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# TM 9-1865

WAR DEPARTMENT TECHNICAL MANUAL

U.S. Dept of Army

*ORDNANCE MAINTENANCE*

# Maintenance of Bomb Disposal Equipment for Access and Sterilization




*WAR DEPARTMENT* • *9 MARCH 1944*

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WAR DEPARTMENT
Washington 25, D. C., 9 March 1944

TM 9-1865, Ordnance Maintenance: Maintenance of Bomb Disposal Equipment for Access and Sterilization, is published for the information and guidance of all concerned.

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BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
*Chief of Staff.*

OFFICIAL:
J. A. ULIO,
*Major General,*
*The Adjutant General.*

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(For explanation of symbols, see FM 21-6.)

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ORDNANCE MAINTENANCE – MAINTENANCE OF BOMB DISPOSAL EQUIPMENT FOR ACCESS AND STERILIZATION

## CHAPTER 1

# INTRODUCTION

## 1. SCOPE.

**a.** This Technical Manual contains information for the guidance of personnel engaged in bomb disposal operations. It contains instructions for the operation, maintenance and repair of materiel used by Bomb Disposal Company (FM 9-40) for getting at, and the sterilization of, unexploded bombs.

**b.** Materiel covered in this manual is as follows (fig. 1):

Air compressor
Nail driver, Ingersoll-Rand, size 6 CND.
Circular saw, Skilsaw 2127
Portable timber saw, Reed-Prentice
Boring machine, Thor No. 62-WB
Rock drill, Thor No. 75
Clay digger, Thor No. 412
Paving breaker, Thor No. 25
Portable sump pump, Ingersoll-Rand No. 25
Hand-operated diaphragm pump, Marine Manufacturing and Supply Co. model 3
Portable diaphragm pump, gasoline engine-driven, Novo model AD-4
Portable centrifugal pump, gasoline engine-driven, Novo model KL3
Portable steam generating plant, Cleaver-Brooks Co. type OB-1

## 2. DATA.

### a. Air Compressor Unit.

(1) GENERAL.

| | |
|---|---|
| Fuel tank capacity | 50 gal |
| Truck | G.M.C. 2½ ton, 6 x 6 |
| Length over-all (bumper to bumper) | 254 in. |
| Width over-all (from outside of fenders) | 90 in. |
| Height over-all to top of muffler | 93 in. |
| Muffler removed | 87 in. |
| Total weight (complete with tools, fuel, and oil) | 14,300 lb |

(2) COMPRESSOR ENGINE.

| | |
|---|---|
| Make | Le Roi |
| Model | D318 |
| Cooling system capacity | 8 gal |
| Crankcase capacity (oil pan) | 14 qt |



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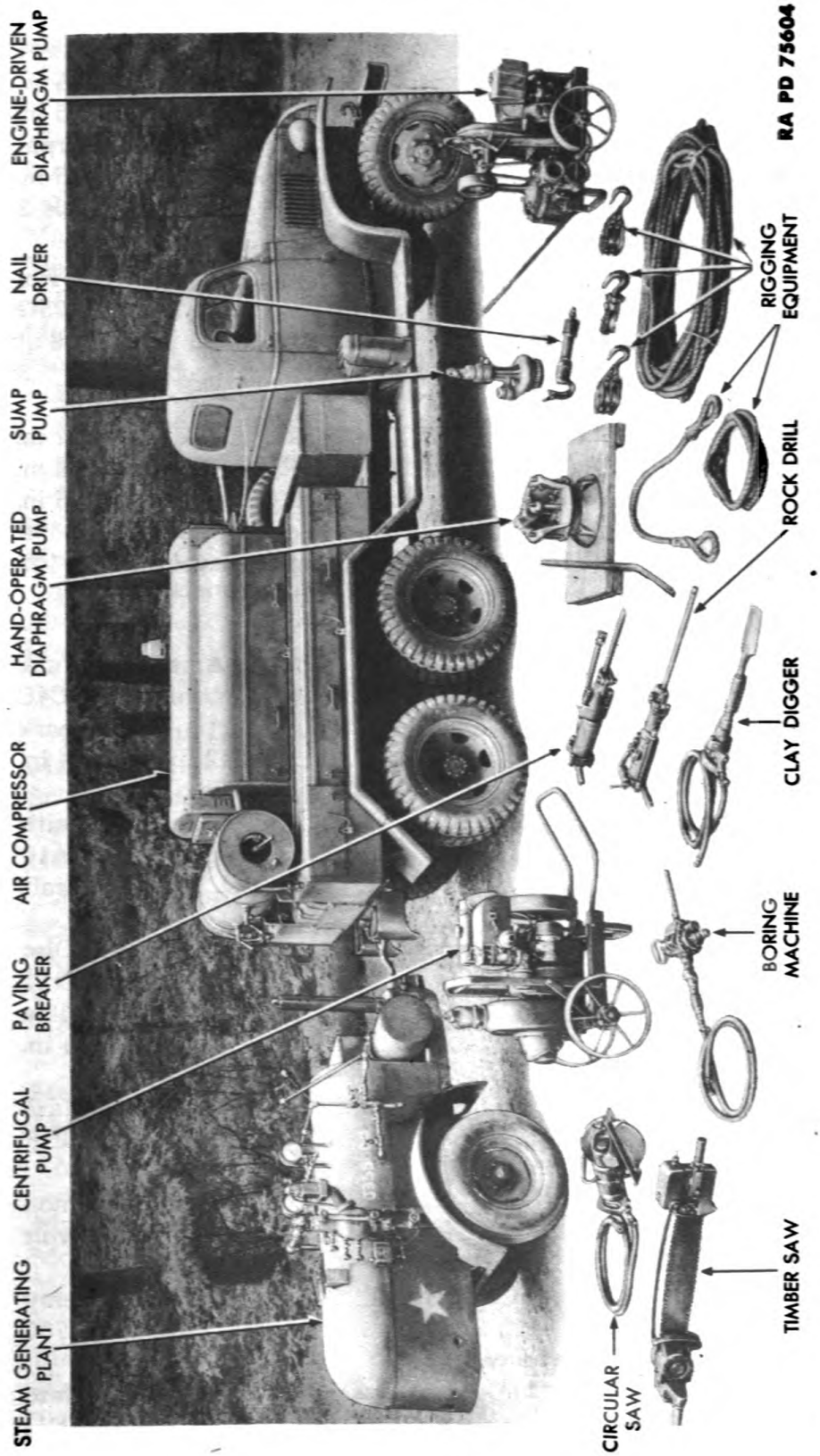



***Figure 1 — Bomb Disposal Equipment***



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## ORDNANCE MAINTENANCE — MAINTENANCE OF BOMB DISPOSAL EQUIPMENT FOR ACCESS AND STERILIZATION

Cylinders ..... 4
Bore ..... 4½ in.
Stroke ..... 5 in.
Engine speed (governed) ..... 865 rpm
Valve clearance (hot) ..... 0.015 in.
Firing order ..... 1-2-4-3

(3) AIR COMPRESSOR.

Make ..... Le Roi
Model ..... 105G
Crankcase capacity (oil pan) ..... 8 qt
Cylinder (2 low pressure — 1 high pressure) ..... 3
Bore:
Low pressure ..... 5¾ in.
High pressure ..... 5 in.
Stroke ..... 5 in.
Stages ..... 2
Output (cu ft per min at 100-lb gage pressure at sea level) ..... 105

(4) ENGINE ACCESSORIES.

*(a) Magneto.*

Make ..... American Bosch
Model ..... MJC4C
Type ..... Fixed spark
Breaker gap ..... 0.012 in. to 0.014 in.

*(b) Carburetor.*

Make ..... Zenith
Model ..... 62A10
Type ..... Updraft

*(c) Clutch.*

Make ..... Twin Disc
Model ..... SL-211
Type ..... Double plate
Size ..... 11½ in.

*(d) Air Cleaner.*

Make ..... Air-Maze
Model ..... 37L-OBF

*(e) Battery.*

Make ..... Globe-Union
Model ..... 134, 6-volt

*(f) Cranking Motor.*

Make ..... Delco-Remy
Model ..... 700

*(g) Cylinder Head Breather.*

Make ..... Air-Maze
Model ..... ZOH



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## INTRODUCTION

*(h) Fuel Pump.*

Make ..... AC
Model ..... 1537453

*(i) Generator and Regulator.*

Make ..... Delco-Remy
Model ..... 1101374

*(j) Magnetic Switch.*

Make ..... Delco-Remy
Model ..... 1459

*(k) Oil Filter.*

Make ..... Purolator
Model ..... N1744
Element ..... N-17
Assembly ..... N1744

(5) COMPRESSOR ACCESSORIES.

*(a) Air Cleaner.*

Make ..... Air-Maze
Model ..... V31-OB

*(b) Unloader Pilot Valve.*

Make ..... Penn Electric Switch Co.
Model ..... G-1

**b. Pneumatic Tools.**

(1) NAIL DRIVER.

Make ..... Ingersoll-Rand
Size ..... 6 CND
Type ..... Pneumatic
Nail sets ..... ½ in., ¾ in.

(2) CIRCULAR SAW.

Make ..... Skilsaw
Model ..... 2127
Type ..... Pneumatic
Size of blade ..... 12 in.

(3) TIMBER SAW.

Make ..... Reed-Prentice
Model ..... Timberhog 24 in.
Type ..... Pneumatic, saw chain

(4) BORING MACHINE.

Make ..... Thor
Model ..... 62WB
Type ..... Pneumatic, piston type

(5) ROCK DRILL.

Make ..... Thor
Model ..... 75
Type ..... Pneumatic



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(6) CLAY DIGGER.

| | |
|---|---|
| Make | Thor |
| Type | Pneumatic |
| Size | 412 |
| Trigger | Closed, inside |

(7) PAVING BREAKER.

| | |
|---|---|
| Make | Thor |
| Model | 25 |
| Type | Pneumatic |

**c. Water Pumping Equipment.**

(1) HAND-OPERATED DIAPHRAGM PUMP.

| | |
|---|---|
| Make | Marine Mfg. and Supply Co. |
| Model | 3 |
| Type | Diaphragm |

(2) GASOLINE ENGINE-DRIVEN DIAPHRAGM PUMP.

| | |
|---|---|
| Make | Novo |
| Model | AD-4 |
| Rated strokes per minute | 60 |
| Capacity (10-ft static lift) | 3,000 gph |
| Capacity (20-ft static lift) | 1,500 gph |

*(a) Engine.*

| | |
|---|---|
| Make | Novo |
| Model | A-16 |
| Number of cylinders | 1 |
| Coolant | Air |
| Bore | 2¾ in. |
| Stroke | 2¾ in. |
| Valve clearance (warm engine) | 0.015 in. |

(3) ENGINE-DRIVEN CENTRIFUGAL PUMP.

| | |
|---|---|
| Make | Novo |
| Model | KL-3 |
| Capacity (10-ft static lift — no discharge head) | 15,000 gph |

*(a) Engine.*

| | |
|---|---|
| Make | Novo |
| Bore | 3¼ in. |
| Stroke | 4 in. |
| Tappet clearance (warm engine) | 0.015 in. |



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## INTRODUCTION

*(b) Magneto.*

Make ..... Bosch
Model ..... MVA 1A 308

*(c) Carburetor.*

Make ..... Holly
Model ..... 859

(4) PNEUMATIC SUMP PUMP.

Make ..... Ingersoll-Rand
Type ..... Rotary, air-driven
Model ..... 25

**d. Steam Generating Plant.**

(1) GENERAL.

Make ..... Oilbuilt (Cleaver-Brooks Co.)
Model ..... OB-1
Maximum pressure ..... 100 lb per sq in.

(2) ENGINE.

Make ..... Wisconsin
Model ..... AK

(3) MAGNETO.

Make ..... Wico
Type ..... C

(4) CARBURETOR.

Make ..... Stromberg
Model ..... OH-⅝

(5) WATER INJECTORS.

Make ..... Chicago Automatic
Number used ..... 2

(6) PRESSURETROL.

Make ..... Minneapolis-Honeywell
Model ..... L404F
Adjustment ..... External screws
Electrical rating ..... 1 hp a-c 230 v
Range ..... 5 to 150 lb
Differential ..... 8 lb, adjustable



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## ORDNANCE MAINTENANCE — MAINTENANCE OF BOMB DISPOSAL EQUIPMENT FOR ACCESS AND STERILIZATION

(7) LOW WATER CONTROL.

| | |
|---|---|
| Make | McDonnel |
| Model | No. 150 |
| Type | High pressure |
| Maximum pressure | 150 lb |

(8) GENERATOR.

| | |
|---|---|
| Make | Marathon Electric Mfg. Corp. |
| Model | BL145641 |
| Type | AG |
| Operating temperature (continuous) | 50 C |
| Operating speed | 3,600 rpm |
| Frame | 204A |
| Characteristics | 220-v, a-c, 5-kva, 60-cycle, 2.2-amp, single-phase |

(9) SOLENOID VALVE.

| | |
|---|---|
| Make | Detroit Lubricator Co. |
| Model | No. 683-3, 4223 series |
| Type | S |
| Switch | 230-v, 60-cycle, 15-w |
| Orifice | $\frac{3}{16}$ in. |
| Maximum pressure | 200 lb |



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## CHAPTER 2

# MOTORIZED AIR COMPRESSOR

## 3. DESCRIPTION AND FUNCTIONING.

**a. General** (fig. 2). The air compressor unit is mounted on a 2½-ton, 6x6, truck equipped with tool boxes for convenient storage of pneumatic tools, spare parts, and miscellaneous equipment (figs. 3 and 4). A tool box mounted transversely behind the truck cab provides seating facilities for three men and is equipped with safety straps and handrails. A combination vise is attached to a rigid portable workbench stored in the transverse tool box when not in use (fig. 5). The air compressor unit is completely enclosed by a steel hood, hinged side panels, and splash pan.

**b. Air Compressor.**

(1) GENERAL (fig. 6). The air compressor is a 3-cylinder, 2-stage, air-cooled model capable of delivering 105 cubic feet of free air per minute at 100 pounds per square inch pressure at sea level. Two low-pressure outside cylinders compress air from atmospheric pressure to intercooler pressure. One high-pressure cylinder compresses air from intercooler to air receiver.

(2) AIR CLEANERS (fig. 6). An oil bath air cleaner is attached to each low-pressure cylinder. Air drawn from the atmosphere by the low-pressure cylinders, enters through an opening under the top of the filter. It is drawn down through oil in the air filter reservoir and up through the element. Here oil separates from the air and drains back into the bowl, cleaning the element. The cleaned air passes down through the center unit to enter the compressor cylinder. When the compressor unloads, a valve allows air which returns to the cleaner to bypass to the atmosphere without passing through the oil bath.

(3) CYLINDER VALVES (fig. 6). Air compressor valves are circular disk type, assembled in cages which are mounted in the cylinder heads in order to be quickly and easily removed without disturbing the cylinder heads. There is no physical difference between suction and discharge valves, valve springs, or seats. The difference in appearance is due to the design of the retaining cages which hold the discharge valve upside down as compared with the suction valve. There is no operating mechanism; the valves allow passage of air through each valve in one direction only. On the down stroke of the piston, air is drawn into the cylinder through the suction valve. On the up stroke of the piston, air is expelled from the cylinder through the discharge valve.

(4) INTERCOOLER AND AIR RECEIVER (fig. 6). Air from the low-pressure cylinders is discharged into the intercooler which is mounted between the compressor and the air receiver. The intercooler is a tubular, sectional type, air-cooled radiator which cools air entering the



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## ORDNANCE MAINTENANCE — MAINTENANCE OF BOMB DISPOSAL EQUIPMENT FOR ACCESS AND STERILIZATION

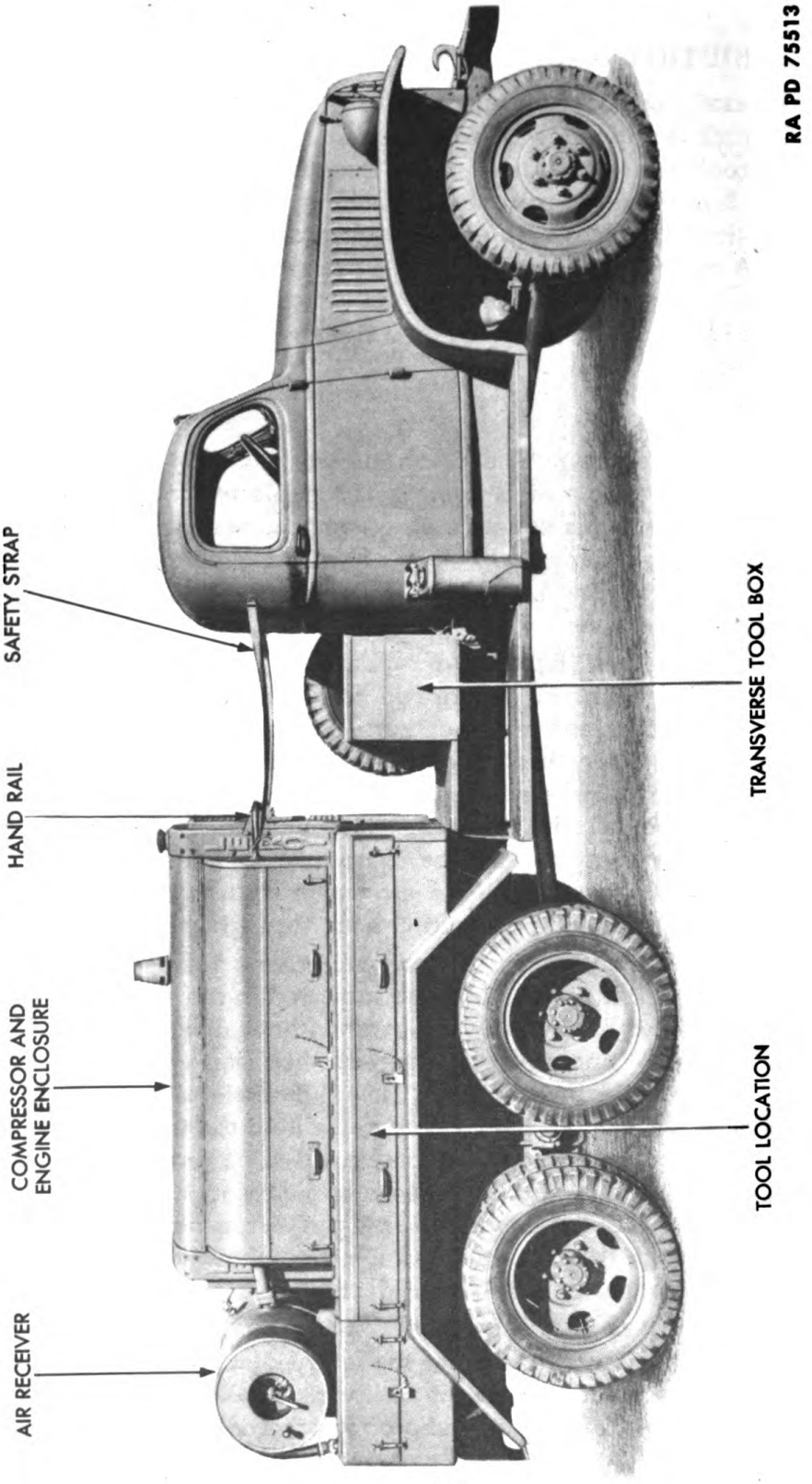



*Figure 2 — Compressor and Truck*



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## MOTORIZED AIR COMPRESSOR

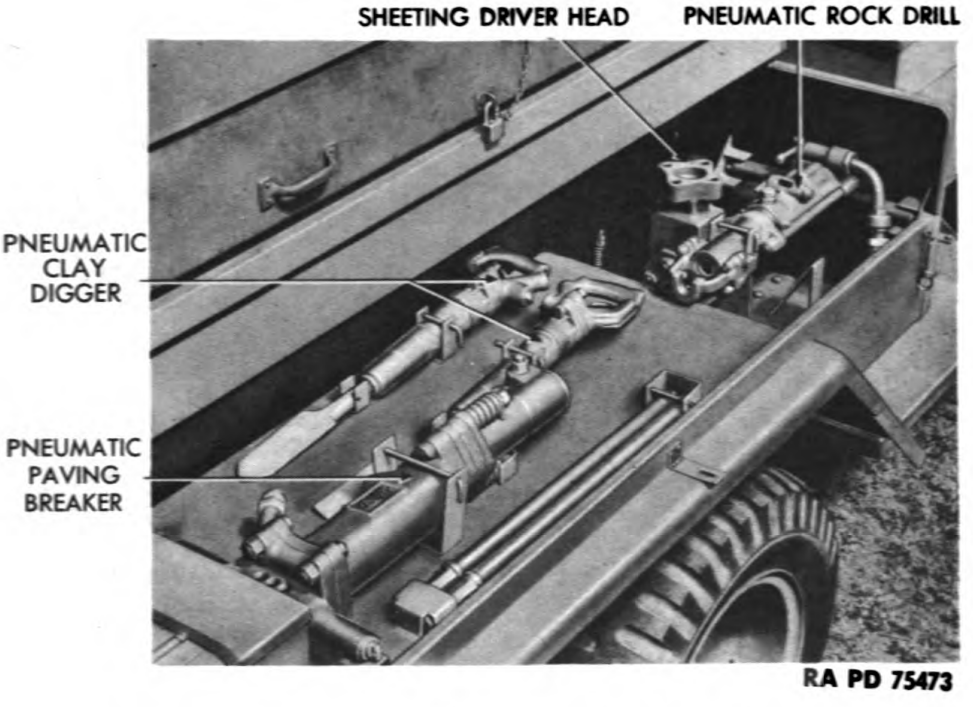



***Figure 3 — Compressor Unit Right-hand Tool Location***

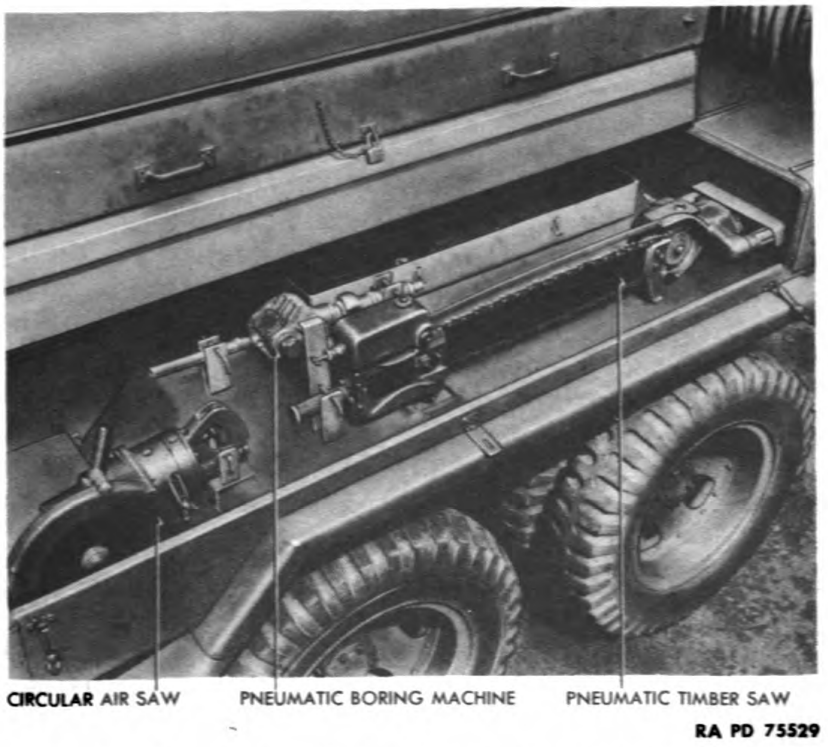



***Figure 4 — Compressor Unit Left-hand Tool Location***



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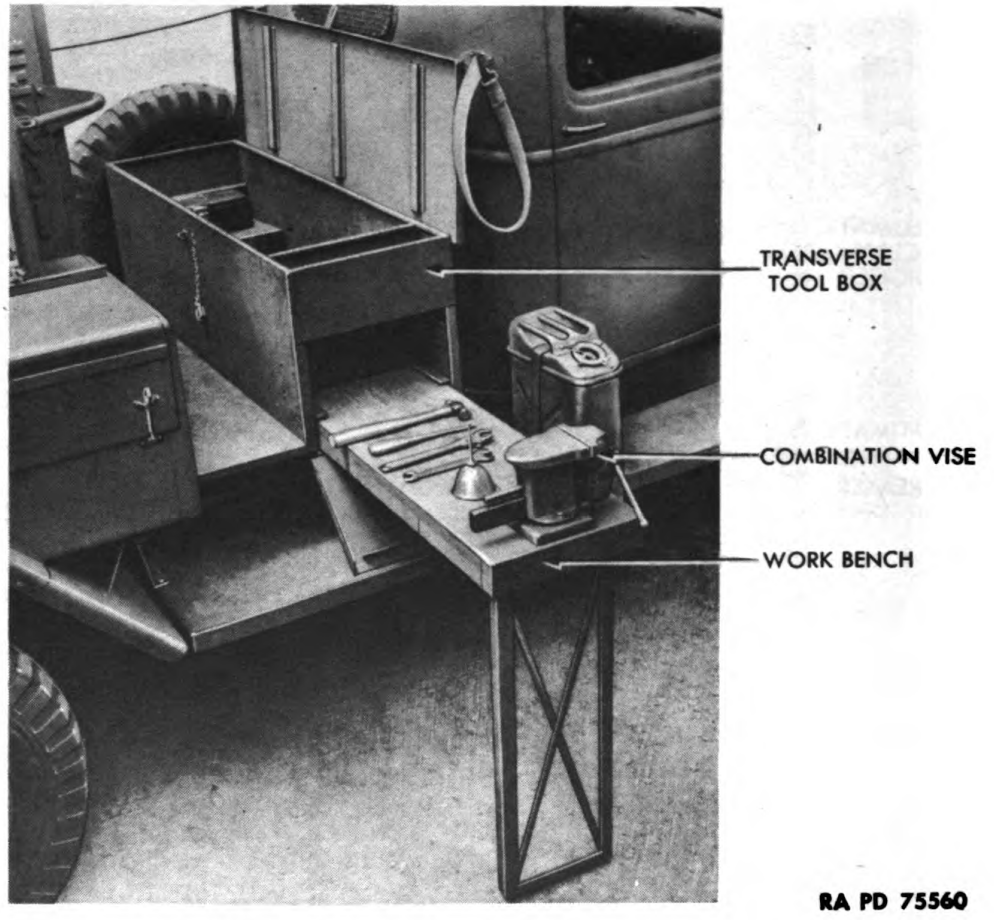



***Figure 5 — Compressor Unit Transverse Tool Box***

high-pressure cylinder to within a few degrees of the suction temperature. An intercooler relief valve, consisting of a cylinder, plunger, and spring, is located at the bottom of the intercooler. When the compressor unloads, air from the receiver forces the plunger back until ports are uncovered and air in the intercooler is released to the atmosphere. This action blows condensate from the intercooler. The high-pressure cylinder of the compressor pumps the air from the intercooler to the air receiver, on the rear of the unit from which compressed air is used.

(5) SAFETY VALVES (fig. 6). Two safety valves are provided to prevent trouble if the air pressure should rise above recommended limits. One safety valve is on the intercooler and is set to trip at a pressure of 50 pounds per square inch. The other is on the air receiver and is set to trip at a pressure of 125 pounds per square inch. These valves do not operate when the outfit is functioning properly. If either



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**MOTORIZED AIR COMPRESSOR**

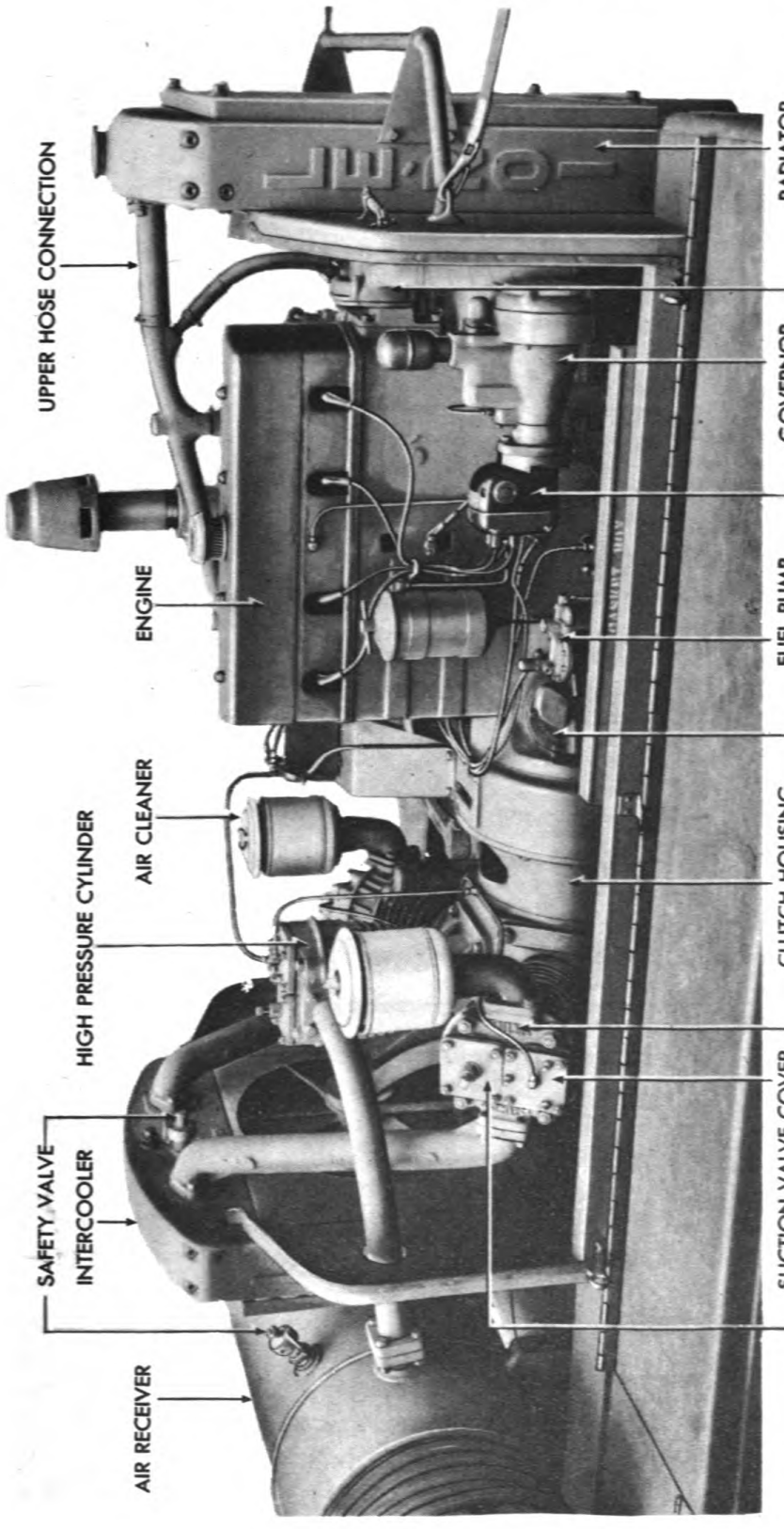



***Figure 6 — Compressor Unit From Magneto Side — Hood Removed***



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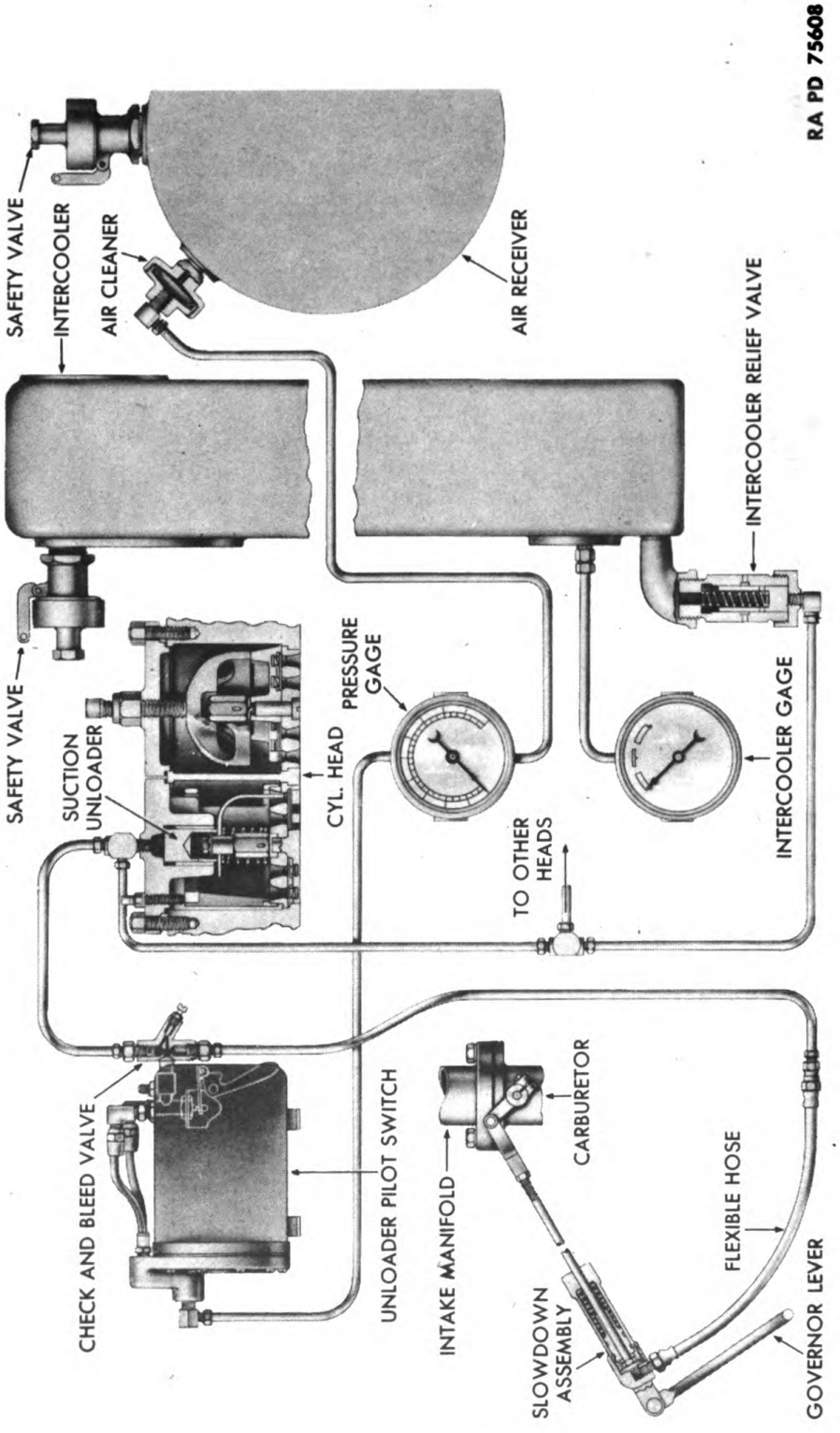



***Figure 7 — Compressor Unit Pressure Control System Diagram***



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## MOTORIZED AIR COMPRESSOR

"pops," it is a sign of trouble and the compressor cannot be operated safely until the trouble is located and remedied.

(6) PRESSURE CONTROL SYSTEM.

*(a) Purpose* (fig. 7). A control system is provided to regulate automatically the operating pressure of the compressor within set limits.

*(b) Operation* (fig. 7). When pressure in the air receiver reaches 100 pounds per square inch, the pilot unloader valve trips. The 105-cubic feet per minute compressor is now delivered with pilot valve set to unload at 90-pound per square inch pressure. This admits air from the receiver to compressor cylinder unloader valves. Unloader valves depress and hold suction valves open. Thus the compressor becomes inoperative. Air is also admitted to the intercooler relief valve from the air receiver. This releases air within the intercooler to the atmosphere. Air from the receiver is also admitted to the slow-down assembly on the linkage between the governor and the carburetor. This causes the throttle to be partially closed and the compressor engine to idle. When the pressure in the receiver drops to 88 pounds per square inch, the pilot unloader valve switch again trips. This allows the air to escape from the unloader valves, intercooler relief valve, and from the slowdown assembly. This escaping air is vented to the atmosphere through a check and bleed valve attached to the unloader pilot switch. The check and bleed valve is constructed so that air from the slowdown assembly can escape freely, while air from the unloader valves and intercooler relief valve is restricted. Consequently, a time delay is attained which allows the engine to speed up before the compressor load comes on.

*(c) Unloader Pilot Switch* (fig. 7). The unloader pilot switch is the Penn Electric Switch Company's type G1. Its function is to unload and load the compressor upon the rise or drop of pressure in the air receiver. It is located on top of the instrument panel. It actuates suction unloaders located in the cylinder heads directly over the suction valves. The suction unloaders serve to hold the suction valve open and unload the compressor when the maximum pressure is reached. This is accomplished by admitting air from the receiver to the unloader, which forces a plunger down. When the plunger moves down, it contacts a set of fingers which hold the valve open and makes the cylinder inoperative. When pressure in the receiver drops, air is released from the unloaders and a spring under the fingers returns the plunger to its original position, allowing the compressor to start pumping again. Unloader bodies are fitted to very close tolerances. This eliminates the use of piston rings or other packings and makes it necessary to service the unloaders as complete assemblies.

*(d) Intercooler Relief Valve* (figs. 7 and 8). Consisting of a cylinder, plunger, and spring, this valve is located in the bottom of the



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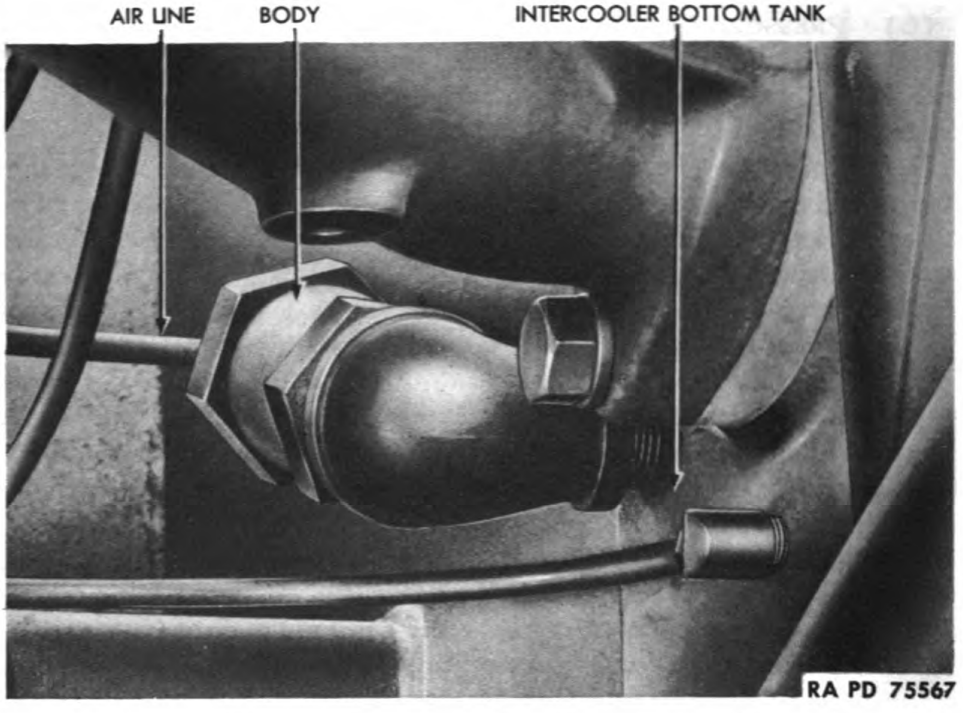



***Figure 8 — Compressor Intercooler Relief Valve***

intercooler. When the compressor unloads, air from the receiver is admitted to the cylinder. This forces the plunger forward until holes in the plunger and cylinder are in a line. Through these holes intercooler air escapes to the atmosphere, automatically draining condensate from the intercooler. When pressure in the receiver drops, air is released from the relief valve and the spring returns the valve to normal operating position.

*(e) Carburetor Slowdown* (fig. 7). The slowdown assembly is integral with engine governor rod. One end is attached to the governor lever and the other end to the carburetor throttle valve lever. When the compressor unloads, air from the receiver enters the slowdown assembly and moves the plunger outward. This advances position of the governor rod and adjusts the carburetor lever to idle position. When pressure in the receiver drops, air is released from the slowdown. The spring then returns the plunger to its former position allowing the engine to assume full load speed.

*(f) Check and Bleed Valve* (fig. 7). The check and bleed valve is inserted in the control air line between the pilot unloader valve on one side and the unloaders, intercooler relief valve, and slowdown on the other side. Its purpose is to slow the escape of air from the un-



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loaders and relief valve while allowing rapid escape of air from the slowdown when the compressor load is applied to the engine.

**c. Clutch** (fig. 6). The air compressor is coupled to the engine through a manually operated Twin Disc clutch. The clutch is of the spring loaded double plate type which affords maximum plate wear before adjustment is required. The double plates are 11½ inches in diameter.

**d. Engine.**

(1) GENERAL (fig. 6). A 4-cylinder valve-in-head gasoline engine drives the air compressor. With a displacement of 318 cubic inches, the engine develops a maximum of 34 horsepower at 865 revolutions per minute. Removable wet type cylinder sleeves are used. Special steel inserts are provided to minimize pitting and wear of exhaust valve seats. Both main and connecting rod bearings are babbitt lined, steel back, precision type.

(2) COOLING SYSTEM.

*(a) General.* A conventional liquid cooling system is provided to control the temperature of the engine. Units of the cooling system are a radiator, fan, water pump, and thermostat. Capacity of the system is 8 U.S. gallons.

*(b) Radiator* (fig. 6). A flat tube and fin type radiator is mounted on the front of the unit. Air drawn through the fins by the fan serves to dissipate heat of the coolant circulating through the tubes.

*(c) Fan and Water Pump* (fig. 10). A 22-inch diameter, 4-blade fan assembly is secured to the fan hub by four cap screws. In turn, the hub is pinned to the water pumpshaft which rotates in bronze bushings. An impeller is pressed onto the shaft. Sealing is accomplished by means of a sealing washer held in contact with a shoulder, and a rubber bellows and spring which automatically take up wear. Water pump capacity is 27 gallons per minute. Both fan and pump are driven by a V-belt.

*(d) Thermostat.* A thermostat set to open at 160 F is located in the radiator upper hose connection (fig. 6). It restricts the flow of coolant through the radiator until a desirable operating temperature is attained. A bypass tube is provided to allow the coolant to circulate through the engine only, with the thermostat closed.

(3) FUEL SYSTEM.

*(a) General.* Units composing the fuel system are fuel tank, fuel pump, carburetor, air filter, and governor. The engine is equipped with a combination intake and exhaust manifold cast in one piece.

*(b) Fuel Tank* (fig. 9). Gasoline to operate both the truck and the compressor engines is carried in a 50-gallon fuel tank located beneath the air receiver on the rear of the vehicle. A heavy steel



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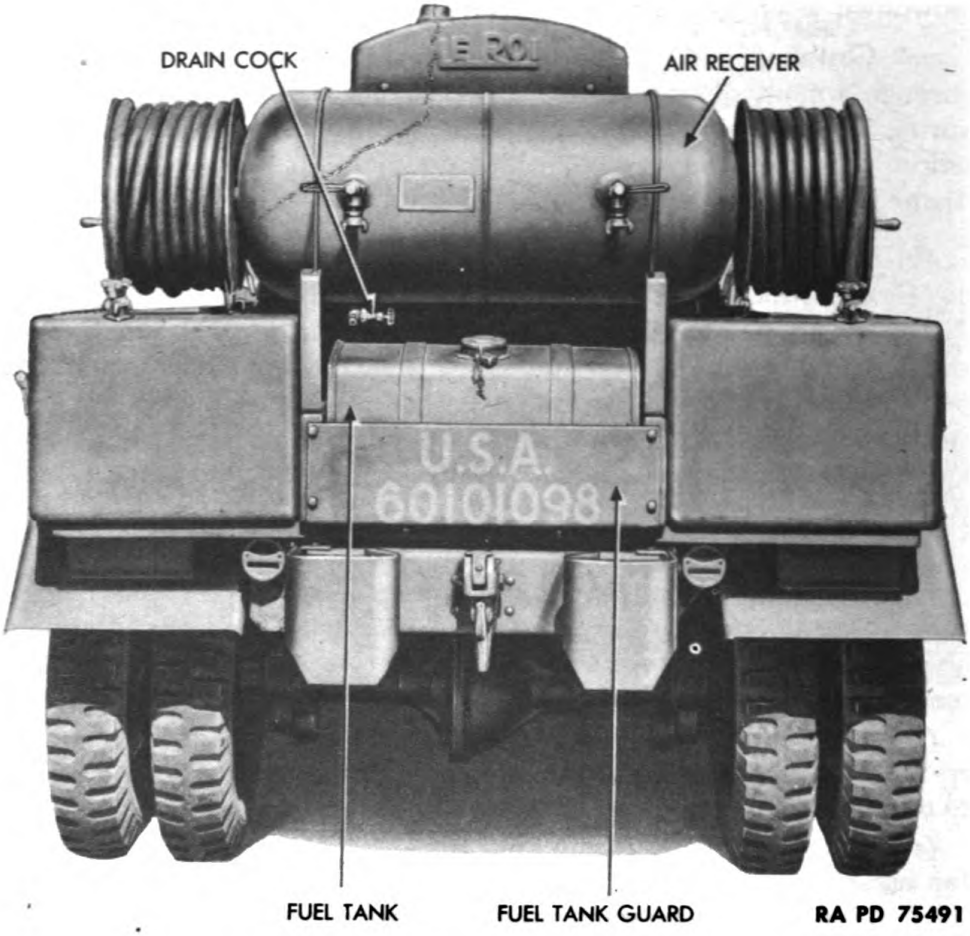



***Figure 9 — Rear of Compressor Unit***

guard partially shields the tank and protects about one-half of its contents. When full, the tank provides enough fuel to drive the truck about 150 miles and to operate the compressor for about 8 hours.

*(c) Fuel Pump* (fig. 6). Fuel is forced from tank to carburetor by an a-c, diaphragm type fuel pump. Operation of the pump is as follows: Rotation of a camshaft eccentric actuates a rocker arm which, through linkage, overcomes the diaphragm spring pressure and depresses the diaphragm. This creates a vacuum in the pump chamber and causes fuel from the line to the tank to flow into the sediment bowl, through a screen and through a one-way valve into the pump chamber. On the return stroke, the diaphragm spring returns the diaphragm to its original position. This forces fuel from the pump chamber through a one-way valve into the line to the carburetor. When the carburetor float chamber becomes filled, the float closes a needle valve which prevents more fuel from entering the carburetor.



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## MOTORIZED AIR COMPRESSOR

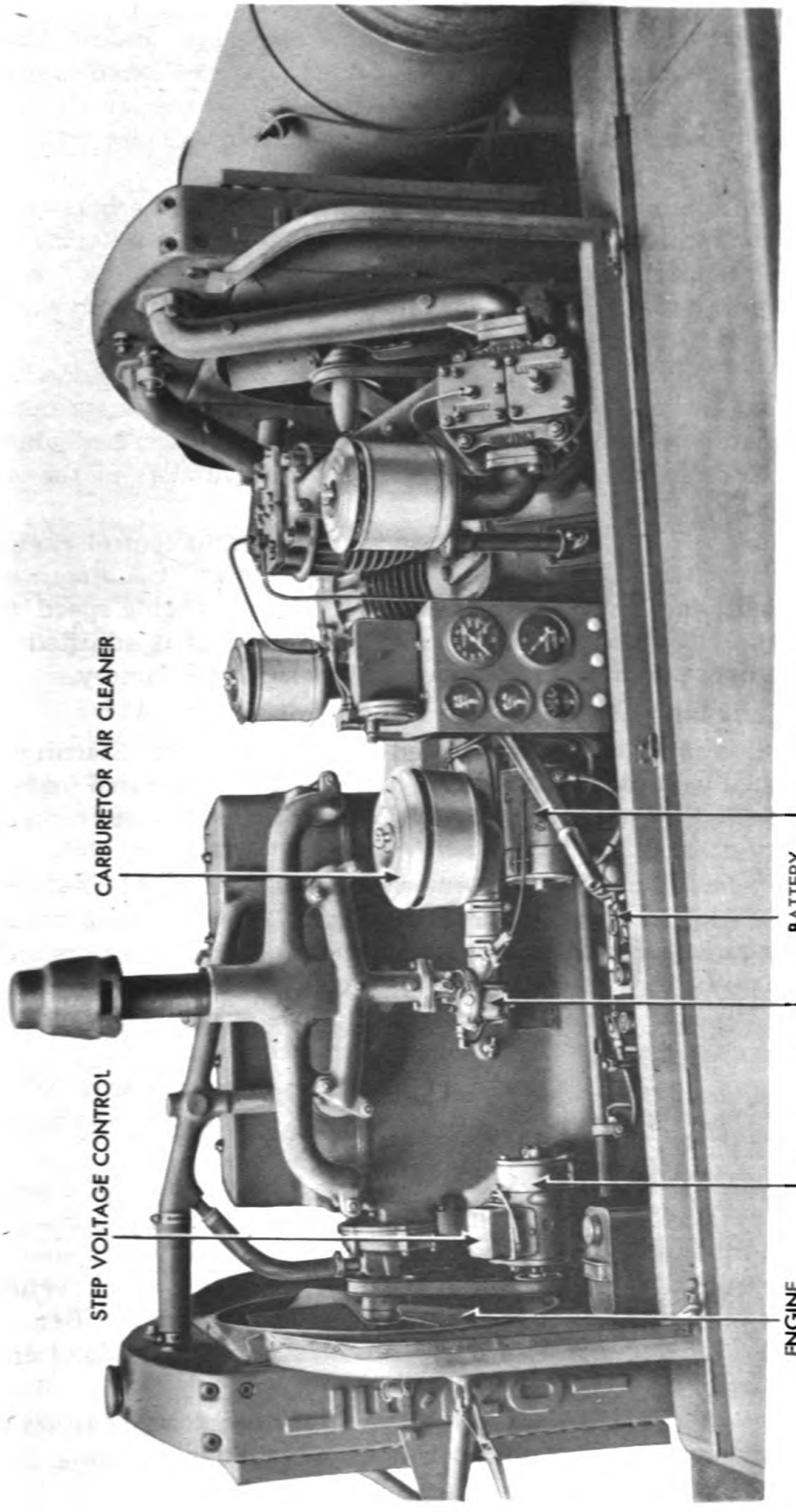



*Figure 10 — Compressor Unit From Carburetor Side — Hood Removed*



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This builds up a back pressure on the pump diaphragm great enough to keep the diaphragm depressed. Thus the pump is rendered inoperative until the carburetor will again take fuel. A rocker arm spring is provided to keep the pump rocker arm in constant contact with the camshaft.

*(d) Carburetor* (fig. 10). A Zenith model 62A10 carburetor is provided to discharge the desired amount of fuel into the entering air stream, to atomize the fuel, and to make an air-fuel mixture. Air-to-fuel ratio varies at different speeds and loads. The carburetor varies the ratio to give best performance for all conditions.

*(e) Air Cleaner* (fig. 10). An oil bath air cleaner is provided to clean the air entering the engine through the carburetor. It is similar in design and operation to the air cleaners previously described which are used to clean air entering the low-pressure cylinders of the air compressor.

*(f) Governor* (fig. 6). A governor is provided to control engine speed. It is a flyball, direct acting, mechanical type. It is driven by the camshaft, and drives the magneto. It controls engine speed by opening and closing the carburetor throttle valve. It is adjusted at 865 revolutions per minute maximum, and sealed at the factory.

(4) ELECTRICAL SYSTEM.

*(a) General.* Ignition is provided for by a magneto. Starting is accomplished by an automotive-type cranking motor operated from a storage battery. A generator and voltage control are provided to keep the battery charged.

*(b) Magneto* (fig. 6). An American Bosch model MJC4C-334 magneto, complete with impulse coupling, is provided to produce ignition spark required to provide combustion in the engine cylinders. The magneto is the fixed spark type with one tungsten and one platinum contact point. A switch is provided on the instrument panel to ground the magneto when it is desired to stop the engine.

*(c) Spark Plugs.* Each cylinder of the engine has one spark plug. All plugs installed should be of the same make. Proper gap setting is 0.025 to 0.030 inch.

*(d) Cranking Motor* (fig. 10). A Delco-Remy model 700 cranking motor is used. It is a 6-volt, 6-pole unit with oilless bearings at the center, commutator, and drive ends. It is provided with a sealed type cover band to exclude dust. A Bendix type drive is used. When the starter button on the instrument panel is pulled out, the Bendix drive of the cranking motor engages teeth on the engine flywheel and cranks the engine.

*(e) Battery* (fig. 10). A 6-volt automotive-type storage battery is provided to supply current for operating the cranking motor.



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**MOTORIZED AIR COMPRESSOR**

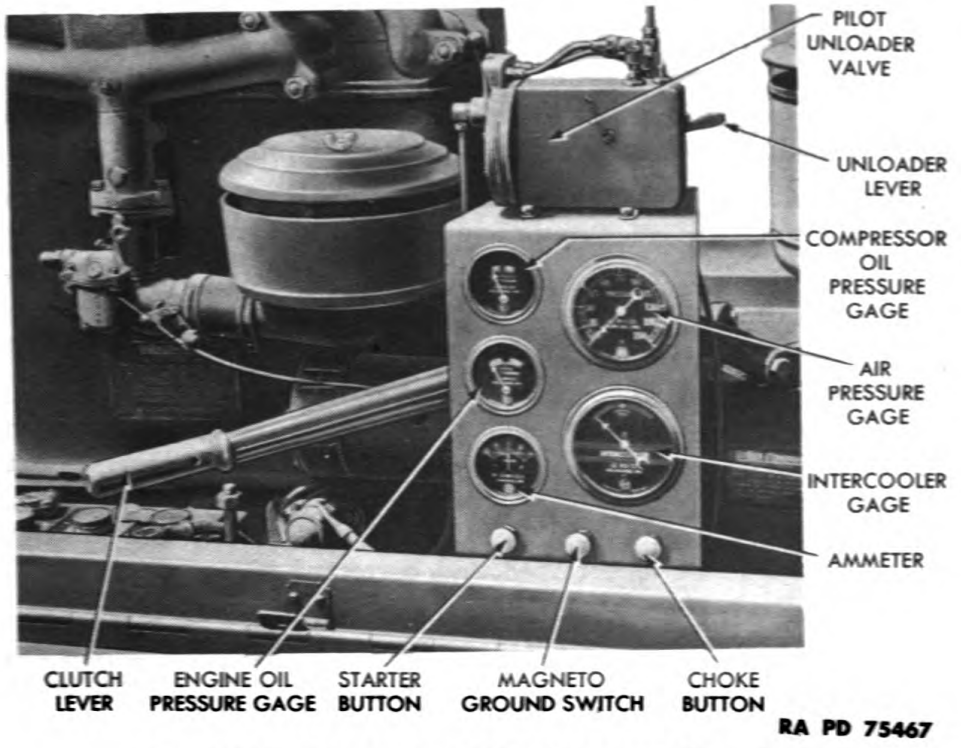



***Figure 11 — Compressor Unit Gages and Controls***

*(f) Generator* (fig. 10). A Delco-Remy model 1101374 generator is used to keep the battery charged. It is a 2-pole, third brush, sealed type unit. Armature support is provided by a ball bearing in the drive end and a bronze bushing in the commutator end.

*(g) Step-voltage Control and Cut-out Relay* (fig. 10). A step-voltage control unit and a cut-out relay unit are mounted on the same base and work in connection with the generator. Both are mounted on top of the generator. The step-voltage control unit is a magnetic switch. It automatically permits full generator output, as determined by third brush position and generator speed, when the battery is low and requires a high charging rate. When the battery becomes charged, the step-voltage control cuts down generator output to avoid overcharging battery. The cut-out relay prevents the battery from discharging through the generator when the engine is stopped or is running too slowly for the generator to charge. This step-voltage control is a Delco-Remy model 5889.

(5) LUBRICATION SYSTEM. A gear type oil pump (fig. 6) ensures full force feed lubrication to all moving parts of the engine. A screen attached to the pump intake stops large particles of foreign matter from entering the oiling system.



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**e. Instruments and Controls** (fig. 11). All controls are conveniently grouped on the instrument panel and sufficient gages are provided to enable the operator to detect, at a glance, any irregularities in the operation of the unit. On the panel are the following:

(1) ELECTRIC STARTER BUTTON (fig. 11). Pulling the button operates a conventional, automotive-type electric cranking motor.

(2) CHOKE BUTTON (fig. 11). Pulling the button closes a butterfly valve in the carburetor which shuts off the air to the carburetor. This causes the carburetor to deliver a richer mixture as an aid to starting the engine when cold.

(3) AMMETER (fig. 11). This is a check on the electrical system. It shows whether the battery is being charged or discharged. With the engine running at normal speed, the ammeter needle should be in the "CHARGE" range. If a "DISCHARGE" is shown continuously, the cause should be ascertained and corrected to avoid completely discharging the battery.

(4) ENGINE OIL PRESSURE GAGE (fig. 11). This instrument indicates oil pressure in the engine. With engine operating normally, the needle should point to the green section, or a little above, on the dial. If the gage shows little or no pressure, stop the engine immediately, investigate and correct the cause.

(5) COMPRESSOR OIL PRESSURE GAGE (fig. 11). This gage performs a function similar to the engine oil pressure gage, except that it is connected to the oil system of the compressor.

(6) AIR PRESSURE GAGE (fig. 11). This indicator shows the pressure of the compressed air in the air receiver tank. In normal operation it should show a maximum pressure of 100 pounds per square inch after the engine and compressor have been thoroughly warmed up to operating temperatures.

(7) INTERCOOLER GAGE (fig. 11). This gage indicates the functioning of the compressed air system. When every part of the system is operating normally, the indicator hand will ride in the center position. When the machine is not in operation and when the unit, in operation, unloads, the hand will drop to the left-hand side. If the hand continuously rides in the left-hand section of the dial, a leak is indicated in the low-pressure system. The leak might be in the valves, lines, or connections. If the hand rides continuously in the right-hand portion of the dial, a leak in the high-pressure system is indicated.

(8) MAGNETO GROUND SWITCH (fig. 11). When this button is pulled out, the magneto is "ON" for operation. Pushing the button grounds the magneto, thereby making it inoperative, and stops the engine.



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(9) UNLOADER PILOT SWITCH (fig. 11). This unit, previously described, is attached to the top of the instrument panel.

## 4. OPERATION.

### a. Before Starting a New Compressor.

(1) Lubricate entire compressor (par. 8).

(2) Check oil levels in air cleaners and of engine and compressor crankcases. Fill to correct level with proper grade of oil (par. 8).

(3) Remove spark plugs and pour about 2 tablespoonfuls of a mixture of half OIL, engine, SAE 10, and half gasoline into each. This ensures lubrication of pistons and cylinders when the engine first starts. This practice is recommended for engines that have been idle for 30 days or more.

(4) Add one pint of light OIL, engine, SAE 10, to each 5 gallons of fuel in the tank, for the first two fillings only.

(5) Close drain cock in radiator tank bottom. Close drain cock on right side of cylinder block near carburetor. Fill cooling system with clean water (rain water or soft water, if possible). Capacity is about 8 U.S. gallons. Use antifreeze if temperature is low enough to warrant it (ch. 7).

(6) Fill fuel tank with MOTOR FUEL, 72 or 80 octane. Keep the funnel in contact with the metal of the tank during the entire operation to avoid static electricity which might ignite the fuel. Never fill the tank in the presence of open flame or with engine running. See that the fuel tank filler cap venthole is open and that the cap is securely replaced after the tank is filled.

### b. Starting Engine.

(1) Place truck as nearly level as possible to ensure equal lubrication to all parts.

(2) Check entire unit in accordance with "maintenance schedule" (par. 8).

(3) Inspect fuel supply in tank.

(4) Open valve in gasoline line located beneath fuel tank. Operate hand priming lever of fuel pump to fill carburetor float chamber.

(5) See that clutch (fig. 11) is disengaged (lever pulled away from engine).

(6) Open drain cock (fig. 9) in air receiver and drain condensate. Close drain cock. Repeat this procedure every 4 to 6 hours during operation, depending upon weather conditions.

(7) With magneto ground switch (fig. 11) in "OFF" position (pushed in) and choke lever pulled all the way out, crank engine one revolution. Push choke in half way, pull magneto ground switch to



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"ON" position, and crank engine. It may be unnecessary to choke a warm engine. If engine does not fire immediately, push in choke and continue to crank. Do not operate the cranking motor for more than 30 seconds at a time without pausing to allow it to cool. In extremely cold weather, when starting is difficult, crank the engine a few revolutions with the choke all the way out. If the engine still fails to start, remove the spark plugs and pour a small amount of gasoline into each cylinder. Install the spark plugs, and wait a few minutes for the gasoline to vaporize, pull ignition switch to "ON" position, and crank engine.

(8) After engine starts, allow it to warm up a few minutes before starting the compressor.

(9) When starting with pressure in receiver tank, lift hand unloader lever on unloader pilot (fig. 11) before starting compressor.

(10) Start the compressor by engaging the clutch (move lever (fig. 11) toward engine).

(11) Trip hand unloader lever on unloader pilot (fig. 11) after compressor reaches operating speed.

(12) Trip intercooler and air receiver tank safety valves (fig. 6) by hand to make certain of their operation.

(13) Observe engine and compressor oil pressure gages (fig. 11). If either fails to show pressure, stop engine immediately. Locate and remedy the cause.

**c. Stopping Engine.**

(1) Disengage clutch (fig. 11) to stop compressor.

(2) Allow engine to idle a few minutes, then push in magneto ground switch (fig. 11).

(3) Open drain cock (fig. 9) in air receiver tank.

(4) Close gasoline shut-off valve if engine is to remain inoperative for any length of time.

**d. Starting Air Compressor After Storage.** Procedure for starting the compressor after removal from dead storage, is as follows:

(1) Remove spark plugs and pour 2 tablespoonfuls of a mixture of half OIL, engine, SAE 10, and half gasoline into each cylinder.

(2) Install battery (fig. 10). Make certain connections are tight and that positive terminal is connected to ground strap.

(3) Push magneto switch (fig. 11) to the "OFF" position. Crank engine until excess oil is blown out through spark plug holes. This will loosen any tight piston rings and wash old gummy oil from valves and pistons.

(4) Drain engine and compressor oil pans. Refill to full mark with proper grade of oil (par. 8).



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(5) Install spark plugs and connect spark plug cables.

(6) Fill cooling system with clean soft water. Add antifreeze if necessary.

(7) Fill fuel tank, open valve in gasoline line, and operate hand priming lever on fuel pump to fill carburetor float chamber.

(8) Close drain cock (fig. 9) in air receiver.

(9) Start engine. Allow to run slowly until thoroughly warmed up before engaging compressor.

## 5. MALFUNCTIONS AND CORRECTIONS.

### a. Compressor and Pressure Control System.

| Symptom | Cause | Remedy |
|---|---|---|
| (1) Noise in air receiver or hot air breathing from intercooler relief valve when compressor is idling. | *(a)* Broken or improperly seating high-pressure cylinder discharge valve. | *(a)* Remove discharge valve from high-pressure cylinder (par. 6 **a** (7) ). Inspect for broken or worn parts. Note especially valve seat to see if it has low spots. Replace broken or worn parts. |
| (2) Air leaking from intercooler relief valve when compressor is pumping or intercooler relief valve fails to open and relieve intercooler pressure when compressor is idling. | *(a)* Intercooler relief valve fails to function. | *(a)* Remove intercooler relief valve (par. 6 **a** (11) ). Inspect for worn or broken parts. Replace unserviceable parts, lubricate, and replace valve. |
| (3) Gage shows intercooler pressure below normal. | *(a)* Leaking low-pressure valves. | *(a)* Remove, clean, and inspect valves. Replace broken or worn parts. |
| (4) Gage shows intercooler pressure above normal. | *(a)* Leaking high-pressure valves or intercooler relief valve not functioning properly. | *(a)* Remove, clean, and inspect valves (par. 6 **a** (5) and (7) ). Replace broken or worn parts. Remove, clean, and inspect intercooler relief valve (par. 6 **a** (11) ). Replace broken or worn parts. Lubricate and replace valve. |
| (5) Compressor fails to pump up to pressure and intercooler safety valve pops off. | *(a)* Worn or broken high-pressure suction valve. | *(a)* Remove (par. 6 **a** (5) ). Clean, and inspect valve. Replace broken or worn parts. |



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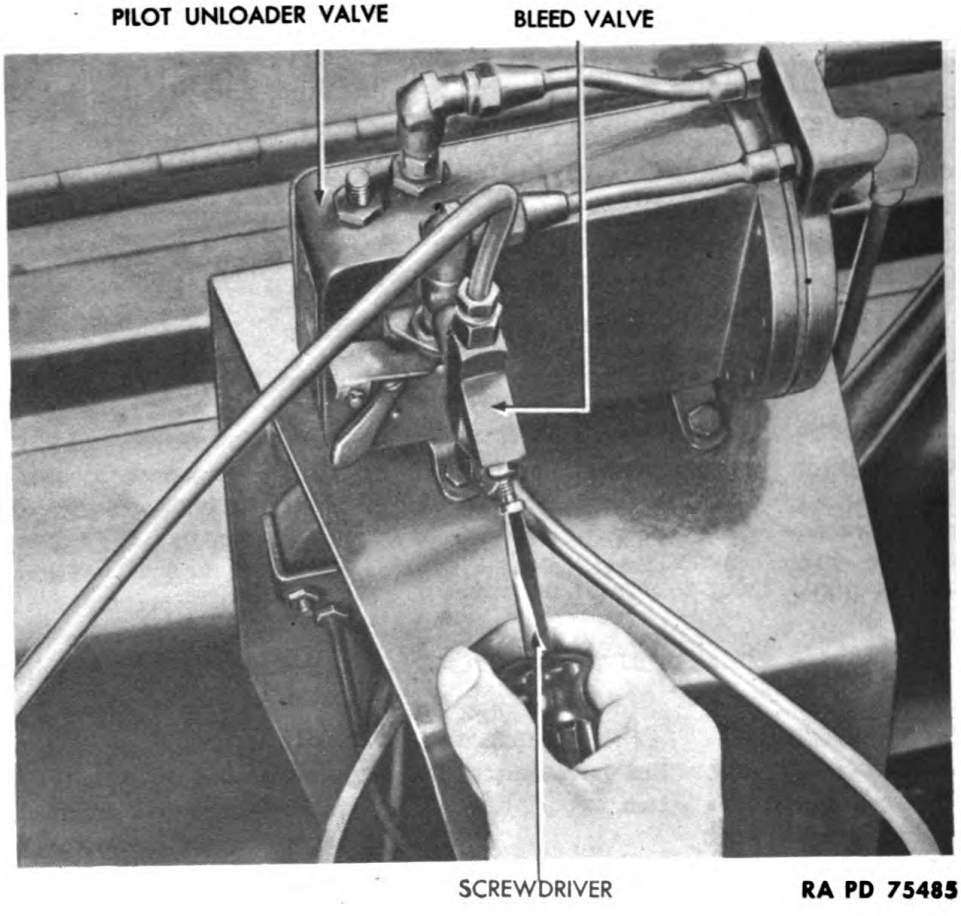



***Figure 12 — Adjusting Compressor Unit Pressure Control System Bleed Valve***

| Symptom | Cause | Remedy |
|---|---|---|
| (6) Compressor oil gage fails to indicate pressure. | *(a)* Line to gage plugged or gage defective. | *(a)* Disconnect line to gage. Clean thoroughly and replace. Be sure all joints are tight. Replace gage if defective. |
| | *(b)* Dirt under ball seat in oil pump or sticking pressure relief valve. | *(b)* Dismantle (par. 6 a (1) ) and clean oil pump. Examine ball seat, and relief valve. Replace worn or broken parts. |
| | *(c)* No oil in crankcase. | *(c)* Fill to "F" mark on bayonet gage with proper oil (par. 8 b). |



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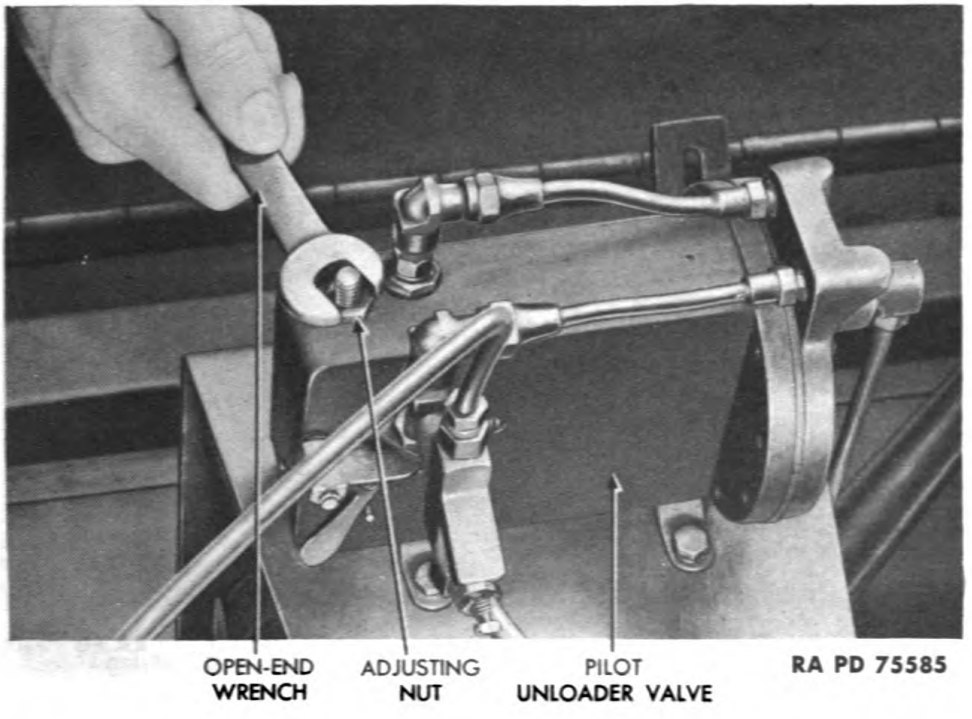



***Figure 13 — Making Pressure Adjustment on Compressor Unloader Pilot Valve***

| Symptom | Cause | Remedy |
|---|---|---|
| | *(d)* Oil pump screen plugged. | *(d)* Remove, clean, and reinstall oil pump screen (par. 6 **a** (1) ). |
| **(7)** Unloader pilot switch chatters. | *(a)* Differential pressures set too close. | *(a)* Adjust differential pressure (subpar. 5 **a** 11, below). |
| **(8)** Compressor knocks. | *(a)* Loose or worn connecting rod or piston wrist pin bearing. | *(a)* Check oil supply with bayonet gage. Fill to "F" mark with proper oil (par. 8 **b** (1) ). If knock persists, remove cylinder and inspect connecting rod and wrist pin bearings. Replace worn or broken parts. |

**(9)** ADJUSTMENT OF PRESSURE CONTROL SYSTEM CHECK AND BLEED VALVE (fig. 12). Normally, the check and bleed valve requires no adjustment. However, the time delay can be changed if necessary as follows: Adjust screw on side of valve with a screwdriver. Turn inward to increase or outward to decrease time delay.



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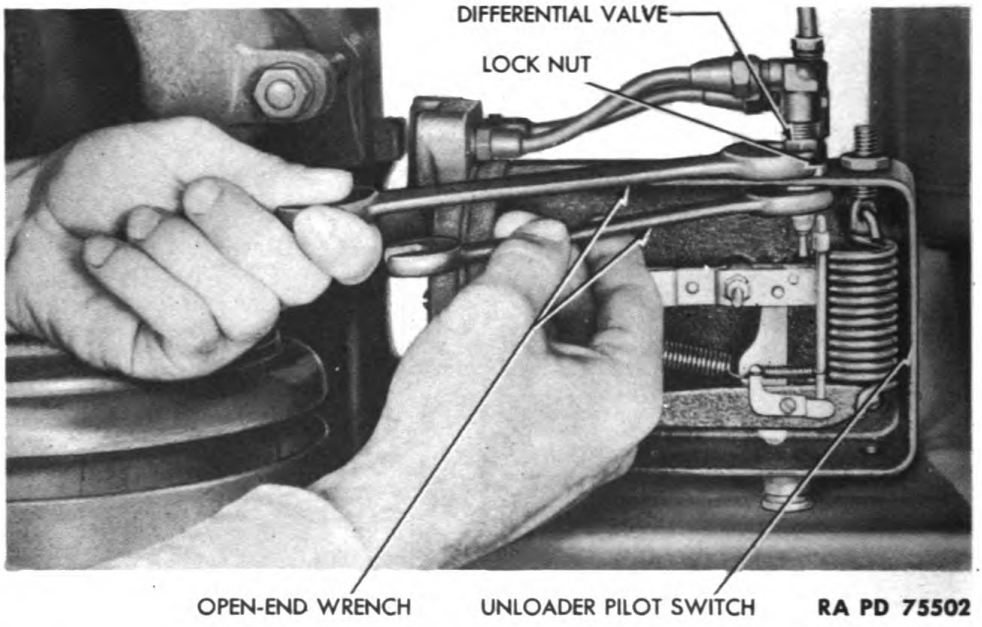



***Figure 14 — Adjusting Differential of Compressor Unloader Pilot Valve***

(10) PRESSURE ADJUSTMENT OF UNLOADER PILOT VALVE (fig. 13). Normally, the unloader pilot switch needs no adjustment. It is set to unload at 100 pounds per square inch pressure, and to load at 88 pounds per square inch pressure. If for any reason the pressure must be changed, proceed as follows: Turn adjusting nut on top of switch clockwise to raise and counterclockwise to lower both unloading and loading pressures.

(11) DIFFERENTIAL ADJUSTMENT OF UNLOADER PILOT VALVE (fig. 14). Do not change the differential adjustment of the pressure control system unless it becomes necessary due to presence of chattering or other difficulty. Differential pressure should never be adjusted to less than 10 pounds because of the danger of inducing chattering. When necessary to adjust differential pressure, proceed as follows:

*(a)* Loosen lock nut on differential valve on top of unloader pilot valve.

*(b)* Raise differential valve to increase differential; lower to narrow.

**b. Clutch Adjustment** (fig. 15). After considerable wear, the clutch may require adjustment to bring it into proper position. As the clutch wears, the pressure springs which take up wear, reach the limit of their expansion. When this occurs, adjust the clutch as follows: Pull



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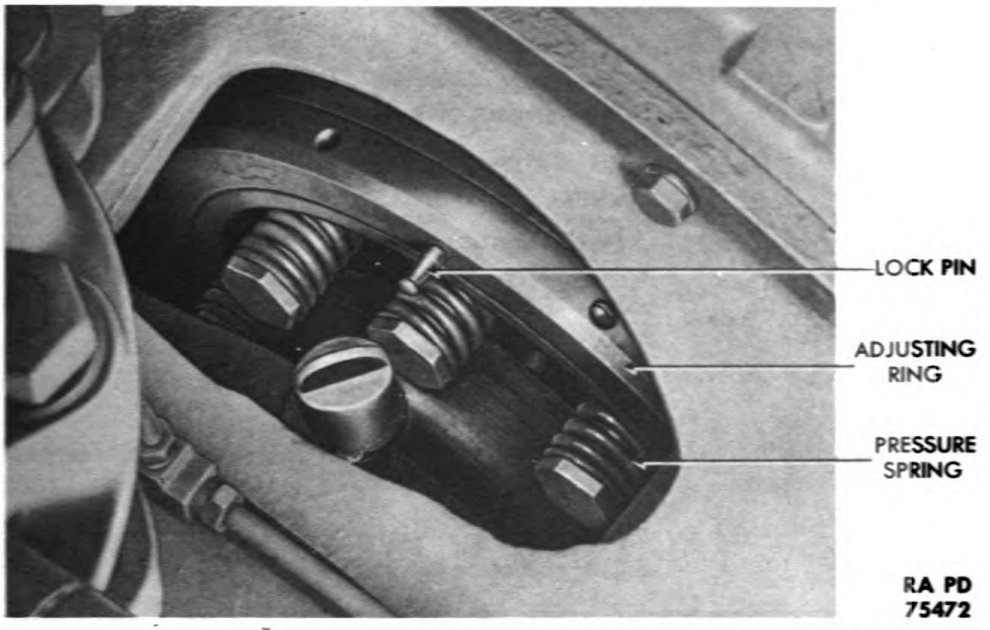



*Figure 15 — Adjustment Fittings on Compressor Clutch*

out lockpin and rotate adjusting ring clockwise approximately two and one-half turns until the pressure springs are compressed to their original height of $1\frac{15}{16}$ inches. This measurement is taken with the clutch in engaged position.

**c. Compressor Engine.**

| Symptom | Cause | Remedy |
|---|---|---|
| (1) Engine hard to start. | *(a)* Weak battery. | *(a)* Recharge or replace battery. |
| | *(b)* Defective magneto. | *(b)* Replace magneto (par. 6 **b** (5) *(b)*). |
| | *(c)* No gasoline in tank. | *(c)* Fill fuel tank. |
| | *(d)* Gasoline flow obstructed. | *(d)* Clean gasoline lines and fittings. |
| | *(e)* Water in fuel supply. | *(e)* Drain fuel system and fill with 72 or 80 octane motor fuel. |
| | *(f)* Loose or defective wiring. | *(f)* Tighten, repair, or replace loose or defective wires. |
| | *(g)* Spark plugs cracked or burned. | *(g)* Replace spark plugs. |
| | *(h)* Spark plugs fouled. | *(h)* Clean and adjust spark plugs. |



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## ORDNANCE MAINTENANCE — MAINTENANCE OF BOMB DISPOSAL EQUIPMENT FOR ACCESS AND STERILIZATION

| Symptom | Cause | Remedy |
|---|---|---|
| | *(i)* Wires connected to wrong spark plugs. | *(i)* Connect wires correctly. |
| | *(j)* Improper gas mixture. | *(j)* Adjust carburetor (step (14) *(d)*, below). |
| | *(k)* Throttle or governor valve loose on shaft. | *(k)* Tighten loose valve (par. 6 **b** (4) *(g)*). |
| | *(l)* Intake manifold leaking. | *(l)* Replace manifold gaskets and/or tighten manifold. |
| | *(m)* Valve seats leaking. | *(m)* Grind valves (step 5 (12) below). |
| | *(n)* Improper timing of ignition or valves. | *(n)* Time ignition (par. 6 **b** (5) *(c)*), and/or valves. |
| (2) Engine misses. | *(a)* Spark plugs fouled or out of adjustment. | *(a)* Clean and adjust spark plugs. |
| | *(b)* Spark plugs cracked or burned. | *(b)* Replace spark plugs. |
| | *(c)* Defective wiring. | *(c)* Tighten, repair, or replace defective wires. |
| | *(d)* Magneto breaker points sticking. | *(d)* Replace magneto breaker points (step (15) *(b)*, below). |
| | *(e)* Magneto breaker point gap wrong. | *(e)* Adjust magneto breaker point gap to 0.014 to 0.018 inch (step (15) *(c)*, below). |
| | *(f)* Cylinder head gasket leaking. | *(f)* Replace gasket and/or tighten head (par. 6 **b** (2)). |
| | *(g)* Manifold gaskets leaking. | *(g)* Replace gaskets and/or tighten manifold. |
| | *(h)* Valves warped or broken. | *(h)* Replace damaged valves. Grind all valves (step (12), below). |
| | *(i)* Valves or tappets sticking. | *(i)* Remove sticking parts. Check for straightness. Replace if bent. Dress down with CLOTH, crocus, if oversize. |



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## MOTORIZED AIR COMPRESSOR

| Symptom | Cause | Remedy |
|---|---|---|
| | *(j)* Valve tappets out of adjustment. | *(j)* Adjust valve tappets to 0.018-inch clearance cold or 0.015-inch clearance with engine warm (step (11), below). |
| (3) Engine overheats. | *(a)* Insufficient water in cooling system. | *(a)* Fill cooling system with clean soft water. |
| | *(b)* Fan belt slipping. | *(b)* Adjust fan belt (step (13) *(c)*, below). |
| | *(c)* Spark retarded too far. | *(c)* Adjust magneto (par. 6 b (5) *(c)*). |
| | *(d)* Water hose obstructed. | *(d)* Remove hose and clean or replace. |
| | *(e)* Water hose collapsed. | *(e)* Replace hose. |
| | *(f)* Carburetor choke valve partly closed. | *(f)* Open choke valve. |
| | *(g)* Improper gas mixture. | *(g)* Adjust carburetor (step (14) *(d)*, below). |
| | *(h)* Radiator clogged. | *(h)* Clean cooling system. If trouble persists, remove radiator and flush by itself. If trouble still persists, replace radiator. |
| | *(i)* Dirt in cooling system. | *(i)* Clean cooling system. |
| | *(j)* Improper timing. | *(j)* Time ignition (par. 6 b (5) *(c)*) and/or valves. |
| | *(k)* Valves leaking. | *(k)* Grind valves (step (12), below). |
| | *(l)* Oil badly diluted. | *(l)* Drain oil. Refill with proper grade, clean, fresh oil (par. 8 b). |
| | *(m)* Insufficient oil. | *(m)* Fill to "F" mark on bayonet gage (par. 8 b). |
| (4) Engine lacks power. | *(a)* Piston rings weak or worn. | *(a)* Replace rings. |
| | *(b)* Piston rings sticking. | *(b)* Replace or free piston rings. |
| | *(c)* Valve seats worn. | *(c)* Grind valves (step (12), below). |



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| Symptom | Cause | Remedy |
|---|---|---|
| | *(d)* Improper gas mixture. | *(d)* Adjust carburetor (step (14) *(d)*, below). |
| | *(e)* Improper timing of ignition or valves. | *(e)* Time ignition (par. 6 **b** (5) *(c)*) and/or valves. |
| | *(f)* Muffler plugged. | *(f)* Replace muffler. |
| | *(g)* Governor or throttle loose. | *(g)* Tighten loose parts. |
| | *(h)* Oil badly diluted. | *(h)* Drain oil and replace with clean, fresh oil of proper grade (par. 8 **b**). |
| | *(i)* Air cleaner fouled. | *(i)* Service air cleaners (par. 8 **c** (1) *(a)*). |
| (5) Engine knocks. | *(a)* Carbon in cylinders. | *(a)* Remove head (par. 6 **b** (1)) and clean carbon from cylinders. |
| | *(b)* Loose main bearing. | *(b)* Adjust all main bearings. |
| | *(c)* Loose rod bearing. | *(c)* Adjust all rod bearings. |
| | *(d)* Worn pistons and cylinders. | *(d)* Replace cylinder sleeves and pistons. |
| | *(e)* Loose valve tappets. | *(e)* Tighten and adjust valve tappets (step (11), below). |
| | *(f)* Engine overheated. | *(f)* Stop engine and allow to cool. Determine and correct cause of overheating (see above). |
| | *(g)* Tight pistons. | *(g)* Add 1 pint engine oil SAE 10 to each 5 gallons of gasoline in fuel tank. Break in slowly with engine idling without load. |
| | *(h)* Loose flywheel. | *(h)* Tighten flywheel to crankshaft. |
| | *(i)* Lack of oil or water. | *(i)* Fill with proper oil to "F" mark on bayonet gage. Fill cooling system with clean, soft water. |
| | *(j)* Stuck valve. | *(j)* Remove valve and clean if gummed. Replace if bent or oversize. |



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## MOTORIZED AIR COMPRESSOR

| Symptom | Cause | Remedy |
|---|---|---|
| | *(k)* Worn timing gears. | *(k)* Replace timing gears. |
| (6) Faulty carburetion. | *(a)* Carburetor improperly adjusted. | *(a)* Adjust carburetor (step (14) *(d)*, below). |
| | *(b)* Valves leaking. | *(b)* Grind (step (12), below), or replace valves. |
| | *(c)* Intake manifold leaking. | *(c)* Replace gaskets and/or tighten manifold. |
| | *(d)* Carburetor gasket leaking. | *(d)* Replace gasket (par. 6 **b** (4) *(e)*). |
| | *(e)* Shut-off valve closed. | *(e)* Open shut-off valve. |
| | *(f)* Using too much fuel, float not working properly. | *(f)* Disassemble (par. 6 **b** (4) *(f)*) and clean carburetor. Replace worn or damaged parts. |
| | *(g)* Water in fuel. | *(g)* Drain fuel system. Fill with motor fuel, 72 or 80 octane. |
| | *(h)* Sediment in fuel tank. | *(h)* Remove fuel tank and clean sediment from it. |
| (7) Excessive smoke from exhaust. | *(a)* Too much oil in crankcase. | *(a)* Remove excess oil. Never fill above full mark on bayonet gage. |
| | *(b)* Carburetor needle valve open too far. | *(b)* Adjust carburetor (step (14) *(d)*, below). |
| | *(c)* Carburetor float sticking or leaking. | *(c)* Disassemble par. 6 **b** (4) *(f)*) and clean carburetor. Replace worn or broken parts. |
| | *(d)* Lubricating oil too thin to seal pistons. | *(d)* Drain oil. Refill with proper oil (par. 8 **b**). |
| | *(e)* Worn bearings, rings, cylinders, and valve guides. | *(e)* Replace worn parts. |
| (8) Explosions in muffler. | *(a)* Ignition too late. | *(a)* Time ignition (par. 6 **b** (5) *(c)*). |
| | *(b)* Weak spark. | *(b)* Clean and adjust spark plugs and magneto. Replace defective parts. |



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## ORDNANCE MAINTENANCE — MAINTENANCE OF BOMB DISPOSAL EQUIPMENT FOR ACCESS AND STERILIZATION

| Symptom | Cause | Remedy |
|---|---|---|
| | *(c)* Valves holding open. | *(c)* Remove and clean valves. Replace bent or warped valves. |
| | *(d)* Valves out of time. | *(d)* Time valves. |
| | *(e)* Missing on two or more cylinders. | *(e)* Check for loose or crossed wires. Clean and adjust spark plugs. Replace defective spark plugs or wires. If trouble persists, clean and adjust or replace magneto. |
| | *(f)* Low on gasoline. | *(f)* Inspect and fill gasoline tank if necessary. |
| (9) Explosions in carburetor or intake manifold. | *(a)* Gas mixture too lean. | *(a)* Adjust carburetor (step (14) *(d)*, below). |
| | *(b)* Intake valves or tappets sticking. | *(b)* Clean parts if gummed. Replace worn, bent, or warped parts. |
| | *(c)* Ignition wires crossed. | *(c)* Connect wires correctly. |
| | *(d)* Engine out of time. | *(d)* Time engine. |
| | *(e)* Intake valve springs weak. | *(e)* Replace intake valve springs (step (12), below). |
| | *(f)* Intake manifold leaking. | *(f)* Replace gaskets and/or tighten manifold. |
| | *(g)* Intake valves warped or broken. | *(g)* Replace warped or broken valves (step (12), below). |
| | *(h)* Intake tappets set too close. | *(h)* Adjust tappets to 0.018-inch clearance cold or 0.015-inch clearance with engine warm (step (11), below). |
| | *(i)* Incorrect ignition timing. | *(i)* Time ignition (par. 6 b (5) *(c)*). |
| | *(j)* Cylinder head gasket leaking. | *(j)* Replace gasket and/or tighten head (par. 6 b (1)). |
| (10) Poor compression. | *(a)* Valves not seating. | *(a)* Grind valves (step (12), below). |



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## MOTORIZED AIR COMPRESSOR

| Symptom | Cause | Remedy |
|---|---|---|
| | *(b)* Valves sticking. | *(b)* Remove valves (step (12), below). Clean if gummed. Replace if warped, bent, or oversize. |
| | *(c)* Valve tappets sticking. | *(c)* Clean gummed tappets. Replace bent or warped parts. |
| | *(d)* Valve tappets set too close. | *(d)* Adjust tappets to 0.018-inch clearance cold or to 0.015-inch clearance with engine warm (step (11), below). |
| | *(e)* Piston rings weak or worn. | *(e)* Replace piston rings. |
| | *(f)* Piston rings broken. | *(f)* Replace piston rings. |
| | *(g)* Piston rings sticking. | *(g)* Remove rings. Clean if gummed. Replace if bent or worn. |
| | *(h)* Loose, cracked, or burned spark plugs. | *(h)* Tighten loose plugs. Replace damaged plugs. |
| | *(i)* Cylinder head loose or gasket leaking. | *(i)* Tighten cylinder head (par. 6 b (2) ). Replace gasket if trouble persists after tightening. |
| | *(j)* Oil too thin to seal pistons. | *(j)* Drain oil. Fill with proper oil to "F" mark on bayonet gage (par. 8 b). |
| | *(k)* Scored cylinders or worn pistons and cylinders. | *(k)* Replace pistons and cylinder sleeves. |
| | *(l)* Weak valve springs. | *(l)* Replace valve springs (step 9 (12), below). |
| | *(m)* Camshaft incorrectly timed. | *(m)* Time engine. |

(11) ADJUSTMENT OF VALVE CLEARANCE (fig. 16). Check valve clearance every 400 working hours, and adjust if necessary. On both intake and exhaust valves, clearance of 0.015 inch is necessary between valve stem ends and rocker arm tappets when valves are closed and engine is warm. Clearance of 0.018 inch is necessary when engine is cold. Adjustment procedure follows:

*(a)* Be sure ignition is "OFF" (button pushed in) to eliminate any danger of engine's starting.



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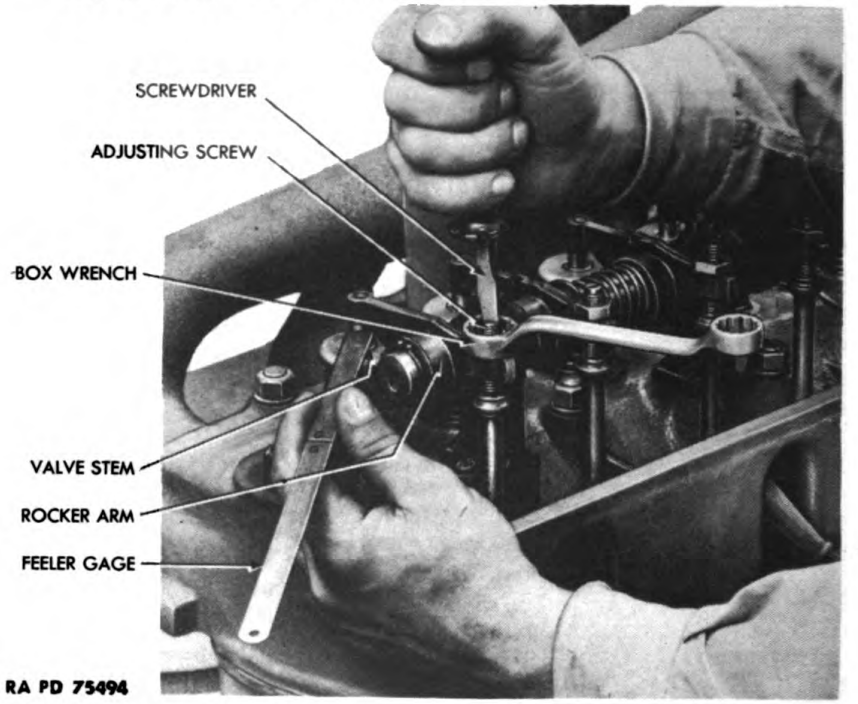



***Figure 16 — Adjusting Compressor Unit Engine Valve Tappets***

*(b)* Remove cylinder head cover.

*(c)* Remove spark plug from number one cylinder adjacent to radiator.

*(d)* Place thumb over spark plug opening and crank engine slowly until outward pressure can be felt. Pressure indicates number one piston is moving toward upper dead center of compression stroke.

*(e)* Continue to crank slowly until top dead center position is indicated by timing wheel pointer on flywheel (fig. 37). Both valves are now closed on compression stroke, and piston is in top dead center position.

*(f)* Loosen lock nut and adjust screw in rocker arm so that 0.015-inch feeler gage slips snugly between tappet and valve stem.

*(g)* Tighten lock nut and recheck clearance.

*(h)* Crank engine one-half revolution at a time, checking clearance of oil valves; adjust if necessary. Firing order of engine is 1-2-4-3.

*(i)* Replace cylinder head cover. Check to see that cylinder head cover gasket is in good condition and makes an oiltight seal. Replace gasket if necessary.



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## MOTORIZED AIR COMPRESSOR

(12) RESURFACING VALVES AND VALVE SEATS. Valve seats and valve faces become worn, scored, and pitted after considerable use. These conditions are indicated by poor compression, lack of power, and by overheating of the engine. Extreme cases may cause explosions or backfiring in the intake manifold or muffler. There are two commonly used methods of correcting the condition, grinding or lapping valves, and resurfacing valve seats and valve faces. The latter method is recommended and outlined below:

*(a)* Remove the four stud nuts which secure cylinder head cover to cylinder head. Lift cover from head.

*(b)* Remove the four stud nuts which secure the rocker arm assembly in place. Lift rocker arm assembly from cylinder head.

*(c)* Remove the cylinder head from the engine (par. 6 b (1) ).

*(d)* Compress one valve spring with a valve spring compressing tool. Lift off the halves of the split special valve spring lock washer. Lift off the cup-shaped valve spring washer. Remove valve spring retaining tool and lift the valve spring from the cylinder head. Pull valve from cylinder head.

*(e)* Repeat step *(d)*, above, to remove each of the other seven valves from cylinder head. Mark the number of the valve on valve head with a steel scribe as valves are removed so they can be installed in the same seat and guide from which removed.

*(f)* Clean all valves and valve seats with SOLVENT, dry-cleaning, and a wire brush. Inspect valves to see if any valve stems are bent, or if any valve heads are warped, broken, or badly pitted. Replace valves that show evidence of any of those conditions. Inspect exhaust valve seats to see if any inserts are badly pitted or so badly worn that resurfacing will likely make it necessary to grind into the metal of the cylinder head. Pull inserts which do not pass inspection with a valve seat insert pulling tool and press new insert into place with an arbor press.

*(g)* Reface valve seats with a 45-degree reamer or with a valve seat grinder set at 45 degrees.

*(h)* Reface valves in a valve grinding machine set at 45 degrees.

*(i)* Test fit of refaced valve in its seat with PRUSSIAN BLUE. A seat of $\frac{1}{16}$ to $\frac{3}{32}$ inch wide must be indicated around the entire circumference of the seat

*(j)* Insert each valve, one at a time, in its individual guide in the cylinder head, with a light spring around the valve stem. The spring must be just long enough to hold the valve face off the valve seat. Spread on fine valve grinding compound so that the valve face contacts the valve seat, and oscillate the valve with the valve grinding tool. Remove the valve and spring from the cylinder head. Wash



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all traces of the compound from the cylinder head and valve with solvent. Observe the lapping marks on the valve face and seat to be sure that a seat of 1/16 to 3/32 inch has been obtained. If at all doubtful, use PRUSSIAN BLUE to make the test. Lap and test again if necessary.

*(k)* Place a valve through its guide from the under side of the cylinder head. On top of the cylinder head, slide a valve spring (compressed with a valve spring compressor), valve spring washer, and both halves of the split special valve spring retainer over the valve stem. Make sure the split washer is seated in its slots on the valve stem. Remove the spring compressor. Repeat the process to install each of the remaining seven valves. Be sure to put each valve into the guide and seat from which it was removed, and into which it was lapped.

*(l)* Assemble the rocker arm assembly to the cylinder head.

*(m)* Install cylinder head gasket, cylinder head, carburetor gasket, carburetor, manifold gaskets, and manifold (par. 6 **b** (2)).

*(n)* Adjust valve tappets (step (11), above).

*(o)* Install cylinder head cover gasket and cover.

(13) COOLING SYSTEM.

*(a) Cleaning Dirt and Sludge From System.*

*1.* Drain system completely by opening drain cock in lower radiator connection and in cylinder block below carburetor. Close cocks.

*2.* Clean cooling system with COMPOUND, cleaning (TM 9-850).

*3.* Remove radiator filler cap, and run engine until water is hot. Drain and flush the system with clear water.

*4.* Refill with clean, soft water.

*(b) Cleaning Radiator Core.* Overheating may be caused by bent or clogged radiator fins. If spaces between fins become clogged, clean them with an air blast. When straightening bent fins be careful to keep from damaging the tubes or breaking the bond between tubes. This information also applies to the intercooler.

*(c) Adjustment of Fan Belt Tension.* Fan belt tension is correct when belt can be depressed, without effort, about ½ to ¾ inch, midway between pulleys. A belt that is too loose or too tight wears rapidly. If the belt is too loose, it is likely to slip and burn. Adjust tension of fan belt by changing the width of the groove in the pulley. This is done by loosening the adjusting lock screws in the pulley. Move flanges together to tighten belt. Tighten lock screws after proper tension is obtained. Check tension of a new belt after 50 hours service. Adjust if necessary.



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## MOTORIZED AIR COMPRESSOR

NOTE: Never adjust a fan belt so it contacts bottom of pulley groove. This causes rapid wear.

*(d)* Repairing Water Pump Leak.

*1.* Remove (par. 6 **b** (3) *(c)*) and disassemble (par. 6 **b** (3) *(d)*) water pump.

*2.* Replace carbon sealing washer and bellows.

*3.* Assemble (par. 6 **b** (3) *(e)*) and install (par. 6 **b** (3) *(f)*) water pump.

(14) FUEL SYSTEM TROUBLE SHOOTING.

| Symptom | Cause | Remedy |
|---|---|---|
| *(a)* Pump supplies insufficient or no fuel to carburetor. | *1.* Fuel tank empty. | *1.* Fill fuel tank with motor fuel, 72 or 80 octane. |
| | *2.* Leaky tubing or connections. | *2.* Replace tubing and tighten all line connections at fuel pump and fuel tank. |
| | *3.* Loose valve plug. | *3.* Tighten valve plug. Replace gasket if damaged (par. 6 **b** (4) *(b)*). |
| | *4.* Bent or kinked tubing. Dirt on screen. | *4.* Replace damaged tubing. Clean the screen. Make certain cork gasket is properly seated when assembling (par. 6 **b** (4) *(c)*). |
| | *5.* Dirty or warped valves. | *5.* Remove valve plugs and valves (par. 6 **b** (4) *(b)*). If valves are warped or damaged, replace them. Examine seats to make certain there are no irregularities which prevent proper seating of valves. Replace valves in valve chambers. Assemble plugs and springs. Be sure springs fit around stems of plugs properly. Use new plug gaskets if old gaskets are worn or damaged. |
| | *6.* Defective or worn linkage. | *6.* Replace worn or broken links (par. 6 **b** (4) *(b)*). |
| | *7.* Broken rocker arm. | *7.* Replace rocker arm (par. 6 **b** (4) *(b)*). |
| | *8.* Broken rocker arm spring. | *8.* Replace rocker arm spring (par. 6 **b** (4) *(b)*). |
| | *9.* Broken diaphragm return spring. | *9.* Replace diaphragm return spring (par. 6 **b** (4) *(b)*). |



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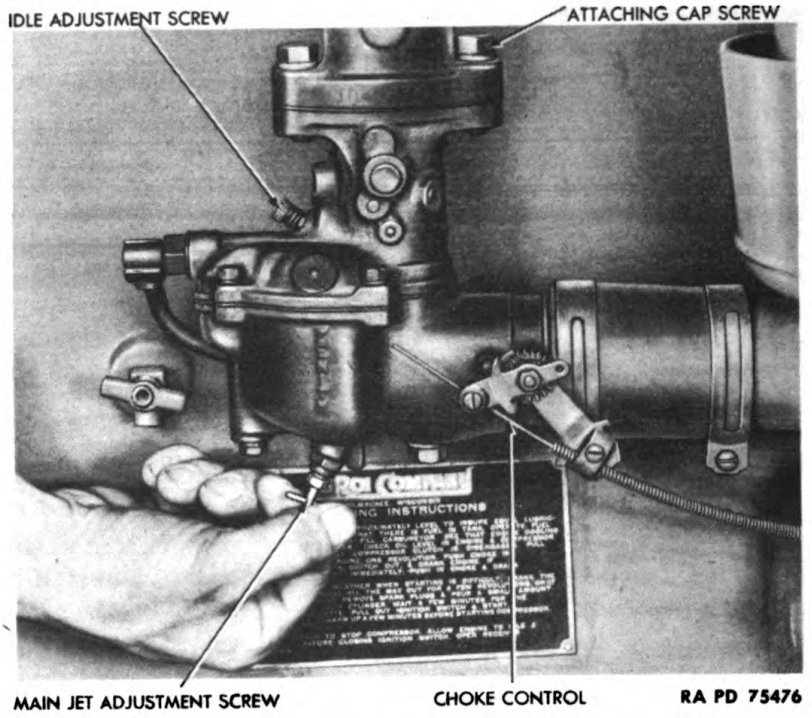



***Figure 17 — Adjusting Compressor Unit Engine Carburetor***

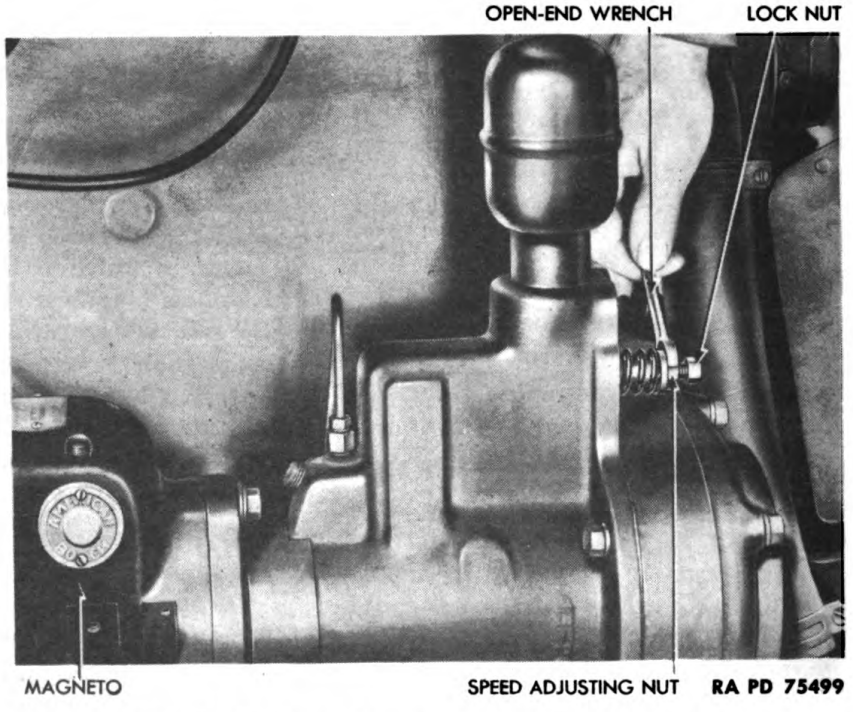



***Figure 18 — Adjusting Compressor Unit Engine Governor***



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## MOTORIZED AIR COMPRESSOR

| Symptom | Cause | Remedy |
|---|---|---|
| *(b)* Gasoline leaks from pump. | *1.* Punctured or worn out diaphragm. | *1.* Replace diaphragm (par. 6 b (4) *(b)*). |
| | *2.* Pull rod gasket worn or loose. | *2.* Replace pull rod gasket, tightening pull rod nut securely (par. 6 b (4) *(b)*). |
| | *3.* Loose cover screws. | *3.* Tighten cover screws alternately and securely (par. 6 b (4) *(c)*). Check outlet and inlet line connections. |
| | *4.* Broken body or cover. | *4.* Completely disassemble pump (par. 6 b (4) *(b)*). Inspect all parts carefully. Replace all bent or broken parts. |

*(c) Repairs to Fuel Pump.*

*1.* Never stretch or in any way alter tension of valve springs. This will reduce capacity of pump. Always replace valve springs if at all questionable.

*2.* If valve operation becomes impaired because of gum-like deposits, disassemble pump and clean and polish valves, valve seats, and gas strainer parts.

*(d) Adjustment of Carburetor.* Only two adjustments can be made on this carburetor without changing parts. These are the main jet, or high-speed adjustment, and the idle adjustment.

*1. Main Jet Adjustment* (fig. 17). With engine running, open throttle to about one-fourth open. Turn main jet adjustment (thumbscrew on bottom of carburetor) clockwise until engine speed decreases due to too lean a mixture. Open adjustment until engine speed decreases due to too much fuel. Set the adjustment halfway between these two extremes.

*2. Idle Adjustment* (fig. 17). With engine idling, turn idle adjustment screw (knurled head screw set an angle near top of carburetor). Clockwise motion enriches mixture; counterclockwise leans mixture. Adjust to position at which engine runs fastest for given throttle adjustment.

*(e) Adjustment of Governor* (fig. 18). Speed of the governor is set at 865 revolutions per minute at the factory. Under normal conditions this setting should not be changed. If it becomes necessary to alter adjustment, proceed as follows:

*1.* Remove seal from governor spring top cover on side opposite to magneto. Remove cover.

*2.* Loosen lock nut and turn speed adjusting nut clockwise to increase speed, counterclockwise to decrease speed. Each one-fourth



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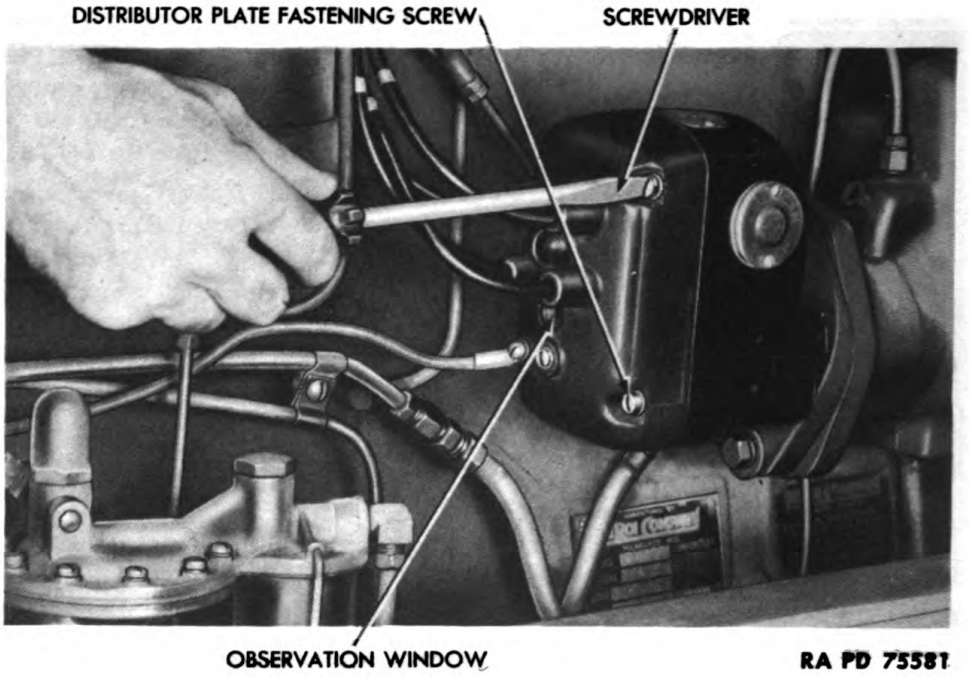



***Figure 19 — Removing Compressor Unit Engine Magneto Distributor Plate Assembly***

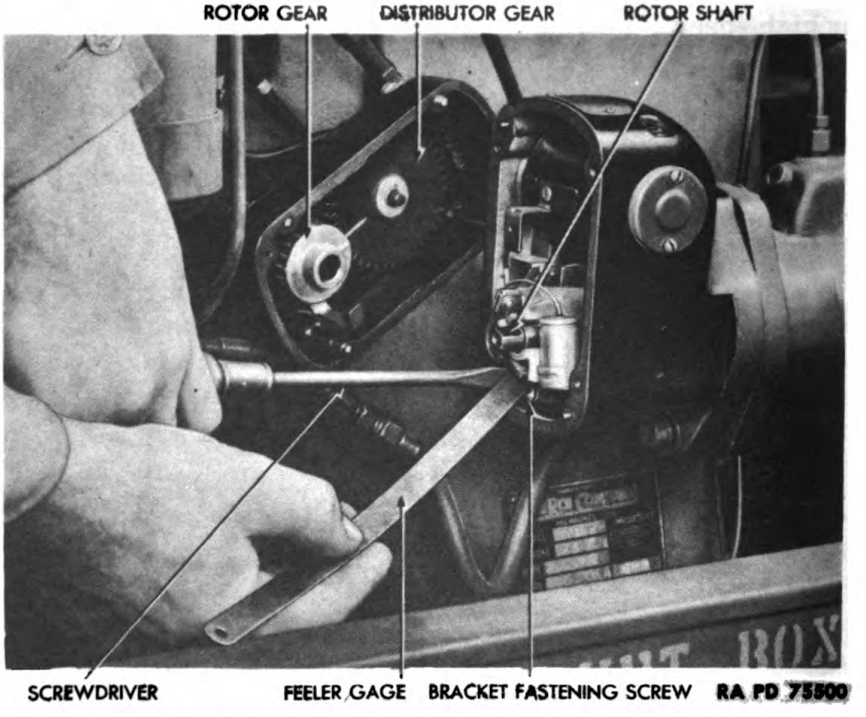



***Figure 20 — Adjusting Compressor Unit Engine Magneto Contact Points***



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turn on nut varies speed approximately 15 revolutions per minute. Speed of engine should be set at 865 revolutions per minute as tested with an indicator.

*3.* Tighten lock nut securely and replace cover and seal.

(15) ELECTRICAL SYSTEM TROUBLE SHOOTING.

| Symptom | Cause | Remedy |
|---|---|---|
| *(a)* Engine starts hard and misses at low speeds. | *1.* Spark plug gaps set too wide. | *1.* Remove and clean plugs. Set gap at 0.025 inch. |
| *(b)* Engine misfires continuously or intermittently. | *1.* Cracked or porous spark plug insulator. | *1.* Replace faulty spark plug. |
| | *2.* Insulation chafed from ignition cable. | *2.* Replace cable. Temporary repair may be made by wrapping exposed wire with friction tape. |
| | *3.* Broken ignition cable. | *3.* Replace cable. |
| | *4.* Loose ignition cable connection. | *4.* Tighten connection. If tips are pulled loose from wire, resolder or replace assembly. |
| | *5.* Magneto misfiring. | *5.* Inspect magneto interrupter assembly and lever for freedom of movement, contacts for cleanness and correct alinement, plate parts for possible arcing or leaking of high-tension current. Replace worn or broken parts (step *(c)*, below). |

*(c) Adjustment of Magneto Contact Points.*

*1.* Rotate engine until line on distributor gear is visible in observation window (fig. 19) on end of magneto. Remove the four fastening screws with a screwdriver and withdraw entire distributor plate assembly.

*2.* Adjust contact opening (fig. 20) to 0.014 to 0.018 inch when interrupter lever fiber bumper rests on top of cam lobe. This is done by shifting adjustable contact bracket. After adjustment, securely tighten bracket fastening screw. Contact points must be free of oil and grease and in proper alinement so the full surfaces of both contacts meet squarely. Clean pitted points with an oilstone; do not



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use a file. When replacing points always replace interrupter lever and contact bracket at the same time.

*3.* Replace distributor plate assembly. Line on distributor gear (fig. 20) must be visible through observation window (fig. 19). Engage magnet rotor shaft with rotor gear (fig. 20) and tighten distributor plate fastening screws (fig. 19).

NOTE: If distributor plate assembly was removed before instructions above were noted, rotate engine until piston of number one cylinder (adjacent to radiator) is in approximate firing position. Rotate distributor gear until line on gear is visible through observation window. Engage magnet rotor shaft with rotor gear, slightly moving gear in either direction, as required, to permit engagement. Tighten distributor plate fastening screws.

*(d) Checking Improperly Operating Cranking Motor.* If cranking motor cranks engine slowly or not at all, proceed as follows to isolate the trouble:

*1.* Check battery (step (16) following), battery terminals, connections, and cables. Replace corroded, frayed, or broken cables. Clean and tighten loose and dirty connections. Check the cranking motor switch for burned contacts. Clean or replace contacts if necessary.

NOTE: If the cranking motor functions properly after completion of one of the steps given here, ignore the rest of the steps. Otherwise proceed with the steps in order given until the difficulty is overcome.

*2.* Remove cover band from cranking motor and inspect brushes and commutator. Brushes should form a good contact with commutator. Spring tension should be 36 to 40 ounces. If commutator is dirty, clean it by holding a strip of PAPER, flint, class B, No. 2/0, against the revolving commutator with a stick. *Never use emery cloth to clean commutator.*

*3.* If commutator is extremely dirty, burned, or has high mica, remove armature from motor and take a cut off commutator in a lathe. Undercut the mica with a mica undercutter. Burned bars on the commutator may indicate open-circuited armature coils. Inspect soldered connections at commutator riser bars. An open armature coil will show excessive arcing at commutator bar which is open, on no-load test. Repair may sometimes be made if not too badly burned by resoldering leads to riser bars, turning down commutator, and undercutting mica. Inspect bearings to see if they are tight, dirty, or worn. Clean in SOLVENT, dry-cleaning, if dirty; replace if worn. Inspect armature shaft to see if it is bent. Replace armature if shaft is bent. Examine field pole screws, tighten if loose.



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*4.* Give cranking motor no-load test and torque test as outlined below:

*aa. No-load test.* Connect motor in series with a 6-volt battery, an ammeter registering several hundred amperes, and a variable resistance. Attach a revolutions per minute indicator to armature shaft. Set variable resistance at 5 volts. Observe revolutions per minute indicator and ammeter readings.

*bb.* Torque test. Remove revolutions per minute indicator used for no-load test. Attach torque wrench or other device for measuring torque to motor shaft. Adjust variable resistance to three volts. Note reading of ammeter and torque measuring device.

*cc. Interpreting results of no-load and torque tests.* No-load test of 3,000 revolutions per minute at 70 amperes at 5.0 volts and torque test of 19 foot-pounds at 5,000 amperes at 3.0 volts indicates normal condition of cranking motor. Low no-load speed, high current draw, with low developed torque may result from tight, dirty, or worn bearings, bent armature shaft, or loose field pole screws which would allow armature to drag; shorted armature (check armature on growler); grounded armature or field. (Check by lifting grounded brushes and insulating them from commutator with pieces of cardboard. Then check between insulated terminal and frame with test lamp. If lamp lights, raise other brushes from commutator and check fields and commutator separately to determine whether it is field or armature that is grounded.) Failure to operate, plus high current draw, may result from direct ground in switch, terminal or fields; or frozen shaft bearings. Failure to operate with no current draw may result from open field circuit (inspect connections and trace circuit with a test lamp); open armature coils (inspect commutator for badly burned bars. Running free, an open armature shows excessive arcing at commutator bar which is open); broken or weakened brush springs; worn brushes, high mica on commutator, or other condition preventing good contact between brushes and commutator. Any of these conditions cause burned commutator bars. Low no-load speed, with low torque and low current draw indicates an open field winding (raise and insulate ungrounded brushes from commutator and test fields with test lamp); high internal resistance due to poor connections, defective leads, or dirty commutator.

(16) BATTERY TROUBLE SHOOTING.

| Symptom | Cause | Remedy |
|---|---|---|
| *(a)* Hydrometer test shows all cells over 1.250 specific gravity, and readings within 10 or 15 points of each other. | *1.* Battery is normal. | *1.* In cold weather, battery should receive charge if readings are below 1.275. |



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| Symptom | Cause | Remedy |
|---|---|---|
| *(b)* Hydrometer test shows all cells reading 1.250 specific gravity or less, and readings within 10 or 15 points of each other. | *1.* Demand from battery is greater than input from generator. | *1.* Recharge battery. Boost charging of generator. Check electrical system for short circuits and loose connections. |
| *(c)* Twenty or more points variation between cells and highest reading over 1.225 specific gravity. | *1.* Short circuit in low cell or cells; evaporation caused by overcharging, unnecessary addition of acid, or loss of electrolyte by leakage. | *1.* Make a momentary test on each cell. If more than 1/10 volt variation between cells, replace battery. Otherwise, recharge battery until gravity of electrolyte remains constant for 4 hours. Adjust gravity of all cells by adding water or small amounts of acid (1.400 specific gravity or less). |
| *(d)* Cells show 20 or more points variation, and highest reading 1.225 specific gravity or less. | *1.* Short circuit in low cell or cells; evaporation caused by overcharging; unnecessary addition of acid; or, loss of electrolyte by leakage. | *1.* Recharge battery if possible and make high-rate test. If more than 1/10 volt variation between cells, replace battery. Otherwise, adjust gravity of all cells by adding water or small amounts of acid (1.400 specific gravity or less). |
| *(e)* Hydrometer reading shows cells over 1.300 specific gravity at 80 F. | *1.* Unnecessary addition of acid. | *1.* If not used long at high specific gravity, battery may be saved as follows: drain cells. Fill with 1.100 specific gravity electrolyte. Charge until gravity remains constant for 4 hours. Drain cells. Fill with 1.285 specific gravity. Charge 3 hours. Adjust gravity to 1.285. Continue charge until gravity of all cells remains constant for 2 hours. |
| | *2.* Addition of battery compounds commonly known as "dope" solutions. | *2.* Replace battery. |
| *(f)* Battery is fully charged but hydrometer test shows gravity of 1.265 or less at 80 F. | *1.* Excessive evaporation usually caused by overcharging. | *1.* Adjust gravity to 1.285 by adding small amounts of acid. Ascertain charging rate of generator and reduce rate if necessary. |



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## MOTORIZED AIR COMPRESSOR

| Symptom | Cause | Remedy |
|---|---|---|
| *(g)* Battery needs frequent addition of water. | *1.* Excessive overcharging. | *1.* Reduce generator or charging rate (step (17) ). |
| *(h)* Container cracked, necessitating frequent addition of water to one cell only. | *1.* Loose installation, stone bruise, or frozen battery. | *1.* Replace battery case. |
| *(i)* Bulge in battery container. | *1.* Excessive temperature probably caused by overcharging. | *1.* Reduce generator charging rate (step (17) ). |
| *(j)* Corrosion on battery terminals. | *1.* Excessive charging rate causing spray of acid on terminals, or lead coating destroyed on terminals. | *1.* Remove terminals from posts, clean posts and terminals thoroughly. Replace cable if corroded excessively. Connect terminals to posts and tighten securely. Carefully coat all exposed surfaces of terminals and posts with grease. Ascertain generator charging rate and reduce if necessary. |
| *(k)* Broken terminal post. | *1.* Loose battery installation or cable too short. | *1.* Remove battery. Build up new post. Replace cable, if too short, with one of proper length. Tighten battery in carrier and also terminals on posts. |

NOTE: All specific gravity readings are given for electrolyte at 80 F. If electrolyte is of appreciably different temperature, apply correction per following table:

| Temperature (deg F) | Correction (specific gravity points) | Temperature (deg F) | Correction (specific gravity points) |
|---|---|---|---|
| 120 | +16 | 45 | −14 |
| 115 | +14 | 40 | −16 |
| 110 | +12 | 35 | −18 |
| 105 | +10 | 30 | −20 |
| 100 | + 8 | 25 | −22 |
| 95 | + 6 | 20 | −24 |
| 90 | + 4 | 15 | −26 |
| 85 | + 2 | 10 | −28 |
| 80 | 0 | 5 | −30 |
| 75 | − 2 | 0 | −32 |
| 70 | − 4 | −5 | −34 |
| 65 | − 6 | −10 | −36 |
| 60 | − 8 | −15 | −38 |
| 55 | −10 | −20 | −40 |
| 50 | −12 | | |



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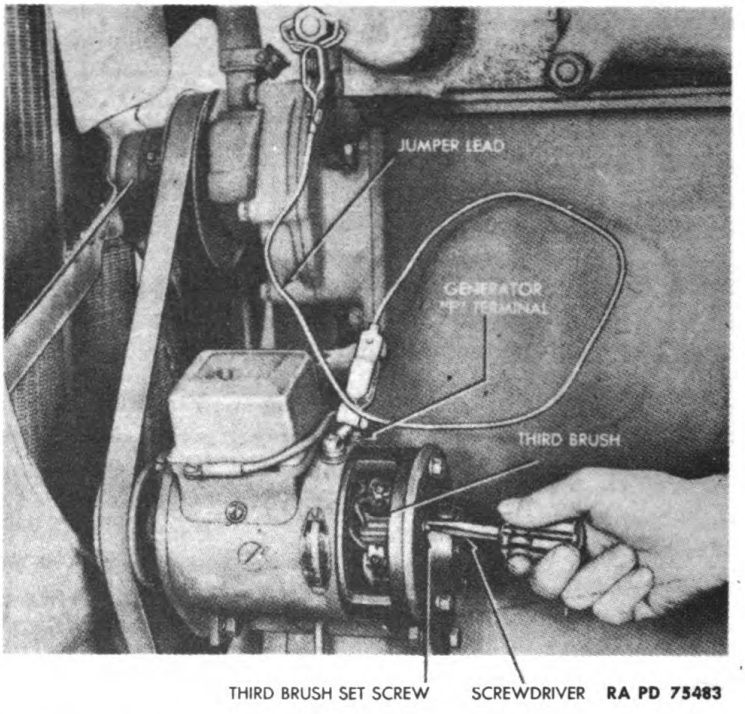



***Figure 21 — Adjusting Compressor Unit Generator Output***

(17) ADJUSTMENT OF GENERATOR OUTPUT (fig. 21).

*(a)* Connect a temporary jumper lead from generator "F" terminal to a good ground.

*(b)* Install a fully-charged 6-volt battery in the unit. If a fully-charged battery is not available, connect a ¼-ohm variable resistance into the circuit and cut in resistance until full voltage, 6-volts, is obtained.

*(c)* Connect an accurate ammeter into the circuit.

*(d)* Remove cover band from generator.

*(e)* Loosen third brush set screw on end of generator.

*(f)* Move third brush in direction of commutator rotation to increase rate, against direction of rotation to decrease rate.

*(g)* Start engine and observe charging rate at governed speed of engine. To protect generator and battery, do not set rate higher than 15 amperes. Reset third brush if necessary.

*(h)* Tighten third brush set screw.

*(i)* Remove jumper, variable resistance, and test ammeter. Install cover band.



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## MOTORIZED AIR COMPRESSOR

(18) CHECKING GENERATOR OUTPUT.

*(a)* If battery is not fully charged and generator has a low or no charging rate, momentarily ground voltage control "F" terminal. If output does not increase, generator is at fault. Inspect for worn or broken brushes; loose, broken, or disconnected wire, etc. If inspection fails to reveal a correctable defect, replace generator. If output increases when voltage control "F" terminal is grounded, step-voltage control is probably at fault. Inspect points for poor contact due to oxidation or lack of proper adjustment. Look for loose connections, defective wiring, or other causes of high resistance. If inspection fails to reveal correctable defect, replace step-voltage control.

*(b)* If battery is fully charged and ammeter shows high charging rate, remove voltage control cover and see if voltage control points are open. If they are not, open them by depressing voltage control armature by hand. If output falls off, adjust voltage control (step (20), below). If output does not drop off with points held open, disconnect voltage control "F" terminal. If output does not drop to 0, a grounded field in generator is indicated. Replace or repair generator. If output drops to 0, a ground field circuit in voltage control unit is indicated. Repair or replace voltage control unit.

(19) CHECKING INOPERATIVE GENERATOR. No output, unsteady or low output, excessive output, or noisy generator may make it necessary to remove generator from engine for further checking. Proceed as follows:

*(a) No Output.* Remove cover band and check for sticking or worn brushes. Burned bars, with other bars fairly clean, indicate open-circuited coils. If brushes are making good contact and commutator appears satisfactory, use a test lamp and check as follows: Raise grounded brush. Check with test lamp from "F" terminal to frame. Lamp should not light. If it does, generator is grounded; raise other brushes from commutator and check field, commutator, and brush holder to locate ground. If generator is not grounded, check field for open circuit. If field is not open, check for shorted field. Field draw at 6 volts should be 3.5 to 4.5 amperes. Excessive current draw indicates shorted field. If trouble is not yet located, remove armature and check for short circuit on a growler.

*(b) Unsteady or Low Output.* Check fan belt tension (step (13) *(c)*, above. Adjust if necessary. Check brushes for sticking



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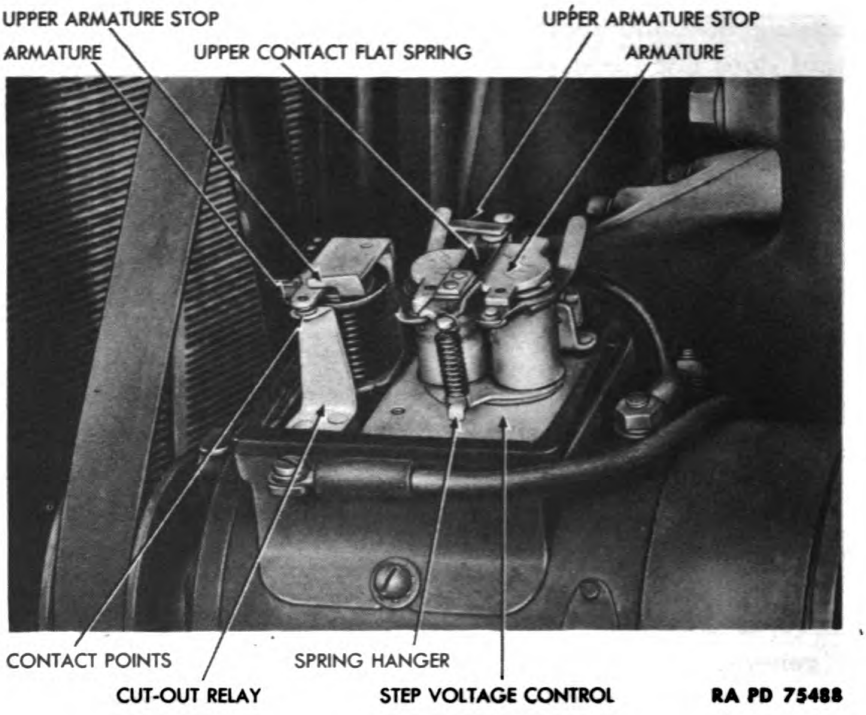



***Figure 22 — Compressor Unit Generator Control Unit — Cover Removed***

or in sufficient tension. Spring tension should be 22 to 26 ounces for main brushes and 16 to 20 ounces for third brush. Inspect commutator for roughness, grease, dirt, dirt in slots, high mica, out-of-round, or burned bars. If any of these conditions are present, remove armature. Turn down commutator on lathe. Undercut mica. In addition, with burned bars which indicate open circuit, open circuit must be corrected or armature replaced.

*(c) Excessive Output.* Excessive output generally results either from wrong third brush adjustment or from generator field grounded internally or externally. Disconnect lead from "F" terminal of generator. If output drops off, field is grounded externally. If output remains high, field is grounded inside generator, either at pole shoes, leads, or at "F" terminals.

*(d) Noisy Generator.* Noisy generator may be caused by loose mounting, driving mechanism, worn dry, or dirty bearings, or by improperly seated brushes. Seat brushes by holding a brush seating stone against revolving armature. Blow dust out with compressed air.



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(20) MECHANICAL ADJUSTMENT OF STEP-VOLTAGE CONTROL (UNIT DISCONTINUED) (fig. 22).

*(a)* Hook a spring gage to flat spring which carries upper contact at contact point. Check pull required to separate joints. Adjust, if necessary, by bending flat spring to secure tension of 0.5 to 1.1 ounces.

*(b)* Push armature down against lower armature stop. Measure air gap between armature and core with a feeler gage. Adjust, if necessary, by bending lower armature stop to secure an air gap of 0.035 inch.

*(c)* Check armature travel by measuring space between armature and lower armature stop. It should be 0.035 inch. Adjust by bending upper armature stop.

*(d)* Using a feeler gage, check contact opening with armature held down against lower armature stop. It should be 0.010 inch. Adjust, if necessary, by bending contact spring post.

(21) ADJUSTMENT OF OPENING AND CLOSING VOLTAGE OF STEP-VOLTAGE CONTROL (fig. 22).

*(a)* With voltage control at operating temperature, connect a test voltmeter between battery terminal and ground.

*(b)* Increase and decrease engine speed. Note voltage at which points open and close. Points should open at 6.45 to 7.35 volts and close at maximum 6.0 volts. NOTE: *If voltage points do not open, cut resistance into circuit.*

*(c)* If necessary, adjust opening voltage by bending spiral spring hanger down to increase voltage, up to decrease voltage.

*(d)* If necessary, adjust closing voltage by slightly bending lower armature stop. Increase gap to raise voltage; decrease gap to decrease voltage. NOTE: *After this adjustment, check contact spring opening. It should be 0.010 inch. If necessary, adjust by bending contact spring post.*

(22) ADJUSTMENT OF CUT-OUT RELAY (fig. 22).

*(a)* Hold contact points closed and check air gap between armature and core with a feeler gage. Air gap should be 0.015 inch. If necessary, adjust by loosening two screws at back of relay and raise or lower armature as required. Tighten screws after adjusting.

*(b)* Measure point opening with a feeler gage. It should be 0.020 inch. Adjust, if necessary, by bending upper armature stop.

*(c)* Connect voltmeter between control unit generator terminal and ground. Gradually increase generator speed and note cut-out closing voltage. Closing voltage should be 6.3 to 6.0 volts. Bend spring post down to decrease spring tension and closing voltage. Bend up to increase voltage.



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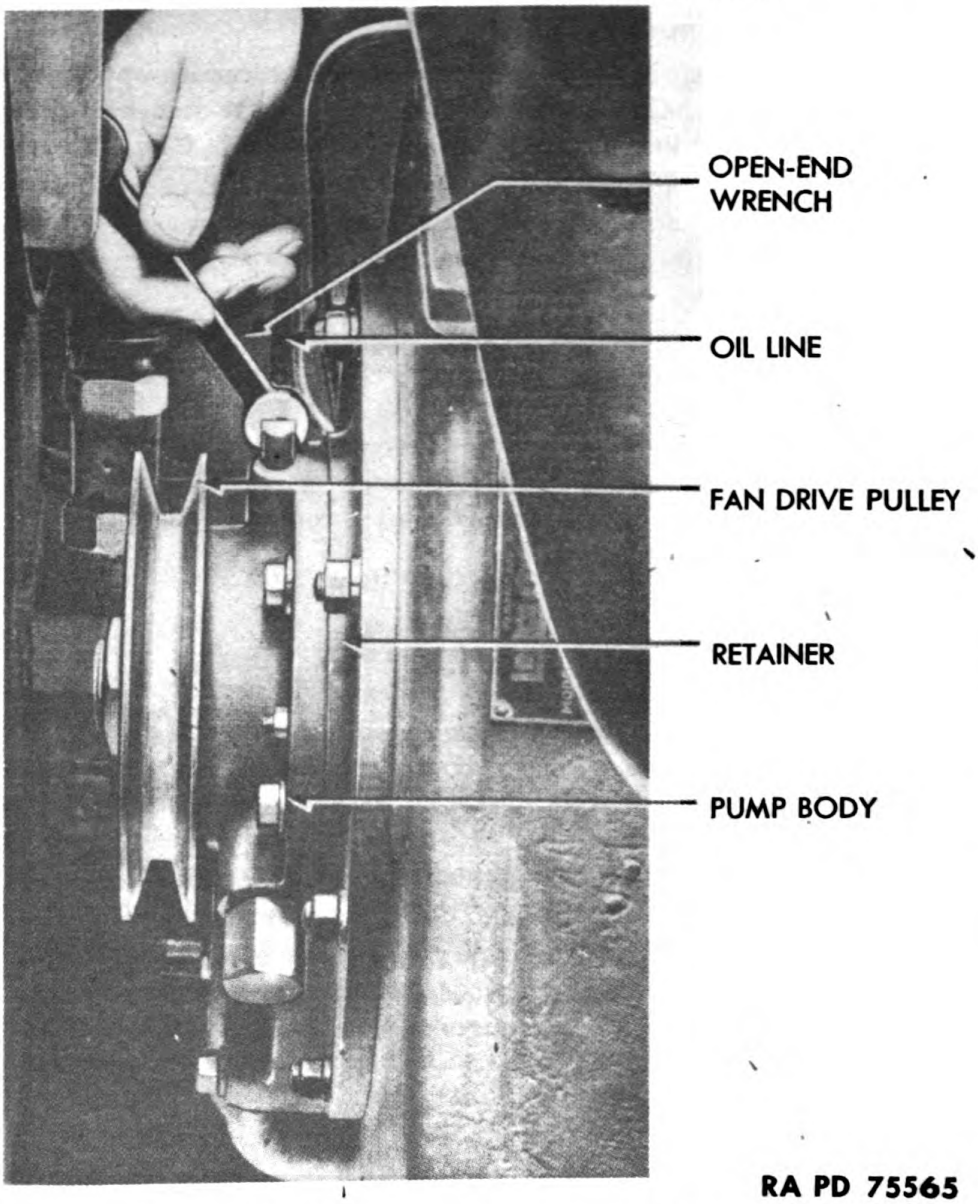



*Figure 23 — Removing Compressor Oil Pump*

## 6. DISASSEMBLY AND ASSEMBLY.

### a. Compressor.

(1) REMOVAL AND DISASSEMBLY OF OIL PUMP (fig. 23).

*(a)* Remove intercooler fan belt.

*(b)* Disconnect oil line from top of oil pump body at elbow.

*(c)* Remove pulley nut and fan drive pulley, being careful to keep from damaging oil seal.



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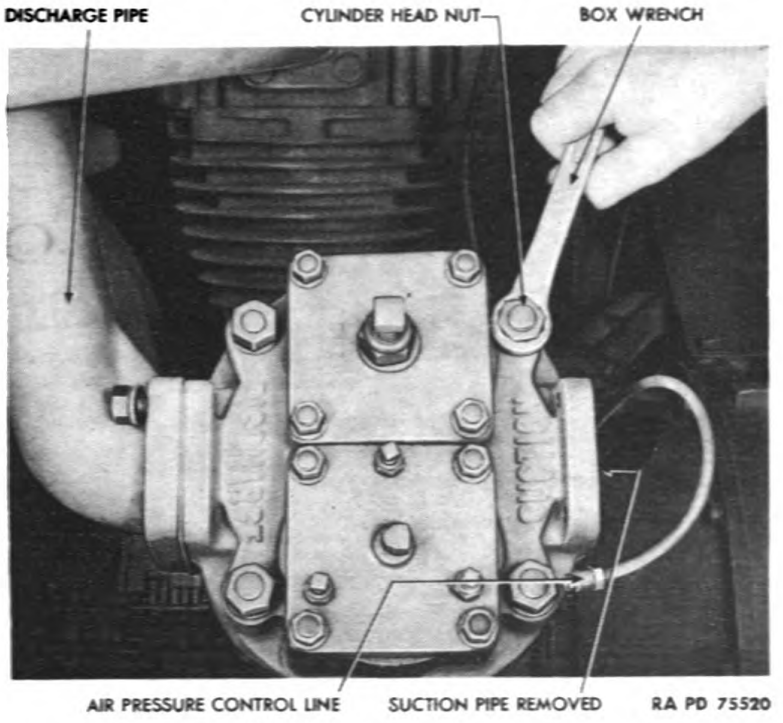



***Figure 24 — Removing Compressor Cylinder Head***

*(d)* Remove cap screws which secure connection beneath pump to oil pan.

*(e)* Remove cap screws and stud nuts which secure pump body to retainer.

*(f)* Lift oil pump body and check valve assembly from compressor.

*(g)* Turn and twist connecting rod and plunger assembly from pump body.

*(h)* Drive out pin which secures connecting rod to plunger with punch and hammer. Lift rod from plunger. *NOTE: Because of close tolerances, both plunger and check valve assemblies are serviced as units.*

(2) ASSEMBLY AND INSTALLATION OF OIL PUMP (fig. 23).

*(a)* Slide connecting rod into plunger and install retaining pin. Be sure pin does not extend beyond edge of plunger.

*(b)* Dip plunger in engine oil *(important)* and insert into body.

*(c)* Assemble check valve to body and place body on compressor. Be sure connecting rod is in place on crankshaft.

*(d)* Install new oil seal in body. Tap into place. Do not drive it beyond outside surface of body. Clearance behind seal must be maintained for oil.



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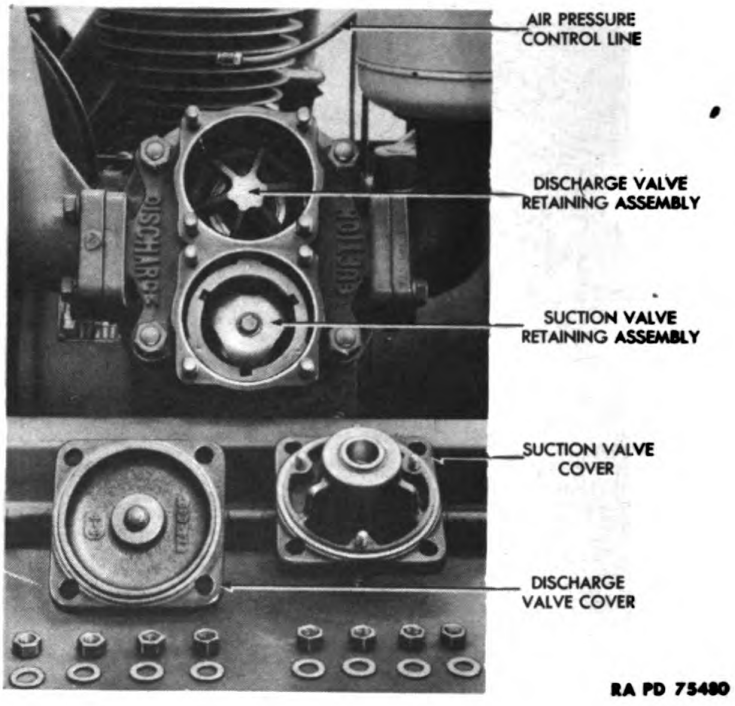



***Figure 25 — Compressor Valve Assemblies in Place With Covers Removed***

*(e)* Install cap screws which secure body to compressor, and tighen only fingertight. Set dowels in place, and tighten cap screws.

*(f)* Install fan drive pulley, nut, and lock.

*(g)* Connect oil line and install fan belt.

(3) REMOVAL OF COMPRESSOR CYLINDER HEAD (fig. 24).

*(a)* Disconnect air pressure control line.

*(b)* Disconnect suction and discharge pipes from head. Do not lose lock washers or gaskets.

*(c)* Remove cylinder head nuts and lock washers.

*(d)* Lift head and gasket from compressor.

(4) INSTALLATION OF COMPRESSOR CYLINDER HEAD (fig. 24).

*(a)* Place head on compressor. Be sure machined surfaces which contact gasket are clean.

*(b)* Install cylinder head nuts and lock washer. Tighten securely.

*(c)* Connect suction and discharge pipes to head. Be sure to use serviceable gaskets and lock washers.

*(d)* Connect air pressure control line.



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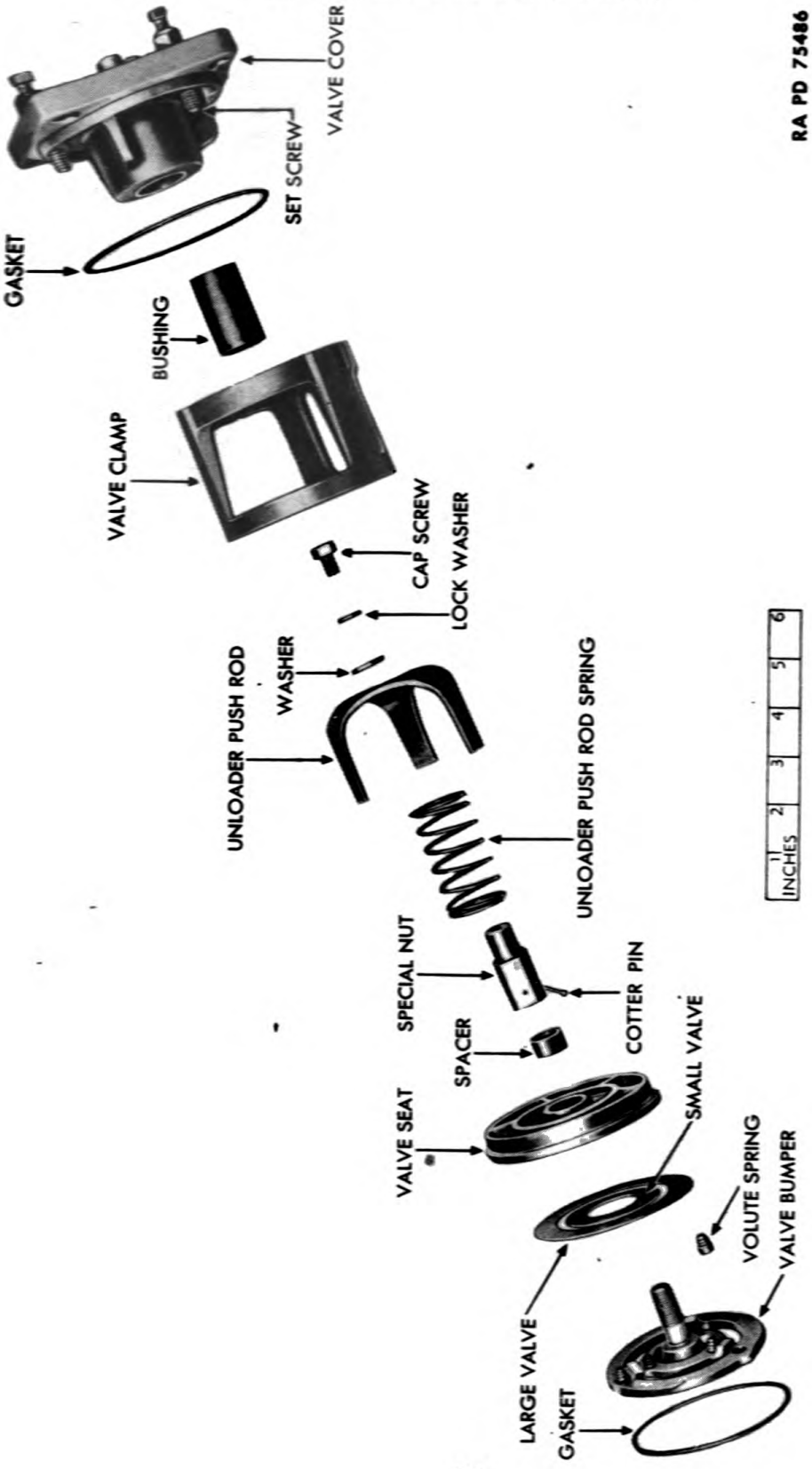



*Figure 26 — Compressor Suction Valve — Exploded View*



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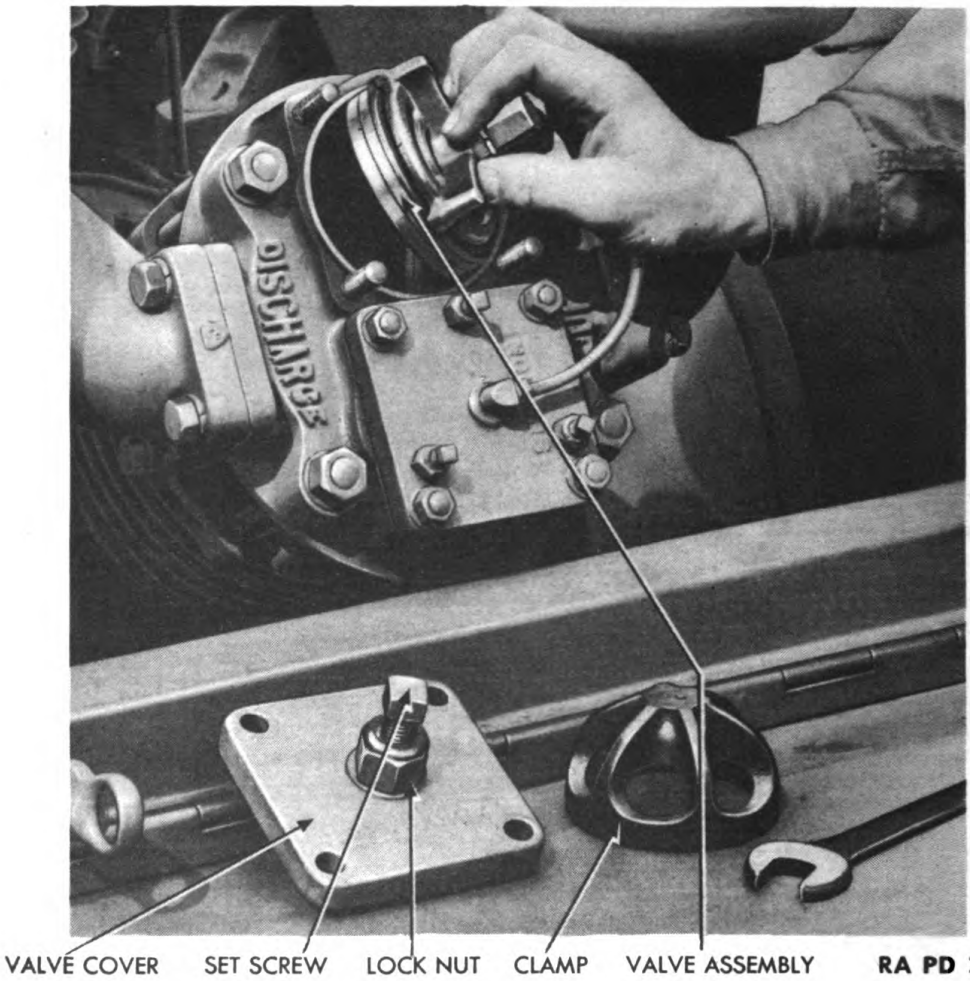



***Figure 27 — Removing Compressor Discharge Valve From Low-pressure Cylinder***

*(e)* Run compressor until hot and again tighten cylinder head nuts.

(5) REMOVAL OF SUCTION VALVE ASSEMBLY FROM CYLINDER HEAD (fig. 25).

*(a)* Disconnect air pressure control line at elbow.

*(b)* Loosen set screw lock nuts on the three set screws several turns. Then loosen set screws several turns.

*(c)* Remove the four nuts and washers which secure valve cover to cylinder head.

*(d)* Remove suction cover. Be careful that unloader plunger does not drop out or become damaged; its operation depends on a close fit.



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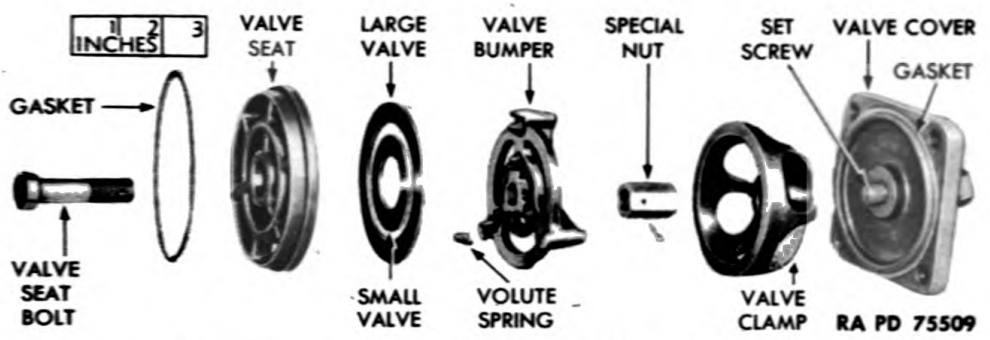



***Figure 28 — Compressor Discharge Valve — Exploded View***

*(e)* Remove suction valve assembly clamp.

*(f)* Remove suction valve assembly. *NOTE: Take care to keep seats and valves from becoming marred. Close fits are essential.*

(6) INSTALLATION OF SUCTION VALVE INTO CYLINDER HEAD (figs. 25 and 26).

**NOTE:** Assemble valve plates in same position as before disassembly because valve becomes tighter as it wears to a seat. See that volute springs are upright with large ends in pockets in bumper. To see that valve is free, depress with a screwdriver and let it snap back into seat. Replace all damaged parts and gaskets *(important)*.

*(a)* Place copper valve gasket in position on shoulder in cylinder head.

*(b)* Insert suction valve assembly into cylinder head and rotate back and forth to ensure that it seats properly on gasket.

*(c)* Insert suction valve clamp and rotate back and forth to ensure that it seats properly on valve.

*(d)* Place valve cover gasket in position on cylinder head shoulder.

*(e)* Carefully place valve cover in position on cylinder head. Be sure that three nodes or nibs on under side properly engage notches in valve clamp so set screws will clamp over staves.

*(f)* Install four nuts and washers which secure valve cover to cylinder head. Tighten alternately.

*(g)* Tighten set screws in top of cylinder head alternately. Tighten lock nuts on set screws.

*(h)* Connect air pressure control line to elbow.

(7) REMOVAL OF DISCHARGE VALVE FROM CYLINDER HEAD (fig. 27).

*(a)* Loosen set screw lock nut on top of valve cover. Loosen set screw several turns.



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*(b)* Remove four nuts and washers which secure valve cover to cylinder head.

*(c)* Lift out discharge valve cover, clamp, valve assembly, and gaskets.

NOTE: Take care to keep seats and valves from becoming marred. Close fits are essential.

(8) INSTALLATION OF DISCHARGE VALVE INTO CYLINDER HEAD (figs. 27 and 28).

NOTE: Assemble valve plates in same position as before disassembly because valve becomes tighter as it wears to a seat. See that volute springs are upright with large ends in pockets in bumper. To see that valve is free, depress with a screwdriver and let it snap back into seats. Replace all damaged parts and gaskets *(important)*.

*(a)* Place copper valve gasket in position on shoulder in cylinder head.

*(b)* Insert discharge valve into cylinder head and rotate back and forth to ensure that it seats properly on gasket.

*(c)* Place discharge valve clamp in position on valve. Rotate back and forth to ensure proper seating.

*(d)* Place copper-asbestos valve cover gasket in position on cylinder head shoulder.

*(e)* Carefully place discharge valve cover in position.

*(f)* Install four nuts and washers which secure valve cover to cylinder head. Tighten alternately.

*(g)* Tighten set screw on top center of valve cover. Tighten lock nut on set screw.

(9) DISASSEMBLY OF UNLOADER PILOT VALVE (fig. 29).

*(a)* Disconnect conveyor tubes across top of assembly at elbows. Unless tubes are to be serviced, do not break connection at diaphragm housing casting, as they are soldered.

*(b)* Remove pressure adjusting nut and spring.

*(c)* Remove by hand small horizontal extension spring, vertical kick-off valve plunger rod, and large horizontal trip lever spring.

*(d)* Remove top and bottom center screws from diaphragm housing.

*(e)* Remove diaphragm housing assembly and conveyor tubes as a unit.

*(f)* Remove eight remaining screws from diaphragm housing and separate housing. Lift diaphragm from housing. *NOTE: If diaphragm only is to be serviced, further disassembly is unnecessary.*



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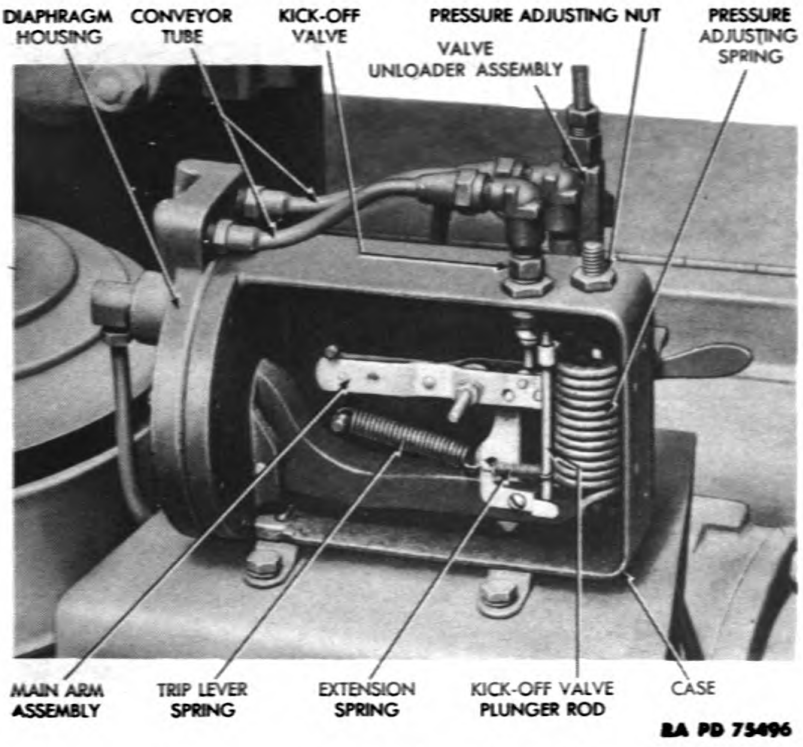



***Figure 29 — Compressor Unloader Pilot Valve — Cover Removed***

*(g)* Drive out main arm assembly retaining pin with light hammer and small punch. Lift arm assembly from main frame.

*(h)* Remove lower lock nut from kick-off valve assembly and lift assembly from top of main frame.

*(i)* Remove the three screws which secure unloader valve assembly bracket to rear of case. Lift assembly and bracket from case. Remove lower lock nut and withdraw valve from bracket. Do not lose plunger pin. *NOTE: Because of close tolerances necessary, kick-off valve and unloader valves are serviced only as assemblies.*

(10) ASSEMBLY OF UNLOADER PILOT VALVE (fig. 29).

*(a)* Place rubber diaphragm on diaphragm housing lower casting. Place plunger disk into position so projection fits through center hole of upper casting. Install eight screws (omitting top and bottom center). Tighten screws firmly and evenly.

*(b)* Place main arm in channel on back of upper diaphragm casting and insert pivot pin.

*(c)* Assemble kick-off valve plunger rod to main arm and connect extension spring.

*(d)* Secure unloader valve bracket to back of case with three screws.



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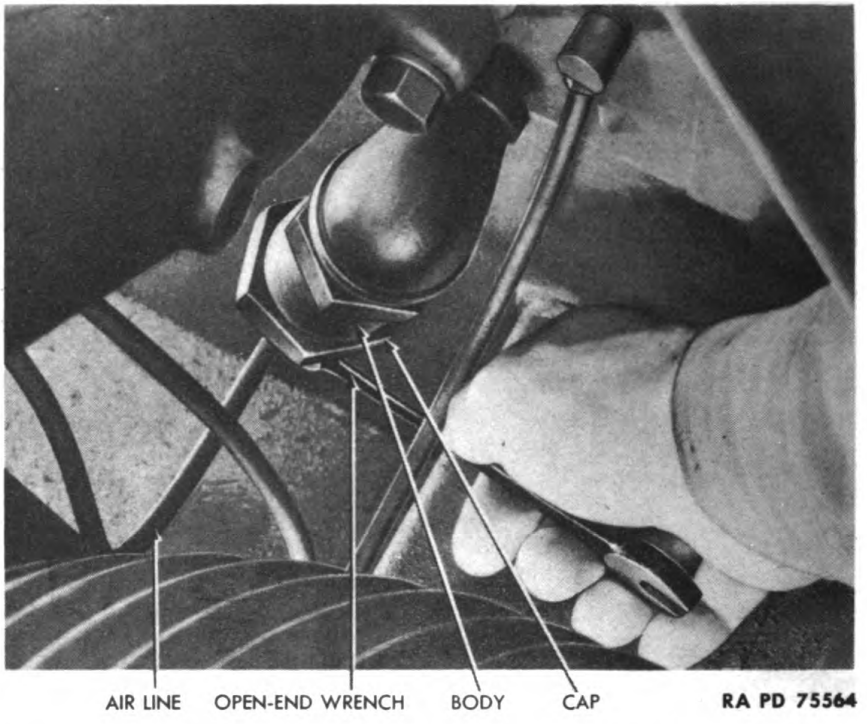



***Figure 30 — Removing Compressor Intercooler Relief Valve***

*(e)* Screw unloader plate pivot stud into main frame and place hand unloader plate on this stud and secure with cotter key.

*(f)* Place bushing through hand unloader handle and attach to frame.

*(g)* Insert trip lever and cover mounting screw from back of case, place trip lever bushing over screw, and place felt washer between yoke of trip lever and mount over bushing. Install lock nut, washer, and remaining lock nut.

*(h)* Attach diaphragm housing and main arm assembly to case by installing two screws through two remaining holes with screwdriver (1½-in. screw in top and 1⅛-in. screw in bottom).

*(i)* Install pressure adjusting spring and tighten pressure adjusting nut fingertight.

*(j)* Install trip lever spring.

*(k)* Insert valve plunger pin pointed end into unloader valve assembly and mount in bracket on rear of case with elbow toward conveyor tube. Adjust valve so there is a little clearance between plate on rear of case and plunger pin when switch is in loaded position (trip lever down). Lock valve in place.

*(l)* Connect conveyor tubes to elbows. Tighten until airtight.



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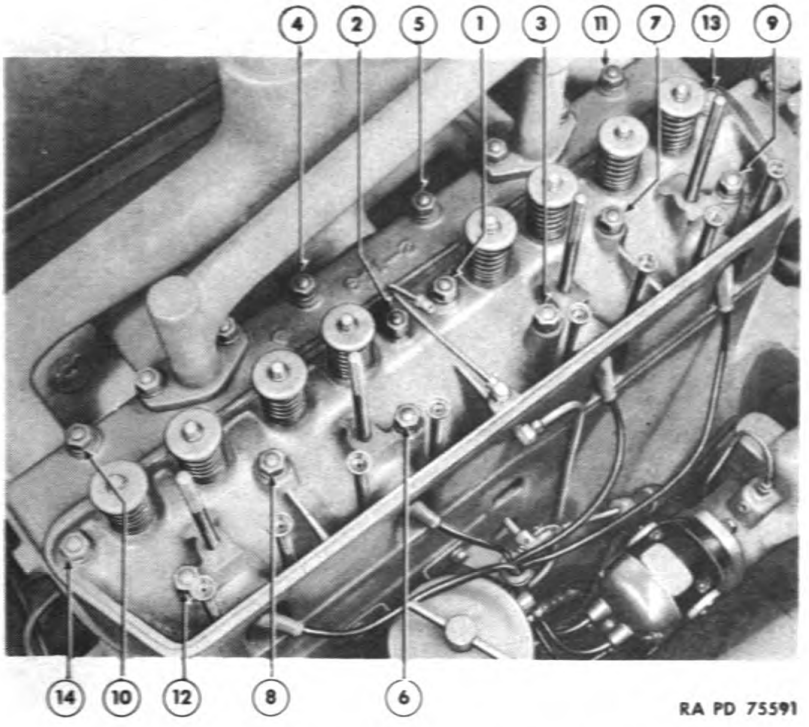



***Figure 31 — Sequence for Tightening Compressor Engine Cylinder Head Nuts***

*(m)* Make pressure adjustment (par. 5 a (10) ).

*(n)* Adjust differential (par. 5 a (11) ).

(11) DISASSEMBLY OF INTERCOOLER RELIEF VALVE (fig. 30).

*(a)* Disconnect air line from elbow on bottom of valve.

*(b)* Unscrew cap from body. Remove gasket from cap, and plunger and spring from body.

(12) ASSEMBLY OF INTERCOOLER RELIEF VALVE (fig. 30).

*(a)* Insert spring and plunger into body in order given.

*(b)* Insert gasket into cap and tighten onto body.

*(c)* Connect air line to elbow.

**b. Compressor Engine.**

(1) REMOVAL OF CYLINDER HEAD.

*(a)* Drain water from cooling system by opening drain cocks on radiator bottom outlet and cylinder block.

*(b)* Remove water connections.

*(c)* Remove carburetor.

*(d)* Remove manifold.

*(e)* Remove cylinder head cover.



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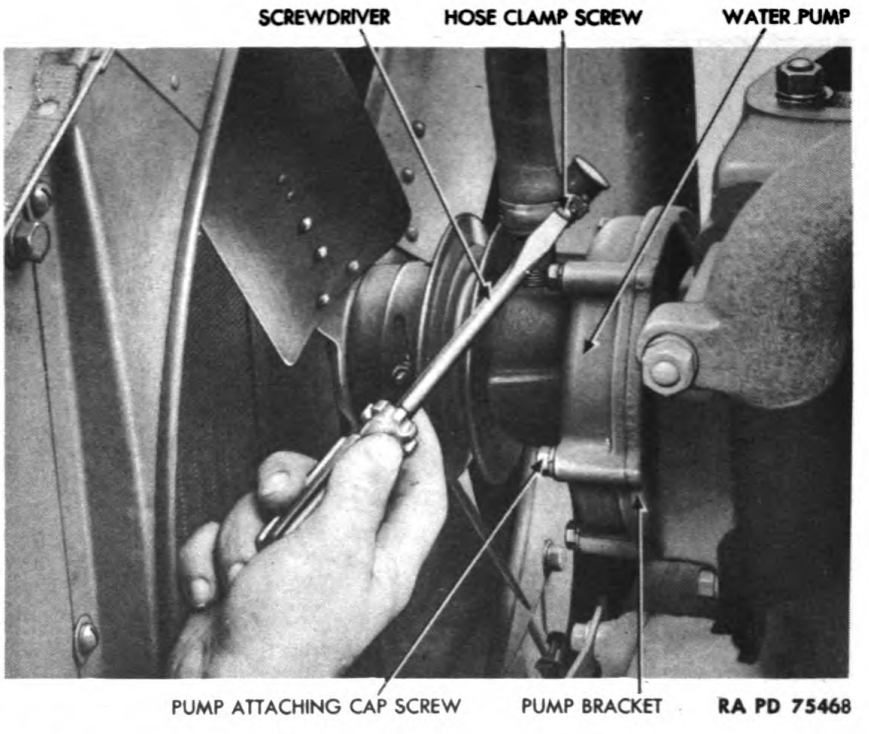



***Figure 32 — Removing Compressor Unit Engine Water Pump***

*(f)* Disconnect oil lines from rocker arm mechanism. Remove rocker arm mechanism by removing the four stud nuts and lifting assembly from head. Lift push rods from cylinder head.

*(g)* Disconnect spark plug wires and remove spark plugs.

*(h)* Remove cylinder head stud nuts.

*(i)* Lift cylinder head and gasket from cylinder block.

(2) INSTALLATION OF CYLINDER HEAD.

*(a)* Carefully clean machined surfaces of cylinder head and cylinder block which contact gasket with putty knife and clean cloth.

*(b)* Place gasket on block with beaded side up.

*(c)* Place cylinder head in position on gasket and tighten cylinder head stud nuts to 100-foot-pounds tension with a torque wrench. Tighten nuts in sequence shown in figure 31. Nuts do not need retightening when engine is hot if these directions are followed.

*(d)* Install spark plugs and attach spark plug wires.

*(e)* Place rocker arm assembly in position and install four stud nuts. Connect oil line to rocker arm mechanism.

*(f)* Install manifold, using a new gasket.

*(g)* Install carburetor, using a new gasket.



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*(h)* Connect water connections, using new gaskets.

*(i)* Fill cooling system with clean soft water after closing both drain cocks.

*(j)* Adjust valve tappet clearance (par. 5 c (11) ).

*(k)* Install cylinder head cover, replacing gasket if damaged.

(3) COOLING SYSTEM.

*(a) Removal of Fan Belt.*

*1.* Loosen set screw in fan pulley flange. Move flanges apart as far as possible.

*2.* Start belt over flange of lower pulley and pry out with light bar or rod. Slowly crank engine at same time and work belt from pulley.

*3.* Work belt free over top of fan blades.

*(b) Installation of Fan Belt.*

*1.* Work belt over top of fan onto upper pulley.

*2.* Place belt over generator pulley.

*3.* Start belt onto lower pulley and crank engine slowly. Belt will seat itself.

*4.* Adjust flanges on fan pulley so belt can be wiggled ½ to ¾ inch each way in its longest span. Tighten flange set screw securely.

*(c) Removal of Water Pump* (fig. 32).

*1.* Open drain cocks on radiator bottom outlet and cylinder block.

*2.* Remove fan belt (see step *(a)*, above).

*3.* Remove hose connections from water pump.

*4.* Remove cap screws which secure pump to bracket.

*5.* Lift pump from bracket.

*(d) Disassembly of Water Pump.*

*1.* Remove cap screws which secure fan blades to fan hub. Remove fan from hub.

*2.* Drive taper pin from hub.

*3.* Pull fan hub from shaft.

*4.* Draw impeller with shaft out of pump.

*5.* Press pump shaft out of impeller.

*(e) Assembly of Water Pump.*

*1.* Be sure driving lugs of carbon seal are engaged in slots in impeller and press impeller onto shaft.

*2.* Aline thrust ring with bushing and flat surface of shaft and insert shaft and impeller into body.

*3.* Press fan hub onto shaft. Be sure to aline pinhole.

*4.* Drive taper pin into opening in hub and shaft.

*5.* Attach fan blade to fan hub.



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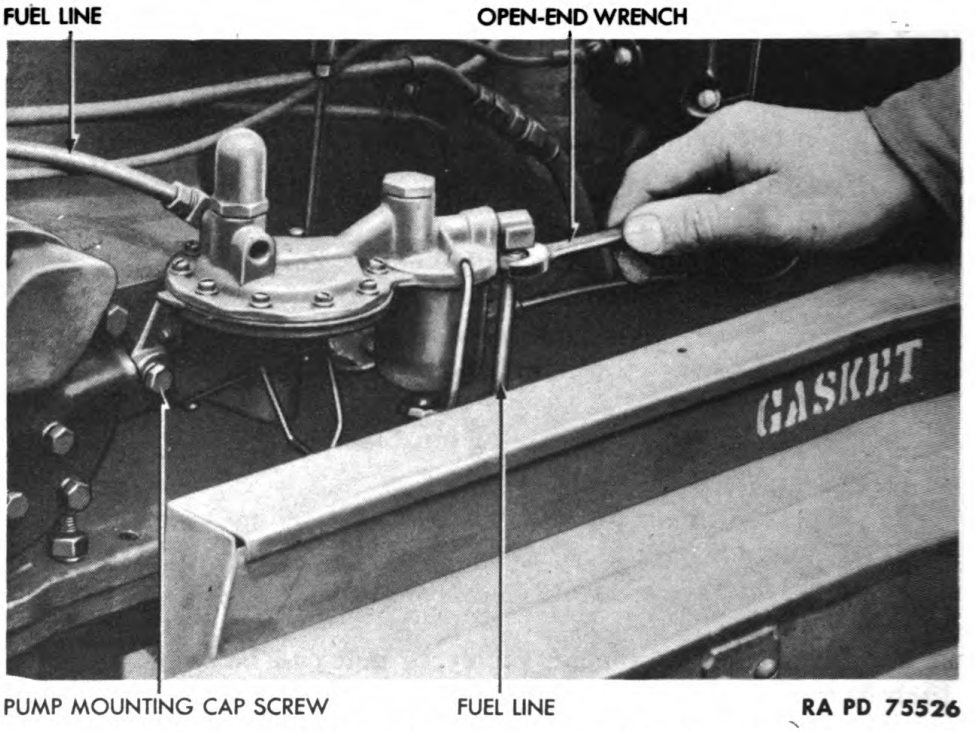



***Figure 33 — Removing Compressor Unit Engine Fuel Pump***

*(f) Installation of Water Pump* (fig. 32).

*1.* Place pump in position on bracket and install cap screws.

*2.* Connect hose connections to water pump.

*3.* Install fan belt (subpar. b (3) *(b)*, above).

*4.* Close drain cocks and fill cooling system with clean soft water.

*5.* Start engine and check pump to be sure that it does not leak.

(4) FUEL SYSTEM.

*(a) Removal of Fuel Pump* (fig. 33).

*1.* Disconnect both fuel lines from pump.

*2.* Remove two pump mounting cap screws and lift pump from cylinder block.

*(b) Disassembly of Fuel Pump* (fig. 34).

*1.* Remove glass bowl, gasket, and bail assembly from pump body. Remove screen from pump cover.

*2.* Remove bottom cover assembly, gasket, diaphragm spring cap, and rocker arm spring cap from pump body.

*3.* Mark position of cover on body with a steel scribe. Remove cover screws from pump. Lift cover, lock washers, and gasket from body.



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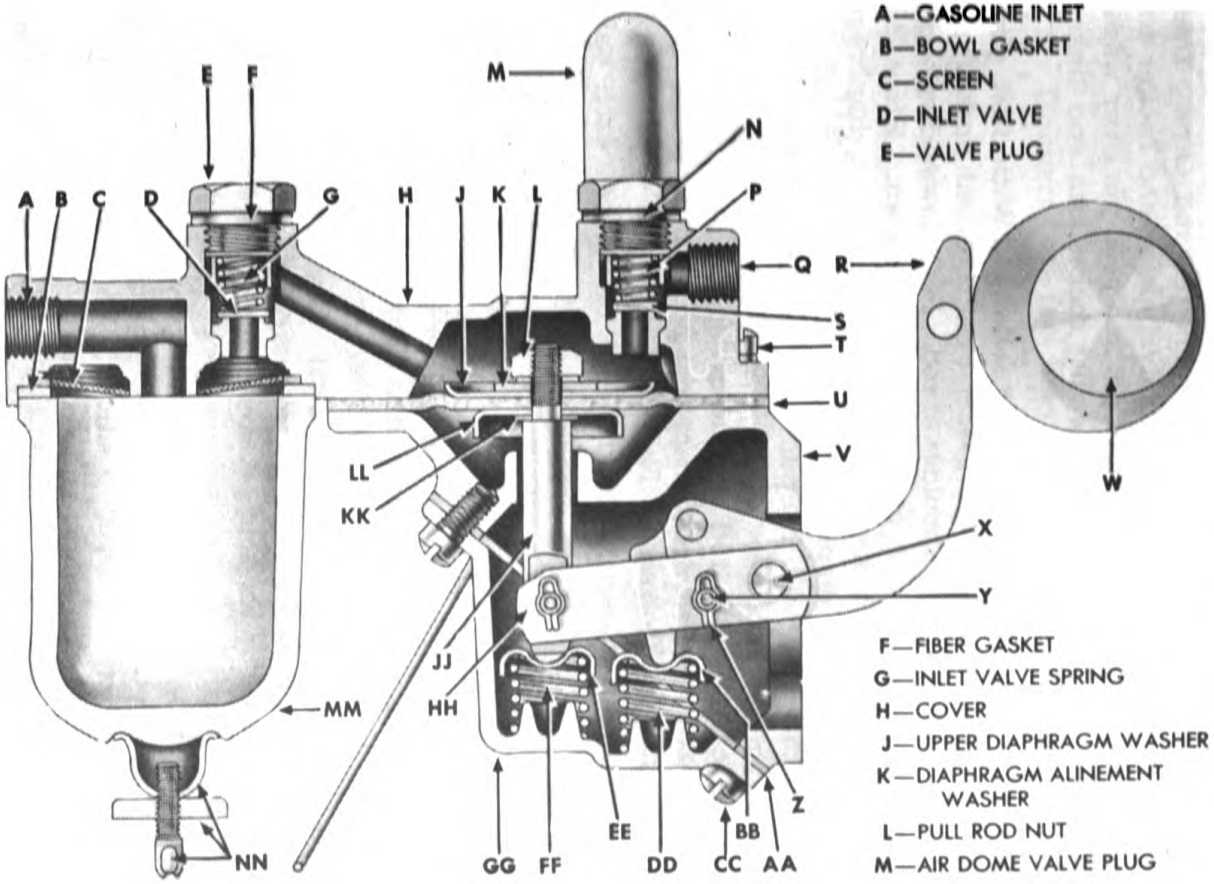



***Figure 34 — Cross Section Through Compressor Engine Fuel Pump***



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*4.* Remove both valve plugs from pump body. Pick washers, valve springs, and valves from body.

*5.* Remove pull rod nut, lock washer, diaphragm, diaphragm washers, and gasket from pull rod.

*6.* Tap rocker arm pin from holes in rocker arm, linkage, and pump body. Remove linkage from rocker arm.

*(c) Assembly of Fuel Pump* (fig. 34).

*1.* Assemble body, rocker arm, and link assembly as follows: Assemble the two side pieces making up linkage, using link pin and clips. Attach linkage to pull rod using link pin and clips. Insert rocker arm pin through holes of pump body, linkage, and rocker arm. Place washer over counterbored end of pin and peen pin over washer with hammer. Check assembly to see that rocker arm and linkage move freely on rocker arm pin.

*2.* Assemble diaphragm assembly as follows: With fuel pump body held in vise, place pull rod gasket over threaded end of pull rod. Seat the gasket against shoulder of rod. Place lower diaphragm washer over threaded end of pull rod, cup-side down. Place diaphragm over threaded end of pull rod. Line up holes in diaphragm with screw holes in body diaphragm flange. Place upper diaphragm washer over threaded end of pull rod, cup-side down. Place hexagonal diaphragm alinement washer over end of pull rod. Assemble lock washer and pull rod nut, using special wrench to hold diaphragm alinement washer stationary and prevent diaphragm from twisting or turning *(important)*. Tighten pull rod nut securely.

*3.* Assemble valve assembly as follows: Blow out each valve chamber and make certain no foreign particles are present. Also make certain no burs or irregularities exist in valve seats and that valve seats are securely held in place in upper cover. Place valves in position in valve chamber. Be sure valves lie flat. Insert valve springs on top of valves. Place fiber gasket on valve plugs; place stems of valve plugs into valve spring and tighten plugs securely into upper cover.

*4.* Assemble cover assembly as follows: Lay cover on pump in position indicated by marks made before disassembly. Insert screws from top through lock washers, upper cover, and diaphragm. Tighten screws until they barely engage lock washers. Insert handle of diaphragm alinement washer wrench or small screwdriver through fuel pump body and exert pressure upward on linkage. This forces diaphragm into its extreme upper position. While in this position, tighten cover screws alternately and securely.

*5.* Assemble bottom cover assembly as follows: Holding pump bottom up, place rocker arm spring cap and diaphragm cap in posi-



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tion over end of pull rod and projection on rocker arm. Place gasket between pump body and lower cover. Place springs for diaphragm and rocker arm in position on bosses in lower cover. Carefully assemble lower cover to pump body. Ascertain that springs and caps remain in their proper positions. Install bottom cover screws and lock washers. Tighten securely.

*6.* Perform final assembly of pump as follows: Place screen in pump cover. Make certain it fits snugly around gasoline inlet and edges of casting. Place bowl gasket next to screen, then complete assembly of bowl, bail, and screw.

*(d) Installation of Fuel Pump* (fig. 33).

*1.* Place pump in position on cylinder block, using new gasket between pump and block. Install two pump mounting cap screws and lock washers.

*2.* Connect both fuel lines to pump.

*3.* Use work hand to agitate pump till bowl, pump, and carburetor are filled with fuel. Check connections and pump for leaks. Repair any leakage.

*(e) Removal of Carburetor* (fig. 17).

*1.* Disconnect fuel line.

*2.* Disconnect air cleaner air hose from carburetor.

*3.* Disconnect choke control and pull throttle control from carburetor.

*4.* Remove two carburetor attaching cap screws and lock washers. Lift carburetor and gasket from manifold. Pull away from engine to protect cross shaft and bearings.

*(f) Disassembly of Carburetor* (fig. 35).

*1.* Loosen clamp screw and remove throttle lever.

*2.* Remove idling adjusting screw and spring from top of body by hand.

*3.* Remove assembly screws.

*4.* Raise throttle body slightly and loosen gasket from bowl assembly.

*5.* Lift throttle body and gasket clear of bowl.

*6.* Turn throttle body upside down on bench.

*7.* Remove body to bowl gasket.

*8.* Remove float axle. Use a small screwdriver to push axle from slotted end of float hinge bracket; use fingers to remove rest of way.

*9.* Remove float and fuel valve needle.

*10.* Remove fuel valve seat and gasket, using service tool C161-85.



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*11.* Remove secondary venturi and main venturi as a unit.

*12.* Remove idling jet.

*13.* Remove economizer jet and gasket. This jet is located in lower face of throttle body, directly under one of throttle shaft bearings.

*14.* Remove throttle plate screws, plate, and shaft.

*15.* Remove throttle stop lever taper pin.

*16.* Tap throttle shaft out of stop lever hub.

*17.* Remove throttle shaft packing retainers and packings. *NOTE: Do not remove identification disk riveted to bowl cover. Do not remove throttle stop, venturi locating pin, priming plug, float hinge bracket, or channel plugs.*

*18.* Remove well vent.

*19.* Remove main discharge jet and gasket, using service tool C161-9.

*20.* Remove lower plug (main jet adjustment).

*21.* Remove main jet and gasket (service tool C161-1).

*22.* Remove air shutter lever retaining nut.

*23.* Remove air shutter lever.

*24.* Remove air shutter bracket retainer screw and bracket.

*25.* Remove air shutter screws and lock washers.

*26.* Remove air shutter and shaft.

*27.* Remove air shutter shaft hole plug. *NOTE: Do not remove air shutter stop pin, bowl vent channel plug, or drip plug.*

*28.* Clean bowl and throttle body castings in dry-cleaning solvent and blow through each channel with compressed air to make sure all channels are clean.

*(g) Assembly of Carburetor* (fig. 35).

*1.* Install air shutter shaft and air shutter. Be sure air shutter valve is correctly located and that shutter is centered before tightening screws and lock washers securely. Air shutter bracket and lever assemblies can be installed on either side of air inlet. Be sure to assemble on same side and in same position as they were before disassembly.

*2.* Install air shutter shaft hole plug.

*3.* Hold air shutter bracket in position and install retainer screw.

*4.* Install air shutter lever with retainer nut and lock washer.

*5.* Check for complete opening and complete closing of air shutter. Change position of lever on shaft if necessary to obtain correct operation.



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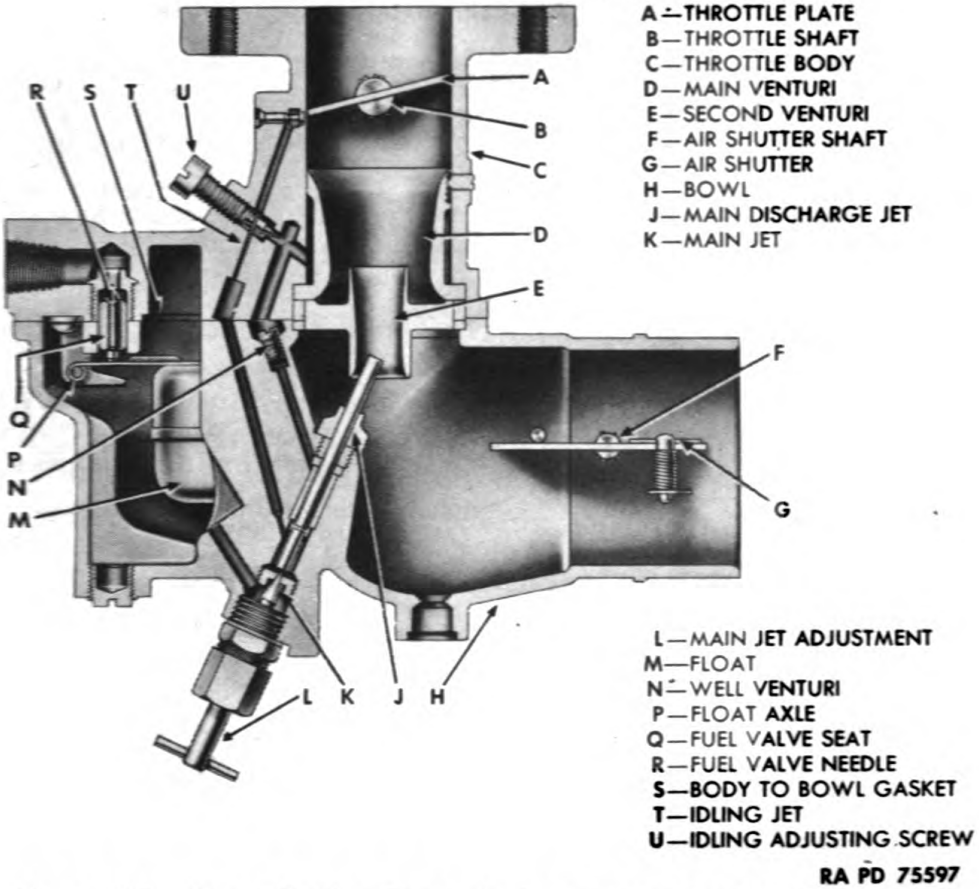



***Figure 35 — Cross Section Through Compressor Engine Carburetor***

*6.* Replace main jet. Use new gasket.

*7.* Install lower plug (main jet adjustment). Use new gasket.

*8.* Replace main discharge jet with service tool C161-9. Use new gasket.

*9.* Replace well vent (no gasket).

*10.* Place new throttle shaft packings in retainers.

*11.* Install throttle shaft packing retainers with packing. Tap into place.

*12.* Install new throttle shaft and throttle plate. Use new throttle plate screws.

*13.* Adjust throttle stop screw to hold throttle just slightly open as a preliminary adjustment.

*14.* Install stop lever assembly on shaft so stop lever rests against stop pin when throttle plate is wide open (straight up and down in barrel).

*15.* Drill and pin stop lever hub to shaft, using No. 45 drill and taper pin CT63-2.



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*16.* Replace economizer jet. Use new gasket.

*17.* Replace idling jet (no gasket).

*18.* Place main venturi in position with locating groove on locating pin.

*19.* Place secondary venturi in slots provided in main venturi.

*20.* Install fuel valve seat, using new gasket.

*21.* Install fuel valve needle.

*22.* Install float assembly and float axle. Use handle of screwdriver to drive flat axle into slotted end of float hinge bracket.

*23.* Check position of float assembly for correct fuel level. With float in closed position (up all the way when carburetor is upright), distance from bottom of float to plane of top of bowl should be $1\frac{39}{64}$ inches plus or minus $\frac{3}{64}$ inch. Alter position if necessary. Be sure float moves freely on its axle.

*24.* Place a new bowl to body gasket in position on throttle body. Be sure economizer channel in throttle body coincides with hole in gasket.

*25.* Place bowl assembly in position on throttle body. Be careful to avoid damaging float.

*26.* Install assembly screws and lock washers. Tighten screws evenly and securely.

*27.* Install idling adjusting screw and spring by hand. Adjust to one full turn open as a preliminary adjustment.

*28.* Install throttle lever. Tighten clamp screw. *NOTE: Location of priming hole plug in relation to throttle plate is extremely important. To maintain uniform relation, manufacturer assembles throttle shaft and plate in throttle body before drilling body for priming hole plug, locating hole in definite relation to throttle plate in each case. Consequently, throttle plates and throttle bodies cannot be interchanged indiscriminately. If it becomes necessary to replace throttle shaft or throttle plate, proceed as follows: Unscrew throttle stop screw to permit closing throttle plate. Hold throttle closed and mark inside of throttle body close to throttle plate with steel scriber. Using scribed line as guide, replace throttle shaft or plate. If new plate shows noticeable variation from old one, select another new part to get one that fits closely to inscribed line. If throttle body needs replacing, replace complete throttle body assembly, including shaft, plate, priming hole plug, etc., built to outline number which appears on identification tag on bowl cover.*

*(h) Installation of Carburetor* (fig. 17).

*1.* Using a new gasket, place carburetor in position under manifold. Insert throttle control into rubber fitting on end of cross shaft. Install two carburetor attaching bolts, lock washers, and nuts.



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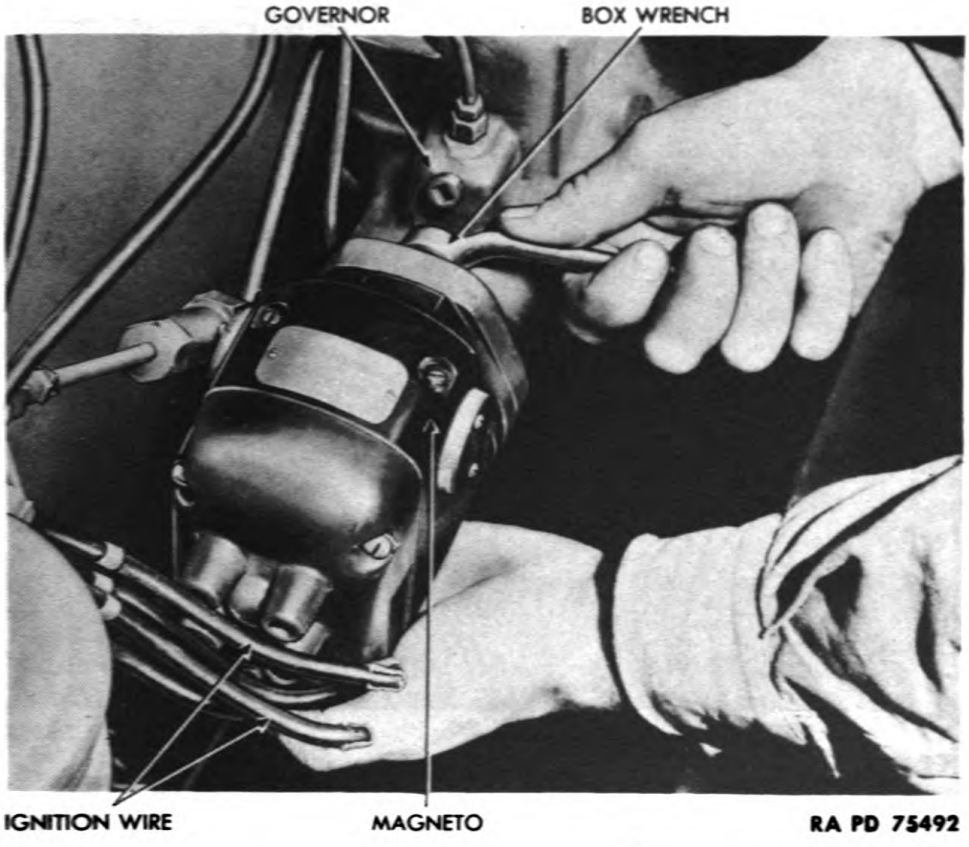



***Figure 36 — Removing Compressor Unit Engine Magneto***

*2.* Connect choke control to carburetor air shutter valve lever. Adjust so valve is open with choke control all the way in.

*3.* Connect air cleaner air hose to carburetor body.

*4.* Connect fuel line to carburetor.

*(i) Removal of Governor* (fig. 6).

*1.* Disconnect all ignition cables from magneto. Note position of cables to aid in replacement.

*2.* Disconnect carburetor slowdown assembly air connection and throttle connection at cross shaft. Use pliers to remove cotter key.

*3.* Disconnect governor oil supply line.

*4.* Remove four cap screws which secure governor assembly to gear cover.

*5.* Lift governor assembly from gear cover.

*(j) Installation of Governor* (fig. 6).

*1.* Rotate engine until "D C" on flywheel is under timing pin with number 1 piston in firing position. Rotate governor driver gear back-



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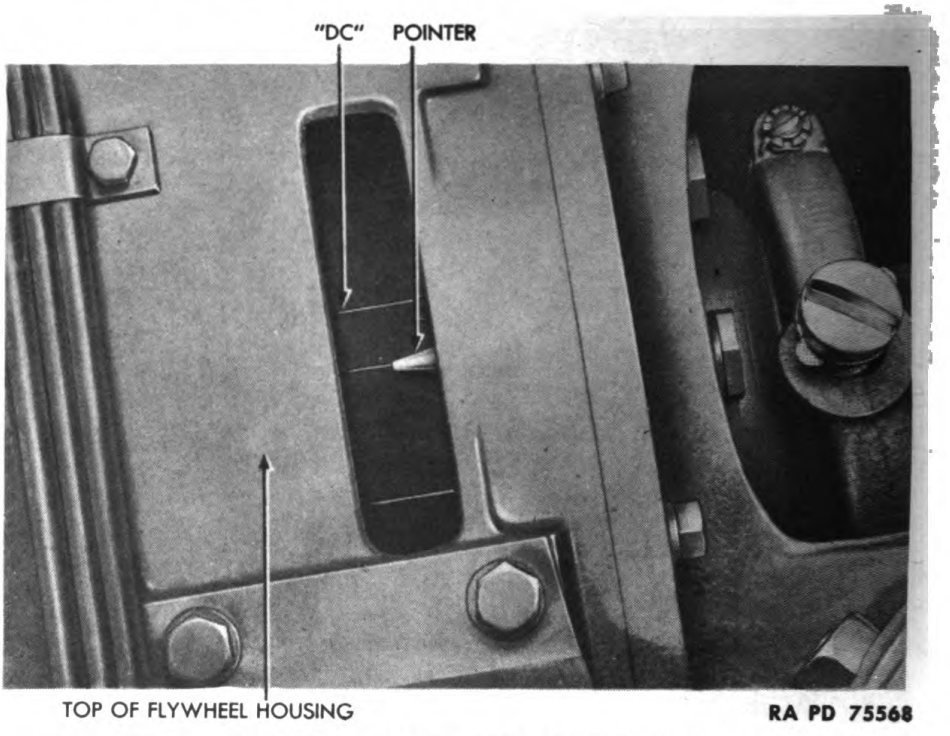



***Figure 37 — Compressor Unit Engine Flywheel Timing Marks***

wards till line on distributor gear centers in observation window on rear of magneto. Tighten governor assembly cap screws securely.

*2.* Connect carburetor slowdown assembly air connections and connect to throttle cross shaft. Install cotter key.

*3.* Connect governor oil supply line.

*4.* Install ignition cables in magneto. Number 1 is marked on magneto. Proceed clockwise from there, installing 1, 2, 4, and 3, respectively.

*5.* Make final timing adjustment of magneto as outlined under subparagraph **b** (5) *(c)*, below.

*6.* Adjust governor speed to 865 revolutions per minute (par. 5 **c** (14) *(e)* ).

(5) ELECTRICAL SYSTEM.

*(a) General.*

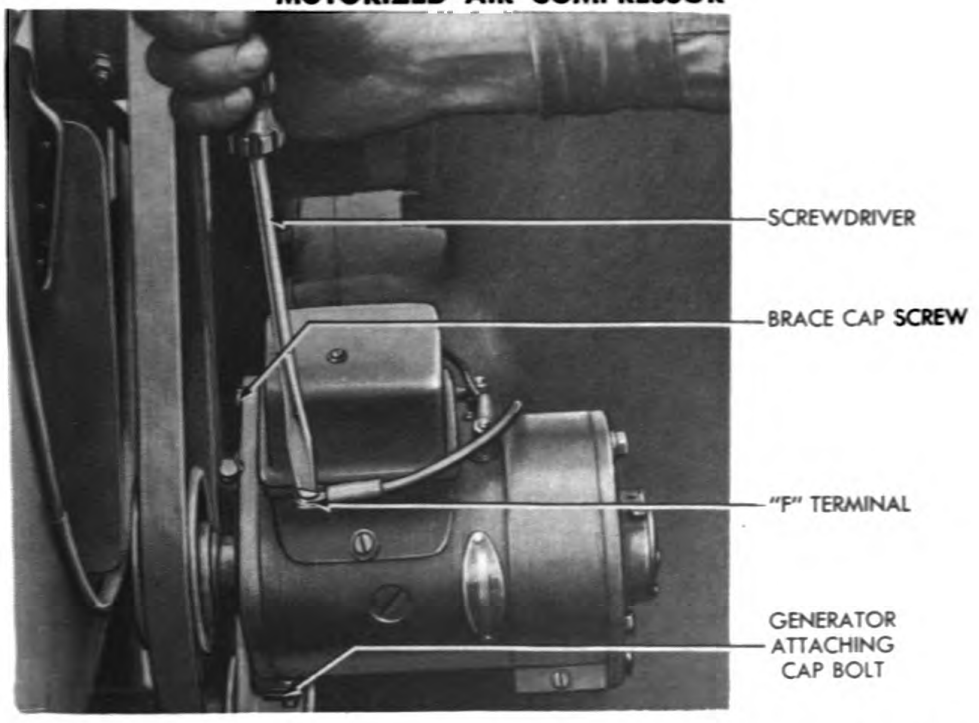
*1.* Before working on any part of electrical system, disconnect ground cable from battery. Do not reconnect until work is completed. This will avoid short circuiting with possible resultant damage to units.

*2.* Be sure all terminals are clean and securely fastened. Make certain no broken wires are used anywhere in the circuit.



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***Figure 38 — Removing Compressor Unit Generator***

*(b) Removal of Magneto* (fig. 36).

*1.* Crank engine until flywheel markings show "D C" with number 1 cylinder in firing position.

*2.* Pull the four ignition wires from magneto.

*3.* Disconnect ignition switch wire from magneto.

*4.* Remove two magneto attaching cap screws.

*5.* Lift magneto from governor.

*(c) Installation and Timing of Magneto* (fig. 36).

*1.* Turn engine with hand crank until piston of number 1 cylinder moves to firing position in compression stroke. Flywheel marking, "D C," must be right under pointer (fig. 37).

*2* Rotate impulse coupling of magneto until line on fiber distributor gear is centered in observation window in rear of magneto. Turn coupling opposite to direction of rotation for greatest ease of locating timing mark.

*3.* Place magneto in position on rear of governor, engage impulse coupling drive tongues, and start magneto attaching cap screws by hand.

*4.* Remove distributor plate by loosening four screws on rear of magneto; this will expose the interrupter assembly.



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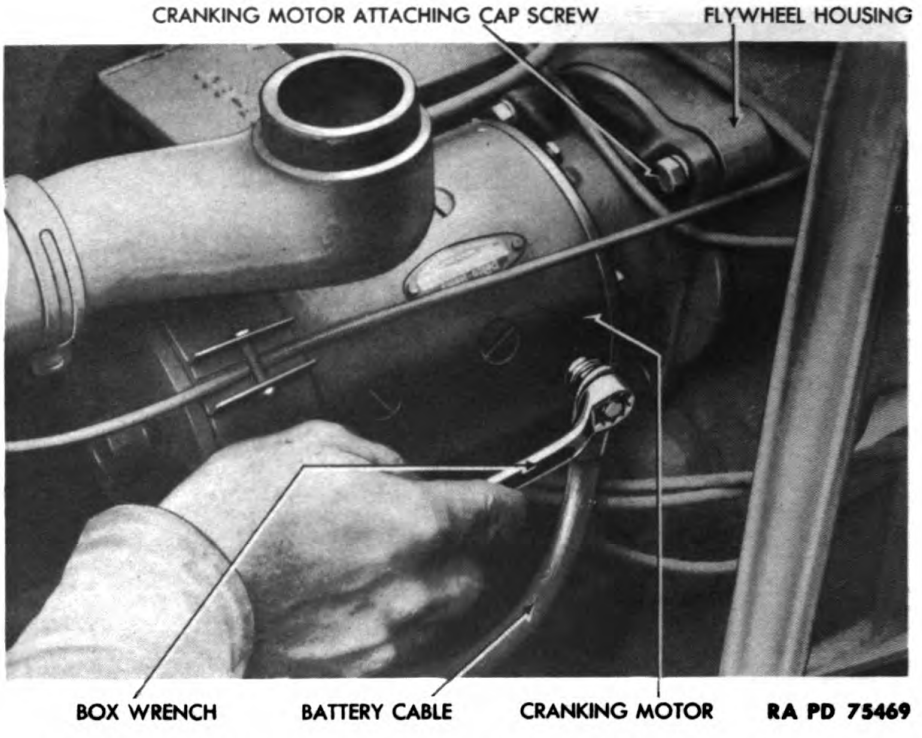



***Figure 39 — Removing Compressor Unit Engine Cranking Motor***

*5.* Tip magneto toward or away from engine so that interrupter points just begin to open. Tighten magneto attaching cap screws.

*6.* Install distributor plate and tighten screws.

*7.* Connect ignition switch wire to its terminal on engine side of magneto.

*8.* Insert number 1 spark plug wire in number 1 outlet marked on magneto. Proceed clockwise from there with spark plug wires 2, 4, and 3, respectively.

*(d) Removal of Generator* (fig. 38).

*1.* Disconnect wire from F terminal on voltage control.

*2.* Remove cap screw which secures brace to top of generator.

*3.* Remove two cap bolts, lock washers, and nuts which attach generator to generator bracket.

*4.* Lift generator from bracket.

*(e) Installation of Generator* (fig. 38).

*1.* Place generator in position on bracket and install two cap bolts, lock washers, and nuts which secure generator to bracket.

*2.* Place fan belt over generator and install cap screw and lock washer which secure generator brace to generator.



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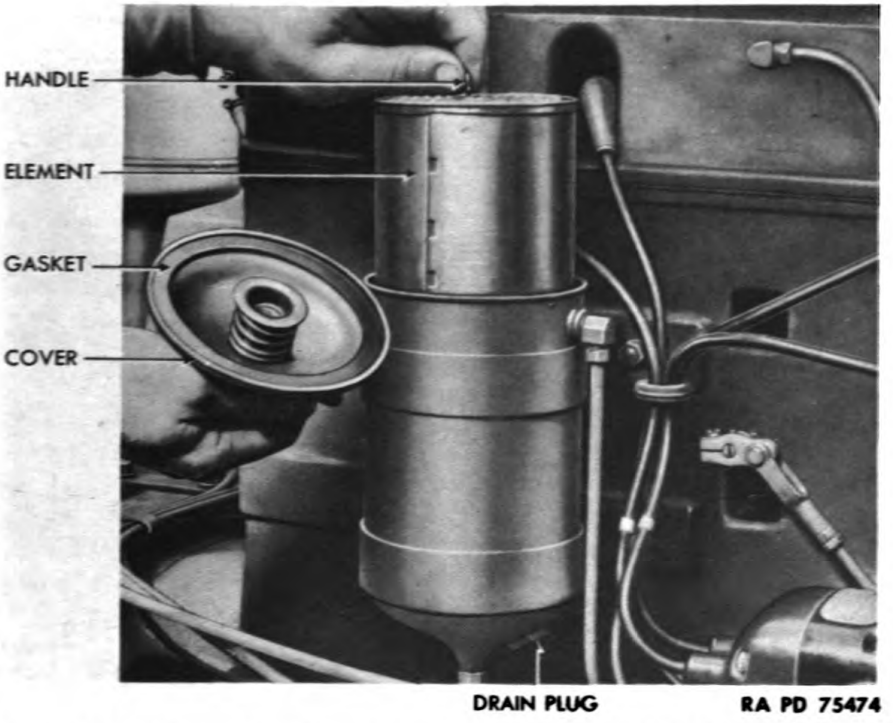



***Figure 40 — Removing Compressor Unit Engine Oil Filter Element***

*3.* Connect wire from ammeter to F terminal of voltage control.

*4.* With battery properly connected but before starting engine, hold a jumper lead momentarily between "BATTERY" and "GENERATOR" terminals of voltage control. This allows a momentary surge of current from battery to generator which correctly polarizes generator.

*5.* Start engine and adjust generator output (par. 5 c (17) ).

*(f) Removal of Cranking Motor* (fig. 39).

*1.* Disconnect electrical cable from terminal on cranking motor.

*2.* Remove four cap screws and lock washers which secure cranking motor to flywheel housing.

*3.* Lift cranking motor from flywheel housing.

*(g) Installation of Cranking Motor* (fig. 39).

*1.* Place cranking motor in position of flywheel housing and install the four cap screws and lock washers which secure motor to housing.

*2.* Connect battery cable to terminal on cranking motor.

(6) LUBRICATION SYSTEM.

*(a) Removal of Oil Filter Element* (fig. 40).

*1.* Stop engine.

*2.* Drain filter by removing drain plug on under side of filter.



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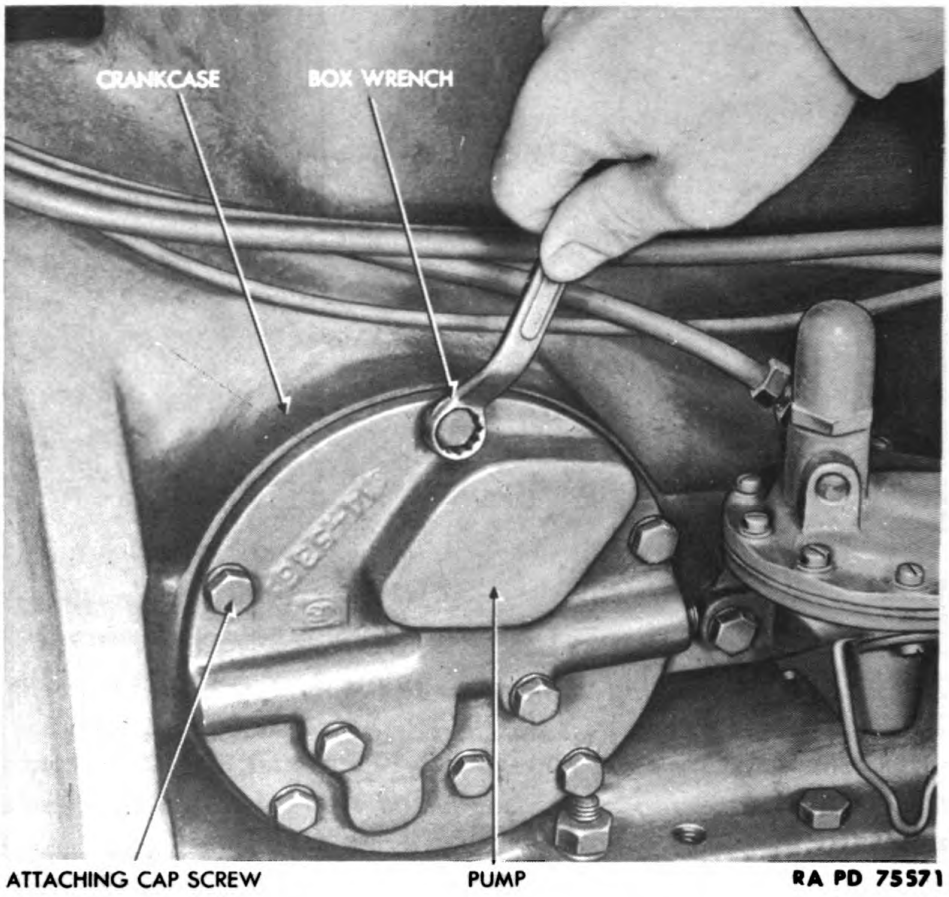



***Figure 41 — Removing Compressor Unit Engine Oil Pump***

3. Unscrew cover from top of filter.

4. Grasp small wire handle on top of element and lift element from case.

*(b) Installation of Oil Filter Element* (fig. 40).

1. Insert new element into filter case, handle side up.

2. Using new cover gasket, replace cover. Turn handle clockwise, handtight.

3. Install drain plug.

4. Start engine and check for leaks.

5. Stop engine and fill crankcase with proper oil (par. 8 b) to "F" mark on bayonet gage.

*(c) Removal of Oil Pump* (fig. 41). Remove the five cap screws and lock washers which secure pump to crankcase. Lift pump and gasket from crankcase.



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*(d) Disassembly of Oil Pump.*

*1.* Drive out pin which locks drive gear on shaft with hammer and punch

*2.* Press drive gear from shaft in arbor press.

*3.* Remove snap wire and screen from head of pump.

*4.* Remove cap screws which attach cover to pump body. Lift off cover.

*5.* Lift drive shaft with gear from pump body.

*6.* Remove lock ring from outer end of drive shaft with screwdriver and push gear from shaft.

*7.* Remove lock ring from outer end of driven shaft with screwdriver and push gear from shaft.

*(e) Assembly of Oil Pump.*

NOTE: If either driver or driven gear is unserviceable, both must be replaced.

*1.* Install driven gear key and gear onto driven shaft and lock in place with lock ring.

*2.* Insert driven gear and shaft assembly into pump body.

*3.* Install driver gear key and gear onto drive shaft. Lock in place with lock ring.

*4.* Install gear pump cover onto pump body.

*5.* Press drive gear onto drive shaft over key and install pin.

*6.* Replace screen over outer end of pump. Wire screen in place. *NOTE: Replace screen if damaged.*

*(f) Installation of Oil Pump* (fig. 41). Using new gasket, insert pump through crankcase opening. Install the five cap screws and lock washers which secure pump to crankcase.

## 7. INSPECTION INSTRUCTIONS.

### a. Compressor and Pressure Control System.

(1) SAFETY VALVES. Trip safety valves daily by pulling down lever on side to prevent sticking. One safety valve is on air receiver; another on intercooler.

(2) INTERCOOLER CORE. Observe fins of intercooler daily to see if they are bent or obstructed. Straighten bent fins. Be careful not to damage tubes or break bond between fins and tubes. Blow out dirt with compressed air.

(3) FAN BELT TENSION. Check fan belt tension daily. Tension is correct when belt can be depressed without effort, approximately ½ to ¾ inch midway between pulleys.



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**b. Compressor Engine.**

(1) CYLINDER HEAD STUD NUTS. After a new engine has run a few hours, and when thoroughly warmed up, stop engine, remove cylinder head cover, and check cylinder head stud nuts for tightness. Tighten nuts in order given in figure 31. Go over all several times to make sure that all are uniformly tight. After tightening cylinder head nuts, adjust valve tappet clearance (par. 5 c (11) ).

(2) COOLING SYSTEM.

*(a) Radiator Core.* Observe radiator fins daily. If obstructed with dirt, blow out with compressed air. If bent, straighten. Be careful not to break bonds between fins and tubes or puncture tubes.

*(b) Fan Belt Tension.* Test tension of fan belt daily by depressing it midway between pulleys. It should deflect ½ to ¾ inch without effort. Adjust if necessary.

*(c) Water Pump.* Inspect water pump for daily leakage. If present, replace or remove, disassemble, and repair pump.

*(d) Hose Connections.* Inspect hose connections daily to see if leaks are present. Tighten loose connections; replace damaged hoses.

(3) FUEL SYSTEM.

*(a)* Measure quantity of fuel in fuel tank daily. Fill if insufficient for day's work.

*(b)* Note fuel lines, connections, fuel pump and carburetor daily to see if leakage is present. Repair leaks by tightening connections or replacing defective parts.

(4) ELECTRIC SYSTEM.

*(a) Spark Plugs.* Remove spark plugs every 200 to 300 working hours or oftener if necessary. Clean in an air blast spark plug cleaner. Set points at 0.025 to 0.030 inch. When adjusting, bend only outer electrode. Observe condition of insulators and points. Replace plug if either is broken or burned.

*(b) Cranking Motor and Generator.* Remove cover band and inspect commutator and brushes every 200 to 300 working hours. If commutator is dirty, clean it with No. 00 sandpaper. Blow out dust with compressed air. Never use emery to clean a commutator. If commutator is rough, out-of-round, or has high mica, remove armature and turn commutator down in a lathe. Undercut the mica. Replace worn brushes. If brushes wear rapidly, check for excessive spring tension (over 40 oz) and roughness or high mica of commutator.



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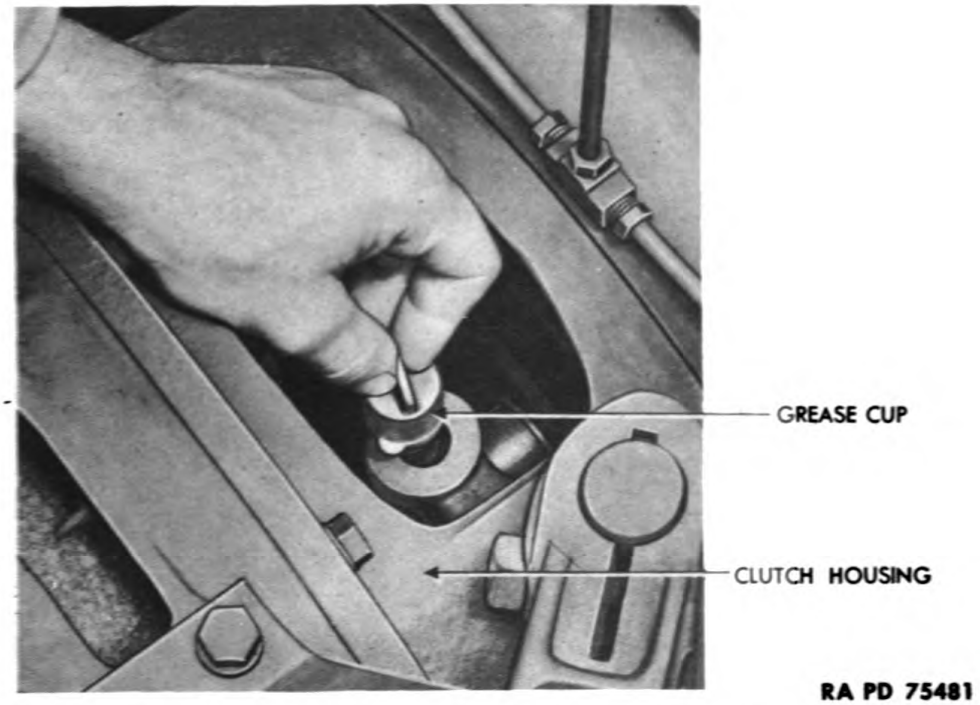



***Figure 42 — Tightening Compressor Clutch Grease Cup***

*(c) Battery.*

*1.* Daily inspect water level of battery. It should be between ¼ and 5/16 inch above tops of plates. Add distilled water to maintain level.

2. Test electrolyte with hydrometer every 50 hours. If under 1.250 specific gravity, recharge battery. If cells vary more than 15 points from each other, see paragraph 5 c (16) (d).

## 8. CARE, CLEANING, AND LUBRICATION.

### a. Maintenance Schedule.

**NOTE:** Before removing inspection covers, plugs, or caps, clean away all dirt. Use clean oil, fuel, and containers. When assembling parts, replace any damaged gaskets.

(1) STARTING EACH DAY AND/OR EVERY 8 WORKING HOURS.

*(a) Cooling System.* Fill with clean, soft water, unless anti-freeze is in the system.

*(b) Air Cleaners.* Clean oil bowl with cloth and fill to bead with OIL, engine (crankcase grade). Keep connections tight.

*(c) Crankcase Oil.* Check level. Fill to "F" mark on bayonet gages with proper grade oil (par. 8 b).



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*(d) Water Pump.* Turn grease cup down snug. When empty, fill with GREASE, general purpose, No. 2.

*(e) Clutch.* Turn grease cup down snug (fig. 42). When empty, fill with GREASE, general purpose, No. 2.

*(f) Fuel Strainer.* Check for presence of water and sediment. Remove, empty, and clean if necessary.

(2) EVERY 50 WORKING HOURS.

*(a) Breathers—Cylinder Head, Engine, and Compressor Oil Filler.* Wash in SOLVENT, dry-cleaning, drain, dip in oil, and drain. Only cleaning required by compressor breather is to wipe with clean cloth.

*(b) Generator.* Fill oil cups with OIL, engine (crankcase grade) (fig. 43).

*(c) Battery.* Clean terminals and caps. Tighten terminals and coat with grease. Check level of electrolyte. It should be ¼ to $\frac{5}{16}$ inch above tops of plates. Add distilled water if necessary.

(3) EVERY 100 WORKING HOURS.

*(a) Engine Crankcase* (fig. 43). Change oil. In extreme dust or heat conditions, change every 50 to 60 working hours. Fill to "F" mark on bayonet gage.

*(b) Oil Filter.* At time of oil change, clean inside of can and replace element and cover gasket.

*(c) Air Cleaners.* Remove elements, clean with SOLVENT, dry-cleaning, and refill with OIL, engine (crankcase grade). *CAUTION: Do not clean compressor filters in gasoline due to danger of explosion in air receiver.*

(4) EVERY 200 WORKING HOURS.

*(a) Compressor Crankcase* (fig. 43). Change oil. In extreme heat or dust conditions, change every 100 to 120 hours. Fill to "F" mark on bayonet gage.

(5) EVERY 1,000 WORKING HOURS.

*(a) Magneto* (fig. 43). Remove distributor cover and place a few drops of OIL, engine, SAE 30, on felt cam wick.

*(b) Cooling System.* Drain and flush entire system.

*(c) Crankcase.* If oil drained is thick and congealed, remove oil pan and remove all traces of sludge.



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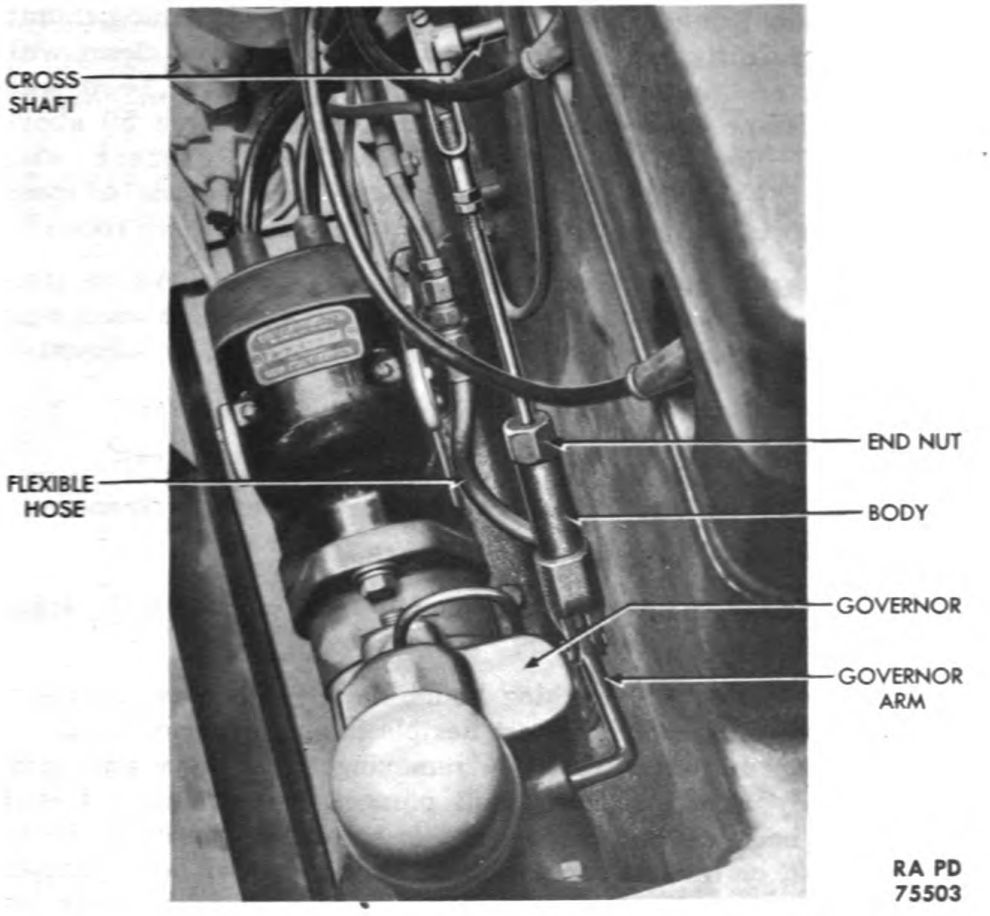



***Figure 43 — Compressor Engine Carburetor Slowdown Assembly***

**b. Crankcase Lubrication.**

**(1) CAPACITIES.**

| | |
|---|---|
| Engine crankcase | 14 qt |
| Compressor crankcase | 8 qt |

**(2) ENGINE OIL (TB 9-2835-3).**

| | |
|---|---|
| Engine crankcase: | |
| Below 32 F | SAE 10 |
| Above 32 F | SAE 30 |
| Compressor crankcase: | |
| Below 32 F | SAE 10 |
| Above 32 F | SAE 30 |

**c. Service Maintenance.**

**(1) COMPRESSOR AND PRESSURE CONTROL SYSTEM.**

***(a) Air Cleaners.*** Daily (or at more frequent intervals under



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dusty conditions) remove filter element and bowl by loosening thumb screw. Empty dirty oil pan from bowl and wipe bowl clean with cloth. Wipe or brush dirt from felt pad. Fill bowl to bead with engine oil of same viscosity as used in crankcase. Do not fill above bead level. Every 100 working hours, clean element with SOLVENT, dry-cleaning. *CAUTION: Never use gasoline to clean compressor air cleaners because of danger of explosion in air receiver.*

*(b) Pressure Control System Air Cleaner* (fig. 7). Air to actuate pressure control system is filtered through a filter located near top of left side of air receiver. To clean filter, proceed as follows:

*1.* Disconnect air line from filter.

*2.* Remove top. Lift out screen, felt, and second screen.

*3.* Clean screens and felt with air hose and assemble cleaner.

*(c) Carburetor Slowdown Assembly* (fig. 43).

*1.* Oil plunger shaft with OIL, engine (crankcase grade), regularly every 3 working days.

*2.* Every 200 to 300 working hours, disassemble slowdown and clean parts as follows: Disconnect flexible hose. Remove slowdown from governor and cross shaft by removing cotter keys and pins. Unscrew body from end nut. Pull plunger, leather washers, and spring from body. Clean metal parts in solvent. Inspect all parts. Replace worn or broken parts. Insert spring, washer, and plunger into body; install end nut, assemble slowdown to governor and cross shaft, and connect flexible hose.

(2) COMPRESSOR ENGINE.

*(a) Draining Cooling System.*

*1.* Open drain cock on cylinder block beneath carburetor.

*2.* Open drain cock in radiator bottom tank.

*3.* Be certain drain cocks are not plugged and system drains completely before closing cocks.

*(b) Servicing Engine Air Cleaner.* Engine air cleaner is similar in design to compressor air cleaners. The same servicing instructions apply (subpar. c (1) *(a)*).

*(c) Lubrication of Magneto.* Remove magneto distributor plate and lubricate cam felt wick with few drops of OIL, engine, SAE 30, every 100 working hours. Annually disassemble magneto and pack bearings with GREASE, ball and roller bearing. Be careful to keep contact points free of grease or oil.



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*(d) Lubrication and Care of Generator.*

*1.* Put 8 or 10 drops of OIL, engine (crankcase grade), in each of two hinge cap oilers every 50 working hours. Do not oil excessively. Never oil commutator.

*2.* Annually disassemble, clean, and inspect governor. Never clean armature or fields in degreasing tank or SOLVENT, dry-cleaning. Clean with compressed air or dry, clean brush. Clean ball bearing and pack with GREASE, general purpose, No. 2. If necessary, true commutator on lathe and undercut mica. Check all wiring connections. Resolder doubtful or poor connections, using rosin flux. Never use acid flux on electrical connections.

*(e) Care of Cranking Motor.* No lubrication is required. A few drops of OIL, engine (crankcase grade), may be put on bearings whenever motor is disassembled.



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# CHAPTER 3

# PNEUMATIC TOOLS

## Section I

## NAIL DRIVER

### 9. DESCRIPTION AND FUNCTIONING (fig. 44).

a. The nail driver is an air-operated, hammer type tool consisting of a handle unit, barrel and valve mechanism, piston, nail driving set, rivet buster, and safety set retainer. The handle contains an air inlet, air control valve, and a thumb-operated throttle lever which controls admission of air through the air control valve. An air strainer screws into the handle air inlet. Its function is to keep dirt and foreign matter from entering the tool. The throttle or air control valve in the handle is of the poppet type, giving sensitive graduation to the flow of air entering the tool. It is opened by thumb pressure on the throttle lever and closed by spring tension and air pressure. A ball oiler, screwed in the end of the throttle valve guide in the handle, serves as the oiling point for the entire tool. A barrel houses the valve mechanism, piston, and set. The valve mechanism governs the flow of air to the front or rear of the piston and to exhaust openings. Compressed air admitted to alternate ends of the barrel valve mechanism, reciprocates the piston in the barrel bore. The piston delivers the force of its forward stroke directly to the set. The return stroke is cushioned by air trapped in a pocket at the rear of the valve. Delivering the force of the piston directly to the work, a nail set drives nails or a rivet buster cuts rivets. A sleeve on the nail set prevents the set from sliding off the nail. A safety set retainer made of heavy spring wire screws on the nozzle end of the barrel and holds the set.

### 10. OPERATION.

**a. Before First Use or After Storage.**

(1) Clean rust-preventive oil from tool by dipping tool in SOLVENT, dry-cleaning. Swab out barrel with a cloth saturated in SOLVENT, dry-cleaning. Pour a teaspoonful of SOLVENT, dry-cleaning, in line air inlet and run tool for about 10 seconds.

(2) Immediately after cleaning, inject a teaspoonful of OIL, engine, SAE 10, into ball oiler or air inlet and operate tool for a few moments.



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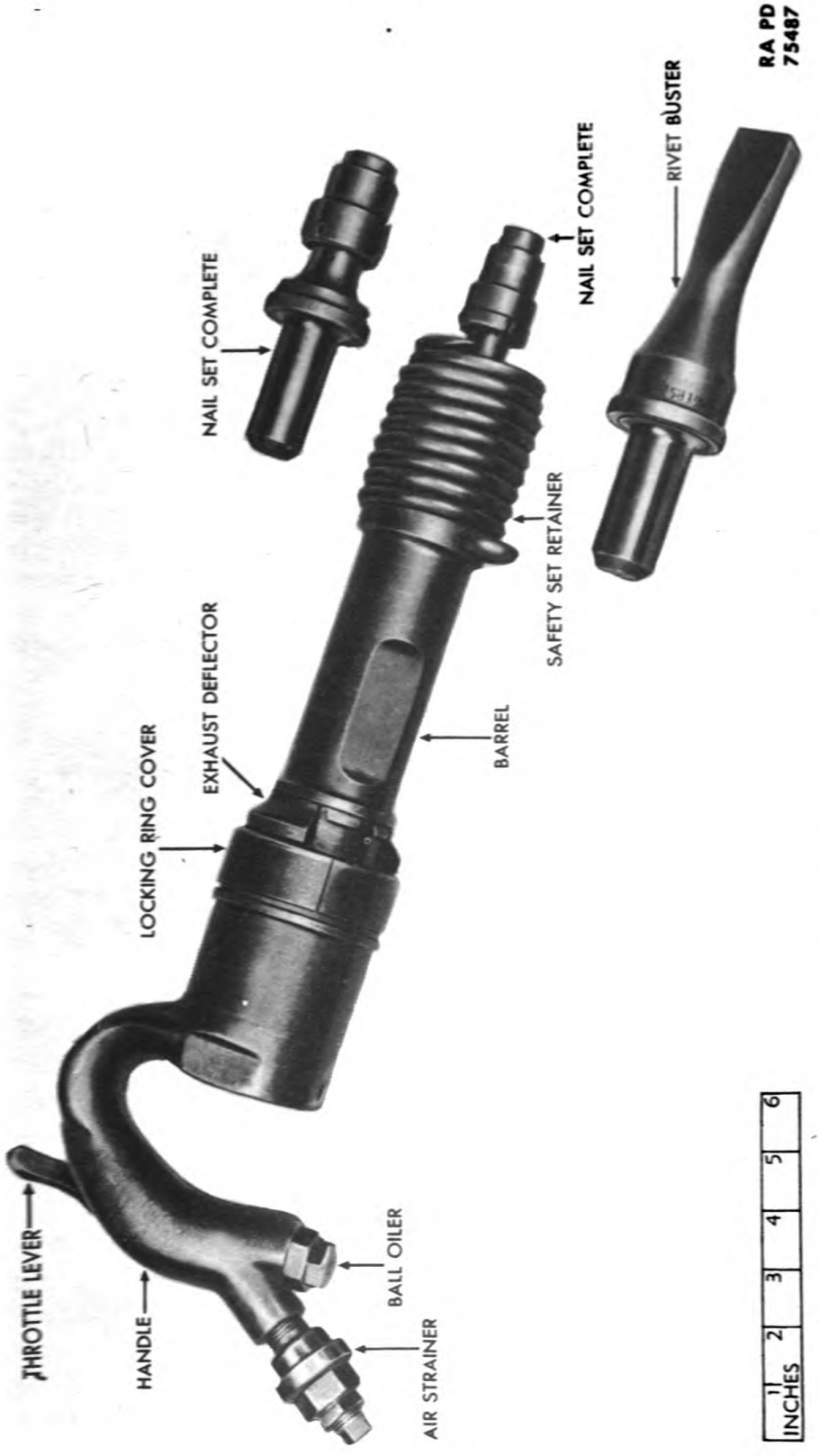



*Figure 44 — Pneumatic Nail Driver*



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*Figure 45 — Pneumatic Nail Driver in Operation*



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**b. Setting Up for Operation** (figs. 44 and 46).

(1) Slip piston into barrel from front end.

(2) Place set in nozzle hole of barrel.

(3) Screw safety set retainer on barrel to hold set in place. Drive curled up end of retainer into locking notch with a soft hammer.

(4) Lubricate tool (par. 14 b).

(5) Connect air hose from compressor to air inlet on handle. *NOTE: This tool works best on 80- to 90-pound per square inch air pressure.*

**c. Use as Nail Driver** (fig. 45).

(1) Start nail with a hand hammer.

(2) Place nail set against nail head of driver and press throttle lever with thumb. Release throttle lever and remove tool when nail is driven.

**d. Use as Rivet Buster.**

(1) Place chisel point of rivet buster under head of rivet and hold tool securely.

(2) Depress throttle lever with thumb until work is completed.

## 11. MALFUNCTIONS AND CORRECTIONS.

**a. Trouble Shooting.**

| Symptom | Cause | Remedy |
|---|---|---|
| (1) Set and piston "shoot" from barrel. | *(a)* Safety set retainer not screwed tightly on barrel, or curled up end of retainer not properly seated into locking notch. | *(a)* Set tool up properly before operation (par. 10 b). |
| (2) Oil is blown out of oiler during process of lubrication. | *(a)* Air to tool not turned off prior to lubrication. | *(a)* Disconnect air hose before attempting to lubricate tool. |
| (3) Tool operates sluggishly. | *(a)* Tool insufficiently lubricated. | *(a)* Lubricate nail driver (par. 14 b). |
| | *(b)* Hose of too small size in air line. | *(b)* Use ¾-inch hose, or larger. |
| | *(c)* Dirt in tool. | *(c)* Inject a teaspoonful of SOLVENT, dry-cleaning, through ball oiler and operate tool. Lubricate (par. 14 b) immediately thereafter. |



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| Symptom | Cause | Remedy |
|---|---|---|
| (4) Tool operates when throttle lever is not depressed. | *(a)* Dirt in throttle valve. | *(a)* Inject SOLVENT, dry-cleaning, into ball oiler and operate tool. Lubricate (par. 14 **b**) immediately thereafter. |
| | *(b)* Worn throttle valve. | *(b)* Disassemble handle. Regrind valve on its seat with COMPOUND, grinding, valve, fine (subpar. **b**, below). |

**b. Reseating Throttle Valve** (fig. 46). Remove ball oiler, spring, valve, and plunger (par. 12 **a**). Screw a $\frac{7}{16}$-inch, 14-thread bolt into throttle valve. Apply valve lapping compound to tapered seat only and lap in. Wash parts in SOLVENT, dry-cleaning, and reassemble (par. 12 **b**). Be sure there is a little play between plunger and valve.

**c. Replacement of Throttle Valve Guide** (fig. 46). Remove old throttle valve guide (par. 12 **a**). Coat new guide front end with LEAD, white, basic-carbonate, type C, to give good seal. Lap valve into seat (subpar. 4 **b**, above). If a new throttle valve complete is used, it will not be necessary to lap in old throttle valve.

## 12. DISASSEMBLY AND ASSEMBLY.

**a. Disassembly** (fig. 46).

(1) Drive curled up end of safety set retainer from locking notch with a soft hammer and unscrew retainer from barrel.

(2) Remove set and piston from barrel.

(3) REMOVE HANDLE FROM BARREL.

*(a)* Spring exhaust deflector out of groove and slide it off barrel.

*(b)* Slide locking spring cover from barrel.

*(c)* Push locking ring toward front of barrel thus disengaging locking spring.

*(d)* Unscrew handle from barrel.

(4) REMOVE VALVE BOX FROM BARREL.

*(a)* Insert a 1-inch (or smaller diameter) steel rod about 15 inches long into piston box until it strikes top of valve box. Tap steel rod lightly to force valve box from barrel.

*(b)* If valve box cap remains in barrel, strike handle end of barrel against wood block to jar it loose.



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(5) Disassemble air strainer by screwing strainer cap from strainer base. Lift air strainer screen from base.

(6) Disassemble Handle Further Only if Replacement of Some Part Is Necessary.

*(a)* Screw strainer base from handle.

*(b)* Screw oiler complete from throttle valve guide. Lift throttle valve spring, throttle valve, and throttle valve plunger from throttle valve guide. Screw throttle valve guide from handle.

*(c)* Drive out throttle lever pin and remove throttle lever from handle.

(7) Disassemble Valve Box.

*(a)* Hold valve box upside down. Grasp it around center of valve box cap. Insert piston in valve box.

*(b)* Tap end of piston with small hammer to separate cap and box.

*(c)* Pick valve from box. *CAUTION: Do not grip valve box or cap in vise, or pry it apart with screwdriver or similar tool.*

(8) Disassemble Nail Set.

*(a)* Push nail set centering sleeve back on nail set, compressing centering sleeve spring.

*(b)* Insert screwdriver in slot in back end of centering sleeve and force centering sleeve retainer out of its groove.

*(c)* Lift centering sleeve and spring from nail set.

**b. Assembly** (fig. 46).

(1) Assemble Nail Set.

*(a)* Force centering sleeve retainer over shoulder of nail set.

*(b)* Place centering sleeve spring on small end of nail set and slip centering sleeve over spring.

*(c)* Force and hold centering sleeve back on set, compressing centering sleeve spring slightly.

*(d)* Work centering sleeve retainer into its groove in end of centering sleeve.

(2) Assemble Valve Box. *CAUTION: Be sure all parts of valve box are clean and uninjured on the surfaces that bear against each other. Misalinement of box and cap will cock valve and slow hammer action.*

*(a)* Place piston in valve box to act as guide for valve.

*(b)* Slip valve over piston into valve box.

*(c)* Put valve box cap on valve box. Press it firmly onto box.



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## ORDNANCE MAINTENANCE — MAINTENANCE OF BOMB DISPOSAL EQUIPMENT FOR ACCESS AND STERILIZATION

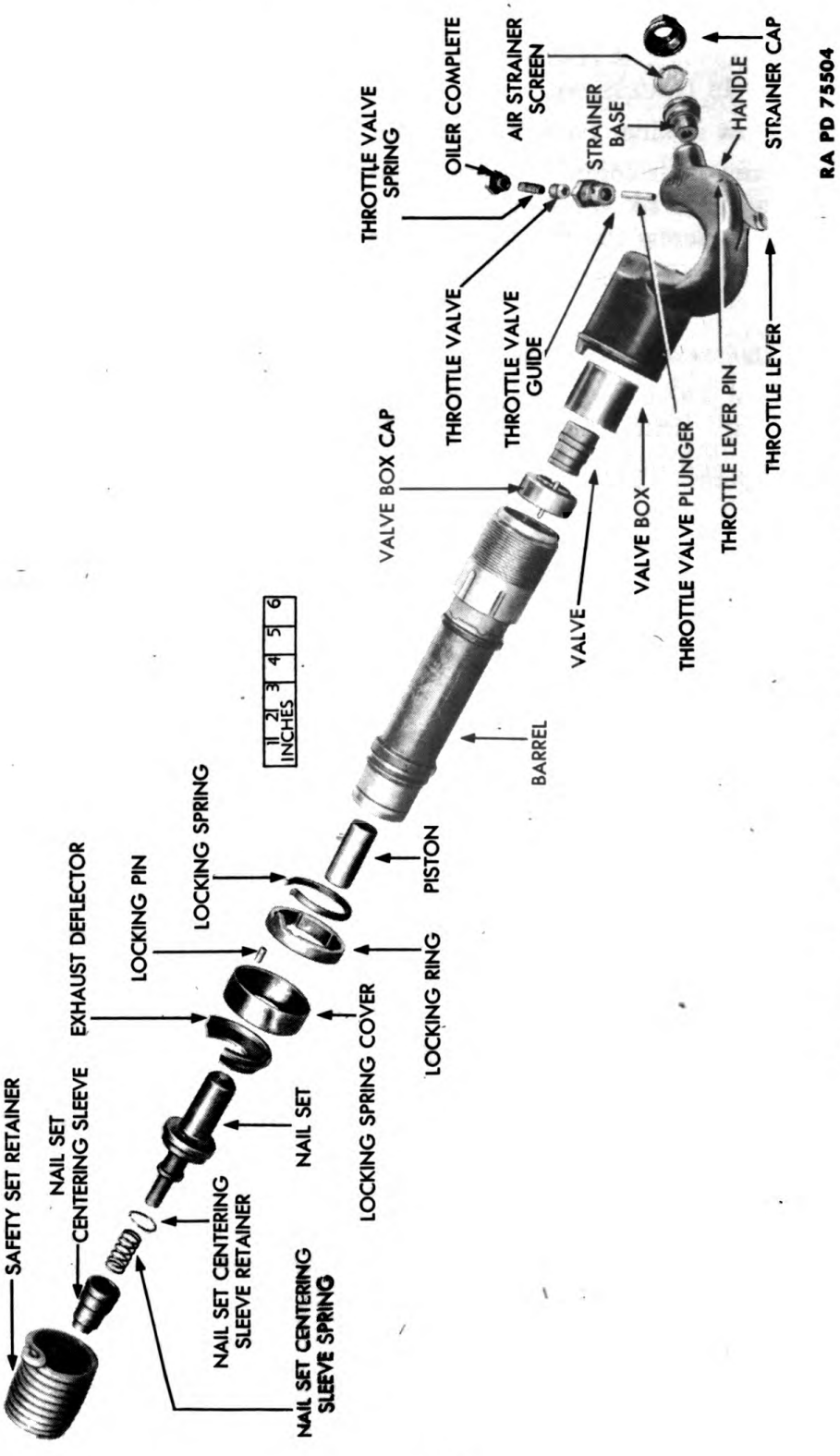



*Figure 46 — Pneumatic Nail Driver — Exploded View*



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*(d)* Shake assembled valve up and down to be certain valve moves freely.

(3) ASSEMBLE HANDLE.

*(a)* Hold throttle lever in place in handle and tap throttle lever pin into position. Peen pin sufficiently to keep it in place.

*(b)* Put a small amount of white lead on threads of throttle valve guide. Screw throttle valve guide into end of handle. Insert throttle valve plunger, throttle valve, and throttle valve spring into guide. Screw oiler complete into throttle valve guide. *NOTE: If guide or valve is replaced with new part, lap valve to seat in guide (par. 11 b).*

*(c)* Screw strainer base into its boss on rear of handle.

(4) Place air strainer screen in strainer base and screw strainer cap on base.

(5) Place valve box in barrel so that arrow stamped on valve box is in line with arrow stamped on barrel.

(6) INSTALL HANDLE ON BARREL.

*(a)* Screw handle onto barrel tightly.

*(b)* Place locking spring and locking ring on barrel so that one end of spring bears against lug on handle and other end against lug on ring.

*(c)* Turn locking ring in direction in which handle was screwed on until tension is placed on spring and line up a pair of half holes in barrel and locking ring. Place locking pin into hole thus formed. *NOTE: In some cases, only about ⅛-inch movement is necessary to line up a pair of half holes. This is not enough. Rotate ring until another pair of half holes line up. Do not rotate so far that spring expands sufficiently to prevent slipping locking spring cover over assembly.*

*(d)* Place locking spring cover over handle locking assembly.

*(e)* Slip exhaust deflector into place on barrel.

(7) Place piston in piston bore of barrel.

(8) Enter set into nozzle of barrel.

(9) Screw safety set retainer onto front end of barrel. Strike curled up end of retainer with a soft hammer while turning on by hand to force it into locking notch.

(10) Lubricate tool (par. 14 b).

## 13. INSPECTION INSTRUCTIONS.

### a. Before Each Use.

(1) Inspect piston to be sure tool is not treated with rust-pre-



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ventive compound in preparation for storage. Clean (par. 14 a) if rust-preventive is present.

(2) Inspect safety set retainer to be certain it is screwed on tightly and curled up end is in notch. If retainer comes loose, set and piston can be "shot" from barrel and may cause injury.

(3) Inspect all fittings to see that none are loose.

## 14. CARE, CLEANING, AND LUBRICATION.

**a. Care and Cleaning.** After each day's use clean tool in SOLVENT, dry-cleaning. Put a small amount of SOLVENT, dry-cleaning, in ball oiler (fig. 46) or in air intake (fig. 44) and run tool a few moments. Swab out barrel with clean cloth dampened with SOLVENT, dry-cleaning. Immediately lubricate hammer after cleaning with SOLVENT, dry-cleaning.

**b. Lubrication.**

(1) LUBRICANT. Never use heavy or dirty oil as it will cause sluggish action and may cause cutting of parts. Use OIL, engine, SAE 10, for all temperatures.

(2) PROCEDURE. Before starting tool, apply a small quantity of oil through ball oiler in handle (fig. 46). When in continuous operation, add oil every hour. After using apply a few drops of OIL, engine, SAE 10, and run for about 10 seconds. Since the tool may be thoroughly lubricated by the use of Ingersoll-Rand, type F "Oil-1R" air line lubricator, it is suggested that this lubricator be used when available as it dispenses with the procedure just mentioned. Fill the lubricator (1-pt capacity) with OIL, engine, SAE 10. Connect the air line lubricator with its 12-foot leader hose to the pneumatic tool and the air supply. Thus, when the air supply reaches the tool it is saturated with oil which lubricates the parts. Always oil immediately after cleaning with SOLVENT, dry-cleaning. *NOTE: Turn off air supply and bleed hose, or disconnect hammer from hose, before attempting to put oil in ball oiler. If an attempt is made to oil tool with air turned on, oil will be blown out of oiler.*

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### Section II

## CIRCULAR SAW

## 15. DESCRIPTION AND FUNCTIONING (fig. 47).

**a.** Skilsaw model 2127 pneumatic saw is designed to operate on 80- to 100-pound per square inch air pressure. It requires 50 to 55 cubic feet of free air per minute under normal load and 75 cubic feet



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## PNEUMATIC TOOLS

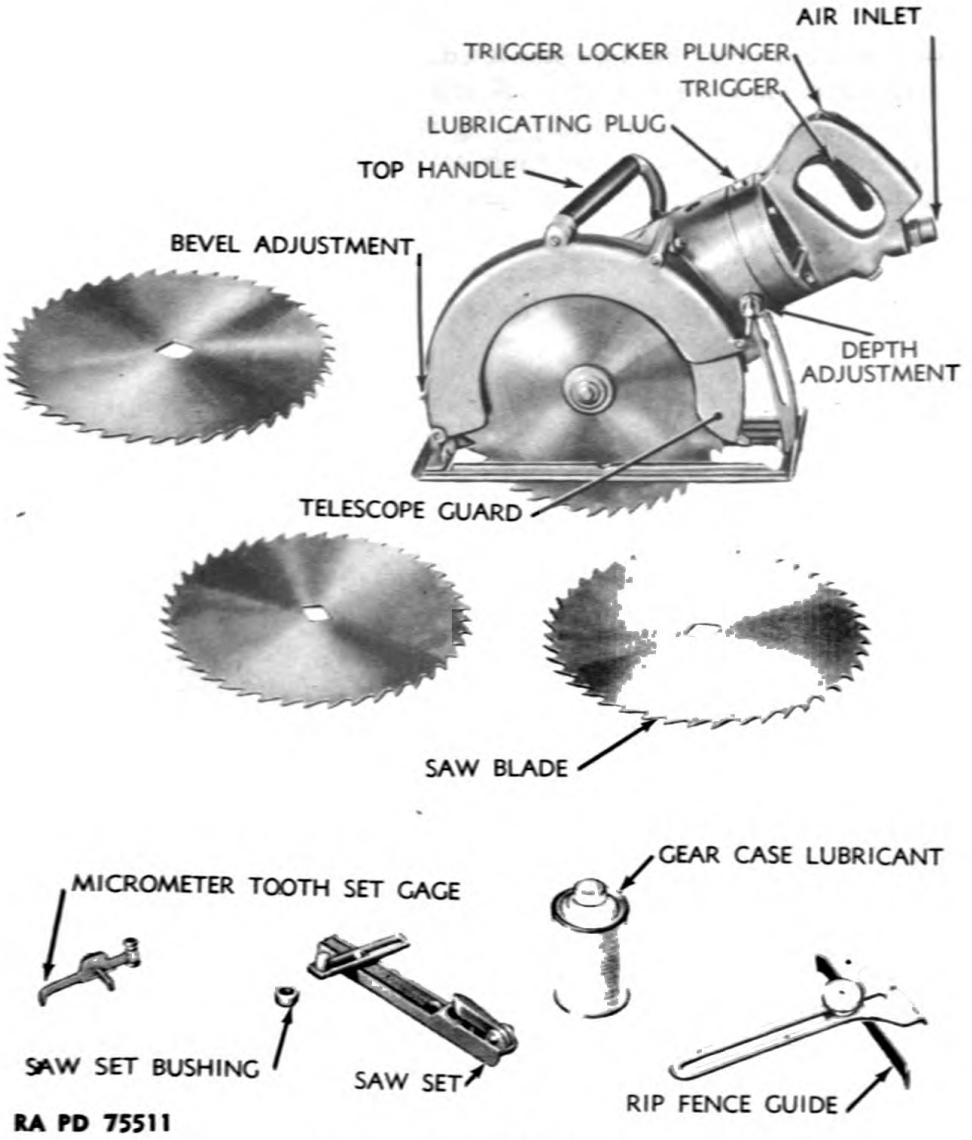



***Figure 47 — Circular Saw***

per minute when delivering maximum power. It is equipped with a 12-inch blade. Depth of straight cuts is adjustable from 2 3/8 inches to 4 3/8 inches. Bevel cuts can be made up to 3 5/16 inches at 45 degrees. Maximum capacity is based upon use of a full-size blade. After blade has been jointed (par. 17 b (5)), its capacity is reduced in proportion to decrease in diameter of blade. A pneumatic rotary type air motor is provided. Motor speed is controlled by a non-adjustable governor. Motor motion is transmitted to saw blade by a shaft and gear arrangement. The saw body is an aluminum alloy casting. A trigger-operated valve controlled by a safety latch admits air to motor. A spring-operated telescopic guard returns to a



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closed position after cut is completed. Base adjustment wing nuts control depth and angle of cut. A top handle serves as a hand grip for the operator. A lubricating plug is provided for lubricating all the air motor except rotor bearings and governor. A metal tool kit is furnished with saw and contains the following tools and accessories:

Blades, combination rip- and cross-cut, No. 382 (3)
Fence, rip, adjustable, 6-inch, No. 154 (1)
Hammer, hand (1)
Screwdriver (1)
Wrench, socket, T-handle (for saw stud and No. 738 plug) (1)
Wrench, open-end, 9/16-inch (for P57805 oil plug) (1)
Wrench, open-end, 1-inch (for hose nipple) (1)
Wrench, open-end, 3/8-inch (for P55000 nuts) (1)
Files, mill bastard, three-cornered, 8-inch, 3/4-inch base and 30-degree isoceles cross section
Set, saw, hammer type, No. 284 (1)
Gage, set, tooth, micrometer (1)
Lubricant, 8-ounce can, No. 249 (for gear case) (1)

## 16. OPERATION.

### a. Before Each Use.

(1) Clean air line by letting a blast of air through hose.

(2) Inspect saw blade for sharpness. Sharpen blade (par. 17 b) or replace (par. 18) with sharpened blade if saw is dull.

(3) Check lubricant level of both gear case and air motor and bring up to proper level (par. 20 b).

(4) Visually inspect tool to determine if any parts are misadjusted, damaged, or broken, if saw blade has worked loose between clamping washers, or if telescopic guard operates freely without binding. Replace damaged or broken parts, tighten loose parts, free and lubricate binding parts.

### b. Using Tool To Cut Wood (fig. 48).

(1) Loosen depth adjustment wing nut (fig. 47) and adjust saw to desired depth of cut. Tighten wing nut.

(2) Loosen bevel adjustment wing nut (fig. 47) and tip saw to desired angle. Tighten wing nut. *NOTE: If considerable ripping is to be done, install rip fence guide on tapped hole about 2 inches back of front of foot on blade side by means of wing screw. Adjust guide to desired width (minimum 1½ in., maximum 7¼ in.).*

(3) Blow out air hose. Connect air hose to tool.



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## PNEUMATIC TOOLS




***Figure 48 — Circular Saw in Operation***



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(4) Place forward part of foot squarely on timber to be cut. *NOTE: To make cut beginning in center of board instead of starting at edge, rest front part of foot on board. Manually move lower guard to a point where saw rests on front of foot and lip of guard with blade clearing wood.*

(5) Press trigger locking plunger down with thumb. Press trigger with fingers. Allow blade to operate freely a few seconds before cutting.

(6) Start the cut by moving saw gently into its work. Do not jam saw blade into its work as this procedure strains the blade and makes an untrue cut.

(7) Guide the saw, without forcing, through the cut. The two notches in front of foot serve as guides for cutting on line. The deeper notch is located in line with blade for right-angle cutting. The smaller notch is used when cutting a 45-degree bevel. Line up the proper notch with the line to which the cut is being made. *NOTE: If rip fence guide was installed, as per note following step (2), cut is kept in straight line by guiding the saw so guide follows edge of board.*

## 17. MALFUNCTIONS AND CORRECTIONS.

### a. Trouble Shooting.

| Symptom | Cause | Remedy |
|---|---|---|
| (1) Trigger will not open. | *(a)* Safety lock engaged. | *(a)* Press trigger lock plunger down with thumb before pressing trigger with fingers (par. 16). |
| (2) Telescopic guard binds. | *(a)* Sawdust packed around bearing. | *(a)* Blow sawdust away from bearing with air hose. |
| | *(b)* Guard or other part bent so that binding occurs. | *(b)* Straighten or replace (par. 18) bent part. |
| | *(c)* Guard bearing lacks lubricant. | *(c)* Lubricate telescopic guard bearing (par. 20 b). |
| (3) Saw shows evidence of loss of power. | *(a)* Screen in reducer plugged. | *(a)* Remove screen (par. 18) and clean in SOLVENT, dry-cleaning. |
| | *(b)* Insufficient air pressure or air quantity. | *(b)* Connect tool to a source of air at 80- to 100-pound pressure and capable of delivering up to 75 cubic feet free air per minute. |



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| Symptom | Cause | Remedy |
|---|---|---|
| | *(c)* Air hose too small. | *(c)* Use a ½-inch or larger air hose. |
| | *(d)* Lack of lubrication to all moving parts. | *(d)* Disassemble saw (par. 18 a) and inspect parts. Remove any obstructions to free flow of lubricant. |
| | *(e)* Rotor blades in air motor worn. | *(e)* Replace blades if worn 25 percent or whenever motor has been taken apart for inspection and appreciable wear is in evidence. |
| | *(f)* Saw blade binding in cut due to insufficient set in blade. | *(f)* Set saw blade properly (subpar. b (4), below) or replace blade. |
| | *(g)* Saw blade dull. | *(g)* Sharpen and set (subpar. b, below) or replace (par. 18) saw blade. |
| | *(h)* Saw blade circumference out-of-round, gullets too shallow, or blade warped or dished. | *(h)* Recondition (subpar. b, below) or replace (par. 18) saw blade. |

**b. Reconditioning Saw Blades.**

(1) GENERAL.

*(a)* Saw blade must be kept sharp. A first class job can be done only by a skilled saw fitter; therefore, after a number of sharpenings in the field, the blades should be reconditioned by an experienced saw man. Complete refitting of saw blades involves five distinct operations. In proper sequence, these are: hammering, gumming, setting, jointing, and filing.

*(b)* In most cases a blade can be satisfactorily conditioned by filing and setting only. Jointing is not necessary if the blade is round and gullets need not be gummed out until they have worn to about two-thirds of their original depth. Unless the blade has been abused, hammering will not be necessary.

(2) HAMMERING (fig. 49). Hammering is the art of straightening a blade that has become warped or "dished." This work should be done by an experienced saw fitter since skill is attained only through years of experience. Procedure follows:

*(a)* Test blade with a straightedge to ascertain which is the concave or "dished" side and which is the convex or "bulged" side.

*(b)* Place blade, concave side down, on a level-surfaced steel plate.



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## ORDNANCE MAINTENANCE — MAINTENANCE OF BOMB DISPOSAL EQUIPMENT FOR ACCESS AND STERILIZATION

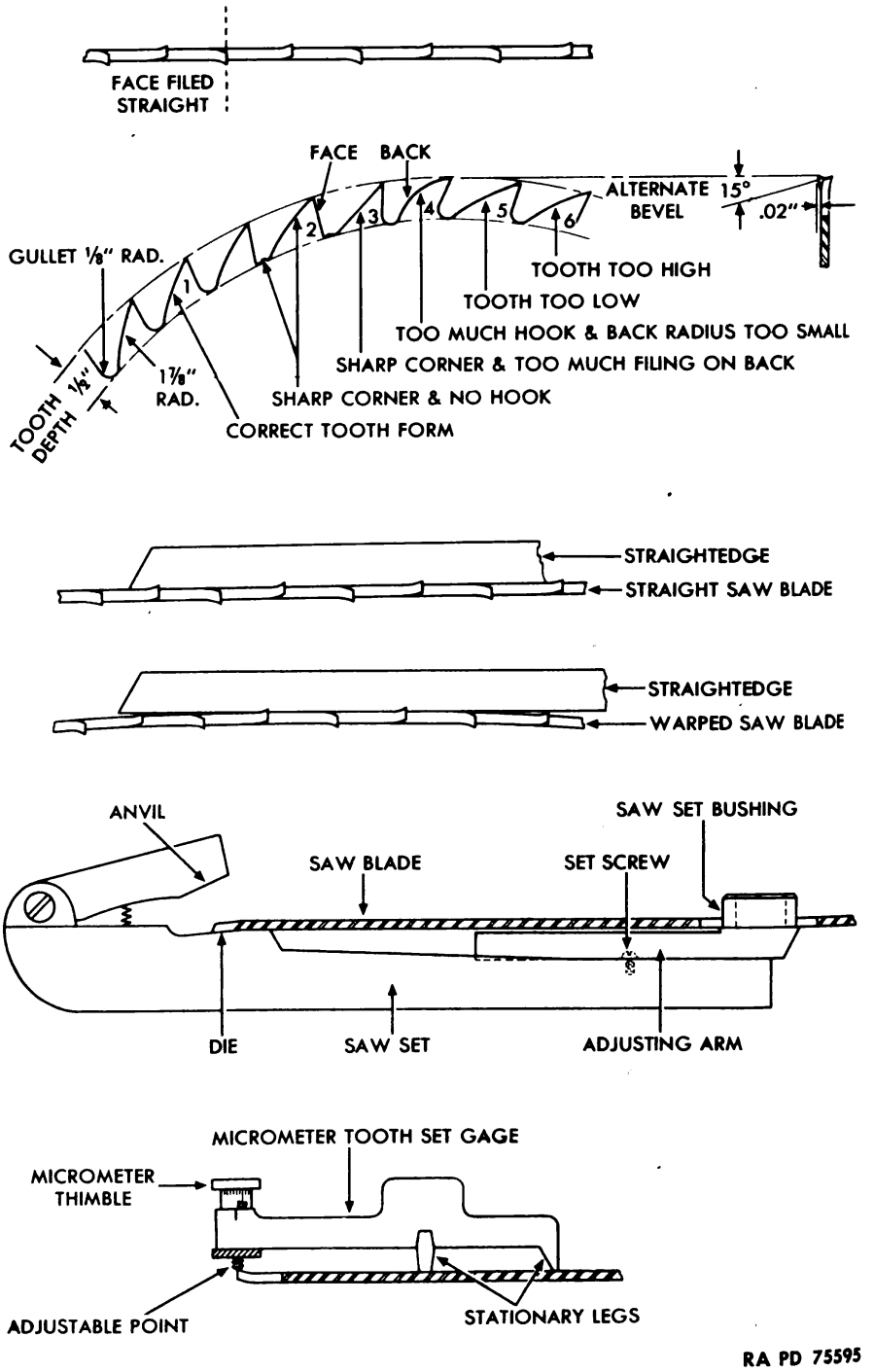



*Figure 49 — Circular Saw Blade Reconditioning Data*



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*(c)* Hammer convex surface of blade, working out radially to the periphery.

*(d)* Test hammered blade with straightedge. Repeat steps *(b)* through *(d)*, above until blade is perfectly straight.

(3) GUMMING (fig. 49). Gumming is the process of deepening saw blade gullets which have been shortened by repeated filing or by jointing. Gumming should be performed on a blade by an experienced saw fitter after the teeth have worn to about two-thirds of their original length. File gullets until teeth are brought back to original height. Keep gullets semicircular in shape and with a radius of approximately ⅓ inch. Sharp corners must be avoided.

(4) SETTING (fig. 49). If blade does not require hammering, gumming, or jointing, setting is the first step in its conditioning. Periphery must be wider than blade thickness to overcome binding. This is done by bending alternate teeth points in opposite directions from plane of saw blade. For average cutting, the amount of set should be 0.020 inch. If lumber is wet or green, amount of set can be increased up to 50 percent.

*(a)* Check tooth set with micrometer tooth set gage (fig. 47). Place micrometer tooth set gage on flat surface of saw blade with gage's three stationary legs all contacting saw blade. Adjust micrometer thimble until adjustable point beneath thimble just contacts surface of saw blade. Note reading of thimble screw which is graduated in thousandths of an inch. It will probably read somewhere between minus 0.003 and plus 0.003 inch. This is gage's neutral reading and represents corrections which must be made on reading of gage. If blade is to have a set of 0.020 inch and neutral reading of thimble is minus 0.003 inch, reading when the thimble screw point contacts blade point should be 0.017 inch. If neutral reading is plus 0.003 inch, then reading at blade should be 0.023 inch.

*(b)* Adjust micrometer tooth set gage to set desired, taking into account correction obtained in preceding step *(a)*.

*(c)* Place gage on blade with thimble screw point on extreme tip of tooth and three stationary legs on blade. Observe approximate set which must be put in blade point. *NOTE: If some teeth are shorter than others, measure set of shortest tooth.*

*(d)* Place saw set (fig. 47) in a vise or attach it securely to a bench. Lay saw blade on saw set with center hole on adjusting arm. Place saw set bushing on hub in center hole of saw blade. Move adjusting arm in or out until die and anvil appear to give blade point proper set. Lift blade carefully from saw set and tighten adjustable bracket set screw. Replace blade on saw set.

*(e)* Strike die one solid blow with a hammer.



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*(f)* Remove saw blade and measure set of point with micrometer tooth set gage. If it is other than desired set, repeat steps *(b)* through *(d)* above, until desired set is obtained. This will ordinarily be obtained in a maximum of two trials. Note that moving adjusting arm toward anvil increases set, moving away decreases set.

*(g)* When exact location of adjusting arm is determined, set every second tooth by placing tooth under anvil and delivering one solid blow (hammer) on anvil. Reverse the blade and set alternate teeth in same manner.

(5) JOINTING (fig. 49). Jointing is the process of truing blade circumference.

*(a)* Remove blade from saw, turn over, and install on saw. Teeth and blade will now revolve backward. *NOTE: Do not attempt jointing unless blade is turning in reverse.*

*(b)* Start saw and hold piece of abrasive against teeth points for an instant. *CAUTION: Exercise great care to avoid possible injury to operator. Use a dressing stone large enough so operator's hand need not be brought near saw teeth.*

*(c)* Stop saw and examine saw blade teeth.

*(d)* Repeat steps *(b)* and *(c)* above, until all teeth are shortened to length of shortest tooth. Do not grind away more metal than necessary.

(6) FILING (fig. 49). Filing is the sharpening of saw teeth. An 8-inch, three-cornered mill bastard file is used.

*(a)* Secure blade in a soft-jawed vise with jaws as close to circumference as possible but not close enough to disturb set.

*(b)* File points alternately at a 15-degree angle. When cutting hardwood, file points straight across. File face of teeth straight across and with a hook of about 15 degrees. File each tooth back with a radius of approximately 1⅞ inches. If teeth backs are filed straight, they break easily; if filed with too short radius, they clog easily.

## 18. DISASSEMBLY AND ASSEMBLY.

**a. Disassembly (fig. 50).**

(1) REMOVE AIR MOTOR.

*(a)* Remove the two screws which attach top handle. Lift top handle from saw.

*(b)* Remove the three upper guard screws. Lift upper guard from saw.



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*(c)* Remove depth adjustment wing nut and washer. Remove bevel adjustment wing nut, washer, and bolt. Remove foot hinge pin. Lift foot assembly from saw.

*(d)* Remove the four screws which attach motor housing to front housing. Lift motor and attached grip handle assembly from front housing Lift star connector from end of drive shaft.

(2) REMOVE AND DISASSEMBLE GRIP HANDLE ASSEMBLY.

*(a)* Remove the four handle attaching nuts and washers. Lift grip handle assembly and handle gasket from air motor.

*(b)* Screw stem bushing cap from grip handle assembly. Lift stem bushing spring and stem bushing from grip handle assembly.

*(c)* Screw air inlet reducer from grip handle assembly. Push air strainer from reducer.

(3) REMOVE GEARS.

*(a)* Screw front bearing cap from front housing. Pick off front bearing cap gasket. Screw lock nut and washer from end of drive shaft. Rotate saw in direction opposite to normal rotation, and front ball bearing and worm will be ejected. If bearing and worm do not eject freely, strike teeth of blade a light sharp blow with a rawhide mallet.

*(b)* Remove the four retainer screws and lift center bearing retainer from front housing. Lift drive shaft with attached center ball bearing and drive shaft spacer from front housing. Pull spacer from shaft. Pull drive shaft oil seal from front housing.

*(c)* Remove saw shaft bolt (left-hand thread). Lift outer washer, saw blade, and inner washer from saw shaft.

*(d)* Remove the three bearing cap screws. Tap protruding end of saw shaft (soft hammer) and lift saw shaft complete with worm wheel, saw shaft outer bearing, and side bearing cap from front housing. Do not attempt to remove worm wheel without first removing worm. Tap (rawhide mallet) bearing cap from bearing. Use care to keep from injuring bearing cap gasket.

(4) REMOVE SAW SHAFT INNER BEARING.

*(a)* Remove the four retainer screws and lift inner bearing retainer from front housing.

*(b)* Lift bearing, saw shaft spacer, and saw shaft oil seal from housing.

(5) REMOVE TELESCOPIC GUARD.

*(a)* Remove the three screws which secure guard bearing retainer to front housing. Rotate guard so screws are accessible through small hole near pivot hole.



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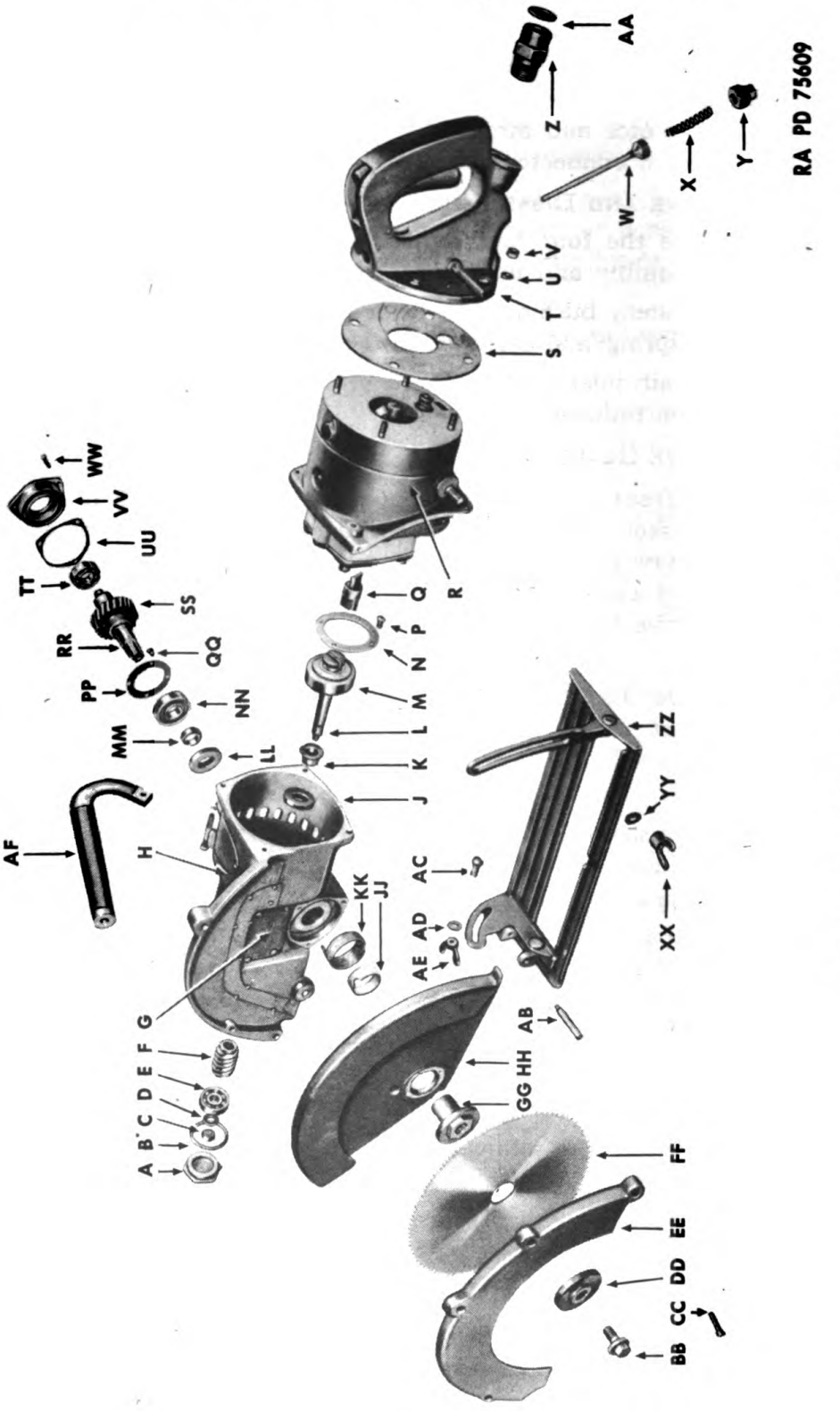



*Figure 50 — Circular Saw — Exploded View*



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A—FRONT BEARING CAP
B—FRONT BEARING CAP GASKET
C—DRIVE SHAFT NUT
D—DRIVE SHAFT WASHER
E—FRONT BALL BEARING
F—WORM
G—GEAR CASE
H—FRONT HOUSING
J—DRIVE SHAFT OIL SEAL
K—DRIVE SHAFT SPACER
L—DRIVE SHAFT
M—CENTER BALL BEARING
N—CENTER BEARING RETAINER
P—RETAINER SCREW
Q—STAR CONNECTOR
R—AIR MOTOR
S—HANDLE GASKET
T—GRIP HANDLE ASSEMBLY
U—HANDLE ATTACHING NUT WASHER
V—HANDLE ATTACHING NUT
W—STEM BUSHING
X—STEM BUSHING SPRING
Y—STEM BUSHING CAP
Z—AIR INLET REDUCER
AA—AIR STRAINER
BB—SAW SHAFT BOLT
CC—UPPER GUARD SCREW
DD—OUTER WASHER
EE—UPPER GUARD
FF—SAW BLADE
GG—INNER WASHER
HH—TELESCOPIC GUARD
JJ—FLOATING RING
KK—SPECIAL SPRING
LL—SAW SHAFT OIL SEAL
MM—SAW SHAFT SPACER
NN—SAW SHAFT INNER BEARING
PP—INNER BEARING RETAINER
QQ—RETAINER SCREW
RR—SAW SHAFT
SS—WORM WHEEL
TT—SAW SHAFT OUTER BEARING
UU—SIDE BEARING CAP GASKET
VV—SIDE BEARING CAP
WW—BEARING CAP SCREW
XX—DEPTH ADJUSTMENT WING NUT
YY—WING NUT WASHER
ZZ—FOOT ASSEMBLY
AB—FOOT HINGE PIN
AC—BEVEL ADJUSTMENT BOLT
AD—WING NUT WASHER
AE—BEVEL ADJUSTMENT WING NUT
AF—TOP HANDLE

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***Legend for Figure 50 — Circular Saw — Exploded View***



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*(b)* Lift guard with attached bearing retainer, gasket, and bearing from front housing.

*(c)* Lift floating ring and special spring from front housing.

**b. Assembly** (fig. 50).

(1) INSTALL TELESCOPIC GUARD.

*(a)* Place guard spring in any one of the four holes in guard bearing.

*(b)* Place floating ring in position within spring.

*(c)* Lower guard in a position about 60 degrees beyond normal closed position.

*(d)* After spring has engaged front housing, rotate guard back to normal closed position.

*(e)* Press bearing into place and install the three screws which secure guard bearing retainer to front housing.

(2) INSTALL SAW SHAFT INNER BEARING.

*(a)* Place saw shaft oil seal in position with lip of leather pointing toward inside of front housing.

*(b)* Place saw shaft spacer in center of oil seal.

*(c)* Place saw shaft inner bearing and inner bearing retainer in position.

*(a)* Install the four retainer screws.

(3) INSTALL GEARS.

*(a)* Tap saw shaft outer ball bearing into side bearing cap with a rawhide metal. Tap saw shaft into bearing with rawhide mallet. Place side bearing cap gasket on bearing cap. Insert saw shaft into position in front housing and tap into place. Use a soft hammer and tap on bearing cap. Install the three bearing cap screws.

*(b)* Place inner washer, saw blade, and outer washer in position on saw shaft. Install saw shaft bolt (left-hand thread).

*(c)* Push drive shaft oil seal, leather lip first, into position in front housing. Slide drive shaft spacer, flange end first, onto drive shaft. Insert drive shaft into position within front housing. Place center bearing retainer in position and install the four retainer screws.

*(d)* Start worm on drive shaft. Turn saw in direction of normal rotation until worm works into place on drive shaft. Tap front ball bearing into place on end of drive shaft (rawhide mallet). Install drive shaft nut and washer. Place gasket on front bearing cap and screw cap securely into front housing.

(4) ASSEMBLE AND INSTALL GRIP HANDLE ASSEMBLY.

*(a)* Insert stem bushing and stem bushing spring into opening on under side of grip handle assembly. Install stem bushing cap.



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*(b)* Push air strainer into position in air inlet reducer. Screw reducer tightly into grip handle assembly.

*(c)* Place handle gasket and grip handle assembly in position on air motor. Install the four handle attaching nut washers and nuts.

(5) INSTALL AIR MOTOR.

*(a)* Place star connector in position on end of drive shaft. Place motor in position on front housing. Rotate saw blade, if necessary, to make star connector engage motor. Install the four screws which attach motor housing to front housing.

*(b)* Place foot assembly in position on saw. Install foot hinge pin. Install bevel adjustment bolt, washer, and wing nut. Install depth adjustment washer and wing nut.

*(c)* Place upper guard in position on saw. Install the three upper guard screws.

*(d)* Place top handle in position on saw and install the two attaching screws.

(6) LUBRICATE SAW (par. 20 b).

## 19. INSPECTION INSTRUCTIONS.

### a. Before Each Use.

(1) Inspect all external nuts, screws, and fittings to see if they are tight. Tighten any parts that have come loose.

(2) Observe condition of saw blade. Recondition (par. 17 b) or replace blade if it lacks set, is dull, out-of-round, or "dished," or if teeth have worn so that gullets are less than $\frac{5}{16}$ inch deep.

(3) Lubricate tool (par. 20 b).

**b. Annually.** Disassemble saw (par. 18 a). Inspect all parts to see if any are worn, scored, or broken. Replace doubtful parts before assembling (par. 18 b) saw.

## 20. CARE, CLEANING, AND LUBRICATION.

### a. Care and Cleaning.

(1) After using saw, blow sawdust from telescopic guard with air blast. Carefully wipe any moisture from blade. Rub entire exterior, including blade, with a cloth dampened with clean OIL, engine, SAE 10.

(2) At least once a week flush motor by removing air hose and pouring a quantity of OIL, engine, SAE 10, into air inlet. Replace air hose and run motor until oil is blown out exhaust port.

(3) Every 6 months, or more often, drain lubricant from gear case. Fill gear case with OIL, engine, SAE 10, and run saw for a few moments. Remove grease plug and drain oil from gear case. Clean out with



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SOLVENT, dry-cleaning. Turn saw upside down and allow all SOLVENT, dry-cleaning, to drain. Lubricate gear case (subpar. b (3), below).

**b. Lubrication.** This too should be lubricated by the installation of an air line lubricator in the air supply line as described in (par. 14 b (2) ). In addition, the following points of lubrication should be checked. Before checking or filling, carefully clean fittings.

(1) LUBRICATOR FITTINGS ON AIR MOTOR. There are two lubricator fittings on air motor. They provide means of lubrication for rotor shaft bearings and governor. Lubricate weekly, when tool is in daily use, with GREASE, general purpose, No. 1, or GREASE, general purpose, No. 0, if below 32 F. Do not force an excessive amount of grease into these fittings.

(2) OIL RESERVOIR ON AIR MOTOR. An oil reservoir provides means of lubrication for air motor parts other than rotor shaft bearings and governor. It is filled through a lubricating plug (fig. 47). Fill reservoir before putting tool to use and after every four hours of operation. Use OIL, engine, SAE 10, for below +32 F and OIL, engine, SAE 30, for above +32 F. To determine if the correct grade is being used, hold a piece of paper over exhaust. If a few drops of oil accumulate within a minute, the grade is correct. Absence of oil indicates oil is too heavy; surplus of oil indicates oil is too light.

(3) GEAR CASE. Keep gear case filled with lubricant sufficient to just cover worm gear. Use GREASE, general purpose, No. 1, above, +32 F or GREASE, general purpose, No. 0, below +32 F.

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## Section III

# TIMBER SAW

## 21. DESCRIPTION AND FUNCTIONING.

**a. General** (fig. 51). The pneumatic timber saw is a light, powerful timber cutting unit operated by a compressed air motor which drives an endless saw tooth chain. An air supply of 90 cubic feet per minute at 90- to 105-pound per square inch pressure drives the chain at its most efficient speed. The air supply is coupled onto the end of a 30-inch hose which is attached to the left handle of the motor. The 30-inch hose is a safety device designed to protect the operator. In case the air supply hose should come uncoupled, its wild end would be at a safe distance. The handle to which the hose attaches is also the throttle. Air supply is governed by twisting the handle.



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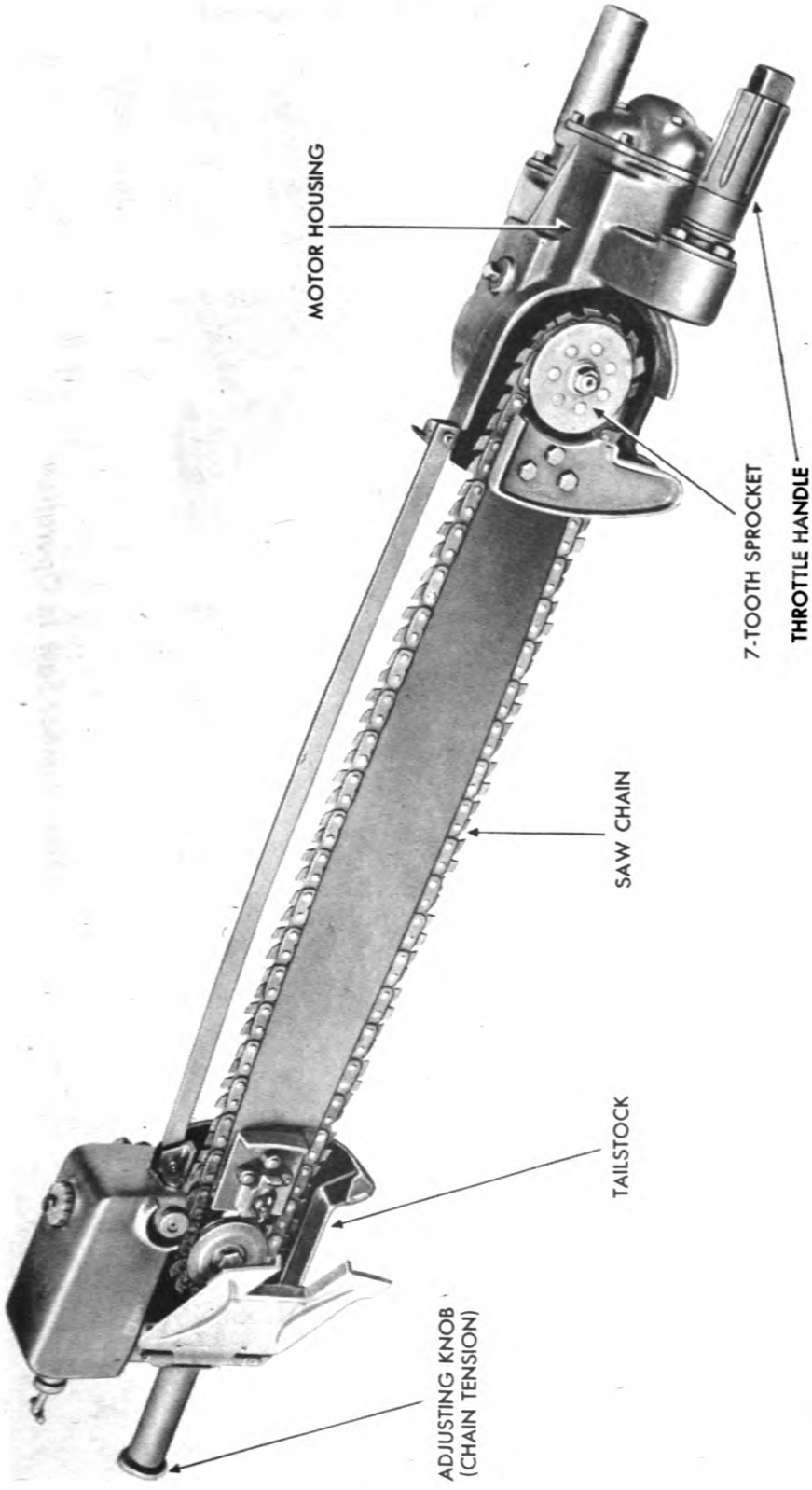
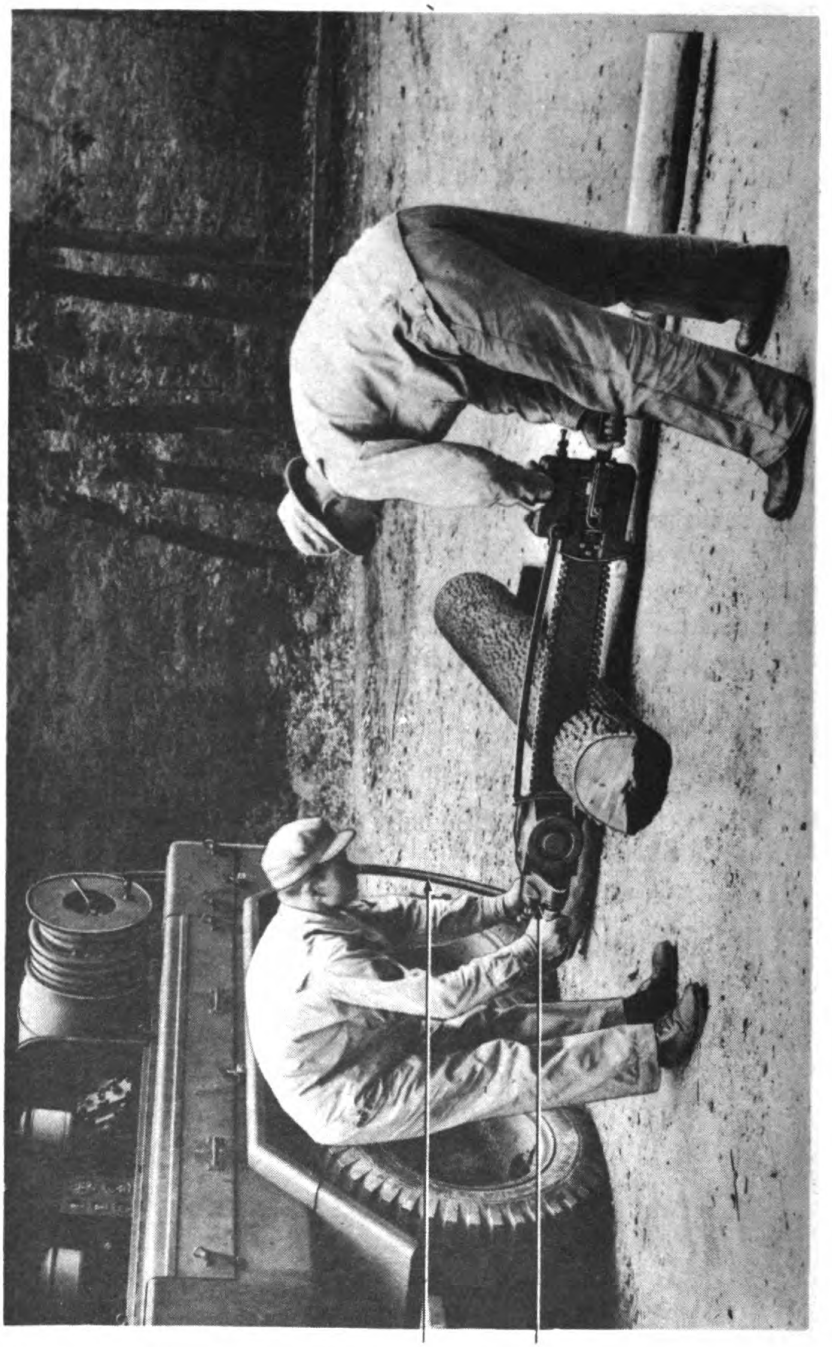



*Figure 51 — Timber Saw*



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*Figure 52 — Pneumatic Timber Saw in Operation*



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**b. Air Motor** (fig. 51). A vane-type compressed air motor supplies power for the unit. The motor incorporates a governor and an automatic oiling device which supplies an oil mist to lubricate the vanes and rotor. The rotor shaft rides on two ball bearings. Since the motor is a self-contained separately-housed assembly, it may be removed from the saw as a unit.

**c. Power Train** (fig. 51). Power from the motor is transferred through a pair of bevel gears to a 7-tooth sprocket. The gear box requires grease but the bearings have lubricant sealed in them and require no special attention. Mounted on the bevel gear shaft, the sprocket drives the chain which travels in a groove in the cutter bar. The cutter bar is rigidly connected at the motor end and at the tailstock end. It is shaped with a slight radius to improve the cutting action of the chain.

**d. Tailstock** (fig. 51). The tailstock contains an idler which is adjustable and is used to remove slack in the chain and govern tension. There is a spring device incorporated in the tailstock which acts as a shock absorber. An oil tank mounted on top of the tailstock supplies oil to lubricate the chain and cutter bar.

**e. Chain** (fig. 51). Easily removed from the saw without disconnecting links, the chain is made of cutter teeth in the form of links riveted together. These links are of case hardened steel and are so shaped that a simple filing or grinding operation keeps the chain in efficient cutting condition. Outer links consist of cutter teeth and plain lengths. Inner links are rakers which extend below the outer links forming a guide which rides in the groove of the cutter bar. These extensions on the rakers provide the means for engaging the driving sprocket. Every six links form a "cutting action." Each cutting action consists of a sequence as follows: left cutter, right raker, right cutter, left raker, left cutter, and center raker. To balance the chain, one cutting action or sequence starts with a left cutter and the next with a right cutter. The sequences are repeated throughout the entire chain which is an endless unit. The rivets which hold the links or teeth together are made with a shoulder against which the outer or side cutters are riveted. The shoulder properly spaces the side cutters so that clearance is maintained with the center links or rakers to provide a flexible chain.

## 22. OPERATION (figs. 51 and 52).

**a.** Lubricate saw (par. 26 b).

**b.** Adjust chain tension (par. 24 b (8) (c) ).

**c.** Couple air hose from adequate source to saw.

**d.** Place saw in position on timber which is to be cut. Slide saw



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across timber until bumper on motor end contacts work. The chain travels toward the motor on cutting side and bumper takes the thrust.

e. Start air motor by slowly turning knurled throttle handle. Use all available power for cutting. Keep feeding saw into work.

f. If sound of exhaust indicates saw is being slowed by overload, ease up on cut. Avoid cutting in a curve which causes binding and consequent overloading.

g. Keep an eye on flow of oil to chain. Stop saw immediately if oil supply cuts off.

h. When cut is completed, stop saw by turning knurled throttle handle. Lift saw from timber.

*CAUTION: Never touch saw chain while hose is coupled.*

NOTE: When felling, cut a notch in side of tree in direction of fall. Make final cut from opposite side of tree into notch.

## 23. MALFUNCTIONS AND CORRECTIONS.

### a. Trouble Shooting.

| Symptom | Cause | Remedy |
|---|---|---|
| (1) Saw slows down or overloads easily. | *(a)* Saw binding in cut. | *(a)* Hold saw straight; avoid cutting in a curve (par. 22). |
| | *(b)* Inadequate air supply. | *(b)* Connect saw to air supply capable of delivering 90 cubic feet per minute at 90- to 105-pound pressure (par. 22). |
| | *(c)* Air strainer plugged. | *(c)* Clean air strainer. |
| | *(d)* Hose with too small diameter in air supply line. | *(d)* Use ¾-inch or larger hose. |
| | *(e)* Saw teeth dull. | *(e)* Sharpen or replace chain. |
| | *(f)* Air motor inadequately lubricated. | *(f)* Lubricate entire unit. |
| | *(g)* Inadequate amount of or no oil on chain. | *(g)* See next entry in "Symptom" column. |
| (2) Lack of oil on chain. | *(a)* Oil reservoir on tailstock empty. | *(a)* Fill oil reservoir. |



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| Symptom | Cause | Remedy |
|---|---|---|
| | *(b)* No air pressure. | *(b)* Pump up air pressure with air pump built into tailstock. |
| | *(c)* Filler cap loose. | *(c)* Tighten filler cap (par. 26 b). |
| | *(d)* Breather on filler open. | *(d)* Close breather on filler cap (par. 26 b). |
| | *(e)* Oil line clogged. | *(e)* Clean obstruction from oil line (par. 24). |

**b. Adjustment of Saw Chain Tension** (fig. 51).

(1) Test chain tension by lifting chain from cutting bar. Tension is correct if chain lifts ¼ inch from center of cutting bar.

(2) Adjust chain tension, if necessary, by turning tension adjusting knob (fig. 51). Turn clockwise to pull idler back and tighten chain, turn counterclockwise to loosen chain.

**c. Sharpening Saw Chain** (fig. 53). File or grind front of each cutting edge. Take care to preserve original angle.

**d. Resetting Saw Chain** (fig. 53). If chain binds in a straight cut, reset cutting teeth. Bend cutter teeth outward so wider cut will result. Use a setting tool to keep set uniform. Use only enough set to clear the chain. Too much set reduces efficiency.

**e. Jointing Saw Chain** (fig. 53). Rakers should be about $\frac{1}{32}$ inch lower than cutters. Measure raker clearance with flat gage furnished with outfit. If necessary, grind or file top rakers to obtain clearance.

**f. Replacement of Damaged Saw Chain Teeth** (fig. 53).

(1) REMOVE DAMAGED CUTTER.

*(a)* Grind or file heads from the two rivets which hold plain link paired with cutter. Do not attempt to remove one rivet at a time because shoulder will not pass through cutter.

*(b)* Separate plain link from rivets with a cold chisel. *NOTE: Plain link may be used again.*

*(c)* Remove damaged tooth together with rivets from chain.

(2) INSTALL NEW CUTTER.

*(a)* Insert rivets in two rakers.

*(b)* Assemble plain link and cutter in pairs and peen heads of rivets. Make sure assembly is complete before riveting.

*(c)* File (par. 23 c) and joint (par. 23 e) replaced tooth so it matches other teeth of chain.



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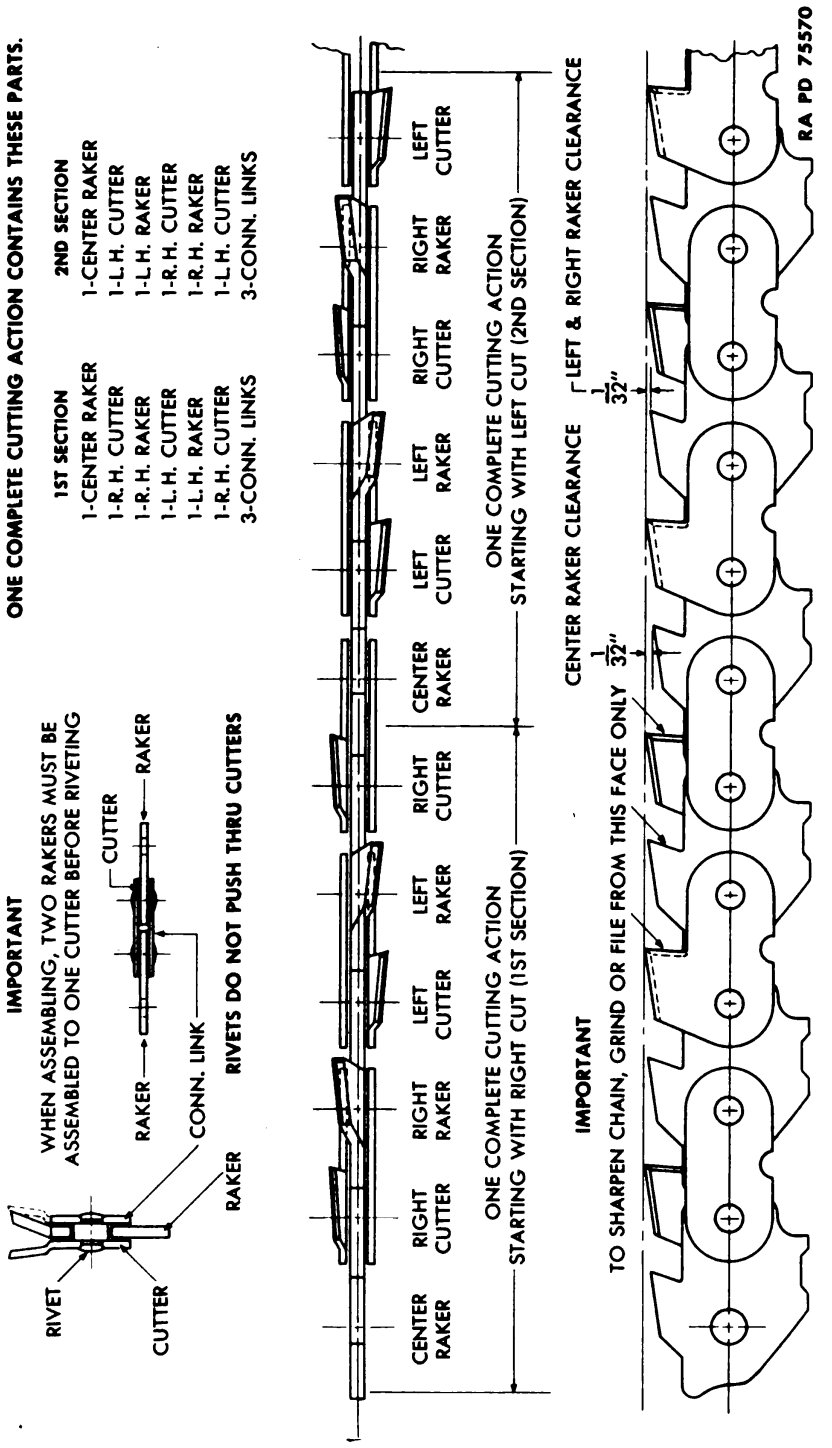



*Figure 53 — Saw Chain Reconditioning Data*



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## 24. DISASSEMBLY AND ASSEMBLY.

**a. Disassembly** (figs. 54 and 55).

(1) PARTIALLY DISASSEMBLE MOTOR.

*(a)* Remove the four recessed head housing cap attaching screws. Lift housing cap and gasket from motor housing. Disassemble cap by removing two fillister-head screws and lock washers from governor lever pin. Slide pin from governor lever and lift pin and lever from cap. Remove the four pipe plugs from cap.

*(b)* Screw governor valve from motor housing. Disassemble by pressing on protruding end of valve stem. Lift valve cage plug, valve spring from other end of cage. Pull valve from cage and screw button from end of protruding stem of valve.

NOTE: Check valve in cage for freeness of fit. Eliminate sticky spots.

*(c)* Remove the six vanes as follows: Screw governor body from rotor (right-hand thread). Remove end plate by striking edge of motor housing with a fiber mallet. Lift vanes from rotor.

(2) REMOVE SAW CHAIN.

*(a)* Loosen saw chain tension completely by turning adjusting knob on end of tailstock handle.

*(b)* Open tailstock door and lift chain from idler.

*(c)* Lift saw chain from 7-tooth sprocket.

(3) REMOVE SPROCKET GEAR SHAFT.

*(a)* Remove check nut and plain washer from end of sprocket shaft. Tap 7-tooth sprocket (using fiber mallet) free from shaft. Remove key from keyway in shaft.

*(b)* Remove the six recessed-head cover screws and lift motor housing cover from motor housing. It may be necessary to heat cover in order to remove Fafnir ball bearing from cover.

*(c)* Pull sprocket shaft from motor housing. Remove narrow spacer, bevel gear (fiber mallet), key, and wide spacer from unthreaded end of sprocket shaft.

*(d)* Remove the six housing cap screws from motor housing cap. Lift cap from motor housing. Pull bearing from cap.

(4) COMPLETE DISASSEMBLY OF MOTOR (NOT ILLUSTRATED).

*(a)* Working through motor-housing openings which were uncovered in step (2), above, remove lock nut and washer from end of rotor shaft. Remove bevel pinion, key, and pinion spacer from end of rotor shaft. Pull rotor from motor.

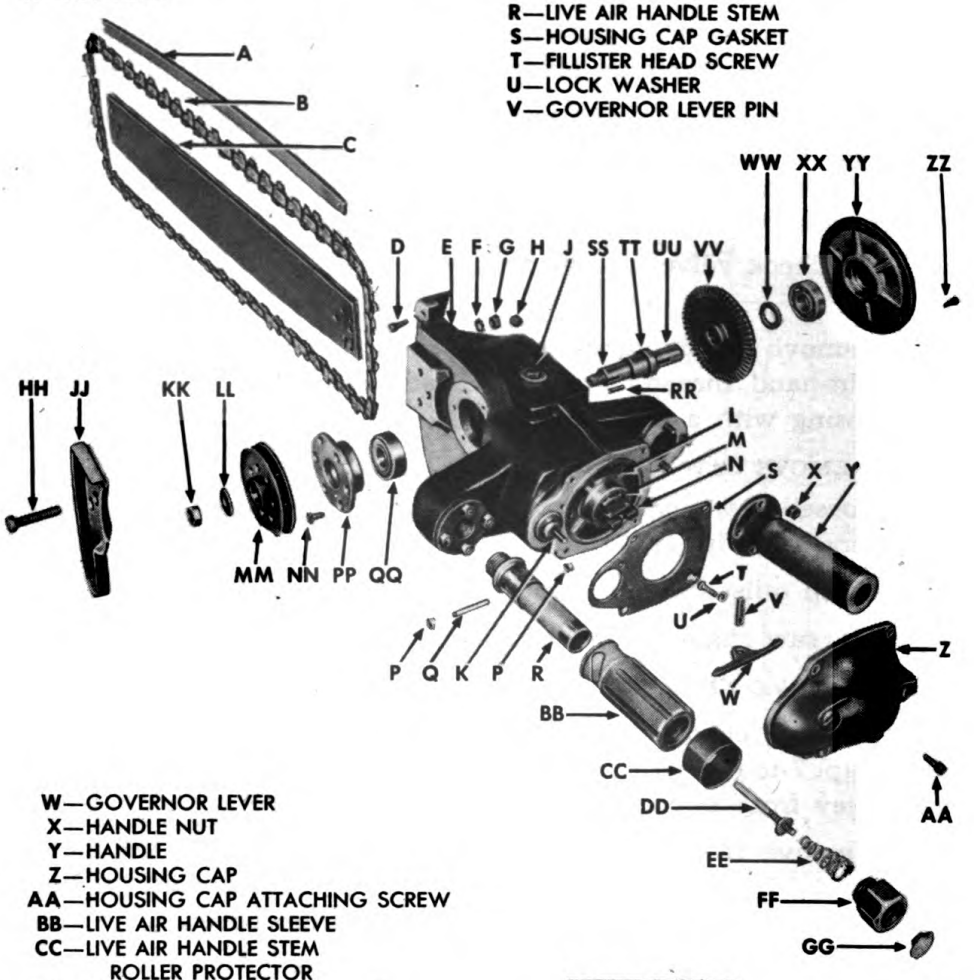
*(b)* If necessary to remove bottom end plate rapidly, heat motor



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## ORDNANCE MAINTENANCE — MAINTENANCE OF BOMB DISPOSAL EQUIPMENT FOR ACCESS AND STERILIZATION

A—SAW CHAIN GUARD
B—SAW CHAIN
C—GUIDE BAR
D—CHAIN GUARD SCREW
E—MOTOR HOUSING
F—LOCK WASHER
G—CHAIN GUIDE CLAMP SCREW NUT
H—PIPE PLUG
J—GEAR BOX OIL PLUG
K—GOVERNOR VALVE
L—END PLATE
M—ROTOR BEARING
N—GOVERNOR BODY
P—LIVE AIR HANDLE STEM ROLLER
Q—LIVE AIR HANDLE STEM ROLLER PIN
R—LIVE AIR HANDLE STEM
S—HOUSING CAP GASKET
T—FILLISTER HEAD SCREW
U—LOCK WASHER
V—GOVERNOR LEVER PIN




W—GOVERNOR LEVER
X—HANDLE NUT
Y—HANDLE
Z—HOUSING CAP
AA—HOUSING CAP ATTACHING SCREW
BB—LIVE AIR HANDLE SLEEVE
CC—LIVE AIR HANDLE STEM ROLLER PROTECTOR
DD—LIVE AIR HANDLE PLUG
EE—LIVE AIR HANDLE PLUG SPRING
FF—LIVE AIR HANDLE CAP
GG—AIR STRAINER
HH—CHAIN GUIDE CLAMP SCREW
JJ—CHAIN GUIDE CLAMP
KK—CHECK NUT
LL—PLAIN WASHER
MM—7-TOOTH SPROCKET
NN—HOUSING CAP SCREW
PP—MOTOR HOUSING CAP
QQ—FAFNIR BALL BEARING
RR—KEY
SS—SPROCKET SHAFT
TT—WIDE SPROCKET SHAFT SPACER
UU—KEY
VV—BEVEL GEAR
WW—NARROW SPROCKET SHAFT SPACER
XX—FAFNIR BALL BEARING
YY—MOTOR HOUSING COVER
ZZ—COVER SCREW

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***Figure 54 — Motor End of Pneumatic Timber Saw — Exploded View***



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housing around outside with blowtorch. This expands housing and allows end plate to drop out. Pull bearing from cap.

NOTE: Never replace only one rotor bearing; always replace by pairs.

(5) REMOVE HANDLE FROM MOTOR HOUSING BY REMOVING THE FOUR HANDLE (STUD) NUTS.

(6) REMOVE AND DISASSEMBLE LINE AIR HANDLE.

*(a)* Screw line air handle cap from end of handle. Push air strainer from cap. Lift line air handle plug spring and line air handle plug from end of handle.

*(b)* Remove line air handle stem roller protector, both line air handle stem rollers and line air handle stem roller pin. Pull line air handle sleeve from line air handle stem.

*(c)* Screw line air handle stem from motor housing.

(7) REMOVE SAW CHAIN GUARD AND GUIDE BAR.

*(a)* Remove the two recessed-head chain guard screws from motor housing and tailstock. Lift guard from saw.

*(b)* Remove three chain guide clamp screws. Lift chain guide clamp and guide bar from motor housing. Remove three cutter bar bolt nuts, lock washers,, and bolts. Lift guide bar from tailstock.

(8) DISASSEMBLE TAILSTOCK.

*(a)* Screw tank cap and air pump from oil tank.

*(b)* Remove latch wing nut, lock washers, door latch, and hinge pin. Lift tailstock door from tailstock.

*(c)* Remove idler stud, washer, and idler from chain tension bracket. Push idler ball bearing from idler.

*(d)* Remove both handle screws and lock washers. Remove adjusting knob and chain tension spring from handle. Remove handle from chain tension bracket and bracket from tailstock.

**b. Assembly** (figs. 54 and 55).

(1) ASSEMBLE TAILSTOCK.

*(a)* Place chain tension bracket in position on tailstock and handle in position on bracket. Insert chain tension spring into end of handle. Install adjusting knob in end of handle. Install both lock washers and handle screws.

*(b)* Press idler bearing (no lubrication necessary) into idler. Place assembly in position on chain tension bracket. Install idler stud washer and stud.

*(c)* Place tailstock door in position on tailstock housing. Install



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## ORDNANCE MAINTENANCE — MAINTENANCE OF BOMB DISPOSAL EQUIPMENT FOR ACCESS AND STERILIZATION

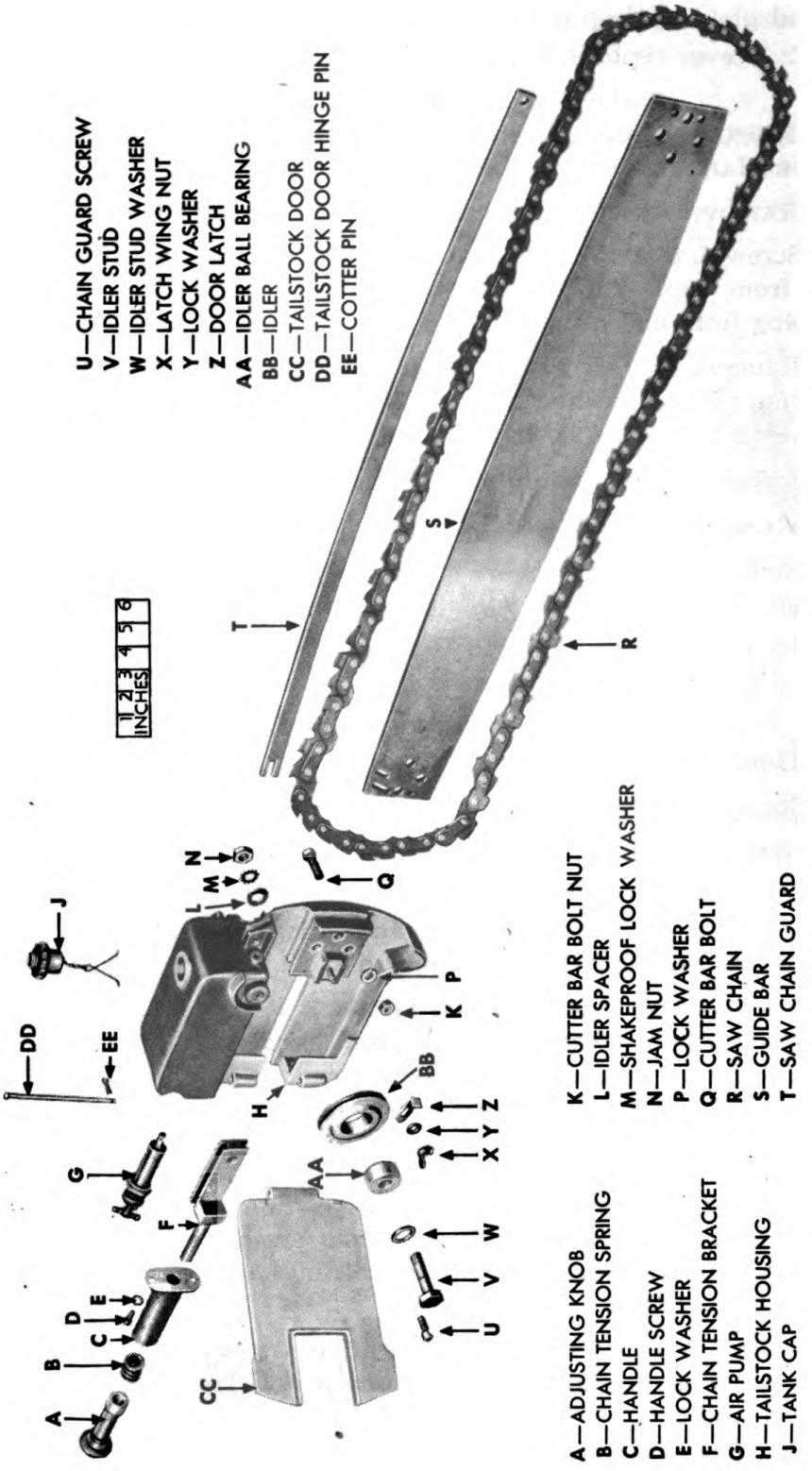



*Figure 55 — Tailstock End of Pneumatic Timber Saw — Exploded View*



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hinge, pin, door latch, lock washer, and latch wing nut.

*(d)* Screw tank cap and air pump into oil tank.

(2) PARTIALLY ASSEMBLE MOTOR.

*(a)* If bottom end plate and bearing were removed, lubricate bearing with GREASE, general purpose, No. 1, and press into end plate. Heat motor housing to expand it. Place end cap in position in heated housing. As housing cools, it contracts and holds end cap in place.

*(b)* Insert rotor into position from top of motor housing. On threaded end of rotor install pinion spacer, key, bevel pinion, washer, and lock nut.

(3) INSTALL SPROCKET SHAFT.

*(a)* Lubricate ball bearing with GREASE, general purpose, No. 1, above +32 F or GREASE, general purpose, No. 0, below +32 F, and press, closed end first, into motor housing cap. Place cap in position on motor housing. Install the six housing cap screws.

*(b)* On unthreaded end of sprocket shaft install wire spacer, key, bevel gear, and narrow spacer, respectively.

*(c)* Insert sprocket shaft, threaded end first, into position in motor housing.

*(d)* Lubricate ball bearing with GREASE, general purpose, No. 1, above +32 F or GREASE, general purpose, No. 0, below +32 F, and press into motor housing cover. Place cover in position on motor housing. Install the six recessed-head cover screws.

*(e)* Install key in keyway on protruding end of sprocket shaft. Tap (fiber hammer) 7-tooth sprocket onto shaft. Install plain washer and check nut on end of shaft.

(4) COMPLETE ASSEMBLY OF MOTOR.

*(a)* Insert the six vanes into rotor from opening in end of motor housing. Tap end plate containing bearing into position in motor housing. Screw governor body into rotor (right-hand thread).

*(b)* Screw button into end of stem of governor valve. Insert valve, button end first, into open end of governor valve cage. Place governor valve spring into open end of valve cage. Place governor valve plug over end of valve stem and press down by hand into open end of cage. Screw governor valve into its opening in motor housing.

*(c)* Install the four pipe plugs in the housing cap. Place governor lever in position on inside of cap and install governor lever pin. Install the two lock washers and fillister-head screws in pin. Place housing cap gasket and cap in position on motor housing. Install the four recessed head housing cap attaching screws.

(5) PLACE HANDLE IN POSITION ON MOTOR HOUSING AND INSTALL THE FOUR HANDLE NUTS.



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(6) INSTALL LINE AIR HANDLE.

*(a)* Screw line air handle stem into its opening in motor housing.

*(b)* Place line air handle sleeve on stem. Install line air handle stem roller pin, both rollers, and line air handle stem roller protector.

*(c)* Insert line air handle plug and spring into end of handle. Push air strainer into position in line air handle cap. Screw cap into end of handle.

(7) INSTALL GUIDE BAR AND SAW CHAIN GUARD.

*(a)* Place guide bar in position on tailstock and install the through cutter bar bolts, lock washers, and nuts.

*(b)* Place other end of guide bar in position on motor housing. Place chain guide clamp in position on guide bar. Install the three chain guide clamp screws.

*(c)* Place saw chain guard in position on motor housing and tailstock. Install the two recessed-head chain guard screws.

(8) INSTALL CHAIN.

*(a)* Turn adjusting knob on tailstock handle so idler moves to its extreme position toward motor.

*(b)* Place chain in position on 7-tooth sprocket, idler, and guide bar. Be sure raker teeth on bottom of saw point toward motor.

*(c)* Tighten adjusting knob until chain can be lifted ¼ inch from center of guide bar.

(9) LUBRICATE ENTIRE UNIT (par. 26 **b**).

## 25. INSPECTION INSTRUCTIONS.

**a. Before Each Use.**

(1) Check lubrication (par. 26 **b**).

(2) Check chain tension by lifting saw chain from middle of guide bar. It should lift ¼ inch. Adjust if necessary by turning adjusting knob on end of tailstock handle. *CAUTION: Do not make this test with air hose connected.*

(3) Inspect all external bolts, nuts, fittings, screws, and pipe plugs to see if any are loose. Tighten loose parts.

(4) Check air strainer in line air handle cap to be sure it is clean. Remove and clean in SOLVENT, dry-cleaning, if fouled.

**b. Daily.** Note condition of saw chain. Reconditioned (par. 23 **c**, **d**, and **e**) or replace if chain is dull, locks set, or needs jointing. Replace damaged teeth (par. 23 **f**).



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**c. At Time of Disassembly.** Clean all parts in SOLVENT, dry-cleaning, and inspect carefully. Replace parts that are scored, broken, or worn. Ascertain that all lubrication orifices are unobstructed.

## 26. CARE, CLEANING, AND LUBRICATION.

**a. Care and Cleaning.**

(1) After each use, blow sawdust from unit with compressed air.

(2) Wipe water or dampness from tool with a clean, dry cloth.

(3) Before putting tool away, rub exterior with a cloth dampened with clean OIL, engine, SAE 10.

**b. Lubrication** (fig. 56). This saw should be lubricated by the installation of an air line lubricator in the air supply line as described in (par. 14 b (2) ). In addition, the following points of lubrication should be checked and oil or grease added if necessary.

(1) Before starting a new or overhauled motor, or one that has been idle for a week or more, pour about a teaspoonful of OIL, engine, SAE 10, into air inlet.

(2) Remove filler cap on tailstock and fill oil chamber with OIL, engine, SAE 10. Replenish as used.

(3) Close breather (knurled knob on filler cap on tailstock) and pump up air pressure for lubrication of chain.

(4) Turn "ON" 3-way valve. When engaged in horizontal cutting, control above blade must be in "ON" position.

(5) Adjust pet cock for oil supply cutter bar.

(6) Check for presence of grease in governor chamber through pipe plug hole on under side of motor housing cap. Add about one tablespoonful of GREASE, general purpose, No. 1, above −32 F; No. 0, below 0 F, every 2 or 3 months, or oftener, if needed.

(7) Remove plug from top of motor housing and check quantity of grease in gear box. Capacity is half a pound. Keep filled at all times. Select lubricant from following table:

| Temperature | Lubricant |
|---|---|
| Above −32 F | GREASE, general purpose, No. 2 |
| 0 to +32 F | GREASE, general purpose, No. 0 |
| Below 0 F | GREASE, general purpose, No. 0 |

(8) Remove rotor oil plug in motor housing cap near fixed handle and fill oil chamber with OIL, engine SAE 10.



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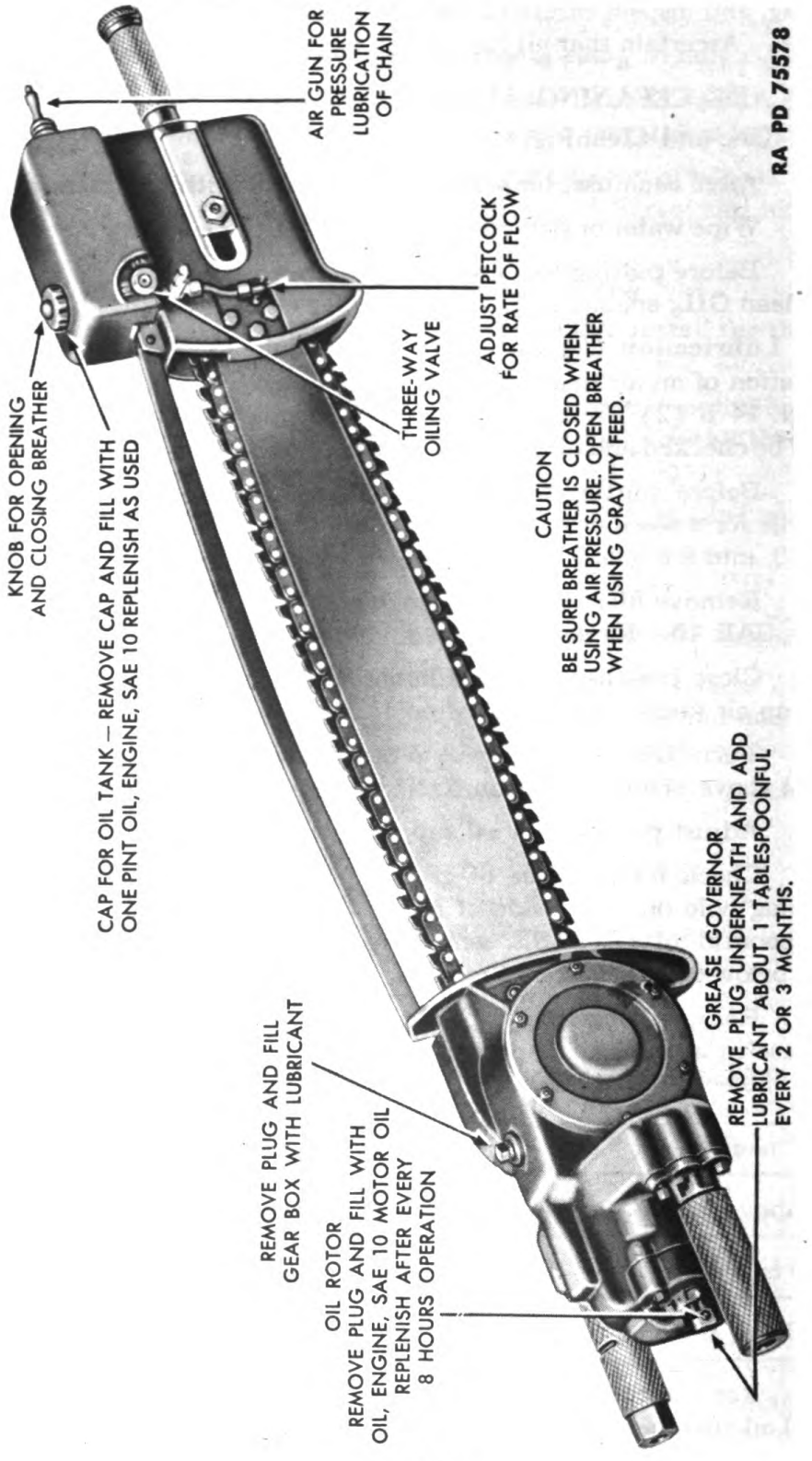



*Figure 56 — Pneumatic Timber Saw Lubrication Points*



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PNEUMATIC TOOLS

Section IV

# BORING MACHINE

## 27. DESCRIPTION AND FUNCTIONING.

a. This boring machine is a precision machine built to close tolerances. Complete disassembly cannot be accomplished by the using arms because some special tools and equipment are needed. It is equipped with a piston type air motor. Four pistons are connected to a crankshaft. Valves open to admit air pressure to the cylinders to force the pistons down. On the upstroke, an exhaust valve opens to relieve the pressure within the cylinder. Operating at high speed, the air motor transmits motion to the boring bit through reduction gears. The outfit is capable of drilling holes up to two inches in diameter in dry, green, or water-soaked lumber or timber.

## 28. OPERATION.

a. **Use of Tool** (fig. 58).

(1) Select desired size bit. Back off recessed-head set screw in chuck and insert auger in end of chuck. Tighten set screw.

(2) Pour about a teaspoonful of OIL, engine, SAE 10, into line air inlet fitting.

(3) Blow out air hose to remove water or dirt. Connect air hose to end of boring machine handle.

(4) Holding boring machine in position to execute work to be done, turn throttle handle clockwise. Return control to original position to stop action. Turn throttle handle counterclockwise to reverse machine.

b. **Operation Cautions.**

(1) Do not allow machine to run without load for any length of time.

(2) Do not use a mutilated wood bit. Be sure cutting angle is correct. Always use gage when sharpening bits.

(3) Do not allow machine to be idle on shop floor or yards for indefinite periods.

(4) Do not leave air hose connected to machine when not in use.

(5) Always blow out air hose before attaching to machine.

(6) Always keep machine properly lubricated (par. 32).



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## ORDNANCE MAINTENANCE — MAINTENANCE OF BOMB DISPOSAL EQUIPMENT FOR ACCESS AND STERILIZATION

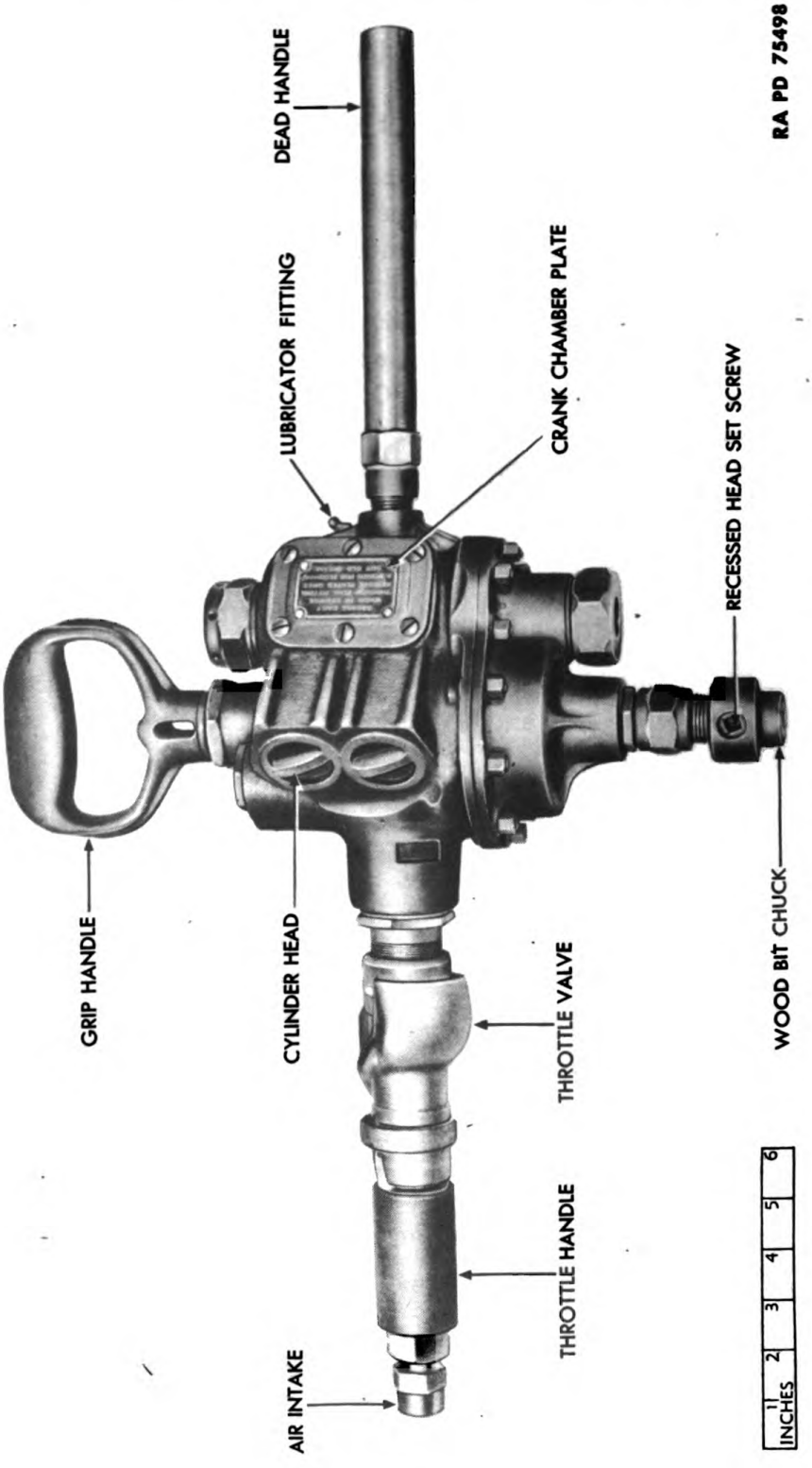



*Figure 57 — Pneumatic Boring Machine*



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***Figure 58 — Pneumatic Boring Machine in Operation***



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## ORDNANCE MAINTENANCE — MAINTENANCE OF BOMB DISPOSAL EQUIPMENT FOR ACCESS AND STERILIZATION

## 29. MALFUNCTIONS AND CORRECTIONS.

| Symptom | Cause | Remedy |
|---|---|---|
| **a. Tool Lacks Power.** | (1) Insufficient supply of air. | (1) Attach tool to air source with at least 90-pound per square inch pressure. |
| | (2) Air hoses too small. | (2) Use air hoses with at least ¾-inch inside diameter. |
| | (3) Dirt, scale, rubber particles, rust, water, or other foreign substance in air hose or tool. | (3) Clean hoses by blowing air blast through them (par. 28). Disassemble, clean, and assemble tool (par. 30). |
| | (4) Tool insufficiently lubricated. | (4) Lubricate boring machine (par. 32). |
| **b. Impossible To Rotate Throttle Handle.** | (1) Throttle valve stuck. | (1) Strike open exhaust end of throttle valve with fiber mallet. This will unseat valve seat. Hold valve off its seat and pour OIL, engine, SAE 10, through exhaust opening to lubricate seat. If valve sticks frequently, disassemble, (par. 30) determine, and correct cause. |
| **c. Tool Does Not Start When Throttle Handle Is Rotated.** | (1) Rust, mud, or other dirt in tool. | (1) Disassemble tool (par. 30) and clean with SOLVENT, dry-cleaning. Be sure all air passages are open. Assemble (par. 30) and lubricate (par. 32) tool. |

## 30. DISASSEMBLY AND ASSEMBLY.

**a. Disassembly** (fig. 59).

(1) REMOVE AND DISASSEMBLE THROTTLE HANDLE.

*(a)* Screw throttle clamp nut from its boss in main housing. Lift throttle handle assembly from main housing.

*(b)* Remove throttle valve housing screw from inner end of throttle stem. Lift throttle valve gasket from stem.

*(c)* Loosen stop nut clamp screw. Slide throttle valve stop nut clamp from throttle valve stop nut. Loosen throttle valve stop nut.

*(d)* Remove air line inlet fitting from throttle cap nut. Push air strainer from fitting.



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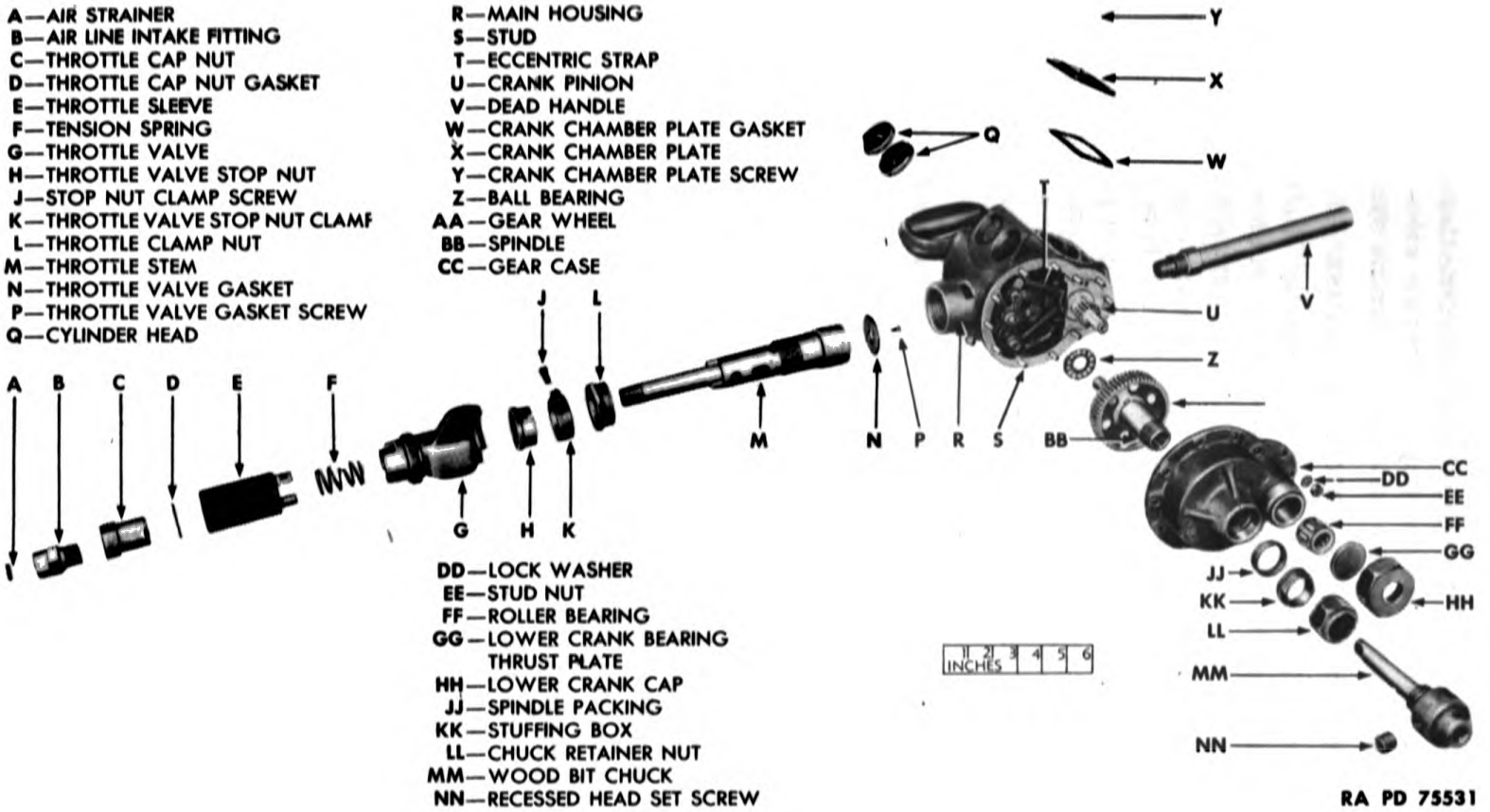



***Figure 59 — Pneumatic Boring Machine — Exploded View***



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*(e)* Remove throttle cap nut, gasket, throttle sleeve, tension spring, throttle valve, throttle valve stop nut, throttle valve stop nut clamp, and throttle clamp nut from outer end of throttle stem.

(2) REMOVE AND DISASSEMBLE GEAR CASE.

*(a)* Screw chuck retainer nut from spindle. Pull wood bit chuck and retainer nut from spindle. Screw chuck retainer nut from chuck. Remove stuffing box and spindle packing from spindle boss in gear case.

*(b)* Remove lower crank cap. Push lower crank bearing thrust plate from cap. Pull roller bearing from crank boss in gear case.

*(c)* Remove the 12 stud nuts which secure gear case to main housing. Lift gear case from main housing. Pull spindle shaft with attached gear wheel from main housing or gear case, with whichever it remains. Pull ball bearing from solid end of spindle.

(3) REMOVE AND DISASSEMBLE DEAD HANDLE.

*(a)* Screw dead handle plug from its boss in main housing.

*(b)* Screw dead handle plug from dead handle.

(4) EXPOSE PISTONS, CONNECTING RODS, AND CRANK FOR INSPECTION OR CLEANING.

*(a)* Screw the four cylinder heads from their respective openings in main housing.

*(b)* Remove all crank chamber plate screws from one crank chamber plate. Lift plate and gasket from main housing.

*(c)* Repeat preceding step to remove other crank chamber plate.

**b. Assembly** (fig. 59).

(1) INSTALL GEAR CASE AND RELATED PARTS.

*(a)* Lubricate ball bearing with GREASE, general purpose, No. 1, above +32 F, or GREASE, general purpose, No. 0, below +32 F, and press into position on solid end of spindle. Insert solid end of spindle into position in gear case. Mesh gear wheel with crank pinion.

*(b)* Carefully clean machined surfaces of main housing and gear case. Place gear case in position on main housing.

*(c)* Lubricate roller bearing with light grease and place in position around lower end of crank within its boss in gear case. Place lower crank bearing thrust plate on end of bearing boss on gear case. Start lower crank cap onto its threads on gear case. Do not tighten cap; turn it on two or three threads only.

*(d)* Install the 12 stud nuts which attach gear case to main housing.

*(e)* Tighten lower crank cap.

*(f)* Press spindle packing into position around spindle inside gear



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case boss. Do not tear packing. Install stuffing box.

*(g)* Screw chuck retainer nut onto wood bit chuck. Screw recessed-head set screw into chuck. Insert chuck shaft into spindle and rotate to mesh flattened end. Screw chuck retainer nut onto spindle.

(2) ENCLOSE PISTONS, CONNECTING RODS, AND CRANK.

*(a)* Place crank chamber plate gasket and plate in position on main housing. Install crank chamber plate screws.

*(b)* Repeat step *(a)*, above, to install other crank chamber plate.

*(c)* Screw the four cylinder heads into their respective openings in main housing.

(3) ASSEMBLE AND INSTALL THROTTLE HANDLE.

*(a)* On small end of throttle stem, place in position throttle clamp nut, throttle valve stop nut clamp, throttle valve stop nut, throttle valve, tension spring throttle sleeve, and throttle cap nut gasket. Install throttle cap nut.

*(b)* Tighten throttle valve stop nut. Slide throttle valve stop nut clamp into position and tighten clamp screw.

*(c)* Push air strainer into position within air line intake fitting. Screw fitting tightly into throttle cap nut.

*(d)* Place throttle valve gasket in position on inner end of throttle stem. Install throttle valve gasket screw.

*(e)* Place throttle handle assembly in position on its boss on main housing. Screw throttle clamp nut securely into its boss on main housing.

(4) INSTALL DEAD HANDLE.

*(a)* Tightly screw dead handle plug into inner end of dead handle.

*(b)* Tightly screw dead handle plug into its boss on main housing.

## 31. INSPECTION INSTRUCTIONS.

**a.** Before first use each day, remove crank chamber plate to ascertain if ample lubricant is present. Chamber should be full of grease. Lubricate if necessary (par. 32). Install plate.

**b.** Before first use each day, check air hoses to be sure no dirt or water is present. Clean if necessary.

**c.** Daily check tightness of all nuts, screws, and plugs. Tighten if loose.

## 32. CARE, CLEANING, AND LUBRICATION.

**a. Lubrication.**

(1) Daily fill crank chamber with GREASE, general purpose, No. 2, through lubricator fitting adjacent to plain pipe handle, every



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working day. Do not force grease in.

(2) Monthly, remove clamp nut from throttle and inspect copper throttle gasket. Replace gasket if broken. Tighten clamp nut for throttle security.

(3) Monthly, remove crank chamber plates. Flush out old lubricant with SOLVENT, dry-cleaning, dry thoroughly. Inspect all four connecting rods and connecting rod screws. Test them to be sure they are tight. Turn over crank to be sure it revolves freely. Pack chamber with GREASE, general purpose, No. 2. Install plates.

(4) Monthly, remove all four cylinder tops. Remove scale, dirt, or rust if present. Inspect cylinder for scored or galled condition. Squirt a few drops of OIL, engine SAE 10, in each cylinder. Tighten cylinder tops securely.

---

## Section V

## ROCK DRILL

### 33. DESCRIPTION AND FUNCTIONING.

a. This pneumatic rock drill is a medium weight tool used for deep hole drilling, shaft sinking, and quarrying. It is conventional in design. Action is controlled by a throttle valve adjacent to the handles. Piston hammer action is augmented by rotation of the bit caused by a ratchet device within the barrel. An exhaust valve is provided to send an air blast into the hole being drilled at the operator's discretion. An oil reservoir provides a constant means of lubrication.

### 34. OPERATION.

a. **Use of Tool** (fig. 61).

(1) Lift steel retainer by hand. Push butt of drill steel into position in front head. Push steel retainer into holding position.

(2) Blow out air hose with an air blast. Attach air hose to swivel fitting.

(3) Set point of drill in position on rock to be drilled at desired angle. Be sure exhaust valve lever is pointed down. Push down on throttle valve handle. Throttle valve handle has three positions, for slow, medium, and high speed.

(4) From time to time move exhaust valve lever to up position momentarily to blow debris from drill and to cool drill steel. Frequency will depend on kind of rock and rate of operation.



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## PNEUMATIC TOOLS

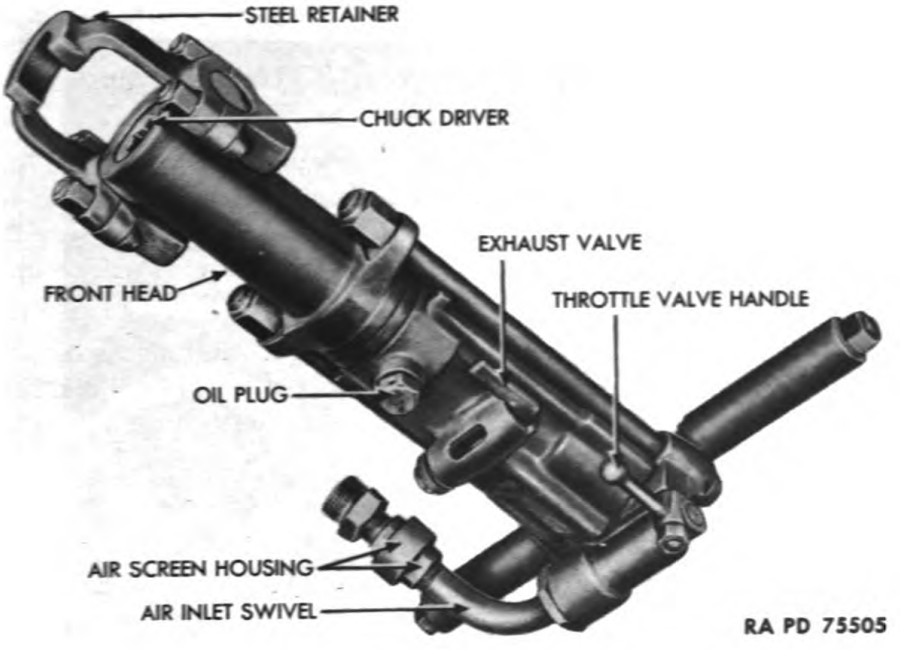



***Figure 60 — Pneumatic Rock Drill***

(5) When work is completed, close throttle lever and remove drill steel from hole.

**b. Operation Cautions.**

(1) Do not run machine without load for any length of time.

(2) Do not attempt to drill with a dull drill steel. This causes undue strain on working parts, and ultimate breakage which may extend back into the drill itself.

(3) Do not attempt to repair drills on the job. Take them into a shop or enclosed place.

(4) Do not leave drill on job as long as it will run. At least once a month, when in daily use, disassemble, clean, inspect, replace worn parts, assemble, and lubricate.

(5) Do not install new parts with worn or defective old parts; neither can function with top efficiency.

(6) Do not use a badly worn chuck driver.

(7) Do not use drill steel having bad shank. Be sure they are 4½ inches collar to end; 1-inch hexagonal section and have a flat top.

(8) Keep all nuts tight.

(9) Keep machine properly lubricated (par. 38 b).



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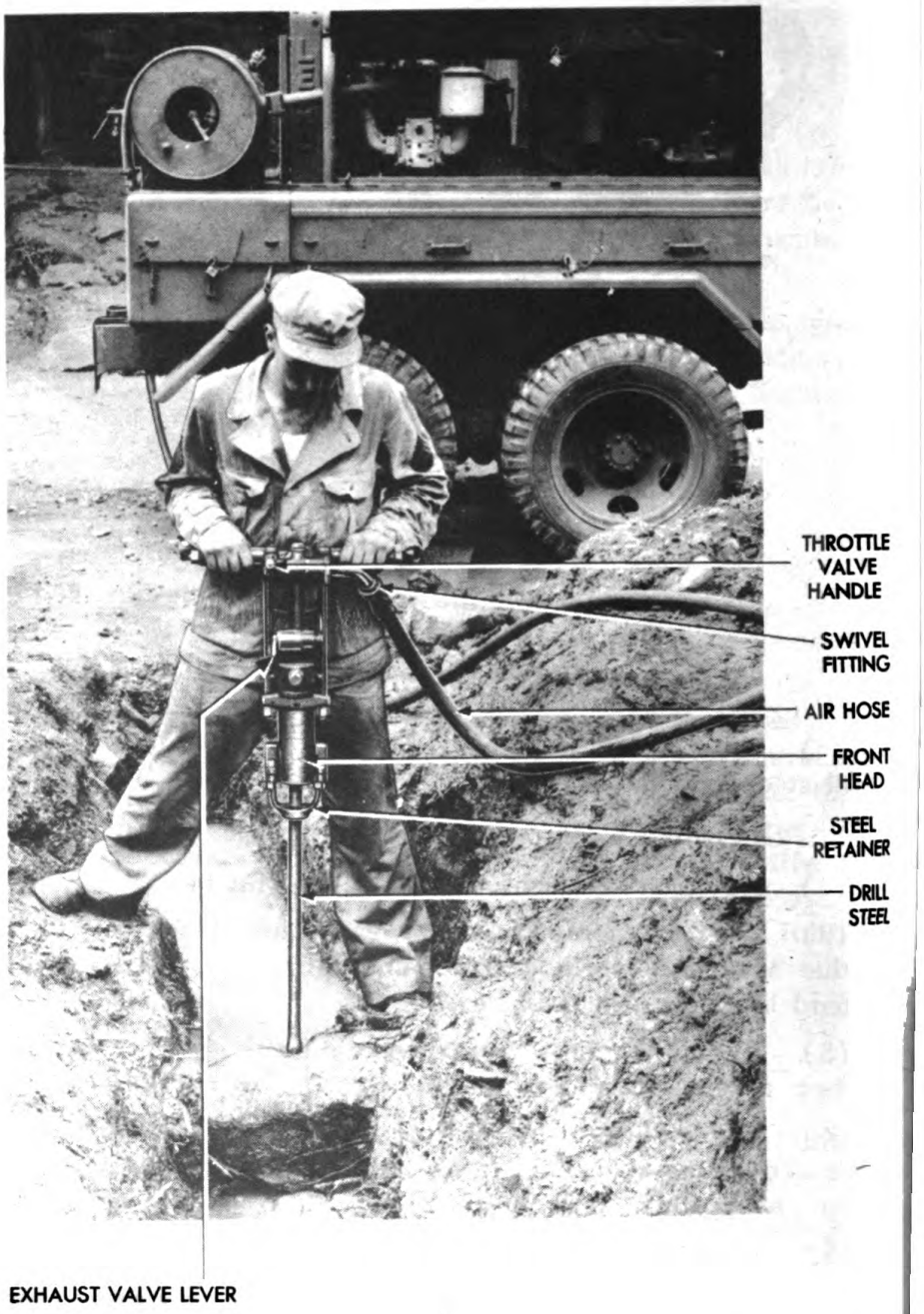



***Figure 61 — Pneumatic Rock Drill in Operation***



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## PNEUMATIC TOOLS

## 35. MALFUNCTIONS AND CORRECTIONS.

| Symptom | Cause | Remedy |
|---|---|---|
| **a. Drill Lacks Power or Action Slows Down.** | (1) Insufficient air supply. | (1) Connect tool to source supplying at least 90-pound pressure. |
| | (2) Air hose too small. | (2) Use air hose having inside diameter of at least ¾ inch. |
| | (3) Air strainer dirty. | (3) Remove female from male portion of air screen housing. Pick out air strainer and clean in SOLVENT, dry-cleaning (par. 36). |
| | (4) Hose or tool obstructed. | (4) Clean out air hose with air blast and/or disassemble tool (par. 36). Clean parts of tool in SOLVENT, dry-cleaning. Assemble and lubricate. Do not use solvent in hose. |
| | (5) Drill bit dull. | (5) Use sharp drill bit. |
| | (6) Machine insufficiently lubricated. | (6) Lubricate tool properly (par. 38 b). |
| | (7) Side rod nuts tightened unequally, thus putting undue strain and wear on internal parts. | (7) Tighten side rod nuts to equal tension (par. 36). |
| **b. Drill Fails To Operate When Throttle Lever Is Pressed.** | (1) Air hose obstructed. | (1) Clean air hose. |
| | (2) Throttle valve plugged. | (2) Disassemble and clean throttle valve. Oil and assemble (par. 36). |
| | (3) Tool plugged with mud or other foreign matter. | (3) Disassemble tool (par. 36). Clean parts in SOLVENT, dry-cleaning. Be sure all air passages are open. Assemble (par. 36) and lubricate (par. 38) tool. |
| | (4) Tool improperly assembled. | (4) Disassemble tool and reassemble, taking care to aline air passages before installing bolts and pins (par. 36). |



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## ORDNANCE MAINTENANCE — MAINTENANCE OF BOMB DISPOSAL EQUIPMENT FOR ACCESS AND STERILIZATION

### 36. DISASSEMBLY AND ASSEMBLY.

**a. Disassembly** (fig. 62).

(1) Screw water tube plug from back head. Lift plug, gasket, air tube, and water tube packing from back head.

(2) Remove both side rod nuts and side rods from front head and back head. Lift back head from cylinder. If necessary, back head plate can now be driven from back head with brass rod inserted through water tube plug hole.

(3) Screw air inlet swivel nut from its boss in back head. Lift swivel and nut from back head. Screw female part of air screen housing from male portion. Remove lock ring and air screen from male part.

(4) Screw throttle valve detent plug from back head. Lift out throttle valve detent plunger and spring and plunger. Remove throttle valve handle nut, lock washer, and bolt. Slide handle off throttle valve. Slide throttle valve out of back head through air inlet opening.

(5) Remove handle bolt nut and washers. Withdraw handle bolt. Remove both rubber grips from handle.

(6) Withdraw rifle bar from ratchet ring. Slide rotation pawls from pawl slots in rifle bar. Be careful to keep from losing pawl plunger and pawl spring which fly out when each pawl is removed.

(7) Lift front head from cylinder. Remove chuck driver from rear of front head. Remove the four steel retainer nuts and bolts. Remove steel retainer and both steel retainer caps. Empty steel retainer lock plunger and steel retainer spring from each cap.

(8) Push piston hammer as far back in cylinder as it will go. Place hardwood block against end of piston hammer and tap gently until complete valve chest assembly can be picked from top of cylinder.

(9) Lift piston hammer from top of cylinder. If necessary to remove rifle nut from piston hammer, place piston hammer in soft-jawed vise. Place rifle bar in rifle nut and turn clockwise with a strap wrench. Use extreme care to keep from damaging parts. Do not remove rifle nut unless replacement of nut or piston hammer is necessary.

(10) If necessary to remove cylinder front bearing, use a hardwood or brass rod and drive bearing from front of cylinder.

(11) Screw the two oil control plugs from top of cylinder and remove oil control felts underneath. Screw oil plug from side of cylinder.



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(12) Depress exhaust valve spring. Remove exhaust valve retainer pin, washer, and spring. Withdraw exhaust valve from its lug on cylinder.

**b. Assembly** (fig. 62).

(1) Insert exhaust valve into its lug on cylinder. Place exhaust valve spring on protruding end of valve. Depress spring and install exhaust valve washer and retainer pin.

(2) Lubricate cylinder front bearing with GREASE, general purpose, No. 1, above +32 F or GREASE, general purpose, No. 0, below −32 F, and press into position in front of cylinder.

(3) Insert the two oil control felts in the two oil control plug holes in top of cylinder. Install the two oil control plugs. Install oil plug in side of cylinder.

(4) Screw rifle nut into top of piston hammer. Place piston hammer in soft-jawed vise. Place rifle bar in rifle nut. Using strap wrench on rifle bar, tighten rifle nut into piston hammer. Remove rifle bar from rifle nut and piston hammer from vise. Place piston hammer in position within cylinder.

(5) Install valve parts. Place front half of valve chest in position within top of cylinder. Place automatic valve in position on front half of valve chest. Place rear half of valve chest in place on automatic valve. Place valve guide plate in position on top of valve chest with flange extending down into valve. Place valve ratchet ring in position on valve guide plate. Make sure all holes for valve chest dowel pin are in perfect alinement. Tap valve chest dowel pin into position through ratchet ring, valve guide plate, and rear valve chest. *NOTE: Do not attempt to drive pin down flush with ratchet ring. End of pin extends into back head plate when assembly is completed.*

(6) Place steel retainer springs and steel retainer lock plungers in position in both steel retainer caps. Place caps in position on their bosses on front head. Place steel retainer in position on same bosses and install the four steel retainer bolts and nuts. Place chuck driver in position within front head.

(7) Insert a pawl spring and pawl plunger into position in its opening in rifle bar. Depress plunger and slide a rotation pawl into pawl slot in rifle bar. Repeat process to install other two springs, plungers, and pawls. Place rifle bar in position through top of ratchet ring.

(8) Slide both rubber grips into position on handle. Install handle bolt washer, handle bolt, other handle bolt washer, and handle bolt nut.



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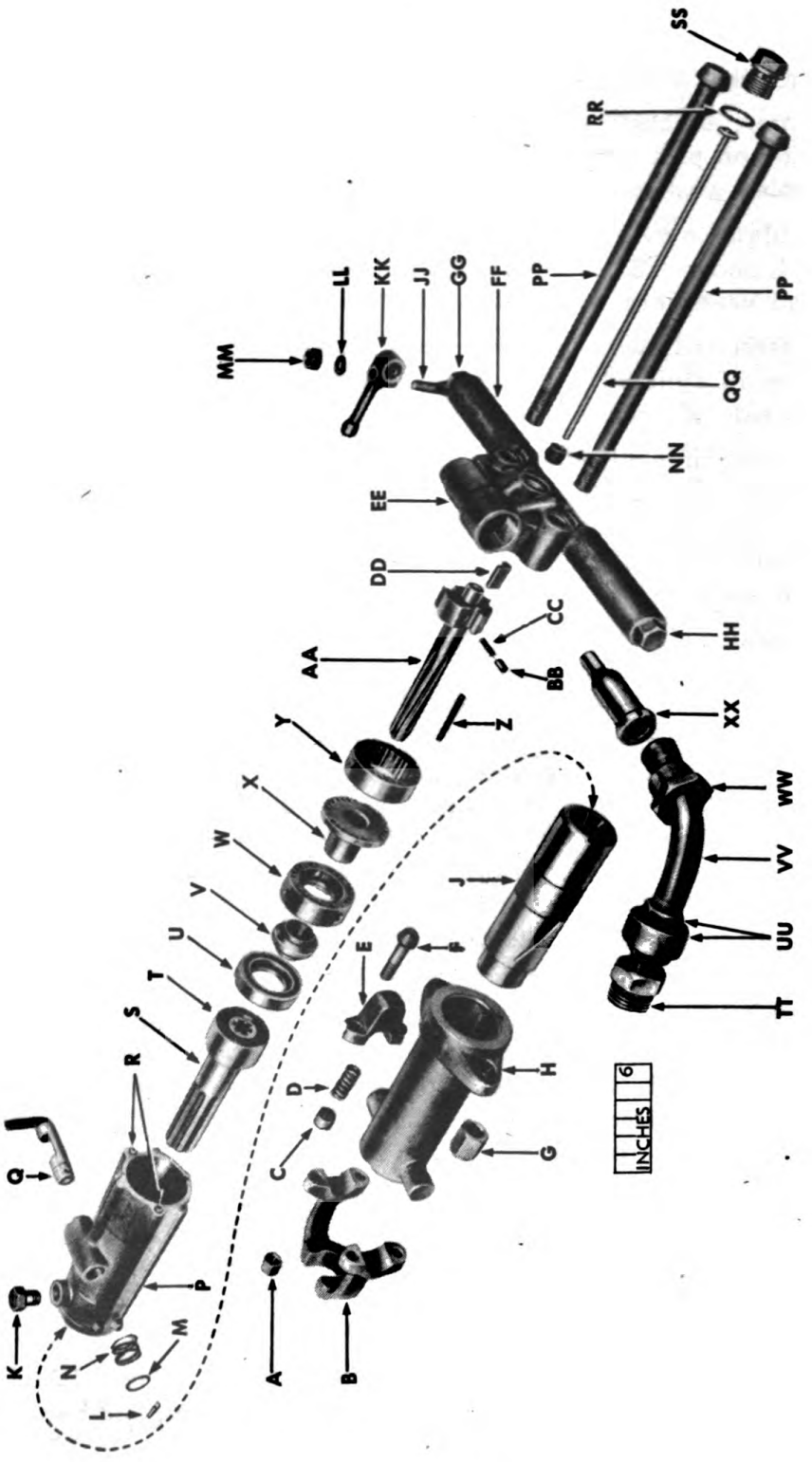



*Figure 62 — Pneumatic Rock Drill — Exploded View*



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A—STEEL RETAINER NUT
B—STEEL RETAINER
C—STEEL RETAINER LOCK PLUNGER
D—STEEL RETAINER SPRING
E—STEEL RETAINER CAP
F—STEEL RETAINER BOLT
G—SIDE ROD NUT
H—FRONT HEAD
J—CHUCK DRIVER
K—OIL PLUG
L—EXHAUST VALVE RETAINER PIN
M—EXHAUST VALVE WASHER
N—EXHAUST VALVE SPRING
P—CYLINDER
Q—EXHAUST VALVE
R—OIL CONTROL PLUG
S—PISTON HAMMER
T—RIFLE NUT
U—VALVE CHEST (FRONT)
V—AUTOMATIC VALVE
W—VALVE CHEST (REAR)
X—VALVE GUIDE PLATE
Y—RATCHET RING
Z—VALVE CHEST DOWEL PIN
AA—RIFLE BAR
BB—PAWL PLUNGER
CC—PAWL SPRING
DD—ROTATION PAWL
EE—BACK HEAD
FF—RUBBER GRIP
GG—HANDLE BOLT
HH—HANDLE BOLT NUT
JJ—THROTTLE VALVE HANDLE BOLT
KK—THROTTLE VALVE HANDLE
LL—THROTTLE VALVE HANDLE BOLT LOCK WASHER
MM—THROTTLE VALVE HANDLE BOLT NUT
NN—WATER TUBE PACKING
PP—SIDE ROD
QQ—AIR TUBE
RR—WATER TUBE PLUG GASKET
SS—WATER TUBE PLUG
TT—AIR INLET FITTING
UU—AIR SCREEN HOUSING
VV—AIR INLET SWIVEL
WW—AIR INLET SWIVEL NUT
XX—THROTTLE VALVE

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***Legend for Figure 62 — Pneumatic Rock Drill — Exploded View***



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(9) Slide throttle valve, small end first, into position within air inlet in back head. Place throttle valve handle in position on protruding end of throttle valve. Install throttle valve handle bolt, lock washer, and nut. Install throttle valve detent plunger, spring, and plug in opening provided in back head.

(10) Place air screen in position in male portion of air screen housing. Install air screen lock ring. Screw female portion of housing onto male portion Place air inlet swivel in position on air inlet boss on back head. Screw air inlet swivel nut securely into back head.

(11) Press back head plate into position in back head.

(12) Place back head in position on top of cylinder. Place front head in position on bottom of cylinder. Insert both side rods through flanges of back head and front head. Draw side rod nuts up evenly. Tighten each nut a little at a time. Tighten both to same tension to avoid internal misalinement and consequent malfunctions.

(13) Slide water tube packing all the way onto air tube. Insert air tube through its opening in top of back head. Install water tube plug gasket and plug in back head.

(14) Lubricate tool (par. 38 **b**).

## 37. INSPECTION INSTRUCTIONS.

**a. Before Each Use.**

(1) Check quantity of oil in reservoir by removing oil plug on side of cylinder. Fill if not full (par 38 **b**).

(2) Check tightness of all external nuts, plugs, and fittings.

(3) Inspect air hose to be sure it is free of dirt and water. Blow out with air blast.

(4) Inspect drill steel to see if point is sharp and shank is in good condition. Replace drill steel if point is dull or if shank is mutilated or wrong in size.

**b. Periodic.** After each 50-hour use, disassemble drill (par. 36 **a**). Clean all parts in SOLVENT, dry-cleaning, and inspect parts carefully. Replace worn, broken, bent, or badly scored parts. Dress slightly scored parts with CLOTH, crocus. Lubricate bearings with GREASE, general purpose, No. 1, above +32 F or GREASE, general purpose, No. 0, below +32 F, and assemble drill (par. 36 **b**). Lubricate tool (par. 38 **b**) immediately after assembly.



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## 38. CARE, CLEANING, AND LUBRICATION.

### a. Care and Cleaning.

(1) After each day's use, pour about a tablespoonful of SOLVENT, dry-cleaning, into air inlet. Run drill about 15 seconds to flush out interior. Pour about a teaspoonful of OIL, engine, SAE 10, into air inlet. Run drill about 15 seconds. Wipe exterior of tool with cloth dampened with OIL, engine, SAE 10.

(2) Stow tool in a safe place when not in use. Do not leave air hose connected overnight.

(3) After each 25-hours' use, remove side rods and lift back head from cylinder. Remove the two oil control plugs (fig. 62) from top of cylinder. Remove oil control felts and wash in SOLVENT, dry-cleaning. Dry felts with an air blast. Clean cylinder with SOLVENT, dry-cleaning, and dry with an air blast. Blow strong air blast through all oilholes to be certain they are unobstructed. Install oil control felts, oil control plugs, back head, and side rods.

### b. Lubrication.

(1) This drill should be lubricated by the installation of an air line lubricator in the air supply line as described in (par. 14 b (2) ).

(2) Remove oil plug from cylinder and fill reservoir with oil each day before using tool. Use OIL, engine, SAE 10.

(3) In the event an air line lubricator is not available, the following procedure is recommended. Before using, and every four hours during operation, squirt approximately a teaspoonful of OIL, engine, SAE 10, into air intake.

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Section VI

# CLAY DIGGER

## 39. DESCRIPTION AND FUNCTIONING (fig. 63).

a. The pneumatic clay digger is a lightweight tool used for light duty trimming and overhead cutting on side walls, in panels, caissons, and other excavations. Tool action is controlled by a trigger-operated throttle valve. A cylinder valve directs air pressure to alternate ends of a piston which moves back and forth in the cylinder. Downward piston force is delivered directly to a clay spade, flat pick, or moil point. Upward piston force is absorbed by air pressure. Lubrication is provided by oil injected into exhaust holes and air intake at frequent intervals.



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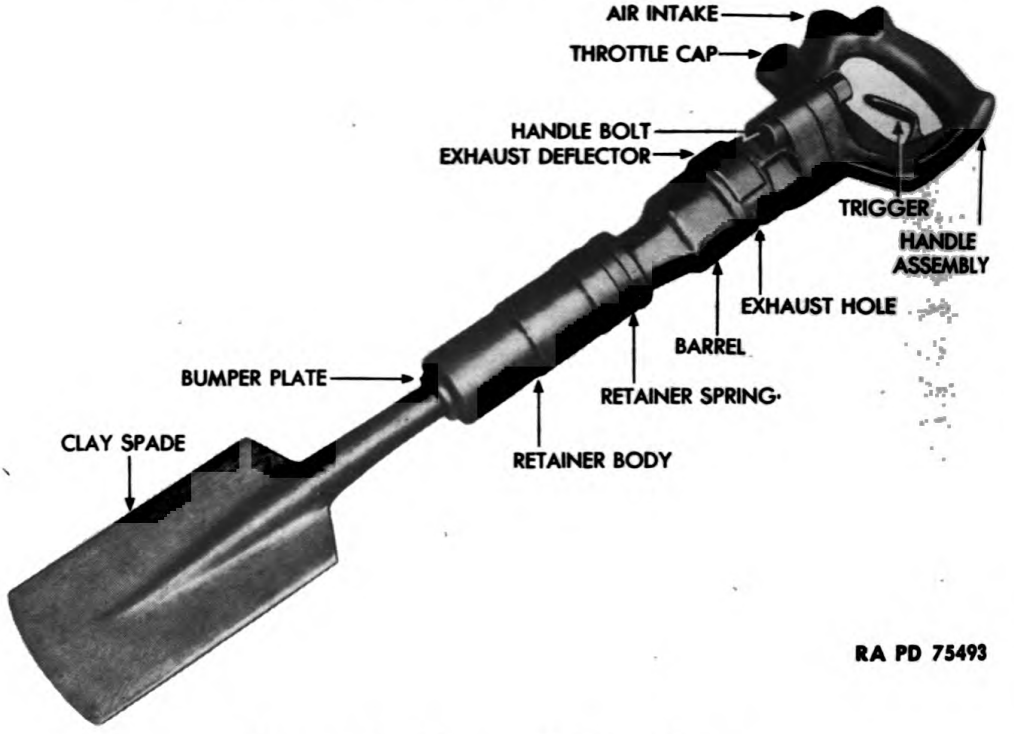



*Figure 63 — Pneumatic Clay Digger*

**40. OPERATION** (figs. 63 and 64).

**a. Lubricate Clay Digger** (par. 44).

**b.** Clay digger can be equipped with a clay spade, flat pick, or moil point. If it is desired to change points, lift upon retainer spring with screwdriver and unscrew retainer body by hand. Pull both halves of split sleeve, rubber bumper, and both halves of bumper plate from large end of retainer body (fig. 65). Use screwdriver, if necessary, to loosen parts. Pull bit from small end of retainer body. Insert bit to be used through small end of retainer body. Place both halves of bumper plate, rubber bumper, and both halves of split sleeve in position around shank of bit inside retainer body (fig. 65). Screw retainer body onto barrel by hand and snap retainer spring into position.

**c.** Blow out air hose. Connect air hose to air inlet on handle.

**d.** Place spade, pick, or point on work to be done and squeeze the trigger.

**e.** When work is accomplished, release trigger.

**f.** Every 4 working hours, inject a good grade of OIL, engine, SAE 10, or equivalent, into exhaust holes and air intake.

**g.** Disconnect and clean (par. 44) tool after day's work is done.



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## PNEUMATIC TOOLS




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***Figure 64 — Pneumatic Clay Digger in Operation***



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## ORDNANCE MAINTENANCE — MAINTENANCE OF BOMB DISPOSAL EQUIPMENT FOR ACCESS AND STERILIZATION

## 41. MALFUNCTIONS AND CORRECTIONS.

### a. Trouble Shooting.

| Symptom | Cause | Remedy |
|---|---|---|
| (1) Clay digger works sluggishly. | *(a)* Insufficient air supply and pressure. | *(a)* Connect tool to source of air at 80- to 100-pound per square inch pressure. |
| | *(b)* Air hose too small. | *(b)* Use air hose of ¾-inch or larger inside diameter. |
| | *(c)* Air hose obstructed by dirt. | *(c)* Remove tool and blow air blast through hose in direction opposite to normal air flow. |
| | *(d)* Clay digger fouled by dirt. | *(d)* Inject SOLVENT, dry-cleaning, into air intake. Run tool about 15 seconds, inject OIL, engine, SAE 10, into air intake and exhaust holes. Run tool about 15 seconds. At first opportunity, disassemble (par. 42) tool; clean parts in SOLVENT, dry-cleaning. Reassemble (par. 42) and lubricate (par. 44) tool. |
| | *(e)* Tool insufficiently lubricated. | *(e)* Inject OIL, engine, SAE 10, into air intake and exhaust holes. |
| | *(f)* Piston badly worn. | *(f)* Replace piston if worn 0.003 or more inches from new diameters of 0.0600 and 1.6850 inches. |
| (2) Tool fails to start when trigger is pressed, although air supply to tool is adequate. | *(a)* Mud, which has worked up past spade shank, accumulated in bottom of barrel. | *(a)* Disassemble, clean, and lubricate tool (pars. 42 and 44). |
| | *(b)* Cylinder valve fouled with dirt. | *(b)* Remove cylinder valve assembly (par. 42). Press valve sleeve from cylinder valve block assembly, remove thrust plug and cylinder valve. Clean all parts in SOLVENT, dry-cleaning. |



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| Symptom | Cause | Remedy |
|---|---|---|
| | | Be sure intake holes in top of valve block are open. Lubricate parts with OIL, engine, SAE 10, when assembling. |
| | (c) Throttle valve fouled with dirt. | (c) Remove throttle cap, valve spring, throttle valve, and valve stem from handle (fig. 65). Remove handle from barrel (par. 42). Clean all parts with SOLVENT, dry-cleaning, and air blast. Be sure air passages are open. Lubricate parts with OIL, engine, SAE 10, and assemble (par. 44). |

## 42. DISASSEMBLY AND ASSEMBLY.

**a. Disassembly** (fig. 65).

(1) Lift up retainer spring with screwdriver and unscrew retainer body by hand. Pull both halves of split sleeve, rubber bumper and both halves of bumper plate from large end of retainer body. Use a screwdriver, if necessary, to loosen parts. Slide clay spade, flat pick, or moil point from small end of retainer body.

(2) Screw throttle cap from its boss in handle assembly. Pick valve spring, throttle valve, and valve stem from throttle cap opening in handle assembly.

(3) Remove both handle bolt nuts, lock washers, and bolts. Pick handle assembly from barrel, pick cylinder valve assembly from top of barrel and press valve from valve sleeve. Empty piston from top of barrel.

(4) Snap deflector from over exhaust holes in barrel.

**b. Assembly** (fig. 65).

(1) Snap deflector into position on barrel over exhaust holes.

(2) Insert piston, small end first, into top of barrel. Press small end of cylinder valve into top of valve sleeve and place the assembly in position in top of barrel. Place handle assembly in position on top of barrel and install both handle bolts, lock washers, and nuts. Draw handle bolt nuts up evenly and tightly.

(3) Insert valve stem, throttle valve, and valve spring into throttle cap opening in handle assembly. Install throttle cap in its opening in handle assembly.



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## ORDNANCE MAINTENANCE — MAINTENANCE OF BOMB DISPOSAL EQUIPMENT FOR ACCESS AND STERILIZATION

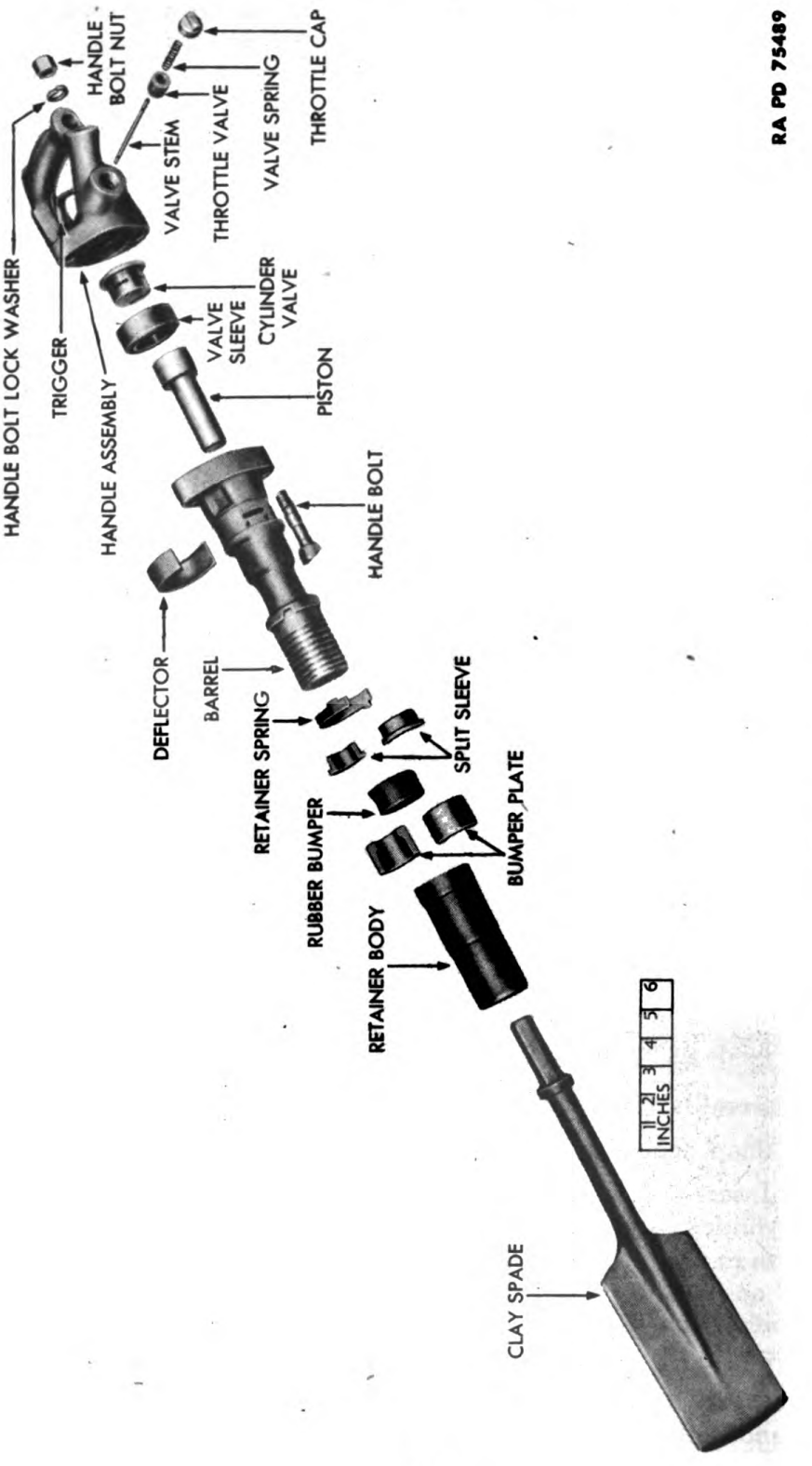



*Figure 65 — Pneumatic Clay Digger — Exploded View*



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(4) Insert shank of clay spade, flat pick, or moil point through small end of retainer body. Place both halves of bumper plate, rubber bumper, and both halves of split sleeve in position around shank of bit inside retainer body. Screw retainer body onto barrel by hand and snap retainer spring into position.

## 43. INSPECTION INSTRUCTIONS.

**a. Before Use of Tool.**

(1) Inspect clay spade, flat pick, or moil point (whichever is to be used) to see if it is reasonably sharp. If battered over on cutting end, grind to shape.

(2) See that retainer body is screwed tightly onto barrel and locked with retainer spring.

(3) Test tension on handle bolts to be sure they are equally tight. This is important in order to avoid misalinment and consequent wear of internal parts.

**b. At Time of Disassembly.** Clean all parts in SOLVENT dry-cleaning; inspect parts to see if any are worn, scored, bent, or broken. Inspect air passages to see if any are plugged. Measure piston with micrometer to see if it is worn to replacement point (0.003 in. from new diameters of 1.0600 and 1.6850 in.). Smooth slighty scored parts with CLOTH, crocus. Replace parts which are broken, bent, worn, or badly scored. Clean obstructed air passages with air blast or wire ramrod.

## 44. CARE, CLEANING, AND LUBRICATION.

**a. Care and Cleaning.**

(1) After use, wipe exterior with a cloth dampened with OIL, engine, SAE 10.

(2) Flush tool by pouring about a tablespoonful of SOLVENT, dry-cleaning, into air intake and running tool about 15 seconds after each 10 hours use. Lubricate immediately thereafter by pouring about a teaspoonful of OIL, engine, SAE 10, into air intake and again, running tool.

(3) After 50 hours use, disassemble, clean, inspect tool (par 42).

**b. Lubrication.** Lubrication of this tool is best taken care of by use of an air line lubricator in the air supply line. For description of use, see paragraph 14 b (2). In absence of the air line lubricator, squirt about a teaspoonful of OIL, engine, SAE 10, into air intake and exhaust holes every 4 hours of operation.



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## Section VII

# PAVING BREAKER

## 45. DESCRIPTION AND FUNCTIONING (figs. 66 and 67).

a. This pneumatic paving breaker is designed for the hardest kind of demolition work. A sheeting driver attachment, furnished with the outfit, can be quickly attached to the pneumatic cylinder in place of the steel retaining front head. This attachment converts the outfit to a sheeting driver capable of driving planks 2 inches thick. When the throttle lever is pressed, compressed air is admitted by a throttle valve to an automatic valve on top of the cylinder. The automatic valve directs the air pressure to alternate end of the solid steel piston. The piston flies up and down within the cylinder. Its upstroke is cushioned by compressed air. On its downstroke, the piston hits a tappet. The tappet transmits the blow to the paving breaker steel or the sheeting driver ram, depending on which attachment is installed.

## 46. OPERATION.

**a. Use as a Paving Breaker** (fig. 68).

(1) Lift steel retainer lever and insert chisel bit point into front head. Release catch.

(2) Blow out air hose. Connect air hose to air inlet swivel.

(3) Place bit, chisel or point, on work to be done and squeeze throttle lever.

**b. Use as a Sheeting Driver** (fig. 69).

(1) Remove retainer body by removing two attaching nuts (fig. 35).

(2) Install sheeting driver head. Use 1¼-inch open-end wrench to install two attaching nuts (fig. 72).

(3) Blow out air hose and connect to air inlet swivel.

(4) Place sheeting driver head on piling to be driven and squeeze throttle lever.

**c. Operation Cautions.**

(1) Keep all nuts tight.

(2) Keep oil reservoir filled.



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***Figure 66 — Pneumatic Paving Breaker With Front Head Installed***

(3) Do not attempt to repair tool on job; take it into a shop or other enclosed place.

(4) Do not leave tool on job as long as it will run. Disassemble, clean, inspect tool at periodic intervals (pars. 48 and 50).

(5) Do not install new parts in conjunction with badly worn parts; neither can perform at top efficiency.

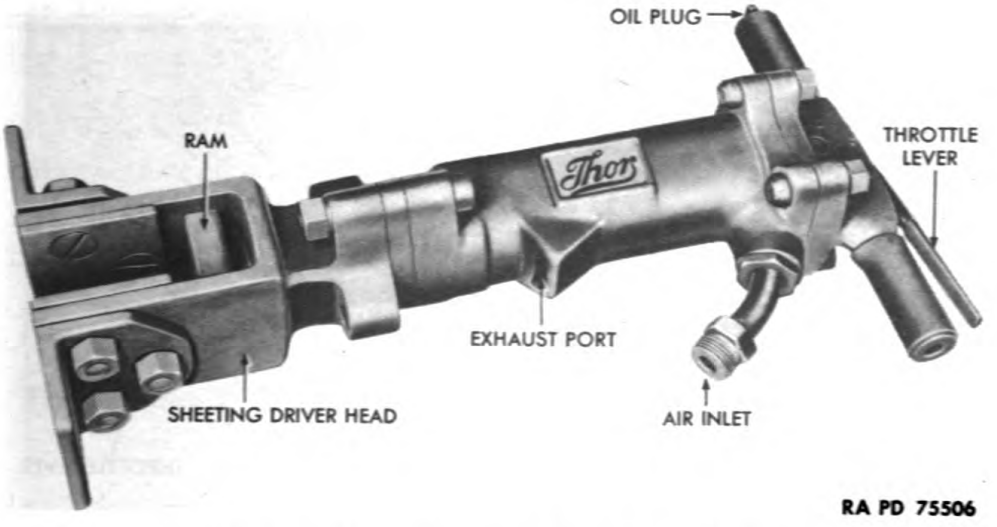



***Figure 67 — Pneumatic Paving Breaker With Sheeting Driver Head Installed***



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## ORDNANCE MAINTENANCE — MAINTENANCE OF BOMB DISPOSAL EQUIPMENT FOR ACCESS AND STERILIZATION




***Figure 68 — Breaking Pavement With Pneumatic Paving Breaker***



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## PNEUMATIC TOOLS




***Figure 69 — Driving Sheeting With Pneumatic Paving Breaker***



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## 47. MALFUNCTIONS AND CORRECTIONS.

### a. Trouble Shooting.

| Symptom | Cause | Remedy |
|---|---|---|
| (1) Paving breaker works sluggishly, lacks power, or fails to operate. | *(a)* Insufficient supply of air pressure. | *(a)* Connect tool to source of air that will remain at 90- to 100-pound per square inch pressure during operation of tool. |
| | *(b)* Air hose too small. | *(b)* Use air hose having an inside diameter not less than ¾ inch. |
| | *(c)* Air hose or air strainer obstructed. | *(c)* Remove air hose. Blow air blast through it in direction opposite normal flow of air. Remove air strainer and wash with SOLVENT, dry-cleaning. |
| | *(d)* Paving breaker fouled with dirt. | *(d)* Pour about a tablespoonful of SOLVENT, dry-cleaning, into air intake. Run tool about 15 seconds. Pour about a tablespoonful of OIL, engine, SAE 10, into air intake and again run tool about 15 seconds. At first opportunity, disassemble tool (par. 48) and clean parts in SOLVENT, dry-cleaning. Reassemble and lubricate tool (pars. 48 and 50). |
| | *(e)* Tool insufficiently lubricated. | *(e)* Lubricate paving breaker (par. 50). |
| | *(f)* Throttle valve, automatic valve, or piston fouled with dirt. | *(f)* Disassemble (par. 48) tool and clean parts with SOLVENT, dry-cleaning, and air blast. Reassemble and lubricate tool (pars. 48 and 50). |
| | *(g)* Tappet incorrectly assembled. | *(g)* Remove tappet from tappet guide (par. 48). Assemble with knob end of tappet down and small end of tappet inserted into under side of guide. |



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| Symptom | Cause | Remedy |
|---|---|---|
| | *(h)* Moisture frozen within tool. | *(h)* Thaw tool in warm room. Flush out with SOLVENT, dry-cleaning, poured into air intake. Operate tool about 15 seconds. Pour OIL, engine, SAE 10, into air intake and operate tool. In extreme cases, thaw, disassemble (par. 48), dry, and lubricate (par. 50) paving breaker. |
| | *(i)* Front head bolt nuts, sheeting, nuts, or back head bolt nuts loose or unevenly tightened. | *(i)* Remedy misalinement due to loose bolts, or uneven tightening. |
| (2) Bit works out of front head. | *(a)* Steel retainer worn or broken. | *(a)* Replace steel retainer (par. 48). |
| | *(b)* Steel retainer plunger lost or broken. | *(b)* Replace steel retainer plunger (par. 48). |
| | *(c)* Steel retainer plunger spring lost or broken. | *(c)* Replace steel retainer plunger spring (par. 48). |

## 48. DISASSEMBLY AND ASSEMBLY.

a. **Disassembly** (fig. 70).

(1) Remove oil plug (fig. 71) from end of handle opposite throttle lever. Drain oil from tool. Flush with SOLVENT, dry-cleaning. Drain SOLVENT, dry-cleaning, from tool.

(2) REMOVE AND DISASSEMBLE FRONT HEAD (IF INSTALLED) (fig. 71).

*(a)* Remove both head nuts, lock washers, bolt springs, and bolts.

*(b)* Lift front head from tappet seat.

*(c)* Remove steel retainer bolt nut, lock washer, bolt, and bushing. Pick steel retainer, steel retainer plunger, and steel retainer spring from front head.

(3) REMOVE AND DISASSEMBLE SHEETING DRIVER HEAD (IF INSTALLED) (fig. 72).

*(a)* Remove both sheeting driver head bolt nuts, lock washers, and bolts.

*(b)* Lift sheeting driver head from tappet seat.



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## ORDNANCE MAINTENANCE — MAINTENANCE OF BOMB DISPOSAL EQUIPMENT FOR ACCESS AND STERILIZATION

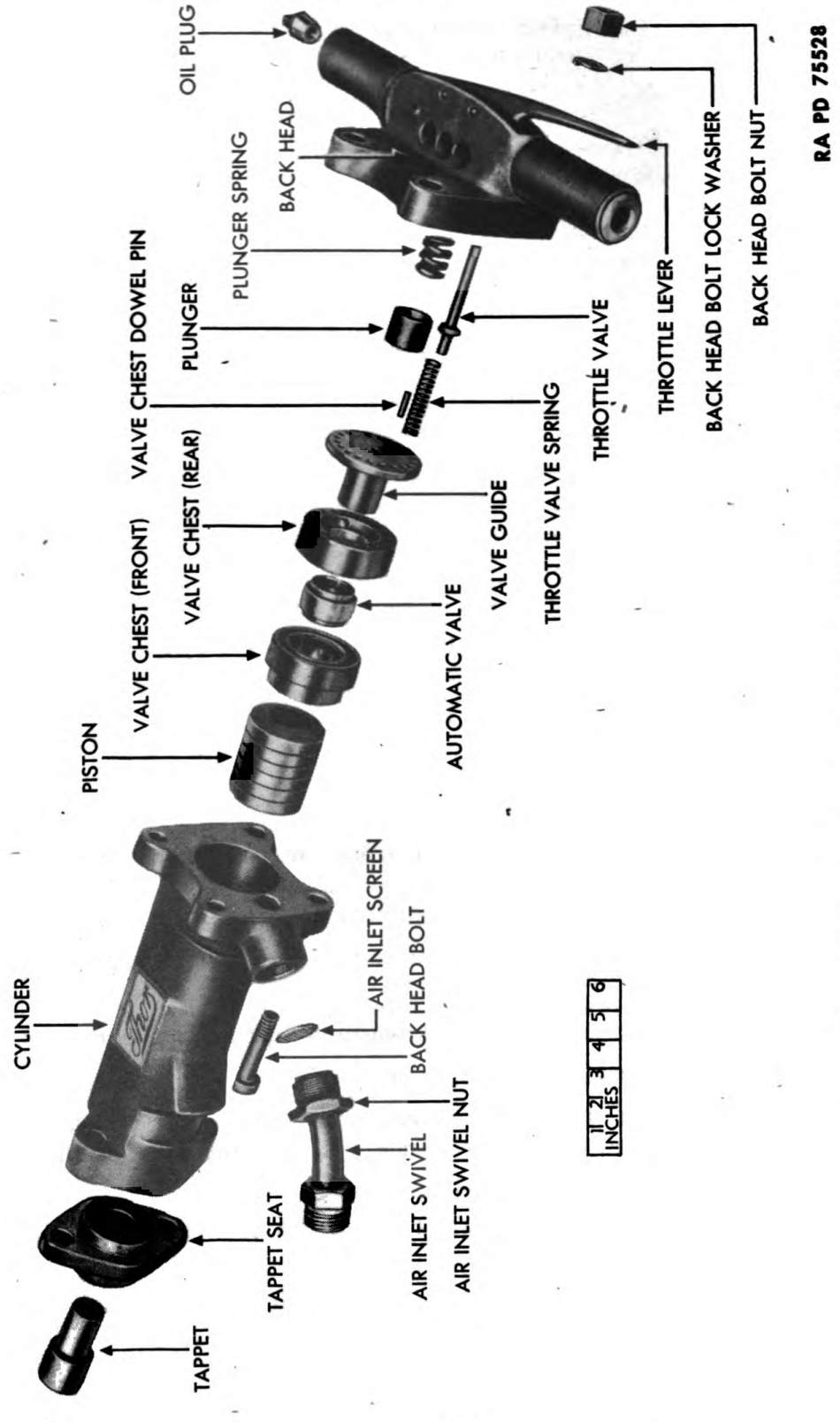



*Figure 70 — Paving Breaker Pneumatic Cylinder — Exploded View*



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***Figure 71 — Pneumatic Paving Breaker With Front Head Exploded***



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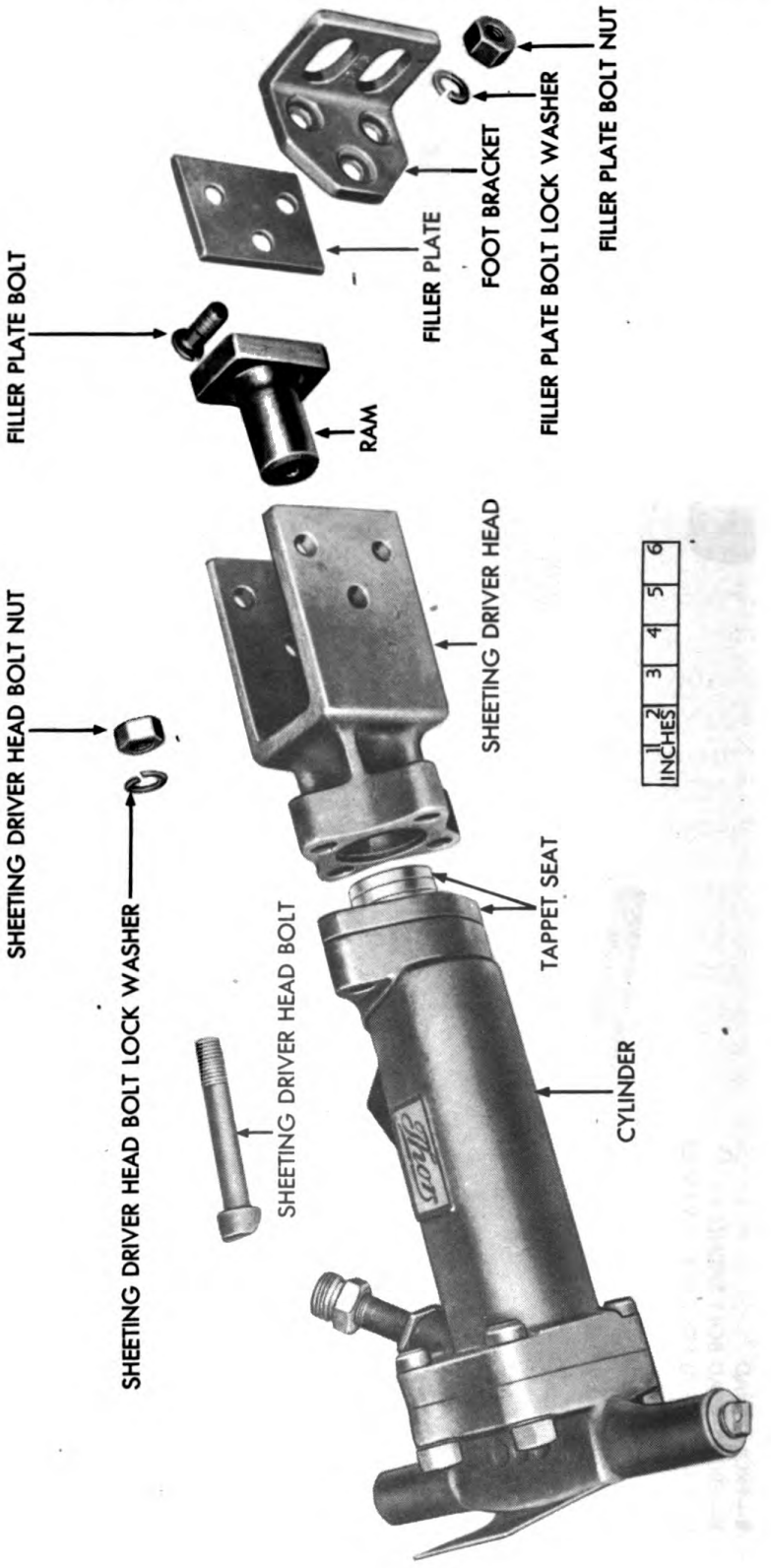



*Figure 72 — Pneumatic Paving Breaker With Sheeting Driver Head Exploded*



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*(c)* Remove the six filler plate bolt nuts, lock washers, and bolts. Pick both foot brackets and filler plates from sheeting driver head.

*(d)* Slide ram from sheeting driver head.

(4) Pull tappet and tappet seat from bottom of cylinder after removal of front head or sheeting driver head.

(5) Remove the four back head bolt nuts, lock washers, and bolts. Lift back head from cylinder. Be careful to keep from losing plunger, plunger spring, throttle valve, and throttle valve spring. Remove oil, control plug, and oil control felt from side of handle. If necessary for purpose of replacement, drive throttle valve stem bushing from back head with ⅜-inch round punch.

(6) Working from bottom of cylinder, gently tap on bottom of piston with wooden handle of hammer until complete valve chest and piston can be picked from top of cylinder. Push valve guide from top of valve chest. Remove valve chest dowel pin. Separate front and rear portions of valve chest. Remove valve from chest.

(7) Screw air inlet swivel nut from cylinder. Lift air inlet swivel from cylinder. Pick air inlet screen from swivel boss in cylinder.

**b. Assembly** (fig. 70).

(1) Clean all parts in SOLVENT, dry-cleaning, and dry with a clean cloth or an air blast. Be sure all air passages are open. Coat all parts with film of OIL, engine, SAE 10.

(2) Place air inlet screen in its place within air inlet boss on cylinder. Place air inlet swivel in position on its boss on cylinder and tighten air inlet swivel nut.

(3) Stand piston upright. From top of cylinder, insert piston. Place front half of valve chest in position on cylinder. Place automatic valve in position in center of valve chest. Place rear half of valve chest in position on front half and around automatic. Be sure hole for valve chest dowel pin is in alinement. Insert stem of valve guide through chest and valve. Use care to have all holes properly alined to show clear passage. Tap valve chest dowel pin in position flush with top of cylinder.

(4) Place throttle valve spring in its recess in cylinder. Press valve stem bushing flush into its opening in back head. If new bushing is installed, ream to 0.00025-inch diameter over diameter of valve stem. Insert throttle valve, long end first, into bottom of bushing. Place plunger spring and plunger in position within recess in bottom of back head. Place back head in position on top of cylinder. Install the four back head bolts, lock washers, and nuts. Draw nuts down alternately, a little at a time. Be sure they are uniformly tight to prevent misalinement and consequent wear of internal parts. Install oil control felt and plug in recess of side handle.



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(5) ASSEMBLE SHEETING DRIVER HEAD (fig. 72).

*(a)* Insert ram into its opening from bottom of sheeting driver head.

*(b)* Place a filler plate in position on inside of sheeting driver head. Place a foot bracket in position on outside of same side of sheeting driver head. Install three filler plate bolts through filler plate, head, and foot bracket. Install three filler plate bolt lock washers and nuts on the three bolts.

*(c)* Repeat step *(b)*, above, to install other filler plate and foot bracket.

(6) INSTALL SHEETING DRIVER HEAD (fig. 72).

*(a)* Insert tappet seat, small end first, into base of cylinder with bolt holes in alinement. Insert tappet, small end first, into tappet seat.

*(b)* Place sheeting driver head in position on tappet seat. Install the two sheeting driver head bolts, lock washers, and nuts. Draw nuts down equally tight.

(7) ASSEMBLE FRONT HEAD (fig. 71).

*(a)* Slide steel retainer bolt bushing, large end first, onto steel retainer bolt.

*(b)* Place steel retainer plunger spring and plunger in position in recess in front head.

*(c)* Place steel retainer in position within flanges of front head and insert steel retainer bolt.

*(d)* Tighten steel retainer bolt lock washer and nut onto bolt.

(8) INSTALL FRONT HEAD (fig. 71).

*(a)* Insert tappet seat, small end first, into base of cylinder with bolt holes in alinement. Insert tappet, small end first, into tappet seat.

*(b)* Place front head in position on tappet seat. Install the two front head bolts, springs, lock washers, and nuts.

(9) Fill oil reservoir in end of handle with OIL, engine, SAE 10. Install oil plug (fig. 71).

## 49. INSPECTION INSTRUCTIONS.

**a. Before Use of Tool.** Check tightness of all nuts. Tighten loose nuts.

**b. At Time of Disassembly.** Clean all parts in SOLVENT, dry-cleaning, and dry with an air blast. Inspect parts to see if any are worn, scored, bent, or broken. Inspect all air passages to be sure all



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are free of obstructions. Smooth slightly scored surfaces with CLOTH, crocus. Replace bent, broken, badly worn, and badly scored parts.

## 50. CARE, CLEANING, AND LUBRICATION.

**a. Care and Cleaning.**

(1) After use, flush tool by pouring about a teaspoonful of SOLVENT, dry-cleaning, into air intake. Run tool about 15 seconds. Immediately thereafter, pour about a teaspoonful of OIL, engine, SAE 10, into air intake and again run tool.

(2) After use, wipe exterior of tool with cloth moistened with light OIL, engine, SAE 10.

(3) Always disconnect tool from air hose when it is to be used for several hours or overnight.

(4) After 50 hours' use, disassemble (par. 48), clean, and inspect (par. 49) tool.

**b. Lubrication** (fig. 70).

(1) The paving breaker should be lubricated by the installation of an air line lubricator in the air supply line as described in paragraph 14 b (2).

(2) Before use and every 2 hours of operation, remove oil filler plug on end of handle and fill reservoir with OIL, engine, SAE 10.

(3) During continuous operation, check oil supply every hour.



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# CHAPTER 4

# WATER PUMPING EQUIPMENT

## Section I

## GENERAL

### 51. GENERAL.

**a.** Four kinds of pumps are used for removal of water from bomb pits or openings; a hand-operated diaphragm pump; a gasoline engine-driven diaphragm pump; a gasoline engine-driven centrifugal pump; and an air-operated centrifugal pump.

**b.** Diaphragm pumps are adapted to jobs of dewatering excavation and to jobs involving dirty water removal from pits and holes in the ground.

**c.** Centrifugal pumps are adapted to pumping large volumes of relatively clean water.

**d.** Care and operation of the hand-operated diaphragm pump are covered in chapter 4 section II. In this chapter, section III deals similarly with the engine-driven diaphragm pump, while section IV is concerned with the engine-driven centrifugal pump and section V, with air-operated centrifugal pump.

## Section II

## HAND-OPERATED DIAPHRAGM PUMP

### 52. DESCRIPTION AND FUNCTIONING.

**a. Description** (fig. 73). Two large iron castings, base and head, compose the body of the hand-operated diaphragm pump. Between the two castings, a rubber diaphragm is secured. A cast iron diaphragm plate is bolted to the diaphragm. It serves as a base for the discharge valve and as a means of connecting the operating linkage to the diaphragm. Two flap-type valves, constructed of cast iron and rubber, are used. The intake valve is located in the suction hose fitting attached to the base. The discharge valve is located in the center of the diaphragm.

**b. Functioning.** In operation, the operator moves the handle up and down. Linkage transmits the handle motion to the diaphragm. As the diaphragm moves up, water is drawn into the pump chamber.



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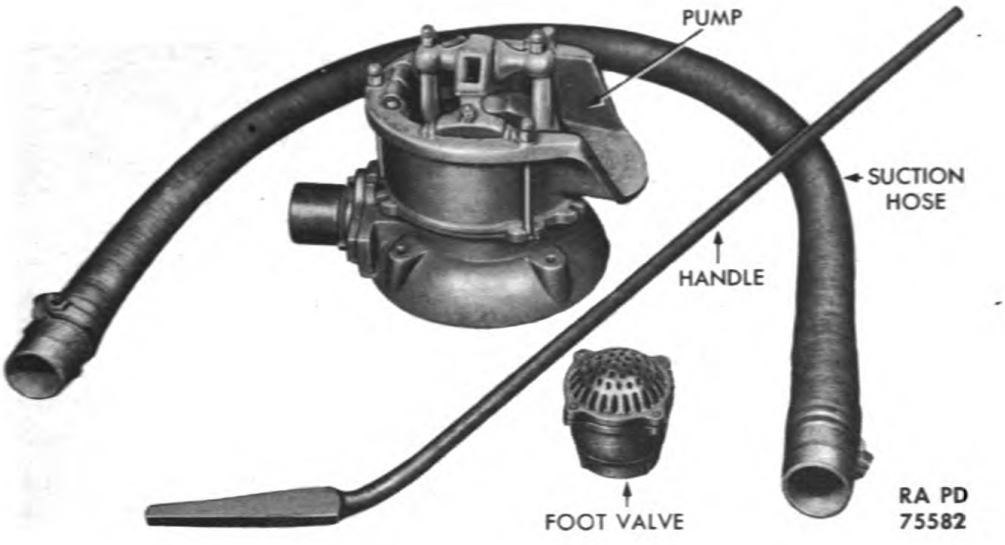



***Figure 73 — Hand-operated Diaphragm Pump***

On the downward motion of the diaphragm, this water is put under pressure and forced through the flap-type discharge valve into discharge outlet.

## 53. OPERATION (fig. 74).

**a.** Tighten suction hose into suction hose fitting located on base of pump.

**b.** Screw foot valve to base of suction hose. Drop foot valve into water that is to be pumped.

**c.** Pour water on top of diaphragm. This serves as an air seal to ensure perfect functioning of the discharge valve.

**d.** Insert handle into handle socket and move handle up and down steadily.

## 54. MALFUNCTIONS AND CORRECTIONS.

| Symptom | Cause | Remedy |
|---|---|---|
| **a.** Pump fails to work or works poorly. | (1) Pebble or other obstruction in intake or discharge valve. | (1) Remove obstruction and clean valve. |
| | (2) Air leak in suction hose or at suction hose fitting. | (2) Inspect suction hose and fitting for leakage. Tighten hose if loose. Replace hose if punctured or damaged. |



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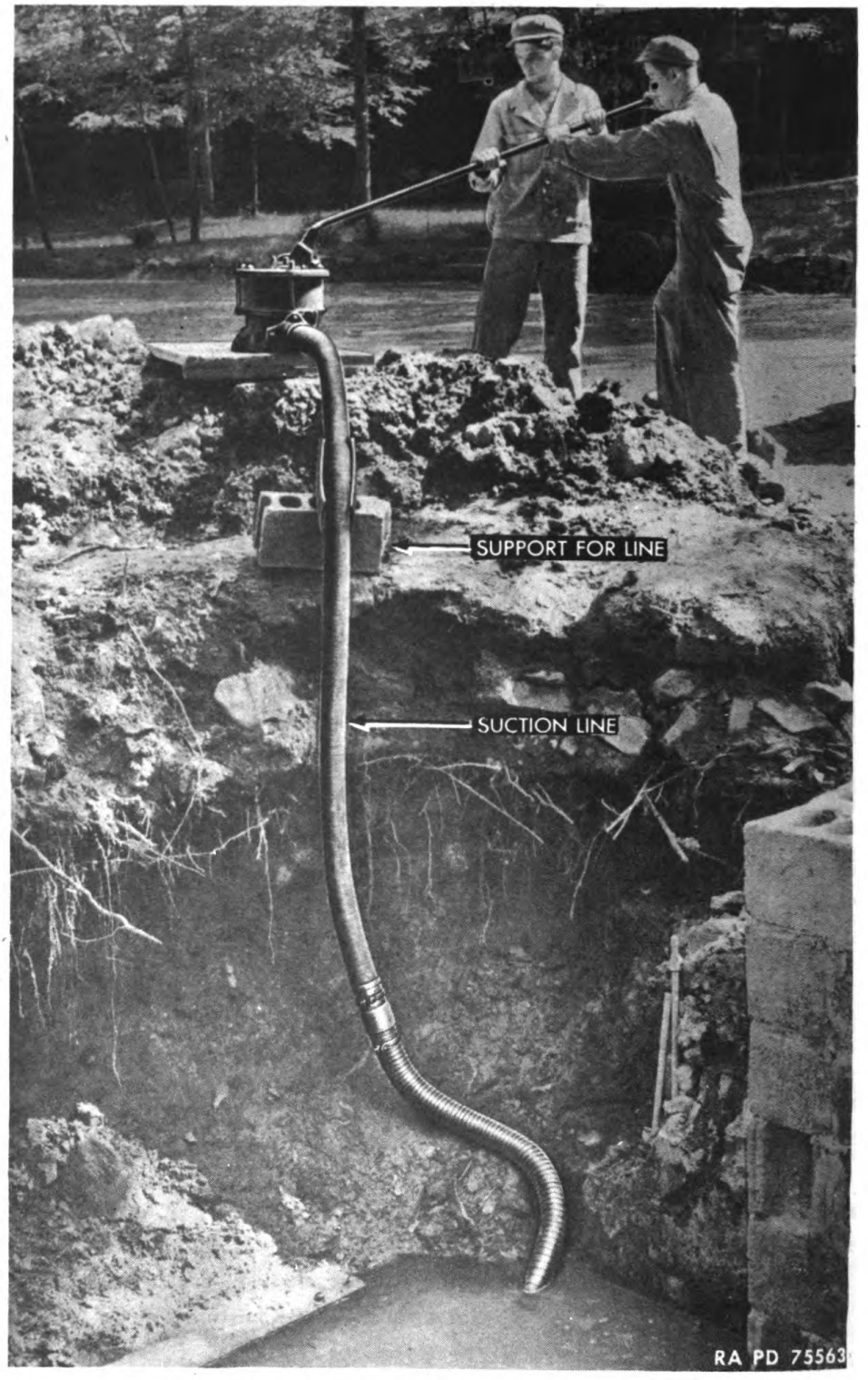



*Figure 74 — Hand-operated Diaphragm Pump in Operation*



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| Symptom | Cause | Remedy |
|---|---|---|
| | (3) Worn, torn, or aged flap in intake or discharge valve. | (3) Disassemble valve (par. 55 d) and replace damaged part. |
| | (4) Diaphragm worn, torn, or aged. | (4) Disassemble pump (par. 55 e) and replace diaphragm. |
| b. Pump loses prime quickly. | (1) Obstructed or damaged foot valve. | (1) Examine foot valve. Remove dirt or foreign matter. Replace flap if damaged (par. 55 a). |

## 55. DISASSEMBLY AND ASSEMBLY.

### a. Disassembly of Foot Valve (fig. 75).

(1) Remove the four stove bolts which secure screen to body.

(2) Lift screen, flap valve assembly, and valve base from body.

(3) Disassemble flap valve assembly by removing nut from bolt through its center. Lift leather washer, large washer, leather flap, small washer, and small leather washer from bolts.

### b. Assembly of Foot Valve (fig. 75).

(1) Assemble flap valve by placing leather washer, small washer, leather flap, large washer, and remaining leather washer on bolt. Tighten nut on bolt securely.

(2) Place assembled flap valve and screen in position on body and install the four stove bolts. Tighten nuts securely on bolts.

### c. Disassembly of Pump (fig. 76).

(1) Loosen the three nuts on long body bolts. Slide bolts from slots in base. Lift head and diaphragm assembly from base.

(2) Remove the three cap screws which secure intake valve casting to base. Lift valve casting and gasket from base.

(3) Remove the two screws which attach intake valve flap assembly to casting. Lift flap assembly from casting. Disassemble flap valve assembly, if necessary, by removing the two screws which secure rubber between two iron plates. Remove suction hose nipple from casting.

(4) Lift discharge valve from diaphragm. Remove pivot lock nut and nut. Lift handle socket and pivot lock from pump head. Remove the two nuts which attach linkage cross bar to long diaphragm bolts. Lift linkage cross bar from diaphragm bolts. Lift pump head from diaphragm assembly.

(5) Drive the two long diaphragm bolts from bosses on discharge valve casting. Lift discharge valve casting and diaphragm from diaphragm casting.



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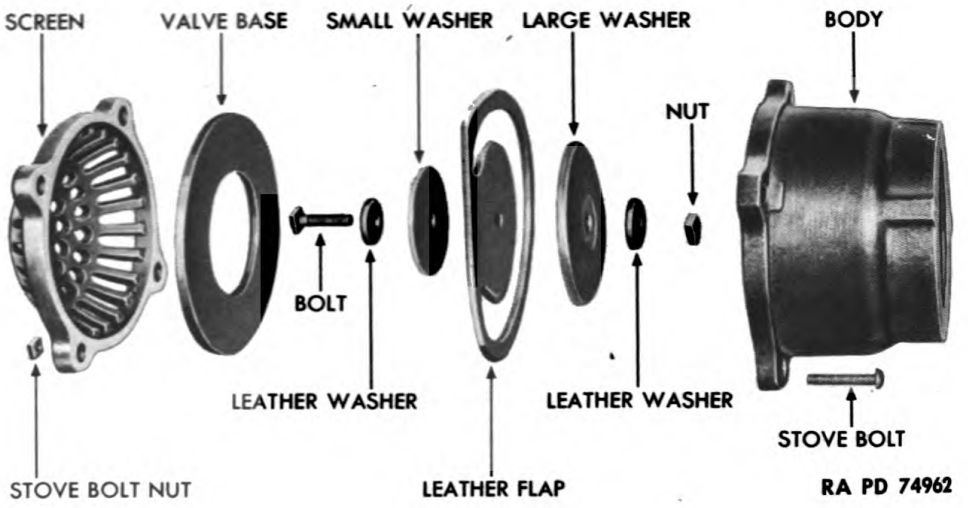



***Figure 75 — Foot Valve — Exploded View***

**d. Assembly of Pump** (fig. 76).

(1) Insert the two long diaphragm bolts through hoses in diaphragm casting. Place diaphragm and discharge valve casting in position on bolts. Tap bolts to seat in discharge valve casting bosses.

(2) Place pump head in position on diaphragm assembly. Place linkage cross bar in position on diaphragm bolts. Install two diaphragm bolt nuts. Place pivot lock in position in slots provided in pump head. Insert handle socket onto pivot lock. Install pivot nut and lock nut. Place discharge valve in position on discharge valve casting on top of diaphragm.

(3) Install suction hose nipple in intake valve casting. Assemble intake valve by placing flap in position between two iron plates and installing the two screws which clamp plates together. Place flap valve assembly in position on intake valve casting. Install washer and the two screws which attach flap valve to casting. Place intake valve casting in position on pump base and install the three intake valve casting cap screws which secure casting to base.

(4) Place head and diaphragm assembly in position on pump base. Place heads of three body bolts in slots provided in pump base and through holes provided in pump head. Tighten body bolt nuts securely.

## 56. INSPECTION INSTRUCTIONS.

**a. Before Each Operation of Pump.**

(1) See that no large pebbles are stuck between valve plate and diaphragm. Note if diaphragm is cracked or checked.



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## WATER PUMPING EQUIPMENT

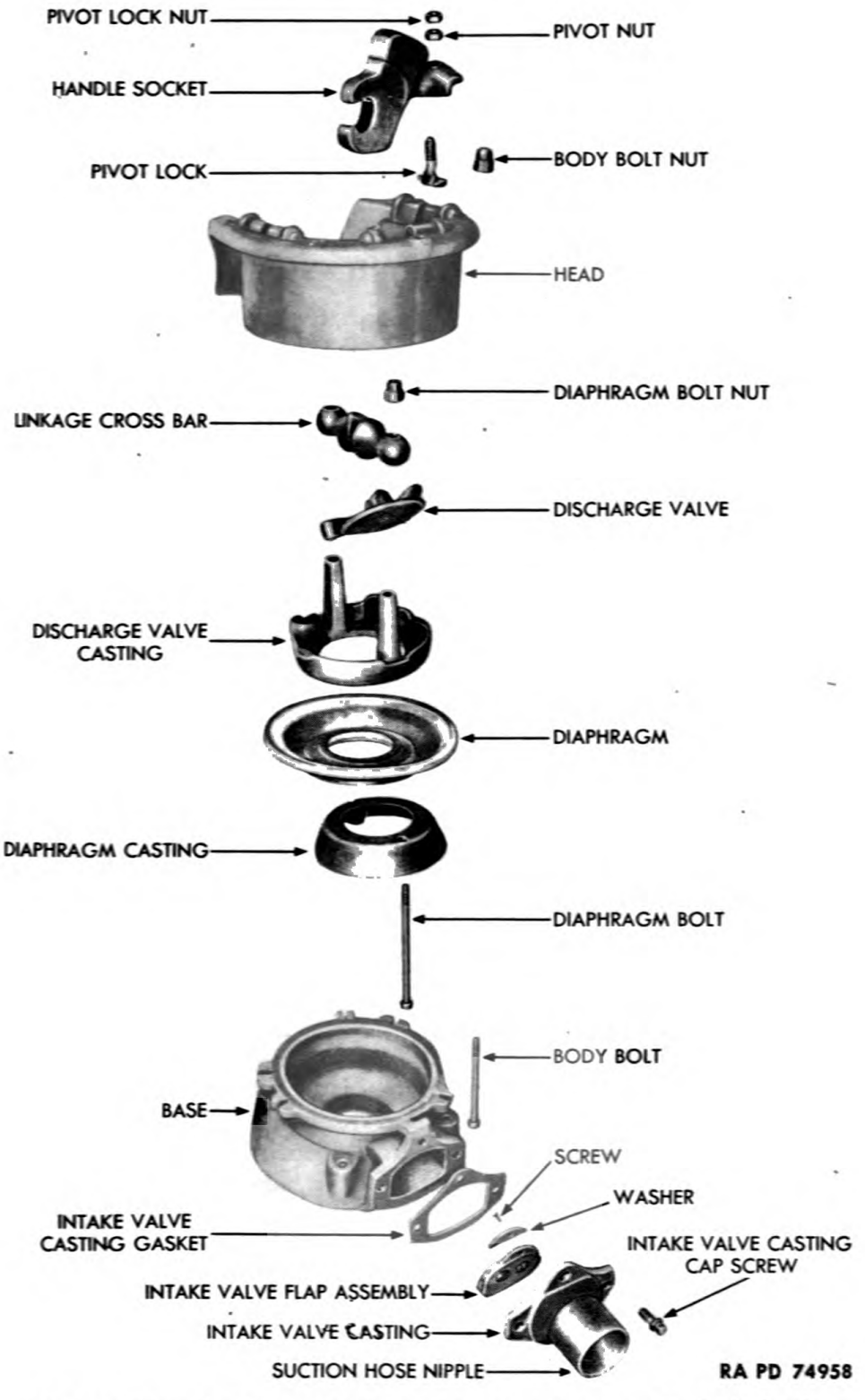



***Figure 76 — Hand-operated Diaphragm Pump — Exploded View***



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(2) Work intake and discharge valves with fingers to be sure neither is stuck.

(3) Check all bolts and nuts to ensure that none is loose.

(4) Visually inspect outside of castings to see if any are cracked.

(5) Note position of pump. For efficient operation it should be approximately level.

## 57. CARE, CLEANING, AND LUBRICATION.

**a. Care of Equipment.** Store pump, foot valve, and suction hose in a cool place out of direct sunlight when not in use.

**b. Cleaning After Use.**

(1) Lift discharge valve from diaphragm. Hold intake valve open by hand. Wash interior of pump with clean running water. Wash exterior of pump with clean water. Lift up on linkage to pull diaphragm to extended position. Remove all pebbles. Replace discharge valve on diaphragm.

(2) Flush suction hose and foot valve with clean water.

**c. Lubrication.** Before each operation of pump, lubricate sparingly with GREASE, general purpose, No. 2, the fulcrum points of the handle to diaphragm linkage. Use care to keep grease from valves and diaphragm.

---

### Section III

# PORTABLE GASOLINE ENGINE-DRIVEN DIAPHRAGM PUMP

## 58. DESCRIPTION AND FUNCTIONING.

**a. Description.**

(1) PUMP (fig. 77). This pump is a lift and force type diaphragm model. Both the suction and discharge valves are contained in readily accessible cages to facilitate inspection and replacement. Valves are the conventional flap type. The base, top, and valve cages which constitute the body of the pump are cast iron. A clean-out door is provided below the discharge valve.

(2) POWER TRAIN (fig. 77). Engine power is transmitted to the pump through an oiltight gear box. Gears are helical cut for efficient and quiet operation. The gears operate a bronze bushed eccentric shaft which imparts motion to the cast iron cross head. Two bolts and nuts attach the cross head to the diaphragm.



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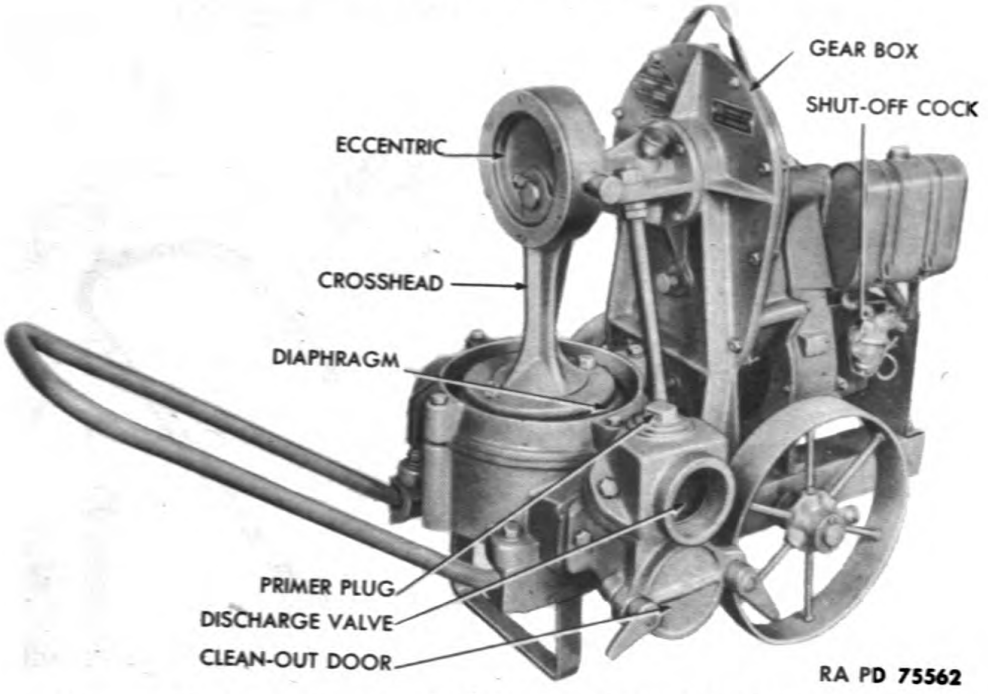



***Figure 77 — Portable Gasoline Engine-driven Diaphragm Pump Viewed From Pump End***

(3) ENGINE (fig. 78). A single cylinder 4-cycle, air cooled gasoline engine supplies power to operate the pump. Ignition is provided by a standard, high-tension magneto with automatic impulse coupling. A standard float-feed, updraft carburetor is used. Fuel is filtered through a standard glass bowl and screen type fuel filter. A blower wheel, mounted on the crankshaft, draws air under the steel hood cover for air cooling. Lubrication is by means of a geared oiler. Engine speed is controlled by a totally enclosed governor. The piston has two compression rings and one oil ring. Cylinder walls are highly polished and cooling fins are cast integral with the cylinder on its exterior. Crankshaft and camshaft have roller bearings. Connecting rod has a bronze bushed piston pin bearing and a babbitted crankshaft bearing.

**b. Functioning.** Engine power is transmitted to the pump diaphragm. As the diaphragm moves up, water is drained into the pump chamber. As the diaphragm moves down, water in the pump chamber is forced from the pump chamber into the discharge hose.

## 59. OPERATION (fig. 79).

**a.** Set the pump as near the source of supply as possible. Keep the suction line short. It should never exceed 25 feet vertical lift. The total head, suction, and discharge should never exceed 50 feet.



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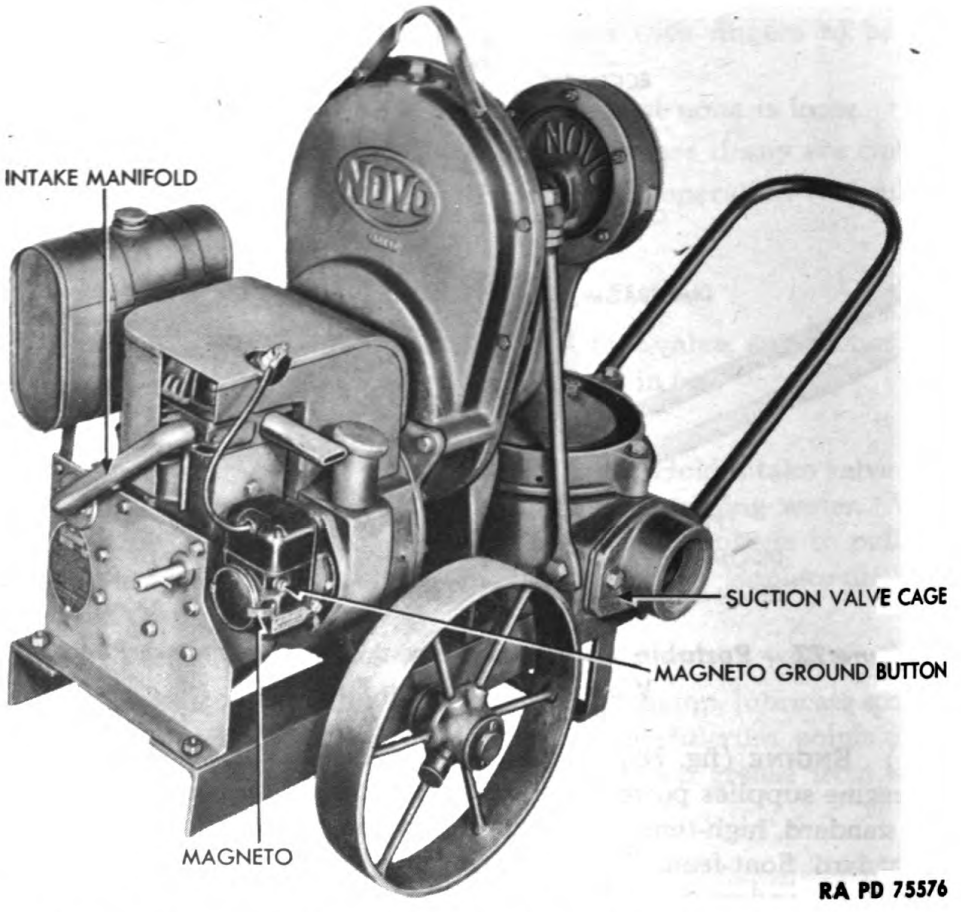



***Figure 78 — Portable Gasoline Engine-driven Diaphragm Pump Viewed From Engine End***

**b.** Connect suction and discharge lines to valve cages. Tighten suction line with large pipe wrench. Anchor and support both lines independent of the pump to avoid possible misalinement and undue strain on pump and driving parts.

**c.** Screw a foot valve with strainer to the free end of suction line. Insert foot valve and suction line into water that is to be pumped.

**d. Start Engine as Follows:**

(1) Open shut-off valve on gasoline filter under gasoline tank (fig. 77).

(2) Close choke by moving lever toward carburetor body.

(3) Crank engine by hand. Note that crank turns counterclockwise. As soon as engine starts, open choke.

**e.** If pump fails to start discharging water after a few minutes,



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## WATER PUMPING EQUIPMENT

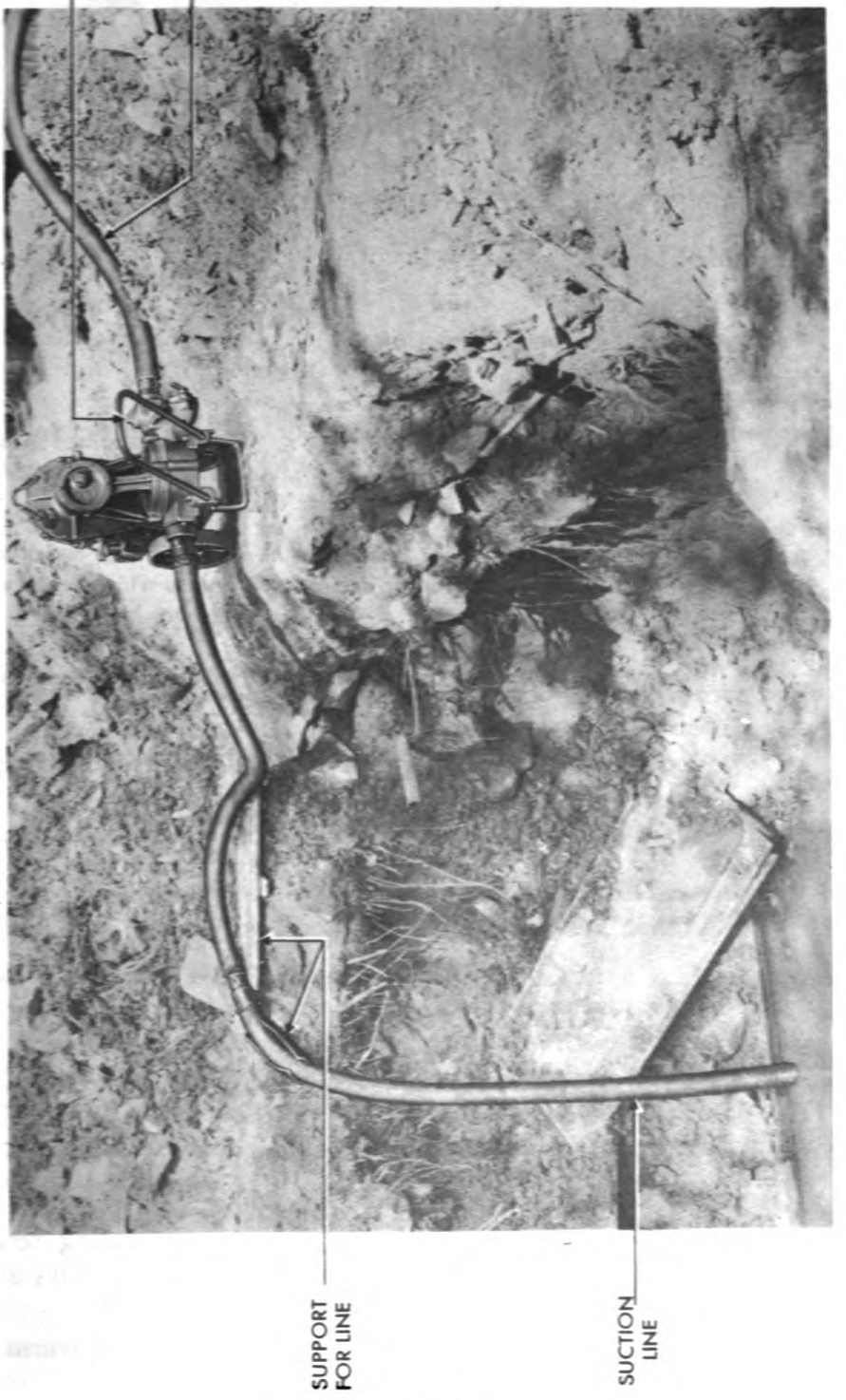



*Figure 79 — Portable Gasoline Engine-driven Diaphragm Pump in Operation*



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prime pump by pouring water down discharge line into pump. If end of discharge line is inaccessible, or lower than pump, remove primer plug on discharge valve cage and pour water into cage (fig. 77). Some portion of discharge line must be at a higher level than the pump during priming in order to keep water from running out of line.

f. To stop engine, press magneto ground button (fig. 78).

## 60. MALFUNCTIONS AND CORRECTIONS.

### a. Trouble Shooting.

| Symptom | Cause | Remedy |
|---|---|---|
| (1) Pump fails to prime or fails to pump efficiently with engine operating normally. | *(a)* Suction lift too great. | *(a)* Reduce vertical suction lift to 25 feet or less (par. 59). |
| | *(b)* Total head, suction, and discharge too great. | *(b)* Reduce total head so it does not exceed 50 feet (par. 59). |
| | *(c)* End of suction line not totally submerged in water. | *(c)* Submerge end of suction line to which foot valve is attached in water (par. 59). |
| | *(d)* Loose connection in suction line. | *(d)* Tighten loose connection (par. 59). |
| | *(e)* Hole in suction line. | *(e)* Replace suction line (par. 59). |
| | *(f)* Suction or discharge valve held open by pebble or other foreign matter. | *(f)* Clean all foreign matter from valves. |
| | *(g)* Suction or discharge valve cut or worn. | *(g)* Replace cut or worn valve (par. 55 c). |
| | *(h)* Diaphragm cut, bruised, or worn. | *(h)* Replace diaphragm (par. 55 c). |

### b. Engine.

(1) ADJUSTMENT OF CARBURETOR (fig. 80).

*(a)* Close carburetor needle valve by turning adjusting screw clockwise. Do not use force. Open adjustment screw one and one-quarter turns. Needle valve is now approximately adjusted.

*(b)* Start engine and run until intake manifold is at least warm to the hand.



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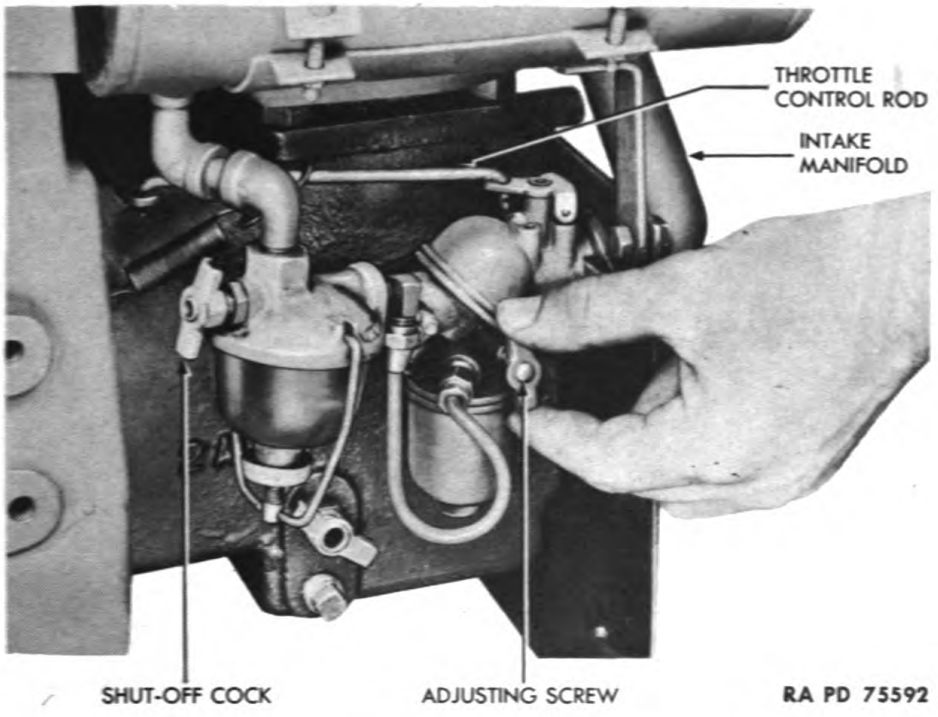



***Figure 80 — Adjusting Diaphragm Pump Engine Carburetor***

*(c)* With engine running under load, close needle valve by turning adjusting screw clockwise until engine slows. Open needle valve just enough for engine to resume governed speed.

(2) ADJUSTMENT OF VALVE TAPPETS (fig. 81).

*(a)* Run engine until thoroughly warmed up.

*(b)* Remove cap screw which secures tappet cover plate to cylinder head. Lift cover plate and gasket from cylinder head.

*(c)* Loosen tappet adjusting lock nut.

*(d)* Insert a 0.010-inch feeler gage (engine warm) between bottom of intake or exhaust valve stem and tappet adjusting screw. Turn screw down into tappet or out of tappet until just a slight drag is discernible on feeler gage. Be sure valve is closed during adjustment.

*(e)* Repeat steps *(c)* and *(d)*, above, to adjust clearance of the other valve tappet.

*(f)* Replace cover plate and gasket.

(3) ADJUSTMENT OF MAGNETO BREAKER POINTS (fig. 82).

*(a)* Loosen both spring clips and lift breaker point cover and gasket from magneto.

*(b)* Loosen fixed contact set screw.



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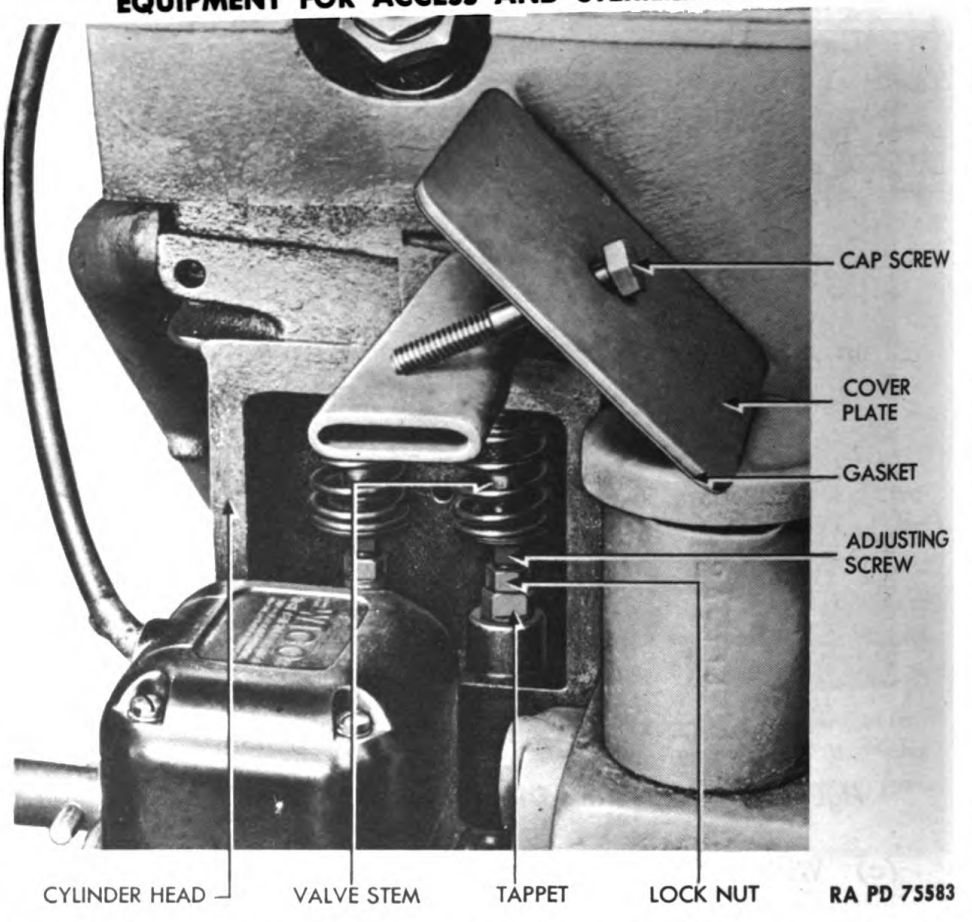



***Figure 81 — Diaphragm Pump Engine Valve Tappet Adjustment Provisions***

*(c)* Adjust eccentric adjusting screw until clearance between points measures 0.015 inch with movable contact held open by lobe on cam.

*(d)* Tighten fixed contact set screw and replace breaker point cover and gasket.

(4) ADJUSTMENT OF GOVERNOR. Adjustable from 1,400 to 2,000 revolutions per minute, governor speed is controlled by the tension of the governor spring on throttle rod. Slide spring clip along throttle rod until desired speed is attained. Greater spring tension increases engine speed.

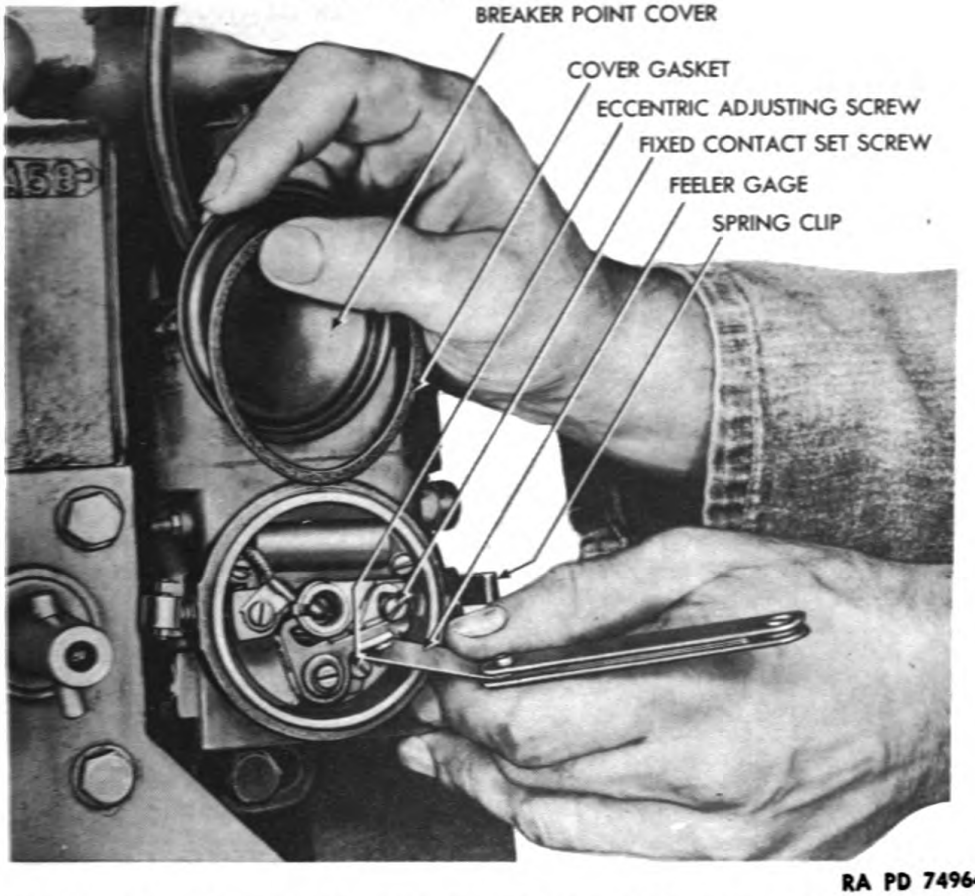
## 61. DISASSEMBLY AND ASSEMBLY.

### a. Removal of Pump (fig. 83).

(1) Remove the four cap screws and washers which attach pump top to base. Lift base up over eccentric.



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***Figure 82 — Checking Magneto Breaker Point Clearance on Diaphragm Pump Engine***

(2) Remove the two brass nuts which attach diaphragm to cross head. Diaphragm may now be lifted from base.

(3) Remove the two cap screws and lock washers which secure the two braces to pump base.

(4) Remove the four bolts, nuts, and lock washers which secure pump to frame.

(5) Lift pump base from frame.

**b. Disassembly of Pump** (fig. 84). *NOTE: Pump may be disassembled while installed on frame. Note, also, that diaphragm was removed in steps (1) and (2), above.*

(1) Remove the two handle nuts and washers which secure clean-out door to discharge flange. Lift plate from flange.

(2) Remove the two cap screws and flat washers which secure upper portion of discharge flange to lower portion. Lift upper portion of flange and gasket from lower portion.



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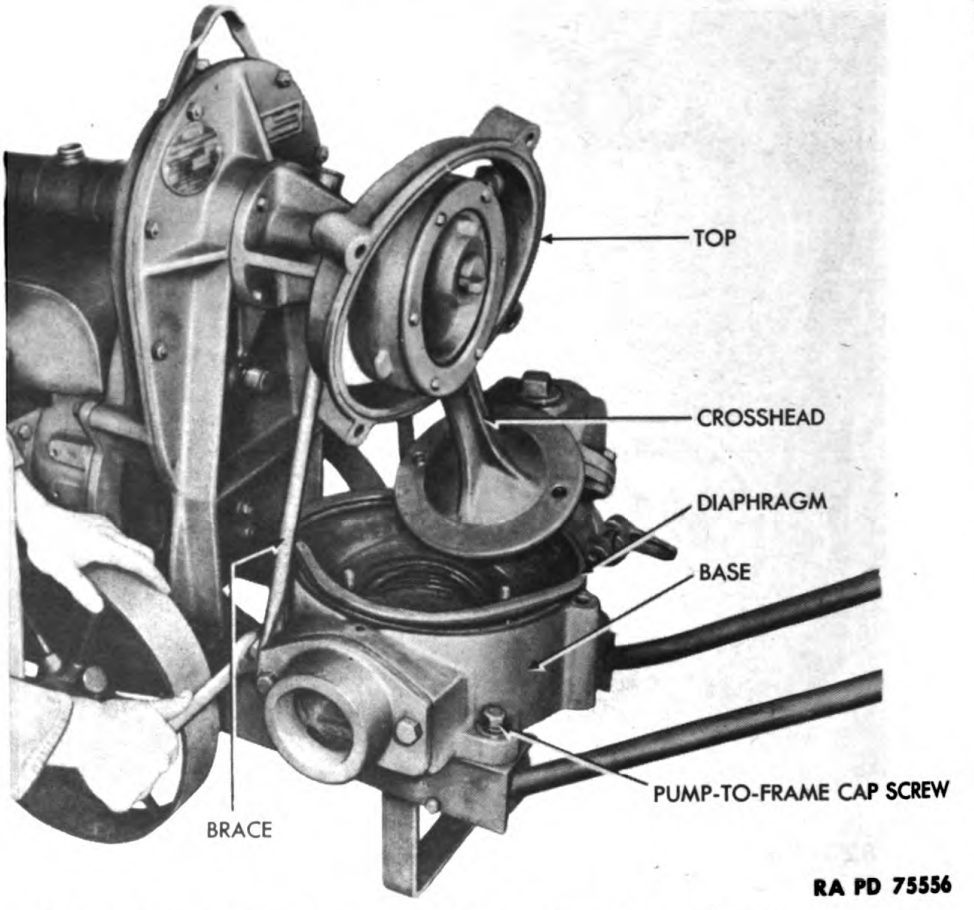



***Figure 83 — Removing Gasoline Engine-driven Diaphragm Pump From Frame***

(3) Remove the two cap screws and flat washers which secure discharge flange to pump base. Lift flange and gasket from base. Remove the two screws which secure flap type discharge valve to discharge flange. Lift valve from flange. To remove rubber from valve, remove the two cap bolts and nuts which clamp rubber between two plates.

(4) Remove the two cap screws and lock washers which secure suction flange to pump base. Lift flange and gasket from base. Remove the two screws which hold flap type suction valve to flange. Lift valve from flange. To remove rubber from valve, remove the two brass nuts and cap bolts which clamp rubber between two plates.

**c. Assembly of Pump (fig. 84).**

(1) Assemble suction valve by placing iron plate, rubber flap, and remaining iron plate on two cap bolts. Tighten cap bolt nuts on



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bolts. Attach suction valve to suction flange with washer and two screws. Place gasket and suction flange in position on pump base, and install the two cap screws and lock washers which secure flange to base.

(2) Assemble discharge valve by placing iron plate, rubber flap, and remaining iron plate on two cap bolts. Tighten cap bolt nuts on cap bolts. Place discharge valve in position on discharge flange, and install washer and the two screws which secure valve to flange. Place gasket and discharge flange in position on pump base and install the two cap screws and flat washers which secure flange to base.

(3) Place gasket and upper portion of discharge flange in position on lower portion of discharge flange. Install the two cap screws and flat washers which secure upper portion to lower portion.

(4) Place clean-out door in position on studs on discharge flange. Install two washers and handle nuts.

NOTE: Diaphragm and pump top are assembled during installation of pump, below.

**d. Installation of Pump** (fig. 83).

(1) Place pump in position on frame and install the four bolts, lock washers, and nuts which secure pump to frame.

(2) Slide pump top, upper side first, over cross head and up onto eccentric. Place diaphragm in position on diaphragm casting studs. Insert diaphragm in pump base and swing cross head down over diaphragm. Work diaphragm casting studs through holes in cross head base. Install two brass nuts on diaphragm casting studs. *NOTE: If difficulty is experienced in starting the two stud nuts which clamp diaphragm between plunger bottom casting and cross head, remove the six nuts, lock washers, and bolts which hold cross head side plates to cross head. Then slide cross head from eccentric. Install diaphragm and then replace cross head on eccentric.*

(3) Pull down pump top into position on pump base, and install the four washers and cap screws which secure top to base.

(4) Install the two lock washers and cap screws which secure the two braces to pump base.

**e. Removal of Engine.**

(1) Remove the three cap screws and lock washers which secure engine to gear box.

(2) Remove the four nuts, lock washers, and cap bolts which secure engine to frame.

(3) Pull engine away from gear box until splined shaft is clear. Lift engine from frame.



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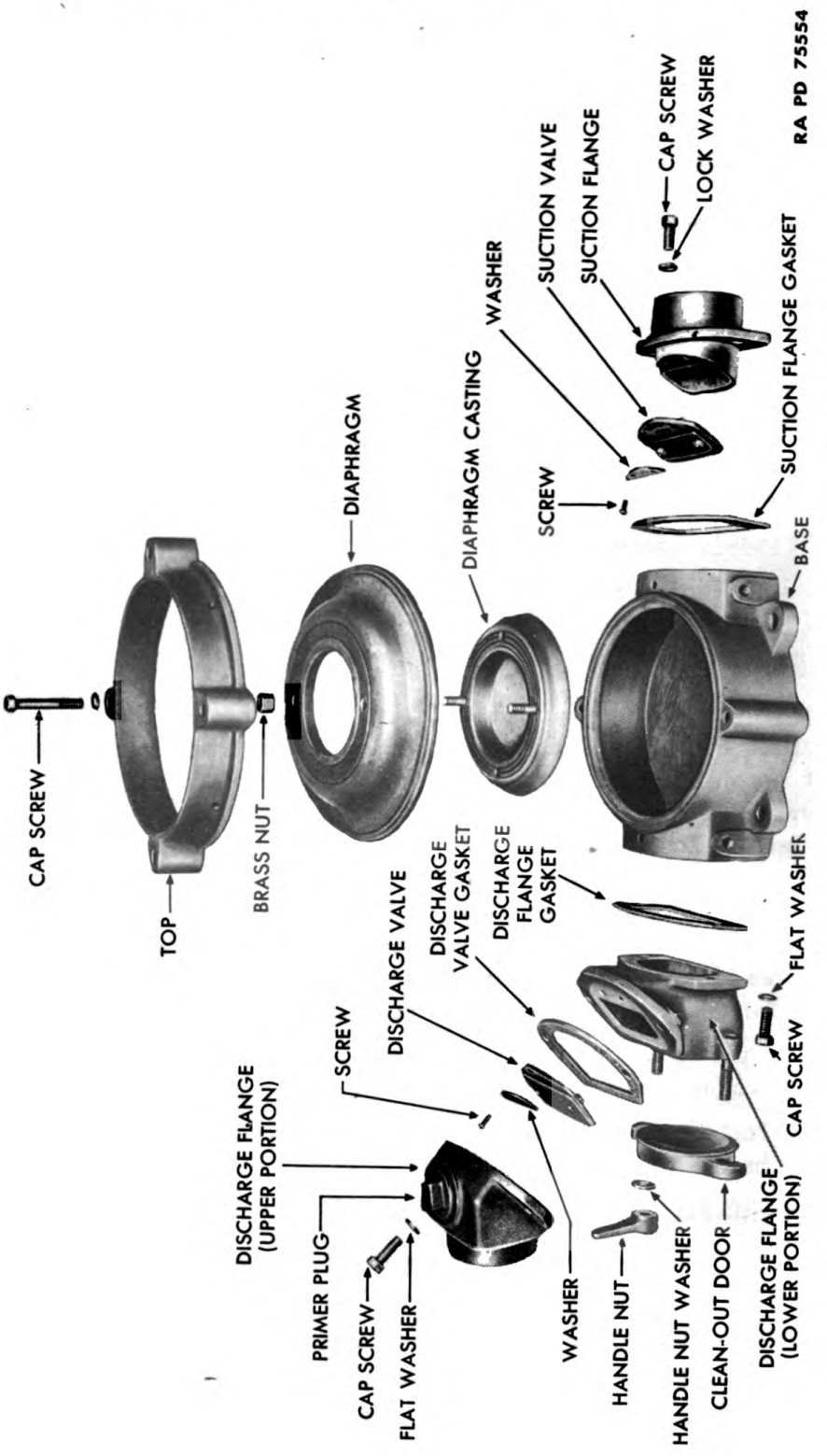



*Figure 84 — Engine-driven Diaphragm Pump — Exploded View*



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**f. Installation of Engine.**

(1) Place engine on frame to rear of normal position. Push engine forward, toward gear box, until splined shaft is engaged and the hold-down bolt holes of engine and frame are alined.

(2) Install the four cap bolts, lock washers, and nuts which secure engine to frame.

(3) Install the three lock washers and cap screws which secure engine to gear box.

**g. Removal of Carburetor** (fig. 80).

(1) Disconnect throttle control rod from carburetor. Use pliers to remove cotter key.

(2) Turn off shut-off cock on fuel filter and disconnect gasoline line from carburetor.

(3) Remove the two carburetor-to-manifold stud nuts and lock washers.

(4) Lift carburetor and gasket from intake manifold.

**h. Installation of Carburetor** (fig. 80).

(1) Place gasket and carburetor in position on intake manifold, and install the two carburetor-to-manifold lock washers and stud nuts.

(2) Connect throttle control rod to carburetor throttle lever. Use new cotter key.

(3) Connect gasoline line to carburetor.

(4) Open shut-off cock on fuel filter and inspect installation for leaks.

**i. Removal of Magneto.**

(1) Pull spark plug wire from tower on magneto cover.

(2) Remove the two cap screws which attach magneto to crankcase, and lift magneto from crankcase.

**j. Installation and Timing of Magneto.**

(1) Remove spark plug and hold thumb over spark plug hole. Crank engine slowly until pressure is felt on thumb. Piston is then coming up on compression stroke. Continue to crank slowly until piston is at highest position, top dead center. If engine is removed, top dead center is easily discernible by position of keyway in crankshaft, straight up.

(2) Turn magneto shaft slowly in direction of rotation, counterclockwise, and note position at which impulse trips (indicated by clicking sound).

(3) Hold magneto in impulse-trip position, place pinion in mesh with cam gear, and install the two cap screws which secure magneto to crankcase.



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(4) Hold spark plug wire about ⅛ inch from cylinder head and slowly crank engine. Observe position of piston, through spark plug opening, when spark occurs. If spark occurs before piston reaches top dead center, disengage magneto and set it back one tooth on the gear. If spark occurs late, after top dead center, set it ahead one tooth. Bear in mind that the magneto pinion rotates left, counterclockwise.

(5) After satisfactory timing is attained, install spark plug and connect spark plug wire.

## 62. INSPECTION INSTRUCTIONS.

**a. Before Starting Engine.**

(1) Fuel tank should be filled with gasoline.

(2) Check oil level in crankcase. Add engine oil to crankcase if it fails to drip from cock. Close cock after checking.

(3) Open oil cock on gear case on carburetor side. Add oil to gear case if oil fails to drip from cock. Close cock after checking.

(4) Note position of pump. It should be approximately level to ensure efficient pump operation and proper engine and gear lubrication.

**b. After Starting Engine.** Note position of carburetor choke lever to be sure it is open (pointing toward flywheel).

**c. Daily.**

(1) Check sediment bowl below gasoline tank. Remove and clean bowl if sediment or water bubbles are visible.

(2) Check tightness of all bolts and nuts. Tighten loose nuts.

(3) Inspect castings for cracks.

## 63. CARE, CLEANING, AND LUBRICATION.

**a. Care and Cleaning.**

(1) PUMP. After each use of pump, remove clean-out plate from discharge flange and clean out foreign matter. Flush with clean water. Wash exterior of pump with clean water. Flush out suction hose, discharge hose, and foot valve with clean water.

(2) ENGINE.

*(a) Removal of Lead Deposits.* After each 50 hours' use, remove carbon deposits from cylinder by water injection method as outlined in paragraph 82 a (3).



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*(b) Care of Spark Plug.*

*1.* Wipe dirt and moisture from spark plug.

*2.* After each 50 hours of operation, remove spark plug. Clean on a sandblast machine. Adjust point so gap is 0.025 inch. Inspect plug carefully. Replace if defective.

*(c) Care of Fuel System.* Keep fuel tank clean. Keep a clean container to be used only for filling fuel tank. Keep container covered when not in use. Remove shut-off cock under tank occasionally and clean screen in SOLVENT, dry-cleaning. Drain water from tank weekly in cold weather. Keep tank as nearly full as possible.

**b. Lubrication.**

(1) PUMP. There are no lubrication points on the pump proper.

(2) GEAR BOX.

*(a)* There are three grease cups on the power train. One is on the eccentric boss of the cross head, another is on the eccentric shaft housing, and the other is located in the approximate center of the gear box on the pump side. Daily, turn each cup down two or three turns. Never allow any cup to become empty. Use GREASE, general purpose, No. 2.

*(b)* After every 50 hours' use, remove drain plug on pump side of gear box and drain gear box completely. Replace plug and refill gear box to level of oil on carburetor side of gear box. Fill by removing filler plug on top of gear box. Use OIL, engine, SAE 30. Check oil level daily and add as necessary to maintain level.

(3) WHEELS. Fill grease cups on wheel hubs with GREASE, general purpose, No. 2, whenever necessary. Turn cups down one turn every day pump is used.

(4) ENGINE.

*(a)* Drain crankcase, after cleaning carbon deposits (par. 82 a (3) ) following each 50 hours' use, by removing drain plug on carburetor side of crankcase. Replace plug after draining is complete. Fill crankcase to level of cock over drain plug, through filler on magneto side of engine. Capacity is approximately one pint. Select oil from chart below.

| Temperature | Viscosity Oil |
|---|---|
| +32 F or over | SAE 30 or 50 |
| +32 F to 0 F | SAE 10 |

*(b)* Once a week, or oftener, squirt OIL, engine (crankcase grade), on fulcrum points of carburetor throttle and choke control linkage.

*(c)* Every 200 hours' operation, fill oiler on outside of magneto to overflowing with high quality OIL, engine, SAE 10.



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Section IV

# PORTABLE GASOLINE ENGINE-DRIVEN CENTRIFUGAL PUMP

## 64. DESCRIPTION AND FUNCTIONING.

### a. Description.

(1) PUMP (fig. 85). Conventional centrifugal pumps consist of an impeller in a housing with packing around the impeller shaft and a check valve on the water intake. It is designed so that around the inside of the impeller shaft packing there is a pressure water seal. Wear plates are installed on both sides of the impeller. Their purpose is to compensate for impeller wear. They are adjustable and removable. The housing is designed with a removable outer pump

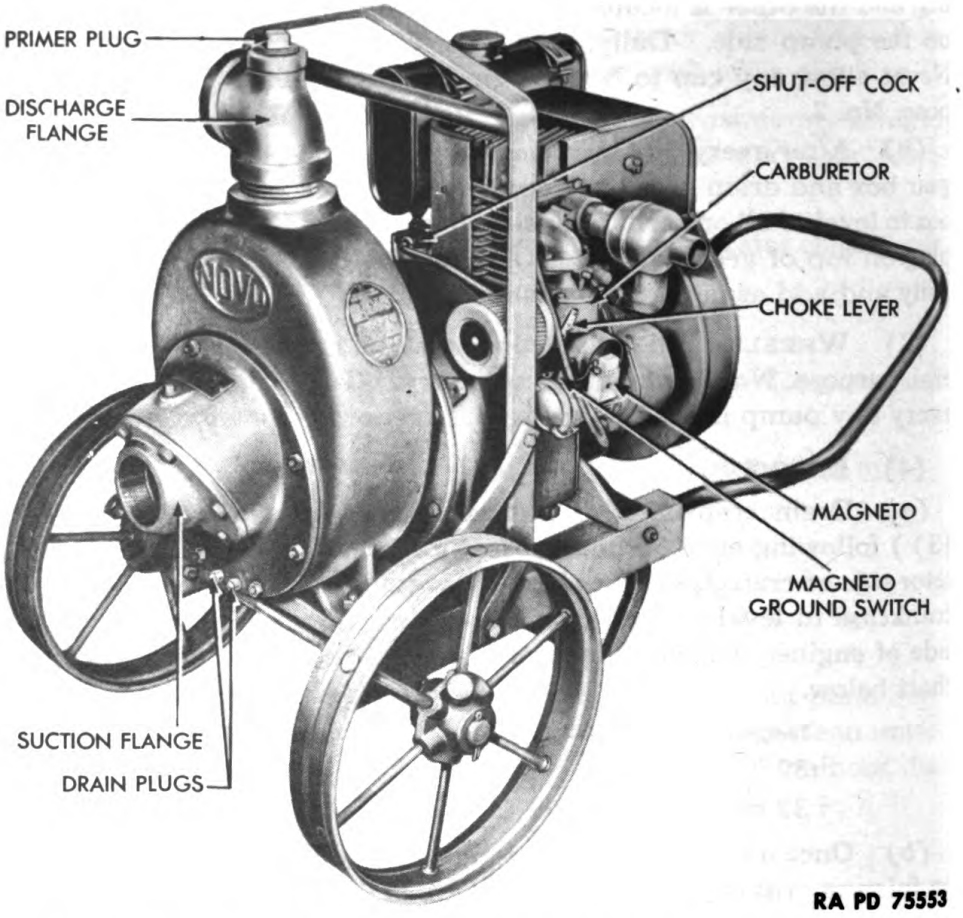



*Figure 85 — Portable Gasoline Engine-driven Centrifugal Pump*



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## WATER PUMPING EQUIPMENT

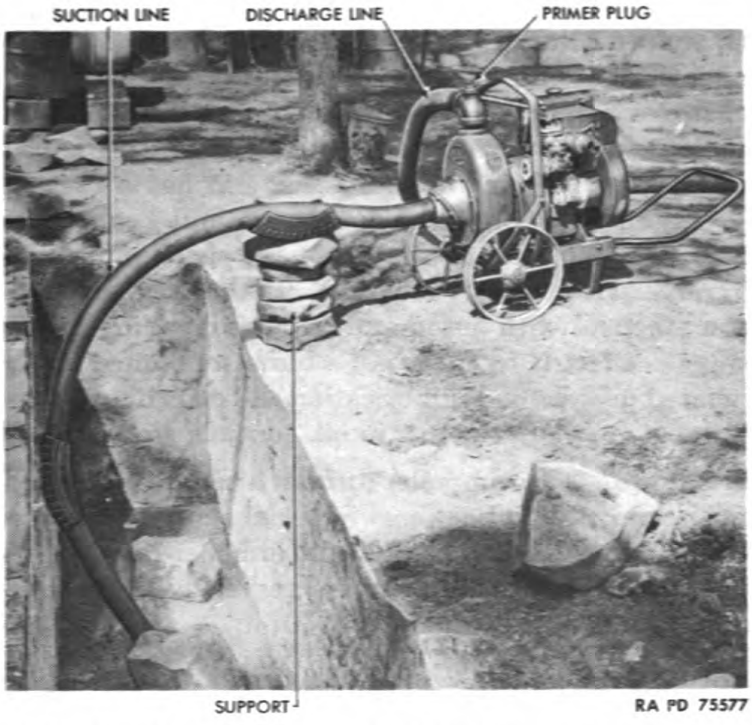



***Figure 86 — Portable Gasoline Engine-driven Centrifugal Pump in Operation***

plate to provide for removal of the impeller with a minimum of disassembly. Capacity of the pump, in gallons per minute, is given in the following table:

| Total Head Including Friction | HEIGHT OF PUMP ABOVE WATER | | | |
|---|---|---|---|---|
| | 10 ft | 15 ft | 20 ft | 25 ft |
| 20 ft | 250 | .... | .... | .... |
| 25 ft | 245 | 210 | 170 | .... |
| 30 ft | 235 | 205 | 165 | 130 |
| 40 ft | 215 | 190 | 160 | 125 |
| 50 ft | 185 | 165 | 145 | 120 |
| 60 ft | 135 | 130 | 125 | 105 |
| 70 ft | 65 | 65 | 65 | 60 |



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(2) GASOLINE ENGINE (fig. 85). A 4- to 5-horsepower, single cylinder, air-cooled, gasoline engine operates the pump. Bore is 3¼ inches and stroke is 4 inches. Compression ratio is five to one. A cast iron piston with two compression rings and one oil ring is used. Cylinder is cast separate from the crankcase and has a cast aluminum alloy detachable head. Crankshaft and camshaft bearings are roller type. The connecting rod has a bronze bush piston pin bearing and a babbitted crankshaft bearing. Helical tooth timing gears are used. A high-tension magneto with automatic impulse coupling provides ignition. Cooling is effected by means of a blower mounted on the crankshaft. A geared oiler provides lubrication. A centrifugal, flyball type, totally enclosed governor, running in oil, controls engine speed.

**b. Functioning.** The impeller turns at a high rate of speed. Water entering at the impeller hub is thrown past the outer circumference of the impeller building up a pressure in the impeller housing. An opening, provided in the top of the housing, serves as a discharge outlet. Prime pump when starting.

## 65. OPERATION (fig. 86).

**a.** Place pump as near water to be pumped as possible but not more than 25 feet above supply. To facilitate engine lubrication, place the pump as nearly level as possible.

**b.** Connect suction and discharge lines to pump. The suction line must be airtight. Never use lines smaller than the pump opening; use line larger than opening of pump if line is long. Support lines independent of pump to avoid strain or misalinement. Install suction strainer on end of suction line and submerge in water to be pumped.

**c.** If pump is empty, remove primer plug on top of discharge flange. Fill pump with water and install primer plug.

**d. Start Engine as Follows.**

(1) Open shut-off cock (fig. 85) on gasoline filter under gasoline tank.

(2) Close choke by turning choke lever counterclockwise while cranking engine. After two or three turns of crank, allow choke to snap open. Continue cranking until engine starts.

**e.** Permit pump to operate a reasonable length of time to pick up and start pumping.

**f.** Do not allow pump to operate empty. When pumping operation is completed, stop pump by pressing magneto ground switch (fig. 85). If freezing weather is anticipated, drain pump by removing plugs (fig. 85) below suction flange.



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## WATER PUMPING EQUIPMENT

# 66. MALFUNCTIONS AND CORRECTIONS.

## a. Trouble Shooting.

| Symptom | Cause | Remedy |
|---|---|---|
| (1) Pump fails to operate satisfactorily. | *(a)* Insufficient supply of water. | *(a)* Use a diaphragm type pump (par. 59). |
| | *(b)* Suction lift in excess of 25 feet. | *(b)* Install pump with maximum of 25 feet vertical lift. |
| | *(c)* Suction line or strainer clogged. | *(c)* Clean suction line and/or strainer. |
| | *(d)* Pump operating too slowly. | *(d)* Check engine speed. Adjust governor, if necessary, to obtain 1750, rpm (par. 66 **b** (4) ). |
| | *(e)* Air leak in suction line. | *(e)* Remove suction line. Plug hole of suction flange with rubber packing. Fill pump with water and operate at normal speed. Observe suction gage on top of suction flange. If gage climbs to 20 inches vacuum, or higher, and holds steady, a leak in suction line is indicated. Repair or replace suction line (par. 65). |
| | *(f)* Leak past water packing. | *(f)* Test as outlined for "Air leak in suction line," above. If gage reads 0, or climbs up and breaks back to 0, an air leak past the packing is indicated, remove and inspect packing (par. 67 **a**). Repair or replace old packing with new. |
| | *(g)* Worn plates, impeller, or pump case. | *(g)* Test as outlined for "Air leak in suction line," above. If gage holds steady but registers under 20 inches vacuum, too much clearance, due to worn wear plates, impeller, or pump case, is indicated. Replace wear plates and impeller to correct the condition (par. 67 **a**). |



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## ORDNANCE MAINTENANCE — MAINTENANCE OF BOMB DISPOSAL EQUIPMENT FOR ACCESS AND STERILIZATION

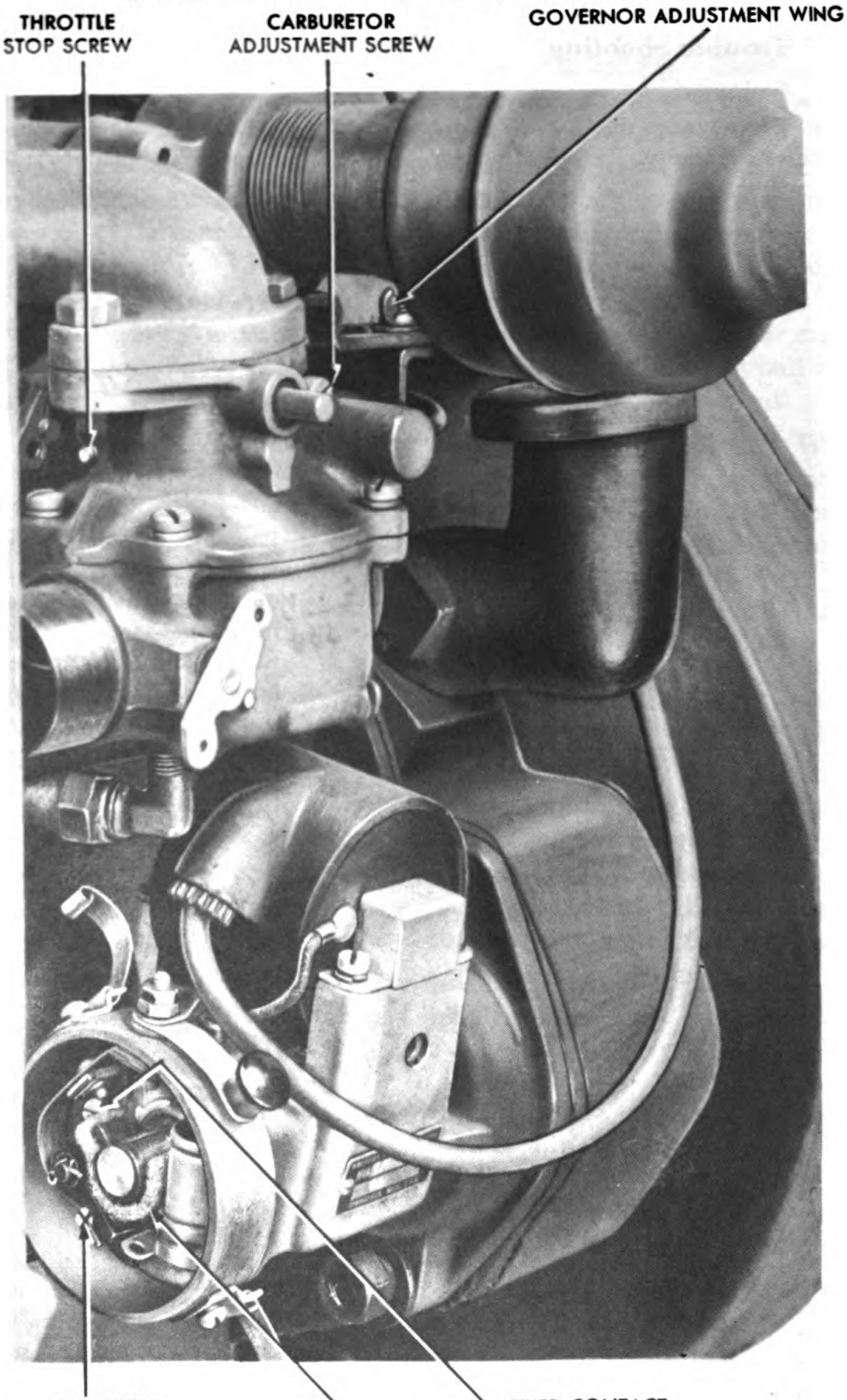



***Figure 87 — Centrifugal Pump Engine Adjustment Provisions***



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## WATER PUMPING EQUIPMENT

| Symptom | Cause | Remedy |
|---|---|---|
| | (h) Lack of sufficient priming water in pump case. | *(h)* Fill pump with water (par. 65 c). Notice if water runs out suction line. Leakage of water through suction line indicates faulty suction valve. Inspect valve by removing suction flange. Remove any worn or damaged valve (par. 67 a). |

### b. Engine.

(1) ADJUSTMENT OF CARBURETOR.

*(a) Needle Valve Adjustment* (fig. 87). Run engine until thoroughly warm. Turn knurled adjusting screw, on carburetor next to exhaust pipe, clockwise until engine slows down. Back screw out until engine resumes governed speed and runs smoothly.

*(b) Throttle Valve Adjustment* (fig. 87). Run engine until thoroughly warm. Pull throttle control rod toward blower end of engine. Turn throttle stop screw, on carburetor next to engine, in or out, to obtain desired idling speed.

(2) ADJUSTMENT OF VALVE TAPPETS (fig. 87).

*(a)* Run engine until thoroughly warmed up.

*(b)* Remove cap screw which secures tappet cover plate to cylinder head behind carburetor. Lift cover plate and gasket from cylinder head.

*(c)* Loosen tappet adjusting screw lock nut.

*(d)* Insert a 0.012- to 0.015-inch feeler gage between bottom of valve stem and top of tappet adjusting screw. Turn screw down into tappet or out of tappet until just a slight drag is discernible on feeler gage. Be sure valve is closed during adjustment. Tighten lock nut.

*(e)* Repeat steps *(c)* and *(d)*, above, to adjust other tappet.

*(f)* Replace cover plate and gasket and tighten cap screw.

(3) ADJUSTMENT OF MAGNETO BREAKER POINTS (fig. 87).

*(a)* Loosen both spring clips and lift breaker point cover and gasket from magneto.

*(b)* Loosen fixed contact set screw.

*(c)* Adjust eccentric screw until clearance of 0.015 inch exists between points while movable contact is held open by lobe on cam.

*(d)* Tighten fixed contact set screw and replace breaker point cover and gasket.

(4) ADJUSTMENT OF GOVERNOR (fig. 87). Governor speed is adjusted by the tension of the spring on throttle rod. To adjust: Loosen



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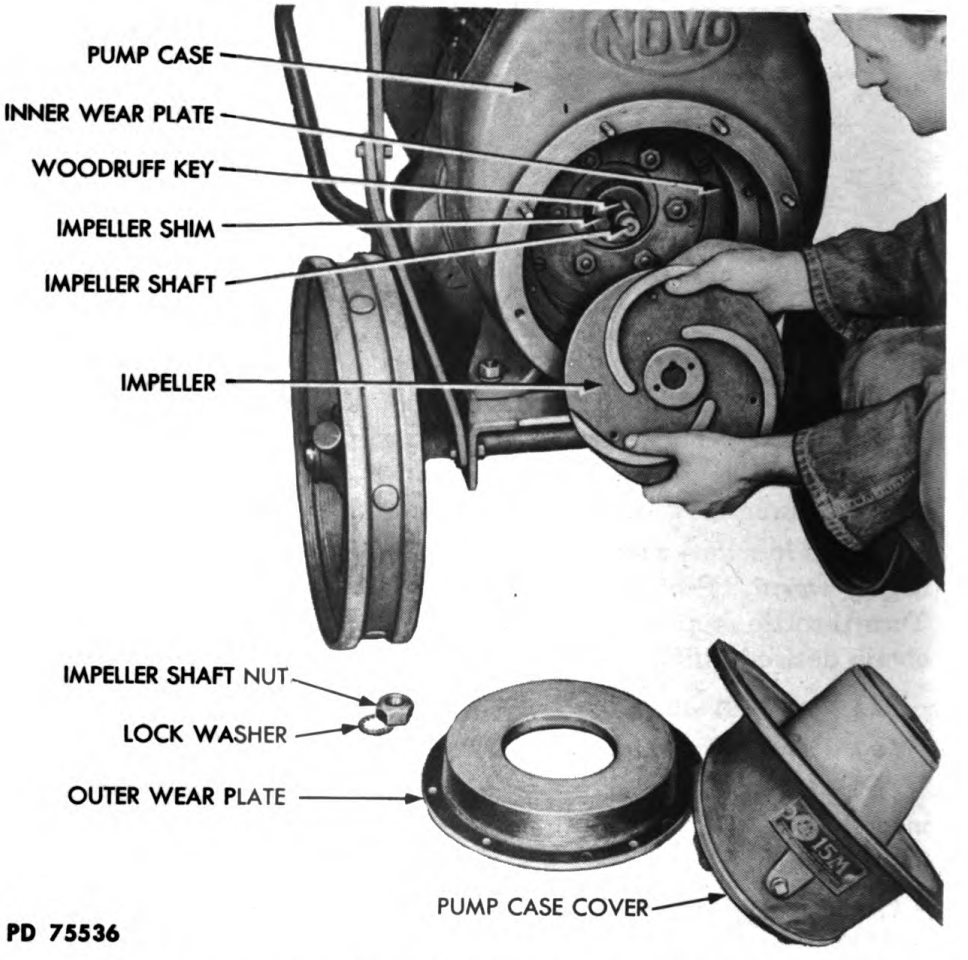



***Figure 88 – Removing Engine-driven Centrifugal Pump Impeller***

wing nut on spring bracket and slide movable part of bracket along stationary part. Increasing spring tension increases engine speed. Tighten wing nut when desired speed is obtained.

## 67. DISASSEMBLY AND ASSEMBLY.

### a. Disassembly and Removal of Pump (fig. 90).

NOTE: It is necessary to remove suction flange and valve assembly, outer wear plate, impeller, and packing before pump can be removed from frame.

(1) Remove the eight stud nuts which secure pump case cover (fig. 88) to pump case. Lift cover and gaskets from case. Remove the six stud nuts which secure suction flange to cover. Lift flange and valve from cover. Disassemble valve by removing cap bolt, nut, and washer which clamp rubber between two plates (small plate on outside).



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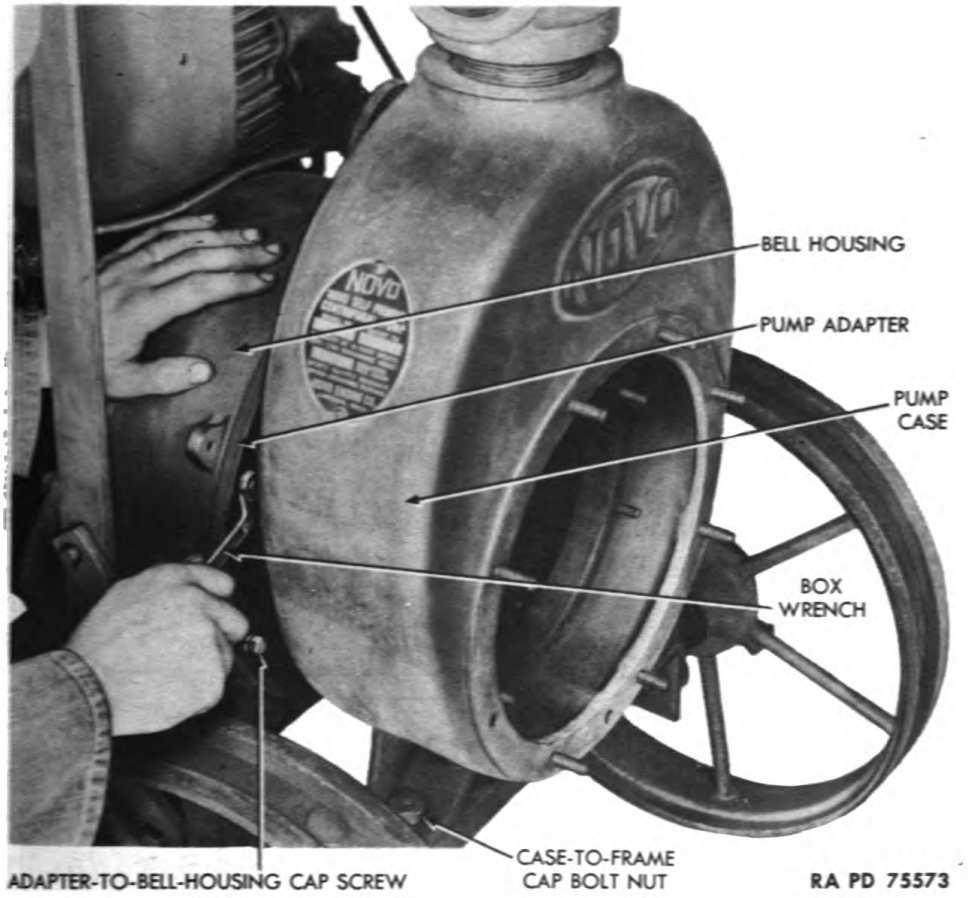



***Figure 89 — Removing Engine-driven Centrifugal Pump Case***

(2) Remove the eight stud nuts which attach outer wear plate (fig. 88) to pump case. Lift plate and shims (if any) from case.

(3) Remove impeller shaft nut (fig. 88) and lock washer.

(4) Pull impeller from impeller shaft.

(5) Tap Woodruff key (fig. 88) from keyway in impeller shaft. Lift impeller shim and packing thrust washer from shaft.

(6) Lift rubber packing from packing sleeve.

(7) Remove the six brass screws which attach inner wear plate (fig. 88) to pump case. Lift inner wear plate from case.

**NOTE:** Further disassembly is unnecessary for replacement of all wearing parts; namely, impeller, wear plates, suction valve, rubber packing, and gaskets.

(8) Remove discharge flange from pump case. Remove primer plug from discharge flange.



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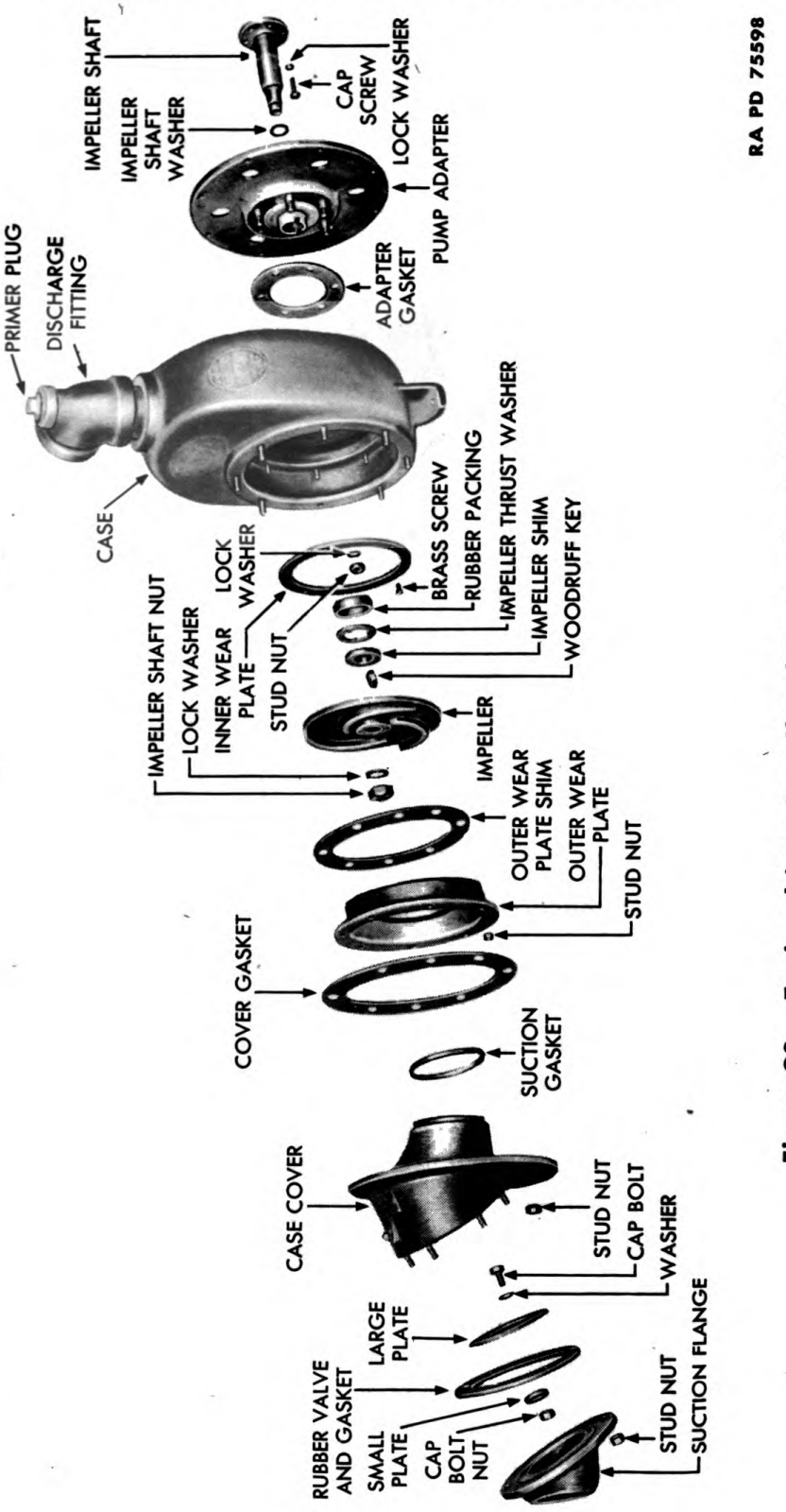



***Figure 90 — Engine-driven Centrifugal Pump — Exploded View***



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(9) Remove the eight cap screws and lock washers which attach pump adapter to engine bell housing.

(10) Remove the two cap bolts, nuts, and lock washers which secure pump case to frame. Lift pump case from frame.

(11) Remove the six stud nuts and lock washers which attach pump adapter to pump case. Lift adapter from case.

(12) Remove the six cap screws and lock washers which secure impeller shaft to engine flywheel. Lift shaft from flywheel.

**b. Installation and Assembly of Pump** (fig. 90).

NOTE: Pump must be installed during process of assembling.

(1) Tap impeller shaft into position on engine flywheel. Be sure to aline cap screw holes in shaft flange and flywheel. Install the six lock washers and cap screws which secure shaft to flywheel. Place impeller shaft washer on impeller shaft.

(2) Place gasket and pump adapter in position on engine side of pump case. Install the six lock washers and stud nuts which attach adapter to case.

(3) Place pump case in position on frame and install the two cap bolts, lock washers, and nuts which secure case to frame.

(4) Install eight lock washers and cap screws which hold pump adapter to engine bell housing.

(5) Screw discharge flange into opening on top of pump case. Screw primer plug into discharge flange.

(6) Place inner wear plate in position inside pump case. Install the six brass screws which secure plate to case.

(7) Place rubber packing on packing sleeve around impeller shaft inside pump case.

(8) Place packing thrust washer and impeller shim on end of impeller shaft. Tap Woodruff key into keyway in end of impeller shaft.

(9) Tap impeller onto impeller shaft. Be sure to lineup keyway in impeller with Woodruff key in shaft.

(10) Install impeller shaft lock washer and nut on end of impeller shaft.

(11) Place outer wear plate in position on interior of pump case. Place outer wear plate shim under wear plate unless pump parts have seen considerable use. In that case, omit shim to compensate for wear. Install the eight stud nuts which hold wear plate to case. Turn impeller by hand. If drag is felt, remove wear plate and add shim. Repeat installation of wear plate and test until impeller just turns without drag.

(12) Assemble suction valve by placing washer, large plate, rubber valve, and small plate on cap bolt. Tighten nut on cap bolt. Place



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valve in position on studs on oblique side of case cover. Be sure large plate is toward case cover and that valve swings from top. Place suction flange on same studs. Install six stud nuts securely. Place suction gasket on boss on inside of case cover. Place cover gasket on studs on pump case (openings in gaskets for drain plugs at the bottom). Place entire case cover assembly in position on pump case studs, using new cover gasket. Install eight stud nuts which clamp case cover to case.

**c. Removal of Engine.**

(1) Remove impeller and packing from pump (subpar. **a**, above).

(2) Remove the eight cap screws and lock washers which secure pump adapter to engine bell housing.

(3) Remove four cap bolts, nuts, and lock washers which secure engine to frame.

(4) Slide engine away from pump and lift from frame.

**d. Installation of Engine.**

(1) Place engine on frame and slide toward pump until in position. Install four cap bolts, lock washers, and nuts securing engine to frame.

(2) Install eight lock washers and cap screws which secure pump adapter to engine bell housing.

(3) Install packing thrust washer, shim, Woodruff key, impeller, wear plate, case cover, and suction flange on pump (subpar. **b**, above).

**e. Removal of Carburetor** (fig. 91).

(1) Remove air cleaner from carburetor.

(2) Disconnect throttle control rod from carburetor. Use pliers to remove cotter key.

(3) Turn off shut-off cock on fuel filter below gasoline tank and disconnect fuel line from carburetor.

(4) Remove the two carburetor-to-manifold cap screws and lift carburetor and gasket from manifold.

**f. Installation of Carburetor** (fig. 91).

(1) Using a new gasket, place carburetor in position on intake manifold. Install the two carburetor-to-manifold cap screws.

(2) Using a new cotter key, connect throttle control rod to carburetor throttle lever.

(3) Connect fuel line to carburetor. Turn on gasoline shut-off cock on fuel filter and check installation for leaks.

(4) Install air cleaner on carburetor.



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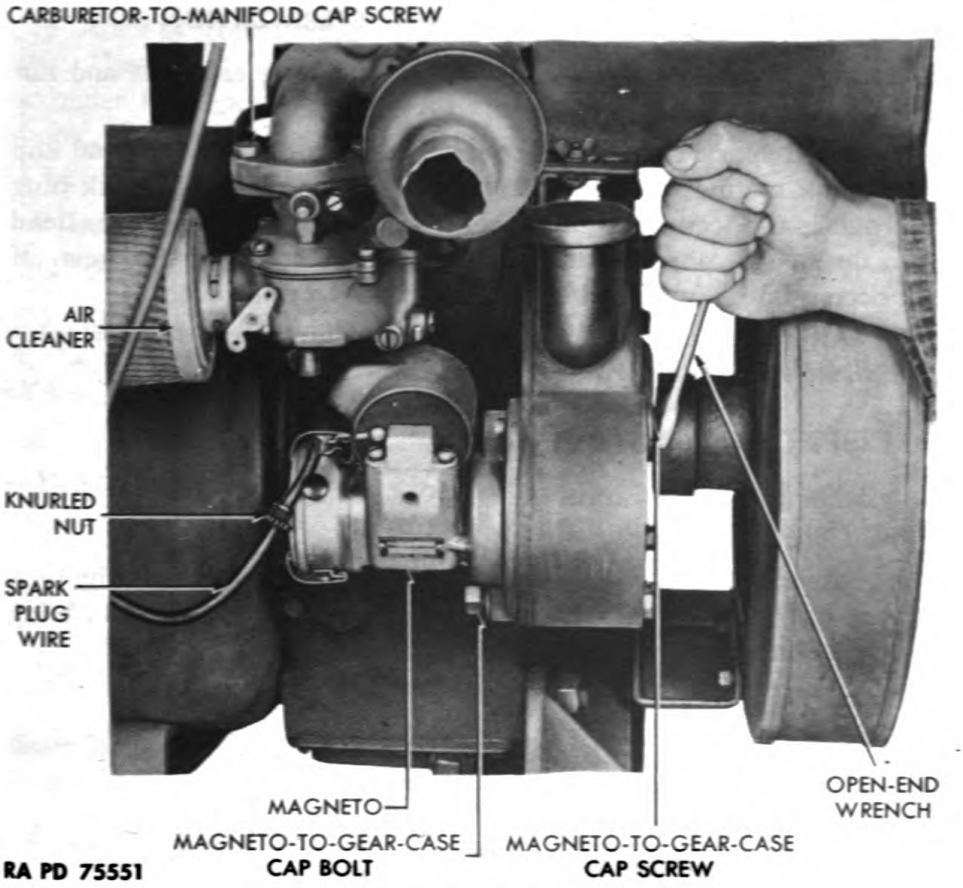



***Figure 91 — Removing Centrifugal Pump Engine Magneto***

**g. Removal of Magneto** (fig. 91).

(1) Unscrew knurled bakelite nut which holds spark plug wire to magneto. Pull spark plug wire from tower on magneto.

(2) Remove the long cap screw and long cap bolt and nut which hold magneto flange to gear case. Lift magneto from gear case.

**h. Installation and Timing of Magneto** (fig. 91).

(1) Remove spark plug. Holding thumb over spark plug hole, slowly crank engine until pressure is discernible on the thumb. Piston is then coming up on compression stroke. Continue to crank slowly until piston reaches top dead center (highest position). If engine is removed from unit, top dead center is discernible by position of keyway in crankshaft straight up.

(2) Turn magneto shaft slowly in direction of rotation and note position at which impulse trips (indicated by clicking sound).

(3) Hold magneto in impulse trip position, place pinion in mesh



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with cam gear, and install the cap screw and long cap bolt and nut which secure magneto to gear case.

(4) Hold spark plug wire about ⅛ inch from cylinder head and slowly crank engine. Observe position of piston, through spark plug hole, when spark occurs. If spark occurs before piston reaches top dead center, disengage magneto and set it back one tooth on the gear. If spark occurs late, after dead center, set it ahead one tooth.

(5) After satisfactory timing has been attained, install spark plug and connect spark plug wire.

## 68. INSPECTION INSTRUCTIONS.

### a. Before Starting Engine.

(1) Check fuel supply.

(2) Measure quantity of engine oil in crankcase as shown by bayonet type gage under fuel tank. Add seasonal oil if necessary to bring to notch on bayonet stick.

### b. Periodically.

(1) Check sediment bowl below fuel tank. Remove and clean bowl if sediment or water bubbles are visible.

(2) Check tightness of all bolts and nuts. Tighten loose nuts.

(3) Inspect castings visually to see if any are cracked.

## 69. CARE, CLEANING, AND LUBRICATION.

### a. Care and Cleaning.

(1) PUMP. After completing a pumping job, remove drain plugs under suction flange and drain pump. Flush with clean water. Install drain plugs. Wash pump exterior with clean water. Flush suction and discharge lines and suction strainer with clean water.

(2) ENGINE.

*(a) Removal of Carbon.* Following each 50 hours of operation, remove carbon from engine cylinder by water injection method given in paragraph 82 a (3).

*(b) Care of Spark Plug.* Wipe dirt and moisture from exterior of spark plug porcelain whenever present. After each 50 hours operation, remove spark plug. Clean in sandblast. Adjust points to 0.025 inch. Inspect plug closely. Replace plug if porcelain is chipped, burned, or broken, or if points are defective.

*(c) Cleaning Air Cleaner.* Remove air cleaner from carburetor and clean in SOLVENT, dry-cleaning. Dry thoroughly and install on carburetor.



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*(d) Care of Fuel System.* Keep fuel tank clean and free of foreign matter. Use a clean container for filling fuel tank. Remove shut-off cock under tank occasionally and clean screen in SOLVENT, dry-cleaning. Drain possible condensate from tank in cold weather. Keep tank full.

**b. Lubrication.**

(1) PUMP. There are no lubrication points on the pump proper.

(2) WHEELS. Turn grease cup caps on hubs of wheels, a turn every day, when pump is in service. Fill caps when necessary with GREASE, general purpose, No. 2.

(3) ENGINE.

*(a)* Drain crankcase following each 35 hours' use, by removing drain plug on magneto side of oil pan. Allow to drain completely, then install drain plug. Capacity is 2¾ quarts. Fill through breather tube from gear case. Use viscosity given below:

| Temperature | Viscosity Oil |
|---|---|
| Above +32 F | SAE 30 |
| Below +32 F | SAE 10 |

*(b)* Once a week, or oftener, squirt OIL, engine (crankcase grade), on fulcrum points of carburetor throttle and choke control linkage.

*(c)* Every 100 hours of operation, remove magneto breaker point cover. Put a few drops of OIL, engine, SAE 30, on cam lubricating felt wick (fig. 87). Do not get oil on breaker points. Annually repack magneto bearings with GREASE, general purpose, No. 2. Do not get grease on breaker points.

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## Section V

# PNEUMATIC SUMP PUMP

## 70. DESCRIPTION AND FUNCTIONING (fig. 92).

**a. Description.** This centrifugal type pump is propelled by a governed rotary air motor. The vane-type air motor is secured to the top of a cast iron housing. An arbor couples the motor to the impeller at the bottom of pump housing. The three ball bearings support arbor and motor rotor. Shims under the impeller compensate for wear. Water to the pump enters through a cast iron grid inlet. Air for motor operation flows through a cylindrical screen-type air strainer. Lubricator fittings and an oil reservoir provide the means of lubrication.

**b. Functioning** (fig. 94). In operation, the air-driven motor turns the impeller at a high rate of speed. The lower part of the pump housing, containing the impeller, is submerged in water. As the im-



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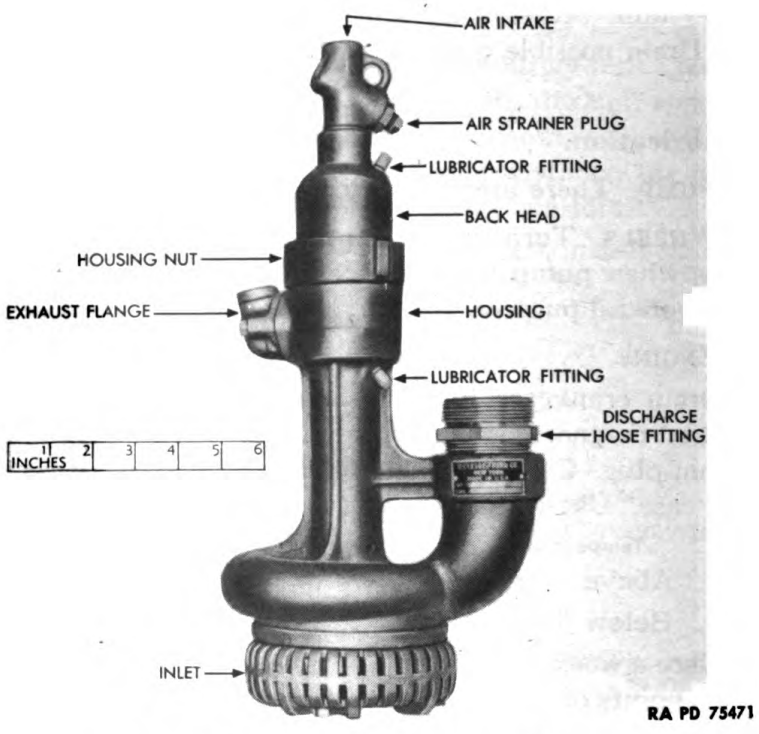



***Figure 92 — Pneumatic Sump Pump***

peller revolves, water enters the suction inlet and is discharged at hose outlet. This action is smooth and continuous throughout the period of operation.

## 71. OPERATION (fig. 93).

### a. Use of Pump.

(1) Lubricate pump (par. 75).

(2) Connect discharge hose to discharge hose fitting on housing.

(3) Connect exhaust hose to exhaust hose flange on side of housing near top. Tighten hose securely. This is important to prevent possibility of water being drawn back into air motor if pump should stop under water. Place free end of hose where it cannot fall into water.

(4) Blow out air hose. Connect air hose to air strainer body on top of pump. Tighten securely to prevent less of air or possible entry of water into air motor.

(5) Place a rock or board on which to rest base of pump in water to be pumped. This precaution will usually be sufficient to keep mud



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***Figure 93 — Pneumatic Sump Pump in Operation***

or gravel from entering pump. In exceptionally dirty water, place a screen box (to strain water) in position so pump can be placed inside it.

(6) Turn on air pressure. As soon as pump starts, submerge it in water on base previously prepared or suspend it a few inches from bottom of water.

(7) If pump is operated for extended periods, stop pump and lubricate it (par. 75) every 4 hours.

(8) To stop pump, lift it from water and quickly turn off air pressure. Do not allow to run free for any length of time.



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**b. Operation Precautions.**

(1) Never operate pump without exhaust hose.

(2) Always blow out air hose before connecting to pump.

(3) Never lower pump to bottom of dirty water. Always place pump on base or suspend a few inches from bottom.

(4) Never run pump for extended periods when not in water. There is danger of injuring water seals by frictional heat thus generated.

(5) Keep pump fully lubricated at all times.

## 72. MALFUNCTIONS AND CORRECTIONS.

**a. Trouble Shooting.**

| Symptom | Cause | Remedy |
|---|---|---|
| (1) Pump slows down or operates inefficiently. | *(a)* Insufficient source of air pressure. | *(a)* Connect pump to source of air capable of maintaining 80 to 90 pounds during operation. |
| | *(b)* Air hose too small. | *(b)* Use air hose having inside diameter of ¾ inch or larger. |
| | *(c)* Air strainer plugged. | *(c)* Turn off air. Remove air strainer plug. Turn air on momentarily. Install plug (par. 73). |
| | *(d)* Pump insufficiently lubricated. | *(d)* Lubricate pump (par. 75). |
| | *(e)* Impeller badly worn. | *(e)* Adjust (subpar. b, below) or replace impeller. |
| (2) Pump operation continues but water discharge falls off. | *(a)* Inlet not completely submerged. | *(a)* Submerge inlet (par. 70). |
| | *(b)* Inlet clogged. | *(b)* Lift pump from water and stop motor. Water running back through discharge hose will usually clean inlet. If water is very dirty, protect pump with a suction screen (par. 71). |
| (3) Pumps fails to start or runs improperly. | *(a)* Gravel wedged around impeller. | *(a)* Remove inlet, impeller cover, and impeller (par. 73). Remove gravel and assemble pump (par. 73). |



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WATER PUMPING EQUIPMENT

| Symptom | Cause | Remedy |
|---|---|---|
| | *(b)* Governor valve fouled with dirt and sticking in bushing. | *(b)* Remove air strainer body (par. 73). Clean all dirt from valve and assemble parts (par. 73). |
| | *(c)* Motor vanes swollen or warped and sticking in cylinder. | *(c)* Remove and disassemble motor (par. 73). Inspect vanes. They should fit freely in slots in rotor and should be no longer than rotor. If necessary, dress down to size with stone. Use extreme care. Do not remove more metal than necessary. Assemble and install motor (par. 73). |

**b. Adjustment of Impeller.**

(1) When made, clearance between impeller cover and impeller is set at about 0.010 inch. Wear increases this clearance, and when $\frac{1}{32}$ inch, remove inlet and cover (par. 73) and take out enough shims from under impeller cover to reduce clearance to about 0.010 inch. Place impeller cover in position and rotate impeller by hand to be sure they do not rub. When approximate adjustment is obtained, install impeller cover and inlet (par. 73).

(2) To adjust impeller to maintain $\frac{1}{64}$-inch clearance between reverse side of impeller and housing, disassemble pump (par. 73), remove enough shims (fig. 94) to give $\frac{1}{64}$-inch clearance, and assemble pump (par. 73).

**c. Adjustment of Oiler.** Pump motor should use about $\frac{1}{2}$ teacup of oil each half day. It is important to maintain this rate. Too little oil used means insufficient lubrication; too much oil used means wasted lubricant. To adjust:

(1) Remove back head (par. 73).

(2) Adjust oil adjusting screw on under side of back head beneath oil chamber plug. To reduce flow, turn clockwise. To increase flow, turn counterclockwise.

(3) Install back head (par. 73).

## 73. DISASSEMBLY AND ASSEMBLY.

**a. Disassembly** (figs. 94 and 95).

(1) REMOVE AND DISASSEMBLE AIR STRAINER.

*(a)* Screw air strainer body from boss on top of back head. Lift air strainer from back head.



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*(b)* Screw air strainer plug from air strainer cap. Screw air strainer cap from air strainer body. Pull air strainer screen from air strainer body.

(2) REMOVE AND DISASSEMBLE AIR MOTOR.

*(a)* Screw housing nut from housing. Lift air motor from housing.

*(b)* Lift seat retaining spring, governor valve spring seat, governor valve spring, and governor valve from boss on top of back head. Screw oil plug and lubrication fitting from back head.

*(c)* Remove back head from cylinder. From inside back head, remove governor valve bushing, oiler adjusting screw, and felt oiler. Pull housing gasket from lip of back head.

*(d)* Screw governor from rotor shaft (left-hand thread, turn clockwise). Pull arbor bearing, rear end plate, and spacer from rotor shaft.

*(e)* From lower end of rotor shaft, remove rotor key screw, rotor key, arbor bearing, and front end plate.

*(f)* Pull rotor from cylinder. Slide vanes from slots in rotor.

(3) REMOVE IMPELLER.

*(a)* Remove the four inlet cap screws and lock washers. Lift inlet and impeller and impeller cover from housing.

*(b)* Remove arbor nut and washer end of arbor.

*(c)* Pull impeller from arbor with fingers while tapping gently on end of arbor with a wood block. If impeller fails to come off arbor, screw two ¼-20 bolts into holes tapped in impeller. Remove impeller key and shims from end of arbor.

(4) REMOVE ARBOR.

*(a)* Pick rotor spring from hollow top end of arbor.

*(b)* Using a wood block on lower end of arbor, gently tap arbor from top of housing.

*(c)* Pull impeller spacer and arbor bearing from arbor.

(5) DISASSEMBLE HOUSING.

*(a)* Screw entire lubrication fitting from the housing.

*(b)* Remove the two exhaust flange screws and lock washers from exhaust flange and housing. Pick flange and gasket from housing.

*(c)* Remove water seal from inside lower end of housing.

**b. Assembly** (figs. 94 and 95).

(1) ASSEMBLE HOUSING.

*(a)* Screw entire lubrication fitting into its opening near top of housing on discharge side.



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*(b)* Using a new or undamaged exhaust flange gasket, hold flange in place on side of housing and install both exhaust flange lock washers and screws.

(2) INSTALL ARBOR.

*(a)* Press arbor bearing up against shoulder from lower end of arbor.

*(b)* Slide impeller spacer onto lower end of arbor up against bearing.

*(c)* Place arbor in position within housing from top of housing.

(3) INSTALL WATER SEAL.

*(a)* Press new water seal onto impeller spacer within lower end of housing. Press far enough to leave venthole in housing at least partially open but not far enough to press against bearing. *NOTE: In case pump was not completely disassembled, do not attempt to remove old water seal before installing new one.*

*(b)* Press new seal onto impeller spacer right up against old seal. Press back just far enough to partially open venthole in housing in order to keep from crowding bearing with old seal.

(4) ASSEMBLE AIR MOTOR.

*(a)* Place vanes in slots in rotor and insert rotor in cylinder.

*(b)* On lower end of rotor, install front end plate and pin to cylinder with end plate dowel. Slide rotor bearing spacer onto lower end of rotor shaft. Press arbor bearing, previously lubricated with GREASE, general purpose, No. 1, above −32 F or GREASE, general purpose, No. 0, below −32 F, onto lower end of rotor shaft. Install rotor shaft. Install rotor key and screw.

*(c)* Slide other rotor bearing spacer onto upper end of rotor shaft. Install rear end plate on cylinder with cylinder dowel, alining the two parts. Press arbor bearing, previously lubricated with GREASE, general purpose, No. 1, above −32 F or GREASE, general purpose, No. 0, below −32 F onto upper end of rotor shaft. Screw governor into hollow end of rotor shaft (left-hand thread, turn counterclockwise).

*(d)* Press governor valve bushing into back head from inside. Place felt oiler in its opening inside back head. Install oiler adjusting screw. Draw up until snug but not tight. *NOTE: Oiler adjusting screw regulates flow of oil. About one-half teacup of OIL, engine, SAE 10, should be used each half day. If rate differs noticeably from this after pump is put in service, remove back head and adjust screw. Turn clockwise to reduce flow; turn counterclockwise to increase flow.*

*(e)* Place housing gasket in position inside lip of back head. Install lubrication fitting and lubrication fitting cap in its opening near top of back head.



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## ORDNANCE MAINTENANCE — MAINTENANCE OF BOMB DISPOSAL EQUIPMENT FOR ACCESS AND STERILIZATION

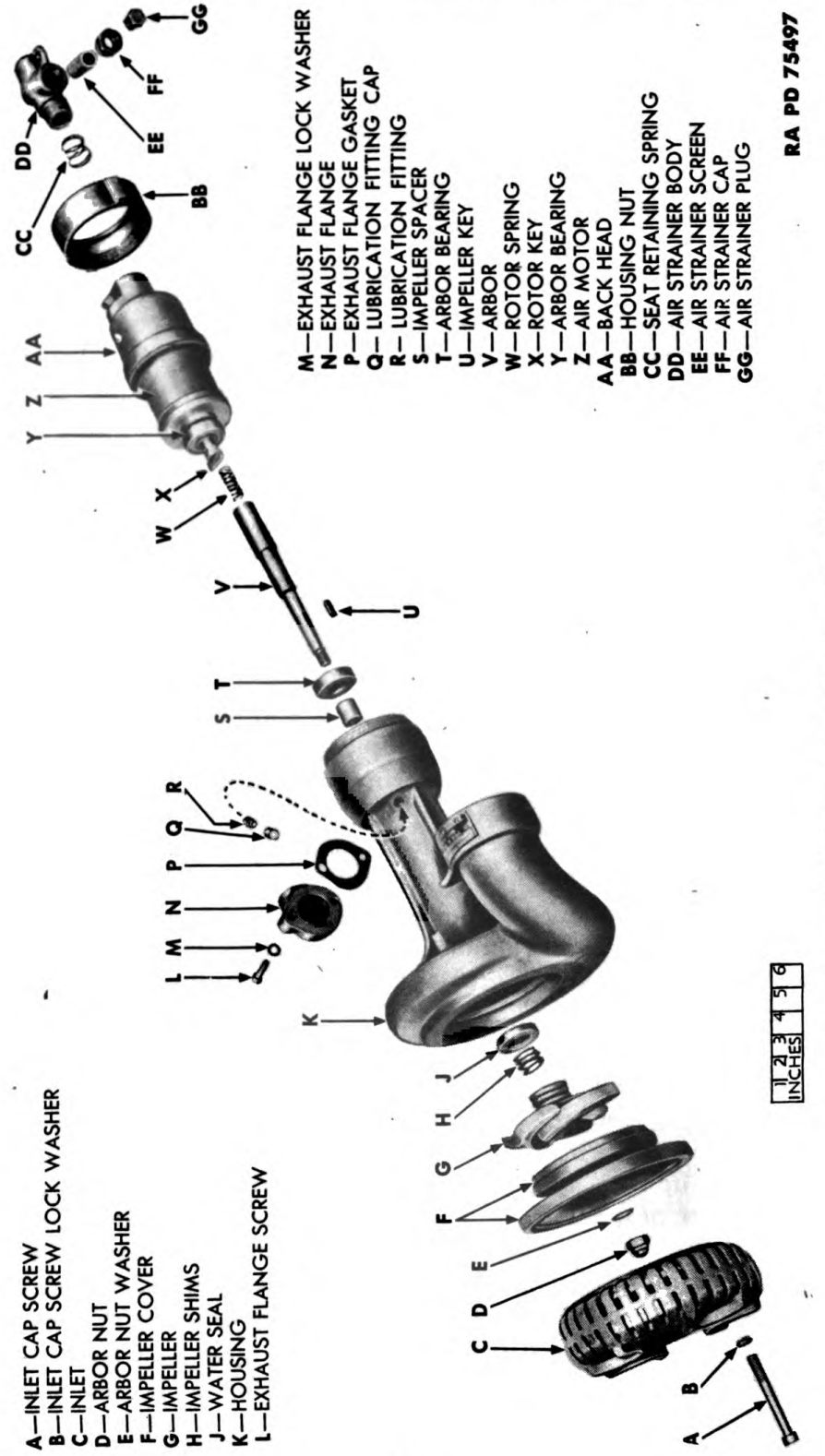



*Figure 94 — Air-driven Sump Pump — Exploded View*



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## WATER PUMPING EQUIPMENT

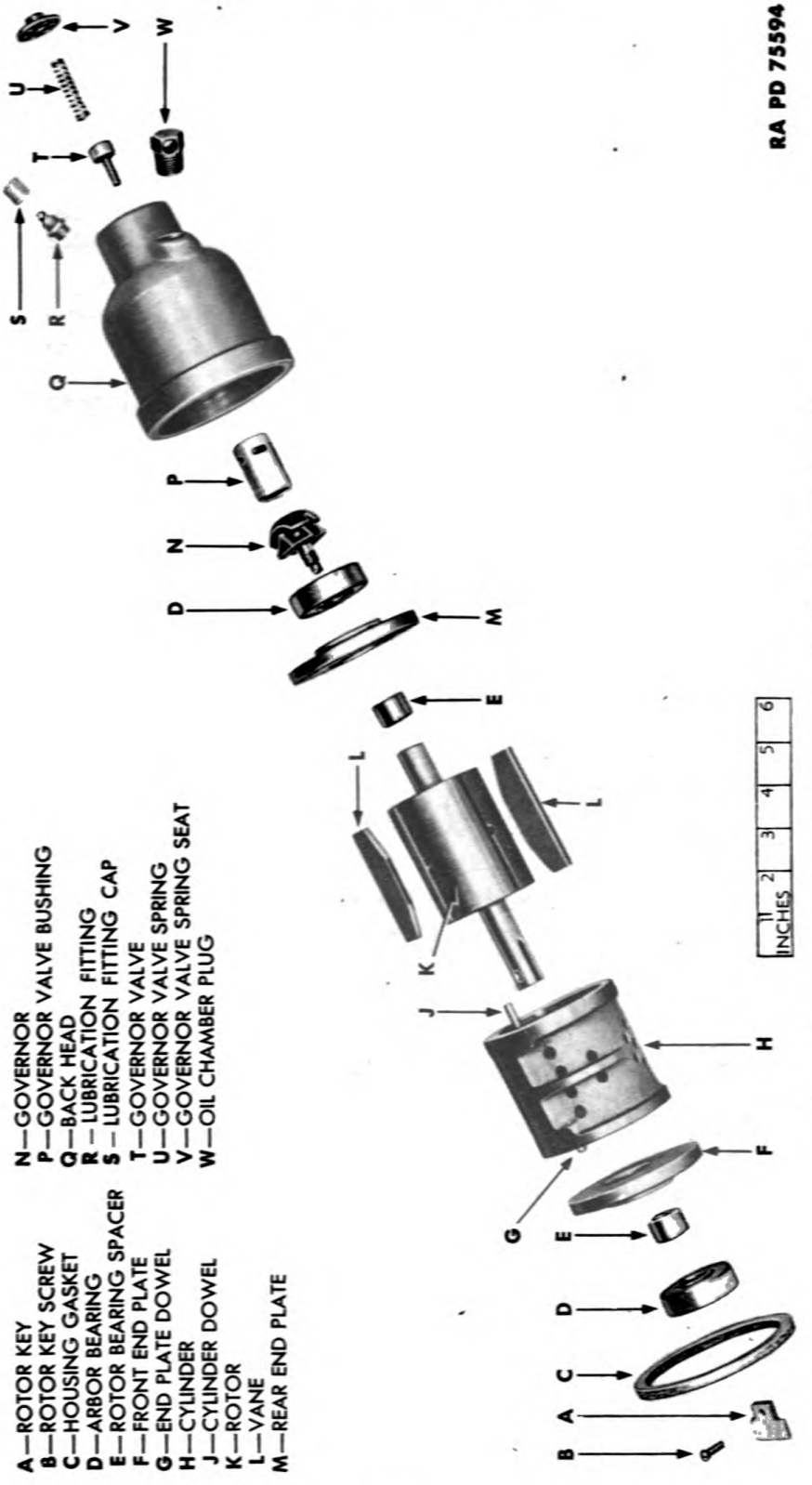



*Figure 95 — Air-driven Sump Pump Motor — Exploded View*



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*(f)* Install back head on top of cylinder. Place governor valve, governor valve spring, governor valve spring seat, and seat retaining spring in position within boss on top of back head.

(5) INSTALL AIR MOTOR.

*(a)* Insert rotor spring in hollow top of arbor.

*(b)* Place motor in position on top of housing with rotor key in slot in top of arbor.

*(c)* Screw housing nut onto top of housing.

(6) ASSEMBLE AND INSTALL AIR STRAINER.

*(a)* Insert air strainer screen boss on side of air strainer body. Install air strainer cap and plug.

*(b)* Be sure seat retaining spring, placed in position in step (4) *(f)*, above, is still in position. Screw air strainer body into boss on top of back head.

(7) INSTALL IMPELLER.

*(a)* Place impeller shims, sufficient to give impeller and housing $\frac{1}{64}$-inch clearance, on end of impeller.

*(b)* Tap impeller key into keyway in end of arbor.

*(c)* Tap impeller onto arbor and key with a soft hammer. Install arbor nut, washer, and nut.

*(d)* Turn impeller by hand. If it rubs on housing or binds, remove and install more shims.

*(e)* Place impeller cover and inlet in position on lower end of housing. Install inlet cap screw lock washers and screws.

(8) Lubricate pump (par. 75) and install oil chamber plug in its boss on back head.

## 74. INSPECTION INSTRUCTIONS.

### a. Before Each Use.

(1) Inspect inlet to see if screen is plugged or if inlet cap screws are loose. Clean inlet if dirty; tighten screws if loose.

(2) Check air strainer screen to see that it is unobstructed. Clean screen if dirty.

(3) Check tightness of air strainer plug, oil chamber plug, the two lubrication fitting caps, exhaust hose, exhaust flange screws, and air hose. Tighten any loose parts.

(4) Check condition of exhaust hose. It is important that it have no leaks.



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**b. At Time of Disassembly.** Clean all metal parts in SOLVENT, dry-cleaning. Inspect metal parts carefully to see if any are worn, broken, warped, bent, or scored. Note whether or not tips are broken on impeller. Check vanes to ascertain that they fit freely into slots in rotor and are not elongated beyond length of rotor body. Inspect bearings to see if there is noticeable play or visible wear in races. Inspect all castings to see if any are cracked. Dress slightly scored forgings with CLOTH, crocus. Dress slightly misshaped vanes with CLOTH, crocus. Replace all broken, bent, badly worn, badly scored, or badly warped parts. Replace gaskets and water seals regardless of apparent condition.

## 75. CARE, CLEANING, AND LUBRICATION.

**a. Care and Cleaning.**

(1) When not in use, remove pump from water and disconnect hose. Store pump in a place.

(2) Rub exterior of pump with a cloth moistened with OIL, engine, SAE 10, after use. Drain all water from pump.

(3) Once every 10 hours of operation, remove air hose and inject about a teaspoonful of SOLVENT, dry-cleaning, into air strainer body. Run pump about 15 seconds. Inject about a teaspoonful of OIL, engine, SAE 10, into air strainer body. Again run pump briefly.

(4) Once every 50 hours of operation, disassemble pump (par. 73) and inspect parts (par. 74). Assemble (par. 73) and lubricate (subpar. b, below) pump.

**b. Lubrication.**

(1) In order that the pump may be well lubricated at general points the air line lubricator should be used as described in (par. 14 b (2) ). In addition the following should be done:

(2) Before starting pump, remove oil chamber plug (fig. 95) from back head. Fill oil chamber with OIL, engine, SAE 10. Refill after each 4 hours of operation. *NOTE: Rate of consumption should be about one-half teacupful every 4 hours. If rate varies noticeably from this, adjust oiler (par. 72 c).*

(3) Once daily, or every 8 hours of operation, lubricate bearings through the two fittings (fig. 92) provided for the purpose. Remove lubrication fitting caps from fitting. Give each fitting two or three "shots" from a hand-operated grease gun. Use GREASE, general purpose, No. 0. Screw lubrication fitting caps tightly onto fittings after lubricating. This prevents entrance of water to fittings and also protects fitting tips from damage. *NOTE: Grease made for automobile water pumps is too hard for cold water operation and must not be used. Do not use ordinary cup grease because it emulsifies in water.*



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# CHAPTER 5

# STEAM GENERATING PLANT

## Section I

## GENERAL

### 76. GENERAL.

a. Care and operation of the portable steam generating plant are treated in this chapter. Ordnance bomb disposal personnel use this plant to generate live steam with which to sterilize bombs.

## Section II

## PORTABLE STEAM GENERATING PLANT

### 77. DESCRIPTION AND FUNCTIONING.

a. **Description.**

(1) GENERAL (figs. 96 and 97). A portable steam generating plant, type OB-1 is a part of ordnance bomb disposal company equipment. It is used to generate live steam with which to sterilize bombs. Its operation is described in the following text. This plant consists of a boiler, oil burner complete with air blower, fuel pump, dual water injectors, automatic ignition, fuel tank, tool compartment, piping, gages, engine, and control instruments. This equipment is mounted on a rubber-tired, low-center-of-gravity, two-wheeled trailer. The trailer is equipped with semielliptical springs and an adjustable steel, stiff-leg support for stationary operation. A description of the plant follows:

(2) BOILER (fig. 98). The boiler is a horizontal, 4-pass, downdraft, fire tube, internally fired, self-contained type. It is of steel construction and cylindrical in shape. It has integral internal fire chamber and flues to facilitate transmission of heat to the water. The internal diameter of each of the flues is 2 inches. A 2-inch blanket of mineral wool insulation enclosed in a steel outer covering insulates the upper half of the boiler.

(3) OIL BURNER (fig. 99). Bolted to the engine end of the boiler, the oil burner consists of a fan-type blower, an oil nozzle, a diffuser plate assembly, and an igniter. The burner is a pressure atomizing type. A manually-operated butterfly valve is provided to regulate the volume



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of air which passes through the blower into the combustion chamber. A V-belt from the engine drives the blower fan. Oil is ejected and atomized by the nozzle which receives it under pressure from the fuel oil pump. The diffuser plate assembly, or baffle, aids in atomizing the oil. The igniter consists of two electrodes placed so a constant spark from the engine magneto ignites the spray of oil vapor as it leaves the nozzle. The fuel nozzle, diffuser plate assembly, and igniter are readily removable from the blower housing for adjustment and cleaning.

(4) INJECTORS (figs. 96 and 97). Two ½-inch, manually-controlled, feed water ejectors, with a complete set of control valves, are installed on the unit, one on either side. Injectors require pressure steam for operation and suction must be connected to a source of supply. They are easily replaced as an assembly.

(5) GASOLINE ENGINE (fig. 99). The 1-cylinder gasoline engine which dries the blower, fuel pump, and generator, is a type AK manufactured by Wisconsin Motor Corporation, Milwaukee, Wisconsin. It is equipped with a Wico Series C magneto, manufactured by the Wico Electric Company, Plainfield, Massachusetts. This magneto also supplies current to the automatic electric fuel igniter. The engine develops its maximum power at 2,600 revolutions per minute, and is of the 4-cycle type. The camshaft has the driving gear and the cams formed integral. The oil pump eccentric is also part of the camshaft. The shaft is bored throughout and runs on a stationary pin fastened in the crankcase. Mushroom type valve tappets are employed. No valve tappet adjusting screws are used. The proper tappet clearance for these engines is ten to sixteen one-thousandths of an inch (0.010 to 0.016 in.) for both intake and exhaust valves. The crankshaft is carried on two Timken bearings. The cones are a tight press fit on the crankshaft. The outer race or cup of the Timken bearings, at the power take-off end of the engine, is carried in a plate bolted to the crankcase. Under this plate several shims are fitted for adjusting the bearings. The bearings are properly fitted at the factory with 0.006-inch end play when the engine is cold. It is very seldom necessary to change this adjustment for wear, and then the work should be done only by an experienced man. The connecting rod crank ends are babbitted. A dipper on the connecting rod caps provides ample lubrication for all internal parts of the engine. The pistons are fitted with three compression and one oil regulating ring each. The piston pin is a light press fit in the piston, and steel wire snap rings in the piston bosses prevent end movement of the pin. The oil pump is of the plunger type, formed integral with the splash trough. The plunger is held up against the driving eccentric on the camshaft by a spring. The up or suction stroke of the pump is caused by this spring and the down or discharge stroke by the eccentric. Two ball check valves are used in the pump. The



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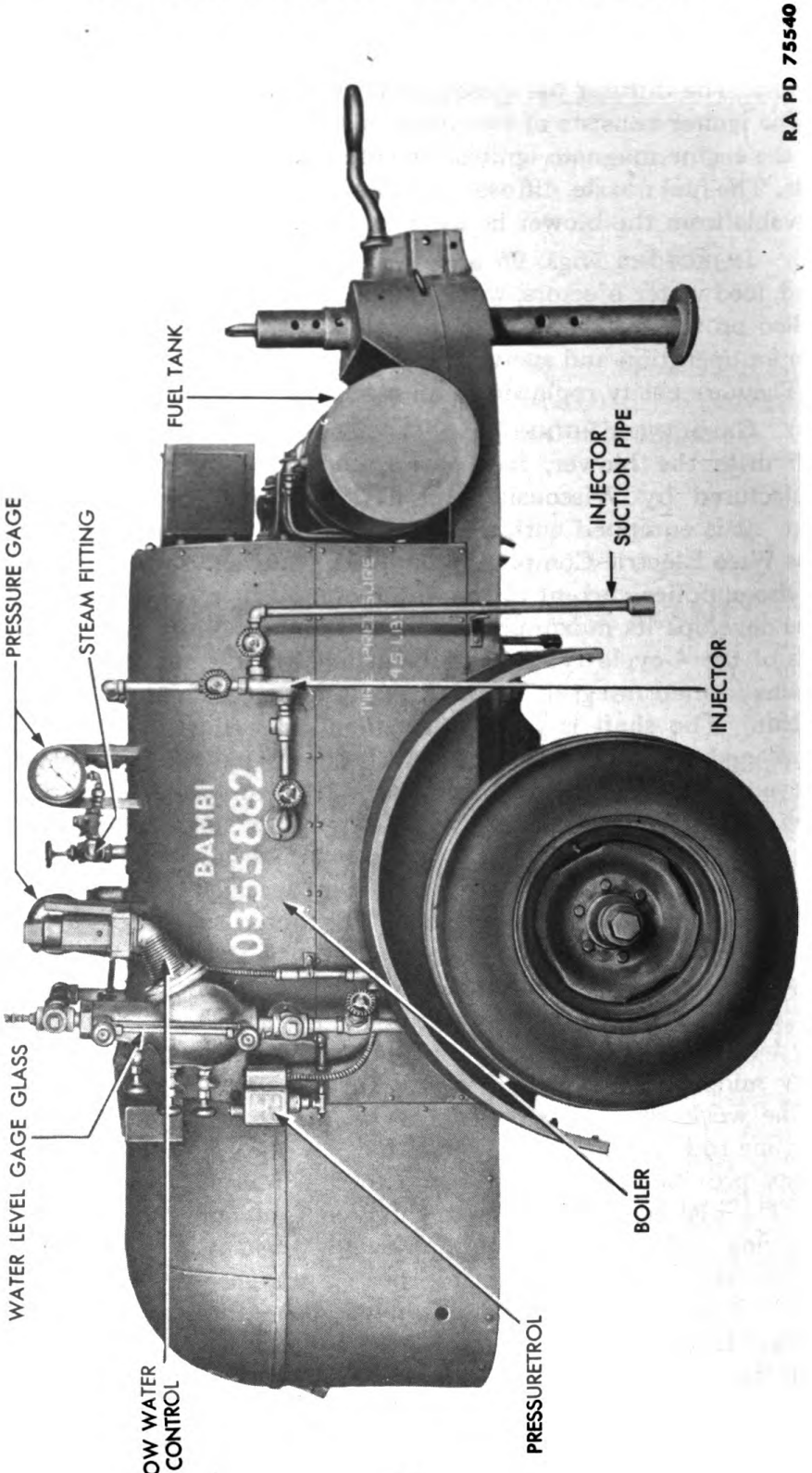



*Figure 96 — Right Side of Steam Generating Plant*



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## STEAM GENERATING PLANT

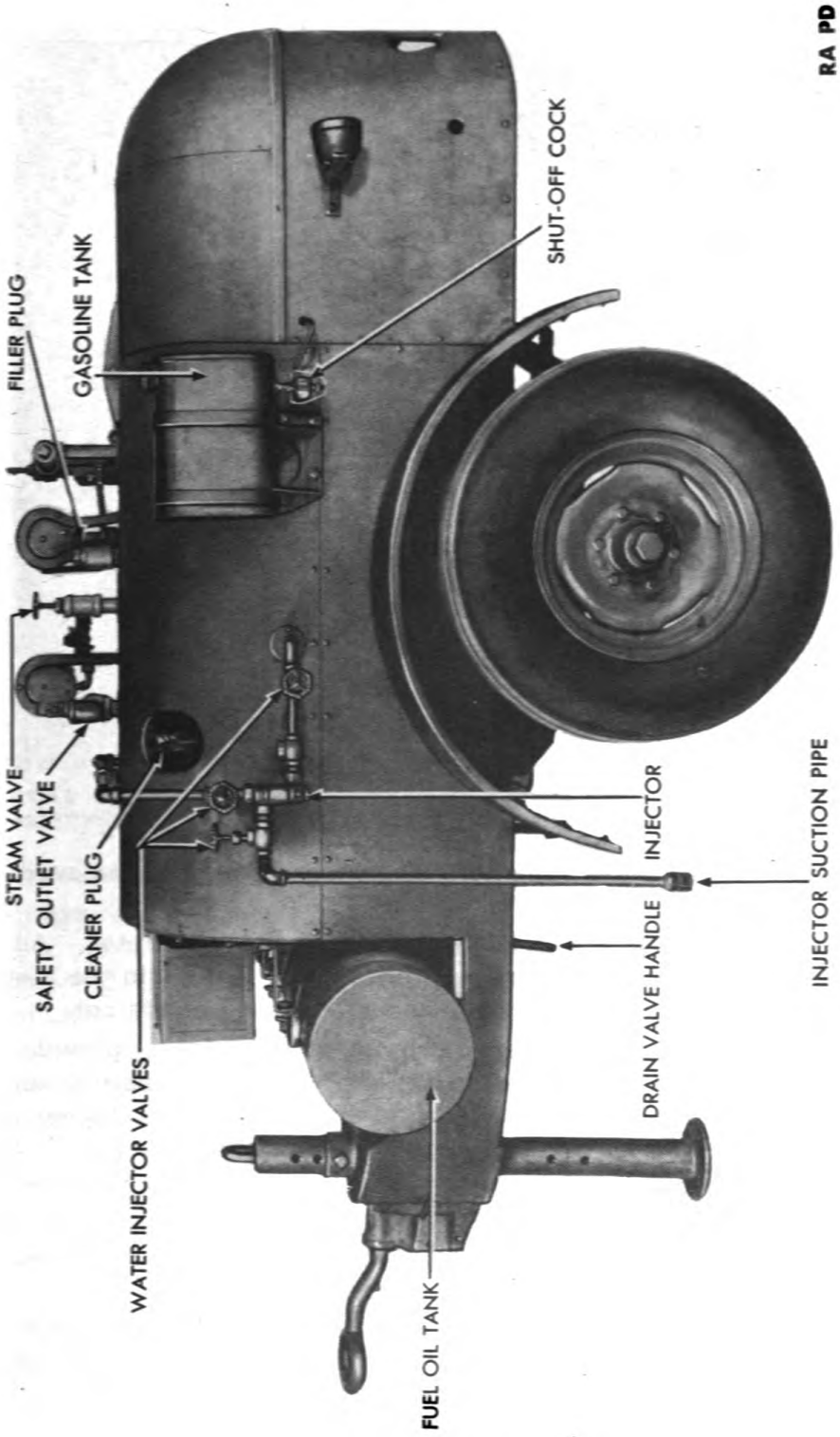



***Figure 97 — Left Side of Steam Generating Plant***



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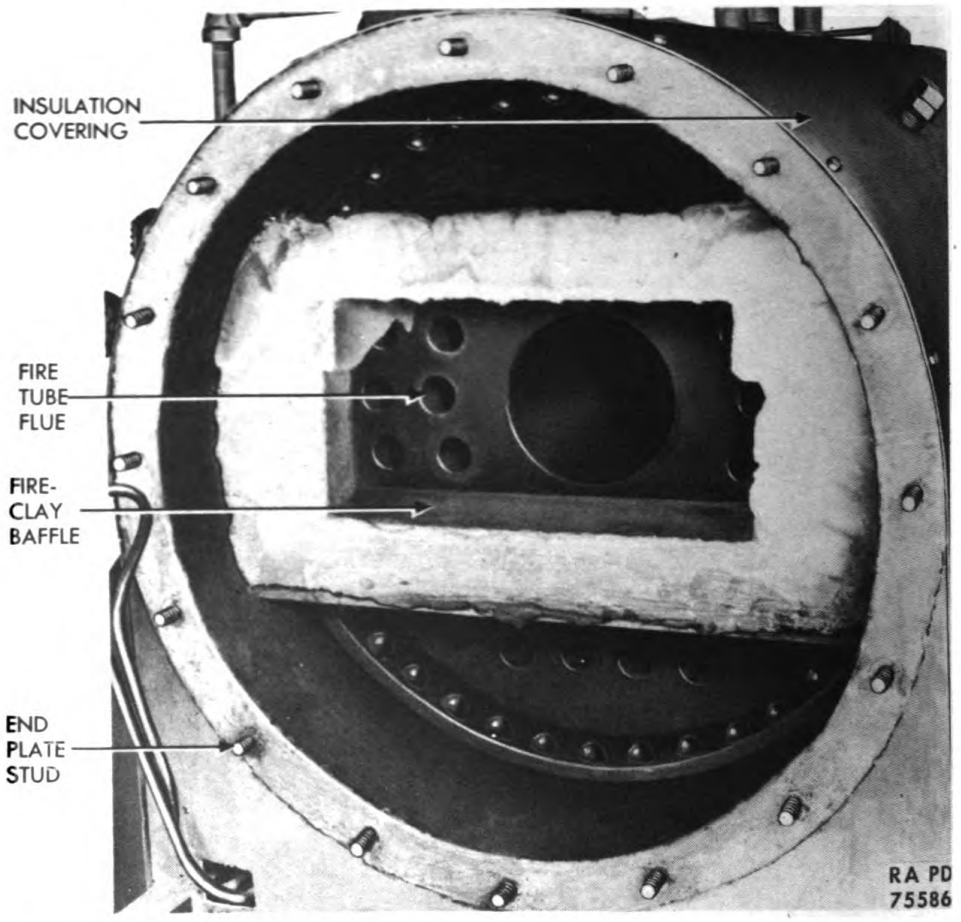



***Figure 98 — Steam Generating Plant Boiler With End Plate Removed***

engine is equipped with a Stromberg "OH" series carburetor. Adjustable needle valves are incorporated in the unit to obtain the best possible performance and economy under operating conditions.

(6) PIPING AND GAGES (fig. 115). A globe valve is provided in the discharge line to control steam discharge. An auxiliary steam pressure gage is installed to provide a visual indication of discharge working pressure. This gage is identical with the boiler gage. A ½-inch metallic discharge fitting provides for steam hose connection.

(7) FUEL TANK (figs. 96 and 97). A 25-gallon fuel oil tank is installed in front of the boiler on channel members of the trailer frame. It holds enough oil for about 8 hours operation.

(8) PRESSURETROL (fig. 96). Burner operation is controlled by a steam pressuretrol mounted near the water column. This is adjustable to permit operation of the boiler at any desired pressure. There is a switch on the pressuretrol which closes when the steam



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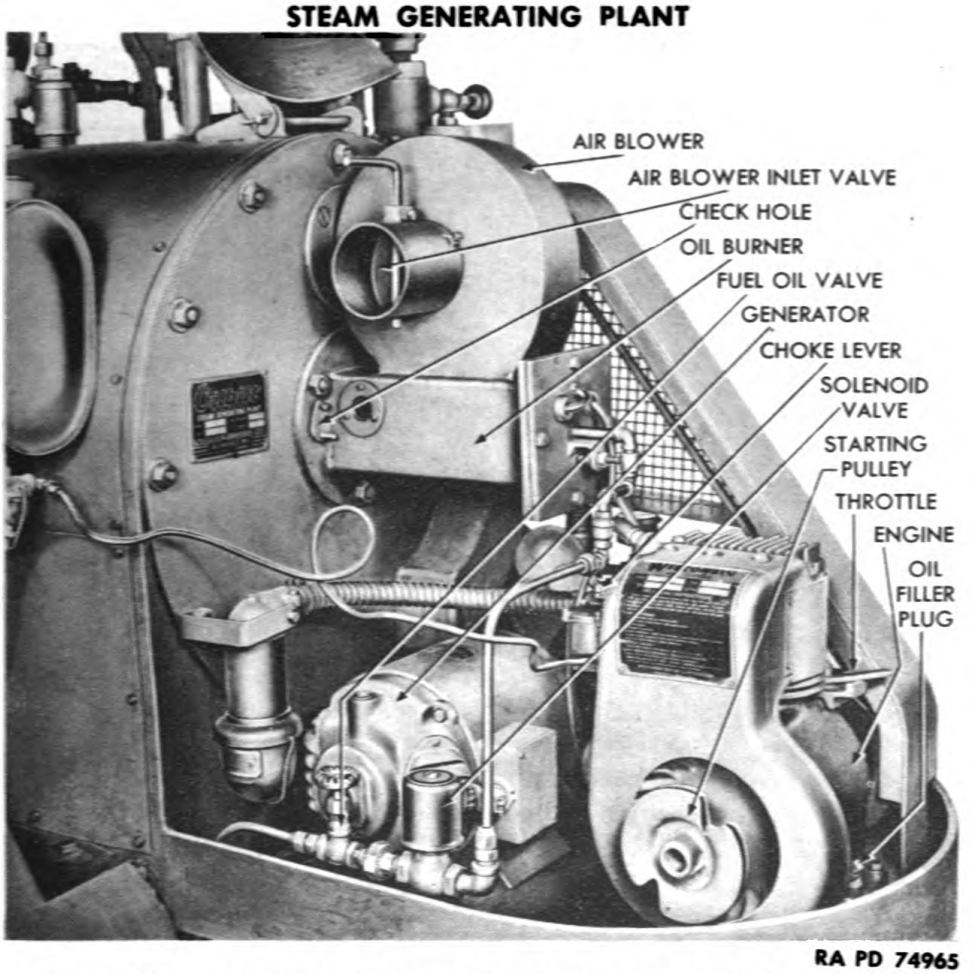



***Figure 99 — Left Side of Steam Generating Plant Engine Section — Section Skirt Removed***

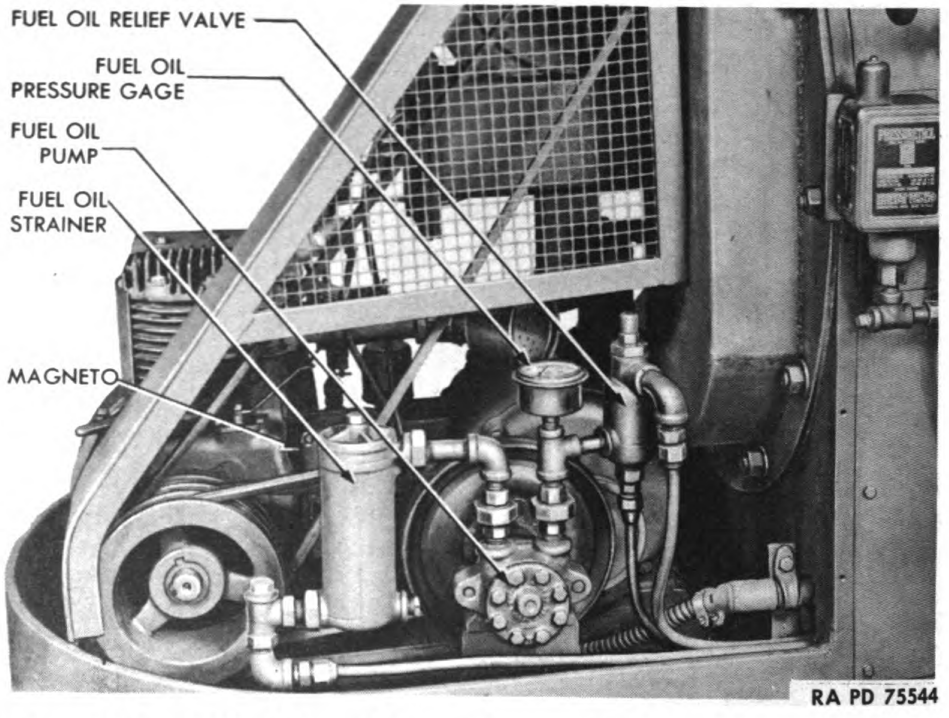
pressure drops to a set point; this opens the solenoid oil valve and permits oil to flow to the burner. When a set maximum pressure is reached, the pressuretrol switch opens; this closes the solenoid valve, shutting down the burner.

(9) LOW WATER CONTROL (fig. 96). A low water control is mounted on the right side of the boiler. It consists of a housing containing a float. The float is connected by levers to a switch which is in the generator-to-solenoid valve circuit. When the water level in the boiler gets low, the float opens the low water control switch. This closes the solenoid valve and makes it impossible for the burner to get oil until water is injected into the boiler.

(10) GENERATOR (fig. 99). A 220-volt, low-amperage, alternating-current generator is mounted ahead of the engine. It is driven by the engine and supplies current to keep the solenoid valve in the fuel line open when the circuit is not broken by an open pressuretrol switch or low water control switch.



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***Section 100 — Right Side of Steam Generating Plant Engine Section - Engine Skirt Removed***

(11) SOLENOID VALVE (fig. 99). A solenoid valve is installed in the fuel oil line between the oil pump and burner. So long as current from the generator continues to flow through the solenoid valve coil, the valve remains open and permits fuel oil to flow to the burner. When the flow of current to the coil ceases, the valve closes and cuts off the supply of oil to the oil burner.

(12) SAFETY VALVE (fig. 97). A 1-inch safety valve is installed on top of the boiler. It consists of a valve which is normally held closed by a spring. Excessive steam pressure opens the valve. If the safety valve operates, shut down the plant, then locate and repair the defective part of the pressure control system. It is adjusted to open at 100 pounds pressure. The adjustment is sealed and should not be tampered with.

(13) FUEL OIL STRAINER (fig. 100). Oil from tank to pump is forced through a strainer located at the rear of the oil pump. The strainer has a cast iron body and an element consisting of two fine wire screen cylinders. Its design permits quick removal of screens for cleaning.

(14) FUEL OIL PUMP (fig. 100). Fuel is forced from tank to burner by a centrifugal pump, operated by means of a V-belt from



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the engine. This pump depends upon close tolerances for its effectiveness and should not be disassembled by operating personnel.

(15) FUEL OIL RELIEF VALVE (fig. 100). A relief valve is installed above the oil pump. It is a piston type "pop" valve equipped with an adjusting screw to regulate tension on the piston spring. Normally it is set at 100 to 120 pounds. It serves to bypass to the tank excess oil which the pump has forced into the line to the burner.

(16) DRAIN VALVE (fig. 97). A high-pressure drain cock is located under the boiler. It has 1½-inch female fittings. A quarter turn of the handle opens it completely to drain the boiler.

**b. Functioning.**

(1) GENERAL. When the plant is in operation, the engine drives the fuel oil pump, blower, and generator. The fuel oil pump forces fuel oil from the tank to the burner nozzle. Since the capacity of the pump is greater than that of the nozzle, a spring loaded return valve, set at 100 to 120 pounds pressure, is provided in the line between the pump and nozzle. This valve allows excess fuel to return through connecting line to tank. The engine-driven burner (complete with blower) atomizes the fuel, mixes it with air, and ejects the mixture into the combustion chamber. Electrodes in the combustion chamber in front of the nozzle ignite the mixture with a constant spark obtained from the engine magneto. Steam is generated as the water evaporates.

(2) PRESSURE CONTROL AND SAFETY FEATURES. When the steam pressure builds up to 90 pounds, a diaphragm within the pressuretrol moves against spring tension. This opens an electric switch which breaks the circuit from the engine-driven generator to the solenoid valve in the pump-to-burner-nozzle fuel line. When the solenoid valve closes, the fuel supply to the nozzle shuts off and combustion ceases. When the pressure in the boiler drops, the pressuretrol diaphragm is pushed back to its original position. This closes the switch which restores the generator-to-solenoid valve circuit. The valve opens and combustion resumes. If the water level in the boiler falls below a safe minimum, a float in the low water control opens a switch which breaks the generator-to-solenoid valve circuit and stops combustion. Before combustion can be resumed, water must be added to the boiler.

## 78. OPERATION.

**a. Before Starting a New Steam Generating Plant.** Lubricate engine, blower bearings, and generator (par. 82 b).

**b. Before Starting Engine.**

(1) Level up boiler.

(2) Fill fuel oil tank on front of boiler (fig. 97). Use OIL, Diesel,



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fuel, at 100 F. During cold weather, use Diesel fuel oil. Use no other fuel unless Diesel fuel oil is not available.

(3) Fill gasoline tank on left side of boiler (fig. 97).

(4) Check engine crankcase oil. If necessary fill to level of filler plug (fig. 100) on rear of engine with proper grade engine oil (par. 82b).

(5) Vent and fill boiler through filler (fig. 97) on top of boiler until gage (fig. 96) on right side of boiler shows water slightly above "WATER LINE" mark.

**c. Starting Engine.**

(1) Open fuel tank shut-off cock (fig. 97).

(2) Open throttle on right rear of engine halfway (fig. 99).

(3) Turn choke lever on top of carburetor counterclockwise to choke carburetor (fig. 99).

(4) Wrap starting cord around starting pulley counterclockwise (fig. 99).

(5) Pull starting cord. Repeat cranking until engine starts.

(6) Turn choke lever clockwise as far as it will go.

(7) Check reading of fuel oil pressure gage (fig. 100) on top of fuel pump. It should show 100 pounds pressure.

(8) Allow engine to warm up from 3 to 5 minutes.

**d. After Engine Warm-up.**

(1) Open air blower inlet valve on left side of air blower by turning handle so it points straight away from blower (fig. 99).

(2) Open fuel oil valve at left side of generator by turning counterclockwise (fig. 99).

(3) Open check hole (fig. 99) on left side of fuel nozzle to see if burner is operating. If flame is not present, observe if fuel vapor is present. Presence of fumes indicates faulty ignition. Absence of fumes indicates faulty injection. Stop engine, locate and repair the trouble before again starting engine.

**e. During Process of Building Up Steam Pressure.**

(1) Connect hose of required length to steam fitting on top of boiler between pressure gages (fig. 96).

(2) Place water container filled with water in front of right-hand wheel. Drop water injector suction pipe into water (fig. 96). Keep water level above end of suction pipe at all times. *NOTE: Another suction pipe is located on left-hand side of unit and can be used in place of, or in addition to, the right-hand suction pipe (fig. 97).*



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**f. While in Operation.**

(1) Pressuretrol (fig. 96) is normally set at 90 pounds per square inch. However, steam may be used before this pressure is reached.

(2) Open steam valve on top of boiler to permit pressure needed to flow through hose (fig. 97).

(3) Watch water level as indicated by water level gage glass on right-hand side of boiler (fig. 96). Add water to boiler when level gets down to "WATER LINE," as follows: Open completely right-hand and left-hand (facing boiler) water injector valves (fig. 97). Open center valve (fig. 97) just enough to stop steam exhaust from injector. Observe water level gage. Close all three valves (center valve first) when water is about 2 inches above "WATER LINE" on gage.

**g. Stopping Boiler.**

(1) Close fuel oil valve located at left side of generator (fig. 99). This shuts off fuel oil from burner.

(2) When fire goes out, allow engine to run about 1 minute; then stop engine by pressing the magneto ground button on the front of the magneto (fig. 100).

(3) During cold weather, or if unit is to be idle for a considerable time, drain boiler and pipes. To drain boiler, open boiler drain valve underneath fuel oil tank (fig. 97). Be careful of live steam. To drain low water control, open valve under body of control (fig. 96). To drain pipes, remove plugs or open draincocks at low points.

## 79. MALFUNCTIONS AND CORRECTIONS.

**a. General.**

(1) CUTTING OIL-CHECK HANDHOLE. Engine oil level is checked by removing plug on rear of engine. Access to plug will be eased by cutting a 4- by 7-inch handhole in rear of engine compartment skirt (fig. 101) with an acetylene torch.

(2) ELIMINATION OF BOUNCING. If generating plant bounces badly when being towed, proceed as follows: Remove the eight bolts which secure the four spring brackets to frame. Drill new bolt holes in frame about 2 inches to rear of old holes with $^{9}/_{16}$-inch drill. Install the spring brackets with bolts in new holes. This shifts wheels and axle 2 inches to rear, changes weight distribution, and minimizes bouncing.

(3) REMOVAL OF SCALE. To remove scale caused by water containing lime or other impurities, place parts in a bath of OIL, engine, SAE 10, or a solution composed of one part muriatic acid and five parts water.



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## b. Burner.

| Symptom | Cause | Remedy |
|---|---|---|
| (1) Burner goes out or fails to light. | *(a)* Normal operation of low water control due to insufficient water in boiler. | *(a)* Add water to boiler to about 2 inches above "WATER LINE" of gage (par. 78). |
| | *(b)* Normal operation of pressuretrol due to maximum steam pressure in boiler. | *(b)* A normal condition. Allow engine to continue in operation. Burner will start when pressure drops (par. 77 **b**). |
| | *(c)* Insufficient oil in fuel oil tank. | *(c)* Fill tank with fuel oil. |
| | *(d)* Fuel oil relief valve out of adjustment. | *(d)* Adjust fuel oil relief valve to 100 to 120 pounds on gage (par. 79 **g**). |
| | *(e)* Oil pump inoperative. | *(e)* Replace oil pump (par. 80 **m**). |
| | *(f)* Oil strainer plugged. | *(f)* Remove oil strainer cap and lift out two screen cylinders (par. 80 **l** (2)). Clean screens in SOLVENT, dry-cleaning, and assemble strainer (par. 80 **l** (3)). |
| | *(g)* Defective or improperly set electrodes. | *(g)* Remove burner end cap assembly and examine electrodes. Replace electrodes (par. 80 **b** (2)) if porcelains are cracked or if points are badly burned. Adjust gap to 0.100 inch and aline with nozzle opening. Use metal shims around porcelains if necessary (par. 80 **b** (3)). |
| | *(h)* Screen in nozzle plugged. | *(h)* Remove burner end cap assembly (par. 80 **b** (1)). Unscrew nozzle, remove tip, and lift out screens (par. 80 **b** (2)). Clean in SOLVENT, dry - cleaning, and assemble. |



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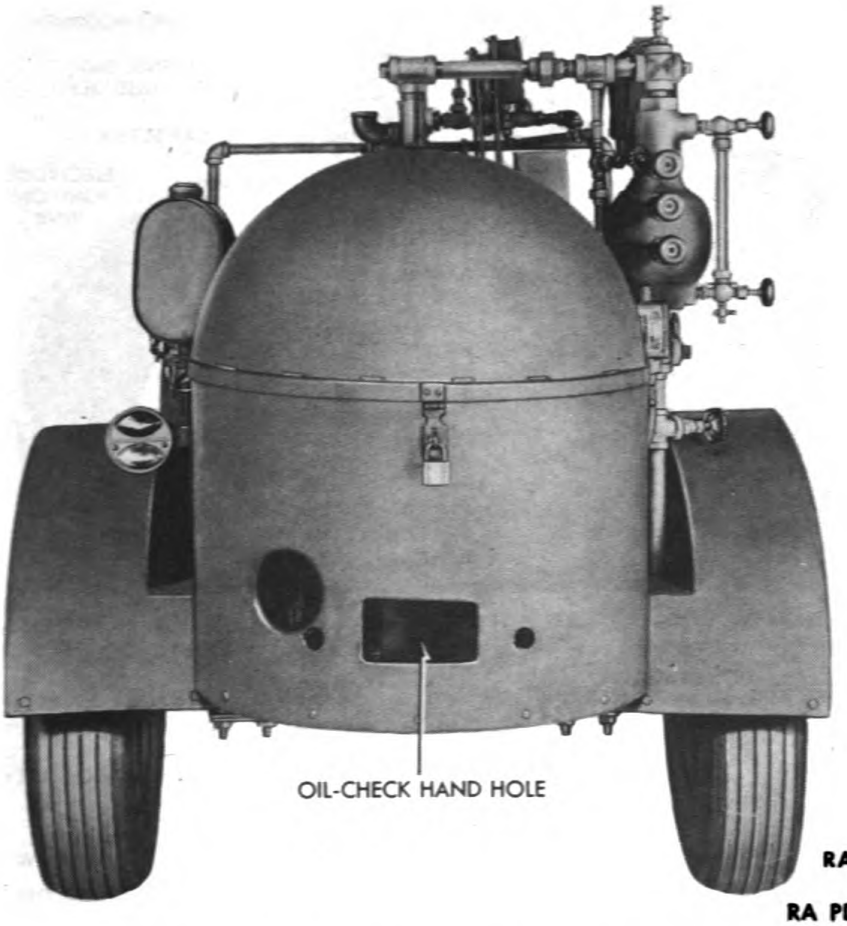



***Figure 101 — Rear of Steam Generating Plant***

(2) ADJUSTMENT OF ELECTRODES (fig. 102).

*(a)* Pull electrode ignition wire from its socket in magneto.

*(b)* Disconnect fuel oil tubing at fitting on elbow near top left side of engine.

*(c)* Remove the four cap screws which secure burner end cap assembly to burner housing.

*(d)* Carefully pull end cap assembly from housing.

*(e)* Clean electrodes, nozzle, and baffle plate with SOLVENT, dry-cleaning, and iron brush. Inspect porcelains to see if broken. Inspect points to see if burned. Measure gap with feeler gage. It should be 0.100 inch. Gap should be alined with nozzle opening and about ¼ inch from end of nozzle. Loosen clamps around porcelain



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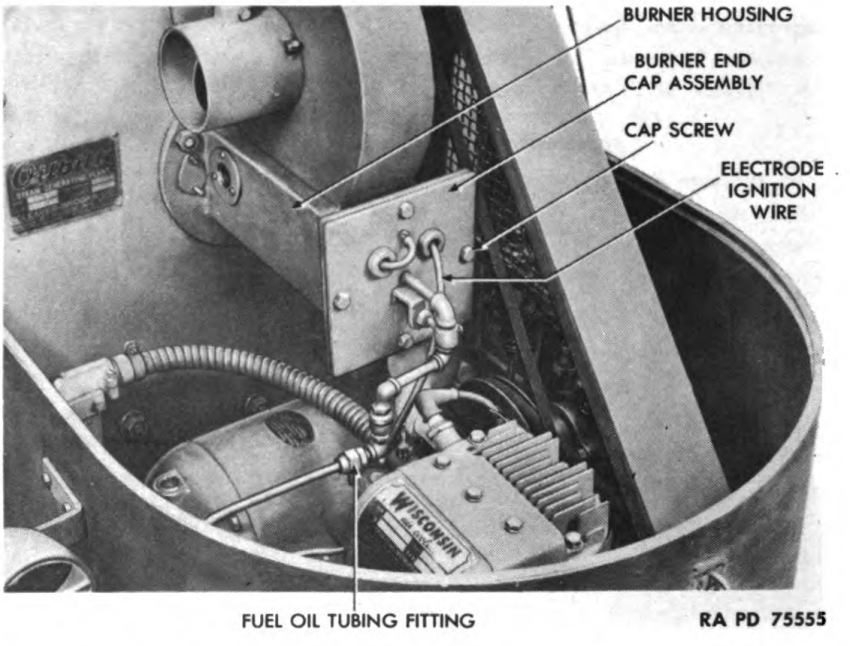



***Figure 102 — Burner Installed on Steam Generating Plant***

with screwdriver to adjust gap. Metal shims may be used between clamp and porcelain if necessary.

*(f)* Install burner end cap assembly in burner, using a new gasket if old one is damaged. Install four cap screws, connect oil line, and connect ignition cable to magneto.

(3) CLEANING NOZZLE SCREEN (fig. 109).

*(a)* Remove burner end cap assembly from burner as outlined in steps (2) *(a)* through (2) *(d)*, above.

*(b)* Remove entire nozzle from oil pipe.

*(c)* Remove nozzle tip.

*(d)* Screw screen from nozzle tip by hand.

*(e)* Clean screen in SOLVENT, dry-cleaning, and screw back into nozzle tip.

*(f)* Assemble tip to nozzle chamber and nozzle assembly to oil pipe.

*(g)* Install burner end cap assembly into burner as outlined in step (2) *(f)*, above.



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## STEAM GENERATING PLANT

**c. Water Injectors.** Trouble shooting data follows:

| Symptom | Cause | Remedy |
|---|---|---|
| (1) Injector will not lift water. | *(a)* Suction pipe loose. | *(a)* Tighten suction pipe to eliminate air leaks (par. 80 c (3) ). |
| | *(b)* Suction pipe strainer plugged. | *(b)* Screw strainer from end of pipe and rinse in water (par. 80 c (2) ). |
| | *(c)* Overflow plugged. | *(c)* Remove obstruction from overflow. |
| | *(d)* Overflow check is sticking. | *(d)* Disassemble and clean check (par. 80 c (2) ). Replace worn or broken parts. |
| | *(e)* Steam pipe to injector plugged. | *(e)* Remove (par. 80 c (1) ) and clean pipe. Use OIL, engine, SAE 10, or dilute muriatic acid (one part acid to five parts water) to loosen scale. |
| (2) Injector lifts water and forces part of it into boiler, but drips and spits hot water from overflow. | *(a)* Suction pipe loose. | *(a)* Tighten suction pipe (par. 80 c (4) ). |
| | *(b)* Dirt in suction. | *(b)* Remove all dirt. |
| | *(c)* Water supply is too hot. | *(c)* Use cooler water. |
| | *(d)* Steam pressure is too high. | *(d)* Adjust pressuretrol to maximum of 90 pounds (par. 79 e (1) ). |

**d. Engine.**

(1) ADJUSTMENT OF MAGNETO BREAKER POINTS (fig. 103).

*(a)* Remove the two screws which secure breaker box cover to magneto. Lift cover and gasket from magneto.

*(b)* Loosen round-headed breaker point locking screw.

*(c)* Adjust opening to 0.015 inch by means of flat-headed eccentric screw.

*(d)* Tighten breaker point locking screw. Be sure breaker box cover gasket is in place and install breaker box cover.

(2) FLUSHING OF MAGNETO IMPULSE. If impulse becomes clogged with dirt, trip arms fail to engage or disengage, or action is sluggish, correct as follows:

*(a)* Remove magneto (par. 80 d (3)).



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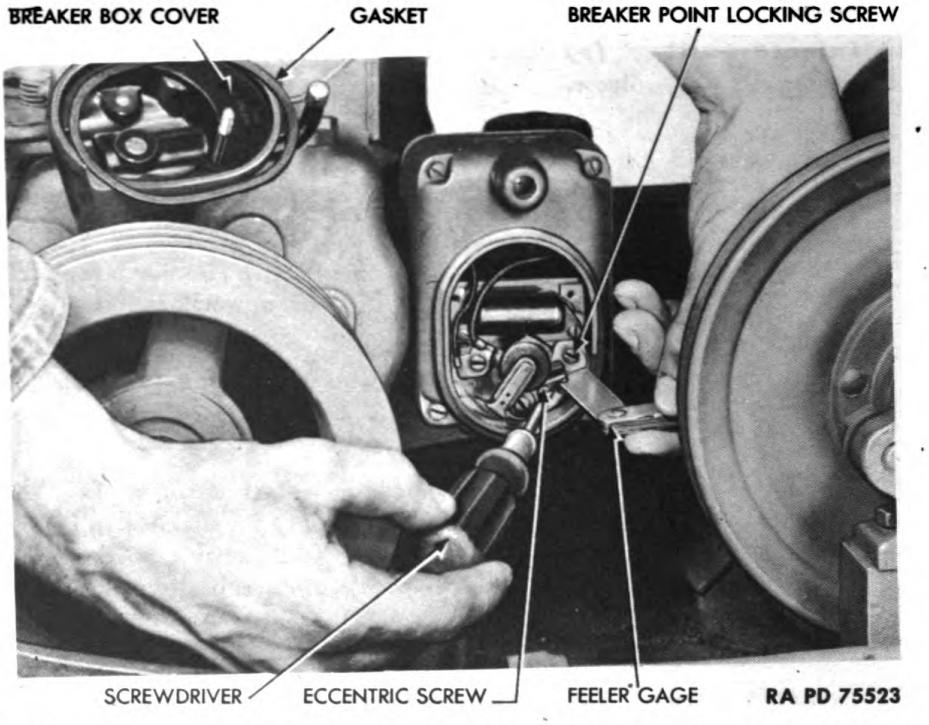



***Figure 103 — Adjusting Steam Generating Plant Engine Magneto Points***

*(b)* Flush impulse with **SOLVENT**, dry-cleaning. Take care to keep **SOLVENT**, dry-cleaning, from entering magneto housing.

*(c)* Install magneto (par. 80 **d** (4)).

(3) REPLACEMENT OF BREAKER POINTS. Magneto failure may be due to broken, burned, or worn points. Remove breaker cover with screwdriver and inspect points. If slightly burned or dirty, points may be cleaned with a file or **PAPER**, flint, class B, grade 2/0. Never use emery cloth. Replace points as follows:

*(a)* Lift rotor from shaft.

*(b)* Remove movable contact by removing breaker arm clamp screw and lock washer, and breaker arm spring terminal screw and lock washer. Lift movable contact point (integral with spring and spring terminal) from breaker arm pivot.

*(c)* Remove stationary point by removing fixed contact screw and lock washer. Lift point from pivot.

*(d)* Install new stationary point on pivot and install fixed contact screw and lock washer.

*(e)* Install new movable contact point and spring assembly on pivot. Install spring terminal screw and lock washer, and breaker arm clamp screw and lock washer.



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**STEAM GENERATING PLANT**

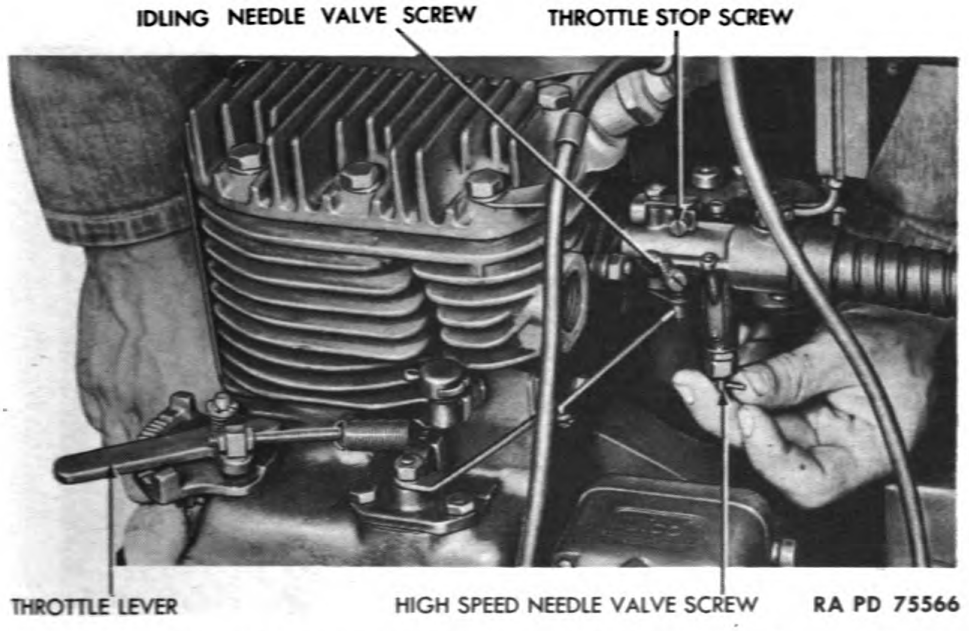



***Figure 104 — Adjusting Steam Generating Plant Engine Carburetor***

*(f)* Adjust opening (step (1) *(c)*, above).

(4) ADJUSTMENT OF CARBURETOR.

*(a) Idling Speed* (fig. 104). Run engine until flange of carburetor which attaches to engine is warm. Close throttle until minimum idling speed is attained. Turn idling needle valve screw (knurled screw set at angle on top right side of carburetor) "IN," until engine speed decreases. This screw should be turned with the fingers. Turn idling needle valve "OUT" slowly, until engine runs steady and as fast as the throttle position will permit. Set throttle stop screw with a screwdriver to obtain satisfactory idling speed. ***NOTE:*** *If adjustment is unsatisfactory, see that discharge hole into which idling needle valve fits is clear.*

*(b) Intermediate and High Speed* (fig. 104). Set throttle lever about one-third open with engine running. Turn high speed adjustment needle valve (tee screw on bottom of carburetor) "IN," by hand, until engine speed is cut down. Turn high-speed needle valve screw "OUT" slowly, until accumulation is smooth and steady for engine speed desired.

*(c)* Fuel Level. Fuel level adjustment is properly set at the factory and should not be adjusted unless carburetor has been handled roughly, or level has been changed from some other cause. If necessary to reset, remove carburetor (par. 80 d (5)). Remove cover from bowl. Bend float lever arm at curve close to float to get



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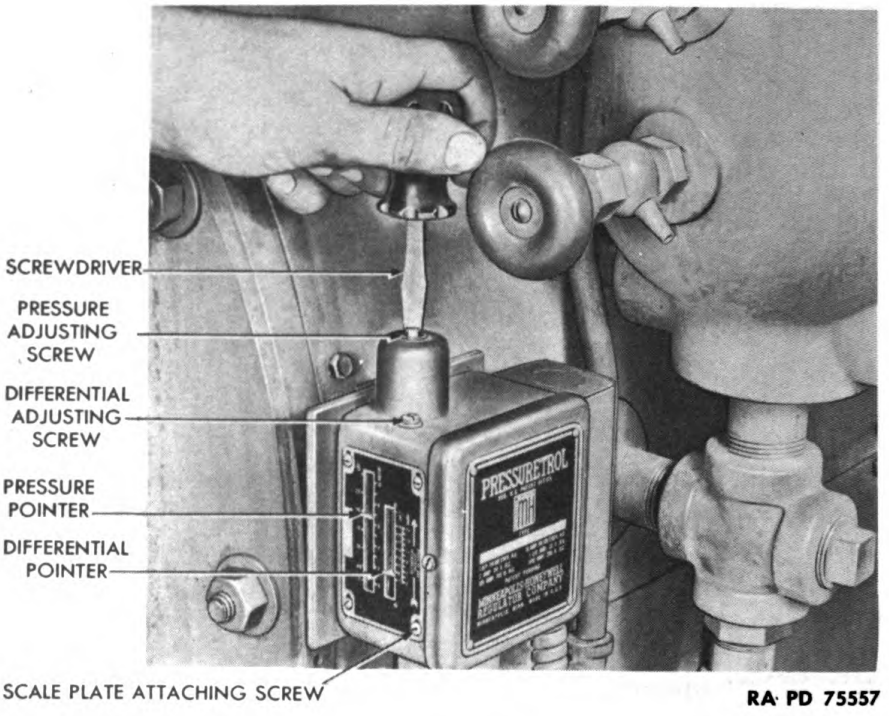



***Figure 105 — Adjusting Steam Generating Plant Pressuretrol***

a measurement of $1\frac{7}{32}$ inch from top of float to top machined surface of bowl casting. When measuring, hold clip (which holds fulcrum pin and float in position) in place by hand so float will be in normal operating position.

**e. Pressuretrol.**

(1) ADJUSTMENT OF MAXIMUM STEAM PRESSURE (fig. 105). Maximum steam pressure at which pressuretrol will close solenoid valve and stop burner should be set at 90 pounds per square inch. Do not set for 100 pounds or more. To adjust, turn pressure adjusting screw (on top of boss on pressuretrol) until pressure pointer indicates 90 pounds.

(2) ADJUSTMENT OF STEAM PRESSURE DIFFERENTIAL (fig. 105). Turn differential adjusting screw (at base of boss on top of pressuretrol) until differential pointer indicates desired differential. Eight to 10 pounds differential is satisfactory.

(3) SYNCHRONIZING PRESSURETROL AND BOILER GAGE (fig. 105). If cut-in and cut-out points do not agree with pressure gage on boiler, loosen the four screws which attach scale plate to pressuretrol case. Move scale slightly up or down until gage and pressuretrol agree. Tighten scale plate screws.



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## STEAM GENERATING PLANT

**f. Fuel Oil Pump.** Trouble shooting data follows:

| Symptom | Cause | Remedy |
|---|---|---|
| (1) Pump fails to operate at full capacity or to deliver at least 100 pounds pressure. | *(a)* No fuel oil in tank. | *(a)* Fill oil fuel tank. |
| | *(b)* Suction line leaks, preventing pump from priming. | *(b)* Tighten connections in suction line (par. 80 **m** (2) ). Replace broken line or fittings. |
| | *(c)* Oil strainer clogged. | *(c)* Remove screens from strainer (par. 80 **l** (2) ) and clean in SOLVENT, dry-cleaning. |
| | *(d)* Burner nozzle strainer plugged. | *(d)* Remove screen from nozzle (par. 80 **b** (2) ) and clean in SOLVENT, dry-cleaning. |
| | *(e)* Pump badly worn. | *(e)* Replace pump (par. 80 **m**). |

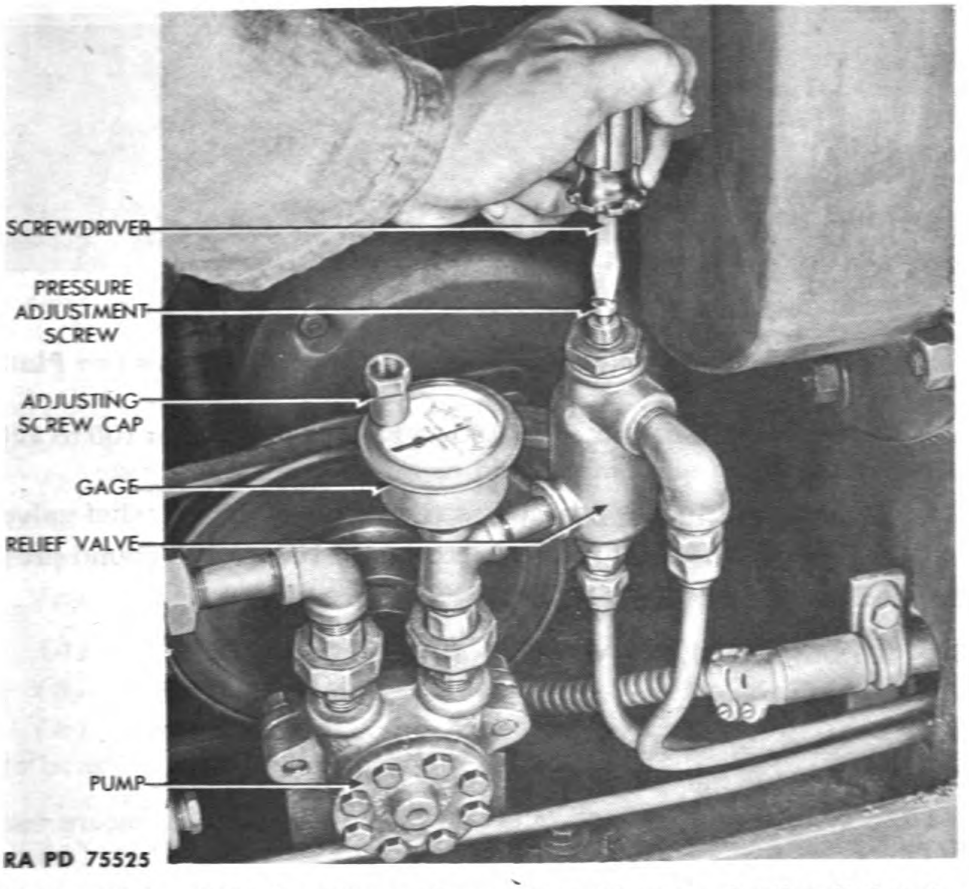
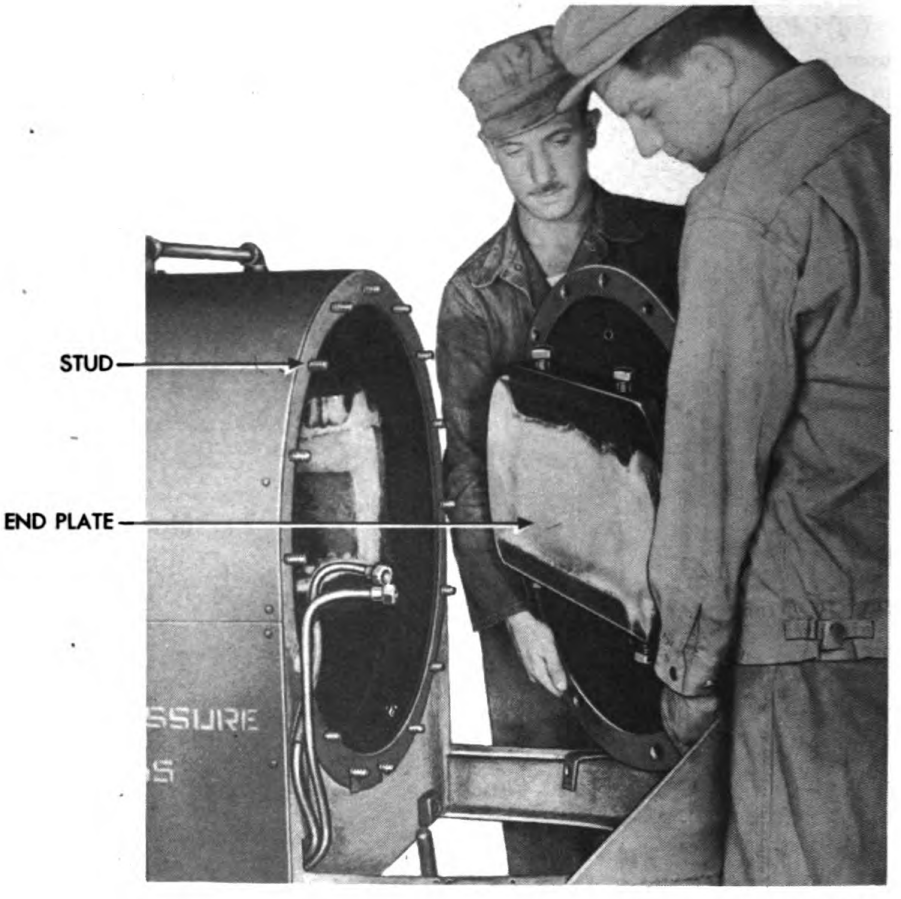



***Figure 106 — Adjusting Steam Generating Plant Fuel Oil Relief Valve***



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*Figure 107 – Removing Steam Generating Plant Boiler Front End Plate*

g. **Fuel Oil Relief Valve** (fig. 106). Fuel oil pressure of 100 to 120 pounds on gage on oil pump should be maintained. To adjust:

(1) Remove cap over adjusting screw on top of fuel oil relief valve.

(2) Turn pressure adjustment screw until 100- to 120-pound pressure is attained. Replace cap over screw.

## 80. DISASSEMBLY AND ASSEMBLY.

a. **Boiler.**

(1) REMOVAL OF FRONT END PLATE (fig. 107).

*(a)* Remove fuel oil tank (subpar. f (1), below).

*(b)* Remove the 16 stud nuts and lock washers which secure end to boiler.

*(c)* Lift end plate and gasket from boiler.



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STEAM GENERATING PLANT

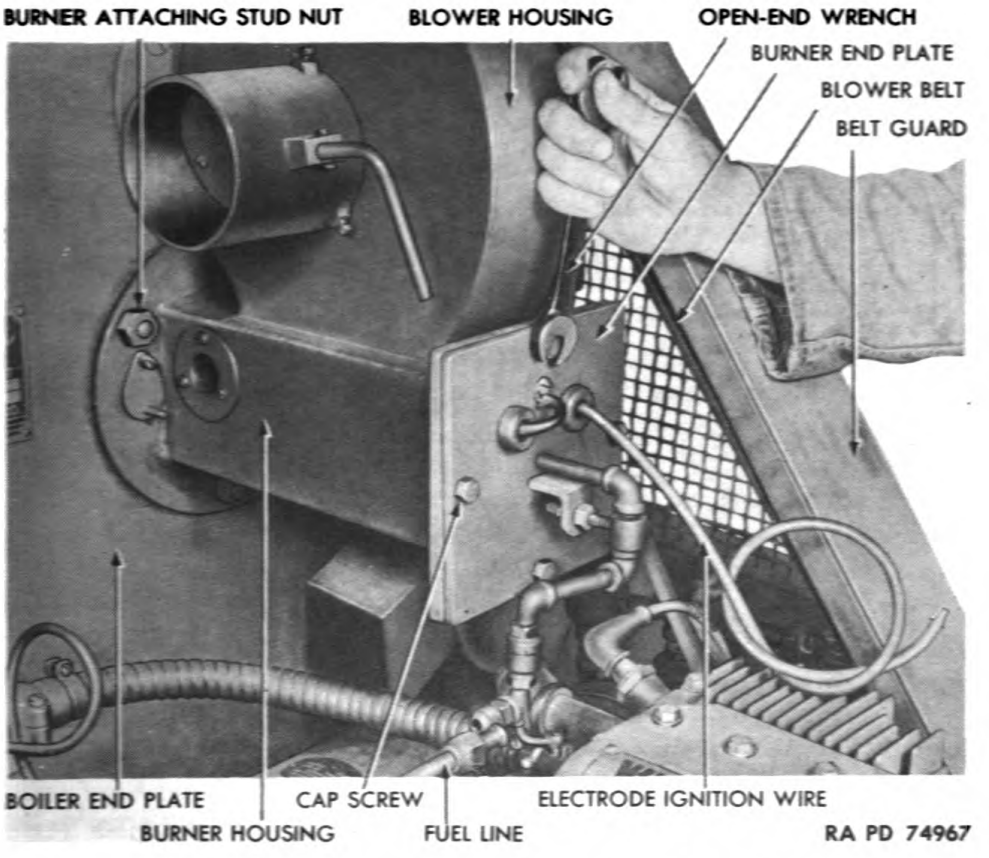



***Figure 108 — Removing Steam Generating Plant Burner End Cap Assembly***

(2) INSTALLATION OF FRONT END PLATE (fig. 107).

*(a)* Clean oil fire clay from fire clay baffles on end of boiler and on end plate. Spread a coat of fire clay on end of baffle on boiler. Place a new gasket on studs on end of boiler.

*(b)* Lift end plate into position (two men) on studs on end of boiler. Install the 16 lock washers and stud nuts which secure end plate to boiler.

*(c)* Install fuel oil tank (subpar. 80 f (2), below).

(3) REMOVAL OF REAR END PLATE.

*(a)* Remove oil burner (subpar. b (1), below).

*(b)* Remove the 12 stud nuts and washers which attach end plate to boiler.

*(c)* Lift end plate from boiler (two men).

(4) INSTALLATION OF REAR END PLATE.

*(a)* Scrape oil fire clay from baffles on boiler and on end plate.



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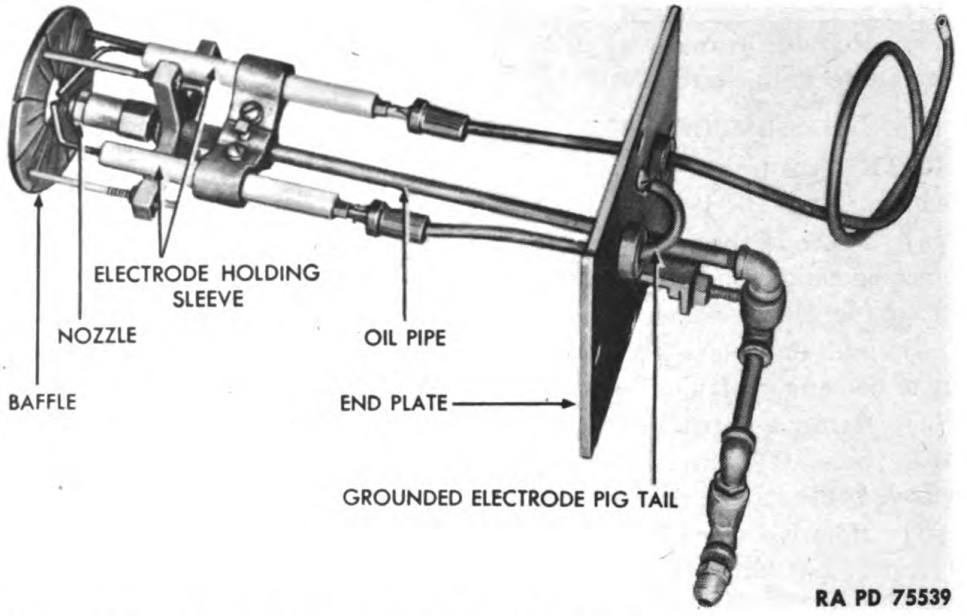



***Figure 109 — Steam Generating Plant Electrode and Nozzle Assembly***

Spread a coating of fire clay on end of baffles on boiler. Place new gasket on studs on end of boiler.

*(b)* Lift end plate into position on studs on end of boiler (two men). Install the 12 washers and stud nuts which attach end plate to boiler.

*(c)* Install oil burner (subpar. **b** (4), below).

(5) REMOVAL OF CLEANER PLUG (fig. 97).

*(a)* Remove square nut from cleaner plug stud. Hang onto stud to prevent plug from falling into boiler.

*(b)* Lift C-clamp from stud. Turn cleaner plug sideways and pull from boiler.

(6) INSTALLATION OF CLEANER PLUG (fig. 97).

*(a)* Turn cleaner plug sideways and insert through opening in boiler. Straighten cleaner plug and slide C-clamp on stud. Do not drop parts into boiler.

*(b)* Install square nut on cleaner plug stud.

**b. Oil Burner.**

(1) REMOVAL.

*(a)* Remove belt guard (fig. 108) by removing the three cap screws which secure it to the boiler and frame.

*(b)* Remove blower belt (fig. 108).



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*(c)* Disconnect fuel line from elbow (fig. 108) on burner.

*(d)* Pull electrode ignition wire from magneto (fig. 108).

*(e)* Remove three stud nuts which attach oil burner and blower assembly to boiler end plate (fig. 108).

(2) DISASSEMBLY.

NOTE: It is unnecessary to remove burner from boiler to disassemble burner (fig. 108).

*(a)* Remove the four cap screws which secure burner end plate to burner housing (fig. 107). (If burner is installed in boiler, first disconnect fuel lines and electrode ignition wire (fig. 108).)

*(b)* Pull end plate and attached electrodes, baffle, and nozzle from burner housing. Lift gasket from housing.

*(c)* Remove entire nozzle from oil pipe (fig. 109). To disassemble nozzle (fig. 110), remove tip. Screw screen from nozzle tip by hand. Remove baffle from tip.

*(d)* Remove the three screws which secure baffle to end of end cap frame. Lift baffle from frame (fig. 109).

*(e)* Remove screws which secure electrodes in holders. Remove screw which secures grounded electrode pigtail to end plate. Lift electrodes from end plate bracket (fig. 109).

*(f)* Remove the four screws which attach blower fan assembly to blower housing. Lift fan assembly and gasket from housing.

NOTE: If burner is installed in boiler, first remove belt guard and blower belt (fig. 108).

(3) ASSEMBLY.

*(a)* Place gasket and fan assembly in position in blower housing (fig. 108). Install four screws which secure fan assembly in place.

*(b)* Assemble nozzle as follows (fig. 110): Screw baffle into tip. Screw screen into tip by hand. Screw tip into body.

*(c)* Install nozzle on end oil pipe. Attach baffle to end of electrodes and nozzle assembly (fig. 109).

*(d)* Place electrodes in bracket and tighten screws just enough to keep electrodes in position. Adjust position of electrodes, using metal shims between clamps and porcelain if necessary, to obtain opening of 0.100 inch between tips of electrodes, with gap alined with nozzle opening and about $\frac{1}{4}$ inch from it. Tighten screws (fig. 109). Ground pig tail from grounded electrode to end plate.

*(e)* Insert electrode, nozzle, and end plate assembly into position within burner housing. Use a serviceable gasket under end plate. Install the four cap screws which secure end plate to burner housing.

(4) INSTALLATION (fig. 108).

*(a)* Using a new gasket, place burner assembly in position on end



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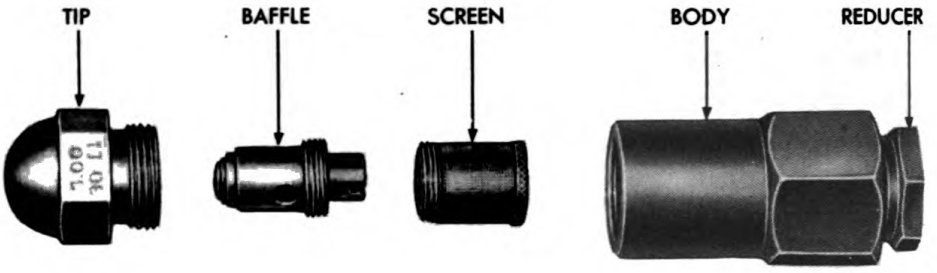



*Figure 110 — Steam Generating Plant Fuel Nozzle—Exploded View*

of boiler. Install the three stud nuts which secure burner to boiler end plate.

*(b)* Insert electrode ignition wire into its tower on magneto.

*(c)* Connect fuel line to fitting at elbow on burner.

*(d)* Work blower belt onto blower pulley.

*(e)* Install belt guard and tighten the three cap screws securely.

**c. Water Injectors.**

(1) REMOVAL (fig. 111).

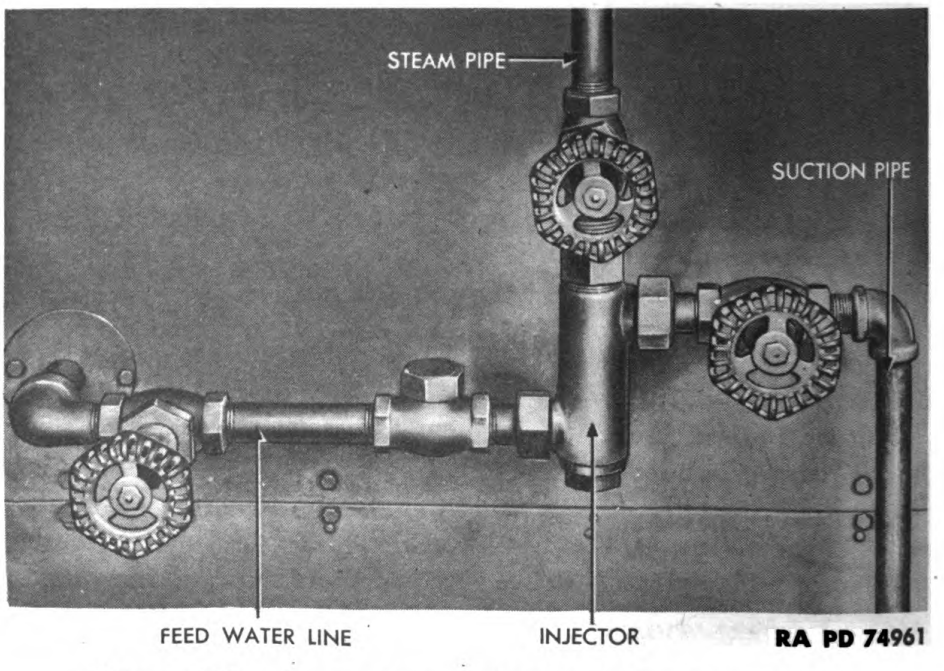



*Figure 111 — Steam Generating Plant Water Injector*



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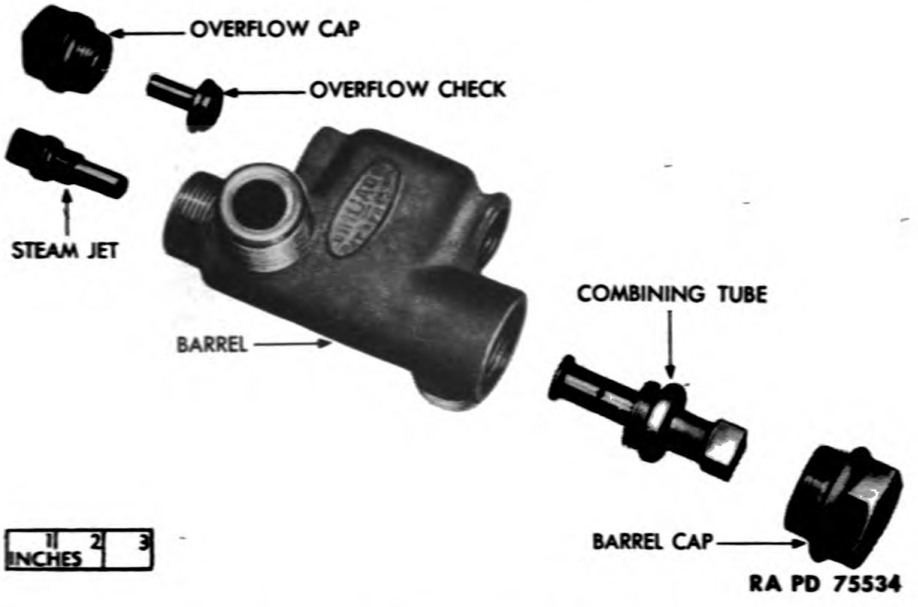



***Figure 112 — Steam Generating Plant Water Injector — Exploded View***

*(a)* Remove suction pipe and valve.

*(b)* Disconnect steam pipe from injector.

*(c)* Remove injector from boiler water line.

(2) DISASSEMBLY (fig. 112).

*(a)* Remove barrel cap from base of barrel.

*(b)* Screw forcing tube from base of barrel.

*(c)* Screw overflow cap from top of small cylinder and lift overflow check from its seat.

*(d)* Screw steam jet from top of barrel.

(3) ASSEMBLY (fig. 112).

*(a)* Screw steam jet into top of barrel.

*(b)* Place overflow check in its seat within top of small cylinder. Screw overflow cap into top of small cylinder.

*(c)* Screw forcing tube into base of barrel.

*(d)* Screw barrel cap into base of barrel.

(4) INSTALLATION (fig. 111).

*(a)* Connect boiler water line to threads near bottom of injector barrel.

*(b)* Connect steam pipe to top of injector.

*(c)* Connect suction pipe to threads near top of injector barrel.



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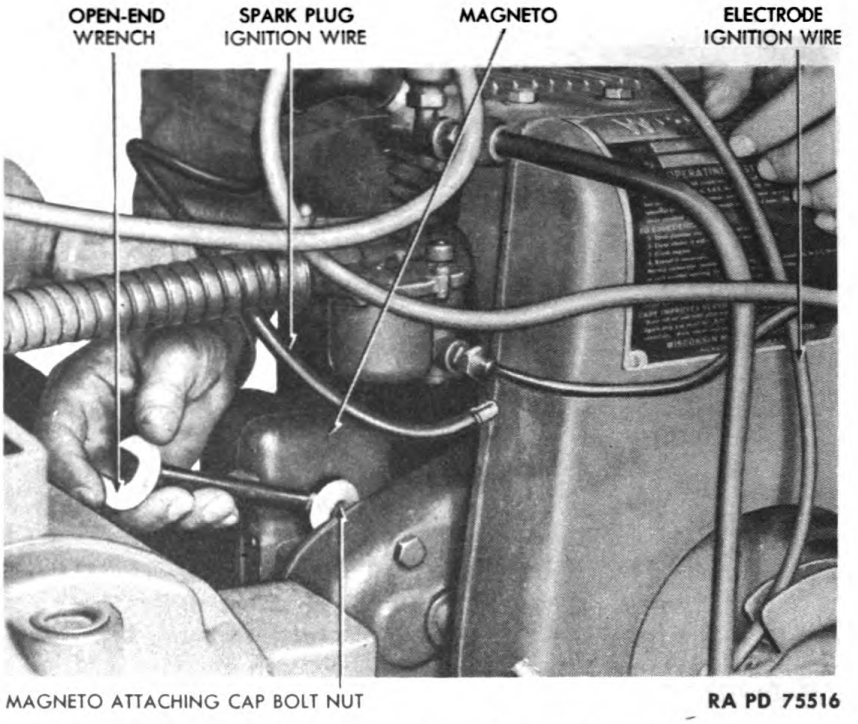



***Figure 113 — Removing Steam Generating Plant Engine Magneto***

**d. Engine.**

(1) REMOVAL OF ENGINE.

*(a)* Remove the 18 cap screws which attach engine compartment skirt to frame and boiler. Lift skirt from unit.

*(b)* Remove three screws which attach belt guard. Lift guard from unit. Remove all three bolts.

*(c)* Disconnect electrode ignition cable from magneto.

*(d)* Disconnect air cleaner flexible line from carburetor with screwdriver.

*(e)* Disconnect gasoline line from carburetor.

*(f)* Remove the four nuts, cap bolts, and lock washers which attach engine to frame.

*(g)* Lift engine from frame.

(2) INSTALLATION OF ENGINE.

*(a)* Place engine in position on frame. Install the four cap bolts, lock washers, and nuts which attach engine to frame, but do not tighten.

*(b)* Place three belts in position on engine pulley. Slide engine back until tension on belts allows ½- to ¾-inch flex under finger pressure midway between pulleys. Tighten engine-to-frame cap bolt nuts.



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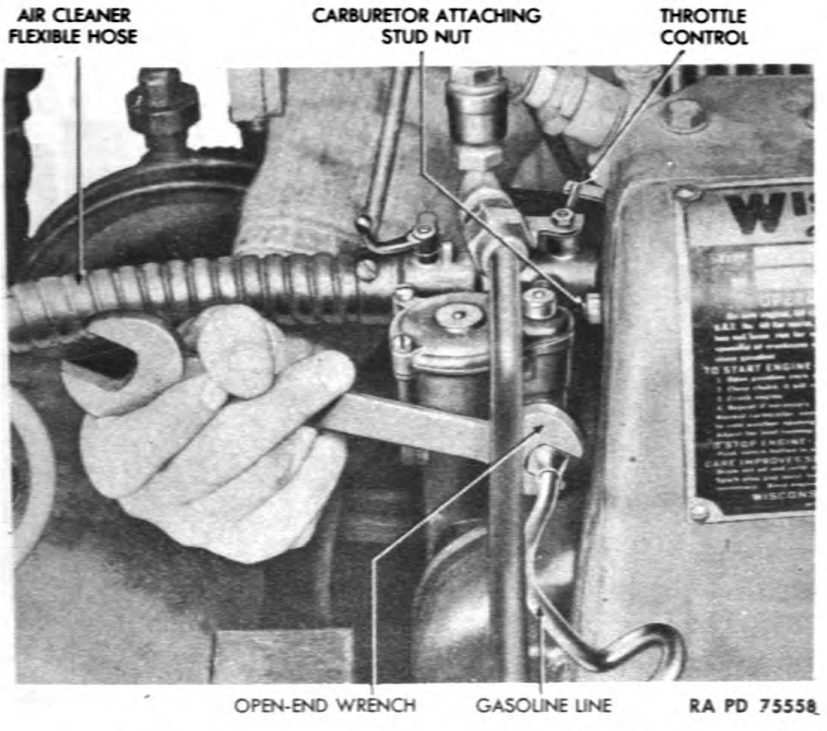



***Figure 114 — Removing Steam Generating Plant Engine Carburetor***

*(c)* Install belt guard. Tighten three cap screws which secure guard to unit.

*(d)* Connect gasoline line to carburetor.

*(e)* Connect air cleaner flexible hose to carburetor.

*(f)* Insert electrode ignition cable into its tower on magneto.

*(g)* Install engine skirt and tighten securely the 18 cap screws which secure skirt to unit.

(3) REMOVAL OF MAGNETO (fig. 113).

*(a)* Pull electrode ignition wire and spark plug ignition wire from magneto.

*(b)* Remove the stud nut, cap bolt nut, and two lock washers which attach magneto to engine.

*(c)* Lift magneto and gasket from engine.

(4) INSTALLATION AND TIMING OF MAGNETO.

*(a)* Place magneto and gasket in position on engine (fig. 113). Impulse will fit two ways. Either is satisfactory since either of two spark outlets can be used for engine ignition.

*(b)* Install the two magneto attaching nuts and lock washers (fig. 113).



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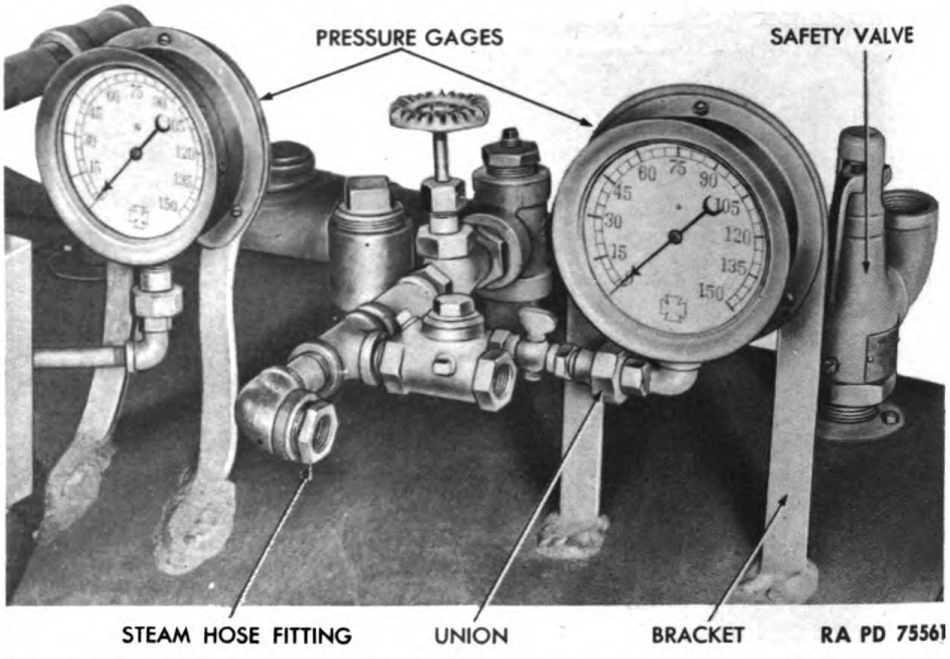



***Figure 115 — Steam Generating Plant Pressure Gages and Safety Valve***

*(c)* Install spark plug ignition wire and electrode ignition wire in outlets on breaker cover (fig. 113). Test operation of engine. If it fails to run, reverse the connections of the ignition wires to the magneto.

(5) REMOVAL OF CARBURETOR (fig. 114).

*(a)* Disconnect gasoline line from carburetor.

*(b)* Disconnect air cleaner flexible hose from carburetor.

*(c)* Disconnect throttle control from carburetor.

*(d)* Remove two carburetor attaching stud nuts.

*(e)* Lift carburetor and gasket from engine.

(6) INSTALLATION OF CARBURETOR (fig. 114).

*(a)* Using a new gasket, place carburetor in position on cylinder head. Install two carburetor attaching stud nuts.

*(b)* Connect throttle control to carburetor throttle lever. Use pliers to bend cotter key.

*(c)* Connect air cleaner flexible hose to carburetor.

*(d)* Connect gasoline line to carburetor.

**e. Piping and Gages.**

(1) REMOVAL OF STEAM PRESSURE GAGE (fig. 115).

*(a)* Disconnect pipe from gage at union.

*(b)* Remove three stove bolts which attach gage to bracket.

*(c)* Lift gage from bracket.



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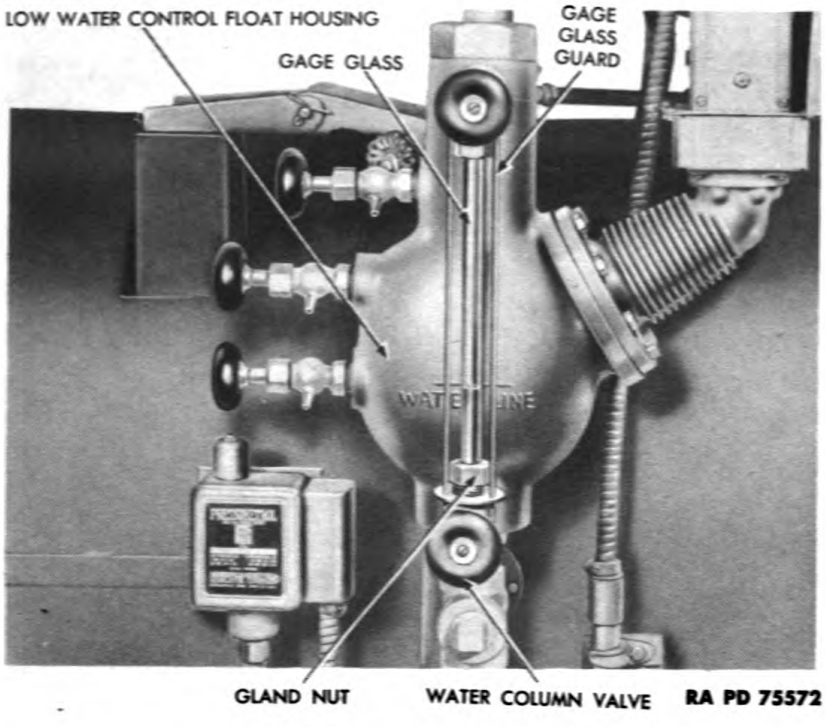



***Figure 116 — Steam Generating Plant Water Level Gage***

(2) INSTALLATION OF STEAM PRESSURE GAGE (fig. 115).

*(a)* Place gage in position on bracket. Install the three stove bolts which hold gage to bracket.

*(b)* Connect steam pipe to gage at union.

(3) REMOVAL OF WATER LEVEL GAGE (fig. 116).

*(a)* Lift two glass guard rods from gage.

*(b)* Completely unscrew both tube fittings from valves. Push fittings and rubber washers toward center of glass tube.

*(c)* Push glass tube into one valve and pull other end free of its valve. Lift tube from valves.

*(d)* Screw both valves from low water control float housing.

(4) INSTALLATION OF WATER LEVEL GAGE (fig. 116).

*(a)* Screw both valves onto fittings of low water control.

*(b)* Place gland nut on gage glass, threaded side toward adjacent ends. Put rubber washers on under gland nuts.

*(c)* Insert one end of gage glass into opening on upper valve, enter other end into opening of lower valve, and bring tube into position between valves. Push rubber washers to ends of tubes and screw gland nuts onto valve threads.



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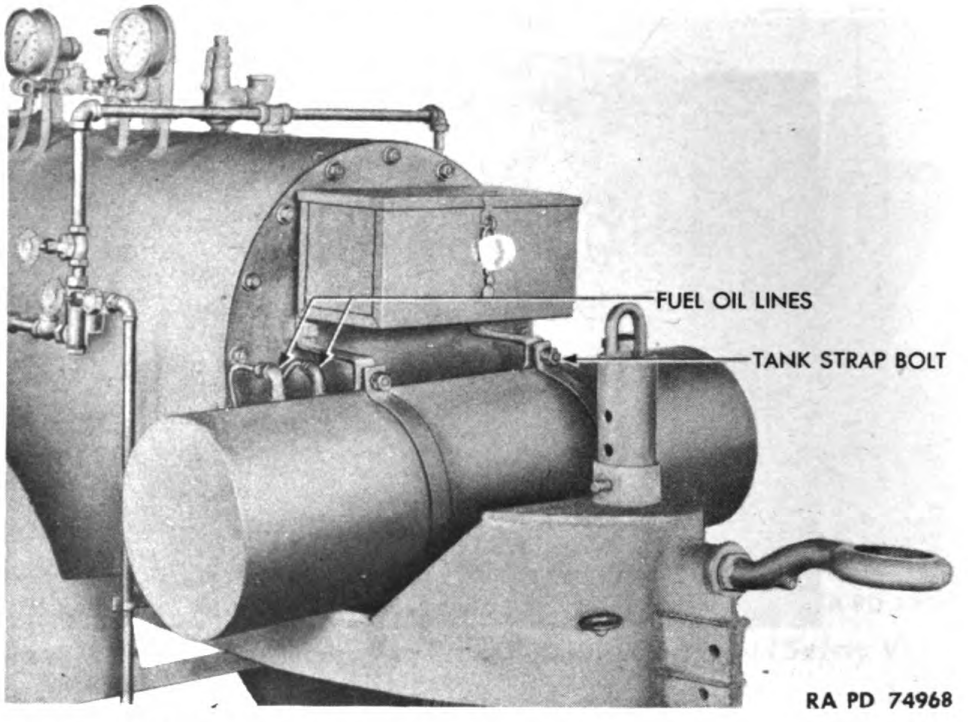



***Figure 117 — Fuel Oil Tank Installed on Steam Generating Plant***

*(d)* Drop two glass guard rods into position through holes in valve flanges.

(5) REMOVAL OF FUEL OIL PRESSURE GAGE (fig. 106). Screw gage from reducer tee on top of fuel oil pump with a soft-jawed pipe wrench or strap wrench.

(6) INSTALLATION OF FUEL OIL PRESSURE GAGE (fig. 106). Screw gage into reducer tee on top of fuel oil pump with a soft-jawed pipe wrench or strap wrench.

**f. Fuel Oil Tank.**

(1) REMOVAL (fig. 117).

*(a)* Remove drain plug from bottom of tank and allow oil to drain.

*(b)* Disconnect two fuel oil lines from fittings on top of tank.

*(c)* Remove the four tank strap bolt nuts, lock washers, and bolts. Lift straps and tank from bracket.

(2) INSTALLATION (fig. 117).

*(a)* Place tank in position on frame in front of boiler. Place straps in position about tank. Install the four tank strap bolts, lock washers, and nuts.



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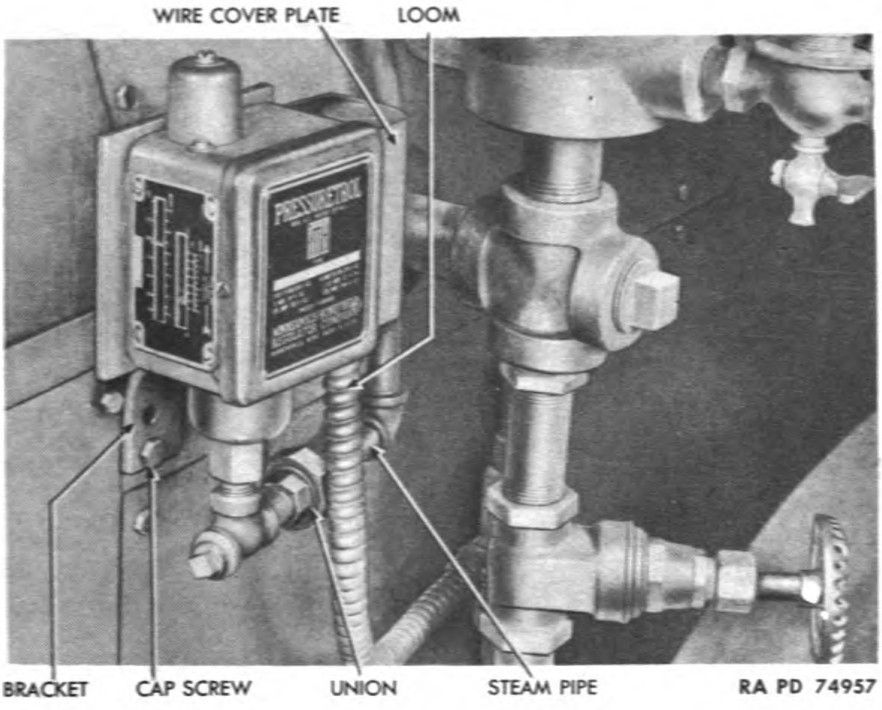



***Figure 118 — Steam Generating Plant Pressuretrol***

*(b)* Connect two fuel lines to fittings on top of tank.

*(c)* Install drain plug in bottom of tank.

**g. Pressuretrol.**

(1) REMOVAL (fig. 118).

*(a)* Remove wire cover plate. Disconnect two wires from switch. Remove BX connector from end of loom. Pull loom and wires free of pressuretrol.

*(b)* Disconnect steam pipe from bottom of pressuretrol at coupling.

*(c)* Remove cap screw which attaches bracket to boiler. Lift pressuretrol and bracket from boiler.

(2) INSTALLATION (fig. 118).

*(a)* Place pressuretrol and bracket in position on boiler. Install cap screw which holds bracket to boiler.

*(b)* Connect steam pipe coupling to threads on under side of pressuretrol.

*(c)* Insert two electric wires through opening in switch bracket. Connect two wires to two terminals of switch (either wire on either terminal). Connect end of loom to switch bracket with BX connector. Install wire cover plate.



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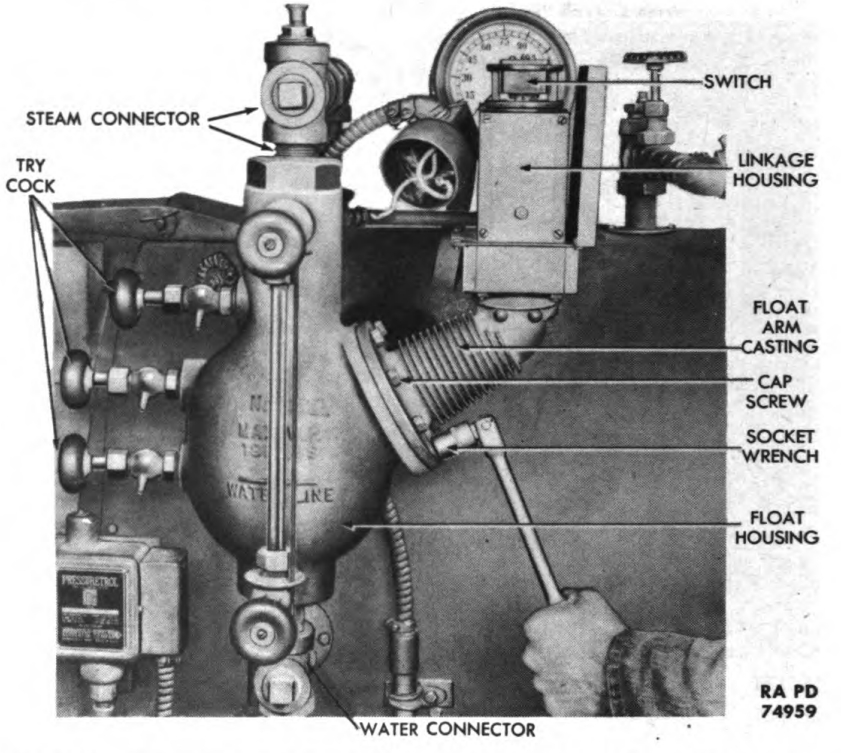



***Figure 119 — Removing Steam Generating Plant Low Water Control***

**h. Low Water Control** (fig. 119).

(1) REMOVAL (fig. 119).

*(a)* Remove two screws which attach switch housing to linkage housing. Lift switch housing from linkage housing. Disconnect electric wires from switch terminals marked "1" and "2."

*(b)* Remove the eight cap screws which secure float arm casting to float housing. Lift float arm casting with attached switch and float assemblies from float housing. Lift gasket from housing.

(2) DISASSEMBLY (fig. 120).

*(a)* To remove switch: remove four screws and lift guard from linkage housing; disconnect linkage by tapping out pin; remove the four screws which attach switch to housing; lift switch from housing.

*(b)* To remove linkage housing and base from float arm casting: remove the four screws which attach linkage housing to its base; lift housing from base; remove four screws which attach base to float arm casting; lift base from casting.

*(c)* To remove float and bellows assembly from float arm casting: remove eight hexagonal-head cap screws which attach bellows flange to float arm casting; lift flange and bellows as far from casting



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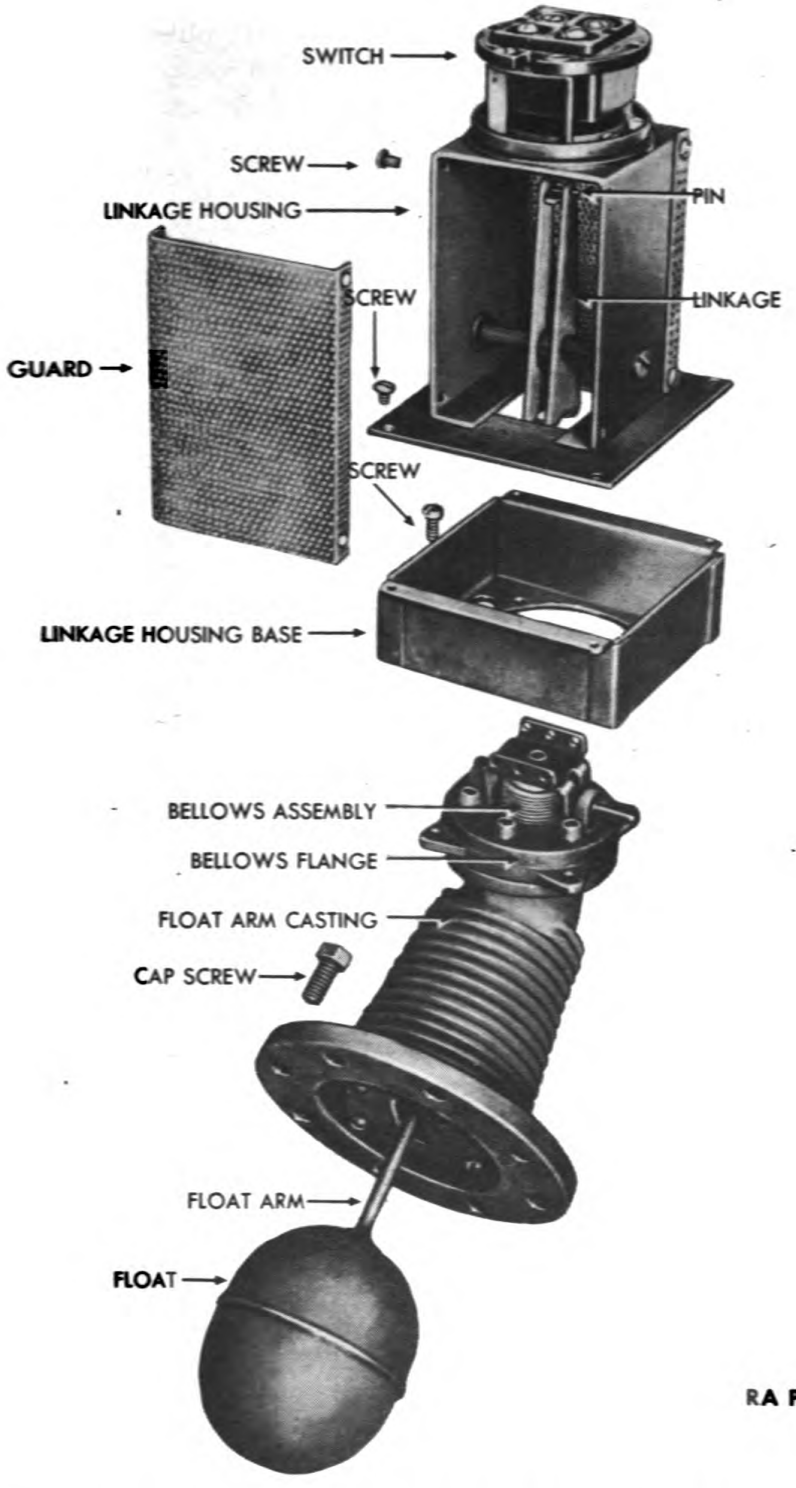



***Figure 120 — Steam Generating Plant Low Water Control — Partially Exploded View***



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as float will permit; take hold of float arm boss with pliers and screw float and arm from boss; lift flange, bellows, and gaskets from top of casting, and float and float arm from bottom of casting.

(3) ASSEMBLY (fig. 120).

*(a)* Place gasket, flange, and bellows upon top of float arm casting. Insert float arm through casting from lower end. Screw float arm into its boss in bellows assembly by hand. Tighten with pliers. Install eight socket-head cap screws which attach bellows flange to float arm casting.

*(b)* Place linkage housing base in position on float arm casting and install the four screws which hold them together. Place linkage housing in position on its base and install the four screws which hold them together.

*(c)* Place switch in position on top of linkage housing with terminals "1" and "2" toward float, and install eight screws. Connect linkage below switch by inserting pin. Install guard on housing.

(4) INSTALLATION (fig. 119).

*(a)* Place new gasket and float arm casting, with attached switch and float assemblies, in position on float housing. Install the eight cap screws which secure casting to housing.

*(b)* Connect electric wires to terminals "1" and "2" on switch. Either wire may go on either terminal. Place switch housing in position on top of linkage housing. Install two screws which secure housings together.

**i. Generator.**

(1) REMOVAL OF GENERATOR (fig. 121).

*(a)* Remove engine compartment skirt.

*(b)* Remove cover from generator junction box.

*(c)* Disconnect red generator lead from black solenoid valve lead. Disconnect red generator lead from blue pressuretrol lead.

*(d)* Remove junction box from generator.

*(e)* Remove carburetor air cleaner flexible hose.

*(f)* Disconnect gasoline line from gasoline tank.

*(g)* Remove the four cap bolts, nuts, and flat washers which secure generator frame.

*(h)* Lift generator from frame.

(2) INSTALLATION OF GENERATOR (fig. 121).

*(a)* Place generator in position on frame and install the four cap bolts, flat washers, and nuts which hold generator to frame.

*(b)* Install generator junction box on generator.



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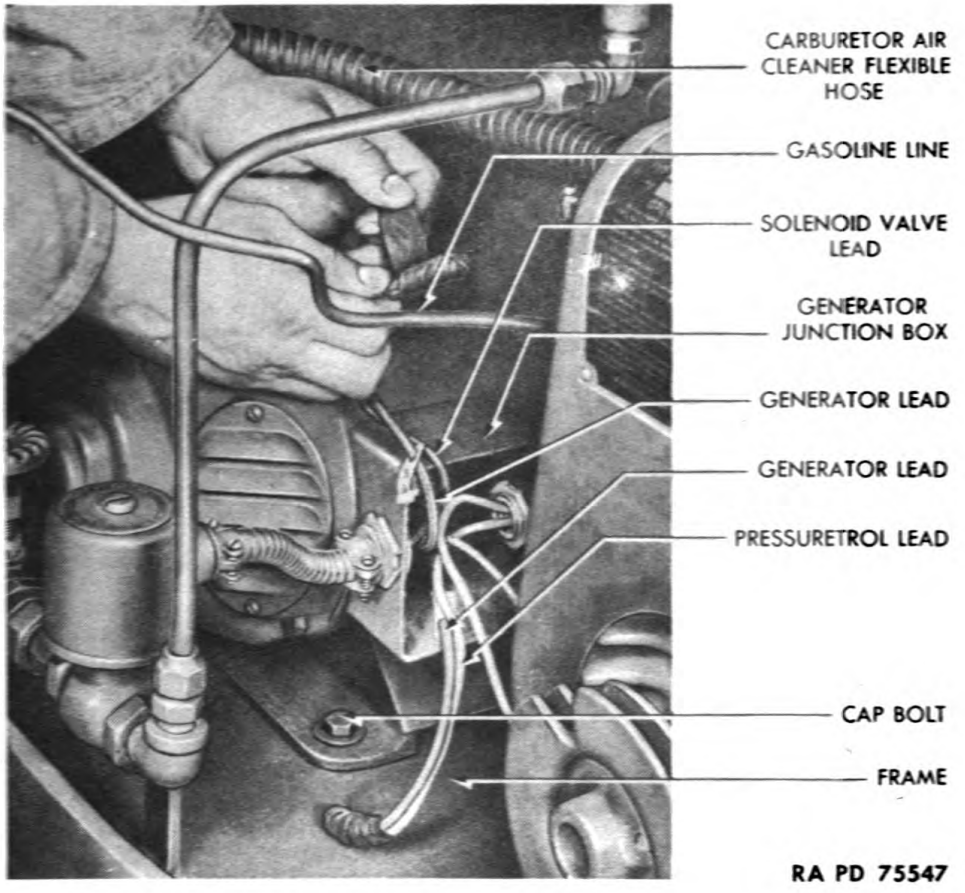



***Figure 121 — Removing Steam Generating Plant Generator***

*(c)* Connect red generator lead (either one) to blue pressuretrol lead; connect other red generator lead to black solenoid-valve lead. Solder and tape connections. Install cover on junction box.

*(d)* Connect gasoline line to tank. Install carburetor air cleaner flexible hose.

*(e)* Install engine compartment skirt.

(3) REMOVAL OF GENERATOR BRUSH (fig. 122).

*(a)* Remove generator brush cover.

*(b)* Remove screw which attaches brush pig tail to brush holder.

*(c)* Lift brush spring and slide brush from holder.

(4) INSTALLATION OF GENERATOR BRUSH (fig. 122).

*(a)* Lift brush spring and slide brush into holder.

*(b)* Connect brush pig tail to brush holder.

*(c)* Install generator brush holder.



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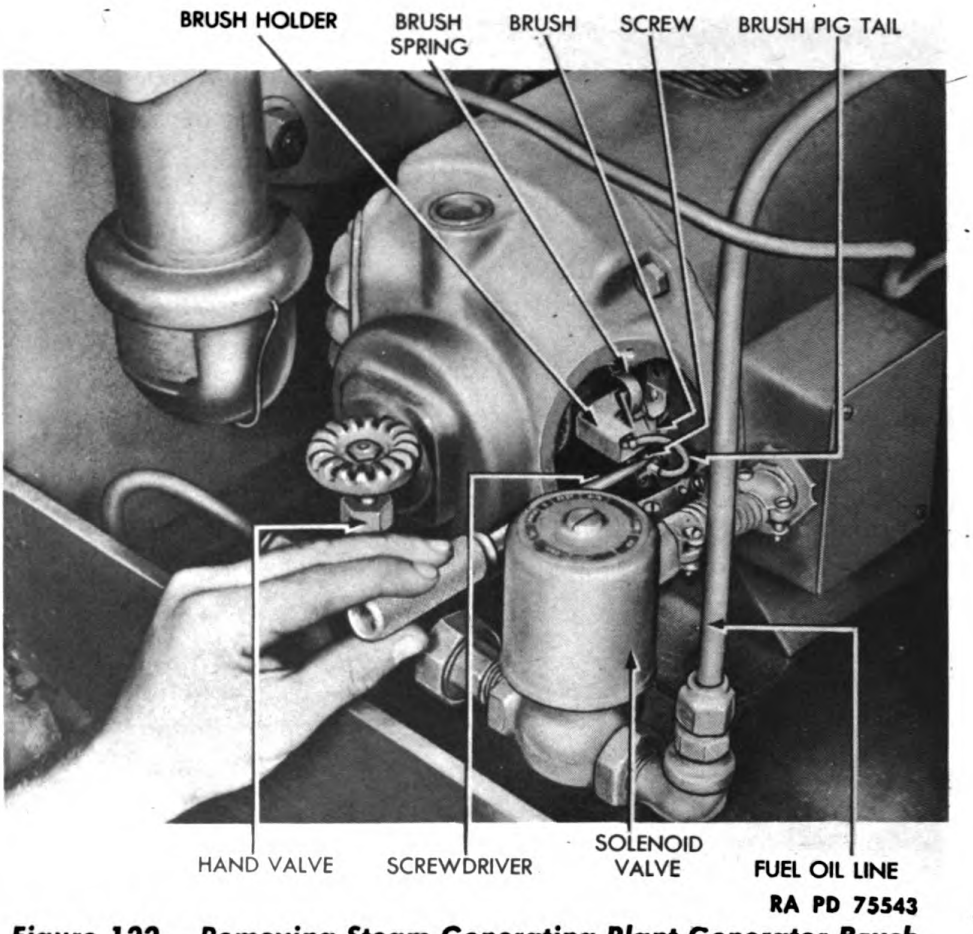



*Figure 122 — Removing Steam Generating Plant Generator Brush*

**j. Solenoid Valve.**

(1) REMOVAL.

*(a)* Remove cover from generator junction box and disconnect two solenoid valve leads.

*(b)* Remove clamp at solenoid valve and disconnect BX loom.

*(c)* Disconnect fuel oil line from solenoid valve.

*(d)* Disconnect union between solenoid valve and hand valve.

*(e)* Remove the two screws which attach solenoid valve to bracket and lift valve from bracket.

(2) INSTALLATION (fig. 122).

*(a)* Place solenoid valve in position on bracket and install two attaching screws.

*(b)* Connect union between solenoid and hand valves.

*(c)* Connect fuel oil line to solenoid valve.



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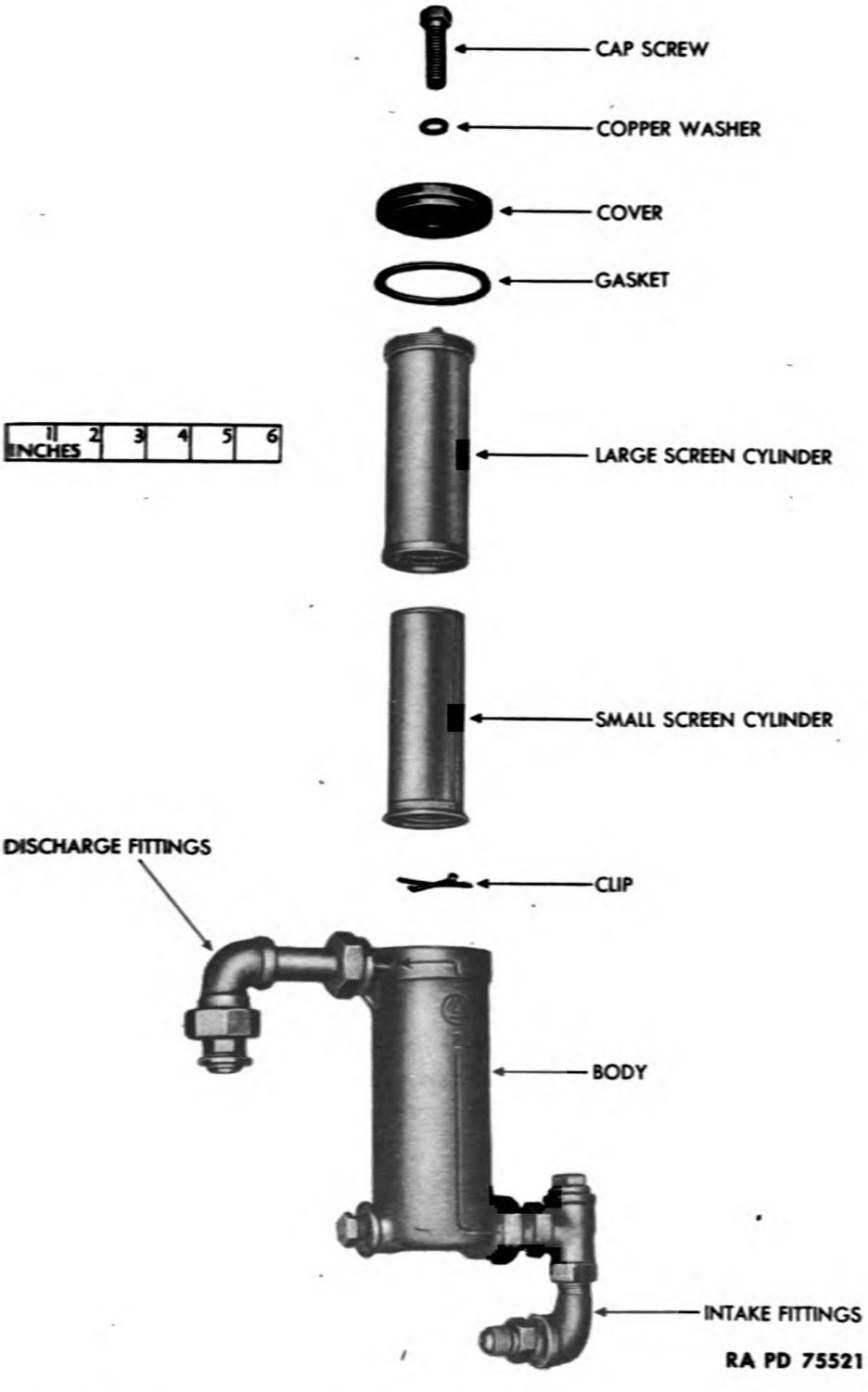



***Figure 123—Steam Generating Plant Fuel Oil Strainer—Exploded View***



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*(d)* Thread valve electric wires through BX loom to generator junction box. Connect loom to solenoid valve.

*(e)* Connect one solenoid valve lead to lead from pressuretrol and low water control. Connect other solenoid valve lead to red generator lead. Solder and tape connections. Install generator junction box cover.

**k. Safety Valve** (fig. 115).

(1) REMOVAL. Unscrew safety valve from boiler.

(2) INSTALLATION (fig. 115). Screw safety valve into opening provided for it on top of boiler.

**l. Fuel Oil Strainer.**

(1) REMOVAL (fig. 100).

*(a)* Disconnect fuel oil line from fitting below strainer.

*(b)* Disconnect union in pipe from strainer to pump. Lift strainer from unit.

(2) DISASSEMBLY (fig. 123).

NOTE: Strainer may be disassembled while installed.

*(a)* Remove cap screw and copper washer from center of strainer cover.

*(b)* Lift cover and gasket from strainer body.

*(c)* Screw strainer element from body by hand.

*(d)* Slide slip from bottom of element and pull small screen cylinder from large screen cylinder.

(3) ASSEMBLY (fig. 123).

*(a)* Slide small screen cylinder inside large screen cylinder and install clip across bottom of large cylinder.

*(b)* Screw strainer element into body by hand.

*(c)* Place gasket and cover in position on top of body. Install copper washer and cap screw in center of cover.

(4) INSTALLATION (fig. 100).

*(a)* Place strainer in position on pipe to pump and connect coupling.

*(b)* Connect fuel oil line to fitting below strainer.

**m. Fuel Oil Pump.**

(1) REMOVAL (fig. 100).

*(a)* Disconnect oil inlet and outlet pipes from pump.

*(b)* Remove pump drive belt from pump pulley.



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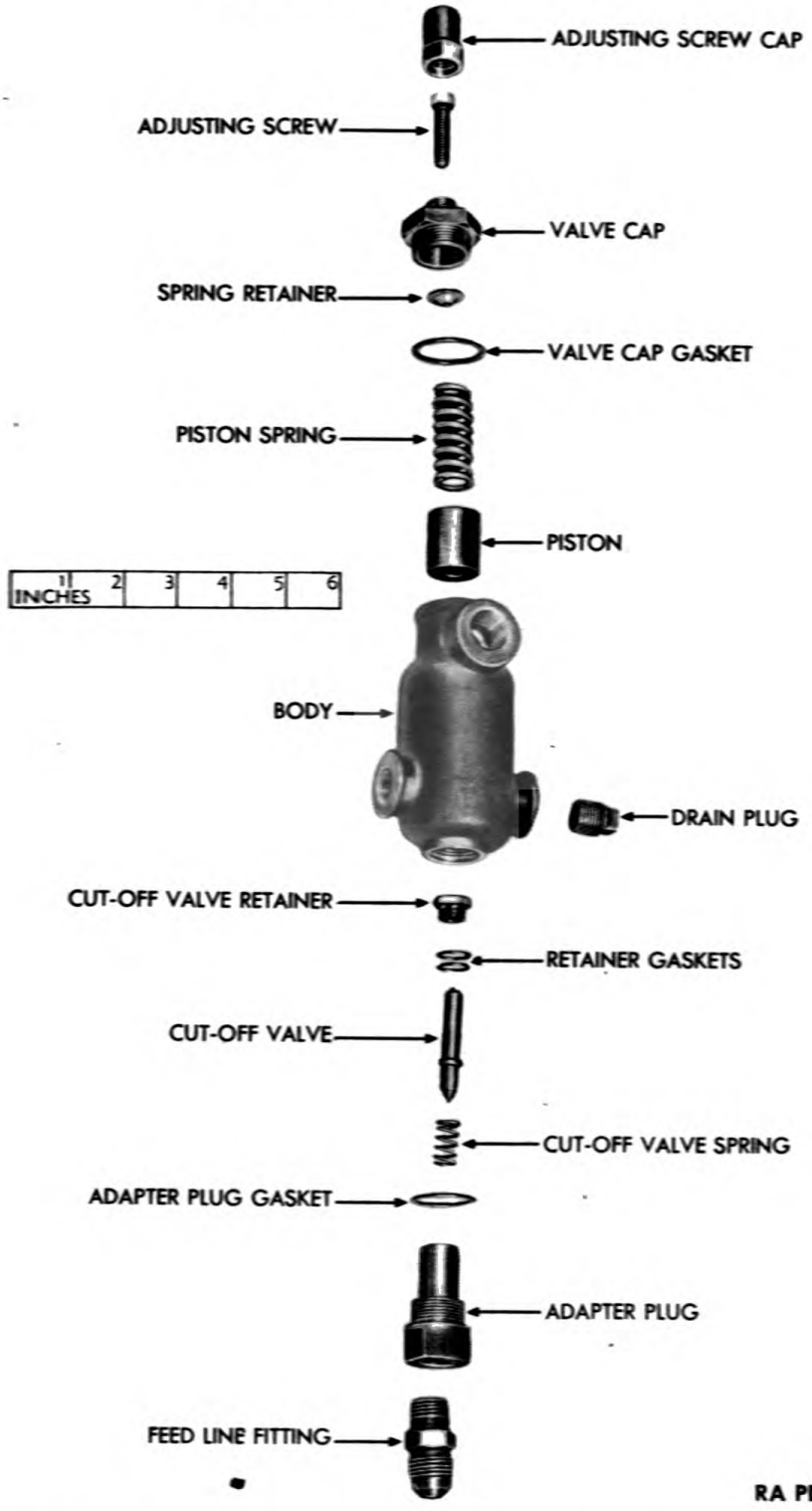



***Figure 124 — Steam Generating Plant Fuel Oil Relief Valve — Exploded View***



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*(c)* Remove the two cap screws and lock washers which secure pump to bracket.

(2) INSTALLATION (fig. 100).

*(a)* Place pump in position on bracket and install two attaching lock washers and cap screws.

*(b)* Work drive belt into pump pulley.

*(c)* Connect oil inlet and outlet pipes to pump at couplings.

**n. Fuel Oil Relief Valve.**

(1) REMOVAL (fig. 100).

*(a)* Disconnect burner feed line from fitting on bottom of relief valve.

*(b)* Disconnect oil return line from fitting on elbow on side of relief valve.

*(c)* Turn relief valve from pipe from oil pump.

(2) DISASSEMBLY (fig. 124).

*(a)* Screw adjusting screw cap from top of valve cap.

*(b)* Screw valve cap from top of body. Lift gasket from cap and screw adjusting screw from cap by hand.

*(c)* Lift spring retainer piston spring, and piston spring, and piston from top of body.

*(d)* Screw drain plug from side of body.

*(e)* Screw feed line fitting from bottom of adapter plug.

*(f)* Screw adapter plug from bottom of body. Lift gasket from plug.

*(g)* Remove cut-off valve retainer from top of adapter plug. Pick two gaskets from retainer. Lift cut-off valve and spring from top of adapter plug.

(3) ASSEMBLY (fig. 124).

*(a)* Slide cut-off valve spring into top of adapter plug. Insert cut-off valve into top of adapter plug. Be sure end of valve to which spring flange is nearer, goes in first. Place two retainer gaskets on cut-off valve retainer and screw retainer into top of adapter plug. Place adapter plug gasket on adapter plug and screw plug into bottom of body. Screw feed line fitting into adapter plug.

*(b)* Install drain plug in side of body.

*(c)* Insert piston, piston spring, and spring retainer into top of body. Screw adjusting screw about one-fourth its length into valve cap. Install valve cap gasket and valve cap on top of body. Screw adjusting screw cap fingertight onto valve cap, pending adjustment after installation.



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***Figure 125 — Removing Steam Generating Plant Drain Valve***

(4) INSTALLATION (fig. 100).

*(a)* Screw relief valve onto pipe from oil pump.

*(b)* Connect oil return line to elbow on fitting on side of relief valve.

*(c)* Connect burner feed line to fitting on bottom of relief valve.

*(d)* Start engine (par. 78) and adjust relief valve (par. 79 g).

**o. Drain Valve.**

(1) REMOVAL (fig. 125).

*(a)* Remove stud nut and lock washer which secure handle bracket to frame. Pull handle and bracket from valve.

*(b)* Remove drain valve from drain pipe.

(2) INSTALLATION (fig. 125).

*(a)* Screw drain valve onto drain. pipe.

*(b)* Insert handle shaft into valve and place handle bracket on stud on frame. Install lock washer and stud nut which secure bracket to frame.

## 81. INSPECTION INSTRUCTIONS.

**a. Before Starting Engine.**

(1) Check quantity of oil in fuel oil tank. Fill tank if necessary.

(2) Check quantity of gasoline in gasoline tank. Fill tank if necessary. See that shut-off valve below tank is "OPEN."



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(3) Check quantity of oil in engine crankcase. Fill to level or filler plug if necessary.

(4) Check boiler water level as indicated by water column gage glass. Fill to 2 inches above "WATER LINE."

**b. During Engine Warm-up.**

(1) Check position of choke lever on engine carburetor to be sure it is "OPEN" (lever all the way toward exhaust pipe).

(2) Note fuel oil pressure as indicated by gage on fuel oil pump. Pressure should be 100 to 120 pounds.

(3) Check position of all valves to see that they are as follows:

| | |
|---|---|
| Gasoline shut-off valve | "OPEN" |
| Fuel oil valve | "OPEN" |
| Pressuretrol valve | "OPEN" |
| Top and bottom water column gage valves | "OPEN" |
| All other valves | "CLOSED" |

**c. While in Operation.**

(1) Note exhaust from boiler stack. Regulate butterfly valve on blower to eliminate smoke.

(2) Watch water level gage. Add water occasionally to keep water level about 2 inches above "WATER LINE."

(3) Note steam pressure as indicated by boiler gage to be sure it stays within limits of pressuretrol adjustment.

(4) Inspect fittings, pipes, and valves for presence of steam leaks.

(5) Check operation of safety valve by tripping it by hand at least once in every 8 hours of operation.

(6) Inspect fuel oil and gasoline lines and fittings to see if leaks are present.

**d. Daily.**

(1) Measure tire pressure. Inflate tires if necessary to maintain 45-pound pressure.

(2) Inspect all bolts, nuts, screws, and joints to see if any are loose. Tighten if necessary.

(3) Check sediment bowl below gasoline tank. Remove and clean bowl if sediment or water bubbles are visible.

**e. Periodically.**

(1) Every 25 hours of operation or sooner if oil pressure drops, remove fuel oil filter element and inspect screens. Clean in solvent to remove dirt. Blow dry with an air blast.

(2) Monthly check condition of insulation on high-tension ignition wires. See that snap-on connectors are in perfect contact with cable ends.



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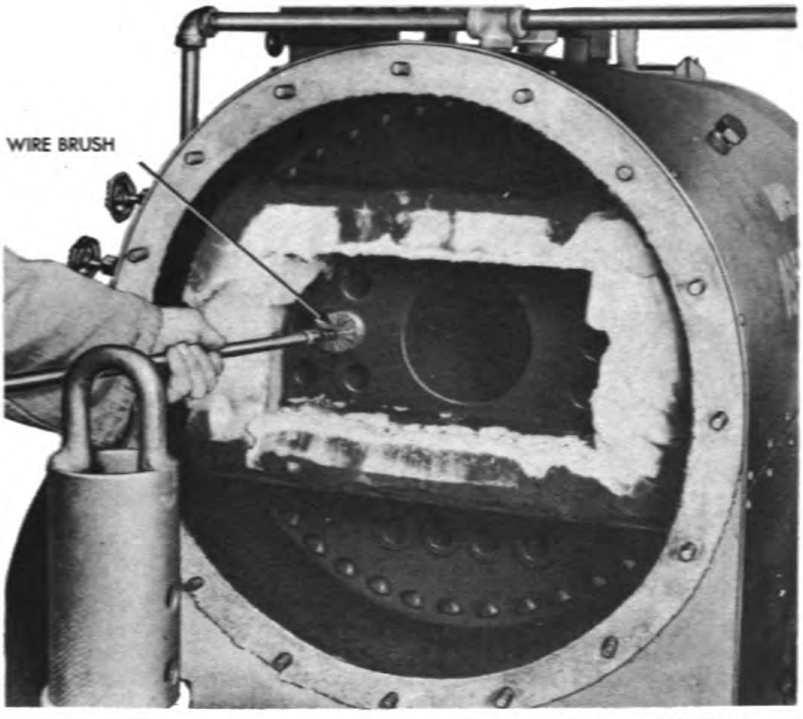



*Figure 126 — Cleaning Steam Generating Plant Boiler Tubes*

## 82. CARE, CLEANING, AND LUBRICATION.

### a. Care and Cleaning.

(1) CLEANING BOILER (fig. 126). In operation, boiler tubes will accumulate soot. Clean boiler tubes as follows:

*(a)* Remove boiler front and rear end plates (par. 80 a (1) and (3) ).

*(b)* Remove all soot from tubes, combustion chamber, and end chambers with a wire brush.

*(c)* Cementing fire brick and using new gaskets, install boiler front and rear end plates (par. 80 a (2) and (4) ).

(2) CLEANING OIL BURNER NOZZLE. Dirt in burner noozle impairs burner efficiency or stops operation entirely. To rectify this condition remove, disassemble (par. 80 a (2) ), and clean nozzle. Use SOLVENT, dry-cleaning, to clean nozzle screen and lacquer thinner to clean orifice. Never use wire or sharp tools as they will mutilate orifice and render nozzle unfit for further use.

(3) CLEANING CARBON DEPOSITS FROM ENGINE CYLINDER. Every 50 hours of operation, remove lead deposits from engine cylinder by water injection method. Procedure is as follows:

*(a)* Disconnect air cleaner flexible hose from carburetor.



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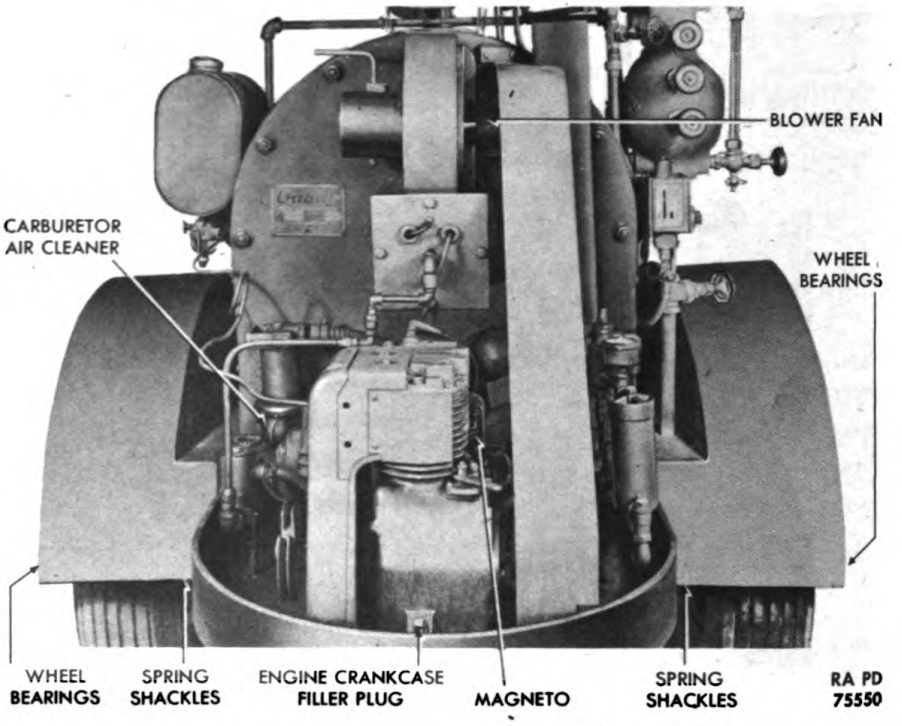



***Figure 127 — Lubrication Points of Steam Generating Plant***

*(b)* Start engine and run it until thoroughly warmed up.

*(c)* Fill a squirt type oilcan having a spout opening $\frac{3}{32}$ inch with clean fresh water (not salt water).

*(d)* With squirt can in one hand and other hand on carburetor choke lever, squirt water into carburetor air intake until engine slows down. Before engine stops, interrupt water injection and partly close carburetor choke until engine recovers speed.

*(e)* Continue process until about 1 pint of water has been used.

*(f)* Drain engine oil *(important)* and fill crankcase with new oil (subpar. b (3), below).

*(g)* Connect air cleaner flexible hose to carburetor.

(4) CLEANING FUEL OIL RELIEF VALVE. Sometimes fuel oil relief valve becomes slow acting because of dirt or gummy deposits. This condition is indicated by fluctuation of oil pressure gage. To rectify, remove (par. 80 n (1) ), and disassemble (par. 80 n (2) ) valve. Clean parts in SOLVENT, dry-cleaning, and assemble (par. 80 n (3) ) and install (par. 80 n (4) ) valve.

**b. Lubrication.**

(1) GENERAL.

*(a) Spring Shackles* (fig. 127). Every 30 days, unless plant is in



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storage, lubricate fittings on spring shackles with GREASE, general purpose, No. 1, above −32 F or GREASE, general purpose, No. 0, below −32 F.

*(b) Wheel Bearings* (fig. 127). Annually, remove wheels and and clean all parts in solvent. Dry thoroughly. Repack bearings with GREASE, wheel bearing, No. 2.

(2) BLOWER FAN (fig. 127). Every day plant is in use, turn grease cup on blower fan shaft housing down two full turns with fingers. When cup empties, fill with GREASE, general purpose, No. 2.

(3) ENGINE.

*(a) Crankcase* (fig. 127). After 50 hours' operation (following cleaning of lead deposits from cylinder as outlined in subparagraph a (3), above, drain crankcase. Replace drain plug and fill to level of filler plug with engine oil selected in accordance with chart below. Approximate capacity is 1¾ pints.

| Season | Temperature Range | Viscosity Oil |
|---|---|---|
| Spring, Summer, Autumn | Above −32 F | SAE No. 30 |
| Winter | 0 to −32 F | SAE No. 10 |
| Winter | Below 0 F | Refer to TB 9-2835-3 |

NOTE: If engine is operated under cover during winter, follow summer recommendations for temperature condition.

*(b) Carburetor Air Cleaner* (fig. 127). Once a week (oftener under dusty conditions), remove air cleaner oil reservoir. Empty oil from reservoir and wipe reservoir with clean cloth. Fill reservoir to bead with OIL, engine (crankcase grade) (approx. ¼ pt). Install reservoir on filter. Periodically, depending on conditions under which plant operates, remove entire air cleaner and wash element in SOLVENT, dry-cleaning. Dry thoroughly and install.

*(c) Throttle Linkage and Choke Lever.* Once a week, or oftener if necessary, oil throttle linkage and choke lever with OIL, engine (crankcase grade).

*(d) Magneto* (fig. 127). After every 200 hours operation, fill the two oilers (one on each side of main housing) to overflowing with OIL, engine, SAE 10. It is necessary to remove (par. 80 d (3) ) the magneto to reach the oilers on this installation.



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## CHAPTER 6

# SPARE PARTS AND ACCESSORIES

### 83. GENERAL.

**a. Spare Parts.** Extra parts are provided with ordnance bomb disposal equipment for replacement of parts most likely to fail and for use in making minor repairs. Keep spare parts clean at all times. Keep metal parts lightly oiled with OIL, lubricating, preservative, medium, or OIL, engine, SAE 30. Apply oil to prevent rust. Keep sets of spare parts complete at all times. Whenever a part or assembly is taken from a set to replace a defective part, procure a new part or repair the defective part and place it in the spare part set as soon as possible. Keep assemblies carried in spare parts sets complete, correctly assembled, and ready for installation at all times.

**b. Accessories.** Tools are furnished with ordnance bomb disposal equipment for assembling, disassembling, and cleaning. Do not use accessories for purposes other than those for which they are intended. When not in use, keep accessories stored in places or receptacles provided for them.

### 84. AIR COMPRESSOR AND PNEUMATIC TOOLS.

**a. General.** In this paragraph, air tools, accessories, and spare parts issued to ordnance bomb disposal personnel with motorized air compressor model 105GA are listed and illustrated. In addition to accessories listed here, others accompany the truck on which compressor unit is mounted. They do not fall within the scope of this manual.



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## SPARE PARTS AND ACCESSORIES

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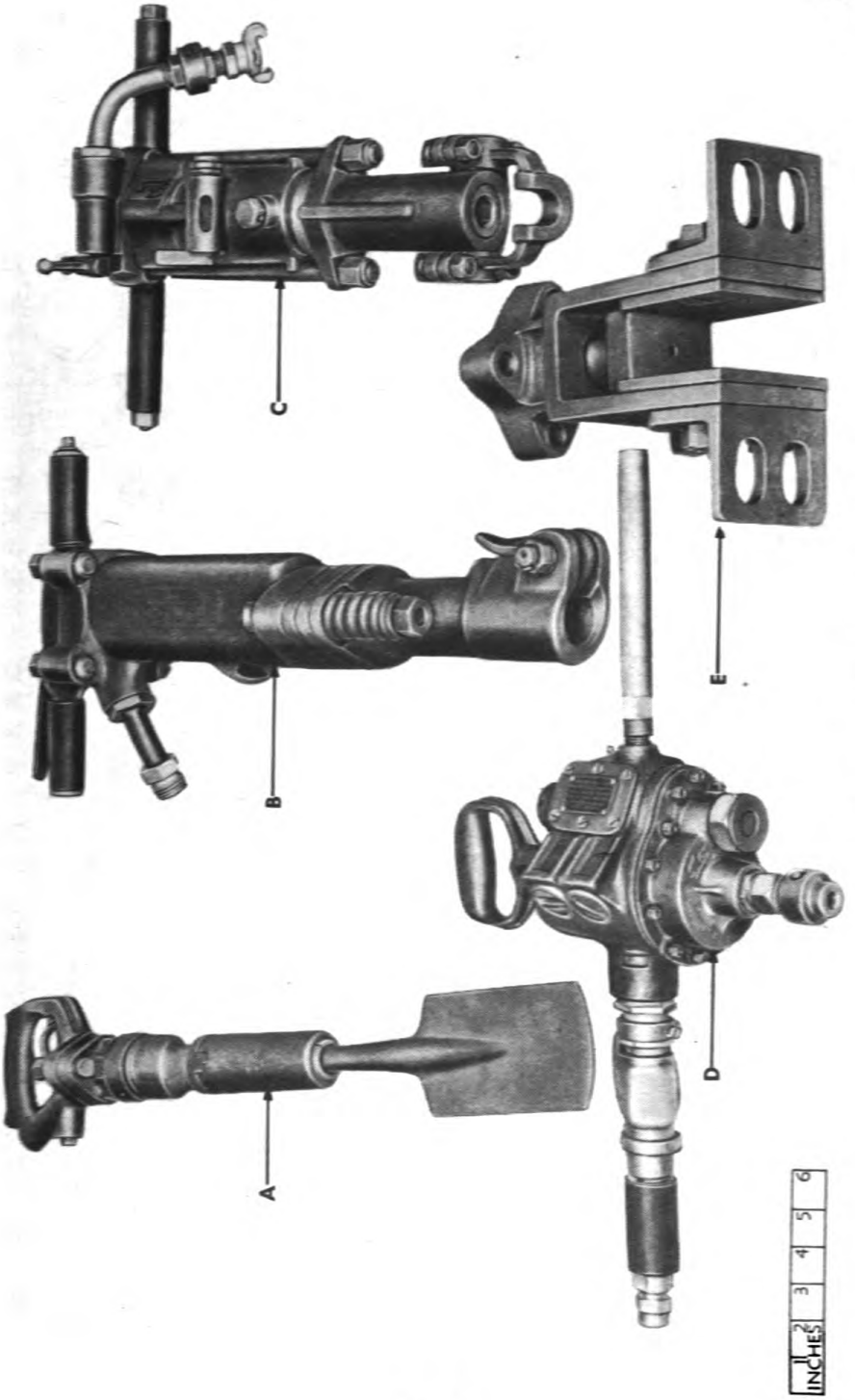



*Figure 128 — Pneumatic Tools*



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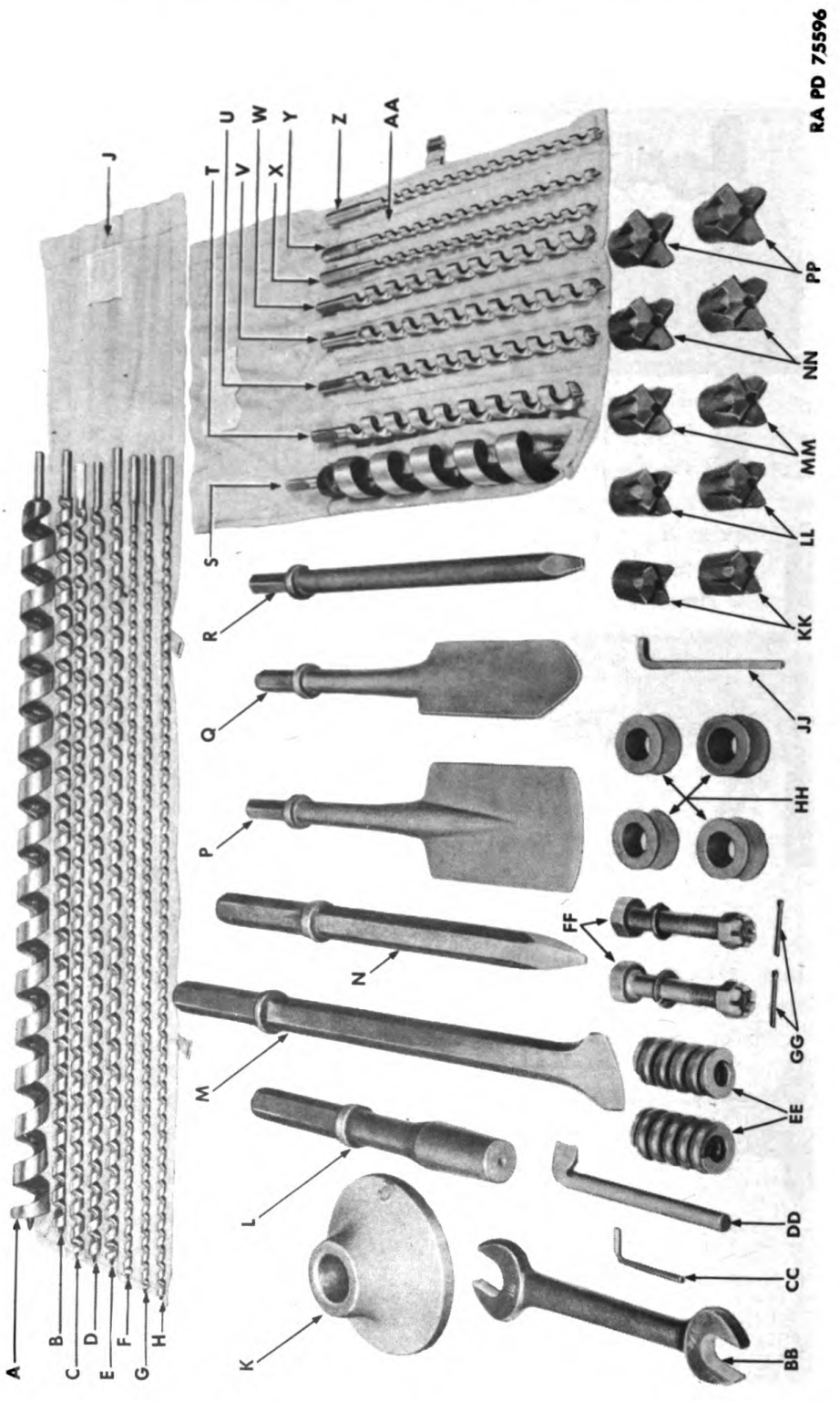



*Figure 129 — Pneumatic Tool Accessories*



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## SPARE PARTS AND ACCESSORIES

### b. Pneumatic Tools and Accessories.

| Item No. | Fig. No. | Part No. | Name | Quantity |
|---|---|---|---|---|
| | 5 | A88-242 | Combination vise | 1 |
| | 5 | A88-238 | Workbench assembly | 1 |
| A | 128 | A88-169-2 | No. 412 Thor clay digger complete, together with HH, fig. 129 | 2 |
| B | 128 | A88-168-1 | No. 25 Thor paving breaker complete, together with E, fig. 128 | 1 |
| C | 128 | A88-167 | No. 75 Thor sinker rock drill complete, together with BB and CC, fig. 129 | 1 |
| D | 128 | A88-170 | No. 62-WB Thor Pneumatic Reversible wood boring machine complete, together with JJ, fig. 129 | 1 |
| E | 128 | C-2590 | No. 25S Thor sheeting driver head | 1 |
| A | 129 | 2" x 36" | Ship auger | 1 |
| B | 129 | 1" x 36" | Ship auger | 1 |
| C, D, E | 129 | ¾" x 36" | Ship auger | 3 |
| F, G, H | 129 | 13/16" x 36" | Ship auger | 3 |
| A-J | 129 | A88-244 | Set of ship auger bits, consisting of A to J incl., fig. 129 | 1 |
| J | 129 | | Canvas case with two tie cords | 1 |
| K | 129 | A88-180-1 | Dirt tamper pad, together with: | 1 |
| L | 129 | | Dirt tamper rod | 2 |
| M | 129 | 88-181 | Chisel bit | 2 |
| N | 129 | 88-182 | Moil point, 1¼" hex 14" | 3 |
| P | 129 | 88-183 | Clay spade | 2 |
| Q | 129 | 88-184 | Flat pick | 2 |
| R | 129 | 88-185 | Moil point, 1" diam x 15" | 2 |
| S | 129 | 2" x 12" | Ship auger | 1 |
| T | 129 | 1" x 12" | Ship auger | 1 |
| U, V, W | 129 | ¾" x 12" | Ship auger | 3 |
| X, Y, Z | 129 | 13/16" x 12" | Ship auger | 3 |
| S-AA | 129 | A88-245 | Set of ship augers, consisting of S to Z incl. and AA, fig. 129 | 1 |
| AA | 129 | | Canvas case with one tie cord | 1 |
| BB | 129 | 1 1/16" x 1¼" | Double open-end wrench | 1 |
| CC | 129 | 3/16" hex. | Recessed-head set screw wrench | 1 |
| DD | 129 | C-2059 | Thor screwdriver | 1 |
| EE | 129 | C-2022 | Thor front head bolt spring | 2 |
| FF | 129 | C-2566 | Thor steel retainer bolt, nut and lock washer | 2 |
| GG | 129 | —— | Cotter pins | 2 |
| HH | 129 | 69124 | Thor rubber bumper | 4 |
| JJ | 129 | ¼" sq | Chuck set screw wrench | 1 |
| KK | 129 | 88-176 | Detachable rock bit, Timken H 1⅝" | 20 |
| LL | 129 | 88-177 | Detachable rock bit, Timken H 1¾" | 20 |
| MM | 129 | 88-178 | Detachable rock bit, Timken H 1⅞" | 20 |
| NN | 129 | 88-179 | Detachable rock bit, Timken H 2" | 20 |
| PP | 129 | 88-203 | Detachable rock bit, Timken H 2⅛" | 20 |



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## ORDNANCE MAINTENANCE — MAINTENANCE OF BOMB DISPOSAL EQUIPMENT FOR ACCESS AND STERILIZATION

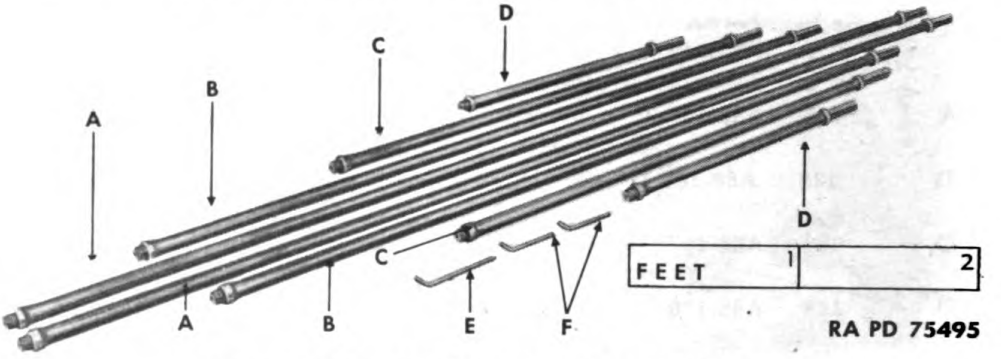



*Figure 130 — Drill Steel and Tool Clip Keys*

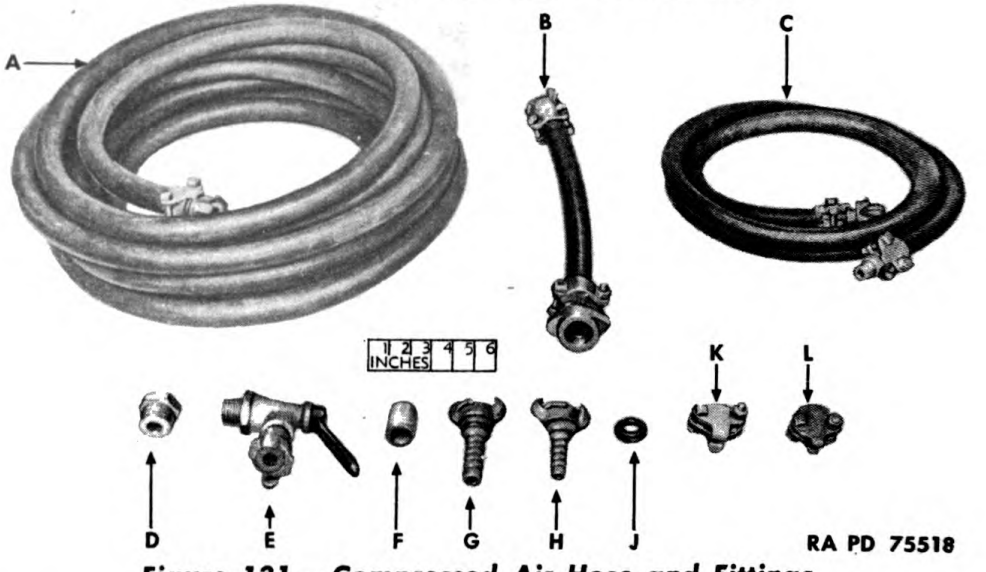



*Figure 131 — Compressed Air Hose and Fittings*

| Item No. | Fig. No. | Part No. | Name | Quantity |
|---|---|---|---|---|
| A | 130 | 88-175 | 8′ rock drill steel | 2 |
| B | 130 | 88-174 | 6′ rock drill steel | 2 |
| C | 130 | 88-173 | 4′ rock drill steel | 2 |
| D | 130 | 88-172 | 2′ rock drill steel | 2 |
| E | 130 | 91-87 | Key for air tool clips, 5¾″ lg | 1 |
| F | 130 | 91-86 | Key for air tool clips, 3½″ lg | 2 |
| A | 131 | 73-261 | Air hose, ¾″, 3 braid x 50′, Goodyear wingfoot | 5 |
| B | 131 | 73-261-1 | Air hose, ¾″, 3 braid x 18″, Goodyear wingfoot | 2 |
| C | 131 | 73-262 | Air hose, ½″, 3 braid x 10′, Goodyear wingfoot | 3 |
| D | 131 | A28-237 | Universal hose coupling, ¾″ male end | 2 |
| E | 131 | 15-323-1 | Air valve, Cleco, 1″ x ¾″ R.A. angle handle | 2 |
| F | 131 | 013-6 | Close nipple, 1″ N.P.T | 2 |
| G | 131 | A28-238 | Universal hose coupling, ¾″ hose end | 12 |
| H | 131 | A28-239 | Universal hose coupling, ½″ hose end | 4 |
| J | 131 | 20-381 | Washers for universal hose coupling | 6 |
| K | 131 | A83-33 | ¾″ hose clamp assembly, Dixon "Air King" A-9 | 12 |
| L | 131 | A83-35 | ½″ hose clamp assembly, Dixon "Air King" A-1 | 4 |



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## SPARE PARTS AND ACCESSORIES

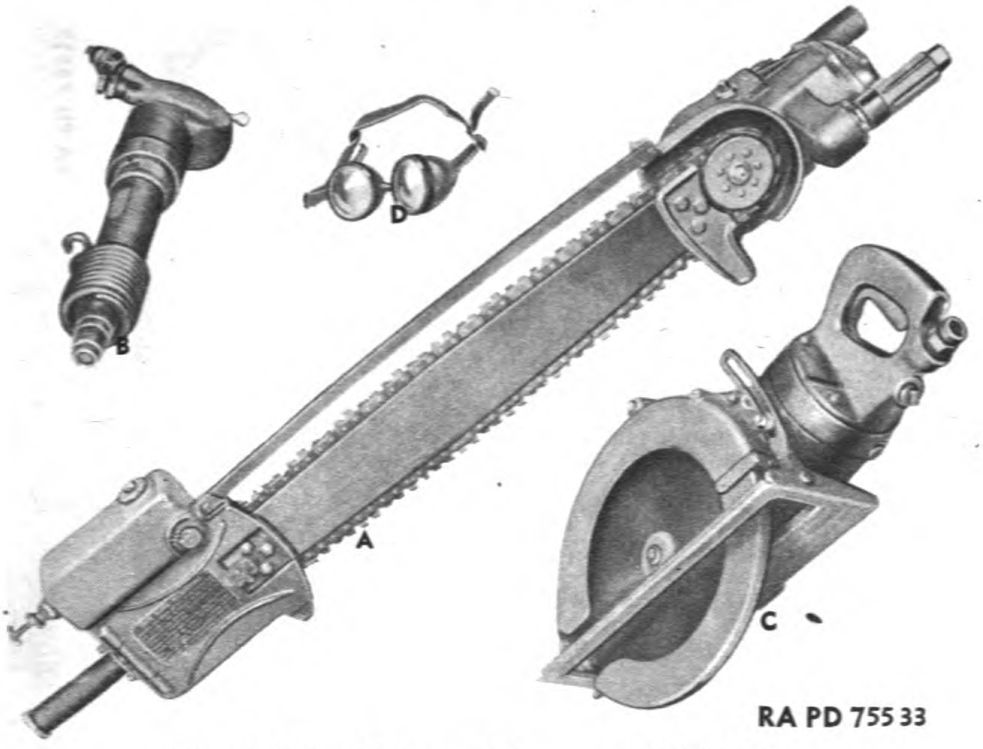



***Figure 132 — Pneumatic Saws and Nail Driver***

| Item No. | Fig. No. | Part No. | Name | Quantity |
|---|---|---|---|---|
| A | 132 | —— | Pneumatic chain saw | 1 |
| B | 132 | —— | Nail driver | 1 |
| C | 132 | —— | Circular saw | 1 |
| D | 132 | | Goggles with extra lens | 4 |



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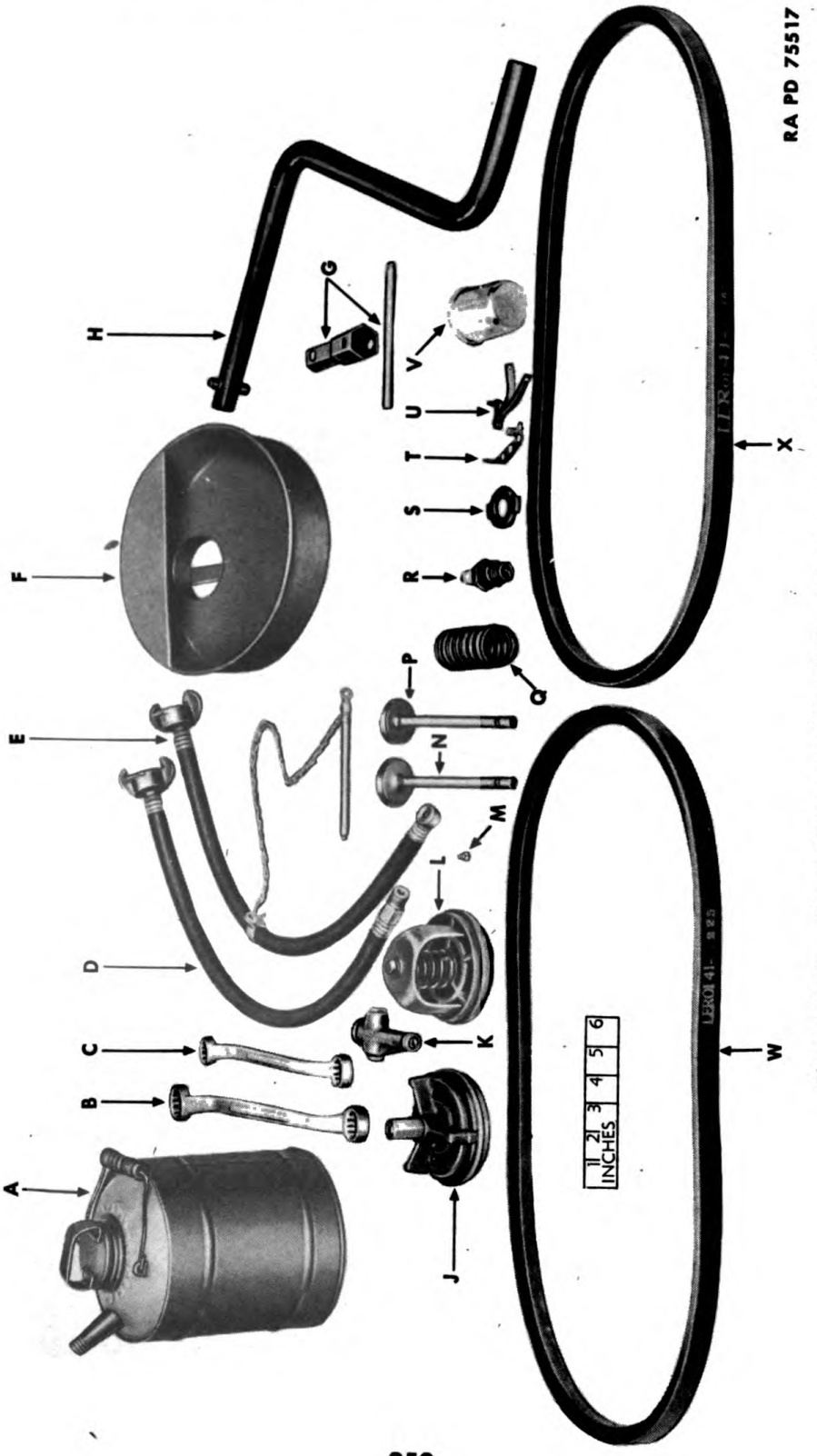



*Figure 133 — Spare Parts and Tools for Air Compressor Unit*



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## SPARE PARTS AND ACCESSORIES

### c. Air Compressor Unit Spare Parts and Accessories.

| Item No. | Fig. No. | Part No. | Name | Quantity |
|---|---|---|---|---|
| A | 133 | 88-166 | Oil can, 1 gal. | 1 |
| B | 133 | 88-105 | Box socket wrench, $\frac{15}{16}$ in. x 1 in. | 1 |
| C | 133 | 88-104 | Box socket wrench, $\frac{3}{4}$ in. x $\frac{25}{32}$ in. | 1 |
| D | 133 | A88-241 | Blow gun attachment, less blow gun | 1 |
| E | 133 | A88-158 | Tire inflating attachment | 1 |
| F | 133 | 88-157 | Funnel, 10 in. diam. | 1 |
| G | 133 | 88-88 | Compressor engine spark plug wrench 18-mm | 1 |
| H | 133 | 50-91 | Compressor engine starting crank | 1 |
| J | 133 | 2A15-325 | Discharge valve assembly | 2 |
| K | 133 | 88-246 | Blow gun, $\frac{3}{8}$ in. PB Cleco | 1 |
| L | 133 | A15-325 | Suction valve assembly | 2 |
| M | 133 | R24-1G | Suction and discharge valve springs | 12 |
| N | 133 | 15-200 | Intake valve | 4 |
| P | 133 | 15-201-1 | Exhaust valve | 4 |
| Q | 133 | B24-26 | Valve spring | 8 |
| R | 133 | 86-9-5 | Spark plug, champion No. 6 | 4 |
| S | 133 | 20-379 | Water pump carbon seal washer | 1 |
| T | 133 | 127-8 | Magneto contact bracket, AM. Bosch | 1 |
| U | 133 | 127-9 | Magneto breaker lever, AM. Bosch | 1 |
| V | 133 | 184-2 | Fuel pump glass bowl, AC | 1 |
| W | 133 | 41-225 | Fan belt for radiator fan | 1 |
| X | 133 | 41-143 | Fan belt for intercooler fan | 1 |



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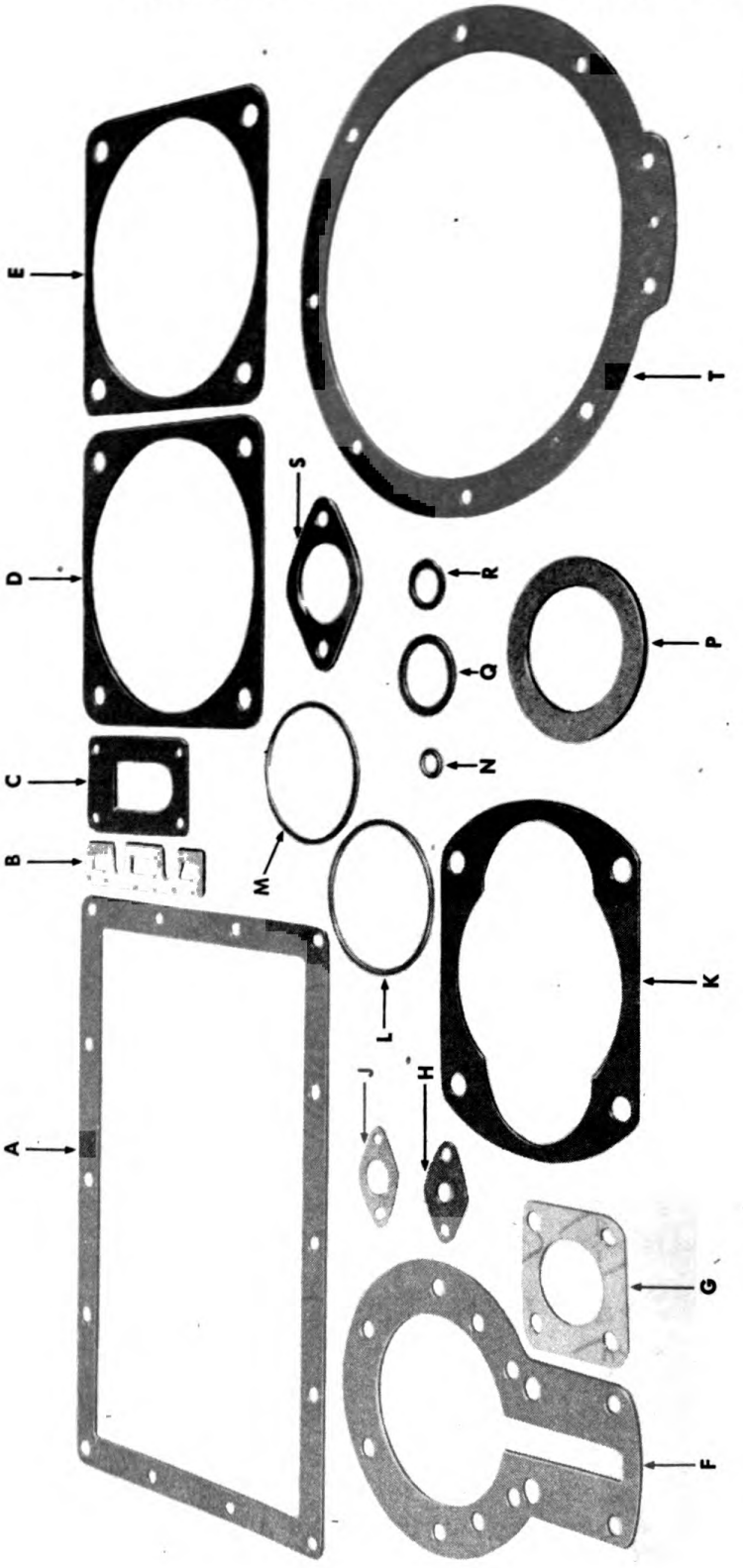



*Figure 134 — Air Compressor Gaskets*



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## SPARE PARTS AND ACCESSORIES

**d. Air Compressor Gaskets.** Packed in a box stenciled "Gasket Box" and bolted to chassis on magneto side of compressor unit, are the following gaskets:

| Item No. | Fig. No. | Part No. | Name | Quantity |
|---|---|---|---|---|
| A | 134 | 16-605 | Oil pan flange gasket | 2 |
| B | 134 | 16-880 | Intercooler and radiator core gasket | 16 |
| C | 134 | 16-616 | Breather body to crankcase gasket | 2 |
| D | 134 | 16-519 | Cylinder flange gasket (0.010 in. thick) | 12 |
| E | 134 | 16-518 | Cylinder flange gasket (0.015 in. thick) | 12 |
| F | 134 | 16-418 | Oil pump body to retainer gasket | 2 |
| G | 134 | 16-640 | Air connection flange gasket | 14 |
| H | 134 | 16-419-1 | Oil pump body connection gasket | 4 |
| J | 134 | 16-419 | Oil pump body to check valve gasket | 2 |
| K | 134 | 16-801 | Cylinder head gasket (service packing) | 6 |
| L | 134 | 16-745 | Suction and discharge valve cover gasket | 12 |
| M | 134 | 16-744 | Suction and discharge valve seat gasket | 12 |
| N | 134 | B16-117 | Oil relief body gasket | 2 |
| P | 134 | 16-627 | Air cleaner base gasket | 4 |
| Q | 134 | 16-422 | Fan drive pulley gasket | 2 |
| R | 134 | 16-791 | Intercooler relief valve cover gasket | 2 |
| S | 134 | 16-664 | Intercooler connection flange gasket | 6 |
| T | 134 | 16-344 | Bearing retainer to crankcase gasket | 2 |



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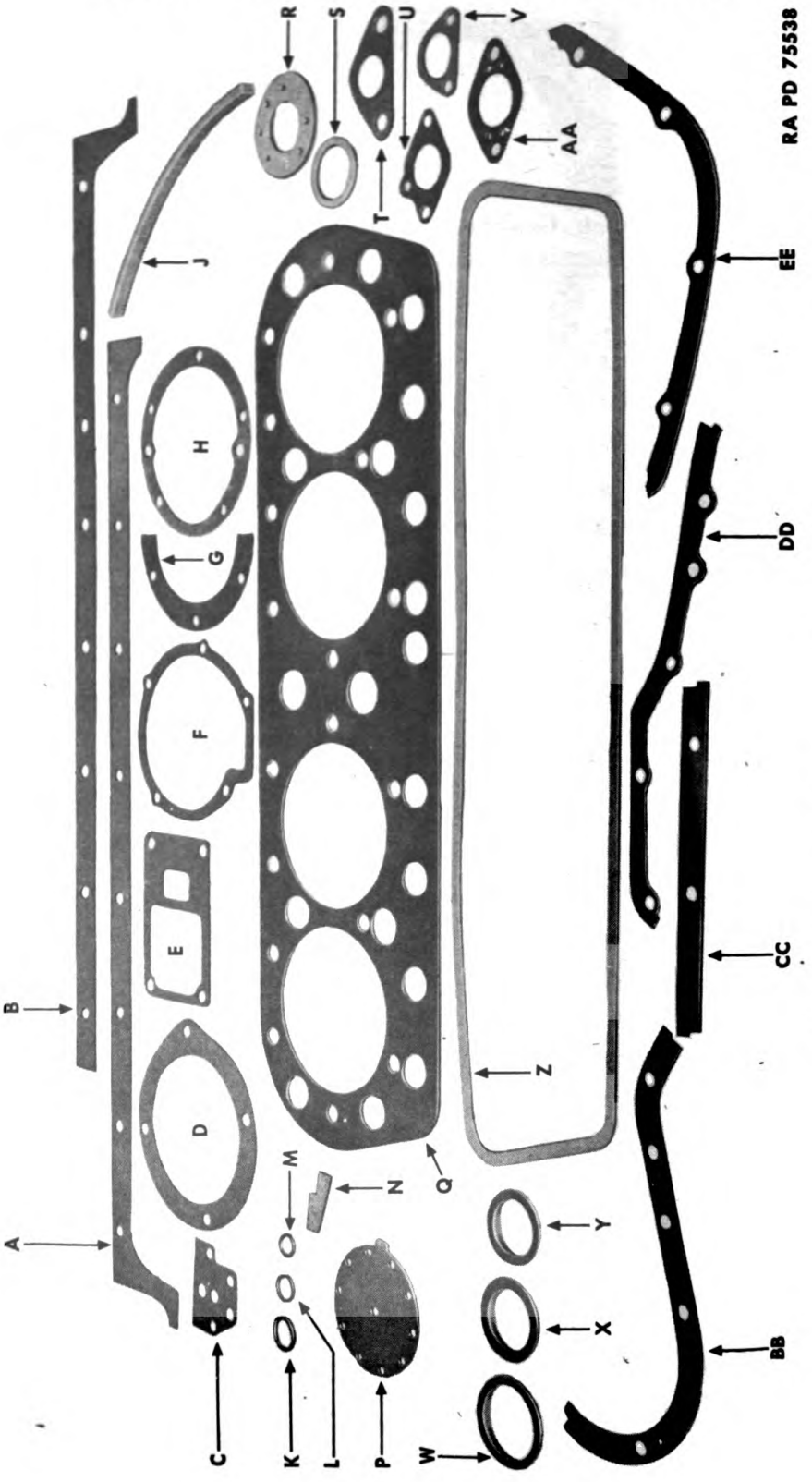



*Figure 135 — Air Compressor Engine Gaskets*



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## SPARE PARTS AND ACCESSORIES

e. **Air Compressor Engine Gaskets:** Also packed in box stenciled "Gasket Box" and bolted to chassis on magneto side of compressor unit, are the following gaskets:

| Item No. | Fig. No. | Part No. | Name | Quantity |
|---|---|---|---|---|
| A | 135 | 16-647 | Oil pan flange gasket, manifold side | 1 |
| B | 135 | 16-648 | Oil pan flange gasket, magneto side | 1 |
| C | 135 | 16-636 | Oil pump body to cover gasket | 1 |
| D | 135 | 16-669 | Governor body gasket | 1 |
| E | 135 | 16-638 | Water pump bracket gasket | 1 |
| F | 135 | 16-754 | Water pump body gasket | 1 |
| G | 135 | 16-777 | Oil retainer to crankcase gasket | 1 |
| H | 135 | 16-635 | Oil pump cover flange gasket | 1 |
| J | 135 | 16-649 | Oil pan flange gasket, bell housing end | 1 |
| K | 135 | B16-117 | Oil relief plug gasket | 1 |
| L | 135 | 16-796 | Spark plug gasket | 4 |
| M | 135 | 16-877 | Slow down body gasket | 1 |
| N | 135 | 16-626 | Oil retainer to crankcase flange gasket | 2 |
| P | 135 | 186-9 | Fuel pump diaphragm | 1 |
| Q | 135 | 16-629 | Cylinder head gasket | 1 |
| R | 135 | 16-643 | Cylinder head breather gasket | 1 |
| S | 135 | 16-921 | Fuel pump glass bowl gasket | 1 |
| T | 135 | 16-646 | Water outlet connection gasket | 2 |
| U | 135 | 16-229 | Fuel pump flange gasket | 1 |
| V | 135 | 16-879 | Governor spring cover gasket | 1 |
| W | 135 | 16-631 | Exhaust manifold gasket, center | 1 |
| X | 135 | 16-630 | Intake manifold gasket | 2 |
| Y | 135 | 16-632 | Exhaust manifold gasket, end | 2 |
| Z | 135 | 16-634 | Cylinder head cover gasket | 1 |
| AA | 135 | 16-27 | Carburetor flange gasket | 1 |
| BB | 135 | 16-653 | Gear cover gasket, magneto side | 1 |
| CC | 135 | 16-650 | Gear cover gasket, upper | 1 |
| DD | 135 | 16-651 | Gear cover gasket, manifold side | 1 |
| EE | 135 | 16-652 | Gear cover gasket, lower | 1 |



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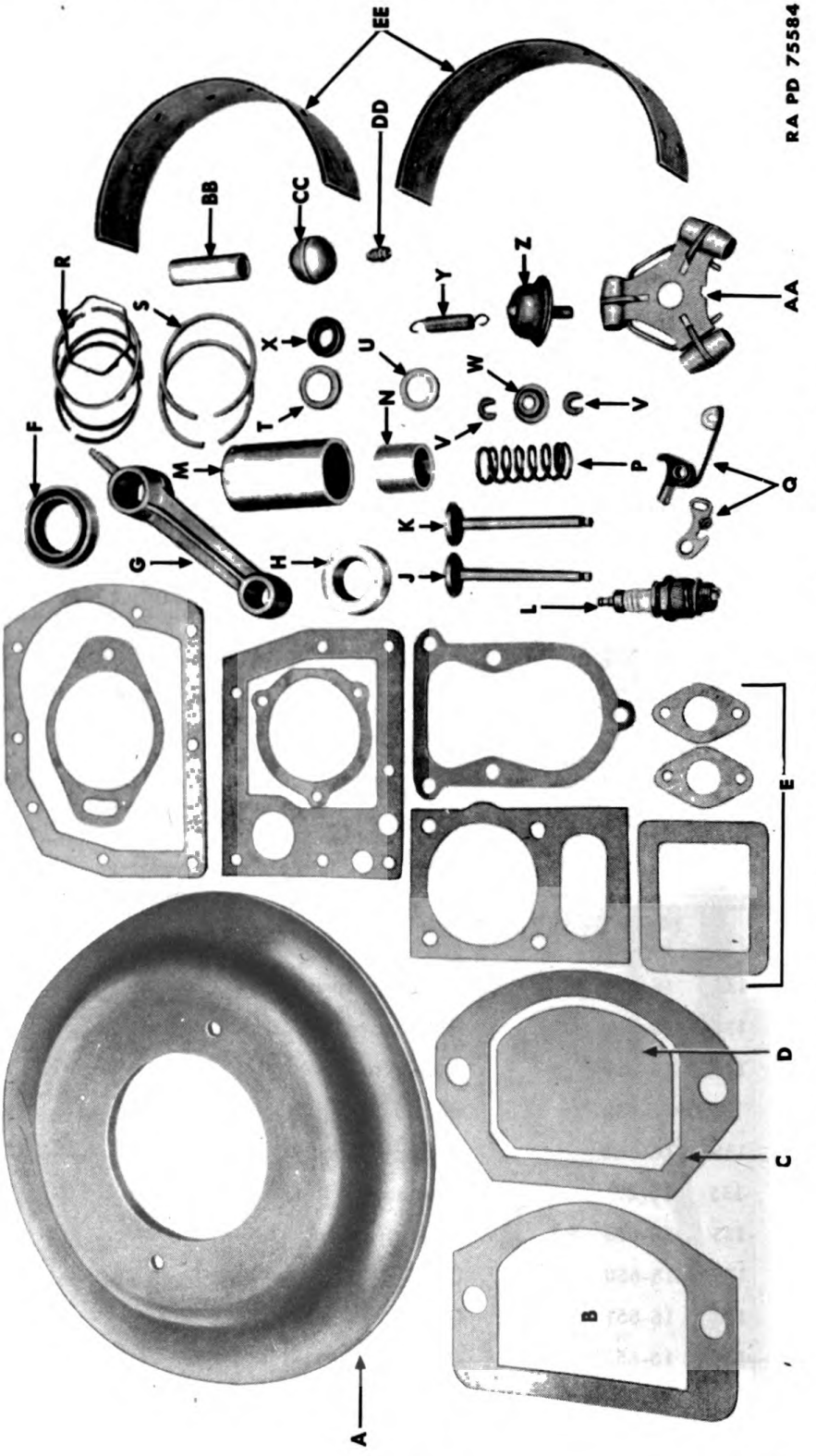



*Figure 136 — Engine-driven Diaphragm Pump Spare Parts*



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## SPARE PARTS AND ACCESSORIES

### 85. PUMPS.

**a. General.** Spare parts issued with each engine-driven pump used by ordnance bomb disposal personnel are listed and illustrated in this paragraph.

**b. Engine-driven Diaphragm Pump Spare Parts.**

| Item No. | Fig. No. | Part No. | Name | Quantity |
|---|---|---|---|---|
| A | 136 | 3D20 | Diaphragm | 1 |
| B | 136 | 3D23D | Flange gasket | 2 |
| C | 136 | 3D23D | Flange gasket | 1 |
| D | 136 | 3D22C | Valve rubber | 2 |
| E | 136 | A16 | Engine gasket set | 1 |
| F | 136 | 1C193 | Crankshaft seal | 1 |
| G | 136 | 4A39 | Connecting rod | 1 |
| H | 136 | 1C108 | Seal | 1 |
| J | 136 | 2A18 | Inlet valve | 1 |
| K | 136 | 2A19 | Exhaust valve | 1 |
| L | 136 | X1007 | Spark plug | 1 |
| M | 136 | 2J154 | Bushing | 2 |
| N | 136 | 2J29C | Bushing | 2 |
| P | 136 | AG22 | Valve spring | 2 |
| Q | 136 | X1196 and X1408 | Contact point and arm group | 1 |
| R | 136 | 1A2 | Piston oil ring | 1 |
| S | 136 | NNV2 | Compression piston ring | 2 |
| T | 136 | 1-1A233 | Camshaft washer retainer | 1 |
| U | 136 | 1-A234 | Cam washer retainer | 1 |
| V | 136 | UF165 | U washer | 2 |
| W | 136 | UF20 | Valve stem collar | 2 |
| X | 136 | 1A235 | Camshaft felt washer | 1 |
| Y | 136 | 1A43 | Governor spring | 1 |
| Z | 136 | T15008 | Governor plunger | 1 |
| AA | 136 | T4741 | Governor weight assembly | 1 |
| BB | 136 | 1A3 | Piston pin | 1 |
| CC | 136 | C85-16 | Float | 1 |
| DD | 136 | C-81-8 | Fuel valve and seat | 1 |
| EE | 136 | 2J74C | Eccentric bushing | 2 |



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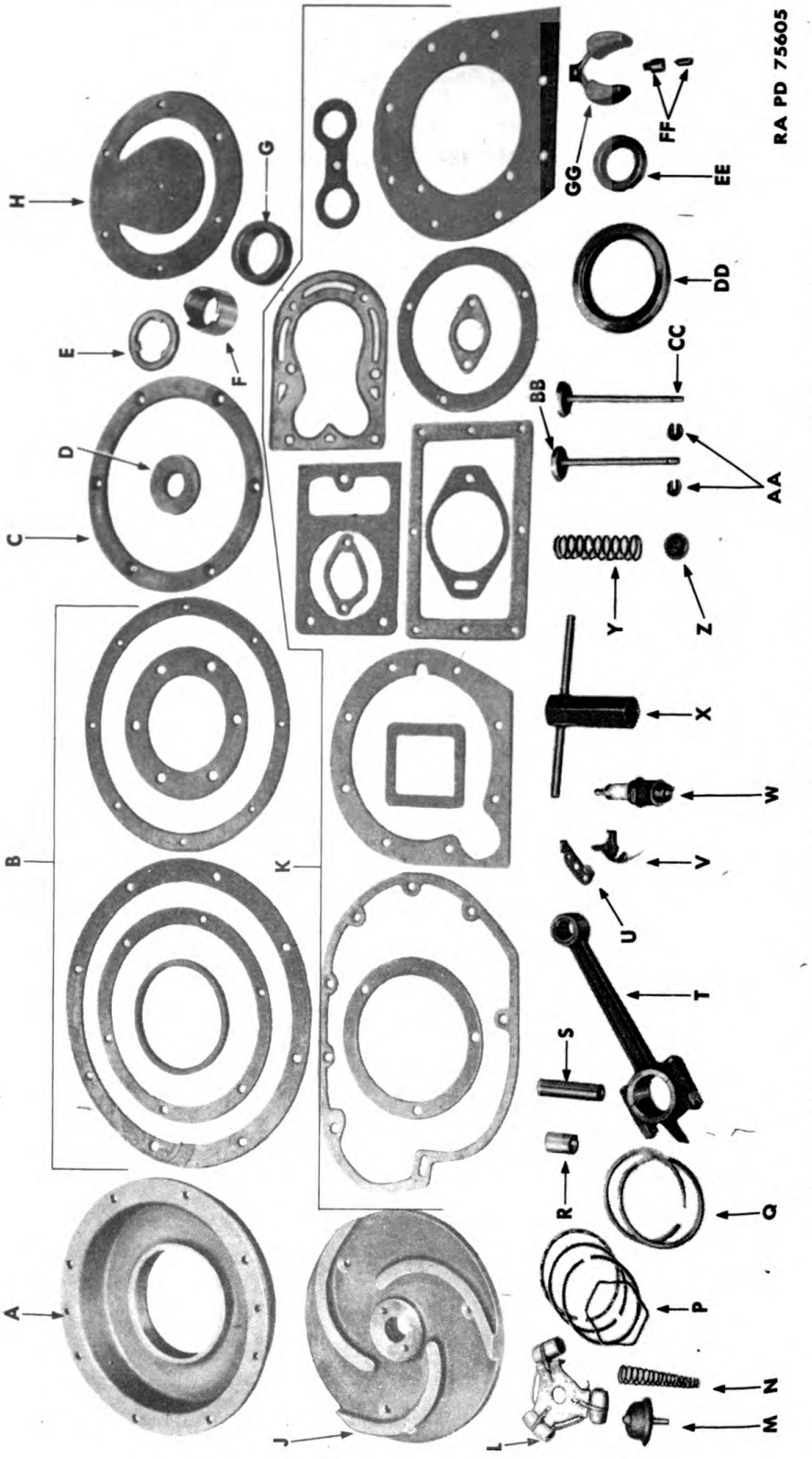



Figure 137 — Engine-driven Centrifugal Pump Spare Parts and Accessories



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## SPARE PARTS AND ACCESSORIES

### c. Engine-driven Centrifugal Pump Spare Parts and Accessories.

| Item No. | Fig. No. | Part No. | Name | Quantity |
|---|---|---|---|---|
| A | 137 | 3V56A | Outer wear plate | 1 |
| B | 137 | KL3 | Pump gasket set | 1 |
| C | 137 | 3V55 | Inner wear plate | 2 |
| D | 137 | 3V42 | Thrust washer | 2 |
| E | 137 | 3V36 | Bronze washers | 2 |
| F | 137 | 3V34 | Packing sleeve | 1 |
| G | 137 | 3V38 | Rubber packing | 2 |
| H | 137 | 3V8A | Suction valve | 1 |
| J | 137 | 3V3G | Impeller | 1 |
| K | 137 | 2CW72 | Engine gasket set | 1 |
| L | 137 | T4741 | Governor weight assembly | 1 |
| M | 137 | T15006 | Governor plunger | 1 |
| N | 137 | 1CW43 | Governor spring | 1 |
| P | 137 | 5C2 | Piston oil ring | 1 |
| Q | 137 | 2C2 | Compression piston ring | 2 |
| R | 137 | VF8 | Piston pin bushing | 1 |
| S | 137 | VF3 | Piston pin | 1 |
| T | 137 | T3227 | Connecting rod | 1 |
| U | 137 | BK5256 | Contact bracket with point | 1 |
| V | 137 | LE5236 | Interrupter lever with point | 1 |
| W | 137 | X1007 | Spark plug | 1 |
| X | 137 | 1 in. | Spark plug wrench | 1 |
| Y | 137 | VR22 | Valve spring | 2 |
| Z | 137 | VF20 | Valve stem collar | 4 |
| AA | 137 | VF165 | Valve stem U washer | 2 |
| BB | 137 | 1CW19 | Exhaust valve | 1 |
| CC | 137 | 1CW18 | Inlet valve | 1 |
| DD | 137 | 1CW109 | Rear oil seal | 1 |
| EE | 137 | 2C108 | Front oil seal | 1 |
| FF | 137 | 18R-8A | Float valve seat | 1 set, 2 pieces |
| GG | 137 | 16R-36H | Float assembly | 1 |



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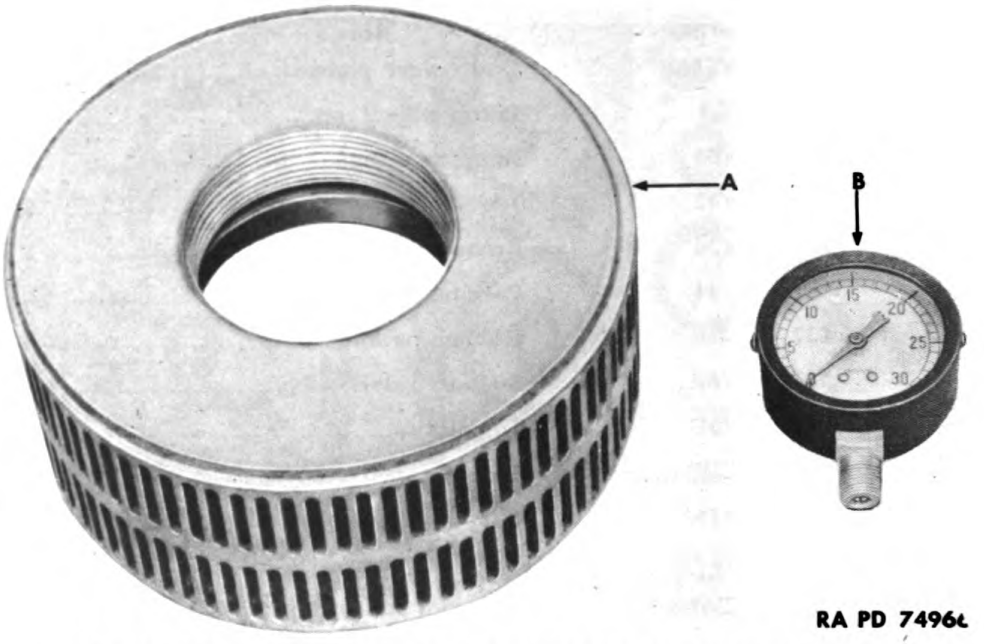



*Figure 138 — Centrifugal Pump Suction Strainer and Gage*

| Item No. | Fig. No. | Part No. | Name | Quantity |
|---|---|---|---|---|
| A | 138 | | Suction strainer | 1 |
| B | 138 | | Suction gage | 1 |

## 86. STEAM GENERATING PLANT.

**a. General.** In this paragraph are listed and illustrated spare parts and accessories issued to ordnance bomb disposal personnel with each steam generating plant.

**b. Spare Parts.**

| Item No. | Fig. No. | Part No. | Name | Quantity |
|---|---|---|---|---|
| A | 139 | | Fuel oil strainer element | 1 |
| B | 139 | | Steam pressure gage | 1 |
| C | 139 | | Fuel oil pressure gage | 1 |
| D | 139 | | Contact bracket with point | 1 |
| E | 139 | | Interrupter lever with point | 1 |
| F | 139 | | Oil burner nozzle tip | 1 |
| G | 139 | | Impulse weight | 2 |
| H | 139 | | Spark plug | 1 |
| J | 139 | | Oil burner electrodes | 1 set, 2 pieces |



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## SPARE PARTS AND ACCESSORIES

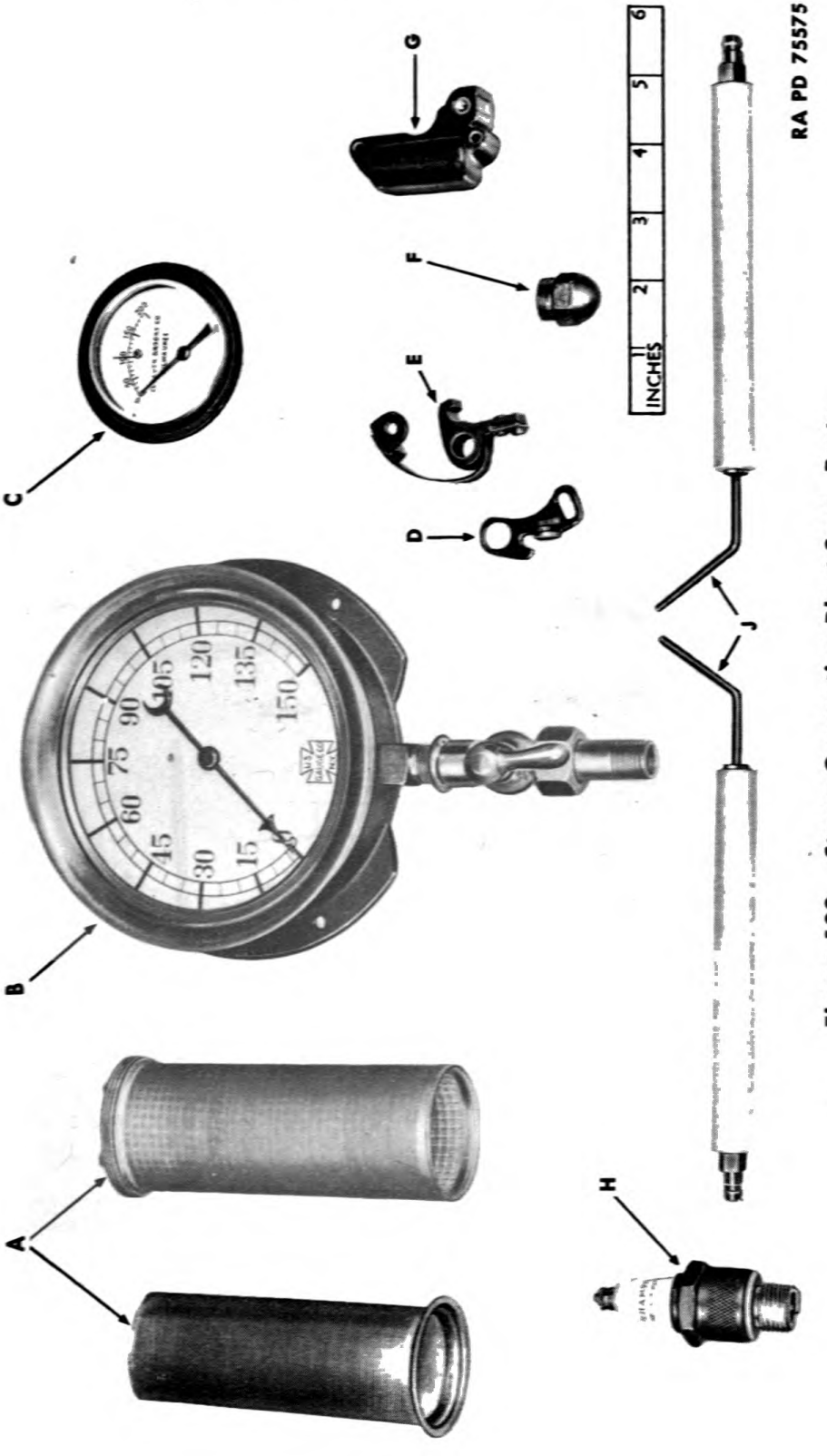



*Figure 139 — Steam Generating Plant Spare Parts*



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## ORDNANCE MAINTENANCE — MAINTENANCE OF BOMB DISPOSAL EQUIPMENT FOR ACCESS AND STERILIZATION

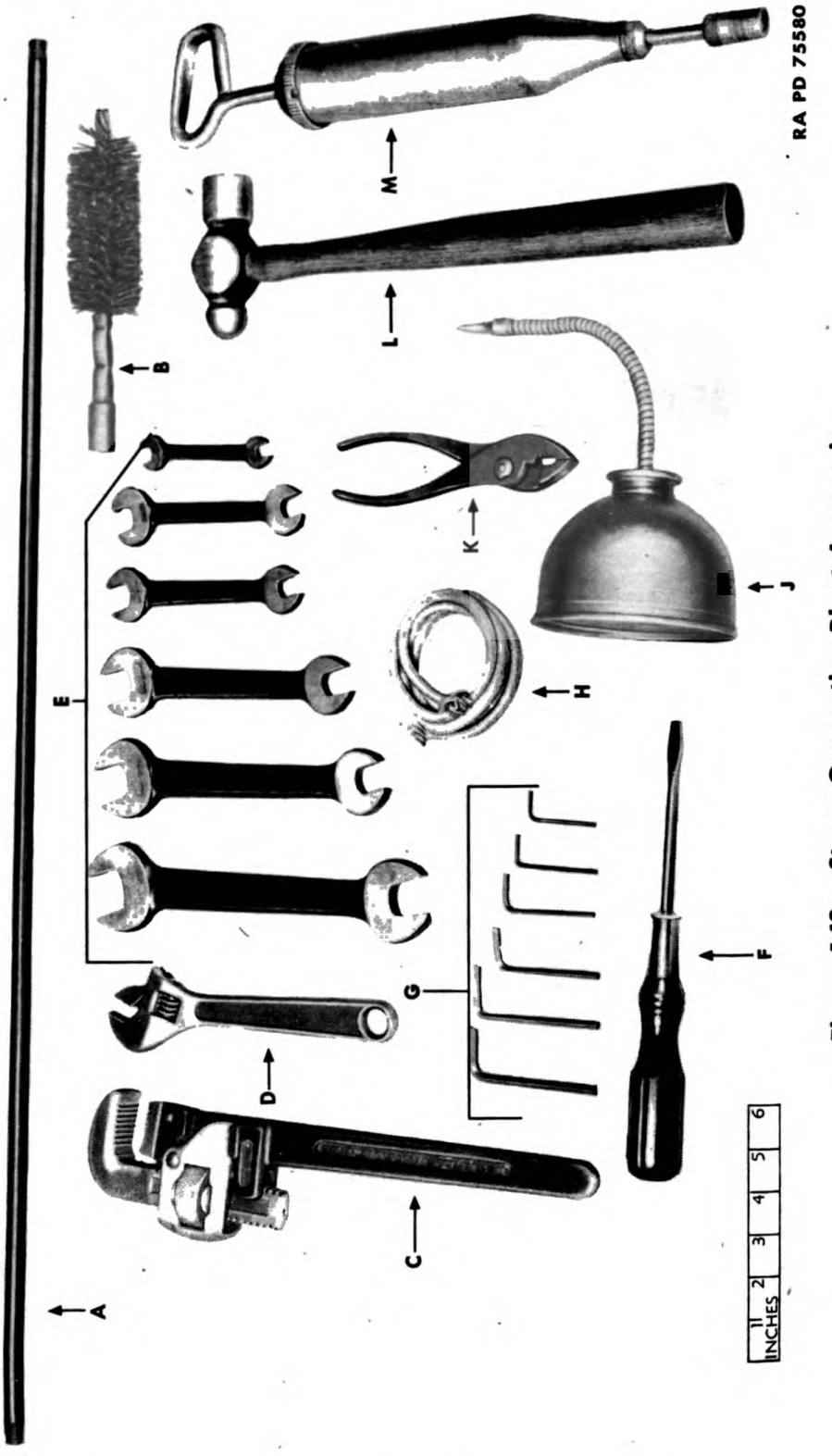



Figure 140 — Steam Generating Plant Accessories



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## SPARE PARTS AND ACCESSORIES

### c. Accessories.

| Item No. | Fig. No. | Part No. | Name | Quantity |
|---|---|---|---|---|
| A | 140 | | Boiler tube wire brush handle | 1 |
| B | 140 | | Boiler tube wire brush | 1 |
| C | 140 | | Pipe wrench | 1 |
| D | 140 | | Adjustable wrench | 1 |
| E | 140 | | Set of open-end wrenches | 1 set, 6 pieces |
| F | 140 | | Screwdriver | 1 |
| G | 140 | | Set of recessed head set screw wrenches | 1 set, 6 pieces |
| H | 140 | | Engine cranking rope | 1 |
| J | 140 | | Oilcan | 1 |
| K | 140 | | Pliers | 1 |
| L | 140 | | Ball peen hammer | 1 |
| M | 140 | | Lubricating gun | 1 |



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## CHAPTER 7

# CARE UNDER EXTREME CONDITIONS

## 87. CARE AND OPERATION IN COLD CLIMATES.

**a. General.** Operation and maintenance of materiel at low temperatures necessitates more time and attention. Failure to give this extra service will result in damage, delay, and expense. Congealing of lubricants and freezing of coolants are two of the most serious obstacles to be overcome.

**b. Cold Weather Accessories.** Accessories useful in care and operation of materiel in cold temperatures are indicated below.

(1) Tarpaulins, tents, and collapsible sheds are useful for sheltering materiel.

(2) Extra batteries and facilities for changing batteries quickly are helpful in starting engines equipped with electric cranking motors.

(3) Metal containers are useful in heating oil.

(4) Fuel line insulation is of value in preventing ice formation inside.

(5) Radiator covers are useful to help control engine temperatures of liquid-cooled engines.

**c. Preventive Maintenance.**

(1) GENERAL. Precautions listed here will do much toward eliminating cold weather troubles.

(2) PROTECTION OF MATERIEL. Keep materiel in a heated enclosure if possible or otherwise in any shelter available. If in the open, cover materiel with canvas.

(3) PROTECTION OF OIL. Remove oil from materiel stored in extremely cold temperatures. Attach a tag marked "Oil is drained" to materiel. Keep the oil in a warm place. If warm storage for the oil is impossible, heat it before again installing in the equipment. Do not overheat oil. Heat only to point where the bare hand can be inserted without burning.

(4) PROTECTION AGAINST FREEZING.

*(a)* Drain all water from pumps and hoses after use. Drain water of condensation from compressed air tanks and hoses. Remove moisture from pneumatic tools by disassembling tools and wiping parts with dry cloth.

*(b)* In radiators using a liquid coolant, use COMPOUND, antifreeze (ethylene glycol type), to protect against expected temperatures. Before installing coolant, flush system thoroughly, check for



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leaks, tighten hose connections, replace damaged hoses, and lubricate water pump. The following table gives permissible antifreeze materials and the quantity to be added to prevent freezing at indicated temperatures:

| Lowest Expected Temperature | Pints COMPOUND, Antifreeze (Ethylene Glycol Type) per Gallon of System Capacity | Pints GLYCERINE, Grade A, U.S.P., per Gallon of System Capacity | Pints ALCOHOL, Grade 2, per Gallon of System Capacity |
|---|---|---|---|
| −10 F | 2 | 3 | 2½ |
| 0 F | 2½ | 3 | 3 |
| −10 F | 3 | 3½ | 3½ |
| −20 F | 3½ | 4 | 4 |
| −30 F | 4 | 5 | 5 |
| −40 F | 4½ | — | 5½ |
| −50 F | 5 | — | 6 |

NOTE: Use glycerine or alcohol, grade 2, only in emergency as they are not satisfactory antifreeze fluid for cooling system.

(5) PROTECTION OF ELECTRICAL AND IGNITION SYSTEMS.

*(a) Generators and Starters.* Check brushes, commutators, and bearings. Keep commutators clean.

*(b) Wiring.* Clean and tighten all connections, especially battery terminals. Check insulation. Replace wire or wrap with tape if insulation is damaged.

*(c) Batteries.* Keep fully charged so hydrometer reading is between 1.275 and 1.300. A fully charged battery will not freeze at temperatures likely to be encountered even in arctic climates, but a fully discharged battery will freeze at 5 F. Battery effectiveness decreases sharply with decreasing temperatures, and becomes practically nil at −40 F.

(6) LUBRICATION.

*(a)* Greases prescribed for use at below −32 F will furnish satisfactory lubrication at temperatures below 0 F. Below 0 F use OIL, lubricating, pneumatic, special, for oilcan purposes. Do not use in crankcases or gear case.

*(b)* Oils thicken at low temperatures. Dilute with kerosene to secure desired viscosity.

**d. Cold Weather Operation.**

(1) STARTING.

*(a)* If possible, warm materiel in heated building before starting.

*(b)* Prior to starting a gasoline engine, see that everything is in readiness so engine has a chance to start on first trial. Be alert to keep engine running by proper use of throttle and choke. When starting, turn over engine as rapidly as possible in order to reach engine's critical cranking speed. Run engine until thoroughly warmed up before putting it under a load.



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*(c)* In order to prevent ice forming in the exhaust valves and parts of pneumatic tools, a mixture of 50-50 containing alcohol and glycerine in the air line lubricator (par 14 **b** (2) ) will permit satisfactory functioning of the equipment under cold weather conditions.

*(d)* Run pneumatic tools about a minute without load before using them. This precaution will usually be sufficient to warm tool so that lubricants will be effective.

## 88. CARE AND OPERATION IN HOT, DAMP CLIMATES.

**a.** In climates where temperature and humidity are high, or where salt air is present, and during rainy seasons, thoroughly inspect materiel at frequent intervals and keep it lightly oiled when not in use. Disassemble materiel sufficiently to enable the drying and oiling of parts at times of inspection.

**b.** Keep all exposed surfaces of materiel clean and covered with a film of oil at all times. Keep distributor dry inside and out.

**c.** Keep cooling systems clean. Blow out dirt from radiator, intercooler, and cylinder head fins with an air blast. Keep fan belts at proper tensions.

## 89. CARE AND OPERATION IN HOT, DRY CLIMATES.

**a.** Wipe all sand and dust from exposed surfaces of materiel. Use air blast to reach inaccessible places. Disassemble materiel daily, or oftener, as necessary to remove grit from working parts.

**b.** Service air cleaners and oil filters often. In particularly sandy localities, it may be necessary to perform these tasks as often as every 4 hours.

**c.** Keep oiling and lubrication of materiel at a minimum, as oil will collect dust and which will cause wear on working parts.

**d.** Keep materiel covered as much as possible during sand or dust storms.



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## CHAPTER 8

# REFERENCES

## 90. PUBLICATIONS INDEXES.

The following publications indexes should be consulted frequently for latest changes or revisions of references given in this chapter and for new publications relating to materiel cover in this manual.

a. Introduction to Ordnance Catalog (explaining SNL system) ..... ASF Cat. ORD 1 IOC

b. Ordnance Publications for Supply Index (index to SNL's) ..... ASF Cat. ORD 2 OPSI

c. Index to Ordnance Publications (listing FM's, TM's, TC's, and TB's, of interest to ordnance personnel, OPSR, MWO's, BSD, S of SR's, OSSC's, and OFSB's; and includes Alphabetical List of Major Items with Publications Pertaining Thereto) ..... OFSB 1-1

d. List of Publications for Training (listing MR's, MTP's, T/BA's, T/A's, FM's, TM's, and TR's concerning training) ..... FM 21-6

e. List of Training Films, Film Strips, and Film Bulletins (listing TF's, FS's, and FB's by serial number and subject) ..... FM 21-7

f. Military Training Aids (listing Graphic Training Aids, Models, Devices, and Displays) ..... FM 21-8

## 91. STANDARD NOMENCLATURE LISTS.

a. **Care and Preservation Repair.**

Cleaning, preserving and lubricating materials; recoil fluids, special oils, and miscellaneous related items ..... SNL K-1

Soldering, brazing and welding material, gases and related items ..... SNL K-2

b. **Pneumatic Tools.**

Breaker, Paving, Pneumatic, Independent Pneumatic Tool Co., Thor Model 24 ..... ASF Cat. ENG 7-B61-1

Digger, Clay, Pneumatic, Independent Pneumatic Tool Co., Thor 412, Model 4913 ..... ASF Cat. ENG 7-D40-1

Drill, Pneumatic, Portable, Wood-boring, No. 2 Morse Taper, Model 62-WB, Independent Pneumatic Tool Co. ..... ASF Cat. ENG 7-D80-1



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| | |
|---|---|
| Saw, Chain, Portable, Pneumatic, 24-In. Blade, Reed-Prentice, Timberhog | ASF Cat. ENG 7-S11 |

## 92. EXPLANATORY PUBLICATIONS.

| | | |
|---|---|---|
| a. | **Automotive Materiel.** | |
| | Military motor vehicles | AR 850-15 |
| | Motor transport | FM 25-10 |
| b. | **Care and Preservation.** | |
| | Cleaning, preserving, lubrication, and welding materials and similar items issued by the Ordnance Department | TM 9-850 |
| | Chemical decontamination materials and equipment | TM 3-220 |
| | Defense against chemical attack | FM 21-40 |
| c. | **Inspection and Maintenance.** | |
| | Echelon system of maintenance | TM 10-525 |
| | Fire prevention, safety precautions, accidents | TM 10-360 |
| | Motor transport inspections | TM 10-545 |
| | Ordnance maintenance procedure, materiel inspection and repair | TM 9-1100 |
| d. | **Miscellaneous.** | |
| | Automotive electricity | TM 10-580 |
| | Electrical fundamentals | TM 1-455 |
| | Internal combustion engine | TM 10-570 |
| e. | Motorized air compressor (Model 105 Ga) | TM 5-5060 |
| f. | **Pneumatic Tools.** | |
| | Breaker, Paving, Pneumatic, Independent Pneumatic, Model 25 | TM 5-4022 |
| | Digger, Clay, Pneumatic Thor No. 412, Model 4913 | TM 5-4024 |
| | Drill, Pneumatic, Portable Reversible, Wood Boring, No. 2, Morse Taper, Thor No. 62, Model 958 | TM 5-4026 |
| | Nail driver, pneumatic, Ingersoll Rand (model 6-CND) | TM 5-540-3 |
| | Pneumatic Chain Saw Timberhog 24-inch | TM 5-4000 |
| | Portable circular saw, Model 2127, pneumatic, hand | TM 5-4004 |
| g. | **Pumps.** | |
| | Diaphragm pump, model AD4 | TM 5-500-8 |
| | Pump, sump, Ingersoll-Rand (model: size 25) | TM 5-500-7 |
| h. | Rigging and engineer hand tools | TM 5-225 |
| i. | Storage of motor vehicles equipment | AR 850-18 |



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