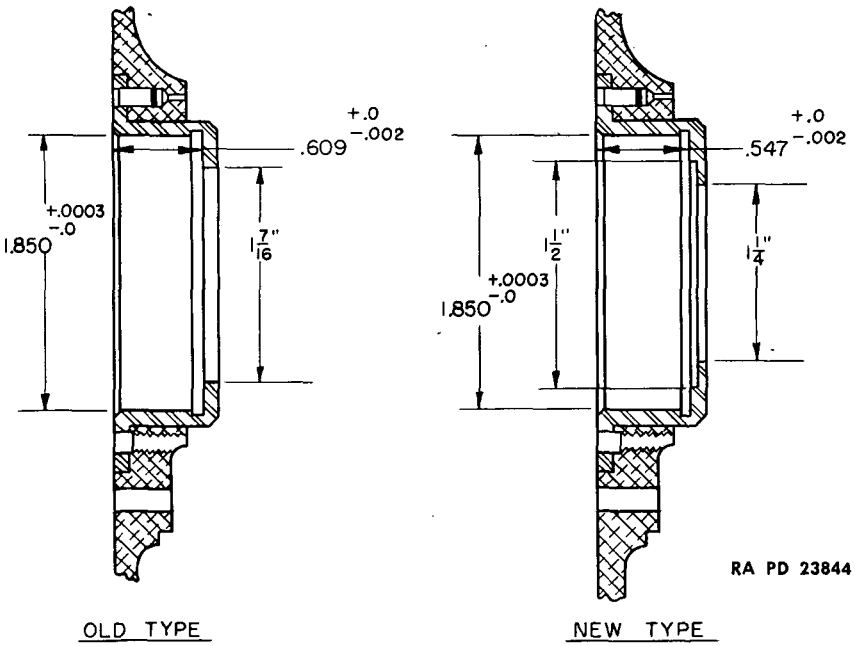


Figure 57—Change Over in Front Head Assembly—Eclipse Generator, Model 31, Type 314

(1) The new type bearing is identified by the numbers EC-20504-1 and EC-465754 stamped on the carton or by the number EC-465754 marked on the inner race of the bearing, and replaces all bearings having cartons marked with the numbers EC-20504-1 and EC-465400.

(2) Do not discard any old type bearings now on hand; use them only in the old type head. However, all future replacement bearings supplied by the manufacturer will be of the new type.

(3) The new type bearing may be used in the old type head, but retaining washer EC-16419 and felt washer cup EC-54581 must be replaced in the original position to serve as a spacer. Felt washer EC-16487 may be discarded.

(4) DO NOT ATTEMPT TO USE AN OLD BEARING IN A NEW TYPE HEAD. As pointed out above, the liner has been redesigned to eliminate the external grease seal, and since the old type bearing is not sealed, the use of this bearing and the new type head would result in an assembly without a grease seal.

(5) The manufacturer will continue to supply felt washer EC-16487, retaining washer EC-16419, and felt washer cup EC-54581 for use on generators now in service which contain the old type bearings and heads.

b. Back Head Assembly. In order to provide a more efficient oil seal and to simplify construction of generator back heads, the manufacturer has redesigned the heads listed below as shown in figure 58. NOTE that this new design eliminates the use of felt washer EC-16203,

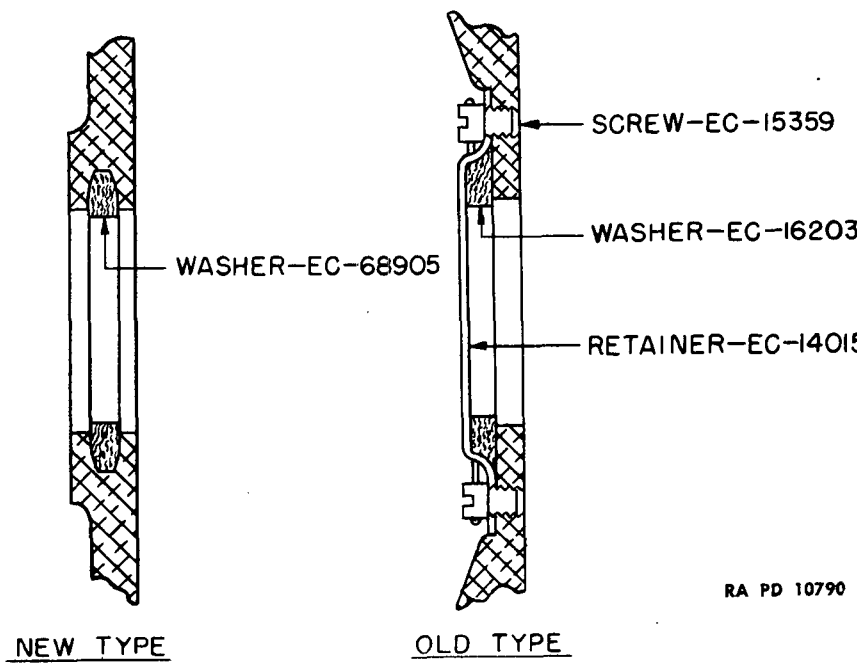


Figure 58—Change Over in Back Head Assembly—Eclipse Generator, Model 31, Type 314

retainer EC-14015, and the six retainer screws EC-15359. Do not discard old type back heads now on hand, since the manufacturer will continue to supply felt washer EC-16203, retainer EC-14015, and the retainer screws EC-15359, for replacement. However, all future back heads supplied by the manufacturer will be of the new type, and therefore must incorporate felt washer EC-68905. The manufacturer has set a number for the assembly of the new type heads with the new felt washer to assist in ordering replacements.

Old type back head number	*Corresponding assembly of new head and felt washer*
72868	97270-4

118. LIST OF TOOLS.

The following tools will facilitate disassembly, assembly, and adjustment of the various parts as indicated.

EC–MT 146 Socket wrench, for nut at commutator end of armature.
EC–MT 309 Screwdriver press, for pole shoe screws.
EC–MT 428 Socket wrench, for nut at drive end of armature.
EC–MT 1380 Spinite wrench, for back head to yoke screws.
EC–MT 4139 Expander, pole shoe.
EC– T 73732 Plug gage, pole shoe.

Section III

VOLTAGE CONTROL

119. DESCRIPTION.

a. General (fig. 59). The Eclipse Type 667, Models 2 and 4, Style A voltage control consists of a three-part container or box (lower box, upper box and cover), containing a voltage regulator, a current limitator, and a reverse current cut-out or main switch. The Model 4 is a modification of the Model 2 which provides fuse protection to the unit. When the auxiliary generating set is used with the Model 4 unit, add a resistor to the generator switch box. Convert all Model 2 units to Model 4 in accordance with Field Service Modification Work Order G–104–W1, February 12, 1942. Instructions for converting the Model 2 to the Model 4 are given in paragraph 124. These units may be identified by their markings. The current limitator is marked "C. LIM" on the heel iron; the reverse current cut-out is marked "R.C. CUT-OUT" on the bracket and the voltage regulator is unmarked. They are attached to a panel which is flexibly mounted in the upper box to prevent damage by vibration. All terminal posts for the connection of outside wires are located in the bottom box and connections to the upper box are made through spring contacts bearing on the terminal posts of the upper box. The upper box is doweled to the lower box by three dowels to prevent incorrect assembly of the two units.

b. Voltage Regulator (figs. 60 and 61). The purpose of the voltage regulator is to maintain a substantially constant voltage across the generator terminals while the generator is operating within its normal speed range (2600 revolutions per minute to 4000 revolutions per minute).

c. Current Limitator (figs. 60 and 61). The purpose of the current limitator is to limit the maximum current output to the rated capacity of the generator. This prevents the generator from becoming overheated due to overloads.

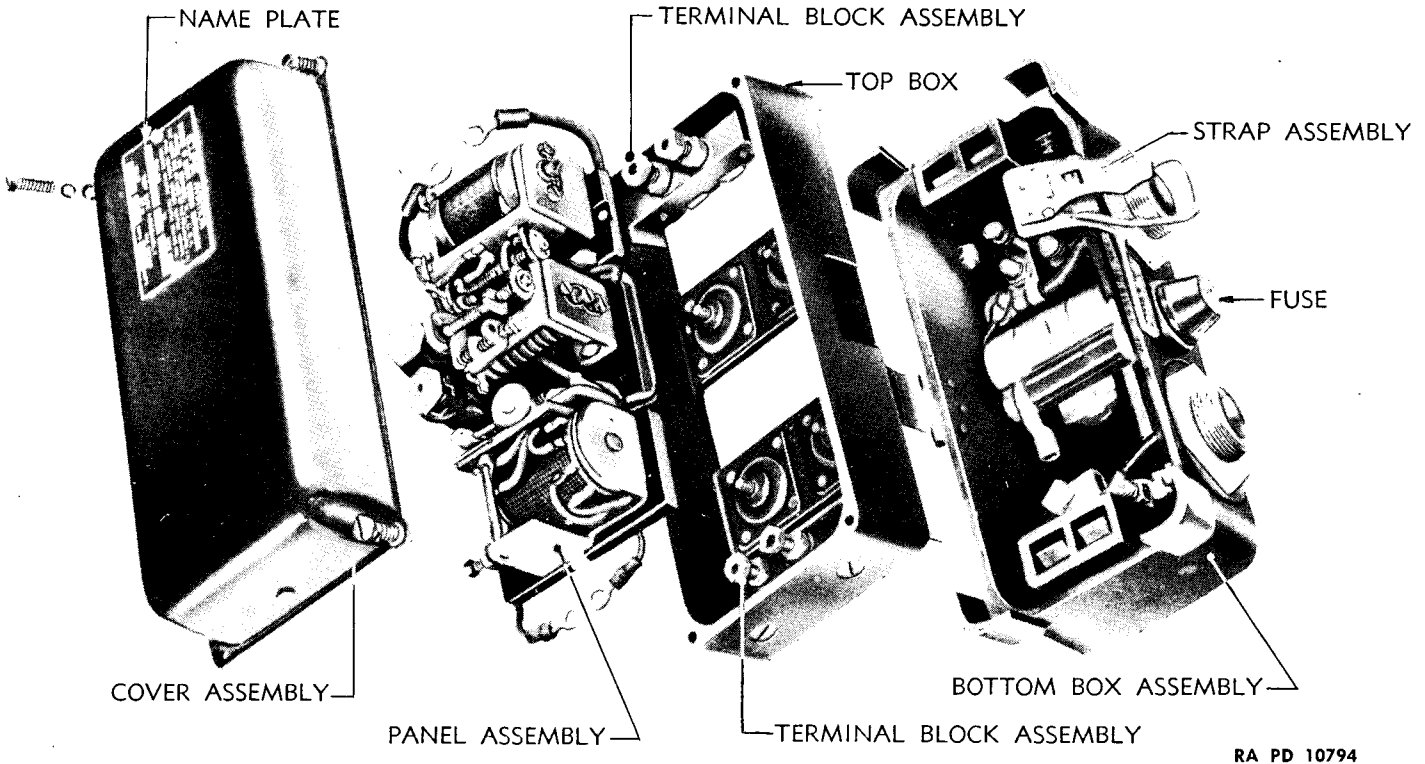


Figure 59—Partially Exploded View, Voltage Control—Eclipse Type 667-4-A

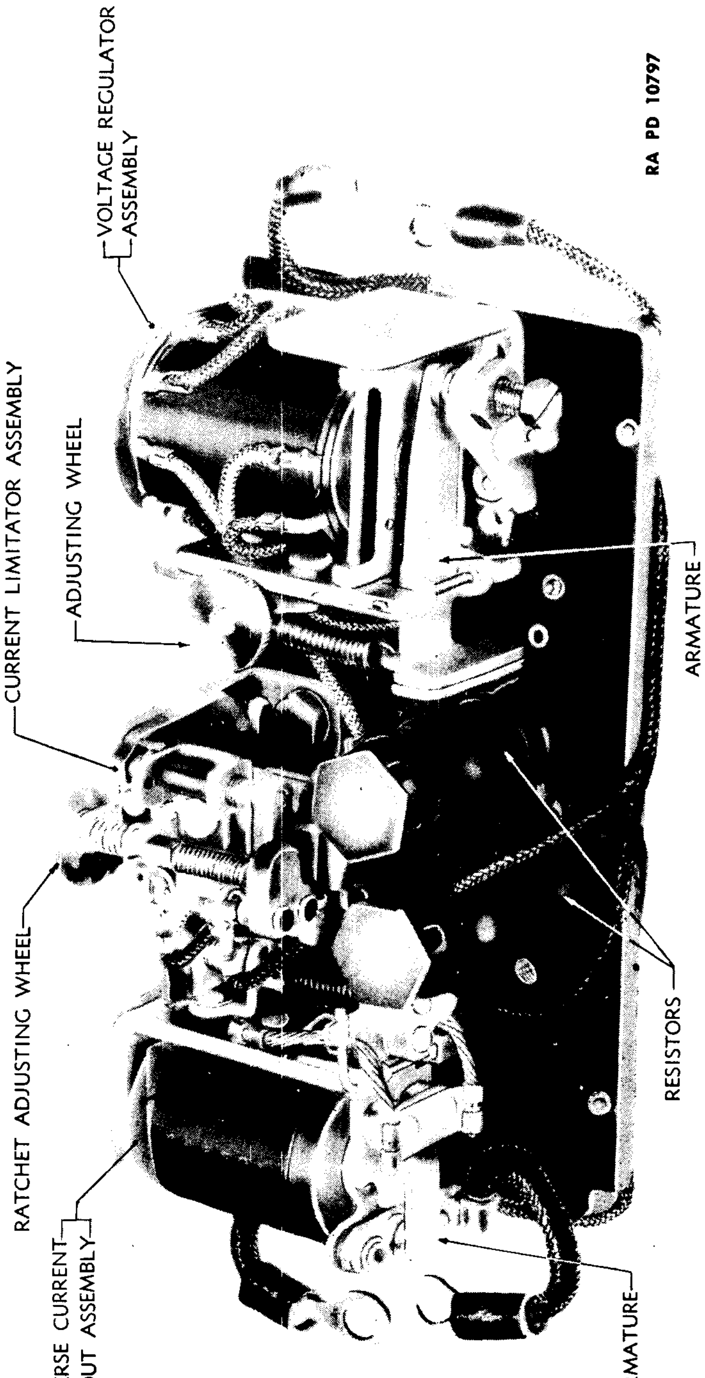


Figure 60—Panel, Rear Side View, Voltage Control—Eclipse Type 667-4-A

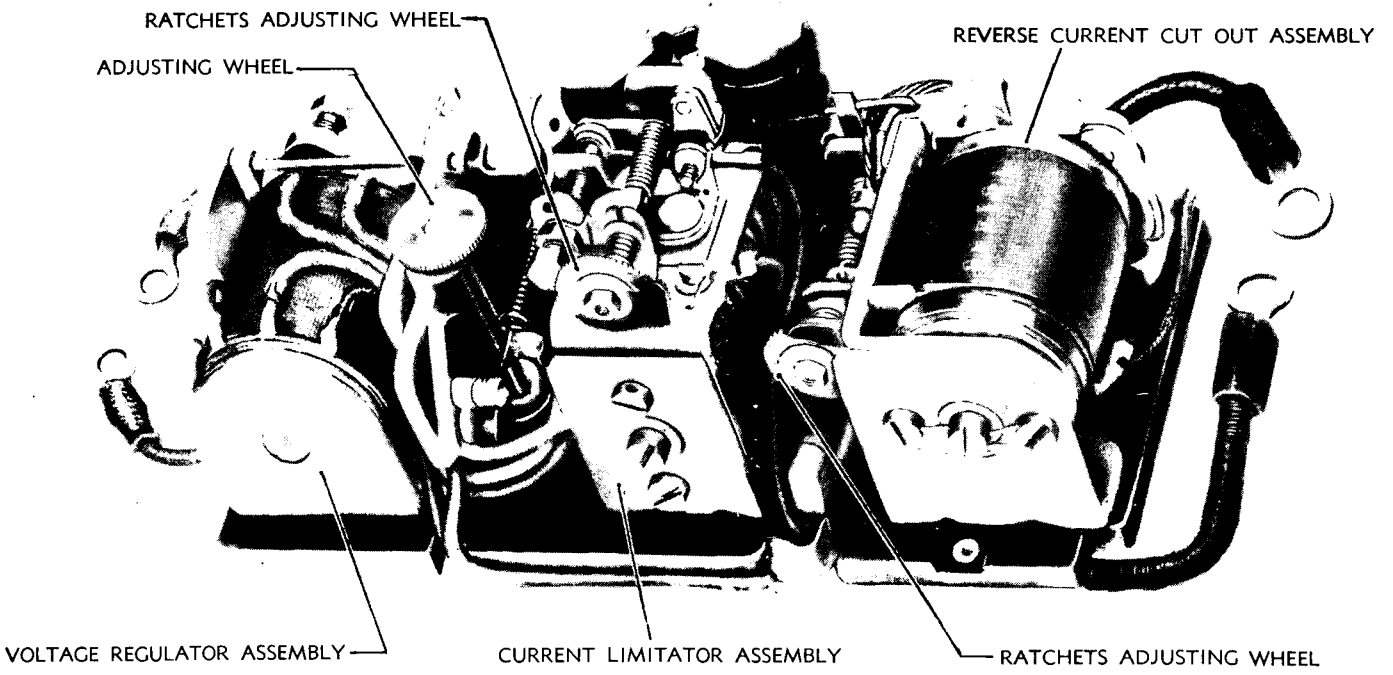


Figure 61—Panel, Side View, Voltage Control—Eclipse Type 667-4-A

d. Reverse Current Cut-Out (figs. 60 and 61). The purpose of the reverse current cut-out is to prevent the discharge of the battery through the generator when at rest or operating at a speed below that required for charging the battery. It connects the generator to the battery and the electrical system when the generator voltage exceeds the battery voltage, and disconnects it when the battery voltage exceeds the generator voltage.

120. REMOVAL (fig. 62).

There are two separate voltage controls; one for the engine generator, and one for the auxiliary generator. These are bolted to a bracket on the rear of the battery box beneath the turret basket. Before starting removal, make sure battery switch is open.

a. Top Box and Cover. Most inspection and repair work can be done by removing the top box and its cover from the bottom box. To remove these parts, release the spring catch on top of the cover and lift the top box with its cover off the bottom box.

b. Bottom Box (fig. 63). To remove the bottom box disconnect the cables from the terminal posts and tag them for correct assembly. Unscrew the knurled nuts holding the two conduits to the box and pull the ends of the cables out of the box. Remove the four screws holding the lower box to the bracket, and remove the lower box.

121. DISASSEMBLY.

Very little disassembly is required beyond removing the panel with the control units from the top box and removing the separate units from the panel. Removal of the contacts is described in paragraph 122.

a. Remove the locking wires and screws with plain and lock washers securing the cover to the top box and lift the cover from the box.

b. Panel Assembly. To remove the panel assembly from the top box, disconnect the cable terminals from the terminal posts at both ends of the box and tag them for correct assembly. Remove locking wires and four screws from the under side of the rubber shock absorbers in the bottom of the top box. Remove the panel assembly.

c. Voltage Regulator. The voltage regulator is fastened to the panel by two screws. To remove the regulator disconnect the cables and tag them for correct assembly. Remove the locking wire and screws from the bottom of the panel and remove the regulator.

d. Current Limitator. The current limitator is fastened to a bracket or heel iron which in turn is fastened to the panel. To remove the limitator from the bracket, disconnect the cables and tag them for correct

VOLTAGE CONTROL

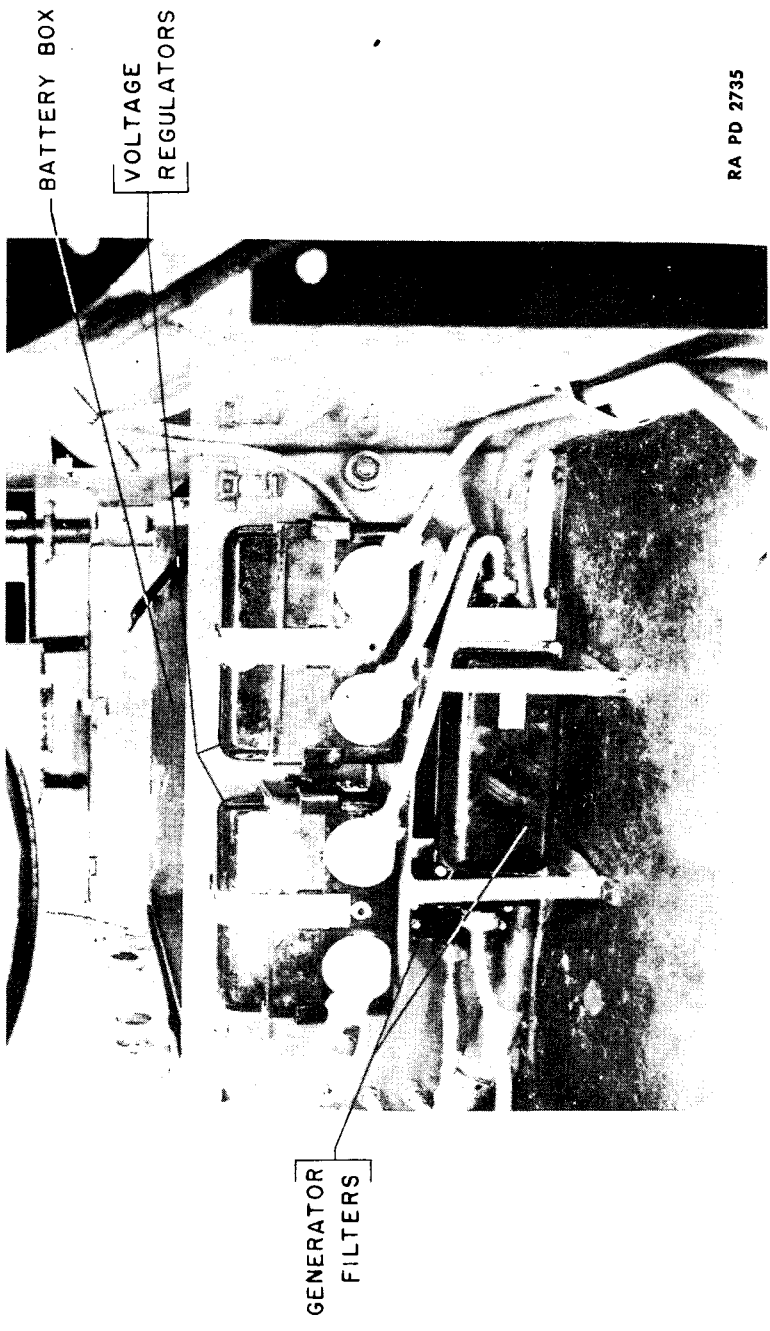


Figure 62—Installation of Voltage Control Box and Generator Filter

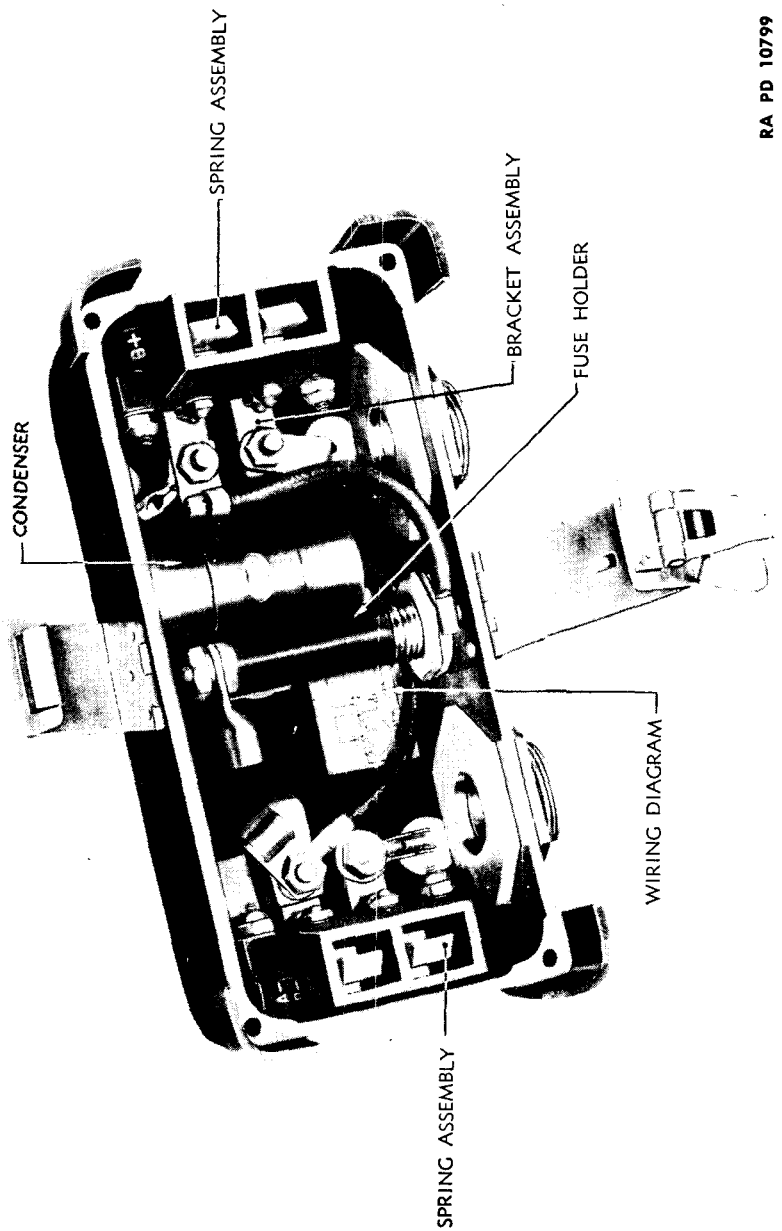


Figure 63—Plan View of Bottom Box Assembly, Voltage Control—Eclipse Type 667-4-A

assembly, remove the locking wires and screws holding the limitator to the bracket and remove the limitator. To remove the bracket from the panel, melt the solder locking the nuts to the screws and remove the screws and bracket.

e. Reverse Current Cut-out. The reverse current cut-out is fastened to a bracket which in turn is fastened to the panel. To remove the cut-out from the bracket, remove the locking wire and screws holding the cut-out to the bracket and remove the cut-out. To remove the bracket from the panel, melt the solder locking the nuts to the screws and remove the screws and bracket.

f. Resistors. Disconnect the cables and tag them for correct assembly, melt the solder locking the nuts to the screws and remove the screws and resistors.

122. MAINTENANCE.

a. Inspection—Control Box. Blow out the boxes and panel with compressed air. Make certain that the four blades and contact springs are clean, to assure good connections between the upper and lower boxes. Remove and clean the contacts of the control units and reset the gaps as described in **b, c** and **d** of this paragraph. Check all the wiring connections within the box for tightness (fig. 64).

b. Voltage Regulator. To remove the armature, loosen the solder around the tension spring at the post on the eccentric, and remove the spring from the post. Remove the hinge pin lock and hinge pin, and lift out the armature. Remove the fixed contact screw by loosening the lock nut. Clean both contacts with a coarse oilstone (for badly pitted contacts), finish with a fine India oilstone No. FB 14-inch or equivalent, and polish with a hard Arkansas oilstone No. HB 13, or equivalent. NOTE: **Do not use oil on the oilstones.** Clean the contacts with carbon tetrachloride. Assemble the armature and replace the spring on the eccentric post, but **do not** solder until after the regulator has been properly adjusted. Adjust the contact screw until the core gap between the armature stop and coil is 0.072 plus or minus 0.005. Tighten the lock nut on the contact screw and solder the tension spring to the eccentric post.

c. Current Limitator. To remove the armature, loosen the solder at either end of the spring, remove the hinge pin and lift out the armature. Bend down the ear of the locking washer, loosen the lock nut, and remove the fixed contact screw. Clean the contacts, following the same procedure as in **b** above. After cleaning the contacts, assemble the armature and hinge pin, but **do not** solder the spring until after the limitator has been properly adjusted. Set the core gap (distance between core and stop on armature) (fig. 60) to 0.040 inch plus 0.010 inch minus 0.000

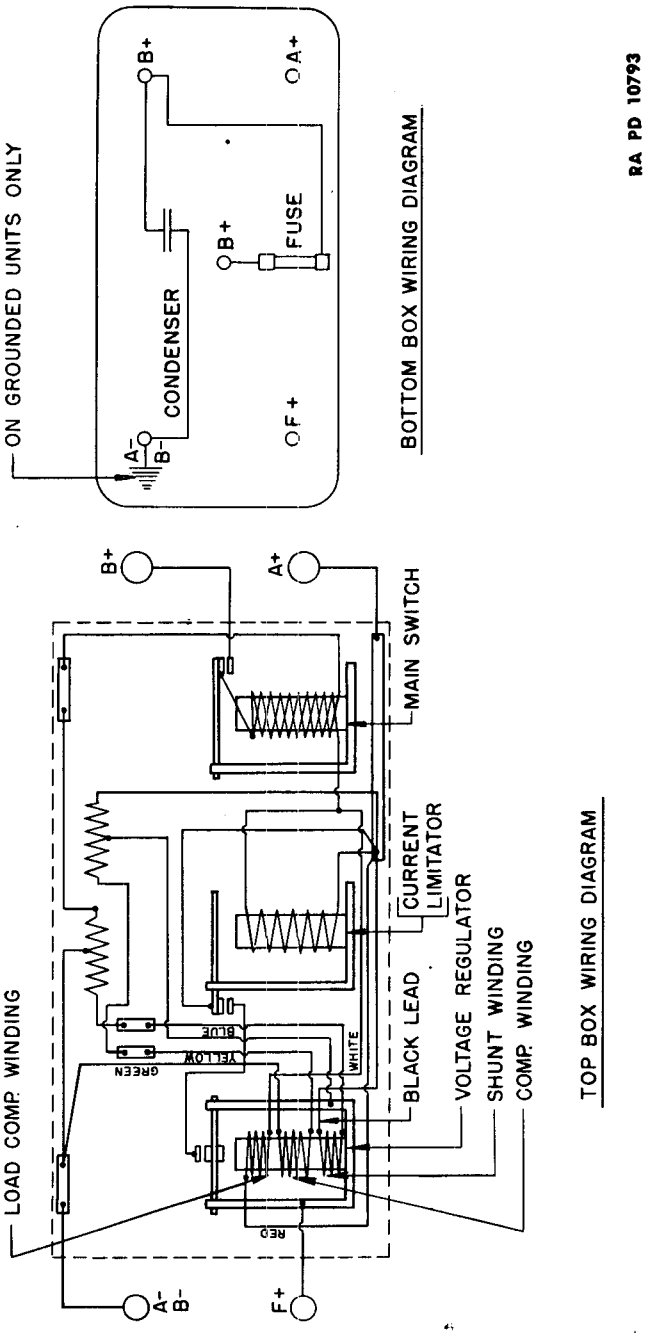


Figure 64—Internal Wiring Diagram, Voltage Control—Eclipse Type 667-4-A

inch by turning the fixed contact screw. Tighten the lock nut and bend back ear on locking washer. Solder the tension spring in place.

d. Reverse Current Cut-Out. To clean the contacts, remove the hinge pin and lift out the armature sufficiently to expose the contact surfaces. **Take care not to injure the tension spring.** Resurface the contacts with a fine ignition contact file, and smooth with crocus cloth. Assemble the armature and hinge pin. Set the core gap (distance between armature and center of core) to 0.025 inch plus 0.005 inch minus 0.000 inch, with the contacts **closed,** by bending the armature stop tab that is riveted to the heel iron. Set the contact gap to 0.040 inch plus 0.005 inch minus 0.000 inch by bending the laminated contact arm. **Make sure the contacts are parallel** after adjustment.

123. ASSEMBLY.

The final test of the voltage control unit is made after the bottom and top boxes have been assembled, but before the cover has been installed on the top box or the complete unit installed in the tank. To assemble the unit to this point refer to paragraph 121 and perform the steps **b, c, d, e,** and **f,** in reverse order. With the unit in this stage of assembly, test as instructed in paragraph 124. After the test, remove the top box from the bottom box, disconnect the cables, remove the bottom box from the test stand and assemble the bottom box, top box and cover.

124. MODIFYING VOLTAGE CONTROL UNIT TYPE 667-2-A to 667-4-A.

a. To add the fuse protection to the type 667-2-A unit, which changes the type designation to 667-4-A (fig. 65), proceed as follows:

(1) Remove top box assembly.

(2) Disconnect the leads from the A+, B+, and F+ terminals, mark them appropriately and remove the conduits from the bottom box assembly.

(3) Remove the bottom box assembly.

(4) Refer to figure 65, and remove the clamping strap assembly EC-677155, by drilling or punching out the three rivets EC-A12661.

(5) After removing strap, measure from the bottom $\frac{7}{32}$-inch and cut off, in order to eliminate the possibility of cracking, the fuse holder when it is installed.

(6) Disassemble the voltmeter jack EC-82801 by first removing the two leads. After this remove nut EC-A27983 and the jack may then be removed from the box. Be sure to remove washers EC-44489, located between the jack and the box.

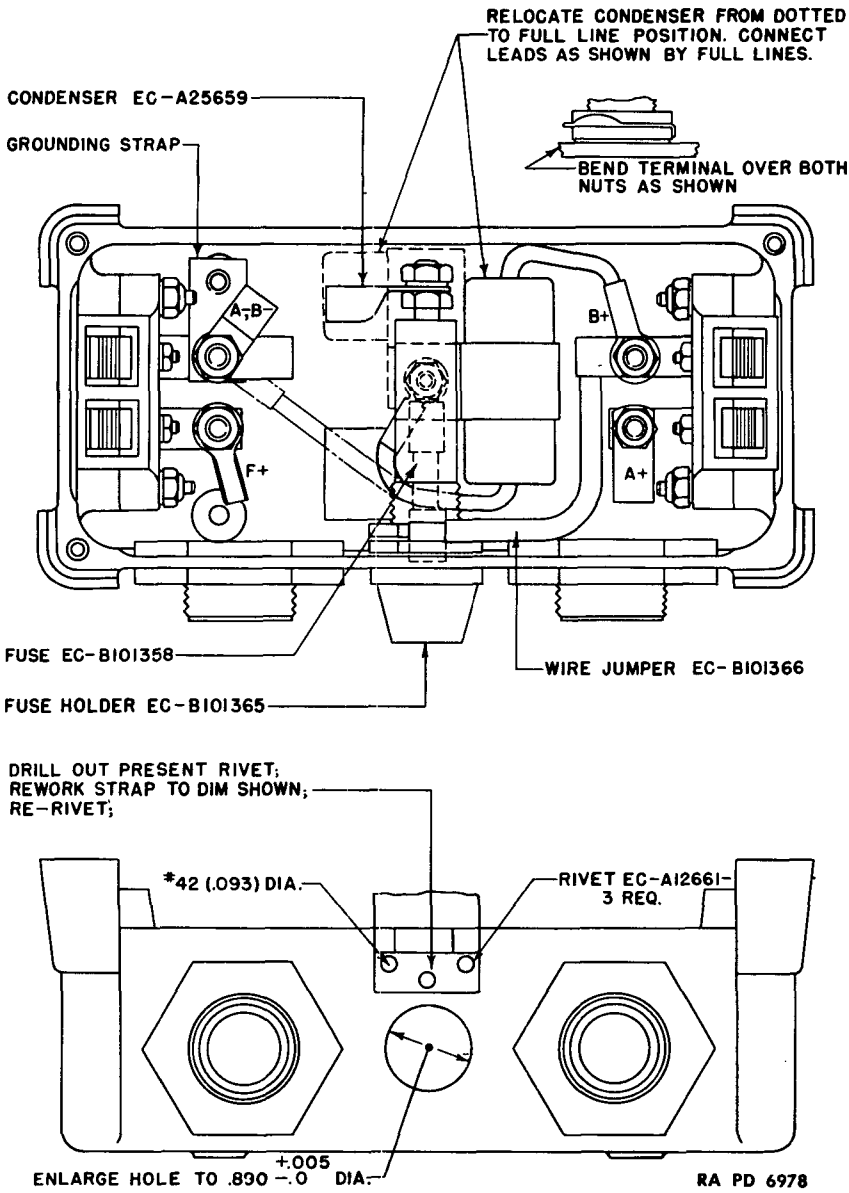


Figure 65—Service Drawing for Conversion of Eclipse Control Box Type 667-2-A to 667-4-A

(7) Then remove condenser assembly EC-B80473. This is done by removing nut EC-45501-6 and the two leads from the terminals to which they are connected.

(8) Open hole from which the voltmeter jack was removed to 0.890 + 0.005 diameter.

(9) With the voltmeter jack and condenser removed, rivet the clamp strap to the box with three rivets EC-A12661. It will be easier to assemble the strap with these units out of the box.

(10) Reassemble the condenser in the box. Rotate the position of the condenser 90 degrees in a clockwise direction from its original position; i.e., mount it perpendicular to the sides of the box and to the right of the hole which has been enlarged. The condenser lead which was previously connected to the A– B terminal should be connected to the B+ terminal and the other lead which was connected to B+ should be connected to the condenser mounting bolt. This is flexible since on grounded boxes the A– B terminal is grounded by means of a grounding strap.

(11) Assemble fuse holder EC-B101365. First remove the two nuts and the insulator which are on it. **These nuts have a left-hand thread.** Slide the fuse holder through the enlarged hole and assemble as follows:

(a) Replace the insulator washer against the inside of box.

(*b*) Replace one of the nuts.

(c) Assemble jumper strap EC-B101366.

(*d*) Replace the remaining nut.

Assemble these pieces before tightening any nut, as there is not enough clearance between the fuse holder and the condenser. After tightening both nuts bend the terminal of the jumper strap over one flat of each nut.

(12) Remove the original name plate, and replace it with a new name plate.

(13) Reinstall the bottom box assembly, reconnect the A+, B+, and F+ wires and install the top box.

b. To add the resistor to the Homelite switch box which is necessary when being used with the type 667-4-A voltage control unit, proceed as follows:

(1) Remove the cover from the switch box of the auxiliary generator.

(2) Drill two holes at the top of the left side of the box for attaching resistor EC-101814-1 (see fig. 66).

(3) Attach the resistor in the box, and connect one lead to the F+ terminal and the other to the A+ terminal. These terminals are the ones

which receive the two wires (No. 14 yellow and No. 8 black) coming out of the conduit which starts from the Eclipse control box.

(4) Replace the switch box cover.

125. TEST.

a. Mount the bottom control box and a generator on a test stand and make connections as shown in figure 56. The connections are made with a No. 8 B. & S. gage flexible insulated wire except the field lead (F+ generator to F+ control box) which may be of No. 18 wire. NOTE: Test the voltage control in the same position it will occupy when installed.

b. Voltage Regulator. To check or reset the voltage regulator, drive the generator at its minimum speed (2600 revolutions per minute) for 15 minutes with no load, so that the generator and control box are operating on an open circuit. At the end of the 15-minute run, the voltmeter should read 29 volts. To change the setting, turn the adjusting wheel (fig. 60). This changes the tension on the spring, an increase in tension increases the voltage while a decrease in tension decreases the voltage. If the regulator operates erratically, insert a clean piece of paper between the contacts, press them together, and pull out the paper. Solder the tension spring after final adjustment.

c. Current Limitator. To check or reset the current limitator, drive the generator at 2250 revolutions per minute, leave battery switch open, and connect resistance until the generator output as indicated on the ammeter is half its normal load (25 amp). Gradually adjust the resistance to increase the current reading on the ammeter. If the limitator setting is correct, the ammeter will record a current value approximately 10 percent in excess of the rated generator output even after the resistors are adjusted for increased output. If the ammeter indicates a current output of less than the rated output, or greater than approximately 10 percent in excess of the rated output, raise or lower the limitator setting accordingly, by turning the ratchet adjusting wheel (fig. 60). Solder the tension spring after final adjustment.

d. Reverse Current Cut-Out. To check or reset the reverse current cut-out, connect enough resistance so that generator will put out approximately 10 amperes when running. With the battery disconnected, drive the generator at 500 revolutions per minute and then gradually increase the speed until the voltmeter needle no longer rises steadily; but suddenly drops a volt or more. This drop in voltage indicates the closing of the cut-out contact point. The voltage observed immediately before this sudden drop in voltage is the closing of the cut-out contacts. The closing voltage should be 26.8 volts to 27.2 volts. To adjust the

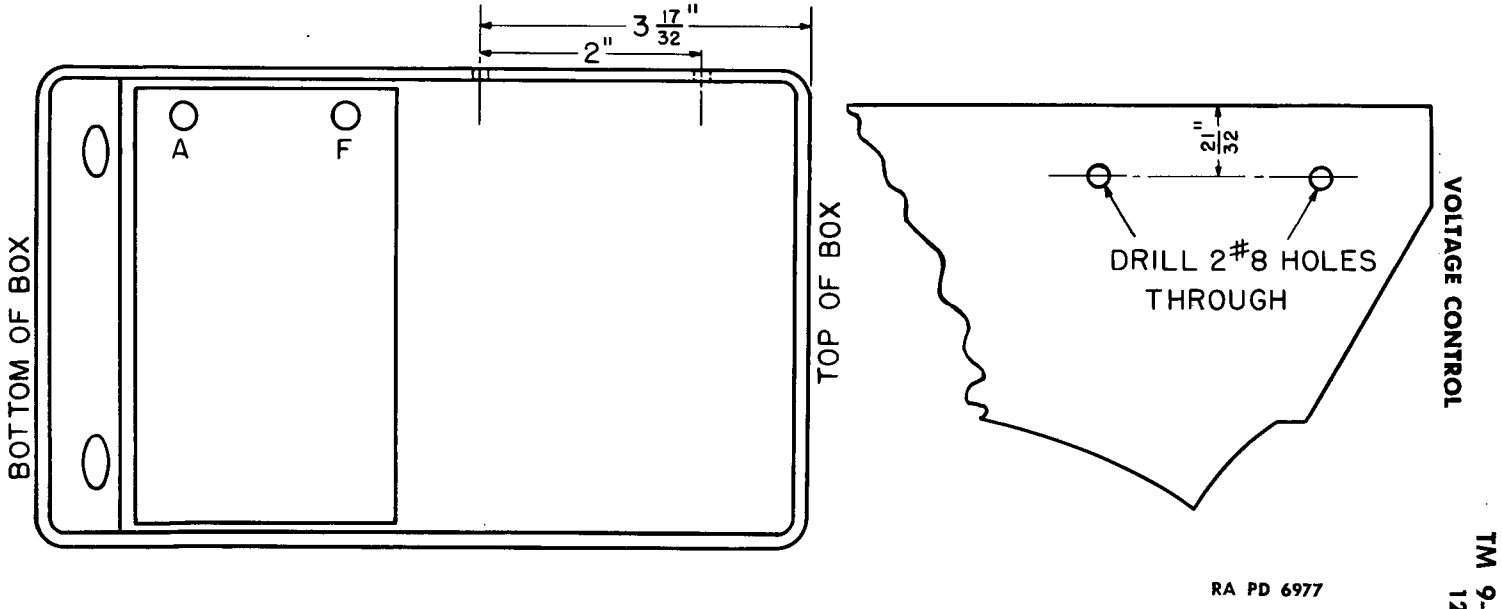


Figure 66—Rework Drawing for Homelite Switch Box When Used with Eclipse Control Box Type 667-4-A

cut-out setting, turn the ratchet adjusting wheel. Increase the closing voltage by increasing the tension of the spring, decrease it by decreasing the tension.

126. INSTALLATION (fig. 62).

To install a voltage control assembly, proceed as follows: release the spring catch on top of the cover and lift the top box and cover off the bottom box. Place the bottom box on the bracket on the rear of the battery box and secure it in place with four screws. Push the cables through the fittings on the rear of the bottom box and attach the conduits to the box by means of the knurled nuts. Connect the cables to their proper terminal posts (fig. 51). Install the top box and cover on top of bottom box, and secure them in place with the spring catch. NOTE: There are three dowels between the top and bottom boxes to prevent incorrect assembly.

127. LIST OF TOOLS.

The only special tool is an insulated wrench for adjusting the current limitator and the reverse current cut-out (EC-MT 5,100).

Section IV

GENERATOR FILTER

128. DESCRIPTION (fig. 62).

The generator filters, Eclipse type 349-1-A are mounted directly below the voltage control boxes which are located at the rear of the fighting compartment beneath the turret basket. There are two generator filters, one used in conjunction with the engine generator and the other with the Homelite auxiliary generating set. The purpose of the filter is to reduce radio interference. The generator brushes riding on the commutator set up radio interference and the filter, which is composed of a choke coil and a condenser, reduces this interference.

129. REPLACEMENT.

a. Removal. Open the battery switch. Remove the locking wire and four screws holding the cover to the base, and remove the cover. Loosen the terminal nuts on the terminals marked "IN+" and "B+" and remove leads. Loosen knurled nuts attaching cable and pull the two leads from the filter box. Remove the four bolts holding the filter to the bracket and remove the filter.

b. Installing. Reverse the procedure in a to install the generator filters. Refer to engine electrical wiring diagram (fig. 51).

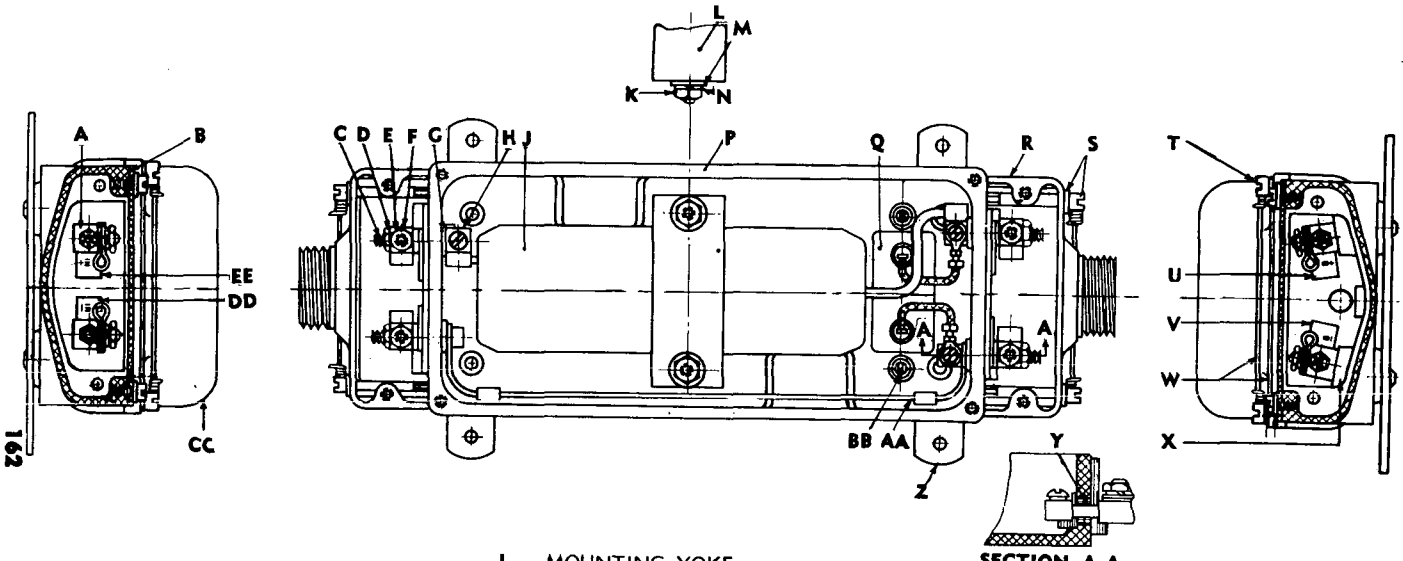
130. DISASSEMBLY, INSPECTION, TEST, AND ASSEMBLY (fig. 67).

a. General. If there is a great deal of interference in the radio equipment, remove and check the filter.

b. Disassembly. The only disassembly necessary will be replacement of the coil and condenser. Necessity for replacement will be determined by test. To remove the condenser, remove the screws holding the leads to the terminals and the two screws holding the condenser to the base. To remove the coil, loosen the terminal screws holding the two leads in place and remove the two nuts holding the coil in place.

c. Inspection and Test. Check the coil for an open or ground circuit with a test light or buzzer. Replace if defective. Test the condenser, which has a rating of 0.5 microfarads, and replace if defective.

d. Assembly. Reverse the procedure given in the disassembly operation.



A — TERMINAL POST SPACER
B — TERMINAL HOUSING COVER
C — TERMINAL POST
D — TERMINAL POST NUT
E — TERMINAL NUT
F — TERMINAL
G — TERMINAL POST INSULATOR
H — COIL TERMINAL
J — BUSHING COIL ASSEMBLY
K — YOKE MOUNTING SCREW & NUT
L — MOUNTING YOKE
M — WASHER
N — LOCK WASHER
P — BOX
Q — CONDENSER ASSEMBLY
R — TERMINAL HOUSING
S — TERMINAL HOUSING SCREW & WASHER
T — BOX COVER SCREW AND WASHER
U — TERMINAL TAG (B+)
V — TERMINAL TAG (B—)
W — LOCKING WIRE
X — INSULATOR
Y — TERMINAL POST BUSHING
Z — BRACKET
AA — BATTERY LEAD ASSEMBLY
BB — CONDENSER MOUNTING SCREW
CC — BOX COVER
DD — TERMINAL TAG (IN.—)
EE — TERMINAL TAG (IN.+)

Figure 67—Generator Filter—Eclipse Type 349-1-A

RA PD 10881

Section V

DIRECT CRANKING ELECTRIC STARTER

131. DESCRIPTION.

The Eclipse Type 817, Model 1, Style A starter, is of the direct cranking type for use with a 24-volt battery. The unit consists of an electric driving motor, reduction gearing, adjustable multiple disk clutch, automatic engaging mechanism, driving jaw, and a hand-cranking mechanism. A schematic wiring diagram of the starter is shown in figure 68.

132. REMOVAL.

Open the battery switch. Disconnect the conduit from the terminal shield on the rear end of the starter, remove the cover from the terminal shield, and disconnect the cable from the starter terminal. Remove the generator and starter supporting assembly. Remove the locking wires, nuts and washers from the studs holding the starter to the engine and remove the starter. Preserve the Vellumoid gasket if it is still in a usable condition.

133. PRELIMINARY TEST AFTER REMOVAL.

At the time of every engine overhaul, remove the starter from the engine and set up on a test stand as instructed in paragraph 138 **n.** Check the clutch setting and if it is within 550 foot-pounds plus 20-foot-pounds or minus 70 foot-pounds, do not disassemble or disturb it during the overhaul of the starter; but, after assembly, reassemble it into the overhauled starter with no alteration except for adjustment. If the clutch setting does not fall within the prescribed limits, or in case the clutch has been left intact for three successive overhauls, dismantle it for inspection and lubrication. However, if suitable test equipment is

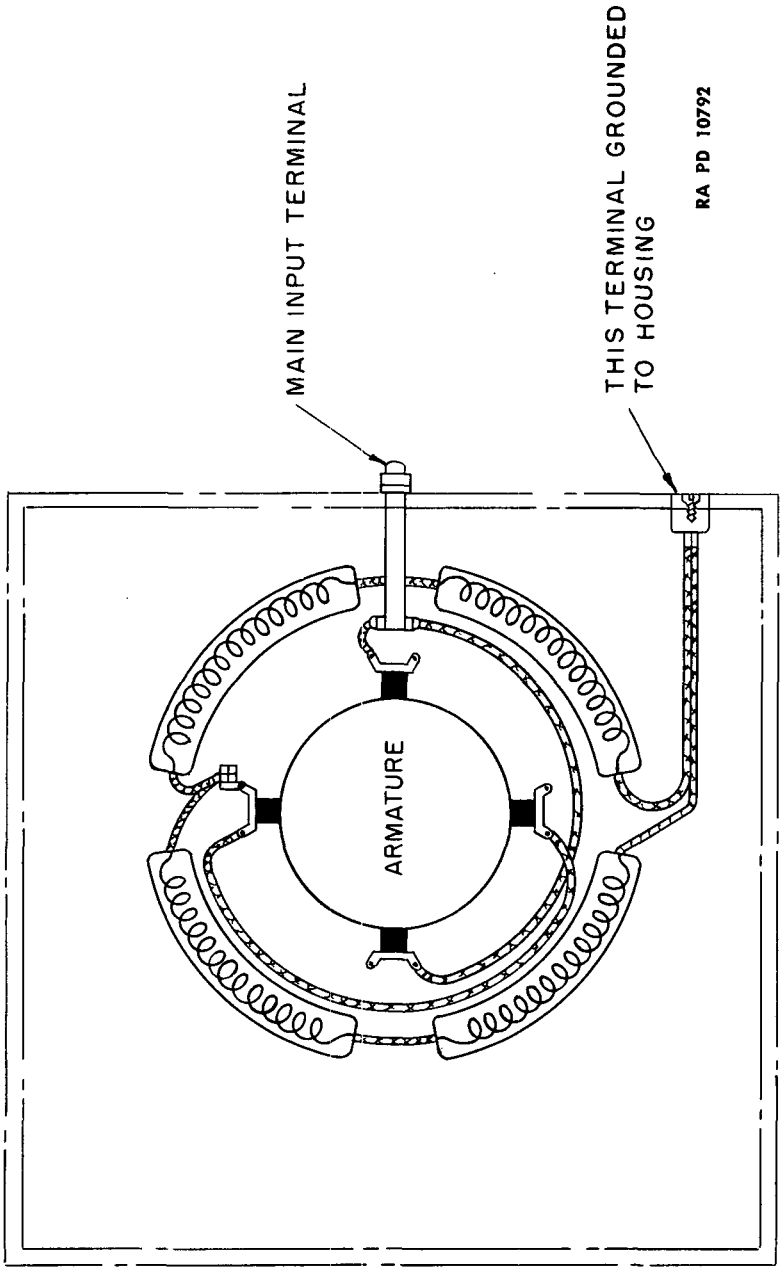


Figure 68—Schematic Wiring Diagram of Type 817-1-A Starter

not available, and starter operation has been satisfactory prior to overhaul, do not disassemble the clutch. In any event, disassemble, clean, and inspect all other parts, except the clutch.

134. DISASSEMBLY.

a. To dismantle the starter, first remove the window strap and lift out the brushes, then remove the meshing rod nut, starter jaw, and baffle plate assembly (fig. 69).

b. To disassemble the starter clutch, remove the clutch adjusting nut lock and loosen the adjusting nut before further disassembly of starter (fig. 70). It is particularly important that the clutch be disassembled if the presence of engine oil is noted in the starter housing. Before disassembling the clutch, note the distance that the barrel projects over the clutch adjusting nut and record for use at assembly.

c. To remove the clutch barrel assembly with planetary gears attached from the clutch housing, separate the starter by removing the six nuts securing the front housing to the intermediate housing and motor housing (figs. 69 and 71). Remove in succession from the crank end of the barrel assembly, the barrel shaft nut, nut lock, spacer, large thrust washer, sun gear, and small thrust washer. With the barrel assembly in the vertical position and the mounting flange upward, remove the large lock ring, external barrel adjusting nut, ball ring and balls. Invert the barrel and housing assembly and remove the clutch barrel assembly with planetary pinions attached. Remove carefully to avoid losing the balls in the front and rear races. If necessary, separate the planetary pinions from the driving barrel by detaching the planetary pinion stud screws and removing the planetary ring. Do not remove the annulus gear unless replacement is to be made.

d. To disassemble the clutch (fig. 70), remove successively the clutch adjusting nut, spring ring, springs, spring spacer, spline nut assembly, spline nut bushing, clutch disks, and spacer. Fasten the clutch disks together to retain their relative order.

e. Remove the tapered screw from the end of the armature shaft and disassemble the intermediate housing, with drive pinion attached, from the shaft. Remove in succession from the intermediate housing, the bearing retainer screws, retainer plate, pinion nut, pinion, and bearing.

f. To remove the hand crank mechanism (fig. 72), remove the cover plate screws, cover plate and gasket to have access to the cranking gear which must be removed in order to dismantle the hand crank mechanism from the motor housing. After detaching the cranking gear, remove the four bolts and lift off the assembly. Further disassembly of mechanism is obvious.

ORDNANCE MAINTENANCE—ACCESSORIES FOR WRIGHT R975-EC2 ENGINES FOR MEDIUM TANKS M3 AND M4

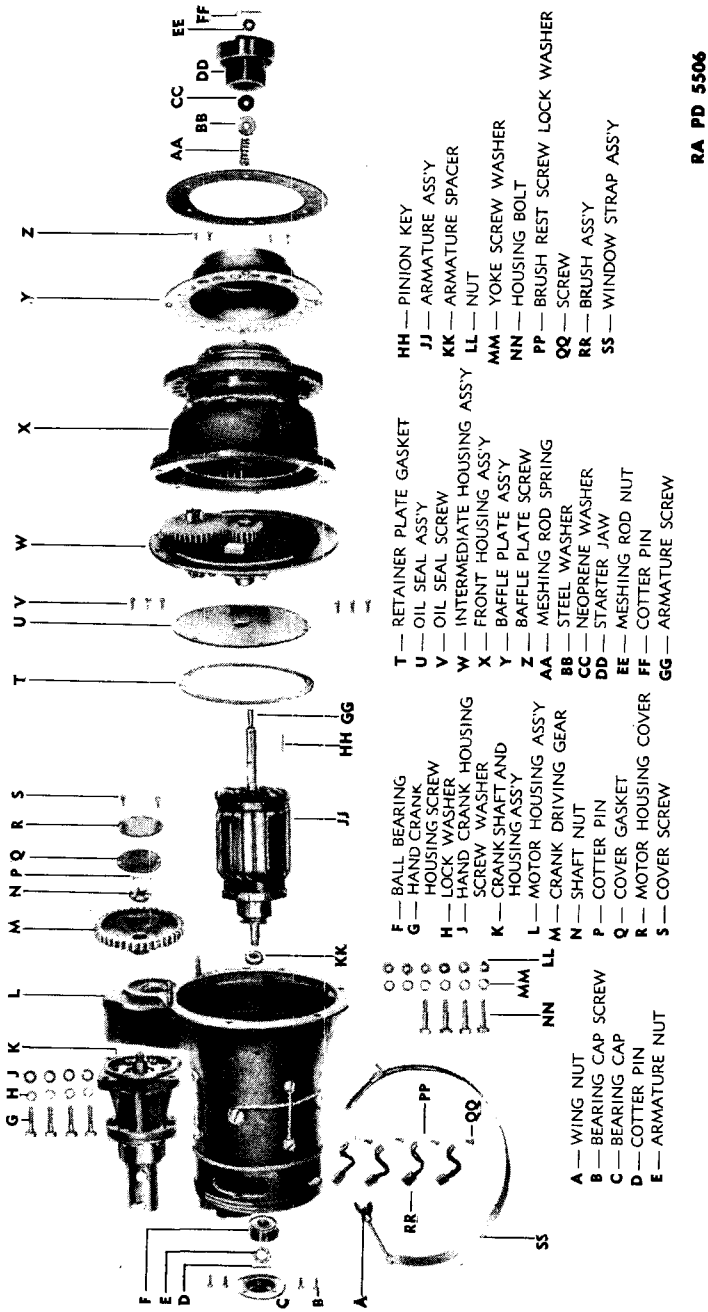
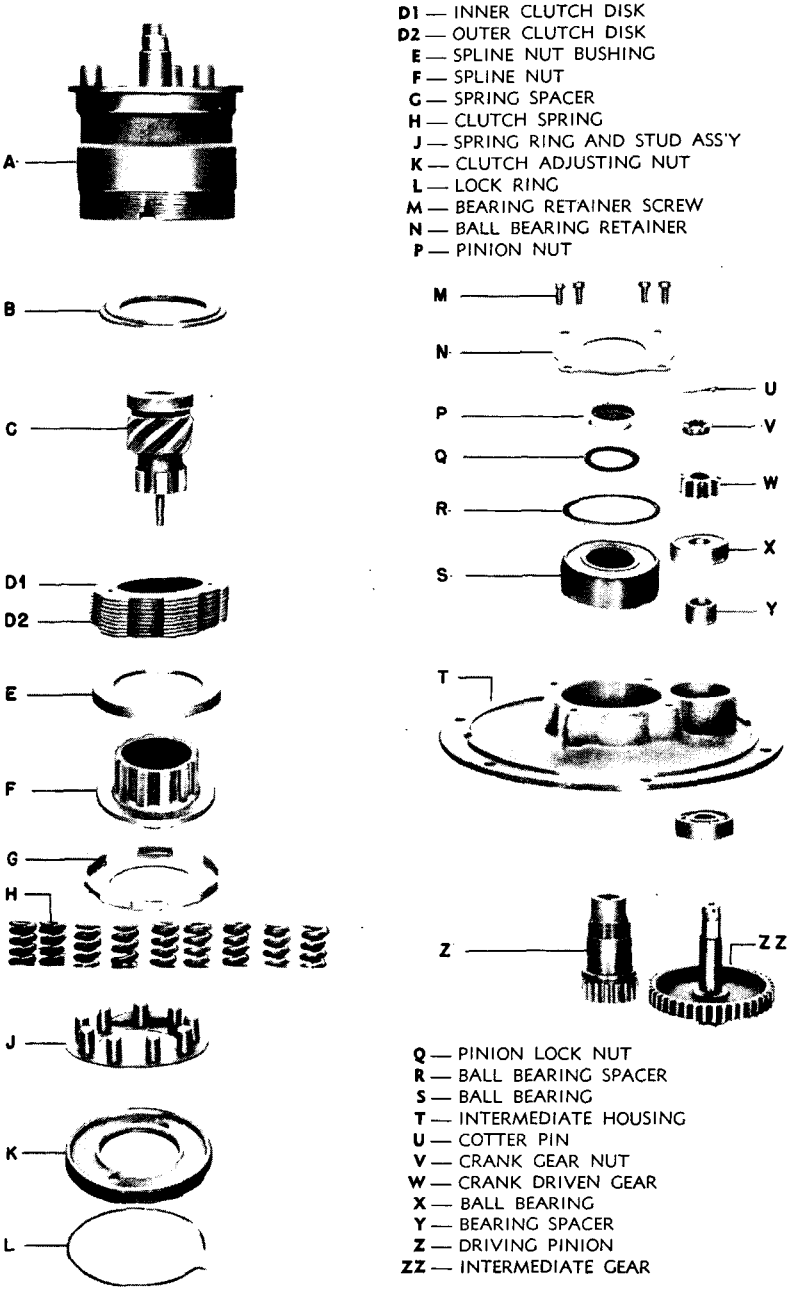


Figure 69—Starter Disassembled

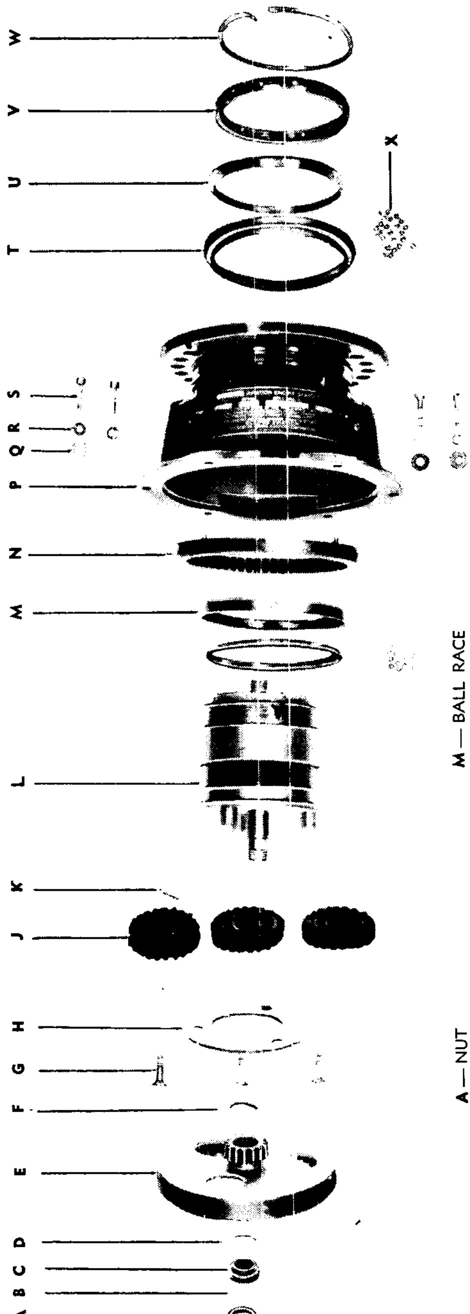
A — BARREL AND STUD ASS'Y
B — CLUTCH SPACER
C — SCREW SHAFT ASS'Y
D1 — INNER CLUTCH DISK
D2 — OUTER CLUTCH DISK
E — SPLINE NUT BUSHING
F — SPLINE NUT
G — SPRING SPACER
H — CLUTCH SPRING
J — SPRING RING AND STUD ASS'Y
K — CLUTCH ADJUSTING NUT
L — LOCK RING
M — BEARING RETAINER SCREW
N — BALL BEARING RETAINER
P — PINION NUT



Q — PINION LOCK NUT
R — BALL BEARING SPACER
S — BALL BEARING
T — INTERMEDIATE HOUSING
U — COTTER PIN
V — CRANK GEAR NUT
W — CRANK DRIVEN GEAR
X — BALL BEARING
Y — BEARING SPACER
Z — DRIVING PINION
ZZ — INTERMEDIATE GEAR

RA PD 5502

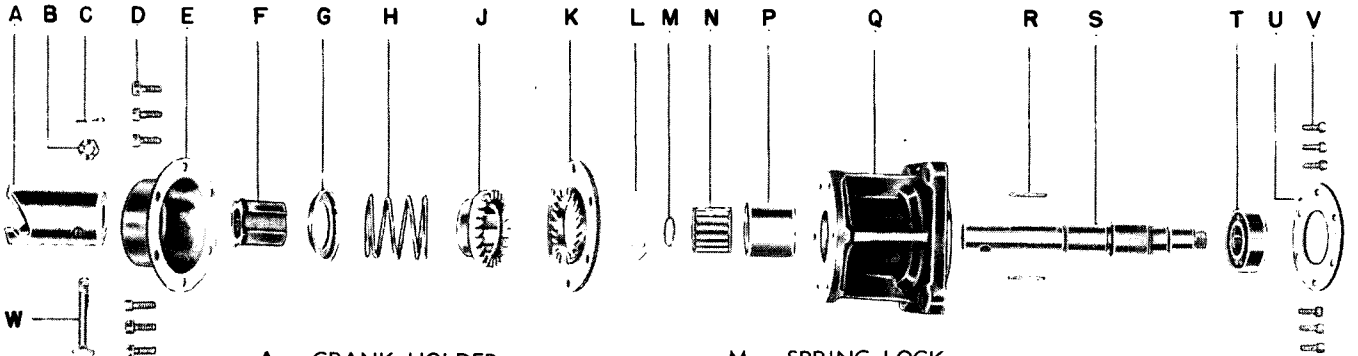
Figure 70—Parts of Starter Clutch and Intermediate Housing Assemblies



RA PD 5505

A—NUT
B—LOCK WASHER
C—SUN GEAR SPACER
D—THRUST WASHER
E—SUN GEAR ASS'Y
F—THRUST WASHER
G—PLANETARY RING SCREW
H—PLANETARY RING
J—PLANETARY PINION ASS'Y
K—BEARING SPACER
L—BARREL AND CLUTCH ASS'Y
M—BALL RACE
N—ANNULUS GEAR ASS'Y
P—FRONT HOUSING
Q—PLAIN WASHER
R—LOCK WASHER
S—ANNULUS GEAR SCREW
T—BALL RACE
U—BEARING RING
V—ADJUSTING NUT
W—LOCK RING
X—BALL BEARING

Figure 71—Parts of Starter Front Housing Assembly



A — CRANK HOLDER
B — CRANK HOLDER SCREW NUT
C — COTTER PIN
D — RATCHET COVER SCREW
E — RATCHET COVER
F — RATCHET SPLINE COLLAR
G — RATCHET SPRING CUP
H — RATCHET SPRING
J — MOVABLE RATCHET
K — STATIONARY RATCHET
L — WASHER
M — SPRING LOCK
N — ROLLER BEARING
P — ROLLER BEARING RACE
Q — HAND CRANK HOUSING
R — SHAFT KEY
S — HAND CRANK SHAFT
T — BEARING
U — BEARING RETAINER PLATE
V — BEARING RETAINER PLATE SCREW
W — CRANK HOLDER SCREW

RA PD 5503

Figure 72—Parts of Hand Cranking Mechanism Assembly

g. Do not remove field coils and pole shoes from yoke unless replacement is necessary as determined in paragraph 137.

135. MAINTENANCE.

After completely disassembling the starter, clean all parts thoroughly with carbon tetrachloride and compressed air except where otherwise specified. Examine and check parts for wear in accordance with the following outline and the tolerance chart (par. 136).

a. Ball and Roller Bearings. Wash bearings thoroughly in clean SOLVENT, dry cleaning. The bearings may be strung on a wire and sloshed in the solvent to remove oil and grease. Afterwards they may be rotated by hand in solvent to complete the removal of old lubricant and dirt. Finish the cleaning with a clean, dry compressed air as follows: Hold inner and outer bearing rings against rotation and direct the air squarely at the side, or face, of the bearing; the air hose nozzle being parallel to the bearing bore. When thoroughly clean, oil each bearing with clean new OIL, engine, and rotate to distribute the lubricant to all surfaces. Following this, the bearing may be examined for serviceability. Replace rough turning or excessively loose bearings.

b. Clutch Barrel. If the clutch has not been disassembled, simply wipe the exterior with a cloth moistened with carbon tetrachloride. Do not immerse in carbon tetrachloride. However, if the clutch has been disassembled, clean all parts thoroughly, and replace worn or scored clutch disks. Coat the clutch disks and pack with GREASE, graphite, light. For instructions on assembling and setting clutch see paragraphs 138 **b** and **n**.

c. Baffle Plate. If oil seal leathers are worn or torn to the extent that they are larger than the outside diameter of the starter jaw, replace the baffle plate assembly. If the baffle plate or meshing rod oil seal is worn, as indicated by the presence of the engine oil in the starter housing, replace it. When replacement of the baffle plate oil seal leather is required, a complete unit will be substituted. Do not break down the assembled unit under any conditions. NOTE: Soak new baffle plate assemblies in OIL, neat's-foot, at 100 F for a period of one hour prior to assembly, to insure free travel of the starter jaw.

d. Meshing Rod Oil Seal (fig. 69). Replace the meshing rod neoprene oil seal at every overhaul.

e. Meshing Rod Oil Seal Cup Washer. Replace if distorted or cracked.

DIRECT CRANKING ELECTRIC STARTER

f. Screw Shaft and Spline Nut. At each overhaul, magnaflux (if possible) the screw shaft and spline nut assembly (fig. 70) and examine closely for cracks. Any evidence of cracks is sufficient cause for rejection and the complete assembly must be replaced in order to prevent failure later.

g. Starter Jaw. Replace the starter jaw if worn to the extent that the sharp corner of the leading edge of the jaw has a $\frac{1}{16}$-inch radius.

h. Gears. Replace gears if the face of teeth becomes worn.

i. Ball Rings. Replace fitted or grooved ball rings at time of overhaul.

j. Ball Races. Replace fitted or grooved ball races at time of overhaul. Should the ball races show evidence of creeping in the housing, it will be necessary to rework the housing for the assembly of oversize ball races.

k. Driving Keys. Replace all driving keys if faces are offset $\frac{1}{32}$-inch.

l. Crank Bolt. Replace crank bolt when worn or offset $\frac{1}{32}$-inch.

m. Oil Seal Felts. If the felts in the motor oil seal assembly (fig. 69) become worn or damaged, replace the complete oil seal assembly.

n. Gasket. Replace the motor oil seal gasket at each overhaul.

o. Armature. Dip the armature assembly in a container of carbon tetrachloride and scrub thoroughly with a stiff brush. Do not leave the armature immersed in the cleaner. Dry and smooth commutator with No. 000 sandpaper. Do not use coarse sandpaper or emery cloth. Clean the armature thoroughly to remove sand particles. If the commutator is extremely rough or burned, mount the armature in a lathe and take a light cut across the face of the commutator. When mounting the armature, make certain that the centers are true and clean. The minimum diameter to which a commutator may be turned is $1\frac{5}{16}$-inch. After turning, carefully undercut the mica insulation between the commutator bars to a depth equal to the width of the mica, or approximately 0.030-inch. Use a cutting tool slightly wider than the mica to insure complete removal of the mica to the required depth. Smooth and polish the commutator after undercutting to remove any burs. Reseat brushes after turning.

p. Field Coils (fig. 73). Test the field coils for grounded, shorted, or open circuits as instructed in paragraph 137. If the field coils must be replaced, remove the pole shoe screws, pole shoes and field coils. Assemble new coils in yoke and pull up pole shoes tightly with an expander EC–MT–4140 and a plug gage EC–T–21626A of 3.021-inch

diameter to assure proper alinement of pole shoes and to prevent interference with the armature windings. Place the complete assembly of yoke, field coils, and pole shoes in an oven and bake at 260 F for two hours. As replacement field coils have been dipped in varnish and partially baked before shipment, this two hour baking period causes the varnish to soften and flow into any crevices in the assembly, and finally harden during the remainder of the baking process. The entire procedure as outlined above results in a well bonded assembly and prevents the field coils from loosening during service.

q. Motor Housing (fig. 73). Thoroughly clean the motor housing with carbon tetrachloride and compressed air to remove all foreign material such as copper chips, solder, or carbon dust. After cleaning, inspect for weakened, cracked, or burnt insulation and test for grounds as instructed in paragraph 137. Replace brush rigging if insulation is cracked or burnt.

r. Insulators. Inspect all terminal post insulators and replace if worn or cracked.

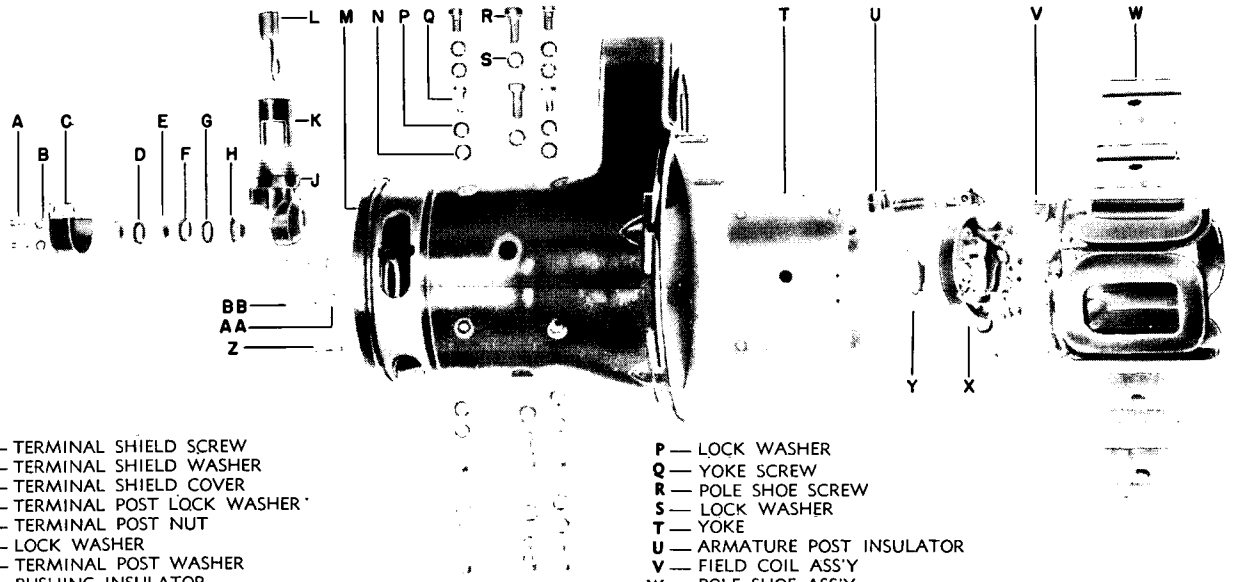
s. Brushes. Maximum permissible wear of brushes is $\frac{5}{32}$-inch from a new length of ½-inch or, when the amount of brush remaining is $\frac{11}{32}$-inch. However, replace brushes before their maximum wear limit is reached, in order to assure proper operation until next inspection period.

136. CLEARANCES.

The following chart is provided to facilitate the inspection of parts for wear and to check clearances when reassembling starters at overhaul:

Description	Clearances
Motor housing ball bearing in housing	0.0008T*–0.0000L*
Motor housing ball bearing on armature	0.0000T*–0.0007L*
Crank gear on crankshaft—double D wear limit	$\frac{1}{64}$-inch rotation of gear at outer edge
Crankshaft ball bearing in housing	0.0000T*–0.0008L*
Crankshaft ball bearing on crankshaft	0.0001T*–0.0006L*
Crankshaft roller bearing race—ID	1.000–1.001
Crankshaft—OD	0.6240–0.6245
Movable ratchet on spline collar	0.003L*–0.006L*
Crank collar on crankshaft	0.0005L*–0.0020L*
Crank collar bolt in crankshaft	0.001L*–0.005L*
Roller bearing race in housing	0.0005T*–0.0020T*
Ball bearing in intermediate housing	0.0008T*–0.0000L*
Ball bearing on intermediate gear shaft	0.0000T*–0.0007L*

* T–tight * L–loose



A — TERMINAL SHIELD SCREW
B — TERMINAL SHIELD WASHER
C — TERMINAL SHIELD COVER
D — TERMINAL POST LOCK WASHER
E — TERMINAL POST NUT
F — LOCK WASHER
G — TERMINAL POST WASHER
H — BUSHING INSULATOR
J — TERMINAL SHIELD
K — TERMINAL LUG INSULATOR
L — TERMINAL LUG
M — MOTOR HOUSING
N — YOKE SCREW WASHER

P — LOCK WASHER
Q — YOKE SCREW
R — POLE SHOE SCREW
S — LOCK WASHER
T — YOKE
U — ARMATURE POST INSULATOR
V — FIELD COIL ASS'Y
W — POLE SHOE ASS'Y
X — BRUSH BOARD ASS'Y
Y — BRUSH BOARD INSULATOR
Z — GROUNDING LUG SCREW
AA — BRUSH BOARD SCREW WASHER
BB — BRUSH BOARD SCREW

RA PD 5504

Figure 73—Parts of Starter Motor Housing and Yoke Assemblies

Description	Clearances
Drive pinion in double row ball bearing	0.0001T*–0.0006L*
Double row ball bearing in intermediate housing	0.0004T*–0.0004L*
Planetary pinion ball bearing on stud	0.0002L*–0.0007L*
Front ball race in housing	0.003T*–0.000L*
Rear ball race in housing	0.002T*–0.0015L*
Bushing in sun gear	0.0015T*–0.003T*
Ball rings on barrel	0.001L*–0.003L*
Spline nut bushing on spline nut	0.001L*–0.004L*
Sun gear thrust washer—small (thickness)	0.030 min
Sun gear thrust washer—large (thickness)	0.030 min
Sun gear on barrel shaft	0.0005L*–0.0015L*

137. TEST AT DISASSEMBLY.

a. Test the armature, and the yoke and field coil assembly for shorted, grounded and open circuits before assembling, with a 220-volt alternating current or direct current line having a lamp in series. If a 220-volt line is not available, a 110-volt line will do. Schematic wiring diagram is shown in figure 68.

b. Shorted Armature. To test for a shorted armature, use a growler.

c. Grounded Armature. To test for a grounded armature, touch one side of the lamp circuit to the armature shaft. Touch the other terminal of the lamp circuit to the commutator bars. If the armature is grounded, the lamp will light.

d. Open Armature. Inspect the commutator for black or burnt commutator bars and make sure that all conductors are firmly soldered into the riser. Loose conductors or blackened commutator bars indicate the possibility of an open circuit.

e. Open Field Circuit. To test for an open field circuit, connect the two terminals of the lamp circuit to the two field coil terminals. The lamp will light if there is no open circuit.

f. Grounded Field Circuit. To test for a grounded field circuit, connect one terminal of the lamp circuit to one of the field terminals, the other field terminal being free. Touch the other lamp circuit terminal to the yoke momentarily. The lamp will light if the field is grounded.

g. Motor Housing. To test for grounds between each brush box and the housing, place one terminal of the lamp circuit on the brush

* T–tight * L–loose

box and the other on the housing. The lamp will light if the board is grounded. Repeat the test for each box and replace the entire assembly if any one is grounded.

138. ASSEMBLY.

Before assembling the starter make certain that all parts are properly lubricated as specified in paragraph 135. Be sure to install all locking devices and safety wires. In addition, observe the following precautions to facilitate and insure proper assembly.

a. Ball Races. In order to facilitate assembly of the clutch barrel in the front housing, coat the ball races with GREASE, special, high temperatures, to hold the balls in place. Sixty balls are required in each race.

b. Clutch Assembly. Lubricate and replace the clutch disks in the same relative position as noted at disassembly. Tighten the adjusting nut so that the barrel extends over the nut the same distance as noted before disassembly. If worn or scored disks have been replaced, assemble the clutch adjusting nut so that the barrel extends approximately $\frac{1}{16}$-inch beyond the nut. NOTE: Too low an adjustment of the clutch setting, prior to testing, will result in burning of the clutch plates. This must be avoided. The procedure for the final clutch setting is outlined in paragraph 138 **n**. NOTE: If worn or scored disks have been replaced, or an entirely new clutch pack installed, it is recommended that the clutch be alternately slipped at 6.5 revolutions per minute, using an outside source of power, and cooled for periods of 5 minutes. Repeat this procedure until 320 revolutions of slipping have been obtained and assemble the clutch in the starter. This method of first running in new clutch disks will aid materially in obtaining the final clutch adjustment. However, this procedure may be eliminated when installing complete packs already run in.

c. Planetary Pinions. It is not necessary to assemble the planetary pinions in any specific position when meshing them with the spur pinion and fixed annulus gear.

d. Thrust Washer, Small. Assemble the small thrust washer with the counterbored side adjacent to the barrel.

e. Barrel Adjusting Nut. Make sure that the barrel adjusting nut is taken up sufficiently to eliminate any appreciable end or side play that may exist when the barrel is assembled in the front housing. To insure proper adjustment of the barrel adjusting nut, tighten until snug and back off one hole. The clearance between the barrel adjusting nut

and the ball ring should be at least 0.003 inch. No binding should exist. After completing adjustments, install the barrel adjusting nut lock ring in place.

f. Drive Pinion and Bearing. Assemble the double row ball bearing with the sealed end adjacent to the shoulder on the drive pinion. Coat the armature shaft with GREASE, special, high temperature, before installing the pinion. Make certain that the tapered screw is assembled with the armature shaft.

g. Gears and Plain Bearings. Coat all gears and plain bearings with GREASE, high temperature, prior to assembling.

h. Pole Shoe Screws. As a precaution against possible seepage of OIL, engine, into the starter motor housing around the pole shoe screws, coat the under side of the screw heads with lacquer. When the lacquer dries, it will form a seal between the screw heads and the counterbores in the yoke.

i. Bearing Cap. Make certain that the motor bearing cap clamps the outer race of the ball bearing.

j. Brushes. The brushes should be a free fit without excessive side play in the brush boxes. To insure proper seating of new brushes, place a thin strip of No. 000 sandpaper between the brushes and the commutator with sanded side of the paper in contact with the brush surface. Turn the armature in the proper direction of rotation, until the brushes are completely seated. Remove all sand or metal particles with compressed air.

k. Brush Springs. Check brush spring tension at assembly and replace if the tension is less than 24 oz. or more than 28 oz. as measured when the spring leaves top of a new brush.

l. Baffle Plate Assembly. Do not assemble the baffle plate to the starter until after the clutch has been properly checked or set as outlined in paragraph 138 **n.**

m. Starter Jaw. With the starter jaw completely retracted, the travel to full advanced position should be $\frac{1}{32}$-inch.

n. Clutch Adjustment and Test. In order to check or adjust starter clutches, and to test the units for proper operation after assembly, use a prony brake test stand with a platform scale (EC–MT 327) (fig. 74). With the baffle plate removed, mount the starter on the test stand and adjust the mounting bracket of the stand so that the distance between the starter jaw and the test stand jaw is $3\frac{1}{2}$ inch with the starter jaw fully retracted. Removal of the baffle plate necessitates manual engage-

ment of the starter jaw with the test stand jaw. When adjusting the starter clutch, as outlined in (1) and (2), take care to attain the required setting gradually without overheating.

(1) CHECKING CLUTCH SETTING. If the clutch disks have not been disturbed or the setting altered during overhaul, check the clutch setting as follows: lock the brake drum and operate the starter for a period of 5 seconds. Repeat the above procedure five times at 1-minute intervals. If the torque reading on the scale remains constant at 550 foot-pounds plus or minus 20 foot-pounds, it can be considered satisfactory. To lower the setting, screw the clutch adjusting nut outward; to raise, screw inward. After the correct setting has been secured, allow the starter to cool to room temperature and operate five consecutive times to determine if setting remains constant.

(2) SETTING CLUTCH. If the clutch has been disassembled and worn disks replaced or a new clutch pack installed, approach the clutch setting gradually, starting with approximately a 200 foot-pound setting. With locked brake, operate the starter for periods of 5 seconds with 1-minute intervals, until the clutch maintains a constant torque value. Gradually increase the torque value, operating the starter after each increase in setting until the required setting is obtained. When the final setting of 550 foot-pounds plus or minus 20 foot-pounds is reached, allow the starter to cool to room temperature and give five consecutive engagements of 5 seconds duration at 1-minute intervals. If the setting remains constant, the clutch has been properly adjusted.

139. TEST.

After the clutch has been properly adjusted, subject the starter to the following test to determine proper performance.

a. Free Run. Unlock the test stand brake drum to permit the starter to operate without load. By means of a carbon pack resistor connected in series with the battery, apply 16 volts across the motor terminals. The minimum speed shall be at least 6500 revolutions per minute with 32 amperes.

b. Load Run. With 18.5 volts maintained across the motor terminals, adjust the brake drum to provide a load of 300 foot-pounds. Under these conditions the maximum current draw shall be 180 amperes, with a minimum speed of at least 3050 revolutions per minute.

c. Hand Crank Test. Set the prony brake at 200 foot-pounds and crank manually to check ratchet assembly for proper rotation. Try to crank in the opposite rotation as a check on the safety feature of the ratchet.

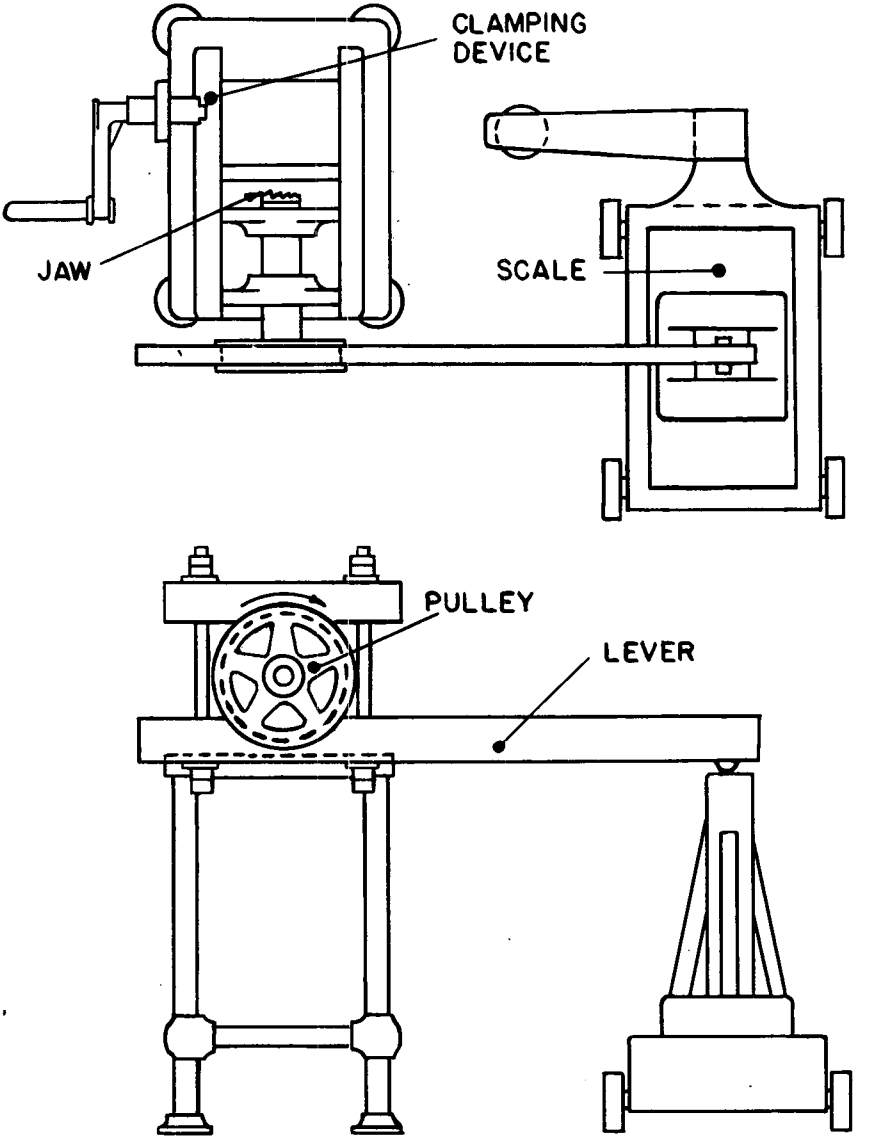


Figure 74—Schematic Diagram of Prony Brake Test Stand

d. Final Assembly. Remove the starter from the test stand and assemble the clutch adjusting nut lock and baffle plate. On older models incorporating a friction ring, check the friction oil seal assembly in the baffle plate to ascertain if there is sufficient tension to hold the starter jaw in position so that it will advance full forward to mesh with the engine jaw before starting to rotate. If the jaw fails to advance when the starter is operated, replace the baffle plate assembly.

140. INSTALLATION.

Install the $\frac{1}{64}$-inch Vellumoid gasket on the starter mounting pad at the rear of the engine and slide the starter into place over the studs. Install the starter with the hand cranking attachment up. Install the washers and nuts on the studs and secure the nuts with locking wire. Install the generator and starter supporting assembly. Connect the cable to the starter terminal, connect the cable conduit to the terminal shield, and install the cover on the terminal shield, securing the screws with locking wire. Refer to figure 51 for the engine electrical wiring diagram.

141. LIST OF TOOLS.

The following is a list of major overhaul tools:

Numbers with Prefix "EC"—Eclipse Aviation Corp.

Piece Mark.	
EC–MT–1197	Fixture, locating intermediate head
EC–MT–21626A	Gage, alining pole shoes
EC–MT–4140	Pole, shoe
EC–MT–1170	Puller, gear
EC–MT–309	Screwdriver, press for planetary pinion and pole shoe screws
	Stand, prony type test
EC–MT–237	Tool, checking tension friction ring
EC–MT–304	Tool, locking ring assembly
EC–MT–98	Wrench, armature shaft driving pinion slotted nut
EC–MT–806	Wrench, clutch adjusting nut
EC–MT–13	Wrench, clutch barrel shaft slotted nut
EC–MT–302	Wrench, armature shaft, commutator end, nut
EC–MT–1310	Wrench, handcrank shaft slotted nut
EC–MT–458	Wrench, nut adjusting ball

Section VI

SOLENOID SWITCH

142. DESCRIPTION (fig. 75).

The Eclipse type 518–21–A solenoid operated switch is used between the battery and the starter to avoid running the heavy cable necessary in this circuit all the way to the instrument panel where the actuating toggle switch is located. The solenoid switch is located on the left side of the generator and starter supporting bracket. Heavy cables run from the contact terminals to the battery and starter and a smaller cable runs from the coil terminal to the toggle switch on the instrument panel. The second coil terminal is grounded.

143. REMOVAL.

Open the battery switch. Remove the locking wire and three screws and washers holding the cover to the bottom of the lower shield and remove the cover. Disconnect the cable from the terminal post of the coil. Unscrew the nut holding the conduit tee to the lower shield, remove the tee and pull the cable out of the shield. Remove the locking wire, screws and washers holding the terminal shield covers to the shields and remove the two covers. Disconnect the cables from the terminal posts, unscrew the knurled nuts holding the conduits to the shields and pull the cable ends out of the shields. Remove the bolts holding the unit to the generator and starter supporting bracket and remove the unit.

144. DISASSEMBLY (fig. 76)

Remove the four bolts holding together the coil and housing assembly, end plate and plunger assembly, and cover assembly and separate the unit into its component parts. Further disassembly is not required unless replacement of parts is necessary. If necessary to disassemble the end plate and plunger assembly, drive out the pin connecting the plunger and the plunger stud, slide the plunger and spring off the stud, and slide the switch blade assembly out of the end plate assembly.

SOLENOID SWITCH

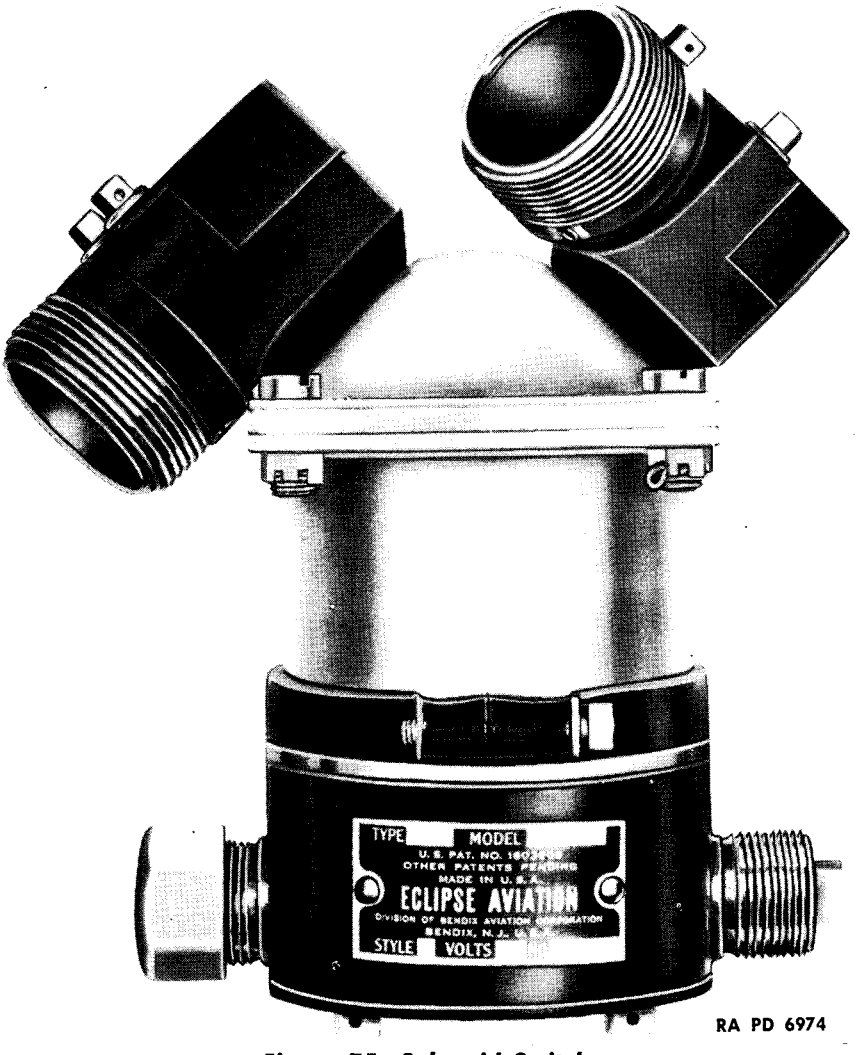
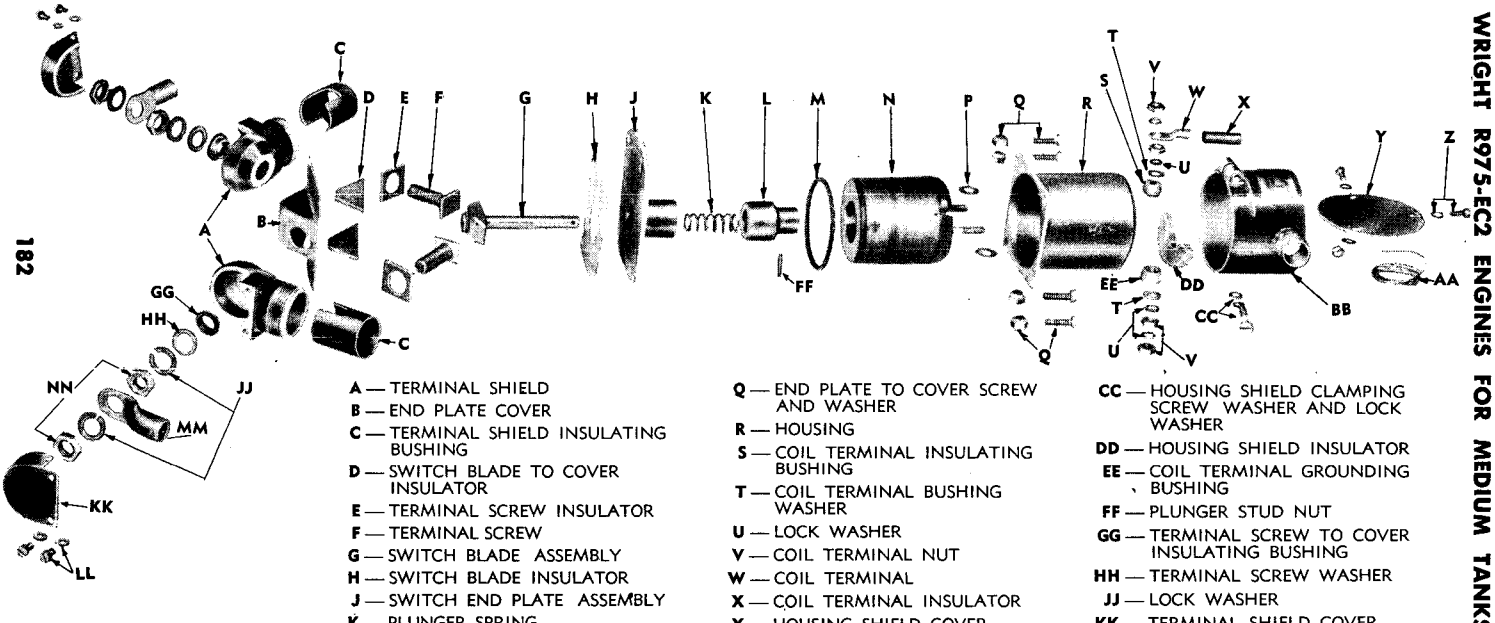


Figure 75—Solenoid Switch

145. MAINTENANCE.

Clean dirty or pitted switch blades and contacts with No. 000 sandpaper or a fine file. If the blades or contacts are badly burned or pitted, replace them with the complete blade and plunger shaft assembly, and the complete cover and contact stud assembly, respectively. Check the coil by connecting the terminals to a 110 volt test lamp circuit. If the lamp fails to light, the coil is open and must be replaced. Remove the grounding bushing from the coil terminal and check for a grounded coil by touching one lead of the test lamp circuit to one terminal of the coil



A — TERMINAL SHIELD
B — END PLATE COVER
C — TERMINAL SHIELD INSULATING BUSHING
D — SWITCH BLADE TO COVER INSULATOR
E — TERMINAL SCREW INSULATOR
F — TERMINAL SCREW
G — SWITCH BLADE ASSEMBLY
H — SWITCH BLADE INSULATOR
J — SWITCH END PLATE ASSEMBLY
K — PLUNGER SPRING
L — PLUNGER
M — END PLATE GASKET
N — COIL ASSEMBLY
P — COIL TERMINAL WASHER
Q — END PLATE TO COVER SCREW AND WASHER
R — HOUSING
S — COIL TERMINAL INSULATING BUSHING
T — COIL TERMINAL BUSHING WASHER
U — LOCK WASHER
V — COIL TERMINAL NUT
W — COIL TERMINAL
X — COIL TERMINAL INSULATOR
Y — HOUSING SHIELD COVER
Z — HOUSING SHIELD COVER SCREW AND WASHER
AA — LOCKING WIRE
BB — HOUSING SHIELD
CC — HOUSING SHIELD CLAMPING SCREW WASHER AND LOCK WASHER
DD — HOUSING SHIELD INSULATOR
EE — COIL TERMINAL GROUNDING BUSHING
FF — PLUNGER STUD NUT
GG — TERMINAL SCREW TO COVER INSULATING BUSHING
HH — TERMINAL SCREW WASHER
JJ — LOCK WASHER
KK — TERMINAL SHIELD COVER
LL — TERMINAL SHIELD COVER SCREW AND WASHER
MM — END PLATE COVER TERMINAL
NN — TERMINAL SCREW NUT

RA PD 10795

Figure 76—Exploded View of Solenoid Switch—Eclipse Type 518-21-A

and the other test lead to the coil housing. If the lamp lights, the coil is grounded and must be replaced.

146. ASSEMBLY AND TEST.

Assemble the switch, following the disassembly procedure in reverse order. If the rubber gasket between the end plate and cover assemblies is worn or torn, replace it. Replace all locking devices. If the end plate and plunger assembly has been disassembled, stake the pin in place after assembly. To test the switch after assembly, connect the coil terminals to an 18 volt supply. Connect a test lamp circuit across the switch terminals and operate the unit a number of times, using the lamp as an indicator to assure proper operation. With switch energized as above, test all terminals for grounds with the test lamp circuit. Make certain that grounding bushing is removed.

147. INSTALLATION.

To install the unit, follow the removal procedure in reverse order. Refer to figure 51 for the engine electrical wiring diagram.

Section VII

FUEL CUT-OFF SOLENOID

148. DESCRIPTION (fig. 77).

The fuel cut-off solenoid switch Eclipse Type 500-15-A is used to stop the flow of fuel to the engine. This is done by linking the solenoid plunger to a spring loaded needle valve in the carburetor. Operation of this valve diverts the suction of the intake manifold from the idle discharge nozzle to the space in the carburetor bowl above the fuel, and stops the fuel flow through the idle discharge nozzle. The solenoid is operated by a toggle switch in the instrument panel and is located on the motor support to the right of center below the carburetor.

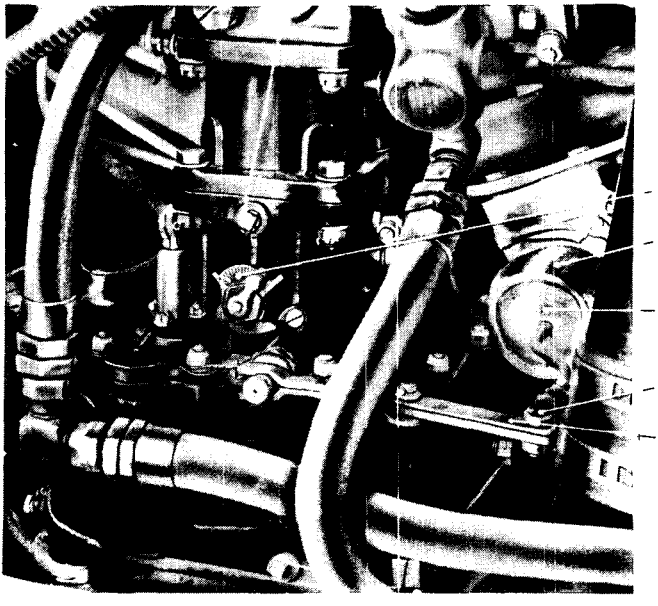


Figure 77—Fuel Cut-Off Solenoid Installation

FUEL CUT-OFF SOLENOID

149. REMOVAL.

Open the battery switch. Remove cotter pin from clevis pin connecting clevis and lever. Remove the leather cover, after which the rod can be unscrewed from solenoid. Remove the locking wire and three screws, and washer holding the cover to the lower shield and remove the cover. Disconnect the cable from the terminal post of the coil. Unscrew the nut holding the conduit tee to the lower shield, remove the tee and pull the cable out of the shield. Remove the two bolts and nuts (3/8-in. wrench) holding the switch and bracket to the engine support beam and remove the unit.

150. DISASSEMBLY (fig. 78).

Remove the four bolts holding the housing assembly to the cover assembly, and separate the unit into its component parts. Do not disassemble further unless replacement of parts is required.

151. INSPECTION.

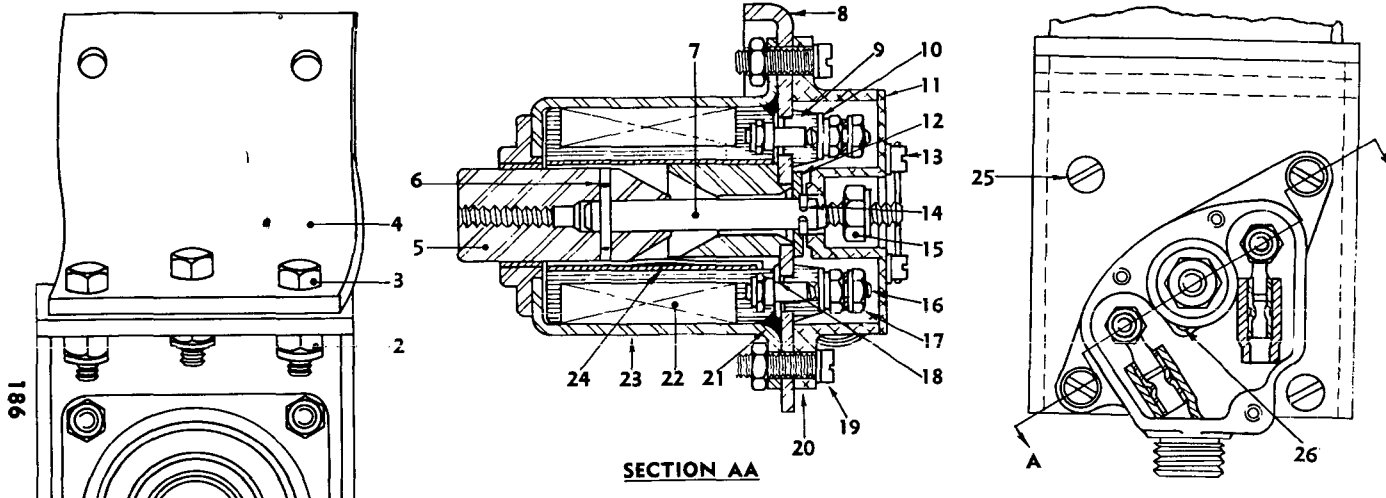
Check the coil by connecting the terminals to a 110 volt test lamp circuit. If the lamp fails to light, the coil is open and must be replaced. Check for a grounded coil by touching one lead of the test lamp circuit to one terminal of the coil and the other test lead to the coil housing. (Be sure to remove the grounding bushing from the coil terminal of grounded unit.) If the lamp lights, the coil is grounded and must be replaced. Check and clean the bore in which the plunger assembly moves. Check the plunger travel restricting spring and see that the spring has sufficient tension.

152. ASSEMBLY AND TEST.

To reassemble the switch, follow the disassembly procedure in reverse order. Replace the gasket between the housing and bracket assembly if worn or torn. Replace all locking devices. If the end plate and plunger assembly have been disassembled, stake the pin in place after assembly. To test the switch after assembly, connect the coil terminals to a 2/3-rated voltage supply. Connect a test lamp circuit across the switch terminals and operate the unit a number of times, using the lamp as an indicator to assure proper operation. With switch energized as above, test all terminals for grounds with the test lamp circuit. Make certain grounding bushing is installed. The plunger travel should be $\frac{3}{32}$ inch. The maximum current draws is 15 amperes.

153. INSTALLATION.

To install the unit, proceed as follows. Refer to engine electrical wiring diagram (fig. 51). Install solenoid. Put solenoid bracket pointing downward and to rear, on front of motor support just to right of center and



SECTION AA

1 — TERMINAL COVER NUT
2 — SAFETY NUT
3 — BRACKET & ATTACHING PLATE SCREW
4 — ATTACHING BRACKET
5 — PLUNGER ASSEMBLY
6 — PLUNGER STUD PIN
7 — PLUNGER SHAFT
8 — MOUNTING BRACKET W/PLATE ASSEMBLY
9 — TERMINAL BUSHING
10 — TERMINAL WASHER
11 — TERMINAL SHIELD COVER
12 — PLUNGER STOP
13 — SHIELD COVER SCREW, WASHER & LOCKING WIRE
14 — PLUNGER STOP LOCK RING
15 — PLUNGER SHAFT NUT
16 — TERMINAL STUD ASSEMBLY
17 — TERMINAL NUT & LOCK WASHER
18 — TERMINAL INSULATING WASHER
19 — SHIELD AND MOUNTING BRACKET SCREW & WASHER
20 — TERMINAL SHIELD
21 — COIL HOUSING GASKET
22 — COIL ASSEMBLY
23 — HOUSING ASSEMBLY
24 — PLUNGER TRAVEL RESTRICTING SPRING
25 — HOUSING AND MOUNTING BRACKET SCREW
26 — SELF-TAPPING SCREW

RA PD 10796

Figure 78—Fuel Cut-Off Solenoid—Eclipse Type 500-15-A

FUEL CUT-OFF SOLENOID

secure in place with two bolts with safety nuts (two 3/8-in. wrenches). Put solenoid in place on bottom of bracket and secure in place with four bolts with safety nuts (two 3/8-in. wrenches). Screw lock nut onto solenoid rod, screw rod into plunger and tighten lock nut ($\frac{7}{16}$-in. adjustable wrench). Put leather boot on rear-end of solenoid and tie in place with lacing. Screw lock nut and clevis onto rear end of rod. Put lever bracket, with stud pointing upward, on studs on rear of carburetor and fasten with safety nuts ($\frac{7}{16}$-in. wrench). Put lever in place with forked end on shut-off rod and hole in center on stud on bracket. Put spring on stud and hook on right side of bracket and front of lever to turn lever clockwise viewed from top. Fasten lever to stud with plain washer and cotter pin. Adjust clevis on rear-end of rod to hole in right end of lever with right end of lever and rod both in extreme rear positions. Insert clevis pin connecting clevis and lever, secure with cotter pin and tighten lock nut on clevis. Remove locking wire, three screws and plain washers holding cover and check to see if one solenoid terminal post is grounded. If not, remove two nuts (3/8-in. socket wrench), lock washer and insulating sleeve from terminal post. Replace with grounding sleeve, nut, lock washer and lock nut. Connect terminal of blue wire (70-in.) to insulated terminal post. Place knurled conduit nut on insert, screw (screwdriver $\frac{1}{16}$-in. x $\frac{9}{16}$-in.) insert into conduit tee, push free end of blue wire through knurled nut and out through end of tee, and screw knurled nut with tee onto threaded end of terminal box. Push conduit ell over wire and screw nut (7/8-in. wrench) onto end of tee. Slide conduit over wire and screw knurled nut onto end of ell. Push yellow wire (90-in.) through tee, ell and conduit having about 24 inches protruding from right end of tee. Fasten conduit to bottom of engine support with two clips held to support by $\frac{3}{16}$-in. slotted head screws with safety nuts (3/8-in. wrench). Slide conduit over yellow wire protruding from right end of tee and fasten to tee by knurled nut.

Chapter 7

LUBRICATION SYSTEM

Section I

GENERAL DESCRIPTION

154. DESCRIPTION OF THE LUBRICATION SYSTEM.

The main oil pressure pump draws oil from the oil tank and forces it directly into the internal passages of the lubrication system. Part of the scavenged oil which drains to the sump is drawn through internal passages to the scavenge sides of the main oil pump and is forced through the "out" connection to the oil tank. Installed in this line which returns the scavenged oil to the oil tank is a filter and an oil cooler. The remainder of the scavenged oil is drawn from the sump by the front crankcase scavenge pump and is returned to the oil tank through the scavenged oil return line. Across the line from the oil tank to the inlet side of the main oil pump is installed an oil dilution valve which facilitates starting in extremely cold weather. Breathing of the engine is done through a line from the front crankcase section to the exterior of the tank. The oil tank is vented to the rear crankcase section through a line starting at the oil tank and terminating at the rear crankcase section.

Section II

ENGINE OIL TANK AND OIL LINES

155. DESCRIPTION AND CONSTRUCTION OF THE OIL TANK (fig. 79).

The L shaped engine oil tank is bracket-mounted to the floor in the rear of the crew compartment against the bulkhead. The oil tank body, hopper, strainer, outlet elbow, and bayonet gage are the principal parts of the oil tank. The oil tank body is of 18 gage (0.0478 in.) all welded sheet steel. To it are welded a steel flanged outlet elbow, a steel drain plug flange, steel supporting brackets at the bottom, and a steel filler cap flange at the top. A steel ring is welded to the under side of top of the oil tank body and is tapped to receive the 12 hopper retaining screws. The oil tank body serves principally as a reservoir for the fresh oil supply. The oil tank hopper consists of a bronze cover brazed to a cylindrical steel body to which is welded a conical shaped steel bottom. The hopper is held in the oil tank body by the twelve screws securing the hopper cover to the oil tank body top. The hopper bottom is fitted in the flanged outlet elbow and directs the scavenged oil out of the oil tank. The scavenged oil enters the oil tank through the inlet elbow attached to the hopper cover. The oil is prevented from splashing excessively by being directed against the side of the hopper body. Additional fresh oil necessary for lubrication is drawn from the oil tank body and through a special passage in the flanged outlet elbow to the outlet line. The brass screen oil strainer filters the fresh oil entering the oil tank. The filler cap is fitted with a brass bayonet gage which indicates the oil level in the oil tank body.

156. INSPECTION OF OIL TANK ON VEHICLE.

Remove the oil tank from the vehicle when:

a. There are traces of sludge or other foreign material in the tank, evidenced by dirty oil at the outlet of the tank.

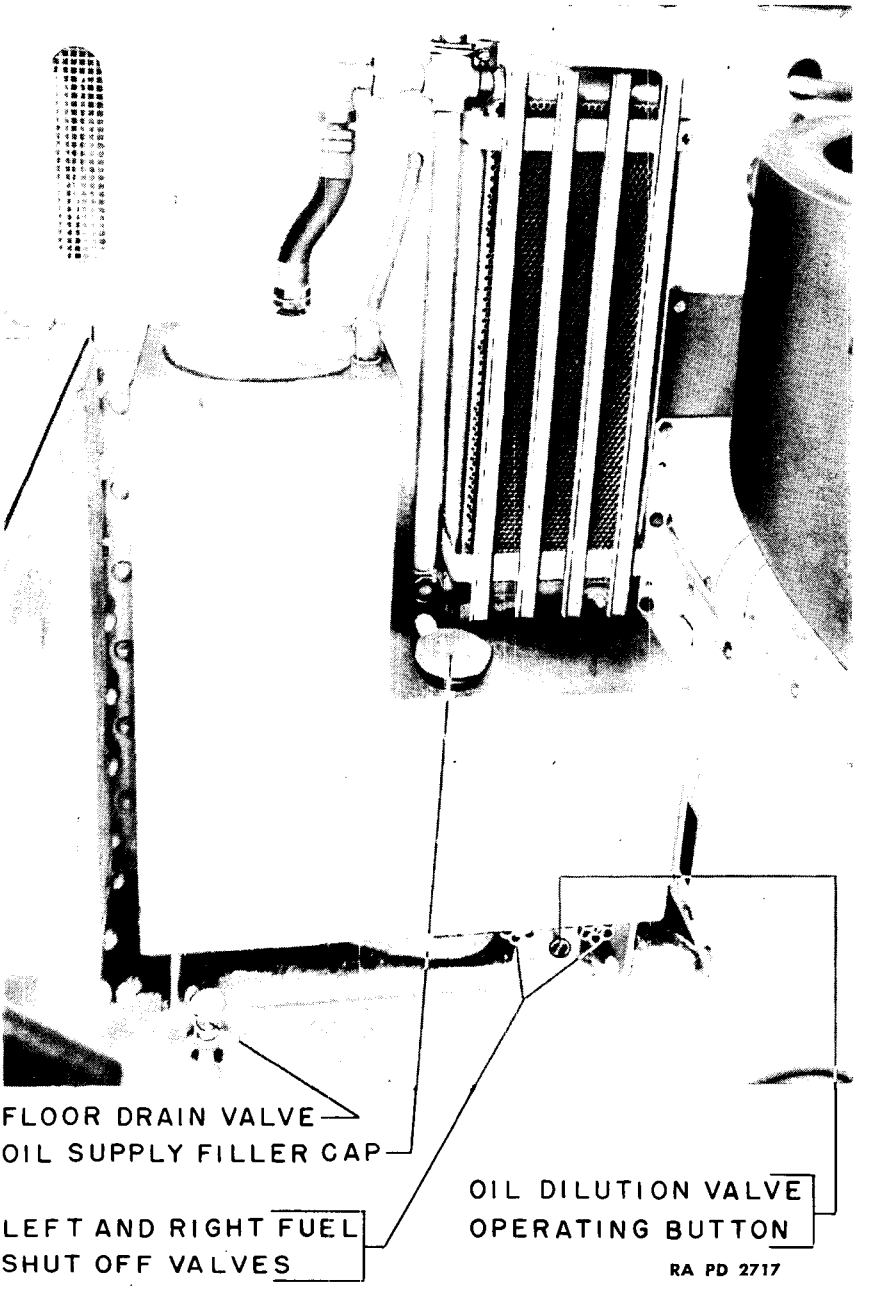


Figure 79—Engine Oil Tank and Cooler

b. A leak is evident at any of the welded seams or joints.

c. There are signs of corrosion on any portion of the tank.

157. REMOVAL OF THE OIL TANK.

a. Equipment.

Block, wooden
Link, drag
Wrench, Allen, $\frac{9}{16}$-in.
Wrench, open-end, 1-in.
Wrench, open-end, 1 $\frac{1}{8}$-in.
Wrench, open-end, 1 $\frac{1}{4}$-in.
Wrench, socket, with ratchet, $\frac{3}{4}$-in.

b. Procedure.

(1) REMOVE ENGINE INSPECTION PLATE.
Wrench, socket, with ratchet, $\frac{3}{4}$-in.

Remove twenty cap screws with lock washers from engine compartment inspection plate and remove plate.

(2) DRAIN OIL FROM TANK.
Link, drag
Wrench, Allen, $\frac{9}{16}$-in.

Remove four screws from plate attached to compartment floor and lift off plate. Then remove drain plug from oil tank and drain oil.

(3) REMOVE ENGINE OIL COOLER.

Refer to paragraph 173, engine oil cooler removal.

(4) REMOVE OIL INLET HOSE ASSEMBLY.
Wrench, open-end, 1 $\frac{1}{4}$-in.

Disconnect oil inlet hose nut from inlet fitting at top of oil tank.

(5) REMOVE OIL TANK BREATHER TUBE.
Wrench, open-end, 1 $\frac{1}{8}$-in.

Disconnect breather tube nut from elbow fitting at top of oil tank.

(6) REMOVE OIL TANK MOUNTING BRACKET BOLTS.
Link, drag
Wrench, open-end, $\frac{9}{16}$-in.
Wrench, socket, with ratchet, $\frac{9}{16}$-in.

Remove four matching oval head bolts and safety nuts from brackets that attach oil tank to compartment floor using a drag link on the bolt heads from beneath the tank.

(7) REMOVE OIL TANK.
Block, wooden
Wrench, open-end, 1-in.

Block up oil tank enough to get a wrench on the oil line outlet, fitting nut at bottom, back of oil tank in tank compartment. Then disconnect oil line nut from fitting and remove tank.

ORDNANCE MAINTENANCE—ACCESSORIES FOR WRIGHT R975-EC2 ENGINES FOR MEDIUM TANKS M3 AND M4

158. DISASSEMBLY, INSPECTION, AND CLEANING OF THE OIL TANK (fig. 80).

a. Disassembly. To disassemble the oil tanks proceed as follows:

(1) Unscrew the twelve screws securing the hopper cover to the top of the oil tank. Remove the lock washers, hopper and the gasket.

(2) Unscrew the filler cap and remove the cap and gage and the oil strainer.

b. Inspection. While the oil tank is disassembled, the following inspections noted will be made:

(1) With a three foot rod, inspect the inside and the bottom of the oil tank body for weak or corroded areas.

(2) Inspect the strainer for cleanliness, dents and wear.

(3) Inspect the oil level gage blade for clear and legible markings. Check the blade for a secure braze to the filler cap.

(4) Check the condition of the braze attaching the hopper cover to the hopper body.

(5) Examine the hopper bottom for corrosion.

(6) Inspect the condition of all threads on connectors, coupling nuts, and flanges.

(7) When testing tank for leaks, proceed as follows: All openings are closed except the one through which the air is introduced and with the tank under 2½ pounds air pressure, test seam rivets and fittings with soapy water. Bubbles indicate leaks.

c. Cleaning of the Oil Tank. Flush the tank for 15 minutes with boiling water admitted at the bottom of the tank, and allow the water to overflow at the top. Steam the tank for one hour, admitting live steam at the top of the tank and allowing it to escape at the bottom outlets. If live steam is not available, flush with boiling water continuously for at least three or four hours. Dry the tank thoroughly with compressed air.

159. REPAIR AND ASSEMBLY OF THE OIL TANK.

a. Repair.

(1) Perform oil tank repair only if the general condition of the tank is good. There may be times when the deterioration of the tank is great enough to warrant the replacement of the oil tank body. This is left to the discretion of ordnance maintenance personnel.

ENGINE OIL TANK AND OIL LINES

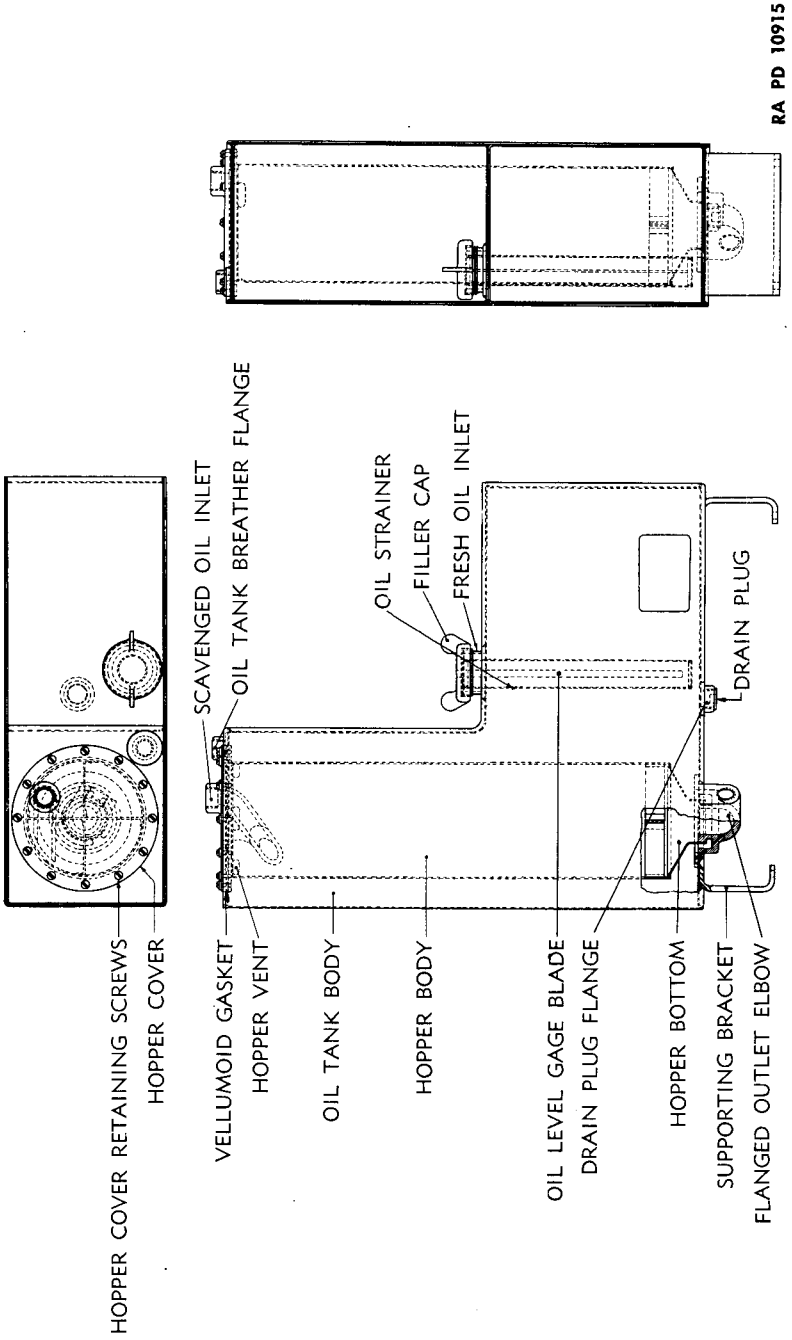


Figure 80—Engine Oil Tank

(2) Weld leaks in the seams, and those in joints between the flanges and their respective oil tank sections.

(3) Repair holes in the oil tank by welding a section of an 18 gage steel sheet over the hole.

(4) When necessary, braze the bronze hopper cover to the hopper body.

(5) Strengthen a poor joint between the oil level gage blade and filler cap by brazing.

b. Assembly. Follow reverse order of procedure set forth in paragraph 158, noting the following precautions:

(1) Use new gaskets and lock washers.

(2) Make sure the sides of the hopper bottom rest against the three fingers of the flanged outlet below.

160. INSTALLATION OF THE TANK.

a. Equipment.

Block, wooden
Link, drag
Wrench, Allen, $\frac{9}{16}$-in.
Wrench, open-end, 1-in.
Wrench, open-end, $1\frac{1}{8}$-in.
Wrench, open-end, $1\frac{1}{4}$-in.
Wrench, socket, with ratchet, $\frac{3}{4}$-in.

b. Procedure.

(1) REPLACE OIL TANK.

Block, wooden
Wrench, open-end, 1-in.

Place oil tank in position against compartment bulkhead and block up tank enough to connect and tighten the outlet oil line nut to the tank outlet fitting. Then replace four oval head bolts and nuts that attach tank brackets to compartment floor plate, holding bolt heads from beneath the tank.

(2) INSTALL OIL TANK BREATHER TUBE.

Wrench, open-end, $1\frac{1}{8}$-in.

Connect breather tube nut to elbow fitting at top of oil tank.

(3) INSTALL OIL INLET HOSE ASSEMBLY.

Wrench, open-end, $1\frac{1}{4}$-in.

Connect inlet hose to inlet fitting at top of oil tank.

(4) INSTALL OIL TANK DRAIN PLUG COVER PLATE. DRAG LINK.

If oil tank drain plug has been removed, replace. Place cover plate in position over drain hole and replace four attaching screws.

(5) INSTALL OIL COOLER.

Refer to paragraph 175.

(6) INSTALL ENGINE INSPECTION PLATE.

Position inspection plate on under side of engine compartment floor plate and secure with twenty cap screws and lock washers.

161. DESCRIPTION OF THE ENGINE OIL LINES (fig. 81).

Oil is supplied to the inlet side of the main oil pressure pump from the flanged outlet elbow at the bottom of the oil tank through a fire resistant hose and steel alloy tube. Across this line is connected the "in" and "out" lines of the oil dilution valve. Discharge from the scavenge side of the main oil pump passes through a fire resistant hose to a Y fitting of which the main branch connects through a steel alloy tube to the oil filter. The third branch of the Y fitting connects to the front crankcase scavenge pump. Scavenged oil passes through the old filter to the oil cooler, through a steel alloy tube and a section of fire resistant hose connected to the oil cooler inlet. From the oil cooler the oil flows through a fire resistant hose to the top of the oil tank. A vent from the top of the oil tank to the rear crankcase section is provided through a steel alloy tube. The front crankcase section is vented to the atmosphere through a steel alloy tube and a fire resistant hose clamped to the tube.

162. REMOVAL OF OIL LINES.

a. Equipment.

Wrench, open-end, $\frac{11}{16}$-in.
Wrench, open-end, $1\frac{3}{8}$-in.
Wrench, open-end, $1\frac{1}{4}$-in.

b. Procedure.

(1) REMOVE OIL LINE ASSEMBLY OIL TANK TO DILUTION VALVE.

Wrench, open-end, $\frac{11}{16}$-in.
Wrench, open-end, $1\frac{3}{8}$-in.
Wrench, open-end, $1\frac{1}{4}$-in.

Disconnect oil line nut from fitting at oil tank inlet elbow and at dilution valve and remove tube assembly.

(2) REMOVE OIL LINE TUBE ASSEMBLY DILUTION VALVE TO ENGINE.

Wrench, open-end, $1\frac{1}{4}$-in.
Wrench, open-end, $1\frac{3}{8}$-in.

Disconnect oil line fitting nut at engine hose connection and at dilution valve inlet fitting and remove tube assembly.

(3) REMOVE OIL LINE TUBE ASSEMBLY, Y FITTING TO OIL FILTER.

Wrench, open-end, $1\frac{1}{4}$-in.
Wrench, open-end, $1\frac{3}{8}$-in.

Disconnect oil line fitting nut at Y fitting and at oil filter inlet fitting and remove tube assembly.

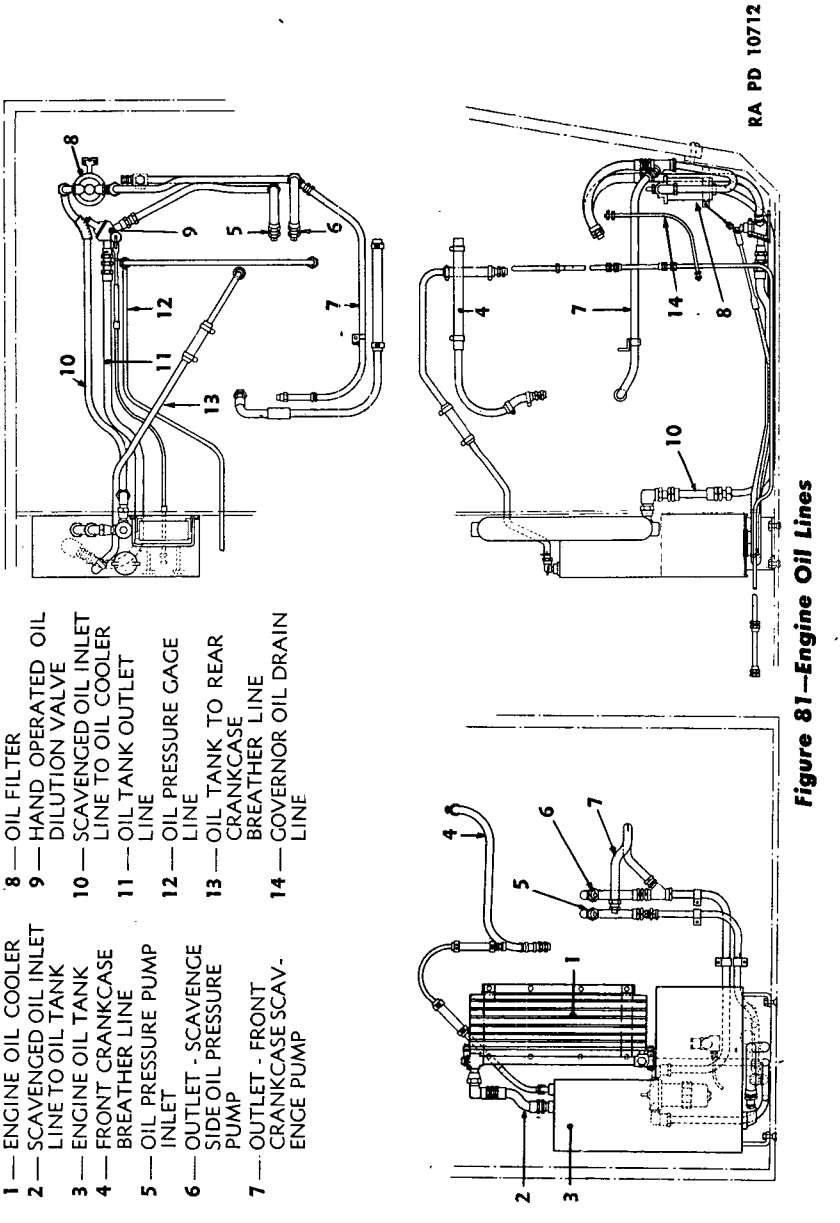


Figure 81—Engine Oil Lines

(4) REMOVE OIL LINE TUBE ASSEMBLY, FILTER TO OIL COOLER.
Wrench, open-end, 1¼-in.

Disconnect oil line fitting nut at oil filter outlet fitting and at oil cooler inlet fitting and remove tube assembly.

(5) REMOVE OIL GAGE LINE.
Wrench, open-end, $\frac{11}{16}$-in.

Disconnect oil gage line nut at engine connector and at oil gage and remove tube assembly.

163. INSPECTION AND REPAIR OF THE ENGINE OIL LINES.

Replace the oil lines when they are dented, punctured or damaged so that the free flow of oil is unimpaired. To replace an oil line, remove the old one and disassemble the connectors from it. From a roll of tubing or hose (whichever type of line is being replaced) cut a length equal to or slightly greater than the one just removed. For steel alloy tubing use a suitable bending tool to shape the new tube the same as the old one. If the connectors just removed are serviceable, assemble them to the new line and install it in the vehicle.

164. INSTALLATION OF ENGINE OIL LINES.

a. Equipment.

Wrench, open-end, $\frac{11}{16}$-in.
Wrench, open-end, 1¼-in.
Wrench, open-end, 1⅜-in.

b. Procedure.

(1) INSTALL OIL GAGE LINE TUBE ASSEMBLY.
Wrench, open-end, $\frac{11}{16}$-in.

Connect oil line tube fitting nuts to fitting at engine and at oil gage.

(2) INSTALL OIL LINE TUBE ASSEMBLY, FILTER TO OIL COOLER.
Wrench, open-end, 1¼-in.

Connect oil line tube fitting nuts to fitting at oil cooler and at oil filter.

(3) INSTALL OIL TUBE ASSEMBLY, Y FITTING TO OIL FILTER.
Wrench, open-end, 1¼-in.
Wrench, open-end, 1⅜-in.

Connect oil line tube fitting nut to fittings at oil filter and Y fitting.

(4) INSTALL OIL LINE, TUBE ASSEMBLY DILUTION VALVE TO ENGINE.
Wrench, open-end, 1¼-in.
Wrench, open-end, 1⅜-in.

Connect oil line fitting nut to fitting at engine hose and dilution valve.

(5) INSTALL OIL LINE TUBE ASSEMBLY OIL TANK TO DILUTION VALVE.
Wrench, open-end, $\frac{11}{16}$-in.
Wrench, open-end, 1¼-in.
Wrench, open-end, 1⅜-in.

Connect oil line tube nut to fitting at oil tank inlet elbow and dilution valve.

ORDNANCE MAINTENANCE—ACCESSORIES FOR WRIGHT R975-EC2 ENGINES FOR MEDIUM TANKS M3 AND M4

Section III

OIL FILTER

165. DESCRIPTION AND OPERATION.

a. Description. The type G Cuno oil filter is bracket-mounted to the right and level with the bottom sill of the engine compartment door. It is installed in the line from the scavenge side of the main oil pressure pump to the engine oil cooler and filters the scavenged oil. The filter is composed of three principal parts: the sump assembly, the filter head, and the cartridge or cleaning element. The sump assembly consists of a steel shell with a drain bushing brazed in the bottom and a shell reinforcing ring containing ten punched holes which is spot welded to the under side of the shell flange. The aluminum alloy filter head contains the inlet and outlet passages, the spring loaded relief valve, and ten tapped holes in its flange to attach it to the sump assembly by ten bolts. The cartridge or cleaning element is composed of thin steel filtering disks and spacers mounted on a spindle which can be rotated. The cleaning blades which fit between the filtering disks are mounted on a stationary cleaner rod.

b. Operation (figs. 82 and 83). Figure 82 shows the path of fluid flow through the filter. Effective filtration is obtainable by passing a fluid containing solids to be removed between strips of metal, separated by spacer pieces of predetermined thickness, placed edgewise to the flow. Solids larger than the space between strips cannot pass. In the Cuno filter the strips take the form of wheel shaped parts called disks (fig. 83), separated from each other by suitable spacer pieces. The fluid to be filtered enters the filter from the right in figure 82, fills the outer casing or sump, and passes through the space between disks to the open passages between the spokes. All solids too large to pass the space between disks are retained on the outer edges of these disks. The central space within the stack of disks is connected to the filter outlet, and provides a means of exit for the filtered fluid. By turning the handle of the filter, the solids which have accumulated on the cartridge are removed as they reach the cleaner blades. Because of the shape and location of these blades all

solids stopped by the filter disks are removed, regardless of whether they merely adhere to the edge of the disks or are actually lodged between them. Figure 86 shows the essential parts of a Cuno filter cartridge. Vertical dimensions have been exaggerated for greater clarity. The stack of disks and spacers, assembled as illustrated, is closed at one end, the opposite end being connected to the filter discharge. Thus, in order to pass the filter, all fluid must go through the slot between disks. When the assembly of disks and spacers is turned by means of the rotatable spindle, solids that have lodged against the disks or between them are carried around until they meet the cleaner blades, which are held in position by the fixed cleaner blade rod, and are positively combed clear of the filter surface. The shape of the cleaner blades is such that solids lodged between disks are combed outward rather than pushed through. These solids are compacted by the action of the cleaner blades, and soon fall to the sump below, out of the stream of incoming fluid.

166. MAINTENANCE ON THE VEHICLE.

Rotate the filter handle at least one full turn daily and drain the filter sump often enough to keep water and sediment out. If a leak occurs around the packing gland of the spindle, that cannot be stopped by the tightening of the packing gland nut, replace the packing as follows: Remove the locking wire (pliers) from the packing gland nut, unscrew ($\frac{13}{16}$-in. wrench) the packing gland nut and slide it up on the spindle. With a pointed instrument, pick out all of the old packing. Insert the new packing and tighten the packing gland nut. Start the engine and if the leak still exists, tighten the nut further. Secure with a new locking wire.

167. REMOVAL.

Disconnect the oil lines ($1\frac{5}{16}$-in. wrench) from the filter. With a screwdriver, loosen the screw in the bracket supporting the oil filter, and lift out the filter. On installations where the solenoid operated oil dilution valve is used, this bracket supports both the oil filter and the solenoid operated oil dilution valve. On installations where the hand operated oil dilution valve is used, the bracket supports only the oil filter.

168. DISASSEMBLY AND CLEANING.

a. Disassembly (fig. 84).

(1) Clamp a block $3\frac{7}{2}$-inch thick in a vise in such a manner that about 1 inch of the jaw length of the vise has a $3\frac{7}{2}$-inch opening. Hold the filter so that the spindle of the cartridge assembly is horizontal and the handle is vertical, then place the handle between the jaws of the

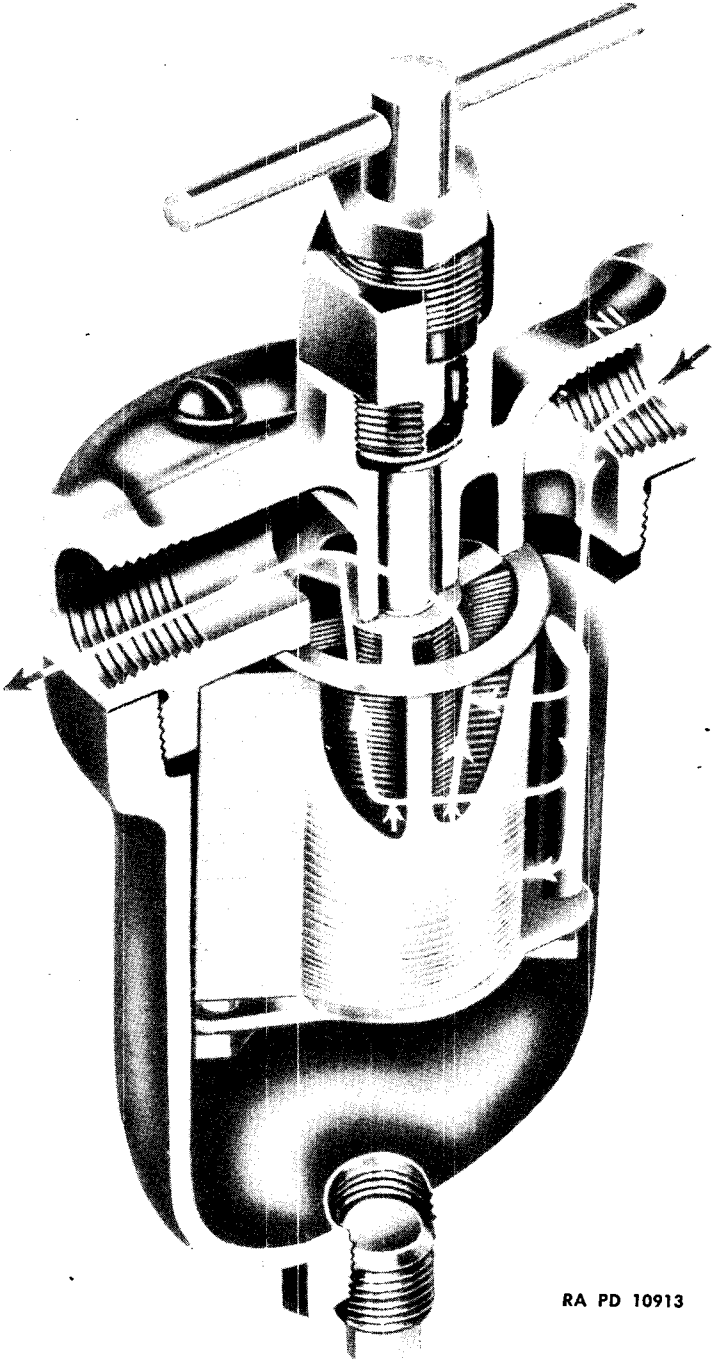
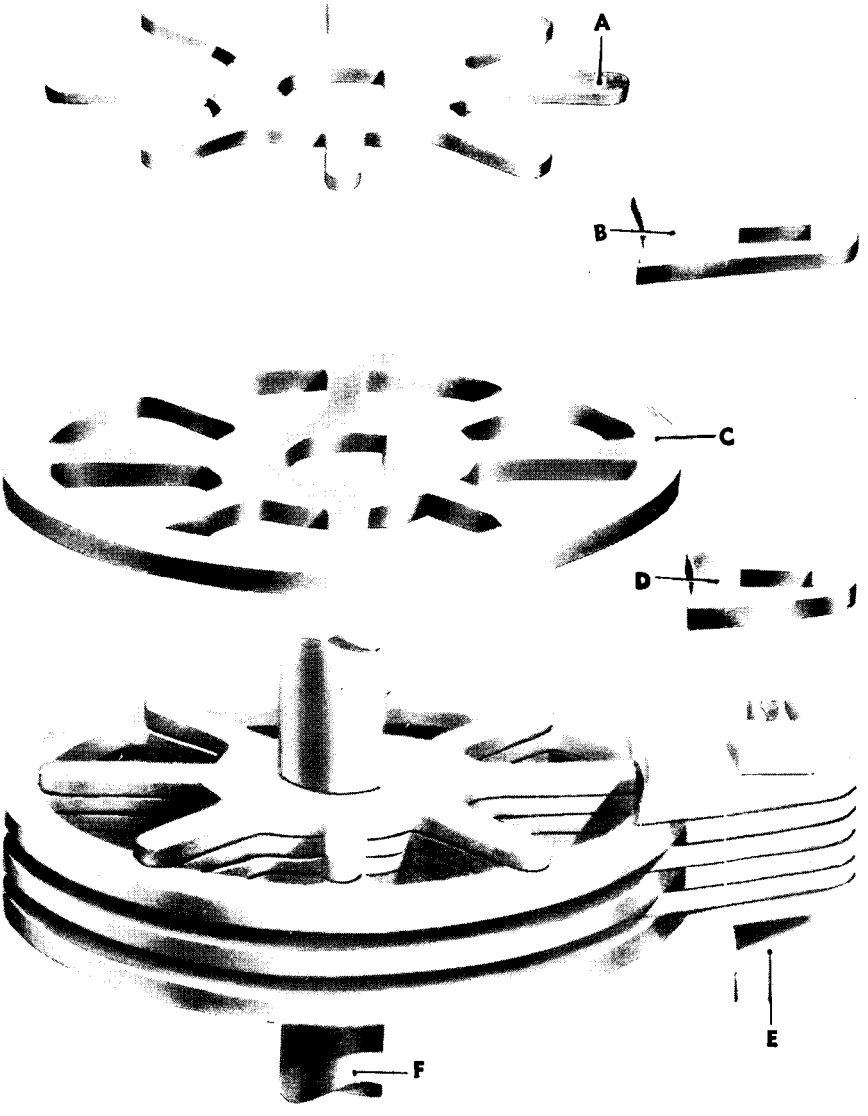


Figure 82—Path of Fluid Through a Cuno Filter

OIL FILTER



A — SPACER
B — CLEANER BLADE
C — DISK
D — CLEANER BLADE SPACER
E — CLEANER BLADE ROD - FIXED
F — SPINDLE - ROTATING

RA PD 10914

Figure 83—Cuno Cartridge Construction

vise so that the spindle is supported on both sides of the handle. With a hammer, drive the handle out of the spindle.

(2) With a pair of pliers remove the locking wire from the ten filter head retaining bolts and unscrew the bolts with a $\frac{7}{16}$-inch wrench. Remove the nuts and lock washers and lift off the filter head and gasket.

(3) Remove the locking wire (pliers) from the packing gland nut and unscrew the nut with a $\frac{3}{16}$-inch wrench. Slide the nut and follower gland off the spindle.

(4) Remove the two cartridge mounting screws attaching the cartridge assembly to the filter head, and slide the filter head off the spindle of the cartridge assembly.

(5) With a pointed instrument pick out the packing from the recess of the filter head.

b. Cleaning. Soak the cartridge assembly in SOLVENT, dry cleaning, from three to five hours to remove oil, grease, dirt and carbon from the disks. With SOLVENT, dry cleaning, and a bristle brush, clean the head and the sump assembly.

169. INSPECTION, REPAIR, AND ASSEMBLY.

a. Inspection.

(1) CARTRIDGE ASSEMBLY. Replace the cartridge assembly if it does not pass the following tests:

(*a*) The spindle and disks must rotate freely.

(*b*) The spindle must be straight, with no score marks caused by the packing.

(2) FILTER HEAD. Examine the aluminum alloy head for thread imperfections, and check the flange face for flatness. Replace the head if any of the threads are defective or the flange has warped more than $\frac{1}{32}$ inch.

(3) SUMP ASSEMBLY. Examine the threads of the sump assembly for imperfections; the flange face for flatness; and the flange reinforcing ring and drain plug bushing for cohesion to the steel shell. If the sump assembly can be easily repaired by welding, do it, otherwise, replace the damaged part with a new one.

b. Repair.

(1) Due to the construction of the cartridge assembly repairs are not economical.

(2) Damaged threads on the aluminum alloy filter head cannot profitably be repaired. A warped flange face may be made flat on a

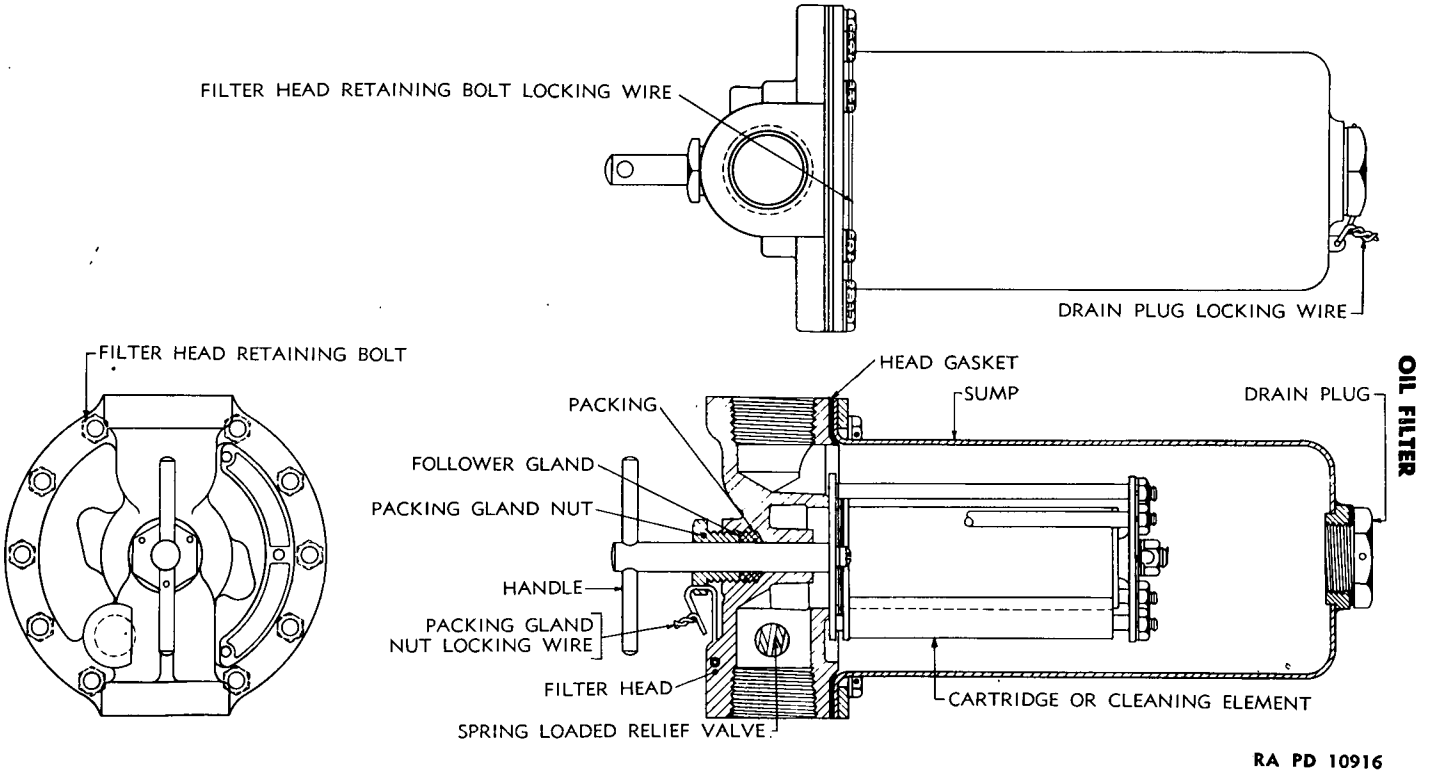


Figure 84—Cross Section of Cuno Oil Filter

sanding machine, or by laying a piece of emery cloth flat on a surface plate, cutting side up, and rubbing the flange face in a circular motion over the emery cloth.

(3) The shell of the sump assembly being made of steel, it is easily welded and straightened. Perform the necessary operations to make this assembly serviceable if it is economically profitable.

c. Assembly.

(1) Slide the filter head over the spindle of the cartridge assembly, flange face toward the cartridge, and replace the two screws to attach the cartridge assembly to the filter head.

(2) Into the recess of the filter head, replace, in the order given, a new packing, the follower gland and the packing gland nut ($1\frac{3}{16}$-in. wrench).

(3) Replace the lock washers and ten bolts ($\frac{7}{16}$-in. wrench) to attach the filter head to the sump assembly. Secure the bolts with a locking wire. NOTE: Use a new gasket between the parts.

(4) Clamp a block $\frac{7}{32}$-inch thick in a vise so that about one inch of the jaw length of the vise has a $\frac{7}{32}$-inch opening. Insert the handle into the hole in the spindle. Hold the filter so that the spindle is horizontal and the handle is vertical, serrated part up, then place the lower part of the handle between the jaws of the vise, resting the spindle on the top of the jaws. With a hammer, tap the handle so that the serrated part of the handle enters the spindle hole about $\frac{1}{4}$ inch.

170. INSTALLATION.

To install the oil filter, follow the reverse order of procedure outlined in paragraph 167.

OIL COOLER

171. DESCRIPTION (fig. 79).

The radiator type oil cooler is located and attached to the bulkhead at the rear of the fighting compartment. Return oil from the engine enters at the bottom of the cooler and flows up and out through the top outlet header into the oil tank. A pressure relief valve, located in the bypass pipe outlet tee, is used to bypass oil in event of excess pressure which might damage the cooler. Two types of oil coolers are used: Harrison Radiator Co. Model AV-32 is a unit made up of a number of individually brazed plates brazed together with crimped center stock soldered to the plates, forming radiating fins and air passages; Young Radiator Co. No. YR 32435-2 is a unit made up for a number of extruded tubes soldered together in two side channels and end tanks. In both types the fittings and the bypass assembly are all silver soldered. The oil cooler inlet is always at the bottom inlet fitting and the outlet is at the pressure relief valve end.

172. TROUBLE SHOOTING.

Symptoms and probable cause	Probable remedy
a. Oil Leaks.	
Defective or loose connections.	Tighten or replace fittings.
Defective oil lines to cooler.	Replace with new lines and fittings.
Defective oil cooler.	Repair or replace.
b. Excessive High Oil Temperature.	
Lack of oil.	Check oil tank and fill to proper level.
Incorrect grade of oil.	Drain and refill with proper oil. Refer to Engine Lubrication Section, Chapter 7.
Pressure relief valve not closing.	Repair or replace.
Clogged oil cooler passages.	Clean and flush with proper solution.
Clogged oil cooler air passages.	Clean and blow out with compressed air.
Obstruction over cooler radiator core.	Remove obstruction.

ORDNANCE MAINTENANCE—ACCESSORIES FOR WRIGHT R975-EC2 ENGINES FOR MEDIUM TANKS M3 AND M4

173. REMOVAL OF OIL COOLER.

a. Equipment.

Wrench, open-end, $\frac{7}{16}$-in.
Wrench, open-end, ½-in.
Wrench, open-end, 1¼-in.
Wrench, open-end, 1⅜-in.
Wrench, socket, with ratchet, ¾-in.

b. Procedure.

(1) REMOVE ENGINE INSPECTION PLATE.

Wrench, socket, with ratchet, ¾-in.

Remove twenty cap screws with lock washers from engine compartment inspection floor plate and remove plate.

(2) REMOVE INLET OIL LINE TUBE ASSEMBLY.

Wrench, open-end, 1¼-in.

Disconnect inlet oil line nut at oil cooler inlet elbow located at the bulkhead in the engine compartment. Then remove inlet elbow.

(3) REMOVE COOLER OUTLET OIL LINE HOSE ASSEMBLY.

Wrench, open-end, 1⅜-in.

Disconnect oil outlet line elbow union nut at top of cooler, holding elbow from turning with wrench.

(4) REMOVE OIL COOLER GUARD.

Wrench, open-end, $\frac{7}{16}$-in.

Remove four cap screws and lift off guard.

(5) REMOVE OIL COOLER.

Wrench, open-end, ½-in.

Remove four cap screws from top and bottom brackets that attach cooler to bulkhead and lift cooler from bulkhead.

174. MAINTENANCE (fig. 85).

a. Cleaning. Make sure that the oil cooler is free from foreign substance both on the inside oil passage and outside air passages. Remove dust, dirt, etc., from the outside surfaces by means of high pressure air. If the oil cooler is too heavily coated, soak it in carbon tetrachloride, trichlorethylene, or any other solvent suitable for removal of foreign substance. To clean the inside oil passages clogged with carbon and sludge, pump the solution through the unit in reverse flow to that of normal operation. If an alkaline solution such as Oakite is used, be sure to wash out the cooler thoroughly after the cleaning operation is completed. Flush with clean

fresh oil. Another good cleaner is a solution made of one pound of SODA, caustic (lye) dissolved in seven gallons of water. When applying this solution, immerse the cooler completely. Use a suitable heating unit to heat the solution in the tank, and allow the cooler to boil until clean. If SODA, caustic, is not available, a solution can be made by mixing one pound of lye in five gallons of water. Use the same method of application with the lye as with the SODA, caustic, solution. Regardless of the cleaner employed, always rinse the cooler thoroughly.

b. Testing. In testing the oil cooler under air pressure, close one end with a ¾-inch pipe plug, fit the other end with a ¾-inch pipe plug or cap having a short tube soldered to it to fit the air hose, and use 75 pounds pressure on the test. Place the cooler in a tank of water and the air escaping through the leak indicates its exact location and nature. Use no more than 75 pounds pressure for testing and determine the exact location of every leak. In emergencies, the cooler may be tested by filling it with water and observing the location of water leaks. Do not use this method where air is available, and confine it to field repairs only.

c. Repairs of Harrison Radiator Co. Model AV-32. Although the plate seams of this type cooler are brazed, it is practical to repair leaks that may develop along the brazed sections with an ordinary soldering operation. Take care to remove all traces of oil, otherwise, soldering becomes very difficult. As this unit is brazed and silver soldered with exception of the crimped cooling fins, it is impractical to repair a unit of this type that has been seriously damaged; in such cases, replace the cooler. Temporary repairs can be made on the Young Radiator Co. AV-11 Cooler Core tubes, since each passage is individual; this emergency repair can be made by solder filling both ends of a damaged tube without affecting the efficiency of the cooler to any extent. Replace badly damaged cores. Repair small air leaks in the cooler tanks by following standard radiator repair practice. When replacing a core on this cooler, unsolder and remove first, the lower-inlet tank and the relief valve pipe (at the inlet tee) as the relief valve pipe is silver soldered at the valve filling. The cooler pressure relief valve is set to open at 50 pounds pressure. Field Service should remove valve assembly, inspect and clean every 100 hours.

175. INSTALLATION OF OIL COOLER.

a. Equipment.

Wrench, open-end, $\frac{7}{16}$-in.
Wrench, open-end, ½-in.
Wrench, open-end, 1¼-in.
Wrench, open-end, 1⅜-in.
Wrench, socket, with ratchet, ¾-in.

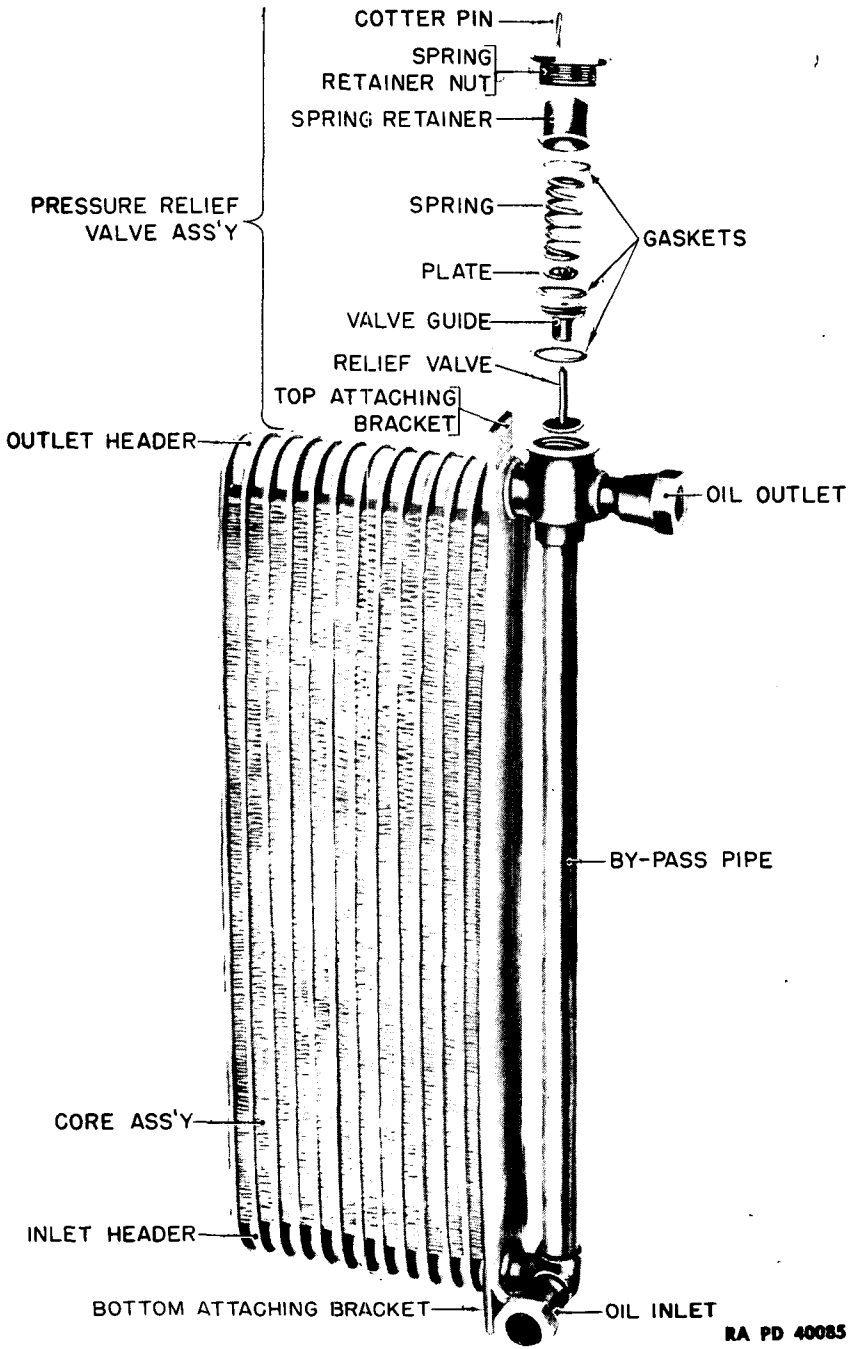


Figure 85—Engine Oil Cooler

OIL COOLER

b. Procedure.

(1) REPLACE OIL COOLER.

Wrench, open-end, ½-in.

Position oil cooler on bulkhead and replace four cap screws that attach oil cooler brackets to bulkhead.

(2) REPLACE OIL COOLER GUARD.

Wrench, open-end, $\frac{7}{16}$-in.

Place guard in position over oil cooler and secure to bulkhead with four cap screws.

(3) INSTALL COOLER OUTLET HOSE ASSEMBLY.

Wrench, open-end, 1⅜-in.

Connect outlet line nut to elbow fitting at top of cooler.

(4) REPLACE COOLER ELBOW AND OIL INLET TUBE ASSEMBLY.

Wrench, open-end, 1¼-in.

Connect elbow to cooler inlet pipe at bulkhead in engine compartment. Then connect oil line nut to elbow fitting.

Section V

OIL DILUTION VALVE

176. OIL DILUTION SOLENOID VALVE.

a. Description. The solenoid operated oil dilution valve is bracket mounted to the right of the engine compartment door in front of the oil filter. Its function is to facilitate starting in extremely cold weather by allowing the oil in the engine crankcase to be diluted with gasoline. When the toggle switch on the instrument panel is operated, the solenoid opens the valve, allowing fuel to flow into the oil line between the tank and inlet side of the pump. This valve is spring loaded and remains closed at all times except while the toggle switch is held closed.

b. Trouble Shooting.

Trouble	Probable cause	Remedy
(1) Leaking valve.	*(a)* Dirt or chips under valve stem or jamming plunger assembly.	Remove valve body, inspect and clean body, valve, plunger assembly and sealing cup.
	(b) Worn valve seat.	Remove valve body and inspect condition of seat, replace if worn excessively.
	(c) Valve held open by coil.	Check electrical connection for short circuit.
(2) Failure of valve to open.	*(a)* Loose connection or broken wire.	Check for connections and broken wires. Replace defective part.
	(b) Plunger assembly jammed.	Check for dirt or chips as above.
(3) Overheating coil.	*(a)* Short circuit in coil connections.	Check insulations and connections. Replace defective parts.
	(b) Broken or defective insulation.	Same as above.

OIL DILUTION VALVE

Trouble	Probable cause	Remedy
	(c) Short circuit in coil winding.	Check coil for current drain, par. e (4). Voltage and coil temperature must be accurately held. Replace if defective.
(4) Leaking of fuel.	(a) Loosened hold-down screws.	Tighten screws.
	(b) Defective gasket.	Replace gasket.
	(c) Leaking couplings.	Tighten or replace.

c. Removal. To remove, proceed as follows:

(1) Open the battery switch.

(2) Close the gasoline shut-off valves.

(3) Drain the oil supply tank. (Drain plug is reached by removing plate beneath floor.)

(4) Disconnect the two fuel lines by unscrewing coupling nuts (½-in. wrench).

(5) Disconnect the conduit from the cover by unscrewing the coupling nut ($\frac{15}{16}$-in. wrench), unscrew the safety nut (⅜-in. wrench) from the top of the cover, lift off the cover, remove the terminal nut ($\frac{11}{32}$-in. wrench) and washer and lift terminal off the terminal post.

(6) Remove the bolt (screwdriver and $\frac{7}{16}$-in. wrench) from the end of the bracket holding the valve to the oil filter and lower the valve out of the bracket.

d. Overhaul.

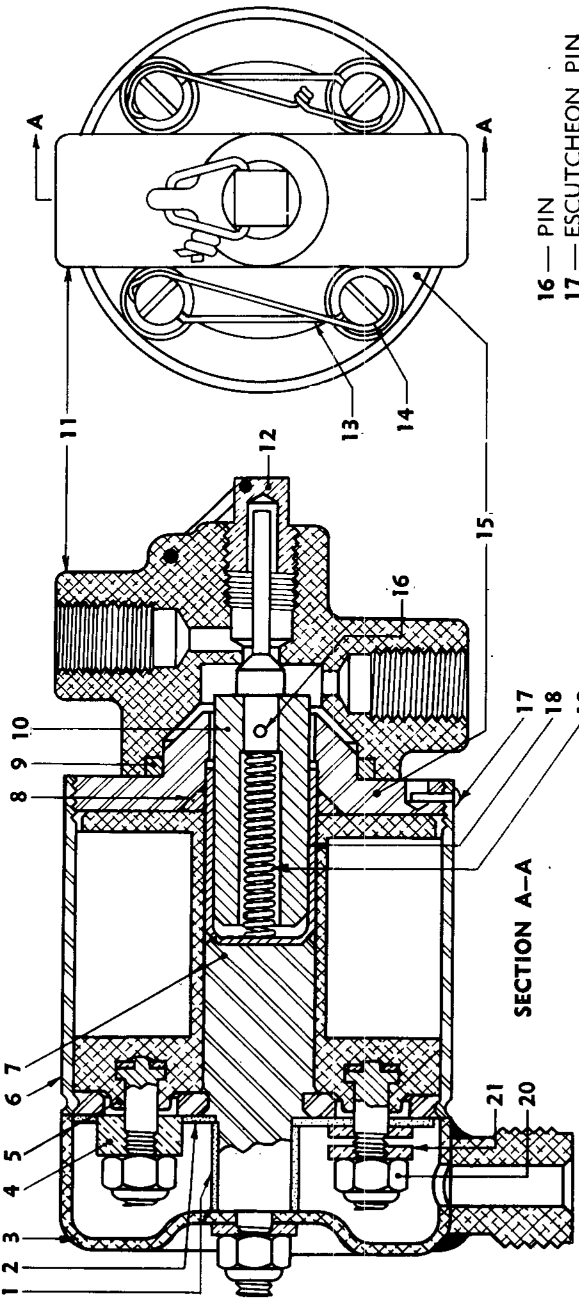
(1) DISASSEMBLY (fig. 86). The following tools needed for the complete disassembly of the oil dilution solenoid valve:

Drill, with square end, ⅛-in.	Screwdriver, 6-in.
File	Wrench, $\frac{5}{16}$-in.
Pliers	Wrench, $\frac{7}{16}$-in.

(a) Remove lock nut ($\frac{7}{16}$-in. wrench) and washer holding cover assembly in place and remove cover assembly. NOTE: This operation has been performed in removing unit from tank.

(b) Remove nut ($\frac{7}{16}$-in. wrench) and collar from grounded terminal.

(c) Remove nut ($\frac{7}{16}$-in. wrench) and washers from insulated terminal.



1 — INSULATING TUBE
2 — INSULATING PLATE
3 — TERMINAL COVER ASSEMBLY
4 — COIL GROUNDING COLLAR
5 — COIL ASSEMBLY
6 — HOUSING
7 — CORE
8 — PACKING RING
9 — GASKET
10 — PLUNGER ASSEMBLY
11 — VALVE BODY
12 — PLUG
13 — LOCKING WIRE
14 — FILLISTER HEAD SCREWS
15 — REMOVABLE END
16 — PIN
17 — ESCUTCHEON PIN
18 — SEALING CUP
19 — SPRING
20 — SAFETY NUT
21 — PLAIN WASHER

RA PD 9849

Figure 86—Cross Section of Solenoid Operated Oil Dilution Valve

OIL DILUTION VALVE

(d) Lift off insulating tube and insulating plate.

(e) Remove locking wire from plug ($\frac{5}{16}$-in. wrench) in bottom of body and remove plug.

(f) Remove the locking wire from each pair of fillister head screws, and holding valve body securely against the pressure of the spring, remove four screws (pliers and screwdriver), and lift off the valve body.

(g) Pull the plunger assembly with the spring out of the lower end of the sealing cup, and remove the spring from the plunger. Do not remove the valve from the plunger.

(h) Remove the gasket.

(i) Remove the escutcheon pin connecting the removable end and the housing. This pin is driven through the lower edge of the housing and the edge of the removable end into a ⅛-inch hole drilled in the lower face of the end. To remove the pin, file off the head, drive the pin in as far as possible, drill the end of the pin out of the ⅛-inch hole with a square end drill, and drive the remainder of the pin in through the hole.

(j) There is no way to hold the removable end with a wrench to unscrew it from the housing. Therefore, secure the valve body to the removable end with the four fillister head screws, and unscrew the removable end which now will be attached to the valve body. Remove the four screws and separate the body and the head.

(k) Pry the packing ring off the sealing cup with a screwdriver.

(l) Pull the sealing cup out of the end of the coil assembly. The cup will probably be damaged in removal and a new one will be installed at assembly.

(m) Slide the coil assembly out of the housing.

(2) INSPECTION. Make the following inspections while the valve is disassembled:

(a) Check for broken or defective insulation.

(b) Check the coil for loose connections.

(c) Examine the insulating tube and plate for cracks.

(d) Check the effectiveness of the spring. The load should be between 3½ pounds and 4 pounds when the spring is compressed to $\frac{81}{64}$ inch.

(e) Examine the sealing cup for scores or cracks.

(f) Check for security of the pin holding valve to plunger.

(g) Check the valve seat for excessive wear.

(3) REPAIR. Practically no repair of parts is feasible. Replace all defective parts.

(4) ASSEMBLY. Follow the reverse procedure of c (1) above, and note the following precautions:

(a) Use a new gasket and packing ring.

(b) After the removable end has been screwed into the housing drill a $\frac{3}{64}$-inch hole through the housing and into the $\frac{1}{8}$-inch hole in the removable end. Drive a new escutcheon pin into place and flatten the end inside the $\frac{1}{8}$-inch hole.

e. Test Before Installation. To determine the serviceability of the unit, make the following tests:

(1) The valve lift should be between $\frac{1}{32}$ inch and $\frac{1}{8}$ inch. To determine the travel, remove the plug and, with a depth micrometer, measure the distance the valve pin extends beyond the bottom of the body. Energize the coil (24 v.) and the plunger assembly will move to its open position. Again measure the distance the valve pin extends beyond the bottom of the body and the difference between this measurement and the one taken first should be from $\frac{1}{32}$ inch to $\frac{1}{8}$ inch. If the measurement is greater, a worn valve seat is indicated, in which case a new body is necessary.

(2) OPERATION TEST. The assembled valve must operate with 15 pounds per square inch gasoline pressure applied at the "IN" connection with the "OUT" connection open and with nine volts direct current applied at the terminals.

(3) LEAKAGE TEST:

(a) Valve. With 15 pounds per square inch gasoline pressure applied at the "IN" connection, with the "OUT" connection open, and prior to the installation of the plug, leakage observed through the valve in excess of ten drops per minute warrants replacement of defective parts.

(b) Joint and body. With 25 pounds per square inch gasoline pressure applied at the "IN" connection and all other openings plugged, any leakage observed warrants replacement of defective parts.

(4) The current drain of the coil with the coil temperature at 25 C (77 F) shall be as follows:

Applied voltage	12	9	18	24
Amperage (approx.)	1.08	0.81	1.62	2.16
Resistance ohms	11-12	11-12	11-12	11-12

f. Installation. Follow the reverse procedure of removal, paragraph c above.

OIL DILUTION VALVE

177. HAND OPERATED OIL DILUTION VALVE.

a. Description (fig. 87). The hand operated oil dilution valve is mounted on a plate, close to the floor, just to the right of the engine compartment door. The purpose of the valve is to facilitate starting in extremely cold weather by diluting the engine oil with the engine fuel. When the operating lever is moved forward it forces the spring loaded valve from its seat allowing the engine fuel to mix with the oil. The spring assures a return of the valve to its seat.

b. Removal.

(1) Close the fuel shut-off valves.

(2) Drain the oil supply tank.

(3) Disconnect the yoke from the operating lever by removing the clevis pin.

(4) Unscrew the coupling nut connecting the fuel line to the valve.

(5) Unscrew the two coupling nuts connecting the oil lines to the valve.

(6) Remove the three retaining screws with lock washers and remove the valve.

c. Overhaul.

(1) DISASSEMBLY.

(a) Unscrew the nut (1¼-in. wrench) holding the lever mounting plate, and remove the plate and lever.

(b) Remove the pin holding the lever to the mounting plate and remove the lever.

(c) Unscrew the plug from the bottom of the body, below the fuel valve stem.

(d) Melt the solder locking the valve stem to the valve guide, and unscrew the stem with a screwdriver. The valve guide will be forced out by the spring behind it when the valve stem is unscrewed. Therefore, hold the one hand over the top of the valve stem to catch the valve guide and the spring. Push the valve stem out through the bottom of the body.

(e) Pull the packing gland and packing out through the top of the body.

(f) Do not remove the drain stem from the body unless it leaks, is damaged, or fails to pass the test as described in step d of this paragraph. If removal is necessary, remove the locking wire from the handle, and file off the head of the brass pin securing the handle to the stem. With a pin punch ($\frac{3}{64}$-in), drive the pin out and lift off the handle, washer,

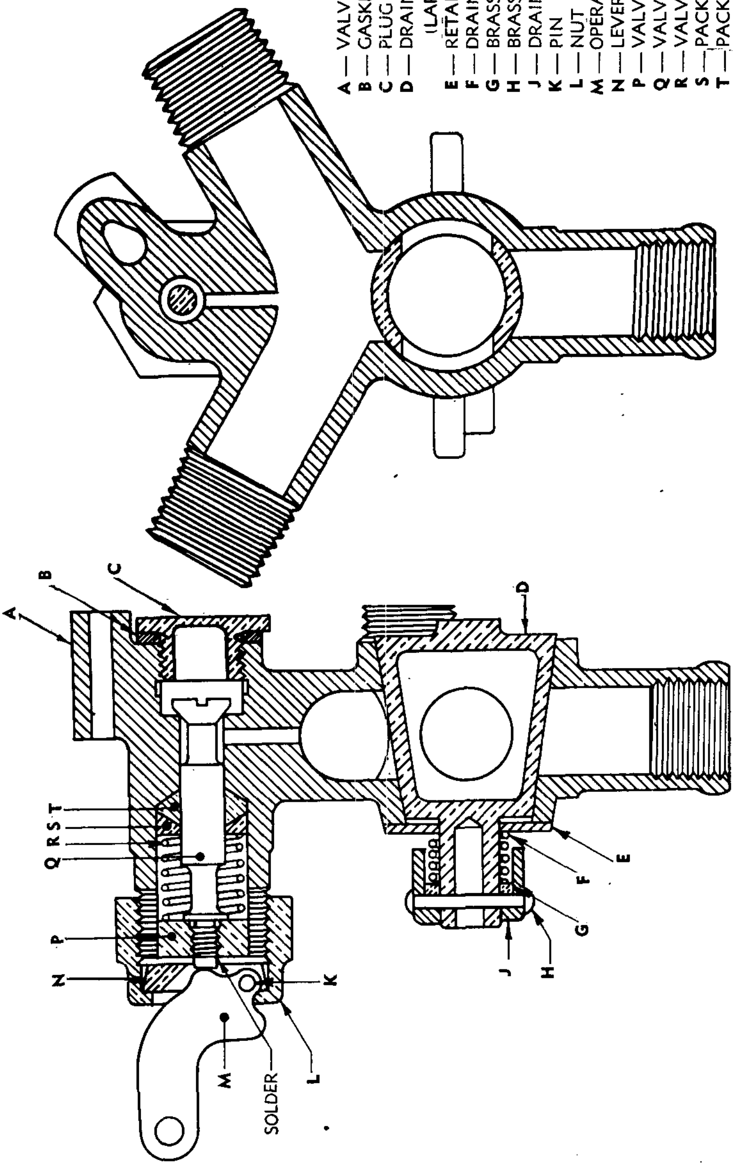


Figure 87—Cross Section of Hand Operated Oil Dilution Valve

spring and retainer. Gently tap the top of the drain stem to start it out of the body and remove.

(2) REPAIRS. Practically no repairs are feasible. Replace all defective parts. NOTE: **Replace the valve body in conjunction with drain stem.**

(3) ASSEMBLY. Follow reverse procedure of paragraph c (1) above, with the following precautions:

(a) Use a new packing, packing gland and gasket.

(b) The drain stem is lapped in place with the valve body, therefore, replacement of the drain stem will necessitate replacement of the valve body and vice versa.

d. Test Before Installation.

(1) When the oil "IN" and oil "OUT" connections are subjected to 5 pounds per square inch air pressure, with the fuel inlet and drain connections open and the valve immersed in OIL, light, no leaks must be evident.

(a) A leak at the drain connection indicates a poor seat between the drain stem and valve body. Replace both parts.

(b) A leak through the fuel inlet indicates a defective valve stem or valve seat. Replace the defective part.

(2) With 10 pounds per square inch gasoline pressure applied at the fuel inlet with all other connections open, any leakage indicates a defective valve stem or valve seat. Replace the defective part.

e. Installation. Follow reverse procedure set forth in paragraph 177 **b**, allowing enough slack in the cable to prevent any tension on the yoke and lever.

Chapter 8
REFERENCES

178. STANDARD NOMENCLATURE LISTS:

a. Cleaning, preserving, and lubricating materials, recoil fluids, special oils and similar items of issue ..... SNL K–1

b. Medium tank M3 ..... SNL G–104, Vol. I

c. Medium tank M4 ..... SNL G–104, Vol. VI

Current standard nomenclature lists are as tabulated here. An up-to-date list of SNL's is maintained as the "Ordnance publications for supply index" ..... OPSI

179. EXPLANATORY PUBLICATIONS:

a. **Automotive Materiel.**

Medium tanks M3, M3A1, and M3A2 ... TM 9–750
Cold weather operation of automotive equipment ..... OFSB 6–G–3
Fuels and carburetion ..... TM 10–550
The "Army Motors" monthly (QMC motor transport school) ..... QMC
The internal combustion engine ..... TM 10–570

b. Cleaning, preserving, lubricating, and welding materials and similar items issued by the Ordnance Department .. TM 9–850

c. Automotive electricity ..... TM 10–580

d. **Lubrication.**

Automotive lubrication ..... TM 10–540
Cold weather lubrication and service of automotive materiel ..... OFSB 6–11
Lubrication instructions for medium tank M3 ..... OFSB 6–G–104A

e. **Maintenance and Repair.**

Echelon system of maintenance ..... TM 10–525
Hand, measuring, and power tools ..... TM 10–590
Motor transport inspections ..... TM 10–545
Maintenance and repair ..... TM 10–520

f. **Miscellaneous.**

Fire prevention, safety precautions, accidents ..... TM 10–360
List of publications for training ..... FM 21–6
Loading of mechanized and motorized army equipment on open top railroad equipment—Association of American Railroads .....

g. Storage of motor vehicle equipment ..... AR 850–18

INDEX

A

B

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

INDEX

M—Cont'd

N

O

INDEX

INDEX

INDEX

INDEX

INDEX

[A. G. 062.11 (7-11-42)
O.O. 461/19274 O.O. (8-12-42)]

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
Chief of Staff.

OFFICIAL:

J. A. ULIO,
Major General,
The Adjutant General.

DISTRIBUTION:

R 9(2); IBn 9(1); IC 9(3).

(For explanation of symbols, see FM 21–6.)

PUBLICATIONS DEPARTMENT · RARITAN ARSENAL