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WAR DEPARTMENT, TECHNICAL MANUAL

TM 11-930

This manual supersedes TM 11-930, 16 August 1943.

POWER UNIT

PE-245-A

WAR DEPARTMENT *6 JUNE 1944*

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[A.G. 300.7 (8 Sept. 43)]
BY ORDER OF THE SECRETARY OF WAR:

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Chief of Staff.

OFFICIAL:
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Major General,
The Adjutant General.

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

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DESTRUCTION NOTICE

WHY—To prevent the enemy from using or salvaging this equipment for his benefit.

WHEN—When ordered by your commander.

HOW—1. Smash—Use sledges, axes, handaxes, pickaxes, hammers, crowbars, heavy tools.
2. Cut—Use axes, handaxes, machetes.
3. Burn—Use gasoline, kerosene, oil, flame throwers, incendiary grenades.
4. Explosives—Use firearms, grenades, TNT.
5. Disposal—Bury in slit trenches, fox holes, other holes. Throw in streams. Scatter.

USE ANYTHING IMMEDIATELY AVAILABLE FOR DESTRUCTION OF THIS EQUIPMENT.

WHAT—1. Shear off all knobs and controls.
2. Smash—Engine block, magneto, carburetor, radiator, cylinder heads, manifold, and fuel tanks.
3. Smash—Generator casting, armature windings, brushes, commutator. Armature winding can be short circuited.
4. Smash—Switchboard meters, relays, switches, wiring.
5. Cut—Connecting wires, cables.
6. Burn—Manuals, records.
7. Bury or scatter—Any or all of the above pieces after destroying their usefulness.

DESTROY EVERYTHING

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SAFETY NOTICE

Operation of this equipment involves the use of voltages dangerous to human life. Observe all normal precautions and safety regulations. Avoid making any adjustments or connections while the unit is operating unless absolutely necessary.

Carbon dioxide, contained in exhaust gases, will cause illness. Make certain that all exhaust connections are gas tight and the room in which the unit is installed is properly ventilated.

WARNING

HIGH VOLTAGE

is used in the operation of Power Unit PE-245-A.

DEATH ON CONTACT

may result if operating personnel fail to observe safety precautions.

OBSERVE ALL POSSIBLE PRECAUTIONS

FIRST-AID TREATMENT FOR ELECTRIC SHOCK

Electric shock is caused by the passage of electric current through the body. If current of sufficient magnitude passes through the breathing center at the base of the brain, breathing stops and the victim loses consciousness. The pulse becomes very weak or ceases entirely and the body turns blue or very white. Occasionally the body becomes stiff. This condition is caused by the electricity and is not an indication of death.

In most cases of electric shock, the victim's life may be saved by the prompt and continued application of artificial respiration. By this means air is supplied to the body until the breathing center resumes its normal function. Resuscitation may take a long time; cases are recorded in which recovery occurred after 8 hours of artificial respiration.

RESCUE

To rescue a person from a live source of electric current, first shut off the current if a switch can be reached without loss of time. If shutting off the current will cause delay, use a dry nonconductor, such as a rope, a board, or rubber gloves, to prevent contact, and free the victim or remove the live conductor. Do not use metal or any moist material. Should it be necessary to cut a live wire, use an ax or a hatchet with a dry wooden handle and turn away to avoid the resulting flash.

Never allow any part of your body to come in contact with the victim's body or the live conductor. Do not attempt a rescue at the hazard of your own life.

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RESUSCITATION

Begin artificial respiration at once, as near the scene of the accident as possible. Every minute counts. Do not wait to loosen the patient's clothing, but do remove false teeth, chewing gum, or tobacco from his mouth, as any such obstruction interferes with the passage of air. Wrap the patient in a blanket, coat, or anything available, since warmth is very important. While one person starts artificial respiration, another should go at once for the nearest physician.

The procedure for artificial respiration follows:

1. Lay the patient face downward, with one arm bent at the elbow and placed so that the patient's cheek rests on the hand or forearm. The face is turned outward to leave the nose and mouth free for breathing. The other arm is extended overhead (figure 1).
2. Kneel straddling the patient's thighs, with your knees placed far enough from the hip bones to allow you to assume the position shown in figure 2. If the patient is a large, heavy person, it may be more convenient to straddle only one leg. Place the palms of your hands on the small of the patient's back, with the little fingers just touching the lowest ribs. The thumbs and fingers should be in a natural position as shown in figure 2.
3. With arms held straight, swing forward slowly, so that a gradual pressure is brought to bear upon the patient. At the end of the forward swing, your shoulders should be directly over the heels of your hands. Do not bend your elbows. The forward swing should take about two seconds.
4. Immediately on completing the forward swing, release the pressure and swing backward to the position shown in figure 3. Wait 2 seconds; then swing forward as before.

Repeat this cycle of pressure and release, which creates a complete respiration, 12 to 15 times a minute. Continue without interruption until natural breathing is restored, or until a physician declares the patient dead. If no physician can be reached, continue until you are sure there is no chance of recovery. Remember that artificial respiration often has to be kept up for hours.

While artificial respiration is being given, some one other than the operator should loosen the clothing about the patient's neck, chest, and waist. Keep the patient warmly wrapped. Apply hot-water bottles, hot bricks or stones, if possible. Do not give the patient liquids until he is fully conscious.

The first attempt to breathe may be a gasp, a faint sigh, or a catch of the breath. Artificial respiration should be withheld when the first breathing begins. Be very careful not to exert pressure as the first spontaneous breath occurs. Continue to watch the patient carefully, as he may stop breathing again after a temporary recovery. In that case, artificial respiration must be resumed at once.

When the patient revives, he must be kept warm and quiet. Do not allow him to sit or stand. If no physician has arrived, give the patient a teaspoonful of aromatic spirits of ammonia in a small glass of water, or a drink of hot coffee or tea, as a stimulant.

If possible, avoid moving the patient until he is breathing normally. Even then, he should be moved only in a lying position. If extreme weather conditions or other hazards make it necessary to move a patient before normal breathing has been restored, continue artificial respiration while he is being moved.

It may be necessary to change operators while administering artificial respiration. The change must be made without interrupting the rhythm of respiration. The relief operator should kneel beside the person giving the artificial respiration. As the pressure is released, the operator falls aside, the relief operator takes his place, and the cycle of pressure and release continues without interruption.

—Adapted from The American Red Cross First-Aid Textbook.

RESUSCITATION DRILLS SHOULD BE HELD REGULARLY BY ALL OPERATING PERSONNEL

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PROPER POSITION FIG. 1
TL-30041

READY TO APPLY PRESSURE FIG. 2
TL-30042

PRESSURE APPLIED FIG. 3
TL-30043

PRESSURE RELEASED FIG. 4
TL-30044

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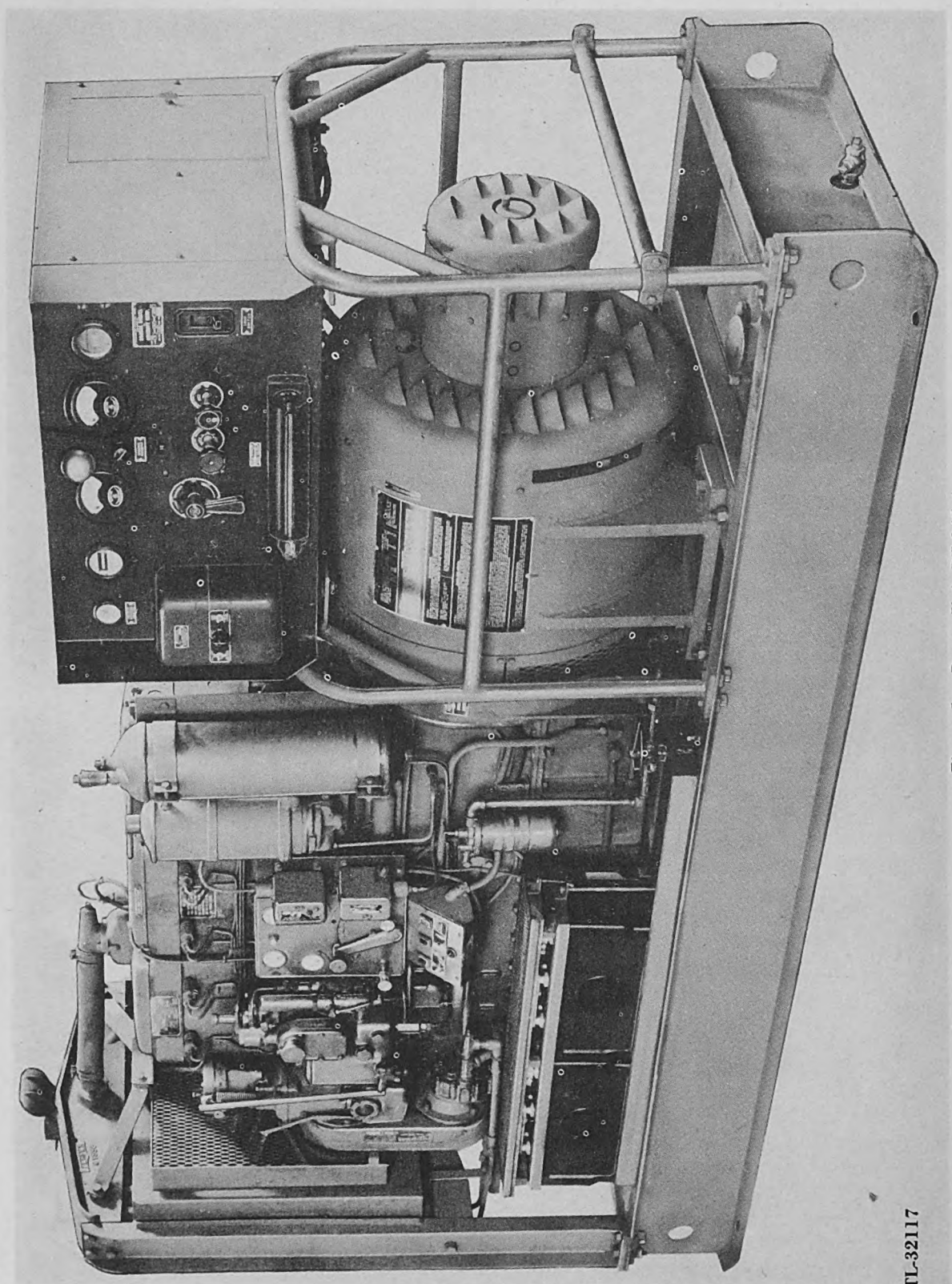

TL-32117

Figure 1. Power Unit PE-245-A.

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Section I
DESCRIPTION

1. POWER SUPPLY. Power Unit PE-245-A consists of a six-cylinder Diesel engine directly connected to a 25-kw, 120/208-volt, 4-wire, 60-cycle, 3-phase generator. The assembly is mounted on a rigid structural-steel sub-base (fig. 1). The weight and dimensions of the power unit are as follows:

a. Net weight, 5,900 lbs.; overall dimensions, uncrated, 36½" by 62½" by 104".

b. Gross weight, 8,000 lbs.; overall dimensions, crated, 50" by 75" by 137".

2. DESCRIPTION OF ENGINE. The engine is of the four-stroke-cycle, Diesel, overhead-valve type, similar to most other overhead-valve engines but with much higher compression. No carburetor or electrical ignition of any kind is used. It is equipped with one fuel pump for all cylinders and a separate injector for each cylinder. The mechanism for measuring the charge of fuel is contained within the fuel pump mounted on the side of the engine. After the pump has measured the proper fuel charge and delivered it to the injectors, the fuel is forced into the injector-cup and, on the compression-stroke, it is partially gasified. Then, with the piston near top-center, the plunger is suddenly depressed by proper cam action, driving this charge of gaseous vapor through the cup into the combustion chamber where ignition takes place and the working stroke is completed. Lubrication is of the force-feed type. Every bearing on the engine proper is fed by the force-feed gear pump mounted on the rear end of the gear cover. The lubricating oil is carried in the crankcase.

3. ENGINE SPECIFICATIONS.

Cylinders	6 (number).
Bore	4-⅞ inches.
Stroke	6 inches.
Displacement	672 cubic inches.
Compression ratio	17 to 1.
Firing order	1-5-3-6-2-4.
Horsepower at 1,200 rpm.	90 hp maximum.
Fuel system	One-for-all distribution and injector system.
Cylinders	Cast enbloc with removable wet liners.
Cylinder heads	Detachable cast in pairs.
Valves—intake and exhaust	Heat-resisting alloy steel, diameter 1-15/16 inches.
Valve location	Overhead.
Pistons	Chrome-nickel iron, cam-ground.
Piston pins	Full-floating.
Piston pin bearings	2 inches diameter.
Piston rings (compression)	3 (quantity), each ⅛ inch wide.
Piston rings (oil)	2 (quantity), one 3/16 inch and one ¼ inch wide.
Connecting rods	Forged alloy steel, 12 inches long, center to center.

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Connecting rod bearings	Copper-lead, steel-backed removable shells, diameter 3-⅛ inches.
Crankshaft	Nickel-molybdenum steel.
Main bearings	7 (number).
Main bearings	Copper-lead, steel-backed removable shells, diameter 4-½ inches.
Area main bearing surface	62.1 square inches.
Camshaft	Special chrome-steel forging.
Camshaft bearings	7 (number).
Crankcase and cylinder block	Iron alloy.
Crankcase oil capacity	12 gallons.
Lubrication	Forced-feed to all bearings.
Engine cooling system capacity	15 gallons.
Governor	Woodward hydraulic.
Governor housing oil capacity	3 pints.
Fan drive	Double V-belt.
Starting method	Electric.
Net weight with standard accessories	2,360 lbs.

4. COOLING SYSTEM. A belt-driven centrifugal pump is mounted on the front of the engine. A six-blade fan is mounted on the water pump pulley and circulates air through a sectional core radiator. Cool water is drawn from the bottom of the radiator by the action of the centrifugal pump, is circulated through the engine into the cylinder heads discharged from the cylinder heads to a water manifold assembly. Two thermostats are mounted in the discharge connection to the radiator and control the flow of water to the radiator. A thermostat located in the bypass connection controls the flow of water back to the suction side of the water pump which recirculates it through the engine. The thermostats control the operating temperature of the circulating water (fig. 8).

5. FUEL SYSTEM.

a. Supply. A 21-gallon fuel tank is located in the sub-base below the main generator. A two-position supply valve is used in the system for changing the fuel supply from this tank to an outside fuel supply. The outside fuel supply can be arranged by use of a 20-foot flexible hose connection between the two-position valve and a standard 55-gallon oil drum. A 20-foot flexible hose with suction pipe is provided for this purpose. The suction pipe may be installed in a standard 55-gallon oil drum by connecting the 20-foot flexible hose between the two-position valve and the suction pipe of oil drum. The position of the fuel valve will designate the source of supply. With the fuel supply valve placed in the position marked TANK, fuel will be drawn from unit fuel tank. With the supply valve placed in the position marked DRUM, fuel will be drawn from the external 55-gallon oil drum.

NOTE: Fuel cannot be drawn from both tanks at the same time.

b. Drawing of Fuel. Fuel is drawn through a primary filter (edge type) by action of a small gear pump in the main fuel pump assembly and is discharged into and through the secondary filter (replaceable element type). From the secondary filter the fuel flows into a small float-regulated fuel chamber. A secondary fuel pump draws the fuel from the float chamber and delivers the fuel under pressure, through an overspeed trip-valve-device into the distributor and metering arrangement, and then to the injector (fig. 10 and the schematic fuel flow diagram, fig. 2).

6. LUBE OIL SYSTEM.

a. Oil Flow. Lubricating oil is drawn up from the oil pan by the action of a gear-type pump driven by the timing gear train (fig. 3), to an oil cooler section of the radiator and back into the filter section of the oil pan. From the filter section of the oil pan the oil

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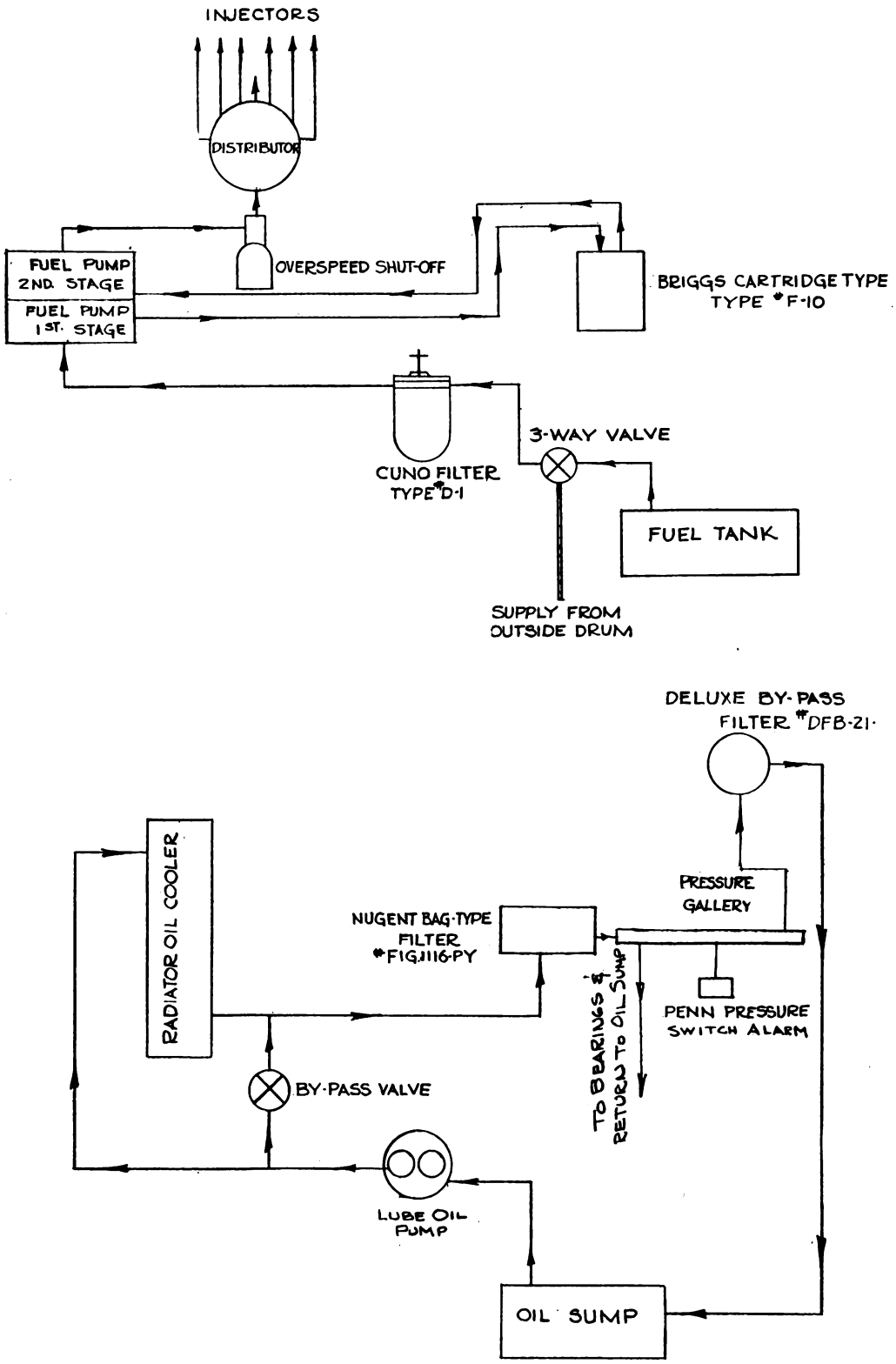

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Figure 2. Lubricating and fuel flow schematics.

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flows into the lubricating oil connection on the engine at the side of the block which leads into an oil galley. From the oil galley the oil flows into the hollow camshaft which has a pressure-regulating valve in the front end. Oil pressure is built up therein by resistance of the pressure-regulating valve, and oil under this pressure is distributed from the oil galley to the bearings, crankshaft, and rockers (fig. 2).

b. Filter. A secondary or replaceable element type filter is mounted on the side of the engine and is connected to the oil galley of the engine. Oil under pressure from the oil galley flows through the element of the filter which removes grit and contamination from the oil. The clean oil returns to the oil pan by a drain line connected between the filter and the engine (fig. 3).

7. AIR INTAKE SYSTEM. Air for combustion is drawn in through two oil bath air cleaners. An air preheater element is incorporated within the air manifold and can be used for heating of air during the initial start of the engine. By manual operation of a hand pump on the instrument panel, a high-tension spark is formed across a pair of electrodes in the air manifold and fuel is forced through a spray valve which sprays it against this spark. The spark ignites the fuel, thereby heating intake air drawn through the manifold when the engine is started. Refer to paragraph 36. The preheating of air is needed only for temperatures below 40 degrees Fahrenheit and eliminates the drain on the batteries which is normally encountered during cold weather starting (figs. 4 and 8).

8. EXHAUST SYSTEM. The exhaust gases leave the engine at the 3½-inch upturned elbow and pass through a four-foot length of corrugated flexible steel pipe into the silencer and out through the tail pipe to the atmosphere.

9. STARTING SYSTEM. The engine is equipped with a 24-volt starting motor connected to five 6-volt starting batteries with cables connected to the engine starter motor, which is in turn connected to the hand-starting switch, cranking contactor, and alarm switches (figs. 4 and 4a).

10. ALARM AND PROTECTIVE SYSTEM. The engine is equipped with two safety alarm contact switches which close independently on falling lube oil pressure or high water jacket temperature. When either of the alarm switches closes, a circuit will be made through to the alarm circuit box relays. Closing of the relays will cause the howler horn to sound. The cause of alarm will be indicated by the lighting of a jeweled light on the alarm circuit box. A 15-foot droplight extension line is supplied for connection to the outlet on the alarm circuit box (fig. 8) for a warning signal outside of the operating station. A red light is used and will blink continually when alarm conditions activate a flasher element within the alarm circuit box. The engine is equipped with an overspeed device which trips a fuel shut-off valve between the fuel gear pump and the distributor assembly, and shuts down the engine in the event that overspeeding occurs. The overspeed trip device is set for approximately 100 revolutions per minute above governed operating speed (fig. 3). The alarm circuit is automatically in operation when the throttle lever is moved. The howler will sound until the engine is started. The push button below the warning light panel may be held down to prevent the howler from sounding.

11. INSTRUMENT PANEL. Centrally located on the engine is an instrument panel upon which is mounted the necessary equipment for setting the fuel throttle and starting the engine. The equipment mounted thereon is shown in figure 10. The function and purpose of each is as follows:

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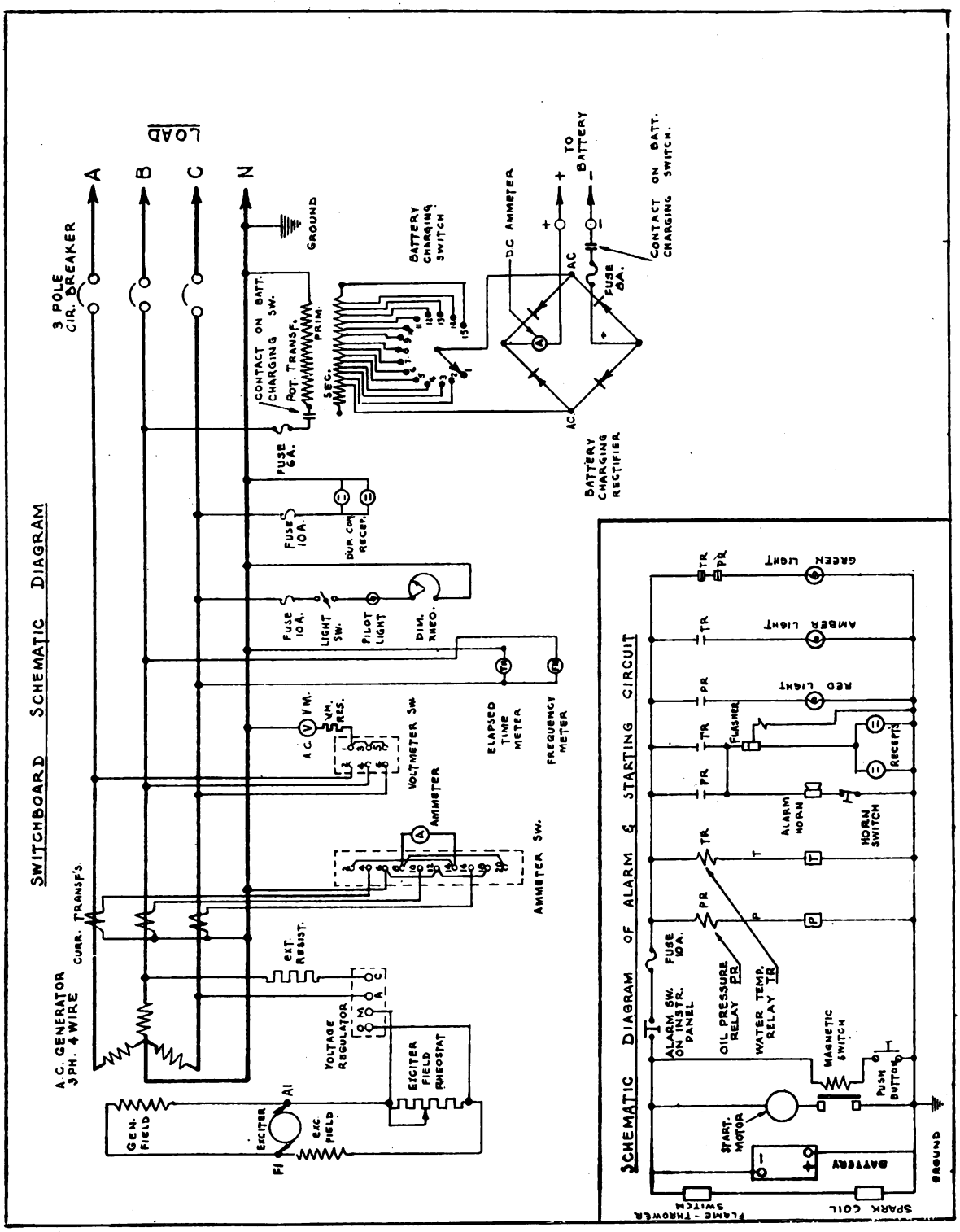

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Figure 4. Switchboard schematic diagram.

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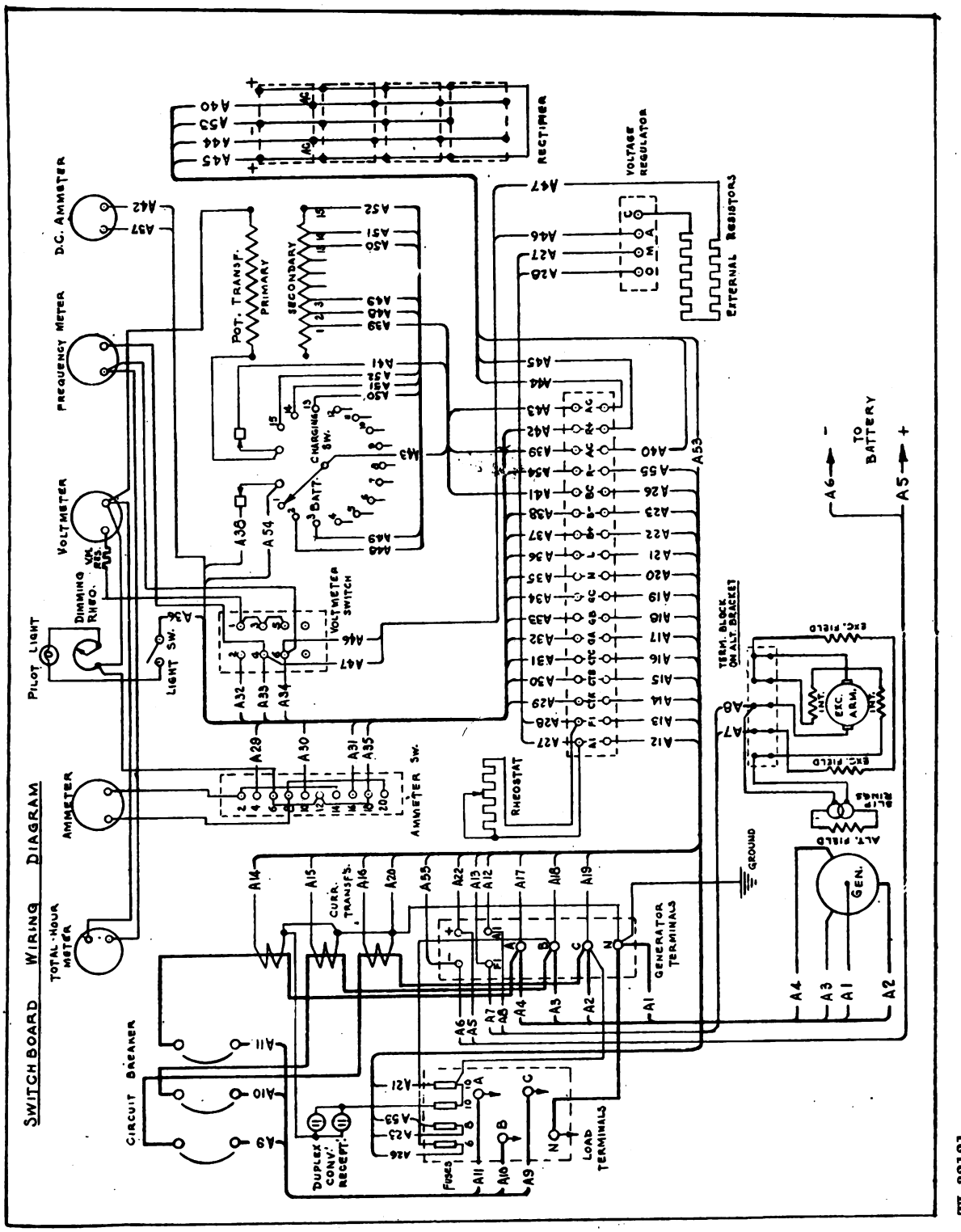

Figure 4a. Switchboard wiring diagram.

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Item	*Function*	*Purpose*
Fuel pump throttle control.	Setting of fuel control within fuel pump to full delivery position, and setting alarm circuit in operating position. Howling of horn designates circuit operating. Horn stops howling as engine starts and oil pressure reaches 15 lbs. reading on gauge.	Manual fuel setting for starting and stopping of engine and making circuit in alarm safety system.
Engine priming pump.	Manual operation of pump bleeds all air from fuel system (par. 28).	Priming of engines and testing pressures in fuel system.
Flame thrower hand pump.	Manual operation of pump causes fuel to be sprayed within air manifold and causes pressure switch to make contact for spark ignition of fuel spray.	Freezing temperature heating of air in manifold.
Alarm light panel.	Green light indicates normal operation. Red light indicates low oil pressure. Amber light indicates high water temperature. Howler stops if lower push button is held down. Prevents static on radio equipment when horn sounds.	To indicate cause of alarm.
Starting switch.	Circuit connection between batteries and solenoid of starter motor.	Manual control for energizing the starter solenoid coil.
Fuel oil pressure gauge.	Register fuel oil pressure from No. 2 gear pump to distributor disks.	Determine fuel oil pressure in lbs/sq. in. of No. 2 gear pump.
Lubricating oil pressure gauge.	Register lube oil pressure.	Determine oil pressure within engine in lbs/sq. in.
Lubricating oil temperature gauge.	Register lube oil temperature.	Determine oil temperature of circulating oil in degrees Fahrenheit.
Water temperature gauge.	Register water temperature.	Determine water temperature of circulating water in degrees Fahrenheit.
Lubricating oil safety pressure switch.	Make and break circuit for alarm control.	Notify operator when low oil pressure exists.
Water temperature safety thermo switch.	Make and break circuit for alarm control.	Notify operator when high water temperature exists in engine.

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12. GUARDS AND COVERS. A mesh wire screen guard is provided over the exhaust manifold and the radiator cooling fan. In addition, a perforated cover and drip cover are arranged over the fan on the generator.

13. GENERATING EQUIPMENT.

Specifications	*Alternator*	*Exciter*
Type	S-110	E 500
Kva	31.2	
Kw	25	1.
Volts	120/208	125
Amperes	79	8
Poles	6	2
Type-winding	Wye	Shunt
Inclosure	Drip-proof	Drip-proof
Temperature rise	40° C. Cont.	
Speed	1,200 rpm	1,200

The generator is driven at 1,200 revolutions per minute. It is a six-pole, salient-pole, single-bearing, ball-bearing alternator. The exciter is direct-connected, the connection between the exciter and generator being a solid shaft coupling. A pilot is provided in the exciter and shield to assist in the support of the direct current armature. A fan is attached to the engine flywheel for cooling of the generator windings.

14. SUB-BASE AND BASE. The supporting member of this generating set consists of a pair of 10-inch by 2-¾-inch cold rolled channels set on end and cross-braced with I beams for rigidity and torsional vibrations. The lower lip of each longitudinal channel is evenly drilled with four 13/16-inch holes to accommodate the foundation bolts. Holes in each end of the channel are provided for insertion of lifting sling bolts or other lifting devices (figs. 5 and 6).

15. COUPLING. The single engagement coupling consists of a semi-steel flange bolted into the engine flywheel with drilled bosses carrying the bolts which attach through four holes in the laminated circular steel disks. Four additional holes are provided in the steel disks to take the drilled bosses of the hub of the coupling which is attached to the generator. For protective purposes the generator hub is lengthened and fits into the flange section in the flywheel with very small clearance so that, in the event of disk failure, the rotor will not drop on the stator.

16. SWITCHBOARD.

a. Generator Control Panel. The generator control panel is rubber mounted on a frame over the generator (fig. 11). This panel provides the necessary controlling equipment and instruments for operating the generator. The generator is connected to the control panel by means of a terminal box within the control panel. A triple connection terminal lug is provided for each phase connection of the generator for individual loads. A battery-charging rectifier is incorporated in the control panel for recharging the engine batteries.

b. Main Assemblies. The main assemblies mounted on the control panel, their functions and ratings are as follows:

Assembly	*Function*	*Classification*
Bulb panel.	Panel light.	40 watt, silver tip.
Circuit breaker.	Disconnect generator from load.	De-ion, 3-pole, 100-ampere, 250-volt thermal overload trip.
Fuse, 10-ampere.	Safety for drop line service.	Renewable cartridge type.
Fuse, 8-ampere.	Safety for battery charging circuit.	Renewable cartridge type.
Outlet convenience.	For 120-volt utility service.	Duplex-double outlet.

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Assembly	*Function*	*Classification*
Meter, a-c ammeter.	Register current flow.	0-150 amperes.
Meter, a-c voltmeter.	Register alternator voltage.	0-150 volts.
Meter, d-c ammeter, battery charging.	Resistor charging rate to storage batteries.	0-6 amperes.
Meter, frequency.	Register cycles of operation.	90-130 volts, 58-62 cycles.
Meter, total hour.	Register total running time.	0-9999 hours.
Regulator, voltage.	Automatic voltage control.	Type-G.L.-1.
Rheostat, panel bulb.	Dimming control for panel bulb.	Ohmite.
Rheostat, exciter field.	Resistance for exciter field.	Slider type, 800 ohms, 2.9 amperes.
Switch, ammeter selector.	To connect ammeter to load circuit.	3 position on. 1 position off.
Switch, battery charger.	To connect and regulate charging rate of current to batteries.	14 point dial.
Switch, panel bulb.	Disconnect switch for panel bulb.	Toggle switch.
Switch voltmeter selector.	To connect voltmeter to generator circuit of individual phases.	3 position on. 1 position off.

17. CONDENSED DESCRIPTION OF EQUIPMENT.

a. Power Unit PE-245-A. The power unit herein described is a complete Diesel-engine-driven electric generating set designed to generate alternating current of 25 kw capacity, 120/208 volts, 3 phase, 60 cycle at 1,200 revolutions per minute. This power unit consists primarily of the following major components.

b. Engine. Cummins Diesel, Model HI-6, six cylinder, 4-7/8 inch bore, by 6 inch stroke, 672 cubic inch displacement. The engine is completely described in paragraphs 1 through 16 in this manual.

c. Generator. Made by Rogers Diesel and Aircraft Corp. of New York City, on their frame No. 193, rated at 25 kw, 120/208 volts, 60 cycle, 3 phase, 1,200 rpm with direct-connected exciter on frame No. 225. The generator is directly connected through a flexible coupling of the stainless steel disk type to the Diesel engine. The comp.. te engine-generator set is mounted on a substantial structural-steel base of welded construction. The generator is completely described in paragraph 13.

d. Control Panel. The control panel, mounted on the unit over the generator is an all steel panel. The panel equipment is completely described in paragraph 16.

e. Batteries and Electrolyte. Five 6-volt, 3 cell batteries are furnished, dry charged, with electrolyte packed separately. See paragraphs 9 and 22.

f. Exhaust Silencer. The exhaust silencer is a Maxim MUC #7, spark arrestor type (par. 8).

g. Fuel Tank and Fittings. A 21-gallon fuel oil tank is mounted on the sub-base. Twenty feet of flexible tubing and a standpipe for inserting it into an outside source of supply is supplied. A two-way valve permits the use of either supply of fuel oil.

h. Dimensions and Weights.

	Length	*Width*	*Height*	*Weight*
Uncrated	104"	36-1/2"	62-1/2"	5,900 lbs.
Crated	137"	50"	75"	8,000 lbs.

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Section II
INSTALLATION AND OPERATION

18. UNCRATING.

a. Procedure. The unpacking procedure is as follows:

(1) Remove both ends, the top and sides of the crate.

(2) Remove the cross bracing and steel straps from the accessory boxes, spare parts, silencer, etc.

(3) Cut open the airtight cover which surrounds the power unit and remove the eight bags of moisture absorbent material. Discard these.

(4) Remove the nuts from the hold-down bolts.

(5) Lift the unit from the bolts.

(6) Remove all processing, rustproofing, and protective tape from the unit.

(7) Inspect the unit for damage and check all material against the packing list.

CAUTION: Whenever practical, the generator set should be moved as a complete unit. Care should be taken not to spring the generator shaft and sub-base by attaching hooks or slings improperly. Unnecessary handling of the equipment at low temperature should be avoided as far as possible, because castings are easily broken at low temperature.

b. Exposure to Low Temperature. If the power unit has been exposed to low temperature do not open the protective covering until sufficient time has elapsed for the unit to attain the temperature of the locality where it is to operate. It is suggested that the unit be allowed to stand at least 24 hours. Failure to take this precaution will result in sweating which may prove injurious to equipment.

19. INSPECTION OF GENERATOR SET.

a. Make a visual overall inspection of the unit to see that no connections, instruments, tubing, or accessories are damaged.

b. Check the radiator fins and tubes for damage and clean out all air passages.

c. Check to see that no foreign objects are inside the generator and that there is no corrosion on the slip-rings or commutator. Resurface, if necessary, with fine (000) sandpaper. Check the air gap clearance between the pole pieces and windings to see that no foreign matter, such as bolts, nuts, or chips of wood, has fallen into the lower section of the generator windings.

d. Check for broken or tight brushes in the holders and set the spring tension properly if necessary. Inspect for loose terminal connections.

e. Remove the rear panel of the switchboard, clean, and check for loose connections.

f. Remove the barring slot cover on the top of the flywheel housing and crank the engine over by hand to be sure that the engine turns over without binding. Engine compression may be released by holding open the compression release lever (fig. 3).

20. INSTALLATION.

a. Foundation Installation. The power unit may be installed on a foundation or a trailer. To install on a foundation make a template or installation jig as shown in figure 6. Mark foundation holes in the template to the dimensions as illustrated. Drill ¼-inch holes through the template for installation hole markings. This template may then be used for marking the holes necessary for bolting the power unit to its foundation. After placing the template in the proposed installation position, the ¼-inch drill may be run through the template holes previously drilled thereby marking the foundation bolt holes. Care must be taken to see that holes are drilled vertically. Enlarge the ¼-inch holes to the size needed for making the installation. Foundation holes on the sub-base are drilled 13/16 inch. Secure the bolts in position by any of the conventional methods such as molten lead or a grout mixture of cement. Place the unit and bolt it securely to the foundation.

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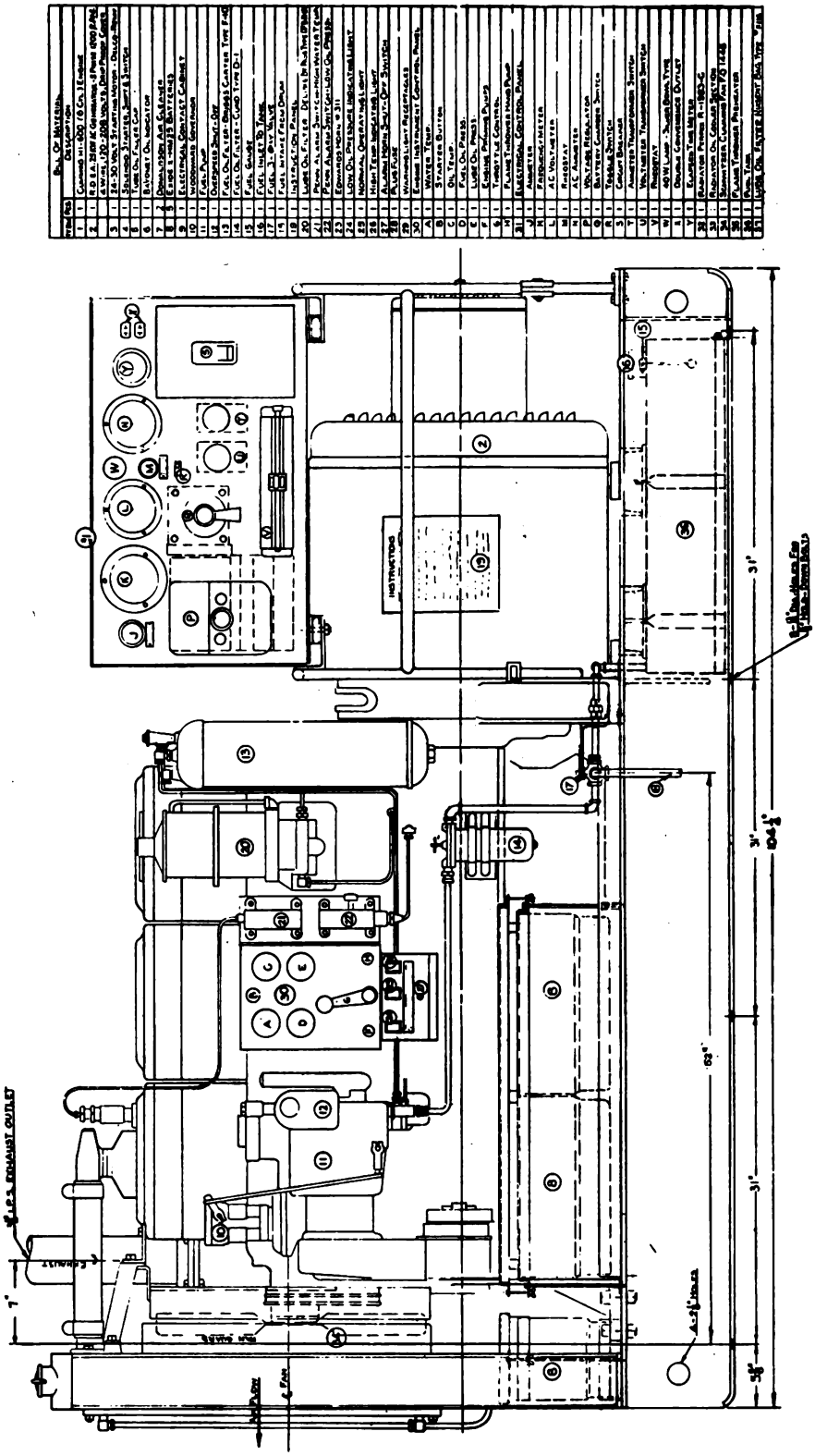

Figure 5. Fuel pump, side elevation.

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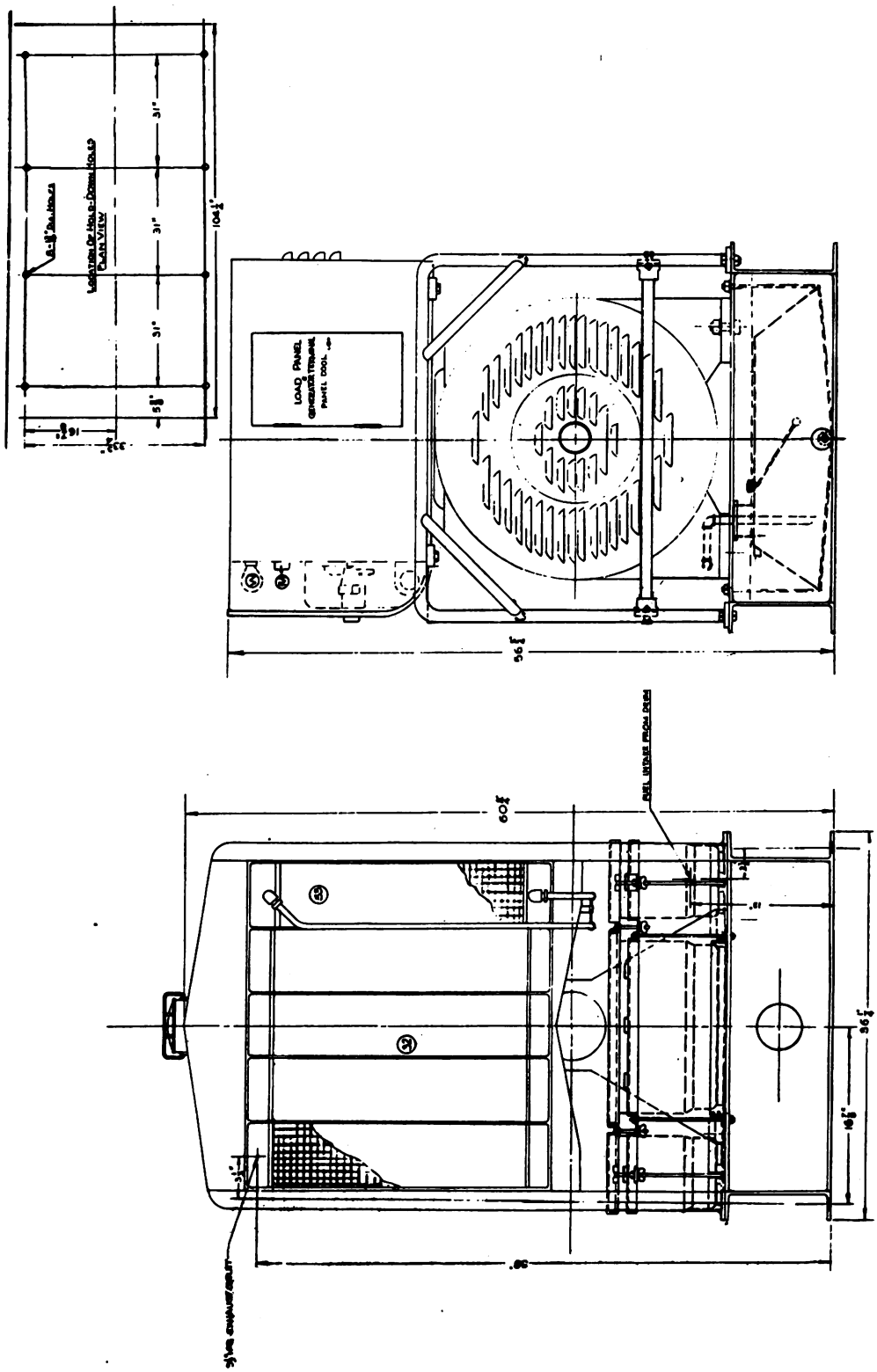

Figure 6. Generating unit, end elevations.

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b. Truck or Trailer Installation. If the unit is installed on a truck or a trailer, metal plates must be used on the bolts to prevent them from pulling through the truck or trailer floor.

NOTE: When making the installation, and before securing the unit to its foundation, it must be ascertained that no high or low spots exist at points where the engine skids rest on the foundation.

21. EXHAUST CONNECTIONS. After the unit is bolted down, connect the flexible pipe provided to the engine exhaust outlet flange (fig. 8). The silencer is attached to this pipe and the tail pipe runs from this to the atmosphere. Care should be taken to brace the silencer when hanging it so that the weight of the silencer and tail pipe will not be imposed upon the flexible steel tubing. It is also necessary that this flexible steel tubing have a slight offset in order to perform properly. The outlet tail pipe must be provided with protection against rain.

22. BATTERY PREPARATIONS AND CARE.

a. Inspection. The batteries with drip covers are mounted on the engine base (fig. 3). Inspect the batteries for damage and check to see that all vent plugs are intact. All contact surfaces should be scraped bright and clean before connecting. Apply a film of heavy grease or vaseline to the connections to prevent corrosion. The batteries are shipped dry with the plates in a partly charged condition. The vent plugs must be left tightly in place until ready to fill with electrolyte (battery acid). Batteries should be filled with acid as soon as possible and at least one hour allowed to elapse before they are placed in service.

CAUTION: Acid should be poured from the container into a glass or porcelain receptacle. Flush the skin with fresh water if acid splashes on the body.

b. Preparation for Service. To prepare the battery for service, proceed as follows:

(1) Unscrew the vent plugs. Remove the temporary paper disks from the filling holes and discard them.

(2) Fill each cell with the prepared electrolyte. The battery is equipped with a nonflooding vent plug and cover. The proper filling level is 3/8 inch above the top of the separators, or at the bottom of the filling well of the cover. The valve or lead ring which normally limits filling to the bottom of the well may not function until thoroughly wetted by the first charge. Excess electrolyte above this point, either on first filling or level adjustment, should be removed.

(3) Allow the battery to stand at least one hour after filling with electrolyte. If the level falls during this time, add electrolyte to restore it. Replace vent plugs in cells. If any electrolyte was spilled on the battery, remove it by means of a cloth slightly dampened with a solution of bicarbonate of soda and water, and rinse with water.

(4) Give freshening charges after placing the battery in service. Make certain that the positive terminal of the battery (marked POS or +, or painted red) is connected to the positive of the charge circuit, and that the negative terminal (marked NEG or –, or painted black) is connected to the negative of the charge circuit.

(5) Gas bubbles cause the electrolyte level to rise on charge. With the vent plug tightly in place, a vent is opened on the under side of the cover which allows normal expansion of the electrolyte and prevents flooding of the cells. When the plug is removed for hydrometer readings during the charge, the electrolyte may rise in the filling well. Take the hydrometer reading promptly. To return electrolyte to the cell, it may be necessary to open the valve by pressing down and tilting the lead ring in the well with a small piece of wood. Replace the vent plug promptly.

(6) Charge the battery until four consecutive hourly readings show no rise in specific gravity for the lowest cell. If the above rate is maintained, the charging time will be at least 12 hours. Lower rates will increase the time proportionately. If the temperature exceeds 110 degrees Fahrenheit, reduce the charging rate. If necessary to restore the electrolyte level during charge, use only approved water. For setting of the charging rate see paragraph 35.

(7) After completion of charge, the gravity should be as shown in the table below, corrected to 77F, and with the level 3/8 inch

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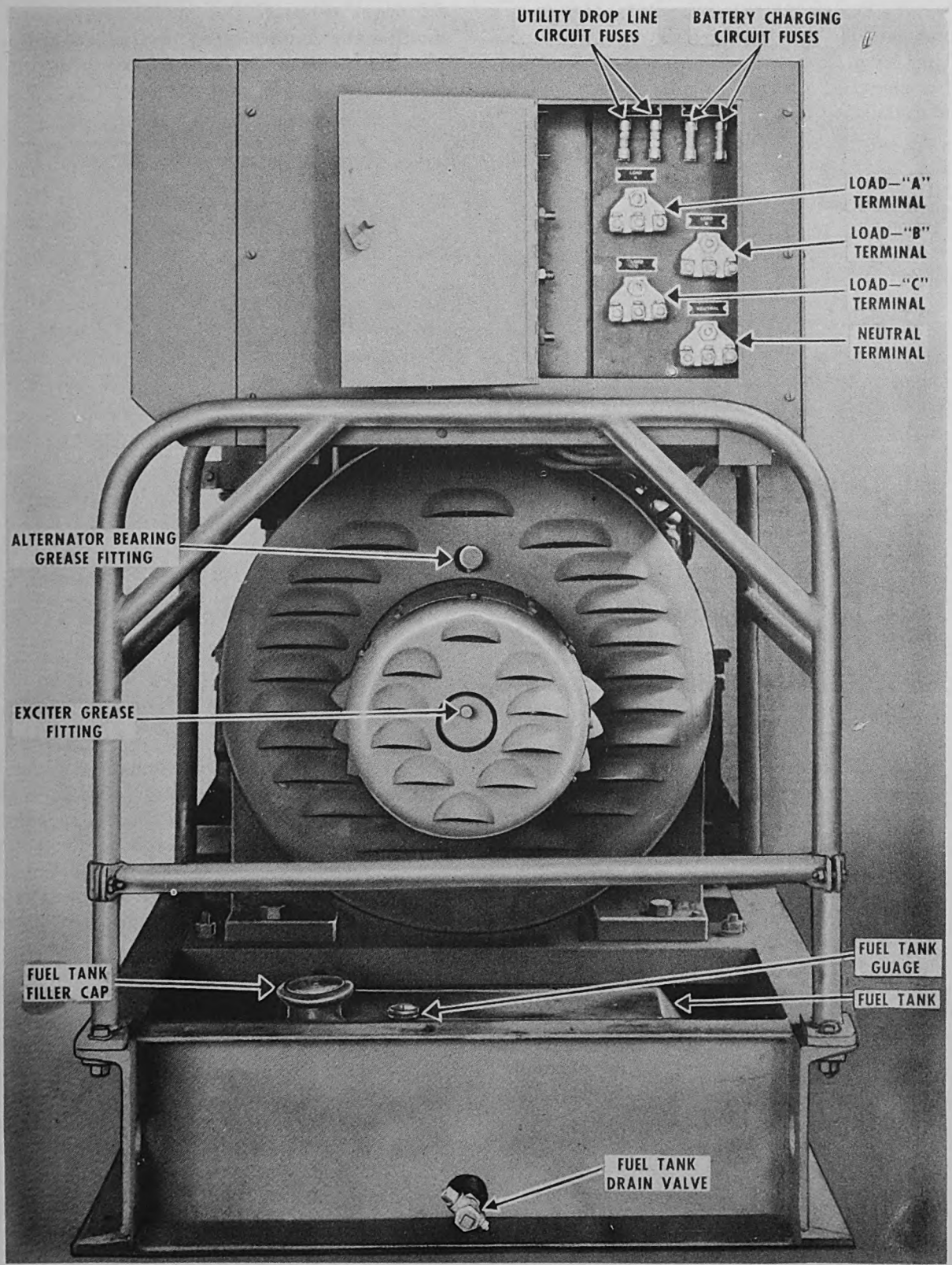

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Figure 7. Power Unit PE-245-A, rear view.

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above the top of the separators. If it is not, adjust by removing some solution and replacing with clean drinking water or electrolyte as required. Charge to mix the solution before testing again.

	Temperate climate	**Tropical climate*
Filling gravity	1.270	1.210
Maximum temperature	110° F.	125° F.
Final gravity	1.270-1.285	1.200-1.220

**A tropical climate is one in which water never freezes.*

(8) After adding water, wipe the battery clean and dry. Have vent plugs in place at all times. Wash and clean the hydrometer barrel and float.

23. ELECTRICAL CONNECTIONS. Insulated load connections may be brought in below the switchboard terminal box and connected to the respective load and neutral terminal posts located at the rear of the switchboard (fig. 7). A connection between neutral and one of the load terminals will give 120 volts. A connection between any pair of the load terminals will give a voltage of 208 volts (figs. 4 and 4A).

24. FUEL CONNECTIONS. All fuel connections between the main fuel tank and the fuel pump are factory installed. The capacity of the tank is 21 gallons, sufficient for approximately 8 hours of full load operation. If desired for the initial run, the unit can be operated without making further connections to the outside fuel system. If an additional fuel supply is needed for longer operation, the standby flexible fuel equipment may be connected to the two-way valve connection provided (fig. 3). A stand-pipe adaptor is provided (for standard 55-gallon oil drum only) which may be screwed into the large hole of a 55-gallon fuel oil supply drum. The flexible hose provided must then be connected between the oil drum and the two-way valve on the fuel tank. It is desirable when making this connection that the flexible line be full of fuel oil. This may be obtained either by pouring fuel down the flexible line connected to the oil drum or by siphoning oil from the oil drum through the flexible hose before making the connection at the fuel tank. Hold the thumb over the end of the hose until ready to make the connection.

NOTE: The fuel lift from the oil drum to the fuel pump should be less than 6 feet; otherwise suction difficulties may be encountered.

25. LUBRICATION.

a. Engine Crankcase. Remove the filler cap from the crankcase and pour in a grade of oil as recommended in tables below (fig. 8). *Use clean containers when handling lubricating and fuel oils.* The oil pan capacity is 12 gallons. The oil level must be checked on the dip stick before and after adding oil in the crankcase.

OIL SELECTION BY AIR TEMPERATURE

Ambient Temperature	*SAE NO.*	*Army Spec. NO.*
90° F.	50	OE-50
32°-90° F.	30	OE-30
0°-32° F.	10	OE-10
Below 0° F.		Special

OIL SELECTION BY OIL TEMPERATURE

Oil Operating Temperature	*SAE NO.*	*Army Spec. NO.*
200-220° F.	50	OE-50
180-200° F.	30	OE-30
140-180° F.	10	OE-10

b. Fuel Pump Governor Housing. A small oil reservoir for the governor oil supply is provided in fuel pump housing (fig. 3). A sight glass window indicates the oil level. Remove the filler cap above the sump and fill the governor housing with an engine grade of oil to the center line of the sight glass. Replace the filler cap.

c. Air Cleaners. Air for combustion is drawn into the engine through the oil bath air cleaners which should be filled to the bead mark shown in the lower reservoir, with lubricating oil of the same grade as that used in the engine (fig. 9). To fill these air cleaners, remove the lower section by loosening the wing bolt until the lower reservoir is loose. Remove the reservoir and fill to the mark. Attach reservoir to the filter and tighten the wing bolt.

d. Starting Motor. Insert not more than five drops of engine oil through the hinge cap on the starter.

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e. Water Pump. The water pump bearings are grease lubricated through a grease-cup connection behind the radiator (fig. 3). Unscrew and fill the grease cup with WB-2 general purpose grease. Screw the cup half way down. Repeat this operation at least once a week, and more often if unit is being run continuously.

f. Main Generator and Exciter. Two grease-cup connections are located at the rear of the generator for lubrication of two roller bearings of the generator shaft (fig. 7). Fill each cup with WB-2 grease and screw down the cups on the fittings. The generator bearings are packed with grease when shipped, and do not require a complete packing of grease when the unit is first put into operation.

26. COOLING SYSTEM.

a. Checking.

(1) Check to see that all drain plugs in the engine block are tight.

(2) Close the drain cock on the radiator.

(3) Fill the radiator through the filler cap with clean drinking water. Approximately 15 gallons of water are required.

(4) In cold weather, partially cover the radiator and add alcohol or antifreeze to the water in the following proportions:

PERCENTAGE BY VOLUME

Pure Methyl Wood Alcohol	*Denatured Wood Alcohol*	*Ethylene Glycol (Prestone)*	*Radiator Glycerine (G.P.A.)*	*Freezes at Degrees F.*	*C.*
13%	17%	16%	37%	20	−7
20%	26%	25%	55%	10	−12
27%	34%	33%	70%	0	−18
32%	40%	39%	81%	−10	−23
37%	46%	44%	92%	−20	−29
40%	53%	48%	100%	−30	−35

NOTE: If an engine has been standing in subfreezing weather for any length of time with the jackets and the radiator drained, never put water into it without a concentrated antifreeze added because, even if the water is warm, there is great danger of its freezing before the engine can be started.

b. Freezing Precautions. Add a small amount of antifreeze from time to time to take care of evaporation. Use a hydrometer daily to check the freezing temperature of the radiator solution during cold weather conditions. If alcohol is used to make the antifreeze solution, frequent checks with a hydrometer will be necessary as evaporation of the alcohol will be rapid.

CAUTION: Before using antifreeze, replace all worn or leaky hoses and repair all leaks.

27. CHECKING THE FUEL SYSTEM.

a. Properties of the Fuel Oil. Fuel oil should be neutral distillate petroleum oil, free from suspended matter, and not a mixture of light oil and heavy residue. Chemical properties should approximate the following requirements: Viscosity (Saybolt Universal Viscosimeter at 100 degrees Fahrenheit) not less than 34 seconds. Gravity from 26 to 36 Baume. Viscosity is more important than gravity. If the gravity is higher than 32, be sure that the viscosity is at least 34 seconds. Fuel must be free from water and grit, with not over 1 percent sulphur and not over 1 percent asphaltum content. Cetane rating should be not under 50. Not less than 10 percent of the fuel should distill below 460 degrees Fahrenheit. Not less than 90 percent of the fuel should distill below 675 degrees Fahrenheit; the end point not to exceed 725 degrees. Minimum recovery should be 98 percent.

b. Use of Light Oils. Extremely light oils, such as kerosene, will burn satisfactorily, but there is no lubricating value in light oils and their use will result in damage to parts which depend upon fuel oil for lubrication.

28. PRIMING THE ENGINE.

a. Cranking the Engine. Fill the fuel tank or tanks with the recommended fuel oil. Crank the engine over by hand, using the crank bar provided. This bar is to be inserted in the recess holes of the flywheel after removing the cover from the top of the flywheel housing. Rotate the flywheel in a clockwise direction, i.e., toward the fuel pump when inserting the bar at the top of the flywheel. To crank the engine easily, pull the compression release and insert the head of a ⅜-inch cap screw behind the release lever (fig. 3). When it has been ascertained that all is free, that no parts are rubbing or bearing on one another, and that the fans and guards are all clear, proceed with the other

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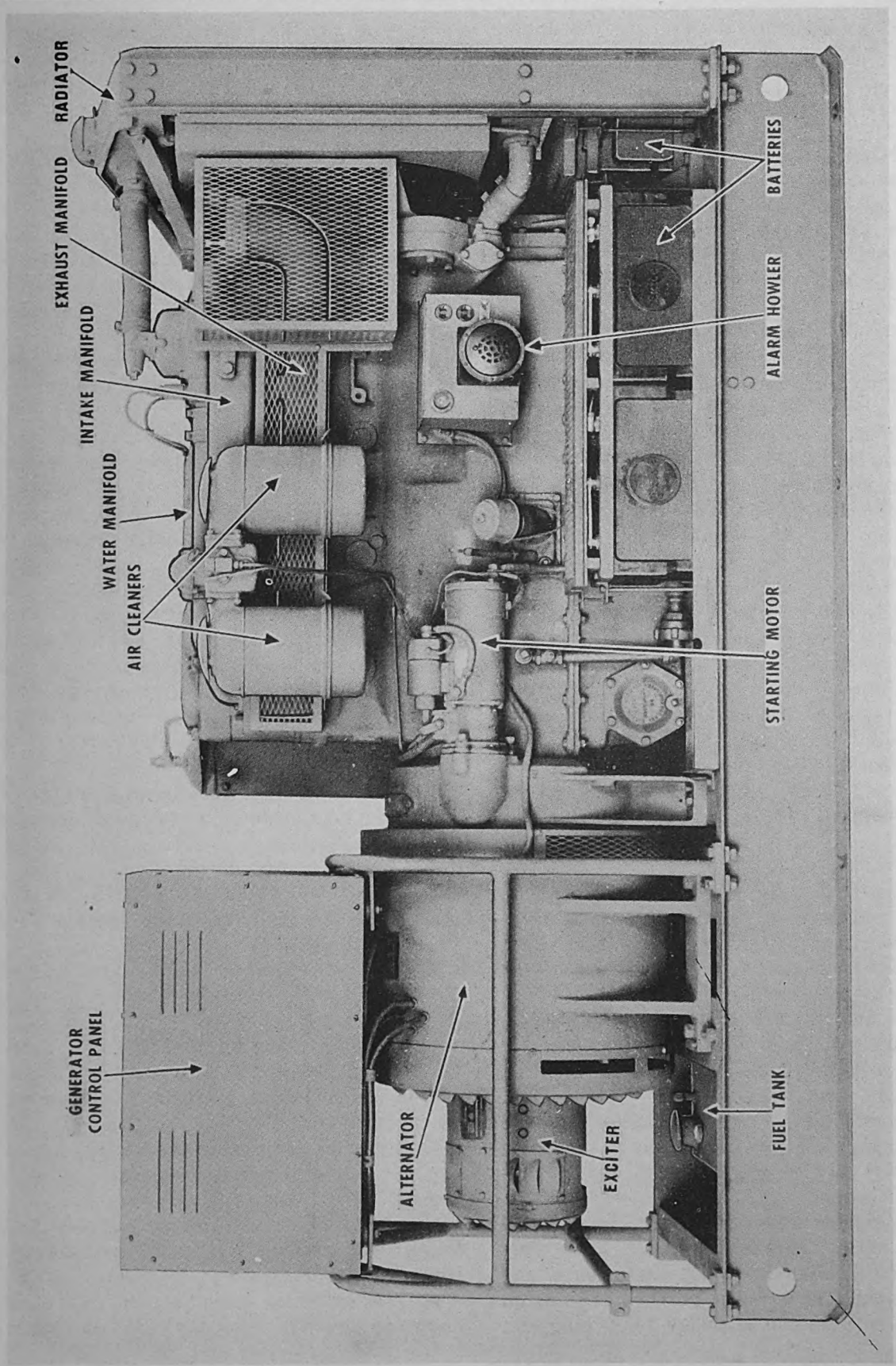

Figure 9. Power Unit PE-245-A, manifold side.

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operations necessary to prepare the engine for starting.

CAUTION: Always remove the cranking bar from the flywheel after turning flywheel to the position desired.

b. Priming the Fuel System. When the engine is started for the first time or if the fuel tank has been run dry, prime the fuel system by removing all air from the lines as described in the following paragraphs. The secondary fuel oil filter as shown in figure 10, must be filled with fuel oil. To do this open the filter vent valve, then remove the plug at the top of the inlet fitting and, using a funnel, fill the filter until oil flows out of the vent valve. Close this valve and replace the plug. Release the compression by pulling the lever on the front of the engine block next to the governor. This may be held open as described above. The capscrew used to hold the lever in the open position must always be removed before starting the engine.

(1) Check and tighten all fuel lines leading from the fuel tank to the fuel pump, including the ¼-inch line leading from the bottom of the fuel pump to the priming pump.

(2) If the oil drum fuel tank is to be used for the fuel supply, make connections as instructed in paragraph 24.

(3) Place the fuel supply valve on the fuel tank at the fuel supply position desired.

(4) Disconnect the ¼-inch fuel line A at the rear of the fuel pump. This line is the discharge of the engine priming pump (fig. 10).

(5) Work the left-hand priming pump plunger on the instrument panel which draws fuel from the fuel tank and discharges it out of the disconnected fitting. Continue the operation of the priming pump until solid fuel, free of air, is discharged from the connection. Reconnect the line.

(6) Loosen all six injector inlet lines at strainer connections B.

(7) Open the priming needle valve C on the fuel pump. This is accomplished by first loosening the packing gland nut and turning the valve one turn.

(8) Engine timing and priming marks are indicated on the inside face of the pulley mounted on the front shaft extension of the fuel pump. Three index notches are cut on the outer edge of the pulley for timing and adjusting of the valves. Three additional priming index lines (marked PR) are etched on the inside face of the pulley. These index marks are between the outer valve notches of the pulley. The priming marks when individually lined up with the priming and timing index notch of the timing gear case, point D, line up the fuel passages in the distributor disk of the fuel pump.

(9) Turn the flywheel with the barring device until one of the PR marks on the inside face of the pulley lines up with the index notch of the timing gear case.

(10) Work the hand priming pump until the fuel, free of air, leaks out of one of the loosened connections.

(11) Retighten the fuel line of the primed injector and give the primer one or two strokes only.

(12) Turn the flywheel over until the next PR mark on the fan drive pulley comes up to the center line mark on the gear housing. This brings the cylinder listed next on the firing order chart to the correct position for priming. Work the hand pump as directed for No. 1 cylinder. Continue to turn the engine to the next PR mark and prime the next cylinder listed on the firing order chart. Follow this procedure until all cylinders have been primed.

(13) Before starting the engine, close needle valve C. Never attempt to operate the engine with valve C open.

29. STARTING INSTRUCTIONS. Before starting the engine for initial operation of the unit, check to see that:

a. The engine has been primed and the fuel supply valve is properly set for the tank in use.

b. The lubricating oil is at the high mark on the dip stick in the crankcase and at the center of the sight glass in the governor housing (fig. 3).

c. The cooling system is full of clean water or antifreeze solution, if necessary.

d. All switchboard switches are in a neutral (off) position, and the control rheostats are set with resistance all-in (no voltage setting).

e. The governor speed control screw as shown in figure 3, is set for speed operation.

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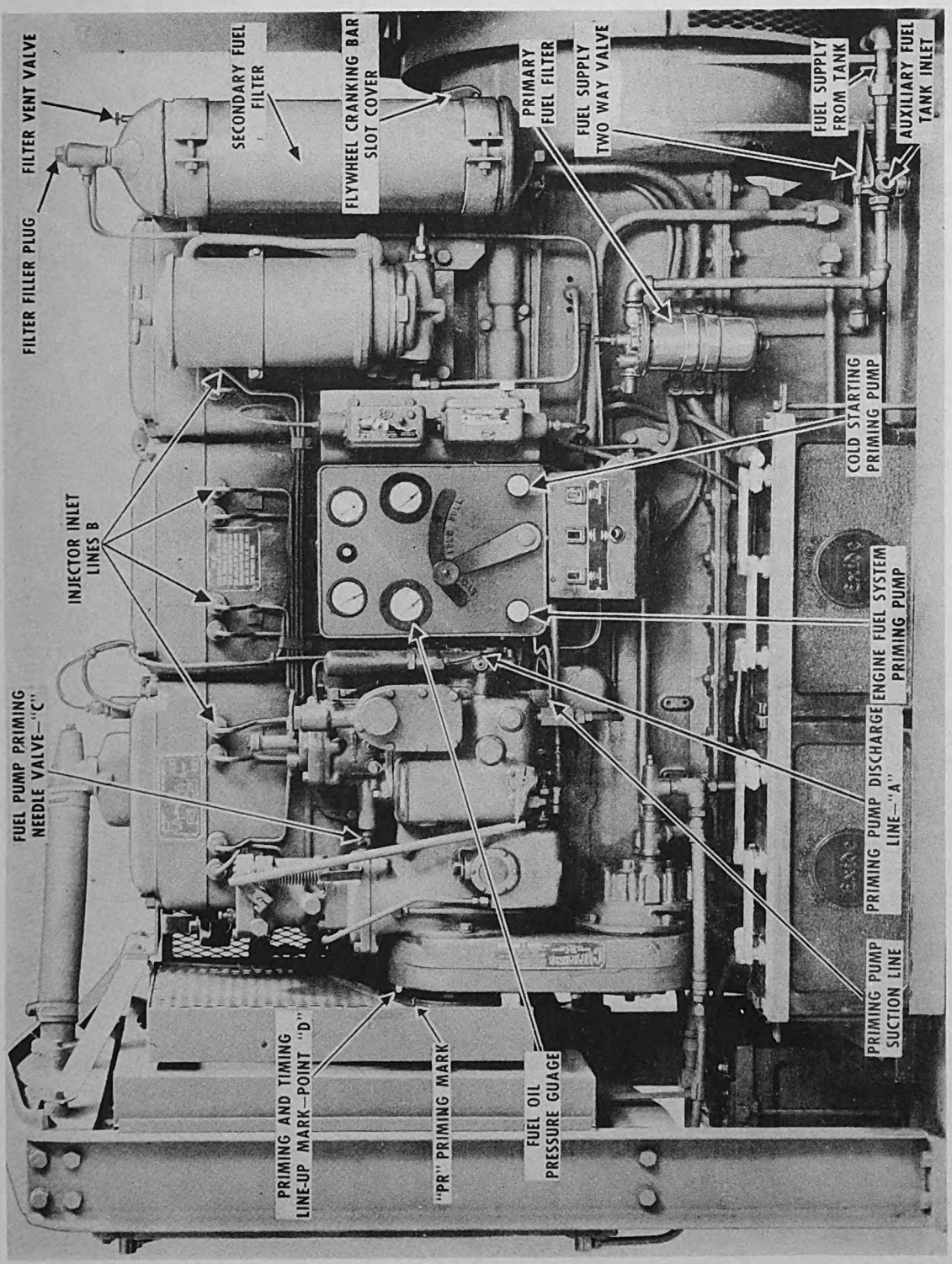

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Figure 10. Priming, engine fuel system.

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Turn the screw approximately five turns in a clockwise position from the slack position.

f. The power unit is properly connected for initial operation. Engine turns freely and all safety precautions have been taken.

g. The alarm circuit operates by pulling out the throttle lever from the stop recess hole. A red light should register on the lower alarm light panel when the howler sounds. Test the lower push button which should disconnect the howler circuit.

NOTE: Remove the generator inspection cover to observe the brush contacts during the initial run of the unit.

30. STARTING THE ENGINE.

a. Place the lever on the instrument panel to the FULL position.

b. Press the starter button firmly until the engine fires. Release it immediately after engine fires.

c. Control the engine speed with the fuel throttle lever. If desired, place the fuel throttle to the FULL position and lower the engine speed by means of the governor speed adjusting screw (fig. 3). The gauge readings should register as follows: oil pressure 40-60 pounds, and fuel pressure 80-150 pounds.

d. For the initial run operate the power unit for at least one-half hour before placing under load. During this time inspect the unit for local overheating, fuel, water, and lubricating oil leaks. Inspect the generator for local overheating and brush contact operation. If rough contact is noticed, stop the unit and polish irregularities as outlined in paragraph 54.

e. When the unit is in operating order, increase the engine speed in gradual stages and recheck the operation. Operating speed at no load is 61-cycle reading on the frequency meter.

NOTE: See paragraph 36 for cold weather starting.

31. SWITCHBOARD CONTROL (refer to fig. 11).

a. To Obtain Proper Engine Speed. Place the voltmeter phase selector switch to a phase-reading position. Voltage is obtained by placing the slider of the hand control rheostat gradually to the right. Note the increase of voltage on the voltmeter. The frequency meter should register 61 cycles with a voltage reading of 120 volts for proper control of generator speed and voltage. The engine governor speed controls frequency meter readings when the voltage is adjusted for 120 volts.

b. Ammeter Phase Selector Switch. Turn this switch to a phase position and apply the load by closing the load switch. The load will be indicated on the ammeter. The rotation of ammeter selector switch will indicate the difference in load on each phase winding of the generator. A normal full load for one phase winding on the generator is 78 amperes. An excessive overload or short circuit will trip the circuit breaker (load switch). This will be noticed when the load switch lever assumes a center position between the ON and OFF position. The operator should notify the officer in charge if the load switch fails to hold in the ON position. By placing the ammeter phase selector switch in a different phase position each time, closing the load switch, and reading the ammeter, it may be determined whether one or all of the phase windings are overloaded or short circuited. If one phase lead is overloaded, determine the cause and divide the load on the phase leads. If possible, operate the unit under a light load and inspect the unit for satisfactory operation. Increase load until a full load is obtained. If required, the unit will operate under 25 percent overload for 2 consecutive hours without overheating or damage to the unit. This is the equivalent of approximately 100 amperes on any or all of the ammeter phase positions.

32. VOLTAGE REGULATOR.

The voltage regulator is described in paragraph 43. Its purpose is to automatically regulate the voltage of the alternator which is accomplished by controlling the amount of excitation delivered to the alternator field by the exciter.

a. Putting the Regulator in Service.

(1) Run the engine but leave the circuit breaker open.

(2) Move the slider of the field rheostat to reduce the alternator voltage to about 25 percent of the normal operating voltage or about 30 volts.

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(3) Close the voltage regulator switch and adjust the voltage regulator rheostat to give an operating voltage of 120 volts. If this cannot be obtained with this rheostat, readjust the exciter field rheostat and then make a further adjustment of the voltage regulator to obtain the required voltage. After this final adjustment is made mark the position of the slider on the exciter field rheostat.

(4) The load may now be added by closing the circuit breaker and the regulator should automatically keep the voltage at the adjusted value.

(5) The voltage regulator may be left in service becoming operative each time the unit is started.

b. Automatic to Manual Control. To change from automatic to manual control without interrupting the service, move the slider on the exciter field rheostat to increase the voltage to about 10 percent above normal or about 132 volts. Then turn off the voltage regulator switch and the alternator will be on manual control and it will then be necessary to maintain the required operating voltage by adjustment of the exciter field rheostat. Under this condition it may be found that frequent adjustment of the exciter field rheostat is necessary.

c. Manual to Automatic Control. To place the regulator in use without interrupting the service, move the exciter field rheostat slider to reduce the normal voltage about 10 percent or about 108 volts and then close the voltage regulator switch and immediately move the slider to the marked position referred to above. Make any necessary adjustment of the voltage regulator rheostat.

d. Polarity Reverse Switch. The position of the polarity reverse switch should be changed daily in order to prevent pitting of the contacts of the vibrator. It is usually found to be good practice to change the polarity each day before starting the unit.

e. Adjustment. Adjustment of the voltage regulator is covered in paragraph 100.

33. STOPPING OF UNIT.

a. To remove the load, place the load switch in the OFF position. Do not change the voltage regulator adjustment.

b. Shut down the engine (do not change the governor speed setting) by placing the fuel throttle in the STOP position. Be sure that the throttle lever knob snaps into the recess hole of the STOP position; otherwise the howler will sound when the oil pressure drops below the setting of the oil pressure safety switch.

NOTE: If the circuit breaker or load switch is opened automatically the setting handle returns only to the mid position between OFF and ON. It will be necessary to move this handle to the full OFF position, in order to engage the latch, before the breaker can be again closed.

34. NORMAL OPERATING PROCEDURES.

a. Checking.

(1) Check the water, oil, fuel, battery, and load switches before starting the engine.

(2) Place the throttle lever to the FULL position and engage the starter switch. When the engine fires, decrease the engine speed with the throttle control and warm up the engine for at least 5 minutes (15 minutes in cold climate). Note the gauge readings and increase the engine speed gradually.

(3) Check the voltage reading on the switchboard. If it is normal (120 volts), close the load switch. Take the meter and gauge readings as required.

b. Engine Gauge Readings. After one hour of operation under a full load, the engine gauge readings should register as follows:

	Min.	*Normal*	*Max.*
Fuel oil—lbs/sq. in.	70	80-140	150
Lube oil—lbs/sq. in.	25	40-55	60
Lube oil temperature °F.	120	140-180	195
Water temperature °F.	130	140-170	190

c. Removal of Load. To remove the load, open the load switch to OFF position. Place the fuel throttle in the stop position.

NOTE: If the unit has been operating in tropical climates, let the engine operate for five minutes without a load. This prevents internal hot spots in the engine.

35. BATTERY CHARGING CONTROL OPERATION.

a. Hydrometer Readings.

(1) Do not charge the batteries unless hydrometer readings have been taken and it has been determined that the batteries need a freshening charge. Always add water before charging when needed.

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(2) Charge the batteries if the readings register below 1.226 specific gravity. The maximum reading is 1.280 specific gravity.

b. Rate of Charge. Place the battery charger switch to a position for a charging rate of 6 amperes on meter (fig. 11). Do Not Charge Above Six Amperes. Check for a blown fuse in the fuse box at the rear of the switchboard if the rectifier fails to operate (fig. 7).

NOTE: For care of batteries, see paragraph 22.

36. FREEZING TEMPERATURE OPERATION.

a. Cold Weather Operation. The power unit should be given careful consideration for cold weather operation. Use antifreeze in the cooling system, a lighter grade of lubricating oil in the crankcase and the governor, keep the batteries well charged, cover the oil and water sections of the radiator to obtain normal operating temperatures, and set the engine governor control for slow speed operation. *Do not start the engine in cold climates at full operating speeds.* Warm up the engine for 15 minutes at a slow speed and gradually increase the speed until full operating temperatures are reached. In emergencies, the foregoing may be disregarded although it should be carried out as far as possible. Observation of this rule will prolong the life of the unit and prevent numerous repairs.

b. Heating the Air. A preheater or flame thrower is provided in the intake manifold for heating the air during cold weather operation. This is accomplished by forcing the fuel through an atomizer nozzle and across a continuous electric spark into the air stream. The pressure needed to force the fuel through the nozzle is obtained from a hand pump on the instrument panel. This pump draws fuel from the inlet connection on the engine fuel pump and delivers it to the nozzle housing (fig. 10). Within the housing is a small check valve which aids in holding pressure in the system. After the pressure has become sufficient to open this check valve, the fuel travels to the nozzle and into the chamber. A 24-volt vibrator type spark coil furnishes the high voltage necessary to jump the spark across a gap between a fixed insulated electrode and a grounded adjustable electrode. A pressure switch mounted on the nozzle housing acts as a circuit breaker in the primary circuit of the coil. This switch operates solely by fuel pressure and makes or breaks the circuit when the pressure exceeds or drops below 45 pounds. When the circuit is closed, a spark is present at the electrodes. When it is broken there is no spark. No manual method of turning the spark on or off is provided. The excess fuel that does not burn is carried from the housing by a one-way drain line. The batteries must be well up to charge (1.275-1.300 S.G. after allowances for temperature) or sufficient cranking speed will not be obtained.

c. Starting the Engine. To start the engine, perform the following operations in the order given:

(1) Prime the engine fuel system, if necessary.

(2) Operate the flame thrower hand pump on the instrument panel (right-hand pump) to maintain fuel pressure by slow even strokes of the hand pump.

(3) Set the governor speed adjusting screw for half-speed and place the throttle in the FULL position.

(4) Engage the starter switch.

(5) Operate the flame thrower pump for approximately 20 seconds (30-40 seconds for temperatures of 10 degrees Fahrenheit and lower).

(6) Stop the flame thrower pump, but continue to crank the engine. The engine should start in approximately five seconds. Should it refuse to start immediately, continue to crank and at the same time give the flame thrower pump a few additional strokes. It may be necessary to perform this operation two or three times. If the engine still refuses to start, it is useless to continue cranking.

(7) Check the fuel system for stoppage caused by freezing of water in the fuel.

37. TYPICAL TEST REPORT. Figure 12 shows a typical test report taken during the inspection and acceptance of the equipment.

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ENGINE AND GENERATOR TEST HEAT RUN

	VOLTS			AMPERES			SW. BOARD					ENGINE						Lube Oil oF	Start and Stop Tests, Seconds
LOAD	A	B	C	A	B	C	Freq.	Elap. Time	Time	Power Factor	Gen. Frame	Kilo-watt	Exhaust oF	Ambient	Jacket oF	PRESSURE Lube	PRESSURE Fuel		
OL	119	119	119	100	105	100	59.5	0.1	9:50		20			18.5	140	50	120	70	1. 2
OL	120	120	120	90	95	90	60	0.6	10:20		23		no	20	140	45	120	100	2. 3
OL	120	120	120	92	97	92	60	1.1	10:50		27			22	140	45	118	120	3. 2
OL	120	120	120	95	100	95	60	1.6	11:20		29		Gauge	22	140	45	118	120	4. 1
OL	120	120	120	94	98	94	60	2.1	11:50		28			21	140	45	118	120	5. 2
FL	120	120	120	86	88	86	60			.8		25							
3/4	120	120	120	67	69	86	60			.8		18							
1/2	121	121	121	45	47	46	60.5			.8		12.5							
1/4	121	121	121	25	27	27	61			.8		6.5							

	REGULATION						SWITCHBOARD							Check
	Volts	Amps.	K. V. A.	K. W.	P. F.	Freq.	A.C. Ammeter ST.	A.C. Ammeter Panel	Voltmeter ST.	Voltmeter Panel	Circuit Breakers Phase	Circuit Breakers Current	Circuit Breakers Time	Frequency Meter	59.5
Full Load	120	100		29	87	89.75								Dimmer Switch	o.k
No Load	125					61	40	41	100	100	A	200	130	Rectifier	o.k
Full Load							60	61	120	119	B	200	156	Charging Meter	o.k
Maximum Volt swing	130						80	81	140	138	C	200	129	Emergency Lights	o.k
¼ Load	124	30		8	80	60.8	100	101						Time Meter	o.k

VOLTAGE REGULATION	o.k			
FREQUENCY REGULATION	o.k	FL to NL 62.5 NL to FL 59.1		
% MAXIMUM VOLTAGE SWING	o.k	Shim Marks	dowel	Overspeed Stop	o.k
STEADY IN SECONDS		Term. Marks	———	Oil Pressure Stop	25
		Water Temp. Stop	o.k	Oil Pressure	47

REMARKS:

DIELECTRIC TESTS

Generator Field	Generator Stator	Exciter Field	Exciter Armature
OK	OK	OK	OK

R.D.A. TESTER

S.C. INSPECTOR

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Figure 12. Typical test report.

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Section III
FUNCTIONING OF PARTS

38. ENGINE AND INJECTOR.

a. Type and Equipment. The six-cylinder engine is of the four-stroke cycle, Diesel, overhead valve type. No carburetor or electrical ignition is used, the charge of fuel oil being ignited by the temperature of air in the cylinders, created by the high-cylinder compression. It is equipped with one metering pump for all cylinders and a cam actuated injector for each cylinder.

b. Cycle of Operation. The cycle of operation is as follows:

Air is drawn into a cylinder through an open intake valve on the downward stroke of the piston. The following upstroke compresses the air thus raising its temperature. Shortly before top dead center of this upward stroke, the correct amount of fuel oil is injected into the cylinder in such a manner that it is mixed with the air. The high temperature of compression fires this mixture and supplies the power for downward stroke of the piston. The next upstroke of the piston forces the burnt gases out through the exhaust valve and manifold into the silencer. This cycle of operation is then repeated.

c. Injector.

(1) The function of the injector is to atomize and thoroughly mix fuel oil with the air in the cylinder. The Cummins fuel injection system differs from the usual type in which the high pressure necessary to atomize and force the oil properly into the cylinders, is supplied by either a single plunger or by a plunger for each cylinder. Such a system requires high pressure tubing from the injection pump to the spraying nozzles.

(2) In the Cummins fuel injection system, used on Power Unit PE-245-A, the fuel charge is measured or metered at low pressure, that is about 50 pounds, and is delivered, at this pressure, to the injector by which it is forced into the cylinder. The injector consists of a forged body fitted with a mechanically operated plunger. An injector cup which is perforated with six spray holes, is mounted on the end of the body (fig. 13).

(3) On the intake stroke of the piston, the fuel pump delivers a measured charge of fuel to the injector. The mechanically operated plunger of the injector, at the same time, moves upward so that fuel oil can be moved along into the open recess occupying some of the space formerly taken by the plunger. A small check valve in the end of the injector prevents the fuel from flowing back in the line. The fuel is also prevented from flowing out through the six holes in the injector tip by the pressure developing in the cylinder during the upward or compression stroke of the piston. During the compression stroke, the hot compressed air enters the nozzle through the small holes and vaporizes the heated fuel oil. Just before the end of the compression stroke, the injector plunger is forced downward by cam action and expels the vaporized fuel into the firing chamber where it is immediately ignited (fig. 13 illustrates this action).

39. FUEL PUMP (all references to figure 14, DWG A-152). The fuel pump on the Model H engine is divided into five separate assemblies as follows: governor assembly, distributor disk housing assembly, metering or fuel pump housing proper, gear pump transfer No. 1 and gear pressure pump No. 2, and the float chamber assembly.

a. Governor Assembly. The duty of the governor is to keep the engine speed constant within its load range. The operation of the governor is described in paragraph 41.

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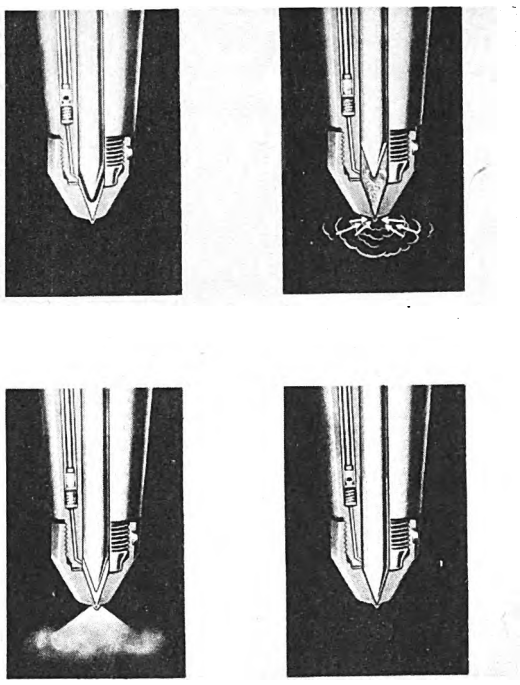

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Figure 13. Fuel injection cycle.

b. Distributor Disk Housing. The purpose of the distributor disks and housing is to transfer a charge of metered fuel, to the cylinders in proper sequence, at the desired point of piston travel.

(1) The distributor disk assembly consists of a set of mated disks drilled with a series of holes, when properly indexed, form passages for the transfer of fuel from pressure pump to metering pump and injectors. A shaft drives the lower distributor disks which rotate against the upper disk cover. A heavy tension spring holds these disks together. A thrust bushing and bearing are provided for shaft thrusts. A mated metering plunger and barrel, item Q, are included in this assembly and the plunger is actuated by means of a dumbbell link. A needle valve, item P, is located in distributor housing for the purpose of obtaining a through priming passage around the disks when valve is open.

(2) When the priming valve is closed and the engine is in operation, a metered amount of fuel is constantly being displaced by the metering plunger. Fuel oil under pressure from No. 2 gear pump is transferred across the upper disk passage leading to metering plunger, filling up whatever space is available by simultaneous downward stroke of metering plunger. On discharge or upward stroke of metering plunger, the lower distributor disk has turned to line up the transfer holes and displaces fuel into injector. The disks are highly polished for the purpose of maintaining a thin film of fuel under pressure. All spill off of fuel oil drains onto and into lower housing and further lubricates the working parts of the pump housing proper.

c. Fuel Pump Housing Proper. The duty of assembled parts in the fuel pump housing is to transmit and control a reciprocating motion to the metering plunger. This metering action must be in coordination with the distributor disk transfer holes and likewise timed with engine camshaft action of injectors. The fuel pump housing consists of a number of subassemblies, namely:

(1) Fuel pump cam, item Y.
(2) Cam rocker assembly, item X.
(3) Vertical lever assembly, item W.
(4) Eccentric assembly, item S.
(5) Control connecting links, items BB and T.

d. Fuel Pump Cam, Item Y. The purpose of the fuel pump cam is to start a cam action upon which the metering plunger is actuated. This action is timed with injector plunger travel.

(1) The fuel pump cam assembly is a one-piece forging with three cam profiles for actuating the cam rocker assembly, item X.

(2) A bevel drive gear for distributor drive shaft and two slinger-ring grooves are machined at forward end of cam forging. The slinger-ring grooves prevent fuel oil splash from entering governor housing.

(3) The fuel pump cam is keyed and pressed on fuel pump main shaft.

(4) The turning of the fuel pump cam relays its cam profiles to the cam rocker assembly, item X, and thereby transmits motion to metering pump plunger.

e. Cam Rocker Assembly, Item X. The purpose of the cam rocker assembly is to change the rotary motion of the fuel pump cam, item Y, into a rocking motion.

(1) The cam rocker assembly consists of a horizontal rocker shaft, supported in fuel pump housing by two bronze bushings.

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(2) At right angles and protruding from both sides of rocker shaft is a quadrant carriage and roller carrier fork.

(3) The upper quadrant carriage consists of a smooth machined surface upon which rides the vertical lever roller, item U. Two stop pins limit travel of roller.

(4) The lower carrier fork is machined to receive a roller, pin and pin rivet. Passages are drilled in casting, to supply fuel oil lubrication.

(5) The quadrant carriage, carrier fork and horizontal rocker shaft is cast and machined as one unit.

(6) Cam roller, pin, pin rivet, and upper carriage stop pins are added to make a complete assembly.

(7) This assembly is supported at both ends in the fuel pump housing at shaft center, item X, which coincides with center line of vertical lever roller, item U, when roller is in full OFF position, designated on figure 14.

(8) Rocker cam roller bears against fuel pump cam, item Y, by spring tension, which prevents the cam roller from jumping at high speeds.

(9) Any motion of fuel pump cam, item Y, will transfer its irregularities to cam rocker roller, item U, this in turn, will give a rocker action to the assembly, because cam roller, item Z, is off center from rocker shaft center line of suspension.

(10) The cam rocker assembly rocker motion is constant, regardless of control linkage, but with vertical lever roller, item U, in full OFF position, no rocker motion will be imparted to this roller since center of cam rocker and vertical lever assembly lie on same horizontal line. The rocker motion of the cam can result only in horizontal motion of the vertical lever roller. As vertical lever roller, item U, moves outward, away from rocker assembly shaft center line mounting, rocker motion impulses will be transferred and increase until a maximum motion is reached at full ON position.

(11) The transfer of rocker impulses from cam rocker assembly, item X, to vertical lever roller, item U, impart and transform the rocker action into reciprocating motion of vertical lever assembly, item W.

f. Vertical Lever Assembly, Item W. Vertical lever assembly, item W, is for the purpose of transmitting reciprocating motion to the metering pump plunger and to vary the amount of motion. The amount of motion is controlled by the governor, through linkage.

(1) The vertical lever assembly consists of a vertical lever supported by needle bearings at its upper end, item V. Its lower end terminates in a needle bearing roller, which rides on the smooth surface of the cam rocker carriage. Vertical lever is connected to a horizontal plunger, which has its fulcrum at item WI. This fulcrum shaft is clamped solidly by means of a cap screw, which also holds the vertical lever shaft and needle bearings at item V. The fulcrum shaft is free floating and supported by two bronze bushings in fuel pump housing. A cup-shaped socket is located at end of horizontal plunger lever. A dumbbell link rides in the cup, and actuates the metering pump plunger.

(2) Any reciprocating motion transferred to vertical lever will in turn, move horizontal plunger lever in a like manner, because of its fulcrum at item WI. It will, therefore, transmit this motion to the metering pump, by way of the dumbbell link which fits into sockets of the horizontal plunger lever and of the metering pump plunger.

(3) The stroke of reciprocating motion is determined by the position or setting of the vertical lever on the cam rocker carriage. The vertical lever is controlled by the governor, and is free to move across the machined surface of the cam rocker carriage within the limits of FULL ON and FULL OFF position, according to load requirements.

g. Eccentric Assembly, Item S. Eccentric assembly, item S, is for the purpose of changing the ON and OFF position of the vertical lever roller U.

(1) The eccentric assembly consists of a shaft upon which is centered a disk with an upper shaft placed off center. The assembly is machined as one piece.

(2) By referring to item S, it may be seen that any movement of this eccentric assembly will change the fulcrum position for the bell crank which can swivel on the upper shaft that is off-center.

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(3) Eccentric position is actuated only by movement of throttle lever R, and is unchanged once a setting is made.

h. Control Connecting Links, Items BB and T. These items are for the purpose of connecting the vertical lever to the governor control rod.

(1) The connecting links are spring loaded ball joints. Link action must be smooth in order to transmit governor reactions.

(2) By link connections the governor action is transmitted through eccentric governor link, BB, to lower end of bell crank, which pivots on the eccentric assembly shaft. The long arm of the bell crank is, therefore, moved a like amount and transmits this motion to connecting vertical lever link T. This action changes the setting of vertical lever and thereby changes the stroke of metering pump plunger.

i. Gear Pump Assembly, No. 1 Transfer and No. 2 Pressure Pump. This in reality, is one assembly. It is shown on schematic print as two separate assemblies for clarity. The purpose of this assembly is to transfer fuel oil free from air and with sufficient pressure in its discharge to overcome losses, regardless of speed. The assembly transfers fuel oil from fuel tank to the metering pump.

(1) The gear pump assembly consists of two sets of gears separated by a spacer plate (not shown) and proper shaft seals, which prevent leakage between pump housings.

(2) The drive gears of each pump are keyed to a common drive shaft.

(3) The gear pump drive shaft extends beyond the gear assembly housing and fits into recess of fuel pump main drive shaft.

(4) The gear pump drive shaft extension is slotted and fits into a drive pin riveted in fuel pump main drive shaft making a positive drive coupling.

(5) The gear pump assembly housing is centered and doweled on fuel pump housing proper, and held in place by four cap screws and may be replaced independently from the fuel pump housing.

j. No. 1 Gear Pump. This pump is for the purpose of transferring and maintaining a constant supply of fuel from the fuel tank to a filter, and then into a small float chamber.

(1) This assembly consists of a set of gears on proper shafting, riding in bushings enclosed in its housing.

(2) A bypass valve assembly, item B, is a working part of No. 1 gear pump, though it is located in the main housing. Cored passageways connect the gear pump with the bypass valve. The bypass valve assembly is a light spring loaded valve in a guide socket.

(3) Fuel inlet ball check valve, item A, and seat are not part of the gear pump assembly, and are also located in main fuel pump housing. For purpose of clarity they are shown schematically attached to No. 1 gear pump.

(4) The turning of gears in No. 1 gear pump assembly creates a suction at item A, lifting the ball check from its seat and allowing oil to flow past the bypass valve chamber, up and around gear pockets of gears. Fuel oil is then discharged into passageway leading into the filter and the float chamber assembly.

(5) When float chamber is filled this passage is closed by action of float needle valve C; pressure built up in discharge passageway will force open the bypass valve and allow oil to flow back into suction side of gear pump.

(6) This balancing of fuel flow, is constantly in action during normal operations and furnishes a sufficient supply of air-free fuel in float chamber.

k. No. 2 Gear Pump. This pump is for the purpose of maintaining a constant supply of fuel under pressure to the metering pump. This transfer of fuel is performed in a manner whereby its pressure will maintain a film of oil between distributor disk faces, regardless of speed. No. 2 gear pump consists of a similar set of gears, as in No. 1 gear pump, enclosed in its housing with drilled and machined passageways for proper distribution of fuel. No. 2 gear pump has additional component parts as follows:

(1) Ball check valve F, is for the purpose of retaining fuel oil in pump housing when unit is inoperative.

(2) Pyramid check valve G. The valve acts as a check valve and will prevent grit from screen K, from falling back into pump gears when unit is inoperative.

(3) Pressure regulator valve H, is for the purpose of controlling pressure of No. 2 gear pump.

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(a) Six small holes are drilled in its lower end which functions as spill off medium for oil. This spill off occurs when regulator valve holes pass beyond end of regulator valve guide sleeve, item H1.

(b) The oil that spills out from pressure regulator valve holes, returns into suction passageway of the gear pump housing.

(c) The pressure regulator valve works upon a spring of precalibrated tension.

(d) This spring tension must be overcome by oil pressure working upon inside of regulator valve and thereby pushing valve downward against the spring tension before a spill off point of valve is reached. In performing this work, the fuel oil pressure build up in housing is approximately 100 to 140 lbs. at full speed.

(4) Pressure regulator valve sleeve H1 is for the purpose of acting as a guide for pressure regulator valve. The sleeve is pressed in housing to a predetermined depth for the purpose of obtaining spill off of regulator valve.

(5) Pressure chamber dome J, is for the purpose of preventing rapid pressure drop in assembly under sudden speed changes.

(a) The pressure dome is a steel tubing with a cap soldered on one end and threaded into gear pump housing.

(b) Whatever air is trapped in this chamber will be compressed by oil pressure rise and chamber will act as an accumulator or pressure retainer for rapid speed changes.

(6) Fuel supply check valve screen K, is to prevent any abrasives from entering into distributor disk assembly. The screen is of 200 mesh gauge and soldered in the fuel supply chamber housing.

(7) Fuel supply chamber check valve L, is for the purpose of retaining fuel oil in line leading to the distributor disk assembly when unit is inoperative. It also acts as a safety pressure valve for distributor disk lubrication.

(a) The check valve assembly consists of a check valve guide, spring and check valve cup, enclosed in a housing.

(b) The lower valve cup seats on the fuel supply screen housing.

(c) Spring tension holds this valve against its seat.

(d) The check valve guide acts as a spring retainer and valve guide. The guide prevents check valve from opening an excessive amount and jamming in assembly.

(e) Fuel pressure will work against closed spring loaded valve. Pressure must build up to approximately 50 lbs. before valve will open fully.

(f) A minimum pressure of 50 lbs. must be maintained between disks for proper lubrication.

(g) In the event of excessive wear in gear pump, pressure will not build up beyond 50 lbs., fuel supply check valve will close and prevent a transfer of oil to metering pump. The engine will automatically stop, due to lack of fuel and will not operate until repairs have been made to increase fuel oil pressure.

(h) If the check valve assembly is removed and unit operated with less than 50 lbs. oil pressure, disk scoring will occur from lack of sufficient pressure lubrication.

(i) Fuel oil flow through this valve is as follows: Fuel pressure forces fuel supply valve off its seat and the fuel flows under edge of valve. Fuel then flows up and into the side holes of valve guide up through inside of the valve to emergency shut valve by way of the hole drilled in center of check valve guide.

(8) Emergency shut off valve M, is for the purpose of manually closing the fuel supply from gear pump assembly to metering pump. In the event engine should refuse to stop in a normal manner or overspeed, the valve can be manually closed, shutting off fuel supply and preventing damage. Valve is ground to assure an airtight fit and has a stop provision.

(9) The action of No. 1 and No. 2 gear pump assemblies as a unit is as follows:

(a) Fuel is drawn from fuel tank and through the primary filter by action of gears in No. 1 gear pump housing. No. 1 gear pump also forces the fuel through the secondary filter. Fuel flows up through suction passageway of housing and around pockets of gear teeth, then discharges into float chamber. Excess fuel is returned to suction passage by action of bypass valve.

(b) No. 2 gear pump draws fuel from float chamber assembly through suction tube E,

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past ball check valve F, to suction side of gear pump. On discharge side of gear pump pressure will be built up by action of the pressure regulator valve. Spill off from this valve will return to suction side of gear pump. Due to action of pressure regulator valve, pressure will build up from 80 to 140 lbs., regardless of speed. This pressure will be sufficient to lubricate and transfer oil through disk transfer holes to the metering pump.

l. **Float Chamber Assembly.** This assembly is for the purpose of maintaining a constant supply of fuel oil, free of air, for the use of No. 2 gear pump assembly.

(1) The float chamber assembly consists of a small supply chamber with a suction tube cast integral with the chamber casting.

(2) A cover is provided for the float chamber which supports the float D, through float lever arm to a float lever hanger and float needle valve.

(3) The float needle valve seat and seat gasket are threaded in float chamber cover.

(4) The float cover is provided with a gasket and bolted to the float chamber.

(5) The float assembly is provided with a gasket and is actually bolted to the bottom of fuel pump housing proper; cored passageways lead to gear pump assembly.

(6) The float cover, upon examination, will have numerous holes, the purpose of each is as follows:

(a) The two holes on outside edge are for 5/16″ cap screws.

(b) The smallest hole on outside edge adjoining cap screw hole is suction passage for No. 2 gear pump assembly.

(c) The large hole in the center of cover is fuel inlet passage from No. 1 gear pump discharge.

(d) The one large hole adjacent to the center hole is for fuel oil drain from fuel pump main housing and injector return lines.

(e) The remaining large hole is for air vent purposes of float chamber, allowing free flow of fuel into float chamber.

40. OPERATION OF COMPLETE FUEL PUMP ASSEMBLY.

a. **Priming Fuel Flow.** The fuel pump and injector assemblies must be primed in order to obtain satisfactory operation of engine.

(1) Inspection of the fuel pump, will show a brass fitting connection at the bottom side of the fuel pump housing. This connection has two openings, the larger opening is made by flexible tubing, direct to the fuel supply, through a suitable filter, the smaller opening connects with the suction side of the priming pump.

(2) The discharge line of priming pump is connected to No. 2 gear pump assembly fitting I. With these three connections, it is now possible to prime fuel pump and injector assemblies.

(3) On suction stroke of priming pump fuel oil will be drawn directly from fuel tank, passing through the primary filter.

(4) On discharge stroke of priming pump, fuel will flow into fitting I, of No. 2 gear pump assembly, across top passage into fuel supply screen K, check valve assembly L, and emergency shut-off valve M, through feed line to disks.

(5) With priming valve P open, fuel will then flow through tubing into lower passage N2 of distributor disk housing, across and into metering pump chamber. From this point the disk transfer hole alignment will present free passage to injector assembly for priming.

b. **Normal Fuel Flow.** After unit has been primed and fuel pump priming valve has been closed, operation of fuel pump is as follows:

(1) Suction created by No. 1 fuel pump draws fuel oil from a tank and delivers it to the primary filter and then to the float chamber assembly. Excess fuel is bypassed back to suction side of gear pump, by closing of float needle valve C, and the automatic opening of bypass valve B. The No. 1 fuel pump also forces fuel oil through the secondary filter.

(2) Suction created by No. 2 gear pump draws fuel oil from float chamber assembly through passage E, up to and past ball check F, and around gear teeth. At discharge of gears, fuel opens pyramid check valve G, and flows across the pressure regulator valve F, forcing valve downward against pressure regulator valve spring, located directly below

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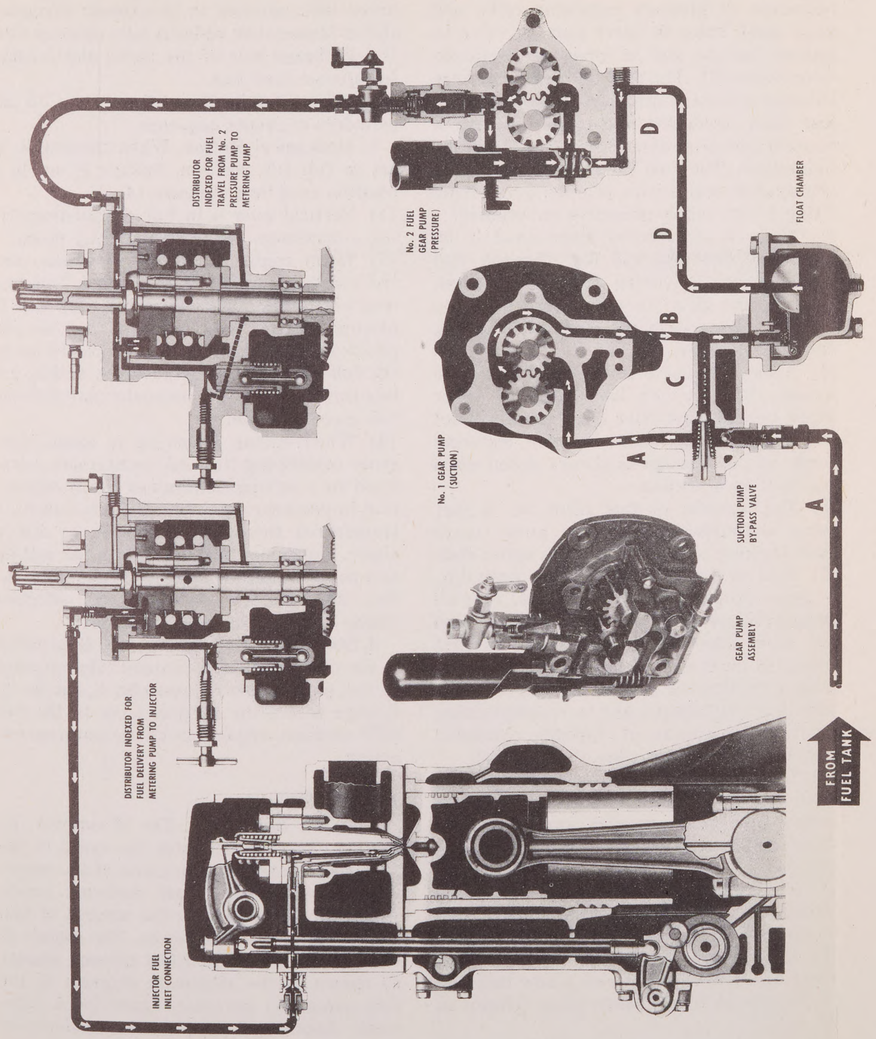

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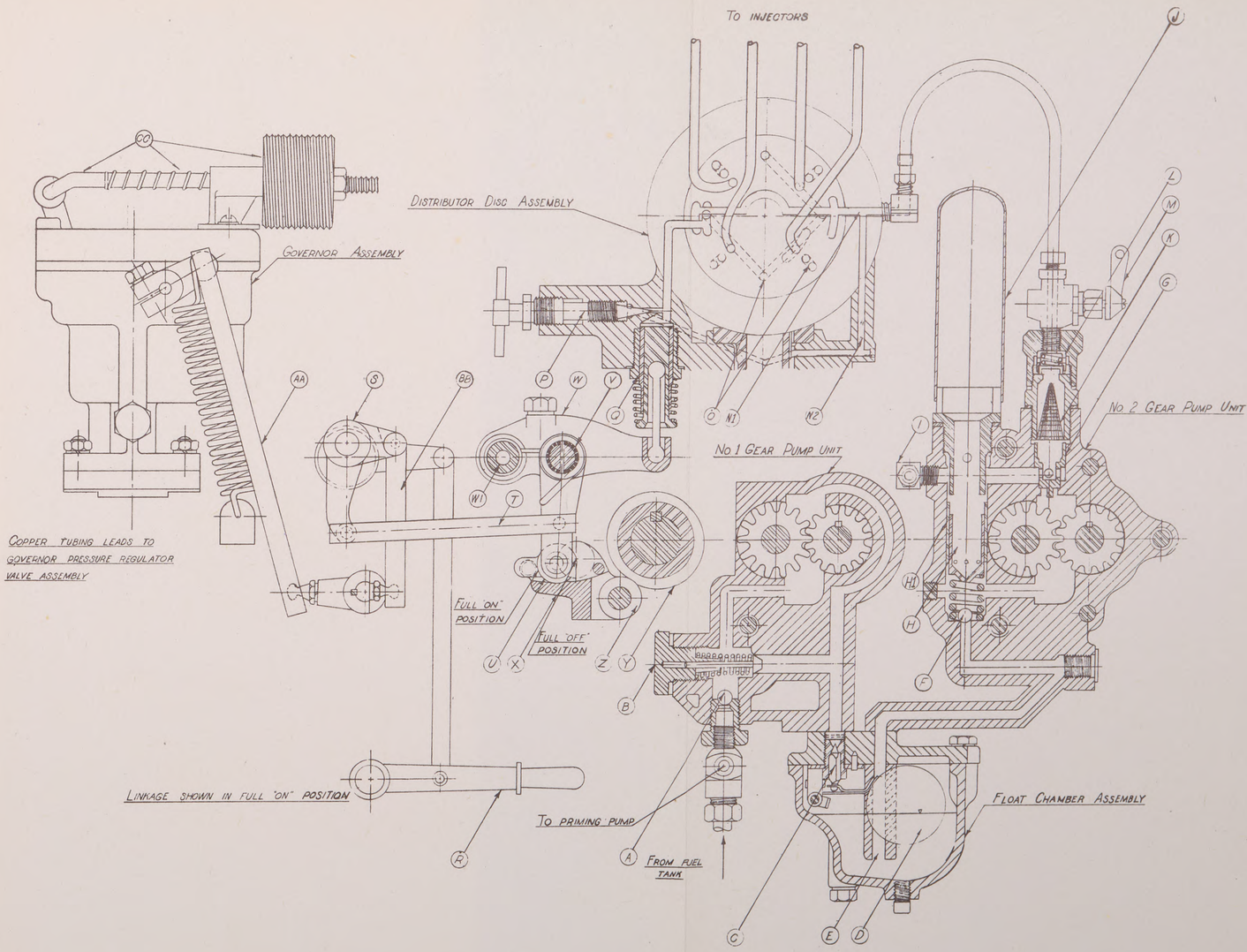

Figure 14. Fuel flow diagram and fuel pump schematic.

valve. As oil pressure is increased, continued movement of pressure regulator valve will cause small holes in lower part of valve to uncover beyond end of pressure regulator valve sleeve H1. The fuel oil under pressure will then spill back into suction side of No. 2 gear pump assembly, and in this manner a constant fuel oil pressure feed to disk will be maintained. The fuel oil pressure gauge is connected in series with priming pump from fitting I, and shows pressures maintained.

(3) When a pressure of approximately 50 lbs. is reached fuel will flow through fuel supply screen K, lifting fuel supply check valve L, and flow through emergency stop valve M, into distributor disks and housing assembly passages.

(4) A small amount of fuel will flow into passage N2, for the lubrication of lower thrust bushing and drive shaft. Fuel will not flow past priming valve P, into metering pump, as this passage is always closed when engine is in operation.

(5) The transfer of fuel from No. 2 gear pump assembly to metering pump takes place through passage N1, across upper disk.

(6) Fuel oil flow from gear pump assembly, is under pressure of 80 to 140 lbs. This oil under pressure will flow into passage N1, and can exert pressure on lower disk of first elongated outer slot of upper disk. This slot is not a medium for fuel oil transfer. Its purpose is for lubrication and to counterbalance lower disk pressure of opposite elongated transfer slot on outer edge of upper disk.

(7) Transfer of fuel to metering pump takes place when one of the double hole transfer jumper holes O, line up with transfer slots of upper disk which leads to metering pump chamber.

(8) The indexing of the holes as stated above, takes place when metering pump is on its downward stroke.

(9) By the end of its downward stroke, lower disk has revolved and a new indexing of transfer holes has taken place (shown on fig. 14).

(10) The discharge stroke of the metering pump forces fuel out of same passage that fuel entered and into new transfer hole of lower disk. One of the single holes O, of the lower disk is now lined up with inner slot of upper disk and fuel will flow through the lower disk passage to innermost elongated slot of blower disk which is now lined up with the discharge hole of the upper disk leading to injector feed line.

(11) This distribution takes place to all cylinders in proper sequence.

c. Mechanical Motion. When throttle R, is set in full ON position, linkage is set in a position as shown in figure 14.

(1) Vertical lever is in full ON position giving a maximum stroke to metering pump.

(2) When engine is started, governor control rod link AA will move upward. This motion will be relayed through links BB and T, placing vertical lever roller in the full ON position. Vertical lever roller cannot be set in the full ON position, by governor action, unless throttle lever R is manually placed in the full speed position.

(3) When engine comes up to speed, governor control rod link AA counteracts downward to a setting determined by fly-ball action in governor assembly. This movement is transferred through its linkage, as stated above, and brings vertical lever roller setting to a point between full ON and full OFF position and thereby decreases the effective stroke of metering pump plunger.

d. Stopping of Unit. When lever R, is placed in the OFF position, it changes fulcrum point of fuel pump eccentric assembly S, and by its linkage forces the vertical lever to the full OFF position, regardless of the governor reaction.

41. GOVERNOR.

a. Speed Regulation. The Woodward hydraulic governor regulates the speed of the engine by controlling the travel of the metering plunger in the fuel metering pump, which in turn, regulates the amount of fuel oil delivered to the injectors. The control of this plunger is accomplished through linkage as shown in the schematic diagram of the fuel pump and governor, figure 14. A schematic diagram of the governor is shown in figure 15.

b. Principal Parts. The principal parts of the governor are:

(1) A speed measuring element, generally called the governor head.

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(2) A power piston which when acted upon by the governor head, performs the work of changing the amount of fuel oil supplied to the injectors.
(3) A stabilizing element that prevents surge of the engine.

c. Integral Gear Pump. An integral gear pump incorporated in the assembly supplies the hydraulic feature by creating pressure on the oil drawn from the sump. The pressure created by the gear pump is maintained by a relief valve which allows surplus oil to be bypassed back to the suction passage. A pilot valve controls the admission of oil to the power piston. The action of the pilot valve plunger is controlled by the centrifugal force of flyweights reacting against the speeder spring which may be manually adjusted. If the engine speed drops below that corresponding to the tension setting of the speeder spring, the flyweights fall inward and lower the pilot valve plunger. This allows oil to be admitted to the piston chamber which raises the piston and so, through linkage, increases the fuel oil travel of the metering pump plunger, thus increasing the fuel supply to the engine. If the engine speed increases over the governed setting, the flyweights move outward and raise the pilot valve plunger. This cuts off the fuel oil supply to the piston chamber. The power piston drops and the fuel oil supply is reduced until the engine has again arrived at the set RPM. Under balanced conditions the pilot valve allows a sufficient amount of oil in the piston chamber to maintain the piston in a given position and to provide for leakage.

d. Speed Droop Adjustment. Speed droop adjustment is obtained by changing the position of the slider shown in figure 15. This is done by loosening the machine screw which holds it in place. Its position controls or limits the movement of the floating lever, the movement of which regulates the engine speed. The droop range of the slider adjustment is from 1½ percent to 7 percent. The correct setting results in a droop of 3 percent.

e. Oil Supply. The governor is provided with an oil supply, for operation and lubrica-

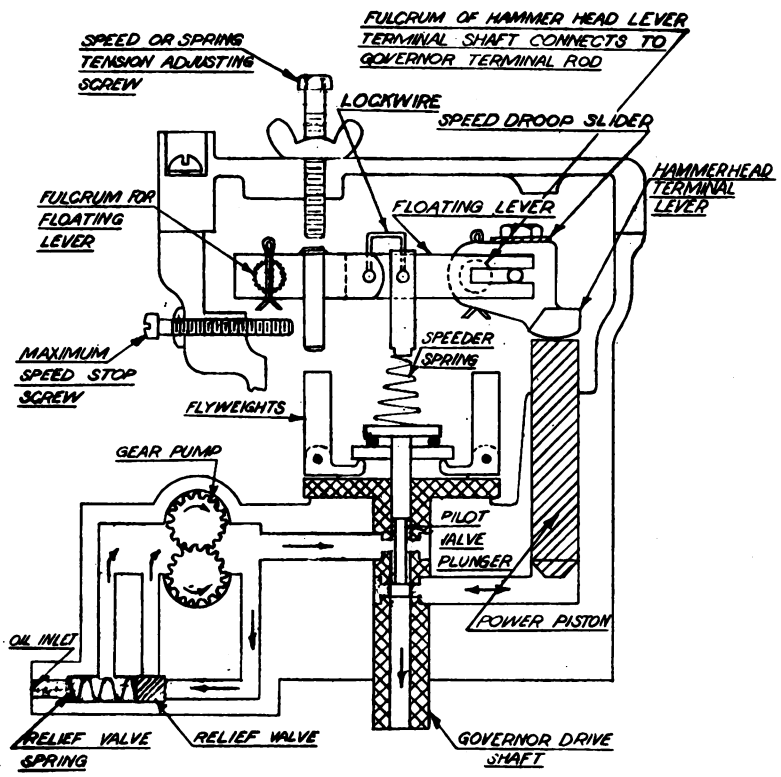

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Figure 15. Governor schematic.

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tion, independent of the engine lubricating system.

42. PREHEATER.

a. Preheating. In order to facilitate starting the engine, if it is operated in a cold location, a preheater or flame thrower is provided in the intake manifold. Preheating is accomplished by forcing fuel oil through an atomizing nozzle and across a continuous electric spark, into the air intake stream. A manually operated pump on the engine instrument panel supplies the pressure to force the fuel oil through the nozzle. A small check valve in the system aids in maintaining the pressure.

b. Spark Coil. A 24-volt vibrator type spark coil produces the high voltage necessary to jump the spark across an adjustable gap in front of the nozzle.

c. Pressure Switch. A pressure switch on the nozzle housing operates to make or break the primary circuit of the coil.

43. VOLTAGE REGULATOR.

a. Function. The voltage regulator is a Burlington, type GL-1. Its function is to automatically regulate the voltage of the alternator.

b. Main Parts. The main parts consist of an alternating current coil with a fixed core, a vibrating type switch which cuts in or shorts out the exciter field rheostat, a rheostat to adjust the voltage on the regulator, and a polarity reverse switch.

c. Alternator Voltage. The alternator voltage is imposed across the regulator coil and series voltage dropping resistor. The series resistor decreases the voltage error due to frequency changes. The magnetism of the core which is varied by the current in the surrounding coil opens the contacts of the vibrator type switch. These contacts, when closed, short out the exciter field rheostat and when open, cut in the previously set resistance in the exciter field circuit. When the alternator voltage is normal, the contacts are in a position to alternately cut the exciter field rheostat into and out of the circuit; the a-c voltage being determined by the average resistance or the ratio of the time contacts are closed to the time they are opened. Since this floating core tends to follow the a-c voltage regulation, these contacts open and close 120 times per second. The regulator response to a given load change is therefore ½ cycle or 1/120 of a second.

d. Stationary Contact. The stationary contact is mounted on a light leaf spring which absorbs the rapid vibration of the moving contact and overcomes the clinging or bouncing which would result if no spring were used.

44. RADIO INTERFERENCE SUPPRESSION.

a. Controlling Static Electricity. Provision is made to control all static electricity, that may be collected in the component parts of the power unit, so that it may be dissipated to the ground.

(1) Grounding brushes of copper graphite, supported on special brackets bear on the exciter and the alternator shaft. The supporting brackets fastened to the frames of the alternator and the exciter, are held rigidly in place by bolts equipped with positive grounding contact washers. The washers are toothed to insure a perfect electrical contact with the frames. These washers and all those used in the static electricity control system, are the Illinois Tool Company's No. 40-IET, Internal, External, Shakeproof type and are rustproofed by plating. The grounding brushes are interchangeable, but will have to be shaped to the shafts.

(2) Electrical contact between the alternator frame and the engine is assured by using flexible, braided, copper straps. These are held in place by machine screws equipped with toothed washers.

(3) The exciter leads to the voltage regulator and to the exciter field rheostat are covered with a woven wire shielding which is grounded.

(4) The contact surface of the cover of the voltage regulator is tinned in spots to attain a positive grounding contact of these parts.

(5) Condensers, to suppress static voltage charges, are installed at critical points.

b. Details Regarding Equipment. Details regarding this equipment are covered in Section IV.

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Section IV
MAINTENANCE, OPERATION AND REPAIR

45. OPERATORS MAINTENANCE SCHEDULE.

a. Obtaining Satisfactory Operation. The following schedule must be adhered to in order to obtain satisfactory operation of the equipment:

b. Daily Schedule.

(1) Check lube oil level in oil pan and governor housing.
(2) Check water level in cooling system.
(3) Reverse polarity switch on voltage regulator.
(4) Turn handle on primary fuel oil filter.
(5) Read and record all instruments.
(6) Check that alarm and starting system is in working order and that horn and signal lights function.
(7) Wipe down generator set and switchboard.
(8) Change oil in air cleaners.

c. Weekly Schedule.

(1) Tighten engine, generator set, hold-down and foundation bolts.
(2) Grease engine water pump.
(3) Check and clean slip rings, commutator, and brushes.
(4) Clean generator.
(5) Make ground test on all electrical equipment.
(6) Check voltage regulator contacts.
(7) Clean switchboard.
(8) Check battery gravity and level of electrolyte.
(9) Check battery connections.
(10) Check engine starter and alarm circuit connections.
(11) Check for fuel, lube and water leaks.
(12) Renew crankcase oil every 200 hours and change filter bag in oil pan. This renewal of the crankcase oil is dependent upon climate and location. In dusty areas, oil should be changed more often.
(13) Drain water and sediment from fuel filters.

d. Monthly Schedule.

(1) Clean oil breather on crankcase.
(2) Clean out air passages in radiator and clean fan blades.
(3) Tighten all engine electrical connections.
(4) Check all switchboard terminal connections.
(5) Drain and renew oil in governor housing.
(6) Replace lubricating oil secondary filter element.
(7) Check voltage regulator contacts.
(8) Check coupling bolts.
(9) Clean battery terminals.
(10) Tighten water pump drive belts.
(11) Check and clean alarm switch contacts.
(12) Check overspeed stop. Overspeed engine to check that valve trips and shuts down engine.
(13) Adjust valve roller and injector settings.
(14) Oil starting motor, sparingly.

46. ADJUSTMENTS.

a. Instructions. The following instructions cover the adjustments necessary for maintaining the unit in an operating condition. By keeping the unit clean inside and out, a high percentage of the causes of poor engine performance may be eliminated. The complete power unit should be wiped down and polished daily. All fuel, oil, or water leaks must be attended to immediately.

b. Determining Cause of Failure. If unusual noise or vibration develops in the engine at any time, the cause of failure should be determined by removing the load from the unit, and consulting the methods for diagnosing troubles as outlined in paragraph 57.

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47. LUBRICATION SYSTEM.

a. Lube Oil Level. Before starting the engine each day and after shutting it down, check the oil level with the dip stick. This stick is marked for the operating level. If the engine is running the oil level should come to the H line. Add oil when necessary to maintain this level. During continuous operation of the engine, check the oil level and pressure two or three times a day. If the oil level is at the low mark on the dip stick, lube oil must be added immediately. The engine oil capacity is sufficient for 200 hours of operation. Full capacity should be maintained at all times.

b. Changing Oil. The oil in the engine should be changed every 200 working hours. Check the oil level and the consistency of the oil daily in order to be sure that no serious dilution is occurring from fuel oil contamination. Renew the crankcase oil when serious dilution (thinning of oil) is found. When this is done, it is also necessary to renew the filter bag in the filter compartment of the oil pan. (See par. 46c.) If the lubricating oil pressure drops below 25 pounds at full speed, check the condition of the lubricating oil. If new oil does not raise the pressure, it is an indication either that the bearings are worn and in need of adjustment, or that suction lines are leaking between the lubricating oil pump and the oil pan.

c. Lubricating Oil Filters. The lubricating oil filters are placed in the system for the purpose of removing contaminations from the lubricating oil. Proper periodic servicing of the filters will improve the performance of the engine. The formation of carbon and sludge in the oil passages will, if neglected, restrict the oil flow to such a degree that bearing surfaces will become etched and overheated, causing serious damage.

d. Primary Filter Element. The primary filter is a replaceable cloth bag filter located in the rear section of the oil pan (fig. 8). The oil drawn from the oil pan is discharged by the oil pump into and through the primary filter before it is circulated through the engine. A safety ball check is incorporated in the filter housing for bypassing the oil around the element when the filter becomes clogged.

e. Changing Primary Lube Oil Filter. Change the primary oil filter every 200 hours, equivalent to every time the engine crankcase oil is changed.

(1) Remove the drain plug from the filter housing cover and drain the oil from the filter compartment.

NOTE: If the engine crankcase is badly sludged with gummy oil residue, it is recommended that the old oil be drained from the crankcase and filters when they are hot. Insert flushing oil or fuel oil in the crankcase to wash out sludge from the oil passages in the engine. When flushing out the engine, leave the old filter elements intact and remove after the flushing process has been completed.

(2) Fill the oil pan with ten gallons of fuel oil and run the engine for five minutes at slow speed. Install new primary and secondary filters.

(3) Redrain the oil pan and the filter compartment and remove the filter cover by removing the nuts which hold it in place.

(4) To change the filter bag, proceed as follows (fig. 16): After the cover is removed, pull out the entire filter element. Unroll the bag and remove it from the spool. To remove the bag from the spool, unscrew the flat nuts on the two clamp screws. Depress the clamp screws and turn them one-fourth turn; i.e., the pins in the clamp screws will stand across the spool. When this is done, the bag with its clamp bar can be pulled off readily. Remove the clamp bar and insert the new bag on the clamp bar so that the lips of the bag may be rolled over the clamp bar. Place the clamp bar with the bag on the spool, depress the clamp screws and turn them back one-fourth turn so that the pins point parallel with the axis of the spool. Tighten the flat clamp nuts, being sure that the clamp screws do not turn or twist when doing so, as this would have a tendency to cut the bag. Place the spacing mat on the bag and roll on the spool with a spacing mat rolling inside next to the spool. With the filter element properly rolled up, place it in the filter housing, being sure that the conical spring on the end of the filter, which holds the entire filter firmly in place, is properly attached to the filter element. Replace the cover, making sure that the cover and the copper gasket in the recess are clean and in good condition.

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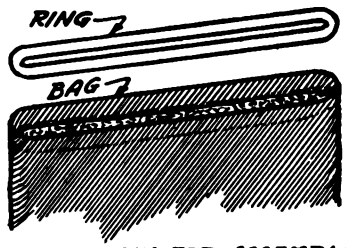
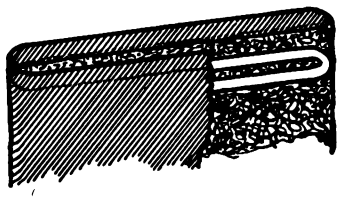
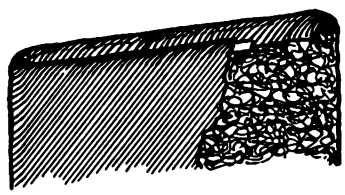


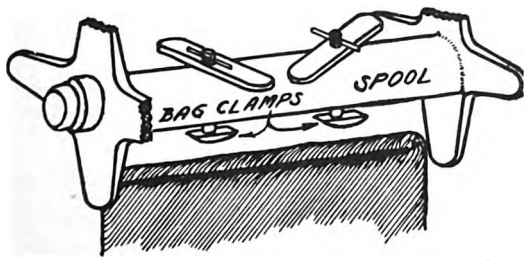
BAG & RING READY FOR ASSEMBLING



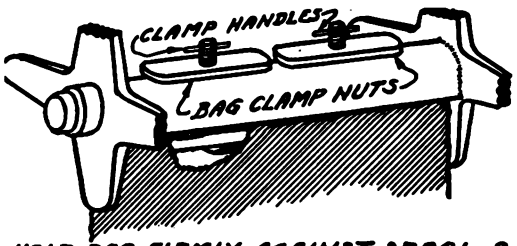
PLACE RING INSIDE OF BAG.



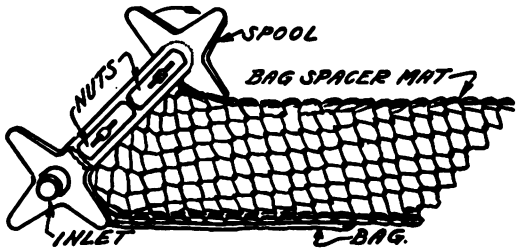
FOLD TOP OF BAG INWARD OVER RING ABOUT ½" STARTING WITH THE ENDS AND THEN THE SIDES.



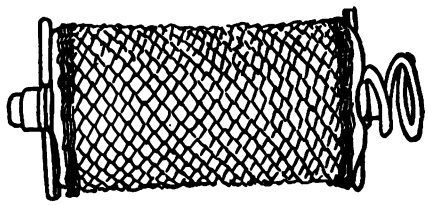
BEFORE APPLYING BAG TO SPOOLTURN BAG-CLAMPS LENGTHWISE SO THAT THEY WILL ENTER BAG OPENING.



HOLD BAG FIRMLY AGAINST SPOOL & GIVE ¼ TURN TO BAG CLAMP HANDLES WHICH BRINGS THEM INTO LENGTHWISE POSITION. HOLD HANDLES THUS WHILE TURNING BAG CLAMP NUTS TO A HAND TIGHT LENGTHWISE POSITION.



WITH INLET END FACING YOU, PLACE SPOOL WITH BAG ON A CLEAN FLAT SURFACE, THEN LAY BAG SPACER MAT ON BAG MAKING SURE THEY ARE FLAT & THAT THE LEFT END OF THE MAT COMES UP CLOSE TO THE SPOOL. THEN ROLL MAT WITH BAG AROUND SPOOL CLOCKWISE



ASSEMBLED FILTERING ELEMENT READY TO INSERT INTO SHELL.

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Figure 16. Changing primary lube oil filter bag.

Tighten the nuts evenly, so that no leak will occur at this cover. Make sure that the lock washer under the nuts is not left off.

CAUTION: The bags in this filter are made of specially treated material, and only bags made of this material should be used.

f. Changing Secondary Lube Oil Filter. The secondary filter is a cotton-waste-type cartridge replaceable element. The filter receives oil under pressure and allows a steady flow of oil which drains into the oil pan without reducing the oil pressure within the engine (fig. 17). Remove the filter cover by turning the handle at the top counterclockwise until the threads disengage. Remove the drain plug to drain the accumulation in the sump. Pull out the dirty cartridge by the wire handle. Insert the new cartridge and replace the drain plug. Check the top gasket carefully and if doubtful, replace with a new

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gasket. With the filter completely assembled, check for leakage by running the engine until the filter is warm.

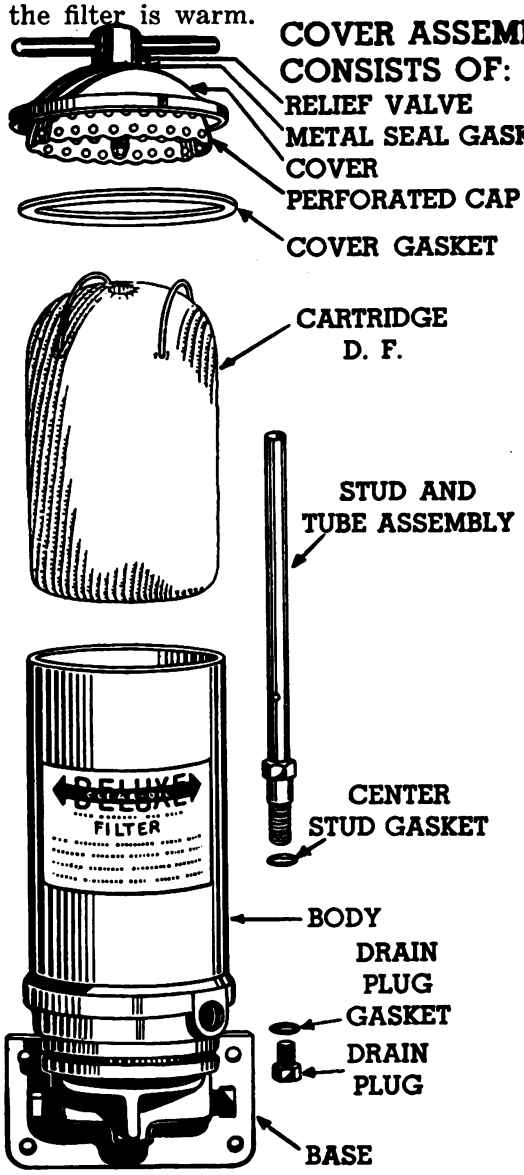

Figure 17. Changing secondary lube oil filter element.

g. Causes for Poor Oil Filtering. If the oil being filtered does not clean up or filter fast enough, check the following:

(1) The primary filter bypass valve may leak.

(2) There may be a leak under the oval bag ring or a hole in the bag.

(3) The bag may need changing.

(4) The bag spool may not seat properly in the cover.

CAUTION: Do not attempt to clean an old filter bag or cartridge element. Replace with a new one. Whenever a new bag or element is installed, put one additional gallon of lubricating oil into the crankcase, as each filter housing contains one gallon of oil.

h. Care of Lube Oil Cooler and Bypass Valve.

(1) Remove the lube oil cooler and flush it out with fuel oil once a year. This may have to be done more frequently depending on the condition of lube oil. The need for flushing will be made known by increasing lube oil temperatures from day to day.

(2) The bypass valve, which protects the lube oil cooler if stoppage of oil through cooler should occur, is located back of the lubricating oil pump on the fuel pump side of the engine. Remove this valve every six months, clean thoroughly and reinstall. Do not change the spring adjustment of the relief valve. This valve is set for 15 pounds pressure.

48. COOLING SYSTEM.

a. Checking the System. Lift the radiator cap once a day and check to see that the cooling system is full. Add soft clean water as needed to restore the level to the top. Excess water overflows through the drain pipe.

CAUTION: Never use kersosene for cooling purposes as it will cut the rubber from the hose and clog the water passages.

b. Water Pump Drive Belts. The unit is driven by two V-type belts. The belt adjustment is obtained by eccentric mounting of the pump assembly. To tighten the belt, loosen the cap screws holding the pump clamp ring. These clamp screws should be loosened only enough to permit the pump to turn on the eccentric, or the assembly will bind, causing the pump to break when it is retightened. The unit may be turned until the desired belt tension is obtained and the clamp ring tightened. Fan belt slippage and heating may result unless these belts are tight.

NOTE: Because of rust conditions within the block and water pump casting, the pump may bind and refuse to turn. Tapping on the pulley with a rubber mallet will loosen rust and binding. Do not force the pump.

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c. Water Manifold Thermostats. Three thermostats control the temperature of the cooling system. Two thermostats are located in the discharge housing which leads to the radiator. A bypass thermostat is located in the bypass housing at the front end of the water manifold (fig. 8). The bypass thermostat is normally open until operating temperature is reached. At this point the manifold thermostats open and the bypass closes. In the event that overheating of the engine occurs, the thermostats should be removed, cleaned and inspected for damage. They may be tested for point of opening by placing them in a container of water, with a thermometer, heating the water to 160 degrees Fahrenheit at which point the thermostats should start to open and should attain full opening at 170 degrees. If operation is unsatisfactory they should be replaced as no adjustment is possible. If the results of the test are satisfactory reinstall the thermostats in the housing and note whether binding exists when opening and closing the valves.

49. AIR INTAKE SYSTEM.

a. Air Filters. Two air filters are provided on the engine to remove the dust and dirt which would otherwise be pulled into the engine and increase cylinder wear by their abrasive action (fig. 9). Keep the filters clean. If allowed to clog up with dirt, insufficient air will pass into the combustion chamber to support combustion of the injected fuel.

CAUTION: Never run the engine with the air cleaner disconnected. Never run the engine with the air stopped up.

b. Cleaning the Filter. To clean the air filter, proceed as follows:

(1) Remove the lower oil cup by loosening the wing nuts, or the clamp screw A, as shown in figure 18, which holds the cup in place on the lower part of the cleaner. Empty the oil from the cup and wash thoroughly with clean fuel oil or kerosene.

(2) Wash the inside of the air inlet tube with a clean rag or brush and cleaning fluid (fig. 18). If this is neglected, dirt will gradually collect on the inside of the tube and pre-

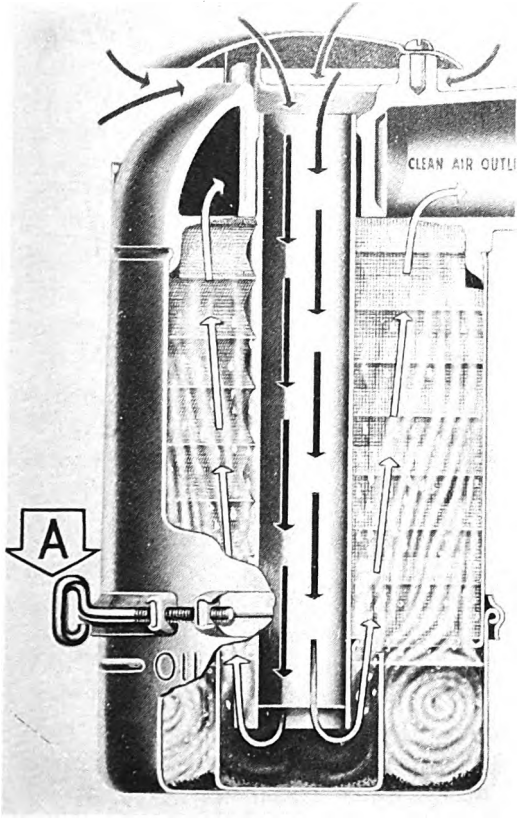

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Figure 18. Cross section of air cleaner.

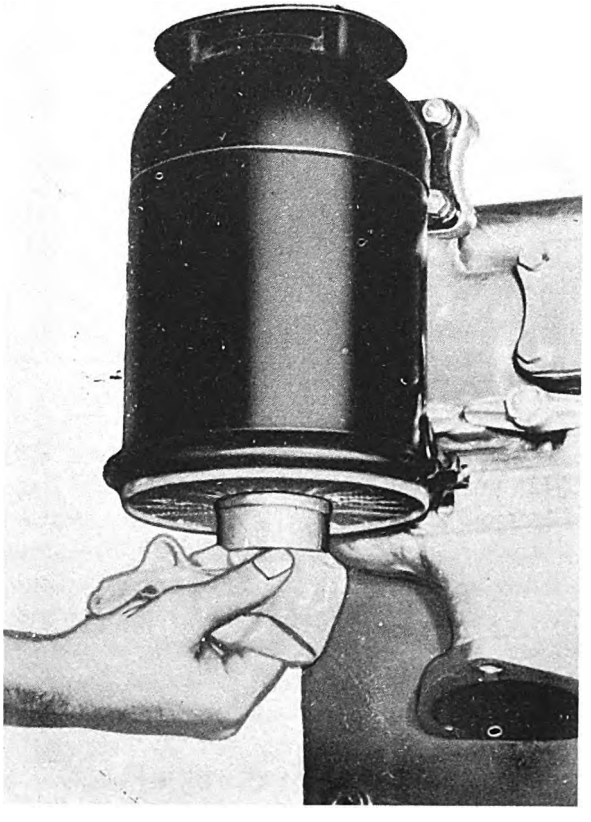

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Figure 19. Air cleaner servicing.

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vent the passage of a sufficient quantity of air for proper combustion and good engine performance.

(3) Fill the oil cup to the level bead indicated on its side with clean fresh oil and assemble the cleaner.

(4) Clean the screens inside the body of the cleaner after every 1,000 hours of operation. Remove the entire cleaner from the engine. When it has been disassembled for cleaning, flush the inside of the cleaner body with fuel oil or equivalent.

(5) After thorough flushing, blow the screens out well with compressed air. When the cleaner is replaced on the engine, be sure that all connections are air tight.

50. EXHAUST SYSTEM.

a. Spark-Arrestor-Type Silencer. The spark-arrestor-type silencer is designed for vertical or horizontal installation. A tail pipe if desired, can be installed on the outlet end to obtain the additional silencing.

b. Inspection and Cleaning. Inspect and clean the silencer periodically so that it will operate with the utmost efficiency at all times. Interior cleaning of the silencer probably will not be required more frequently than once or twice a year unless the engine is operated continuously, or if the carbon deposits are oily. To clean the interior of the silencer, remove all hand-hole covers and scrape out accumulated carbon.

CAUTION: If any connections in the exhaust system are broken be sure that all joints are tight when reassembling. This is important as any carbon monoxide contained in the exhaust gases is a deadly poison.

51. STARTING SYSTEM.

a. Starting Motor. The care and operation of the starting motor for the diesel engine cannot be too highly stressed. Every precaution must be taken that it is in working condition. The load demand on these motors is 100 percent greater than on motors used on conventional gasoline engines. Check the following:

(1) Check and inspect the battery voltages and the circuit terminal connections daily.

(2) Put two or three drops of clean lubricating oil in each oil cup about every one hundred times the engine is cranked. If the bearings appear to run dry before one hundred crankings, lubricate more often.

b. Brush Spring Position. Observe and mark the notch used when new. As the brush wears, it is advisable to tighten the spring end one or two more notches. Remove the brush opening band and observe the brushes when the motor is cranking the engine. If there is destructive arcing between the brushes and the commutator, increase the spring pressure by moving the spring end one or more notches. If insufficient spring pressure causes destructive arcing and the solder is melted from the commutator risers due to the intense heat of the arcing, it may be necessary to resurface the commutator. Replace the springs or holders if the springs become weak from intense heat.

c. Brush-Dust and Dirt. At regular periods, blow brush-dust and -dirt out of the motor, especially at the commutator end, with dry compressed air or hand bellows, in order to prevent short circuits, grounding, and sticking brushes. To take worn brush out of the holder, lift up the lever to relieve spring pressure. The brush can then be removed. Do NOT pull on the brush pigtail against spring pressure. Do NOT snap the lever down on the brush. Inspect brushes regularly and replace when too short. Grind in new brushes with No. 00 (fine) sandpaper, never emery. Clean the commutator with No. 00 sandpaper when replacing brushes. Brushes must move freely in holders to avoid sticking. If brushes are caked with any substance, remove with fine sandpaper laid on a flat surface. Clean brush holders.

d. Motor Commutator. If the commutator becomes slightly rough or coated, clean it while rotating with No. 00 (fine) sandpaper held against it by means of a flat piece of wood or fiber, not metal. DO NOT USE EMERY on the commutator at any time. If the commutator is too rough or out of round, it should be resurfaced. After resurfacing, undercut the mica between the copper segments to the full width of the mica and as deep as its thickness.

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52. FLAME THROWER INSPECTION AND REPAIRS (fig. 20).

a. Inspection. The flame thrower will not require periodic inspection unless it is constantly used in cold climates. For determining if flame thrower operates, remove the inspection plug, in the lower part of the flame thrower housing and operate its pump. A good flame should be visible. If no flame is visible, inspect the nozzle and strainer to see that they have not become plugged with dirt. It is highly important to remember that so long as a flame is burning in the manifold, the engine will not start. This is due to the fact that the flame burns up the available supply of oxygen that is necessary to fire the engine. For this reason, continue to crank the engine after ceasing to operate the flame thrower pump.

WARNING: DO NOT PUT FACE NEAR INSPECTION HOLE.

b. Checking the Electrodes. Check the electrodes. They may be carboned to the extent that a good spark is not present when the circuit is made. Measure the gap between the electrodes. The adjustable electrode may have come loose and increased the gap too much for a spark to jump. The correct gap is 0.094" plus or minus 0.015". Make sure all wiring connections are clean and tight. If adjustments do not restore proper operation, replacement of electrodes, coil, or pressure switch may be required.

53. GOVERNOR.

a. Type. The governor is of the hydraulic type, using lubricating oil under pressure as an energy medium.

b. Oil Supply. The governor is provided with an independent oil supply to prevent the entrance of sludge from the engine lube oil system. A small sump for the governor oil supply has been cast as part of the fuel pump body (fig. 3). A glass window is provided to show the oil level. Oil from this sump is drawn into the governor gear pump through a 5/16-inch copper supply line. There is a check valve at the lowest point of this line to prevent the oil from draining back into the sump from the governor gear pump. A ¼-inch copper vent line is also provided to prevent pressure build-up in the governor housing. This line vents into the engine crankcase.

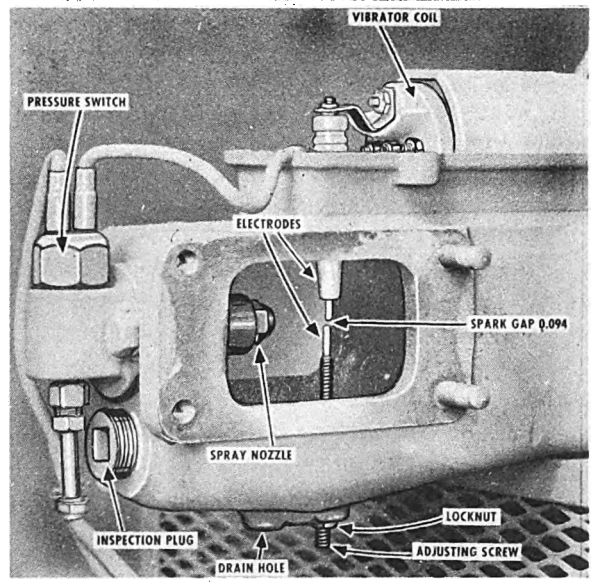

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Figure 20. Flame thrower.

c. Oil Change. Change the oil in the sump after every 30 days of continuous operation. To drain the oil, remove the ⅛-inch pipe plug located on the right-hand side of the sump at the rear lower corner. After draining, replace the plug and refill the sump until the oil level reaches the center of the glass window. Use the same grade of oil as that used in the engine lube oil system.

54. GENERATOR.

a. Lubrication. The major point of maintenance on the generator is lubrication. Lubricate periodically, depending on the degree of service and the temperature. In summer temperatures, check the lubrication once a month. In winter temperatures, every two or three months is sufficient. In all cases it is sufficient to take the plug out of the generator bearing, on the opposite side from grease cup, screw the grease cup down one full turn and allow the equipment to run for one hour to see that excess grease flows out of the opening made by the removal of the plug opposite the grease fitting. The exciter bearing is similarly lubricated with its grease cup. Inspection can be made by removing the rear housing cover.

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b. Brushes, Commutator, and Slip Rings. Use no grease or lubricant on the brushes or the commutator. The commutator and slip ring surface should always be clean and well polished, but they should require only occasional cleaning under normal conditions. Clean them with a piece of canvas or similar hard-woven non-linting material. A roughened commutator or slip ring may need to be polished with a sandstone hone fitted to the curvature. If this is not available, No. 0 sandpaper, followed by No. 4/0, may be used by pressing it against the commutator or slip ring with a block of wood having the same curvature. All of the brushes should be lifted and the commutator or slip ring should be run at full speed while the polishing block is moved slowly back and forth along the surface parallel to the shaft. All grit should be carefully wiped off before the brushes are lowered. NEVER USE EMERY OR CARBORUNDUM CLOTH on a commutator or brushes. Make sure that the brush yoke in the exciter is rigidly locked in its proper position. It is absolutely necessary that the brushes be equally spaced around the commutator. The correctness of the brush setting cannot be judged from the position of the brushes with respect to the pole pieces as this depends upon the exact form of the leads of the armature coils. However, the brushes should be approximately opposite the centers of the main field poles. Each machine has its brushes set, and the brush yoke is locked in the proper position. Do not change this position.

c. Causes of Sparking. Under normal conditions of operation there should be no sparking at the brushes. Injurious sparking should never be permitted to continue. The causes of sparking are:

(1) Brushes not set at the proper place.
(2) Brushes not having proper pressure.
(3) Some brushes having excessive pressure, thus taking more than their share of the current.
(4) Brushes being burned at contact surface due to excessive overloads.
(5) Rough commutator or slip ring.
(6) Loose, high, or low commutator bar, or high mica.
(7) Dirty or oily commutator or slip ring.
(8) Loose connection between the armature conductors and the commutator bars or slip ring or an open circuit in the armature winding.
(9) Short or worn brushes.

d. Causes of Overheating Commutator. Overheating of the commutator or slip rings may be caused by overloads, excessive brush pressure, or excessive sparking. Red hot brush tips may be caused by particles of copper imbedded in the contact surface of the carbon. Such particles should be removed, and the brush refitted with fine sandpaper.

e. Replacing Brushes. When ordering new brushes, give the serial number of the generator, which is stamped on the nameplate, and the size and number of brushes required. Keep a spare set of brushes on hand. After placing new brushes in the holders, carefully fit the rubbing or contact surface of the brushes to the curvature of the commutator or slip ring by means of strips of flintpaper or sandpaper, first using No. 1 and then a finer grade, such as No. 00. NEVER use emery or carborundum cloth or paper. Cut the sandpaper into strips slightly wider than one brush. Insert a strip under a brush with the smooth side of the paper next to the commutator or slip ring and draw the strip back and forth around the commutator or slip ring in the manner of a slipping belt. The final sanding in of the brush should be made by drawing the sandpaper under the brush in the direction of rotation of the commutator or slip ring. On the return stroke the brush should be lifted. This will prevent a rounded brush which is caused by the brush being loose in the holder. Blow out all carbon dust, wipe off the contact surfaces, the connections, and the carbon brushes. If, after polishing the rings with sandpaper, it is detected that they are running out of true, it may be necessary to remove the rotor and turn the rings in a lathe so that they run concentric with the shaft. If this is not done when the rings are running out, trouble will be caused by sparking, and the consequent burning of slip rings and brushes.

f. Arrangement of the Exciter Brushes. The exciter brushes are so arranged that those on a positive stud are staggered with relation to those on the opposite positive

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stud, and those on a negative stud are staggered with relation to those on the other negative stud. This arrangement must be maintained to avoid the wearing of ridges on the commutator. The brush-holder springs should be so adjusted that all brushes will have the same pressure.

g. Inspection and Fitting the Contact. Examine the contact that the brushes make after a short period of operation and continue this inspection and fitting until a thoroughly good contact of the full surface of the brush is obtained.

h. Checking and Cleaning. The brush holders, brushes, and springs should be checked at least twice a week to see that the spring tension is correct, that the brushes are free in the holders, and that the brushes are of sufficient length to bear properly on the commutator or slip rings. Clean the generator at least once each week. All protective covers should be removed from the generator and any accumulation of dust and dirt removed, using an air hose if air is available. If not, use a rag to wipe it out.

55. FUEL OIL PIPING.

a. Checking for Leakage. Check and tighten all fuel lines for leakage. Do not make any changes of any fuel lines from the original installation.

b. Prevention of Dirt in Fuel Tank. When filling the fuel tank, use caution to prevent dirt, water, or lint from entering the tank. If any fuel line connections are removed from the pump, clean them before reinstalling to prevent any dirt from entering the pump.

56. CARE OF FUEL STRAINERS.

a. Primary Filter. It is necessary to drain the sediment and water from the fuel strainer frequently (fig. 10). If this water is allowed to remain in the strainer, it collects on the filtering element and prevents the fuel from passing through. In cold weather this water will freeze, shutting off all fuel entering the engine. If the fuel lines have any low points and the engine is allowed to remain idle for a short period of time, any water in the lines will run to the low spot and freeze in cold weather. This will cause the pressure on the pump to drop and the engine will stop. Be sure that all connections on tanks and strainers are tight. The primary fuel oil filter is easily maintained by turning the handle at the top one turn per day. After six months, the entire unit must be removed and taken apart by removing the cover bolts and gasket. The element should be removed from case and blown out with air. If air is not available, a stiff brush with fuel oil may be used to remove any accumulation of dirt. The container should be wiped dry. The plug should be removed from the bottom of the container before wiping.

NOTE: Reprime the fuel lines to the discharge side of the priming pump fitting whenever fuel lines or filters are drained.

b. Secondary Fuel Filter. When 5000 gallons of fuel have passed through the filter, it is recommended that the filter cover be removed and visual inspection of the cartridge made without removing the cartridge from the filter (fig. 10). If there is any muck whatever inside the filter cover, or if the visible end of the cartridge has a dirty glaze, a new cartridge must be installed. The procedure in changing cartridges is as follows:
(1) Unscrew the cover cap screw and remove the clarifier cover assembly.
(2) Remove and discard the used cartridge from the clarifier case.
(3) Clean all parts of the assembly.
(4) Reverse the procedure to install a new Briggs cartridge.

NOTE: Be sure that the clarifier cover gasket is in good condition and that the clarifier cover is drawn tight.

(5) After the cartridge is changed, fill the filter with fuel oil before the engine is started. After the filter is put back in service, open the air bleed valve and remove all air from the filter.

57. INJECTOR PLUNGER AND VALVE ADJUSTMENT.

a. Clearances and Adjustments. Keep the valve clearances properly adjusted. This assures clean engine operation and long life to the valves. Improper valve clearance causes

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sticking valves, warped valves, pitted valve seats, sluggish engine operation, and wasted fuel. Proper adjustment of the injectors prevents poor combustion and subsequent lack of power and dirty exhaust, as well as carboning of the injector nozzles. Too tight an adjustment causes strain on the injector plungers, connecting linkage, and camshaft profiles. Too loose an adjustment causes late injection which results in poor combustion. The injectors and valves can be adjusted by removing the valve covers on the top of the engine. Over each cylinder are three rocker arms which actuate the valves and injector stems (six rockers per cylinder head). Movement of these rockers will be noted when the engine is cranked by hand. The forward rocker of No. 1 cylinder actuates the exhaust valve. The center rocker actuates the injector rocker. The third rocker actuates the intake valve. On No. 2 cylinder, the rocker order is as follows: Intake (No. 4 rocker), injector (No. 5 rocker), and exhaust (No. 6 rocker). The two additional cylinder head rockers follow the same order, i.e., exhaust, injector, intake, intake, injector, exhaust.

b. Adjustment Procedure. To adjust, carry out the following procedure:

(1) Release engine compression as described in paragraph 28, and crank over the engine slowly in its operating direction. Observe when the injector rocker lever of the No. 1 cylinder (the center rocker) starts to move downward, pushing the injector plunger down with it.

(2) When this lever starts its downward movement, continue to crank the engine over slowly for approximately ⅛ turn until a notch marked 1 and 6 VS on the outside edge of the fan drive pulley registers with the center line mark on the gear housing, marked priming and timing index notch (fig. 57).

(3) The No. 1 cylinder is now in position to set the injector. Loosen the locknut on the injector lever adjusting screw. Back the locknut off two turns to prevent a false adjustment.

(4) With a 10-inch screwdriver provided with unit, tighten the adjusting screw as far as it will go, seating it firmly. No clearance is permitted on the injector plunger setting.

(5) Do not slack off this adjustment. All of the fuel that lies in the injector cup must be expelled, and the plunger tip must bottom firmly on the injector plunger seat of the cup. This setting prevents dribbling of fuel and entrance of gases into the injector cup at the wrong time. The plunger must be made to seat firmly and whenever clearance occurs it must be readjusted to a firm seat again. Tighten the adjusting screw locknut securely after making adjustments.

(6) The same position is used for setting the intake and exhaust valves. Close the compression release lever and set the valves with 0.014 intake and 0.022 exhaust clearance. Ascertain that the compression release is in running position before setting the intake valve. Adjust valves when the engine is warm. Before setting the injectors, check the following points to make sure that the engine is in correct position for the adjustment.

(a) Both intake and exhaust valves of the cylinder being adjusted must be at closed position (valve rollers turn), when the injector plunger adjustment is made.

(b) The VS notch on the fan drive pulley must register with the center line on the gear housing. Turn the engine over until the next VS notch cut in the fan drive pulley indexes with the center line mark on the gear housing. This brings the cylinder listed next in the firing order to the correct position for injector and valve setting.

(c) Follow the procedure and continue in this manner until all cylinders are set. Adjust injector plunger settings after the first 50 hours of service. Reset after each 250 hours of service thereafter. The firing order is 1-5-3-6-2-4.

58. LOCATING ENGINE TROUBLES. To determine and remedy as quickly as possible troubles that may occur in the engine, the following list of symptoms, causes, and remedies is given. When the remedy is not within the scope of the operator, it is so indicated. In such cases the engine requires the attention of the maintenance shop which has the necessary tools, skill, and data.

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ENGINE TROUBLE CHART.

Symptom	*Probable cause*	*Remedy*
a. Failure to start or sudden stopping of engine.	(1) No fuel.	Check fuel tank and shut-off valve. Check for dirty filters, deteriorating flexible lines, insufficient fuel, and inoperative fuel transfer pump or air leak in suction line.
	(2) Insufficient flow of fluel.	
	(3) Air traps.	Bleed the fuel injection system of air.
	(4) Dirt in fuel.	Inspect the secondary fuel filter for clogging. Drain primary filter of sediment.
	(5) Water in fuel.	Drain the filters, the tank, and the fuel injection pump. Reprime engine.
	(6) Plugged line.	Clean the fuel lines and examine for deterioration.
	(7) Overheating of engine.	Check the water and oil. Also check for clogged radiator, stuck thermostat or other restrictions in the cooling system, loose or broken fan belt.
	(8) Low oil pressure.	Check oil level in crankcase. Loose or broken suction line. Broken pressure line. Check for dilution of oil in crankcase.
	(9) Transfer pump failure.	Replace the transfer pump as a unit, sending the old one to the maintenance repair shop where trouble will be corrected.
	(10) No oil in governor housing.	Check and fill to proper oil level.
	(11) No fuel pressure.	Caused by scoring of distributor disk. This is a job for maintenance repair.
	(12) Fuel throttle does not open control at bottom of fuel pump.	Move throttle lever back and forth, notice action of bottom lever control on fuel pump.
	(13) Overspeed valve tripped.	Reset valve control.
	(14) Broken or loose connections in governor or fuel pump linkage.	Check outside control rod of governor when restarting engine. Check for tightness of clamp bolt on control levers. Call maintenance repair if linkage is broken.
b. Loss of power.	(1) Insufficient fuel.	Check fuel tank.
	(2) Air in fuel lines.	Vent or bleed the fuel injection system and check for air leaks.
	(3) Restrictions in fuel line.	See paragraph a(2).
	(4) Weak or misfiring cylinders.	Check valve and injector settings.

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ENGINE TROUBLE CHART (Continued)

Symptom	*Probable cause*	*Remedy*
b. Loss of power (contd.).		**NOTE: To determine if engine is misfiring, loosen slightly the nut of injection line at the injector, no more than half a turn, so that the fuel leaks from loose fitting. If there is no appreciable change in the engine performance that cylinder is not operating. Removal of injector is a job for maintenance repair who will install a service injector or repair faulty injector.**
	(5) Stuck injector plunger.	See paragraph **b**(4).
	(6) Excessive wear in fuel pump.	Call maintenance repair who will replace with service assembly and repair faulty pump.
	(7) Sticking valves.	This is a job for maintenance repair.
	(8) Bad compression.	This is a job for maintenance repair who will check for pitted, burned or warped valves, insufficient valve clearance, worn piston rings or stuck rings.
	(9) Clogged air cleaner.	Remove air cleaner and wash the air filtering element in fuel oil. Wash out oil cup and refill with oil to the correct level.
	(10) Valve and injector settings out of adjustment.	Adjust valve and injector settings.
	(11) Clogged exhaust.	Remove dust catcher and inspect interior of silencer.
c. Overheating.	(1) Lack of cooling water.	Check water in radiator.
		CAUTION: Do not add cold water to an overheated engine. (See paragraph a(7).)
	(2) Sediment or salt in water jackets or clogged radiator.	Flush out cooling system.
	(3) Water pump damaged by ice or other substance.	Check water pump.
	(4) Fuel injection too late or too soon.	Pump should be timed by maintenance repair.
	(5) Fan belts loose or broken.	Tighten fan belts. Call maintenance repair for installing new belts.

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ENGINE TROUBLE CHART (Continued)

Symptom	*Probable cause*	*Remedy*
c. Overheating (contd.).	(6) Stuck thermostat.	Remove thermostat housing on the top of the exhaust manifold and free the thermostat.
	(7) Improper lubrication.	See Lubrication Specifications.
d. Knocking.	Knocks in the Diesel engine can be divided into fuel knocks and those which cannot be directly assigned to the injection process. Knocks other than fuel knocks are either from loose bearings, pistons, flywheel, improperly adjusted valve mechanism, or blow-by due to sticking piston rings. Excessive fuel knocks are caused by too early injection of the fuel with the speed and load on the engine. This may be due to too great an advance of the injection or improper timing of the fuel pump in servicing, also plugged injector nozzles. Trouble from knocking, other than fuel knocks, can usually be found by sounding the knocks out under different load conditions and by cutting out one cylinder at a time. When the loose or incorrectly adjusted part is found, the remedy is usually obvious, and because these corrections should be made by an experienced mechanic, the operator should report any of the mentioned conditions to the maintenance repair.	
e. Excessive smoking.	This may be caused by sticking or worn nozzles, leaky inlet or exhaust valves, stuck or worn piston rings, or scored cylinders. Check the inlet and exhaust valve clearance and make sure that the valve is not sticking in the guide. Check for a dirty air cleaner. As a last resort, assume the trouble to be in the fuel injection pump. If the latter is the case, this becomes a job for the maintenance repair.	

59. LOCATING GENERATOR TROUBLES. The following chart is given to assist in remedying troubles in the generator. When the remedy is not within the scope of the operator it should be turned over to a maintenance shop for repair.

MAIN GENERATOR TROUBLE CHART.

Symptom	*Probable cause*	*Remedy*
a. Exciter overheats.	(1) Shorted or grounded alternator shunt field.	This is a job for maintenance repair.
	(2) Shorted or grounded exciter shunt field or armature.	This is a job for maintenance repair.
	(3) Bearing worn out or defective.	This is a job for maintenance repair.
	(4) Ventilation openings blocked or clogged.	Clear ventilation openings.
b. Alternator overheats.	(1) Shorted or grounded stator or rotor coils.	This is a job for maintenance repair.
	(2) Worn out or defective bearings.	This is a job for maintenance repair.

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MAIN GENERATOR CHART (Continued)

Symptom	*Probable cause*	*Remedy*
b. Alternator overheats (contd.).	(3) Ventilation openings blocked or clogged.	Clear ventilation openings.
	(4) Alternator overloaded.	Reduce line load until control panel ammeter registers normal amperes. See nameplate amperes.
c. Generator noisy.	(1) Exciter or alternator bearings worn out.	This is a job for maintenance repair.
	(2) Exciter or alternator bearings improperly lubricated.	Open drain holes and release surplus grease.
	(3) Alternator stator shorted or grounded.	This is a job for maintenance repair.
	(4) Alternator overloaded.	Reduce line load until control panel ammeter registers normal amperes.
d. No voltage registers on control panel voltmeter.	(1) Voltmeter defective.	This is a job for maintenance repair.
	(2) Exciter commutator dirty or brushes not making good contact.	Clean commutator and free brushes in holders.
	(3) Collector rings dirty or brushes not making good contact.	Clean rings and free brushes in holders.
	(4) Exciter shunt field circuit has an open or poor connection.	This is a job for maintenance repair.
	(5) Alternator shunt field has one or more coils open circuited.	This is a job for maintenance repair.
	(6) Exciter armature short circuited.	This is a job for maintenance repair.
e. Control panel voltmeter registers abnormally low voltage.	(1) Exciter rheostat improperly set.	Turn exciter handle to the right until voltage registers normal. If this fails, it becomes a job for maintenance repair.
	(2) Defective voltage regulator.	This is a job for maintenance repair.
	(3) Alternator field shorted or grounded.	This is a job for maintenance repair.
	(4) Exciter shunt field shorted or grounded.	This is a job for maintenance repair.
	(5) Exciter armature shorted or grounded.	This is a job for maintenance repair.

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MAIN GENERATOR CHART (Continued)

Symptom	*Probable cause*	*Remedy*
e. Control panel voltmeter registers abnormally low voltage (contd.).	(6) Exciter commutator or alternator collector rings dirty or rough.	Clean and polish commutator and rings.
	(7) Engine speed below normal 60-cycle speed, 1200 RPM.	If ammeter on control panel does not indicate extreme overload, check the engine governor.
	(8) Alternator stator winding shorted or grounded.	This is a job for maintenance repair.

60. MAINTENANCE REPAIR SCHEDULE.

a. View of Engine and Parts. A working view of engine and parts are shown in figure 21 and figure 22.

b. Repair Recommendations. The following maintenance and repair recommendations are made so that equipment may be kept in proper operating order at all times. By keeping the tools and working benches clean while making repairs, a high percentage of the causes of poor engine performance can be eliminated. Engine, generator, and switchboard should be repaired inside a building, where possible. If unusual noise or vibration develops in the engine at any time, *start up standby unit immediately and transfer load.* Shut down faulty engine and determine cause of trouble and method of making repairs, by consulting methods described on the following pages.

(1) QUARTERLY.

(a) Clean out carbon residue from silencer.

(b) Check generator and exciter bearing lubrication.

(c) Check circuit breaker contacts.

(d) Check slider contact or rheostat.

(e) Check meters.

(f) Change secondary fuel oil filter.

(g) Clean air filter screens.

(h) Remove and clean fuel injectors and fuel pump screen.

(i) Check and clean voltage regulator and contacts.

(2) SEMI-ANNUALLY.

(a) Minor engine overhaul. Remove heads, grind valves, inspect connecting rod bearings.

(b) Tighten circuit breaker connections.

(c) Clean cooling system. Replace hose if necessary.

(d) Remove starting motor and check bendix drive. Lubricate end bearing.

(e) Remove injectors and clean cups. Replace if necessary.

(f) Remove and clean primary filter.

(3) ANNUALLY.

(a) Major engine overhaul. Complete tear down, renew all worn parts.

(b) Clean soot from exhaust lines and silencer.

(c) Check fuel lines and check-valves in fuel system.

(d) Clean main fuel tanks.

(e) Check governor for sludge conditions. Drain oil from governor sump, fill with fuel oil and operate engine for ½ hour. Drain and refill with new engine oil.

61. TABLE OF CLEARANCES. The following table should be consulted when making adjustments or replacements:

Part	*Minimum*	*Maximum*
Camshaft bearing clearance	0.002″	0.003″
Connecting rod bearing	0.003″	0.005″
Connecting rod end clearance	0.008″	0.012″
Crankshaft end thrust	0.008″	0.010″
Crankshaft main bearings	0.005″	0.008″
Gear cover clearance around crankshaft	0.004″	0.006″

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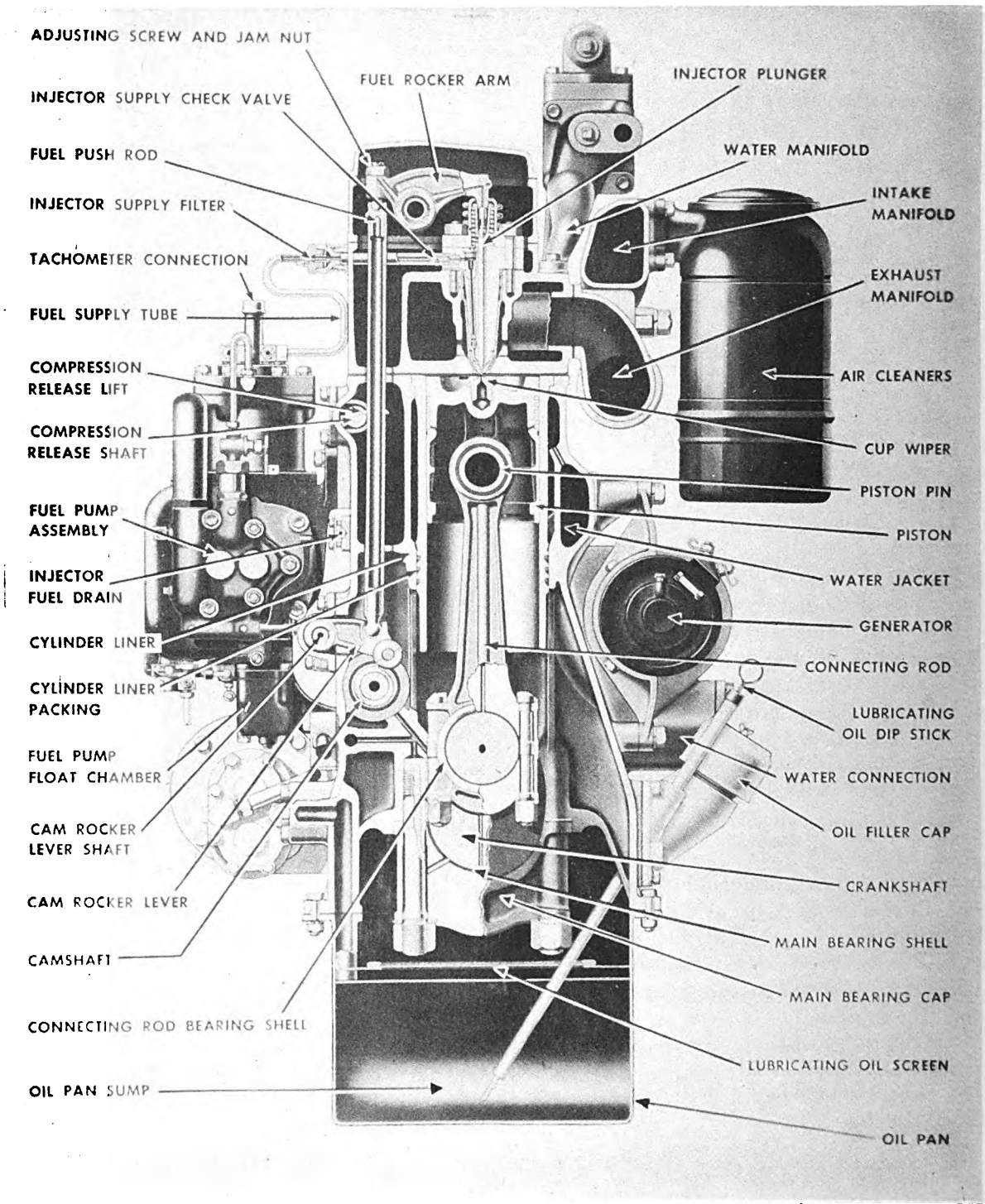

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Figure 21. Cross-section of engine, end view.

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Part	*Minimum*	*Maximum*
Piston pin clearance in piston	0.0005″	0.001″
Piston pin clearance in rod	0.0015″	0.002″
Piston clearance	0.008″	0.012″
Ring gap clearance	0.012″	0.018″
Ring land clearance	0.002″	0.005″
Rear oil seal cover housing	0.006″	
Valve seat angle	30° angle	
Valve seat face width-intake and exhaust	⅛″	5/32″
Valve stem clearance	0.0015″	0.003″
Valve tappet clearance intake } HOT	0.014″	0.014″
Valve tappet clearance exhaust } HOT	0.022″	0.022″

NOTE: If crankshaft should become scored or out of round it can be ground 0.010, 0.020, 0.030, 0.040, on main journals; on connecting rod journals, 0.010, 0.020, 0.030, 0.040, 0.050, 0.060. Bearings can be furnished in these sizes.

62. LUBRICATING OIL PUMP. The lubricating oil pump is of the gear type consisting of two small hardened gears running in a cast-iron case. It is driven directly off the camshaft gear and can be taken off by removing the four nuts holding it to the gear housing.

a. Removal from Engine.

(1) Remove oil tubes leading from pump to cylinder block.

(2) Remove the four nuts and lockwashers holding assembly to the block and pull the complete pump assembly free.

b. Disassembly for Servicing.

(1) Remove the eight cap screws and lockwashers that hold the pump body to pump bracket, and lift body from bracket.

(2) The idler gear stud can easily be removed by pressing from the pump body.

(3) To remove the pump drive gear, use a puller, using the two threaded holes in the gear shown in figure 23.

(4) Remove the Woodruff key from the shaft.

(5) To remove the bracket, tap the edge with a soft hammer.

(6) Uncotter hex nut on end of drive shaft, and remove the nut and retaining washer from the shaft.

(7) Press pump drive gear and shaft from ball bearing.

(8) Press drive gear from shaft and remove Woodruff key.

(9) Remove snap ring from bearing cage and tap bearing from cage.

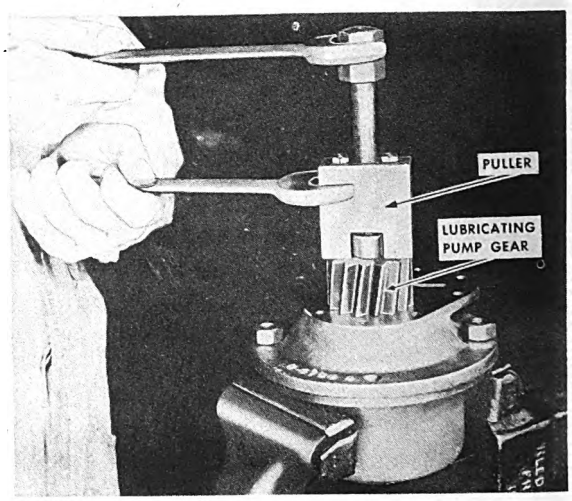

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Figure 23. Pulling lube oil pump gear.

c. Reassembly.

(1) Install Woodruff key in drive end of drive shaft and press driving gear on shaft until it is snug against shoulder.

(2) Press ball bearing into bearing cage and lock in place with snap ring.

(3) Insert end of shaft in cage and install retaining washer, nut, and cotter pin on end of shaft.

(4) Press new bushing in place in pump bracket, and ream with ⅞″ reamer.

(5) Using new gasket, insert pump bracket over bearing cage. Install Woodruff key in shaft and press pump gear on until shaft gear has a clearance of 0.0015″ between gear and bracket, figure No. 24.

(6) Press idler gear shaft into pump body so that shaft is slightly below face of gear body.

(7) Attach pump body to pump bracket with eight cap screws and lockwashers, using new

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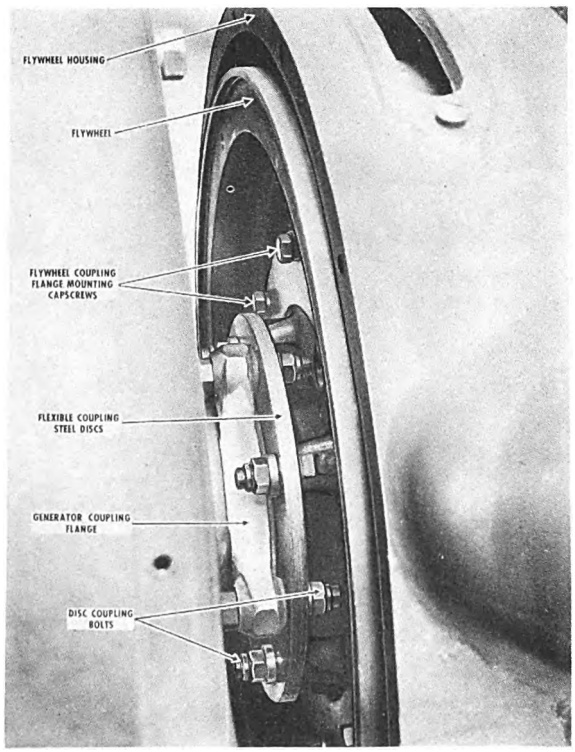
the alarm howler will not sound. Remove the temperature bulb from the engine and place it in a container of water heated to 160° F. Continue heating the water and note the temperature at which the alarm howler sounds. The howler should sound when a temperature of 195° F is reached. If howler does not sound at the proper temperature, it will be necessary to remove the switch cover and increase or decrease the spring tension with the adjusting nut to obtain the point of contact closure.

65. COUPLING MAINTENANCE AND REPAIR, figure 26.

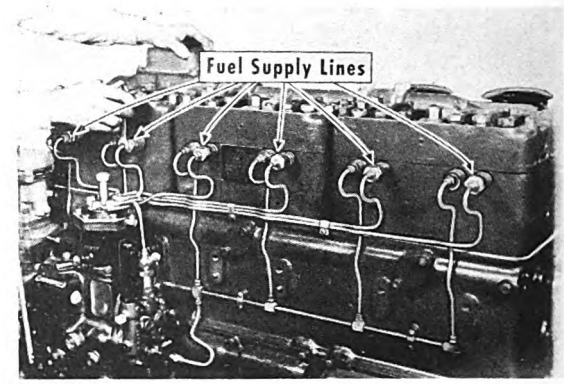
a. Checking. Remove the fan from the flywheel at the engine end of the generator each month and with a box or socket wrench check all the bolts in the coupling for proper tightness. At this time check and make sure that all disks in the coupling are intact.

b. Replacement of Broken Disks. If any of the disks become broken, remove and replace them as follows: With the fan removed, unbolt the coupling from the engine flywheel, remove the two tapered dowels and four hold-down bolts on the generator, and slide the complete unit back, removing the coupling from the flywheel, after which bolts may be removed from the coupling disks and the new disks inserted and the bolts again pulled up, the unit moved back, rebolt into the flywheel, and the tapered dowels and hold-down bolts re-inserted and tightened to the base.



TL-32143

Figure 26. Generator flexible coupling.



TL-32144

Figure 27. Removal of injector fuel tubing.

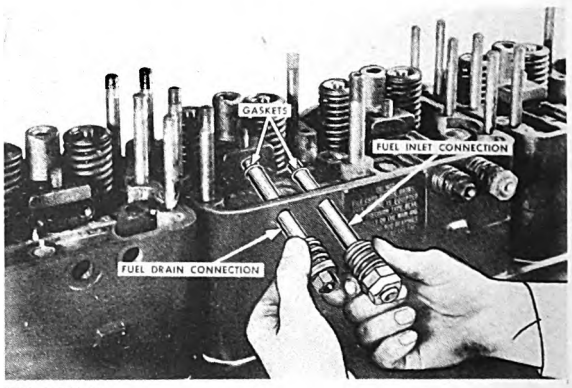


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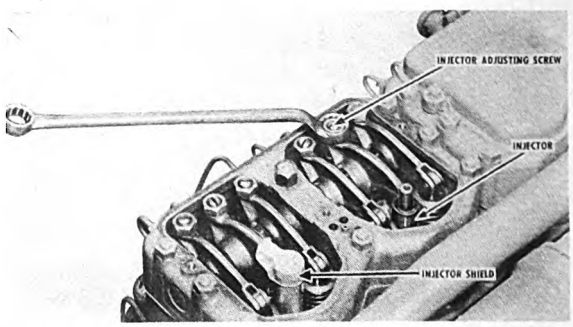
Figure 28. Removal of fuel and drain connections.



TL-32146

Figure 29. Removal of injector rocker arm adjusting screw.

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66. FUEL INJECTION SYSTEM.

a. Operation. The operation of the fuel injection system is covered in section III.

b. To Remove Injector From Engine.

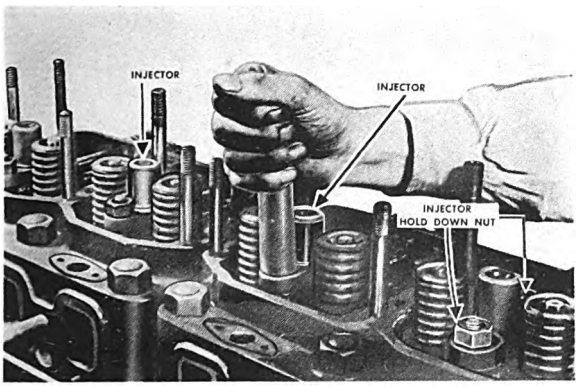
(1) Disconnect fuel tubing (fig. 27).

(2) Unscrew fuel strainer and drain connections (fig. 28).

(3) The small copper gaskets on the ends of the connections are threaded so they will not pull off the connections and drop into the crankcase. When renewing these gaskets it is necessary to use special threaded gaskets supplied by the engine manufacturers.

(4) Loosen locknut and remove injector rocker arm adjusting screw (fig. 29). Move push tube aside and tilt rocker lever away from injector as far as it will go or to a vertical position. Keep each adjusting screw with its respective lever.

(5) Remove the oil shield from around the injector. This shield is pushed on the injector top and may be easily pulled off. This shield prevents the lubricating oil from the rocker lever going into the injector overflow. Remove the two nuts which hold injector in the cylinder head (fig. 30).

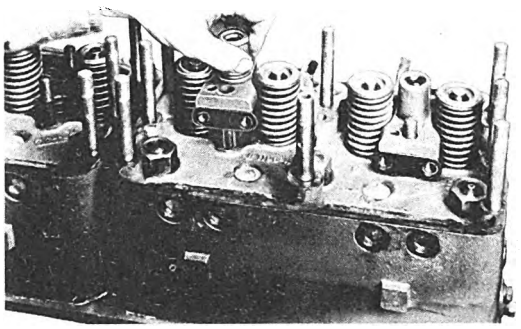


TL-32147
Figure 30. Removal of injector holding nuts.

(6) Lift injector from cylinder head. Use care to prevent the spray tip end of injector from becoming bruised or damaged (fig. 31).

c. To Check Leakage of Injector Check Valve and Other Fuel Leaks. Have separate clean containers for washing the injector and its working parts. Use clean kerosene or some suitable cleaning solvent and thoroughly wash the outside of the injector. Dry the injector with clean compressed air.

(1) Place injector in fixture similar to the one shown in figure 32 with cup end down. Do not clamp directly in vise or damage will result.



TL-32148
Figure 31. Removal of injector.

(2) Remove the fillister head screws holding top housing in place. After removing the top housing, wash the inside of the housing, plunger, and spring before the plunger is removed from the body (fig. 33).

(3) Remove the injector plunger and spring. Fill the injector plunger hole about two-thirds full of clean fuel oil (fig. 34). Hold injector spray tip firmly against a piece of rubber. Insert plunger in place and exert as much pressure on the plunger as possible. If the check valve has a leak, it will show at fuel inlet connection indicated by arrow A (fig. 35).

(4) At same time check leakage between injector plunger and injector body, point B (fig. 35). This leakage should not be excessive.

(5) Check for leakage around injector cup threads, C (fig. 35). If no leakage shows with this test, remove injector from rubber block and spray fuel out of cup by compressing plunger in barrel. At this time fuel spray and angular spray can be noted.

(6) Then draw plunger almost out of barrel and place thumb over tip of cup and lightly compress plunger. Note the leakage of air out of inlet of injector body. If there is no restricting action of plunger in barrel, the check valve is leaking. If a slight leakage of air is perceptible, and by putting in a drop of fuel oil in the barrel and repeated operations do not show leaks, injector check valve will operate satisfactorily under load.

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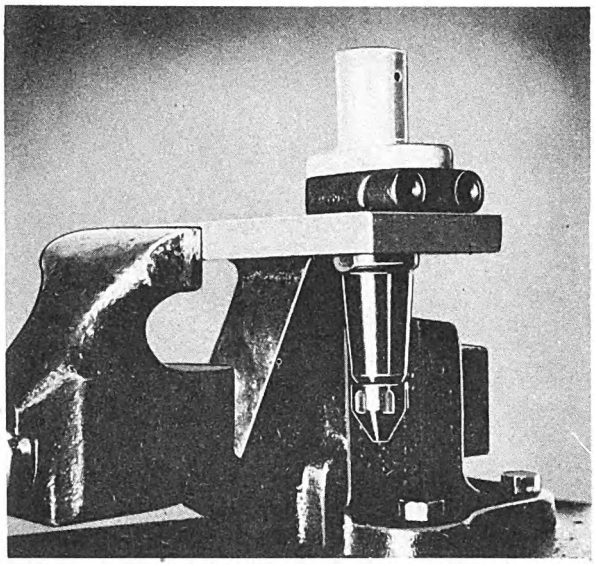
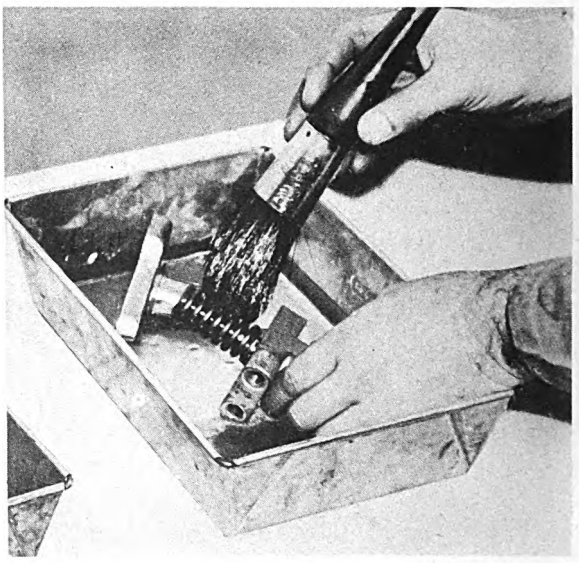
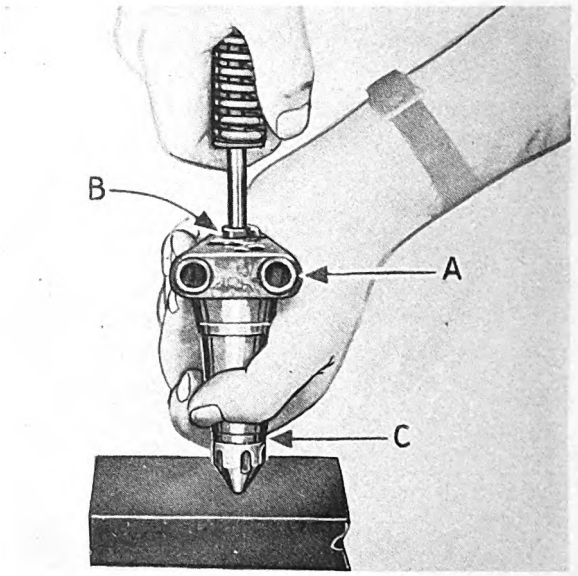


TL-32149
Figure 32. Injector held in fixture.



TL-32150
Figure 33. Washing injector.

TL-32151
Figure 34. Putting fuel oil in injector.



TL-32152
Figure 35. Testing for leaks in injector.

d. Checking Injector Fuel Spray.
(1) With cleaning brush furnished with each engine, brush the injector tip clean of carbon. To lengthen the life of the brush it is always best to pull the brush across the tip. DO NOT USE ANY OTHER METHOD IN DOING THIS (fig. 43).
(2) Refill the injector body with clean fuel as previously instructed. Holding injector in hand, push the fuel out with the plunger and check the fuel spray at the injector cup tip. If six clean even sprays can be seen, it is needless to remove the cup unless the injector has been removed due to dilution (fig. 36).

e. Inspection and Cleaning of Injector Cup Spray Holes. The following illustrations will show what to look for, when inspecting the injector cup. It is recommended that a magnifying glass be used to give the cup a thorough inspection.

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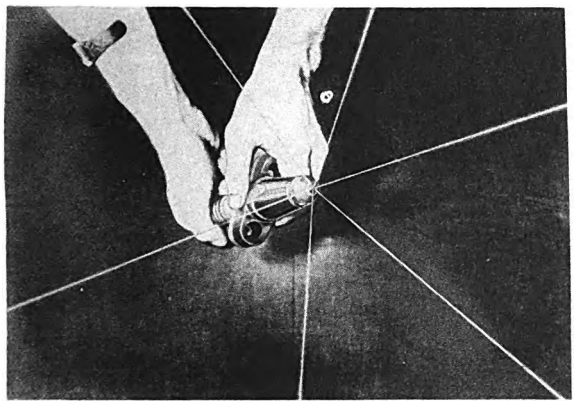
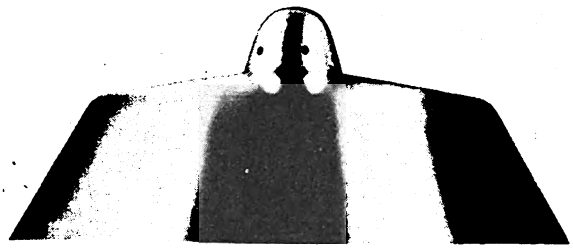
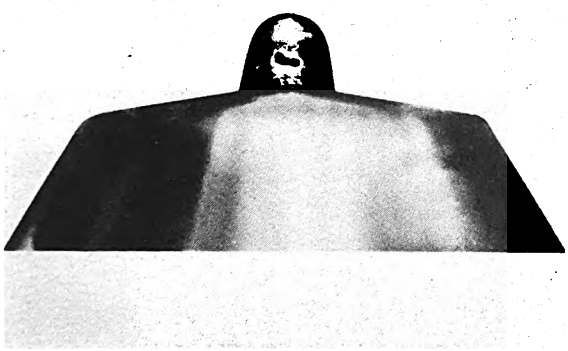


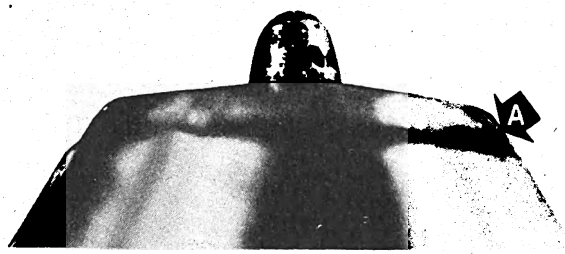
TL-32153
Figure 36. Clean injector cup spray holes.



TL-32154
Figure 37. Perfect injector cup, magnified.



TL-32155
Figure 38. Damaged injector cup, magnified.



TL-32156
Figure 39. Damaged injector cup, magnified.

(1) Figure 37 shows a new injector cup under the magnifying glass.

(2) Figure 38 shows an injector cup damaged by fine abrasives in fuel, such as dust, dirt, etc., which have a sand blasting effect and usually cause this type of cup failure. This damage can also be caused by the improper use of a cup cleaning drill of improper size for the spray hole. Such a condition is frequently caused by breaking the drill off in spray hole and failing to remove it before putting the injector back in the engine. The extreme pressures that are created in the injector cup have a tendency to start cutting out some place around the drill, wearing the metal away.

(3) Figure 39 shows the effect of high acid or sulphur content in the fuel, as well as the effect of excessive heat which could be caused by an overload condition. On the bottom of this cup at A the metal has been eaten away.

(4) The spray holes of the injector cups must be kept free and open at all times. To continue to operate with holes obstructed will cause damage to the engine and loss of power. The cup is so designed that the preheated charge of fuels is injected into the cylinder in a fan shaped spray in order to bring the fuel into contact with all available air.

(5) Figure 40 shows that, in case one injector cup spray hole is plugged with dirt or metal, part of the available air in the cylinder chamber is not in contact with fuel and, over-rich mixture is present in the other part of the cylinder. This causes a falling off in power because of slow burning of the fuel.

f. Injector Cup Cleaning. If the fine fuel spray holes of the injector cup become clogged, it is usually caused by improper setting of the injector plunger, dirt in the fuel, operating the engine at overload, or an overheated engine. A cup cleaning kit is furnished, consisting of the file card brush, with two open-

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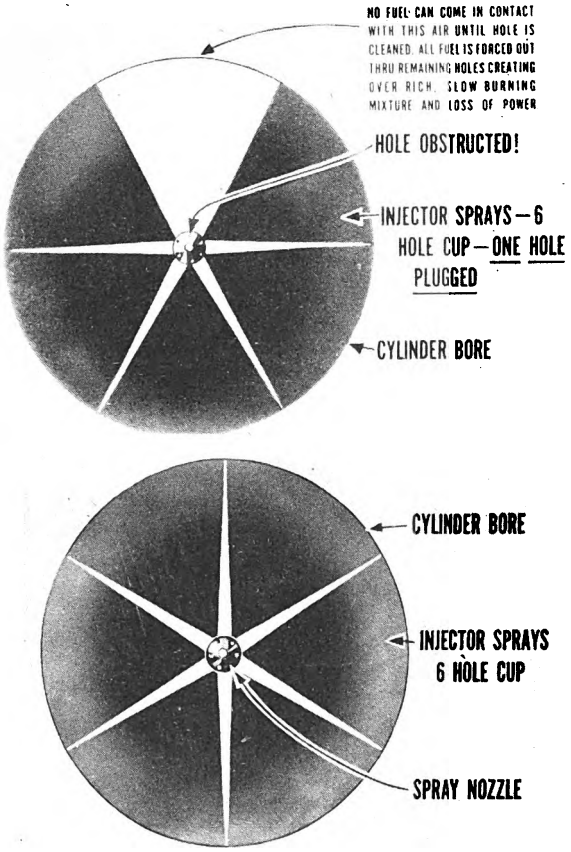
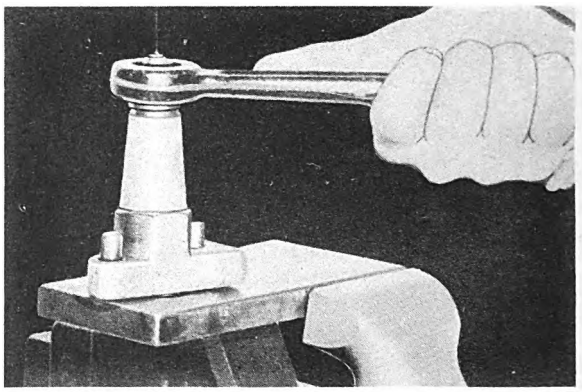
ings in the brush end in which will be found a small drill, several very small wire drills, and a pin vise for holding the small wire drills.



TL-32157

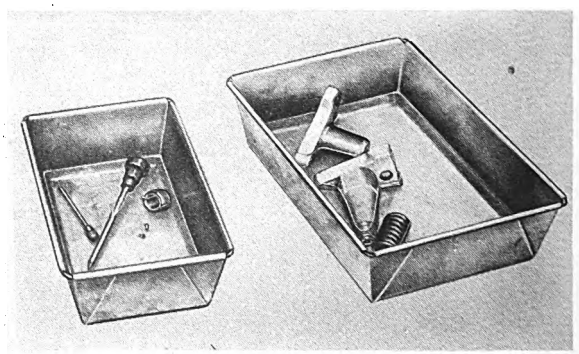
Figure 40. Injector spray diagram.

(3) Before using the small wire drills, furnished for cleaning the spray holes, place the wire in the pin vise, letting it project about 1/16" from the end of the vise. With a very



TL-32158

Figure 41. Removal of injector cup.



TL-32159

Figure 42. Washing injector parts.

(1) Place the injector in the holding fixture as shown in figure 41 with cup end up. Apply the splined wrench, furnished with each engine, on the injector cup, and, with a sharp rap of the hand in a counterclockwise rotation, loosen the cup. When starting these operations, it is very important to have a separate clean container with clean fuel oil or cleaning solvent to wash all parts as they are removed from the injector (fig. 42).

(2) As indicated by B, figure 43, hold the injector cup upside down when using the large drill in order that any foreign matter may fall out of the cup. NEVER USE A DRILL OTHER THAN THE ONE FURNISHED BY THE ENGINE MANUFACTURER. This drill is ground to the proper taper to fit the cup.

fine hone sharpen the end of the drill (fig. 43). This must be done every time a new drill is used or the old one is broken. When a wire drill is cut off or broken, burrs are always present to scratch the inside of the spray holes in the cup. This will cause deflection of spray and poor combustion.

(4) Hold the cup in the fingers as shown by D, figure 43. Be sure to hold the drill to the proper angle as indicated by E, figure 43. This will be at a right angle to the tip so that the drill will follow the hole as it was originally drilled.

(5) A caustic lye or anti-carbon solution may be used to facilitate loosening of carbon in plugged injector cup. Boiling the cup in this solution for one hour will soften carbon to such an extent that drill will easily open hole

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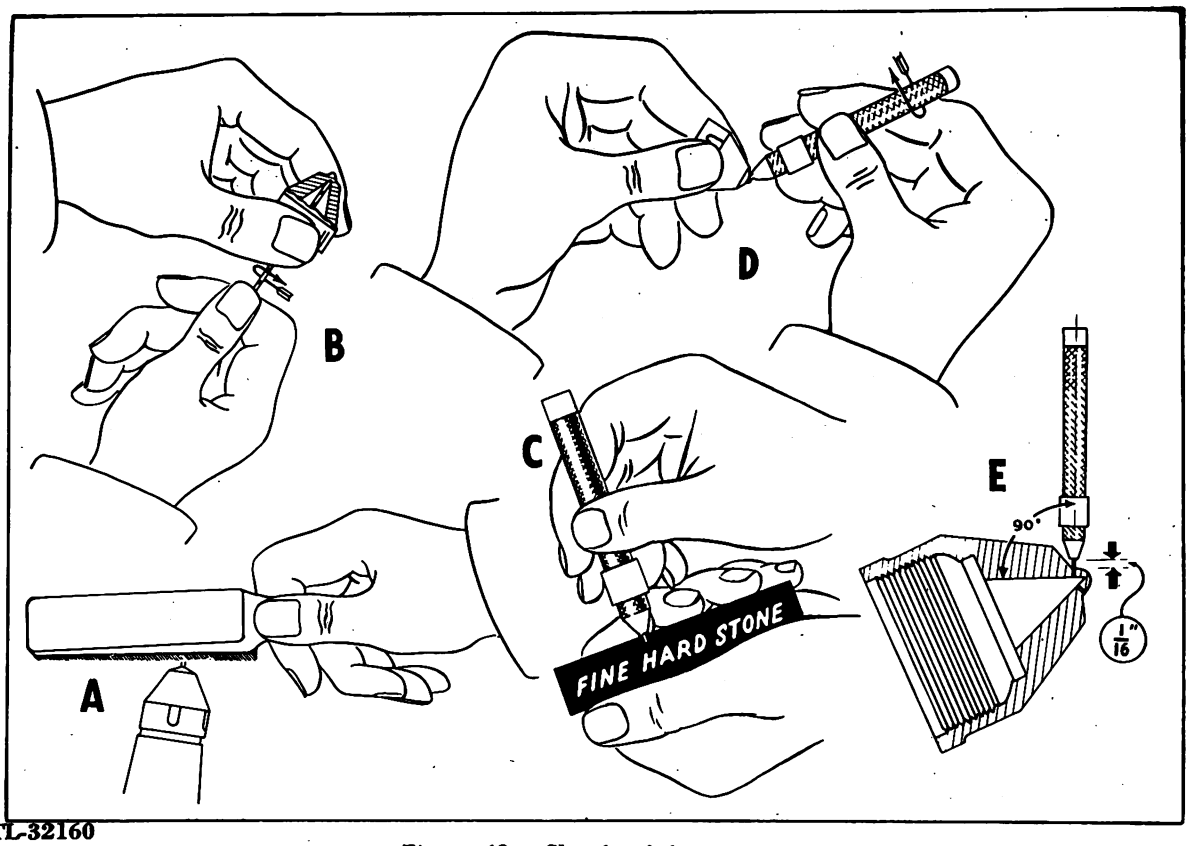


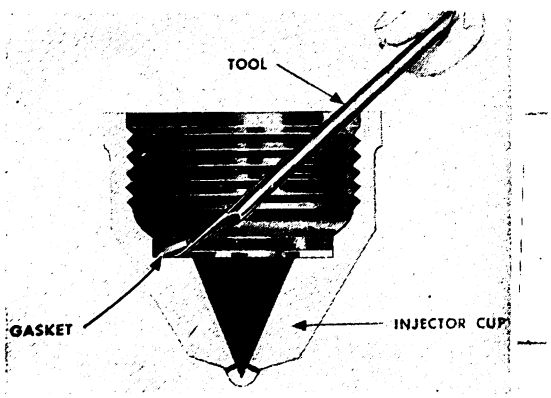
TL-32160

Figure 43. Cleaning injector cup.

without excessive reaming or enlarging of hole.

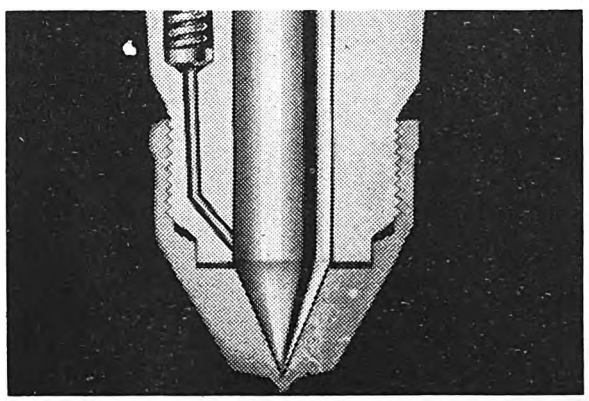
CAUTION: Care should be taken in using solution. Use a wooden stick or long nose pliers and wash cup in fresh water before handling.

g. Assembling Injector Cup. Never assemble an injector cup to the body unless a new cup gasket is used. A tool similar to the one shown in figure 44 will enable you to remove the gasket without damage to the cup. (1) Lubricate the injector plunger, remove spring and insert in body of injector. Have plunger tip protrude beyond end of body. Holding plunger in this position, install cup gasket over plunger tip and screw cup onto injector body. Tighten injector cup with spline wrench. Injector plunger must seat in injector cup as shown in figure 45.



TL-32161

Figure 44. Removing cup gasket.



TL-32162

Figure 45. Injector plunger in cup.

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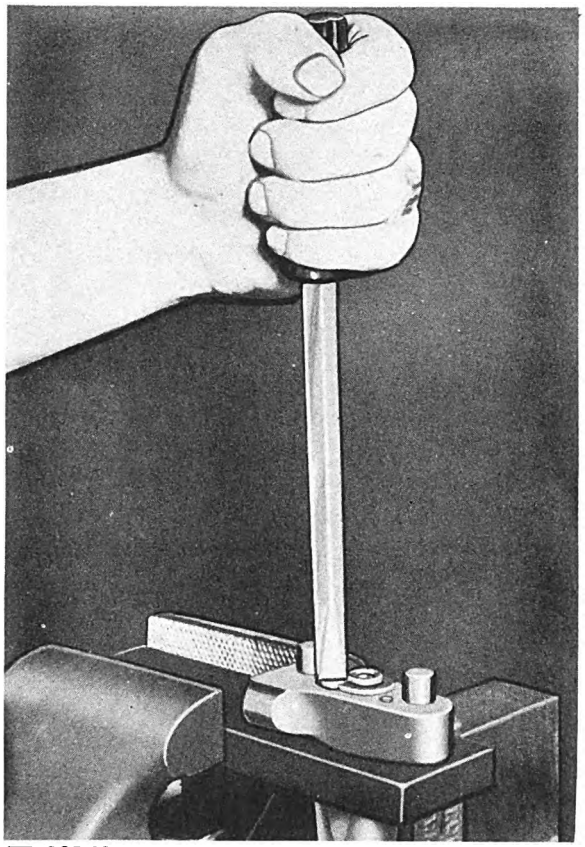
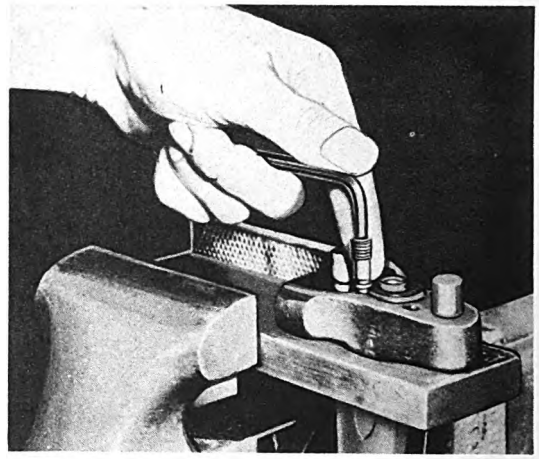


TL-32163
Figure 46. Removing plug over check valve.

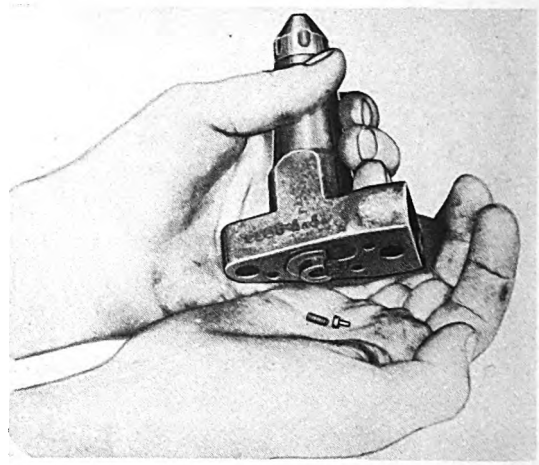
(2) To check for binding of plunger in cup force plunger into cup by tapping lightly with palm of hand. No binding should occur when withdrawing plunger from cup seat.
(3) The above method will help eliminate injector plunger sticking. If the taper of the plunger does not fit freely in the taper of the cup, sticking of the plunger will result. TIGHTENING OF THE CUP WITH A HAMMER WILL AGGRAVATE THIS CONDITION.

NOTE: Use only gaskets furnished by the engine manufacturers. Old or improper gaskets will result in leakage around the cup, causing dilution of lubricating oil.

h. Servicing Injector Check Valve. When servicing injector check valve it is recommended to remove injector cup as previously instructed.
(1) Place the injector in the holding fixture as shown in figure 46. With screwdriver, remove body plug. With allen wrench remove check valve (fig. 47).



TL-32164
Figure 47. Removing injector check valve.



TL-32165
Figure 48. Removing injector valve spring and stop.

(2) Turn the injector body over and tap in the palm of the hand to remove the check valve spring and stop (fig. 48).
(3) If the check valve is stuck in the valve seat, it indicates that the valve has worn through the hardness of the seat and must be replaced. Check valve and seat are supplied only in pairs and must be installed that way.
(4) The check valve gasket must be replaced each time the check valve is removed. The gasket can be removed with a tool made from an old check valve seat as shown in figure 49. It may be necessary to tap the tool a few times with a bronze punch and hammer to enable you to pull the gasket out. DO NOT

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check valve assembly until it bottoms on check valve stem gasket lightly. No binding of assembly should be encountered when screwing in place. Check with travel tool (fig. 52) for spring action of check valve. Then tighten check assembly securely if spring action is found satisfactory.

i. Check Valve Travel. The check valve travel tool (fig. 52) should be used to determine the check valve opening. Limits are from 0.015″ to 0.025″. Too much travel will cause early failure of check valve spring and too little travel will deprive the cylinder of fuel. The tool has graduations of 0.020 each and, if the check valve opens one graduation, the opening is correct.

(1) If the travel is under 0.015″, it may be that the check valve seat gasket has collapsed too much, and it will be necessary to replace with a new gasket. If there is too much travel, the seat should be tightened more.

(2) Insert screw plug and screw it down very tightly using a small wrench on the bit of the screwdriver to assist in tightening it. Be sure its copper gasket is in place and in good condition. This plug seals the fuel from possible leakage.

(3) Be clean in handling injector parts.

(4) Wash all parts with clean kerosene and blow off with air before reassembling.

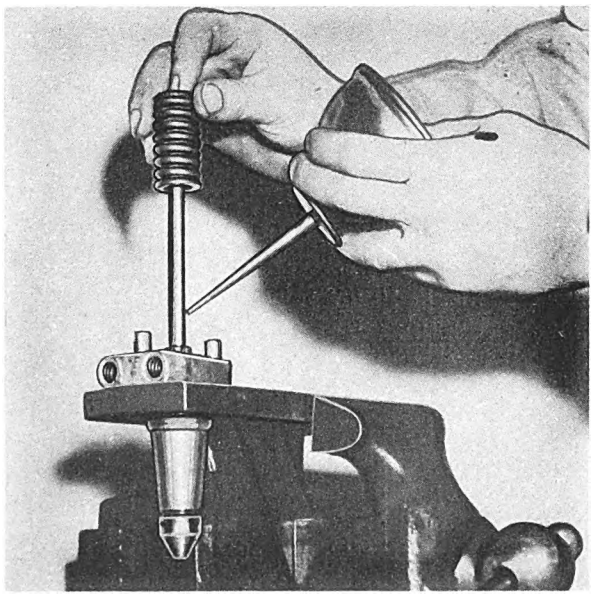
(5) Always use new gaskets when making inspection or repairs.

(6) Before installing cup on body, air should be blown through inlet of injector body or connect injector to priming pump of engine. This can be done by connecting injector fuel strainer to injector and then to tubing on priming pump. Work priming pump and fuel will squirt out of drilled hole in bottom of injector. This will clean out grease and any metal chips from drilled hole. Then, install injector cup and check back on your work as per paragraph *checking leakage of injector check valve and other fuel leaks.*

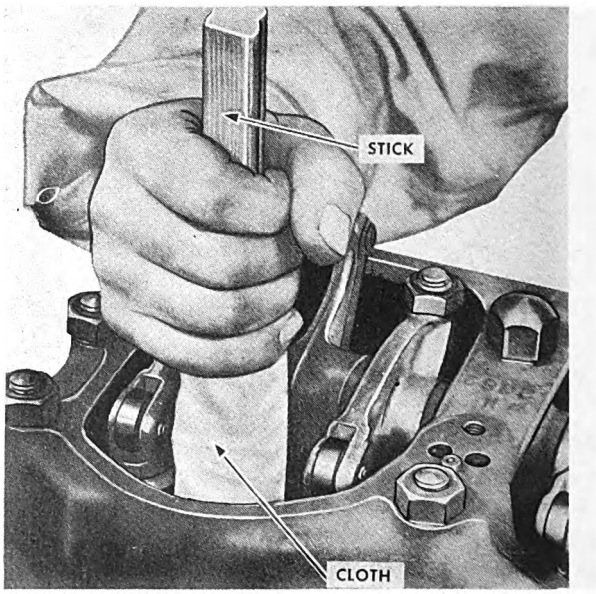
j. Finished Assembly. Install injector cup as previously instructed. Lubricate injector plunger with clean oil and assemble top body with plunger spring in place as shown in figure 53. Assemble housing gasket in place so that the plunger drain hole will be open. Assemble top housing to body and tighten the two fillister head screws in place.

k. To Reinstall Injector.

(1) Wash all parts with clean kerosene or diesel oil and blow off with air before reassembling. With rag and soft pinestick, wipe the seat in the copper sleeve into which injector seats in the cylinder head. This seat must be clean. NEVER ATTEMPT TO SCRAPE OR REAM IT (fig. 54). Place injector into cylinder head (fig. 55).



TL-32170
Figure 53. Replacing injector plunger.



TL-32171
Figure 54. Cleaning injector sleeve.

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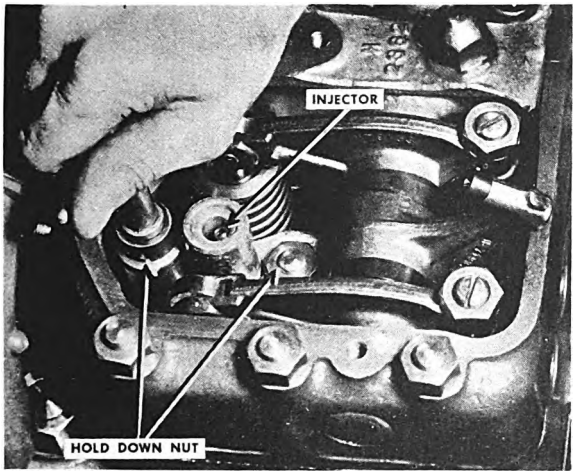
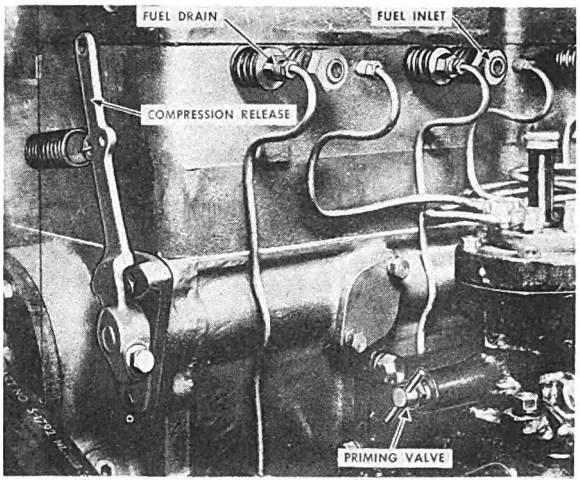


TL-32172
Figure 55. Tightening injector hold-down nut.



TL-32173
Figure 56. Fuel and drain connections.

(2) Screw fuel strainer or drain connections in about two threads to line up injector. Be sure each has a good copper gasket on the shoulder where it screws into the injector (fig. 59). Screw on the injector hold-down nuts. Tighten first one and then the other alternately, pull down both with an even tension. These nuts should be pulled tight enough to seat the injector firmly in the head but not tight enough to strain the injector. Tilt rocker arm into operating position. Screw in adjusting screw enough to hold rod in place (fig. 58).

(3) Tighten fuel inlet and drain connections firmly to prevent any leaks (fig. 28). Then connect the fuel and drain lines to inlet and drain connections (fig. 56).

(4) Whenever an injector is installed in the engine, it is always necessary to spot the engine and set the adjustment of the plunger as directed under *injector plunger adjustment*, paragraph 57.

l. Injector Plunger and Valve Adjustment. (1) Release compression with lever (fig. 3) and crank over the engine slowly in its operating direction until the injector rocker lever, the center lever, starts moving downward, pushing the injector plunger down with it.

(2) When this lever starts its downward movement, continue to crank the engine over slowly for approximately ⅛" turn until a notch marked 1 and 6 VS on the fan drive pulley registers with the center line mark on the gear housing (fig. 57).

(3) Number one cylinder is now in position to set the injector. Loosen the locknut on the injector lever adjusting screw. Back the locknut off several turns to prevent a false adjustment.

(4) With a screwdriver provided with unit, screw the adjusting screw down as far as it will go, firmly seating it. No clearance is permitted on the injector plunger setting (fig. 58).

(5) Do not slack off this adjustment. All the fuel that lies in the injector cup must be expelled, and the plunger tip must bottom firmly on injector plunger seat of cup. This setting prevents dribbling of fuel and entrance of gases in the injector cup at the wrong time. The plunger must be made to seat firmly and whenever clearance occurs it must be readjusted to a firm seat again. Tighten the adjusting screw locknut securely.

(6) The same position is used for setting intake and exhaust valves. Close compression relief and set valves with 0.014 intake and 0.022 exhaust clearance.

NOTE: Ascertain that compression relief lever is in running position before setting intake valve. Adjust valves when engine is warm.

(7) Before setting injectors, check the following points to make sure the engine is in correct position for the adjustment.

(a) Both intake and exhaust valves of the cylinder being adjusted must be at closed position (valve rollers turn), when the injector plunger adjustment is made.

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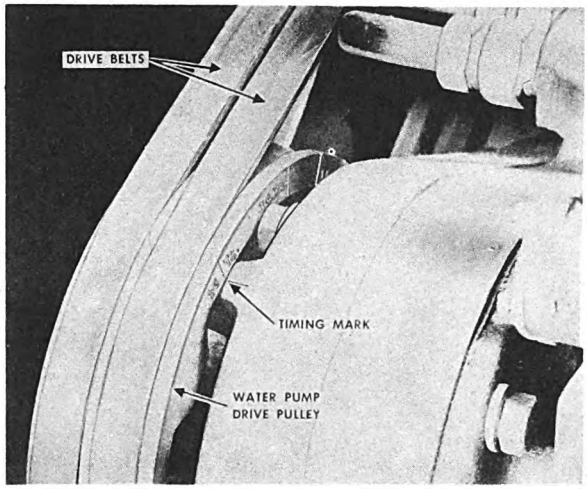
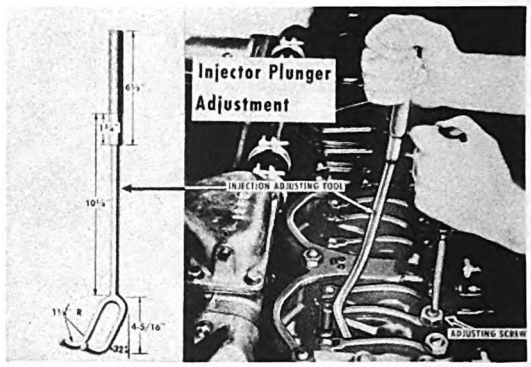


TL-32174
Figure 57. Index timing marks on fan drive pulley.



TL-32175
Figure 58. Setting the injector.

(b) The VS notch on the fan drive pulley must register with the center line on the gear housing. Turn the engine over until the next VS notch cut in the fan drive pulley indexes with the center line mark on the gear housing. This brings the cylinder listed next in the firing order to the correct position for injector and valve setting.

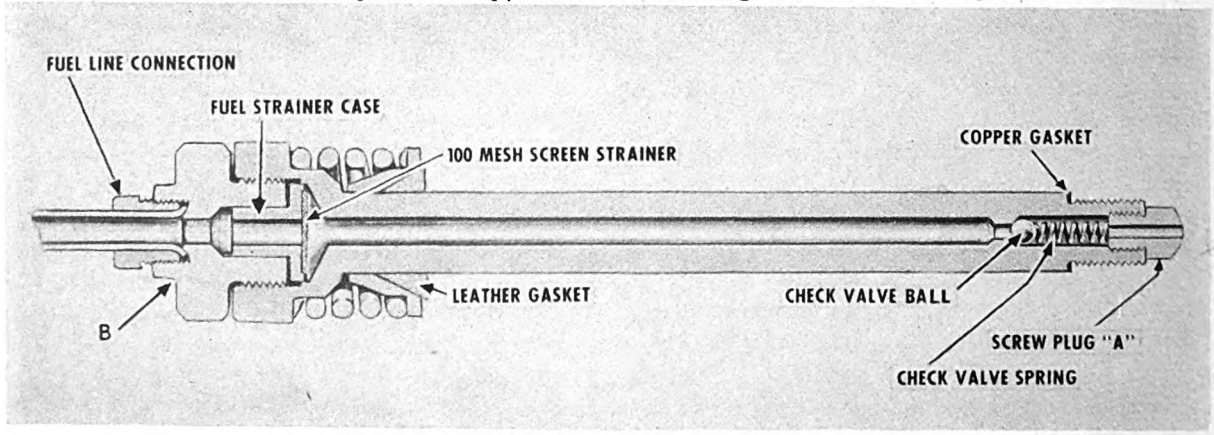
(c) Follow the procedure and continue in this manner until all cylinders are set. Adjust injector plunger settings after the first 50 hours of service. Reset each 250 hours of service thereafter.

m. Injector Filter Check Valves.

(1) There are two check valves in the fuel line between the fuel pump and the injector cup. One is in the fuel strainer connection and the other is in the injector body, near the fuel nozzle. These check valves open when the fuel pump forces fuel through them, admitting the fuel to injector cup and then closing when the pump delivery has finished.

(2) The check in the strainer connection should be checked occasionally for leaks. To check for leaking of check valve, drain out tube by removal of plug A, figure 59. Replace plug A and suck on fitting, and create a vacuum in tube by holding tongue over hole. Check valve is leaking if no vacuum is created. Renew valve and spring if leaking. Tap the old ball on seat with brass rod if new ball will not seat. Replace with new ball check.

(3) Located in the strainer connection is a small strainer. This strainer is accessible by removing the brass hexagon nut from the



TL-32176

Figure 59. Injector inlet connection.

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body. This should be cleaned occasionally. If the screen is replaced, a mesh of not less than 100 to the inch should be used.

(4) The small copper gaskets on the strainer and drain connection are very important. Should these gaskets leak or be left off, dilution will be encountered. These gaskets should be renewed if they show signs of cutting out. These gaskets are threaded and screw on to the ends of these connections. Threaded gaskets should be used when renewing.

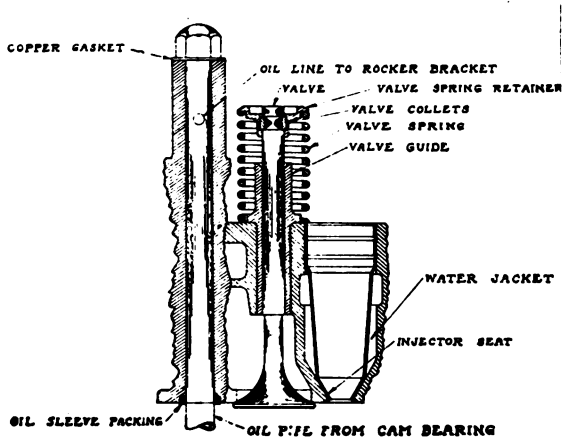
67. CYLINDER HEADS. The cylinder heads are cast in pairs and seat upon a copper asbestos gasket, which is provided with holes to permit the cooling water to pass from the block to the head. This gasket has a soft solid copper ring insert around each cylinder bore which holds the compression. THIS GASKET SHOULD BE REPLACED BY A NEW ONE WHEN ONCE REMOVED OR COMPRESSION, OIL, AND WATER LEAKS WILL RESULT. When the cylinder heads are removed, care must be taken not to nick or mar the face of the head. Any small nick or dent in the gasket seat will make the gasket useless.

a. Disassembly. Place cylinder head on bench and compress valve spring with tool supplied (fig. 61). Take out valve spring locks, retainers, springs, and valves. The valve guides are pressed into the cylinder head and the valve stems have 0.002 to 0.003 clearance when installed. When renewing these guides, they should be driven in with the valve guide inserter to prevent any distortion and reamed to size with a standard ½" reamer. If valve guide bushings require replacement, they can be driven out from under side of head. Use tool supplied with unit. It is not necessary to remove the head to install a new valve spring. Turn the engine over until the piston in the cylinder to be changed comes to top center. The valve spring can then be compressed and the new spring installed.

b. Valve Stem Guide Repairs. Place cylinder head on work bench with smooth face up; insert valve guide knockout tools into guide of valve port. Use press if available or heavy hammer to knock out guide. To insert guide, place cylinder head face down on a smooth wooden bench. Line up new guides in hole by light taps with hammer. Use inserter tool in guides and drive guides until they bottom on head. Use one-half inch reamer furnished with tool kit to ream out guides. Always reface valve seats after inserting new valve guides.

CAUTION: USE A FLAT SURFACE HAMMER TO PREVENT SLIPPAGE OF HAMMER OFF TOOLS AND DAMAGING VALVE SEAT.

c. Injector Seat. The injector seat in the cylinder head is at the lower end of a copper sleeve and should always be wiped clean with a rag on a soft pine stick when changing injectors. If this seat becomes scratched or nicked, the compression will blow through and trouble will result (fig. 60). This copper sleeve is in direct contact with the cooling water and is rolled in place. This sleeve should never be removed unless proper facilities are available to perform the necessary operations on it. When the head is removed, do not set it face down on any hard surface or damage will result to this sleeve.



TL-32177

Figure 60. Valve and lube tube.

d. Valve Grinding.

(1) Valves should be refaced only when warped or leaking. If the valves show a good seat all around and are only slightly pitted they should not be ground. These pits are small particles driven into the seat and would appear again after a few hours run. Repeated grinding counts on the life of the valve and seat so they should only be ground when

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found warped or leaking. The valve seat should be as narrow as possible as a narrow seat will catch less carbon and stand up much longer. The valves have a 30° seat with a ½" diameter valve stem.

(2) In grinding valves in the cylinder head, it is of utmost importance that the valve stems and guides are free from carbon. If a motor driven valve guide cleaning brush is available, use it, if not, the valve guides can be cleaned by wrapping a piece of emery cloth on a round rod and rotating until all carbon is removed. Valve stems can be cleaned by rubbing lightly with emery cloth. Be sure to remove all emery residue.

(3) Remove all carbon from the cylinder head and valve parts by scraping. Insert valves in cylinder head and be sure that they are free in guides. Remove one valve and coat lightly with grinding compound and insert in cylinder head, insert valve grinding tool in slot and rotate 30 to 40 turns, lifting valve occasionally to prevent ridging. Remove valve from head and wipe grinding compound from valve face and seat. CLEAN THOROUGHLY.

(4) Examine valve seat and valve face for carbon pits. Proper seating can be checked by making light, soft pencil marks (fig. 62) across valve face at intervals and then rotating the valve under pressure part of a turn. The rubbing or smearing of all pencil marks indicates proper seating. If seats are not smooth or do not prove out as indicated, repeat regrinding operation until properly finished.

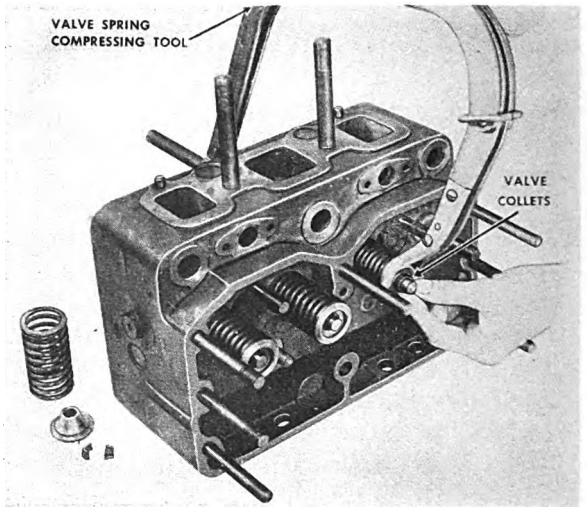
(5) If, in the removal of the valves from the cylinder head when engine is disassembled, the valve faces are found to have a ridge, replace these valves with new ones and grind into cylinder head as outlined above.

(6) If carbon forms on stem of intake valve, it may be due to lubricating oil catching dirt passed through improperly cleaned air filter.

(7) After thorough cleaning of all parts, reinstall valves, springs, retainers, and locks, using valve spring tool shown in figure 61.

NOTE: Always use valves marked CECO. Use valves marked EX in the exhaust.

e. Installing of Cylinder Head Gaskets. Wipe block face clean of all dirt and grit. Scrape down any uneven surfaces and clean cylinder head studs and oil tube. Clean and install new cylinder head gaskets. On top of cylinder head gaskets screw on and slide down over lube oil pipe, two leather packing rings (fig. 63). Clean off and install cylinder head.



TL-32178
Figure 61. Assembling valve springs and locks.

f. Oil Pipe Packing. On the bottom face of the cylinder head, next to the block, where the oil pipe comes through to the rocker arm bracket, there is a counter bore for two leather packing rings. This packing prevents the oil from coming out under the head and should be replaced when the head is reinstalled (fig. 63).

g. Tightening Cylinder Head. Blow out cylinder head with air pressure and clean surfaces before installing. When reinstalling cylinder heads, it is very necessary that all nuts are cleaned, oiled and pulled down evenly, in rotation shown in figure 64. All nuts should be tightened a little at a time, going from one to another in turn and continuing by this method until the nuts are all pulled up tight. Use heavy duty wrench supplied with tool kit. Try to maintain a steady tension on all nuts while drawing down cylinder heads. Use this heavy duty wrench until no more tension can be taken. Use torque wrench and pull each nut down in graduation of 30 ft. lbs. until all nuts are pulled down to 425-450 ft. lbs. tension (fig. 65). Do not use a long piece of pipe on the wrench or damage may result to the cylinder block due to the strain set up.

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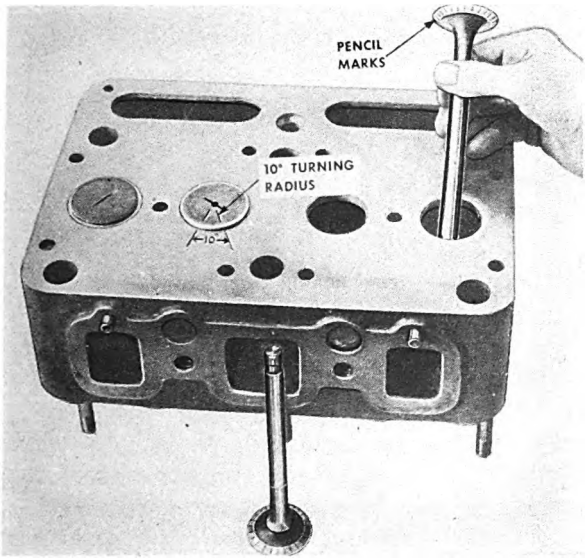
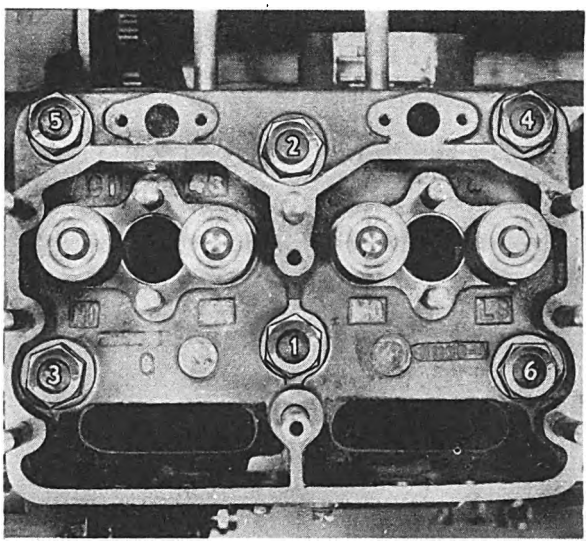
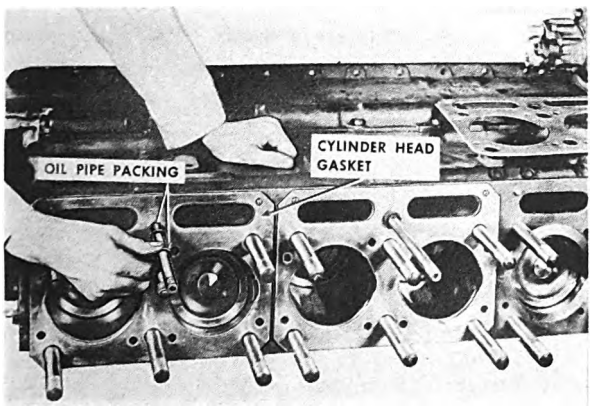


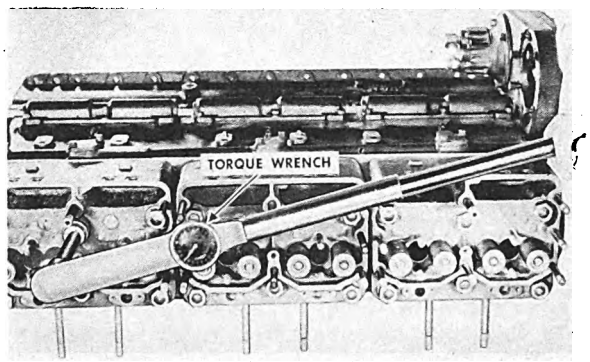
TL-32179
Figure 62. Checking valve seat and valve.



TL-32181
Figure 64. Routine for tightening cylinder head nuts.



TL-32180
Figure 63. Installing cylinder head gasket and lube pipe packing.



TL-32182
Figure 65. Torque wrench on cylinder head nuts.

68. UPPER VALVE ROCKER ASSEMBLY.

a. Rocker Arm Housing. The rocker arm housing contains two sets of levers of three each. One lever in each set is for the exhaust valve, one for the intake valve, and the third or center lever is the injector lever.

b. Removal of Rocker Assembly.

(1) To remove rocker assembly, loosen injector and valve adjusting screws three turns.

(2) Remove seven nuts and oil pipe cap and gasket.

(3) Lift housing assembly from engine.

(4) When removing push rods or any other parts, see that they go back in the same place from which they were removed. This is very important on the intake valve push rod. The heavy rod is for the injector lever or center lever. Do not use this for the exhaust lever (fig. 66).

c. Valve Push Rods. Each cylinder has three push rods. The two outside ones operate the intake and exhaust valves and the center one is the injector push rod. The intake push rod has a collar on it which works in a notch in the compression relief shaft running through the cylinder block. When the compression relief lever is held back the intake valve is held open by the notch in the shaft and the engine may be turned over easily, as it is then not working against compression (fig. 66).

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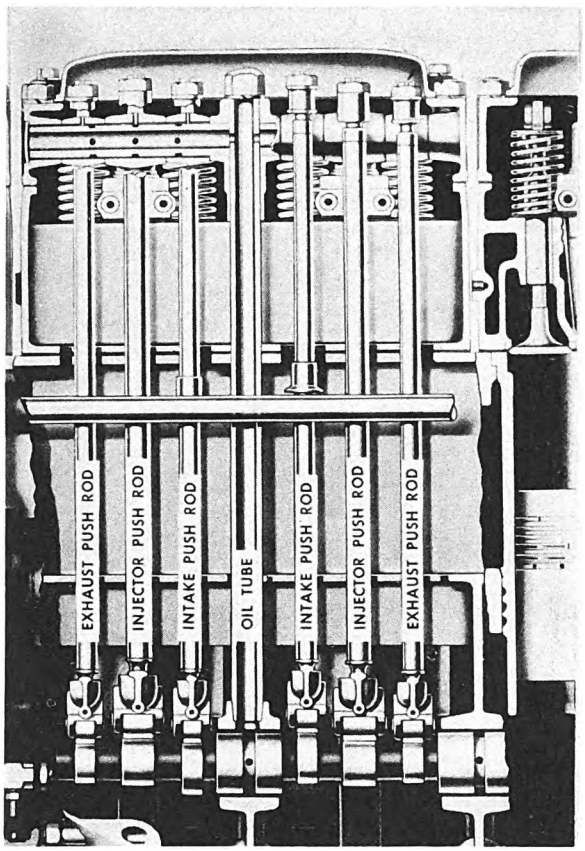


TL-32183

Figure 66. Push rods.

d. Servicing Rocker Assembly.

(1) Take out set screw that holds rocker arm shaft in housing (fig. 67).

(2) Remove expansion plugs at each end of housing. With sharp pointed punch, drive through plug on one end and drive shaft far enough to remove plug from opposite end.

(3) Drive shaft out of housing from either end, and remove rocker arms.

(4) Drive bushings out of levers with suitable drift.

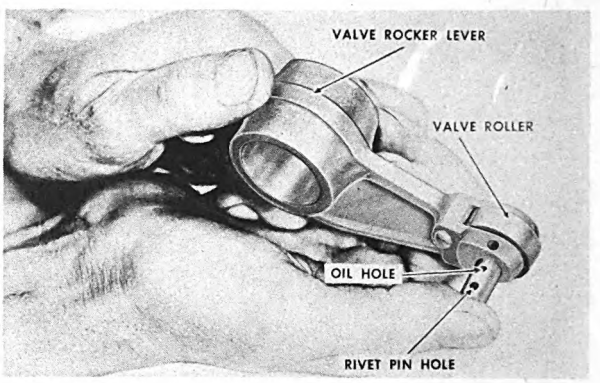
(5) To remove rocker arm roller, tap out rivet and remove pin and roller.

(6) To remove injector rocker socket, press out from top side of lever.

(7) Remove jam nuts and adjusting screws, wash all parts thoroughly and check for wear and open lubrication passages.

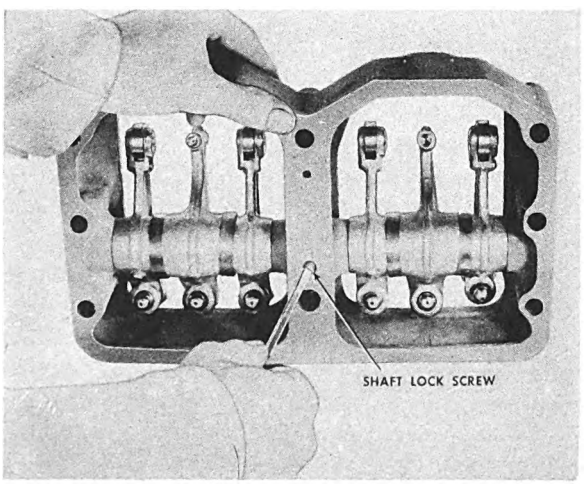
(8) Install new rollers and roller pins, if required, and rivet in place with new rivets. Only exhaust rocker levers are drilled for lubrication to valve rollers (fig. 68).

(9) Press new bushings into rocker levers. Observe that the bushings used for levers must be installed so that the holes for lubri-



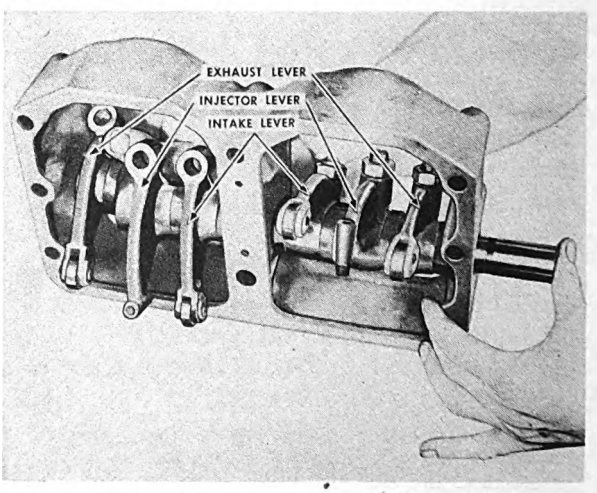
TL-32185

Figure 68. Assembling rocker lever roller pin.



TL-32184

Figure 67. Valve rocker assembly.



TL-32186

Figure 69. Upper rocker housing.

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cation are correctly lined up. Ream bushing to 1.125".
(10) Assemble injector rocker lever socket.
(11) Assemble the levers in the housing, and push rocker shaft in place (fig. 69).
(12) Install lock screw holding shaft and tighten securely.
(13) Install new expansion plugs in each end of housing.
(14) Install circlips between rocker levers.
(15) Place new gasket over studs to cylinder head.
(16) Install rocker housing over studs to cylinder head. Align push rods with adjusting screws.
(17) Install seven nuts and tighten securely.
(18) Install oil pipe line cap with new gasket.
(19) Readjust valves and injectors.

69. WATER MANIFOLD ASSEMBLY. The manifold connects the cylinder head discharge ports to a thermostat and bypass housing assembly which leads the discharged water to the radiator for cooling or back to the suction side of water circulating pump. Capscrew connections are made at each cylinder discharge port to water manifold flanges. Hose connections are made between manifold and radiator and bypass pipe connections, which lead back to water pump.

70. OIL PAN. The capacity of the oil pan is 12 gallons and is fastened to the engine block with 7/16" capscrews and bolts. In order to remove the oil pan from the unit, the following procedure should be followed:

a. Remove the batteries and battery trays from the engine base.

b. Clean the outside of the unit thoroughly with brush and cleaning solvent.

c. Drain oil pan.

d. Drain and remove lube oil filter in pan housing.

e. Remove lube oil drain piping from the oil pan and the oil filler spout and dip-stick housing assembly from the side of cylinder block.

f. Disconnect lube oil lines on fuel pump side of engine including the rear oil seal drain line.

g. Remove all mounting capscrews and bolts from oil pan, with the exception of two, one on each side. Loosen the two bolts enough to drop the pan three-eighths of an inch.

h. Slide a 1" wooden plank across base under pan.

i. Brace pan with plank on one side and remove bolt and lower pan on plank. Proceed to the other side and repeat operation. Pan may then be slid out on plank and removed for cleaning.

j. Remove screen from pan and flush out thoroughly.

k. Reassemble screen and install new filter bag.

l. To reassemble pan to engine reverse procedure.

NOTE: Do not destroy pan gasket unless a replacement gasket is available. It is recommended that a new gasket be installed when replacing oil pan. Ascertain that gasket does not fold over when installing pan on engine block.

71. GENERAL BEARING INSTRUCTIONS.

a. Type of Bearings. Main and connecting rod bearings either standard or under size, are precision type and are provided with the recommended clearance for the oil film on the shaft. UNDER NO CIRCUMSTANCES SHOULD ANY ATTEMPT BE MADE TO SCRAPE OR REAM THESE BEARINGS.

b. Method of Measuring. The method of measuring a bearing shell as shown in figure 70 is to use a micrometer in conjunction with the steel ball, the latter of which will rest on the inside of the bearing shell. Bearing wear can be found by checking the dimensions of a new bearing shell against that of the old one. As bearing shells are in halves, it will be necessary to take the worn dimension of the bearing shell in the bottom half of the shell. A properly fitted bearing, after a reasonable period of service, will show a dull gray appearance indicating running on an oil film. Bright spots indicate metal to metal contact and black spots, excessive clearance.

c. Tightening and Regrinding. Tighten all connecting rod bearing nuts to 105-115 ft. lbs. on torque wrench. If it becomes necessary to regrind the crankshaft, finish grind to standard undersizes; −0.010", −0.020", −0.030", and −0.040" undersize bearings are available in these sizes.

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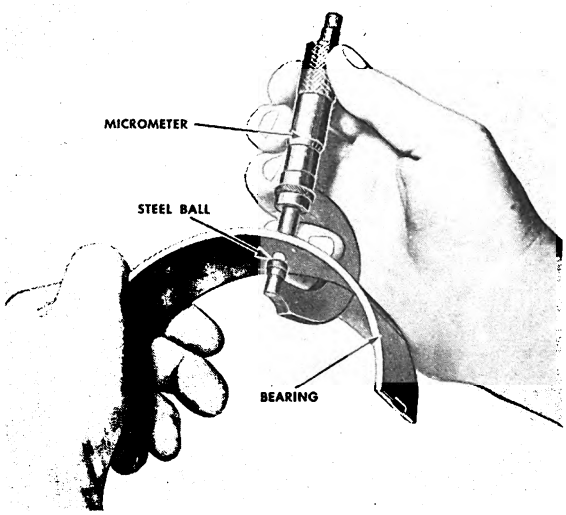


TL-32187
Figure 70. Method of checking bearing wear.

72. CONNECTING ROD AND PISTON. The piston and connecting rod are so closely associated from a service standpoint that the two will be collectively explained in the instructions covering the operations for repairs.

a. Inspection of Connecting Rod Bearings. Straighten lock plates for nuts on connecting rod cap, remove nuts and take off cap. Connecting rod bearings may be examined or replaced without removing rods from engine. Particular care should be exercised that rod caps are not interchanged. Matched numeral marks stamped on the connecting rod and cap must face camshaft side of engine. Small lip projecting from bearing shell fits in the groove of rod and cap for the purpose of doweling it in place (fig. 72).

(1) Before fitting new bearings, clean the crankpin carefully. The back of bearings and bearing seats must be smooth and clean, otherwise the bearings will not fit the shaft properly. Be certain the oil feed holes from the main bearings are open and clean.

(2) Check condition of crankpin surface for out-of-round, wear and taper. Shaft limits when new are 3.125" diameter and 0.0005" for out-of-round and taper.

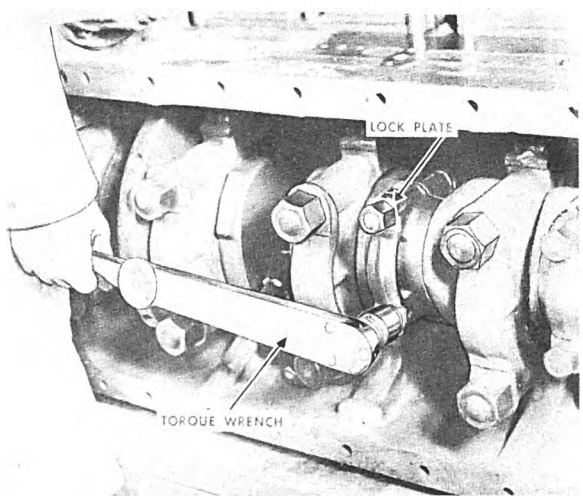
(3) It is very important, when installing the new Bohn lead bronze bearing and connecting rods, that the clearances should be not less than 0.003", and not more than 0.005".

(4) Never file connecting rod or bearing caps. This will cause bearing failure and replacement of parts filed.

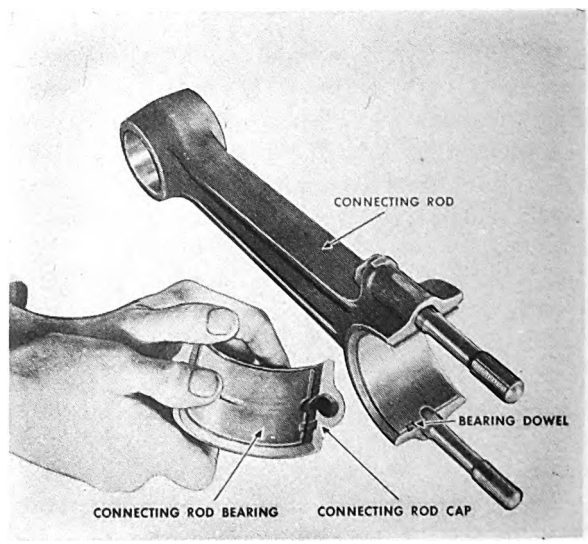
(5) Working from below, place rod and bearing on crankpin, and install bearing shells in position (fig. 71). NUMBER ON ROD AND CAP MUST BE TOWARD CAMSHAFT.

(6) Install lock plates and nuts and turn nuts up tightly to 105 to 115 ft. lbs. on torque wrench before locking with lock plates.

(7) When pulling up the connecting rod nuts, the last 30 lbs. should be applied by pulling steadily on the handle of the wrench until the proper reading is reached. Do not jerk on wrench or reading will be incorrect.



TL-32188
Figure 71. Torque wrench on connecting rod nut.



TL-32189
Figure 72. Connecting rod bearing and dowel.

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b. Inspection of Connecting Rod and Piston. Removal of piston and connecting rod assembly can be made as one unit, by removing lower bearing cap and bearings, and scraping all carbon from inside of cylinder. Push connecting rod up from below and remove piston and rod assembly from top of engine.

(1) The connecting rod is rifle drilled from the crankpin hole to the piston pin hole to distribute oil under pressure to the wrist pin and bushing. The upper end of a new connecting rod contains a hard bronze bushing which is pressed into connecting rod and bored and honed to an accurate size of 2.0015". The hole in the larger end of connecting rod is finished by grinding to provide a smooth backing support for the bearing shells and accurate alignment with the piston pin hole.

(2) Pistons are made of special alloy iron and carefully balanced. Whenever a piston needs replacing be sure to obtain the same weight of piston that is being renewed in the engine. All weights are stamped on top of piston.

(a) Remove snap ring from each end of piston pin and push pin out by hand or use a soft wooden drift.

(b) Remove piston rings, using expanding type pliers.

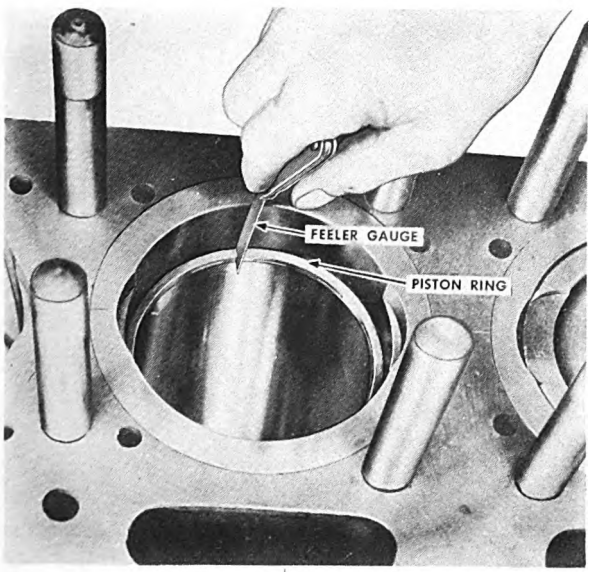
(c) Piston ring grooves must be carefully cleaned of all carbon particles. Polish up piston crown, skirt and piston pin bore with crocus cloth. Clear out all carbon from drain holes in piston oil grooves. Chip out any carbon formation inside of piston. Flush out piston in fuel oil and dry down with air.

(d) Wipe piston dry with clean rag, not waste, and remove any burrs or carbon scores with a fine grain file, finish with a honing stone. Score marks on piston crown or ring lands will not necessarily affect combustion or efficiency of engine. Blow down with clean dry air after cleaning and servicing of piston has been completed. Give piston a detailed inspection for any cracks, hot spots or irregularities in ring grooves.

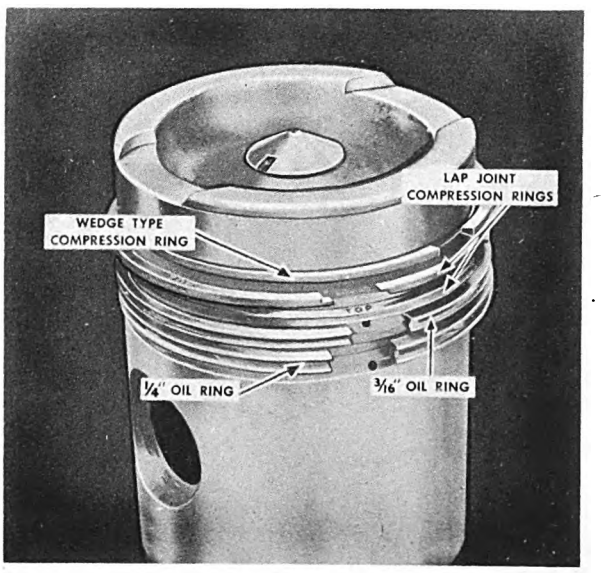
(e) Check wear of piston with a micrometer or by the difference of clearance, when inserting piston in a new liner and rechecking with a new piston in same liner.

NOTE: Piston diameter must be checked at right angle to piston pin hole on skirt of piston for largest diameter.

(3) The piston pin is of the full floating type and is held in place by two snap rings which fit into grooves machined in the piston. The piston pin is fitted to the piston with 0.0005" clearance or until it can be pushed in with the fingers. After the snap rings are in place, the pin should be able to turn in the piston, and connecting rod.



TL-32190
Figure 73. Checking piston ring gap clearance.



TL-32191
Figure 74. Assembling piston rings.

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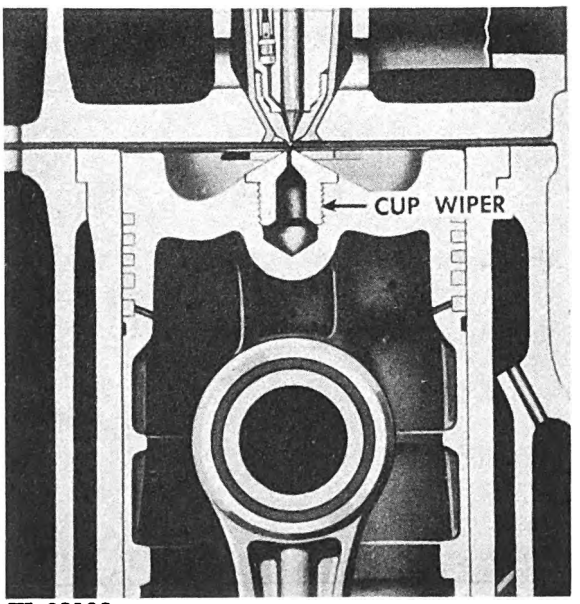
(4) The piston pin bushing is of special bronze and is a press fit in the rod. Three oil grooves with holes leading into the oil groove turned on the outer circumference of the bushing furnish lubrication. A clearance of 0.0015″ is allowed between the pin and bushing.
(5) The cup wiper located in the center of the piston is installed to give better combustion and to prevent carbon from forming on the end of the spray nozzle. The cup wiper should never be removed unless found in a damaged state. There is no wear to this part.
(6) The cup wiper is locked into place by the washer under the head. A ⅛″ hole is drilled in the piston head under the outside edge of the washer. Sink the washer into this hole with a small punch. Turn up one side of the washer in the slot on the cup wiper to lock it securely in place (fig. 75).
(7) The top compression ring is a wedge type ring and should be fitted to the cylinder liner with a minimum of 0.015″ and a maximum of 0.025″ joint clearance when new (fig. 74).



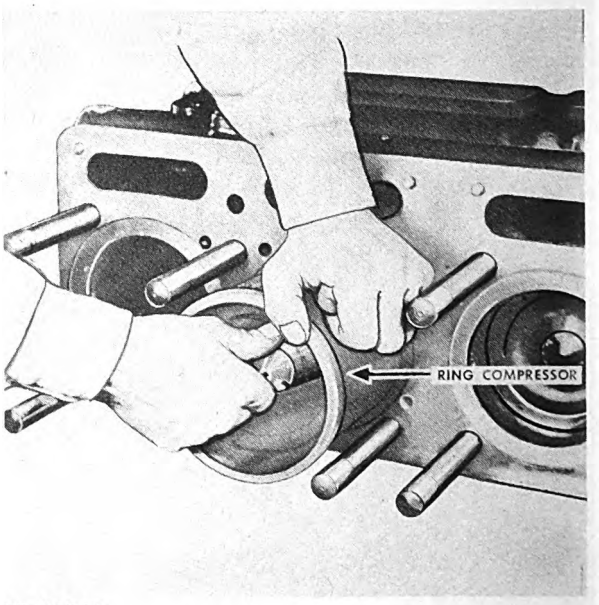
TL-32192

Figure 75. Injector cup wiper.

The next two compression rings are lap joint rings and are marked TOP as shown in figure 74. Always put this side up and do not file joints of these rings. Use a feeler gauge to measure ring joint clearance (fig. 73). The oil rings should be fitted to a minimum of 0.015″ and a maximum of 0.018″ joint clearance. These clearances should be adhered to closely. It is very important that all carbon and sludge deposits be removed from the piston, ring grooves and oil holes before assembling with new rings. Install piston rings, staggering their gaps so that they are not in line with each other or with the piston pin hole. Install each piston ring so that gaps are 180° apart.
(8) Assemble bolts to connecting rod with ends in locked position and insert connecting rod and piston in top of block. While compressing piston rings with ring tool, push piston down into block (fig. 76).

NOTE: Pistons, rings, pins and rod bearings must be fitted as explained in the preceding paragraphs before beginning installation.

73. CYLINDER LINERS. The engine is built with renewable cylinder liners, which should only be removed for cleaning of jacket water passages, scored liner, or excessive wear in liners.



TL-32193

Figure 76. Inserting piston.

a. Cylinder Wear. Cylinder liner wear can be checked by means of an inside micrometer as shown in figure 77. Measurement should be taken as shown in figure 78, dimension points A to G inclusive. If cylinder liner wear exceeds 0.015″ from diameter of new liner at

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and set up as shown in figure 79. Tightening of nut on puller stud will draw out liner from block.

WARNING: COVER CRANKSHAFT WITH A PADDING OF RAGS WHEN PULLING LINER. THIS PREVENTS RUST AND WATER FALLING DIRECTLY ON CRANK JOURNAL. CARE MUST BE TAKEN THAT PULLER DOES NOT FALL ONTO CRANK JOURNAL.

c. Installation of Cylinder Liners.

(1) Scrape rust and scale from liner packing seat and shoulder at top of block.

(2) Try fit of sleeve in engine block without rubber packing rings to assure free fit.

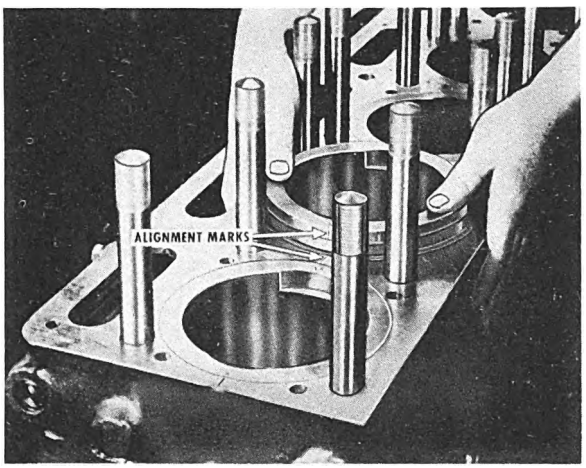
(3) Install the three packing rings in the grooves on the bottom of the sleeve and coat them with soft soap to prevent damage (fig. 80).

CAUTION: Do not use white lead, grease or oil on these rings or serious damage will result.

(4) Insert liner in block with recesses for valves properly located. This is done by locating the line on the side of the liner with the punch mark on top of the block (fig. 81).

(5) Push liner down into block by hand.

CAUTION: Do not drive liner in with hammer, as it should enter by hand pressure only.



TL-32198

Figure 81. Installing cylinder liner.

(6) With cylinder gauge (fig. 77) check inside diameter of cylinder liner for out-of-round as soon as it is placed in the cylinder block. If more than one thousandths out-of-round, or taper from top to bottom is found, pull the cylinder liner and check the bore in the cylinder block for excessive dirt or scale. Reinstall the cylinder liner and recheck at all points with cylinder gauge as indicated in figure 76.

74. CRANKSHAFT AND BEARINGS. The crankshaft is mounted in the cylinder block in seven main bearings. The crankshaft is drilled for oil passage to the connecting rod. Both ends of the crankshaft are provided with an oil sling to prevent the lubricating oil from leaking out. Asbestos seals are placed in the double plates around the crank between the flywheel and rear main bearing on the rear end of the shaft. A metal oil sling is mounted directly behind the crankshaft gear on the front of the shaft. If the flywheel is removed and reinstalled, the zero mark on the flywheel should match with the zero on the crank flange. The crankshaft is counterbalanced and the unit is statically and dynamically balanced.

a. Main Bearings. The main bearing shells are steel backed, precision type and copper lead lined.

(1) Oil is introduced to the main bearings by a drilled passageway from the cam bearings at the point where the load and thrust upon it is the greatest. As the bearing wears and the crankshaft settles down into it, the lubricating oil pressure is thus maintained. This method of lubrication prolongs the life of the bearing shell.

(2) An oil groove is provided in the lower half of bearing shells with holes leading through to index with holes drilled in lower bearing caps. The oil passage continues through in main bearing cap and recess of main bearing stud, into block through keyway groove cut in this same stud, leading into passageway of block (figs. 21 and 22, cross-section of engine).

(3) Number three, upper main bearing shell is drilled to obtain an oil passage to both sides of crankshaft main journal simultaneously. This provides sufficient lubrication for this journal which is not drilled to feed a connecting rod.

b. Bearing Clearance. Main bearings are fitted with a minimum clearance of 0.0055". No shims are provided for adjustments due to the long life of this type of bearing.

(1) Upper and lower main bearing shells are not interchangeable.

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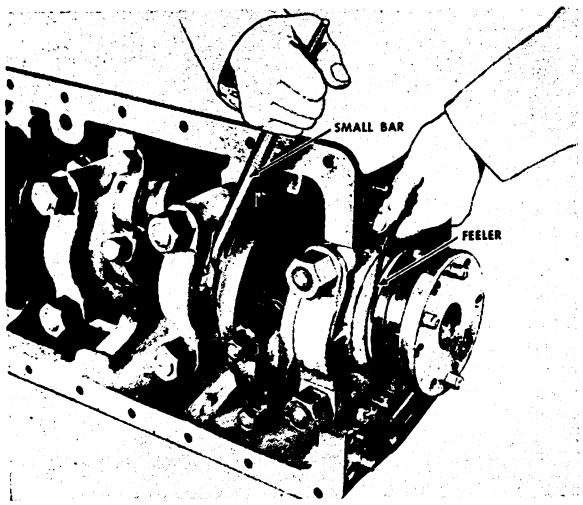


TL-32199
Figure 82. Checking crankshaft end thrust.

(2) The rear main bearing, which is designed to take the crankshaft thrust, must have 0.006" to 0.008" end clearance between the bearing and the thrust flange of the crankshaft. This should be gauged as shown in fig. 82.

(3) To check bearing wear use the method prescribed in general bearing instructions.

c. Renewal of Main Bearing Shells. Should the bearings become worn to a point where they are in need of adjustment, they should be replaced by new shells. Should a bearing burn out, remove melted bearing carefully from the oil holes in the block, bearing caps and crankshaft. Failure to do this will result in another burned bearing. If the remaining bearings have had considerable service, it is recommended that all be replaced.

(1) To change the main bearing shells in the engine it is not necessary to remove the crankshaft from the block.

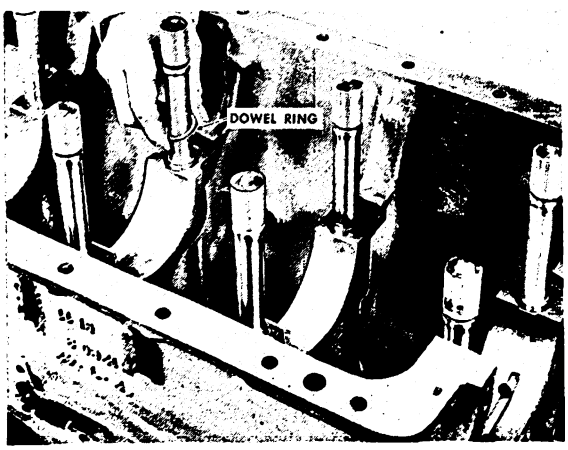
(2) Main bearing shells are positioned in the cylinder block and lower bearing caps by a dowel ring on each stud opposite the camshaft side of the engine (fig. 83). This prevents turning of the bearings in the block. A recess is provided in bearing shells for butting of shell against dowel rings (fig. 86).

(3) Main bearing caps can not be interchanged or turned end for end. Numbers stamped on the caps in line with corresponding numbers stamped on the web of the crankcase, are matched marks and these marks must coincide. Caps are machined at the sides to fit locator shoulder in the block and prevent sideway movement (fig. 84).

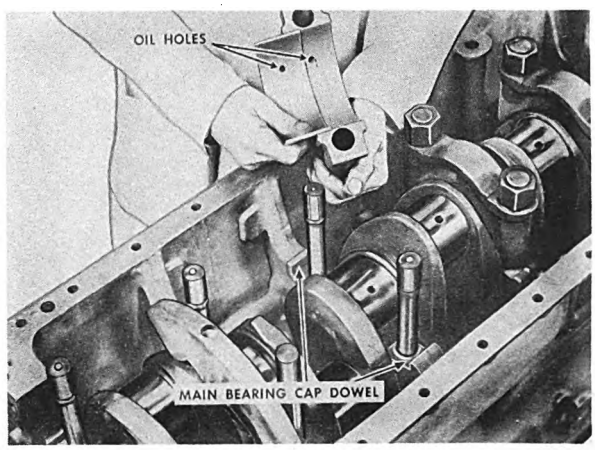
(4) Do not file caps. Main bearing caps should not be filed at any time, as filing the cap changes the shape of the bearing hole.

(5) Holes in the crankcase for main bearings are line bored to close limits and have a smooth finish to provide firm support for the main bearing shells.

(a) First remove the lower bearing cap and shell. Then turn the crankshaft slightly; the upper bearing shell should roll out with the crank as it turns. Should the shell be stuck in the block, a small piece of brass 5/16" diameter and about ½" in length may be used in the oil hole in the crankshaft (fig. 85). It should only extend out about ⅛"



TL-32200
Figure 83. Main bearing dowel ring.



TL-32201
Figure 84. Registry of oil hole in main bearing and cap.

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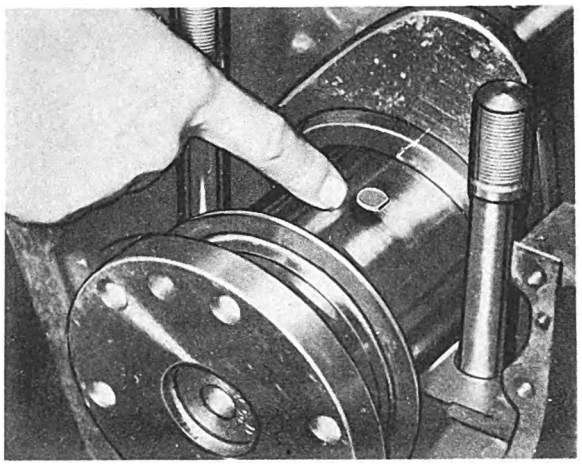
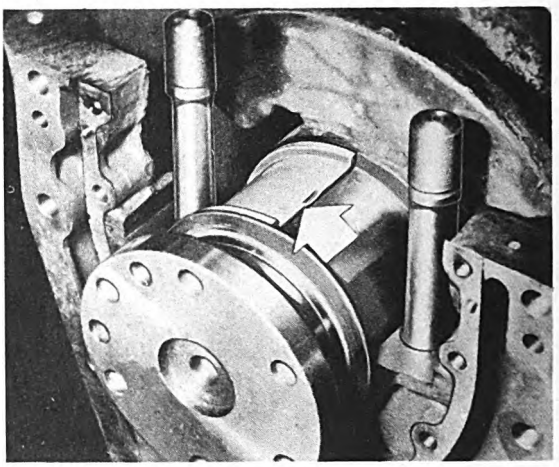


TL-32202
Figure 85. Pin for turning out main bearings.

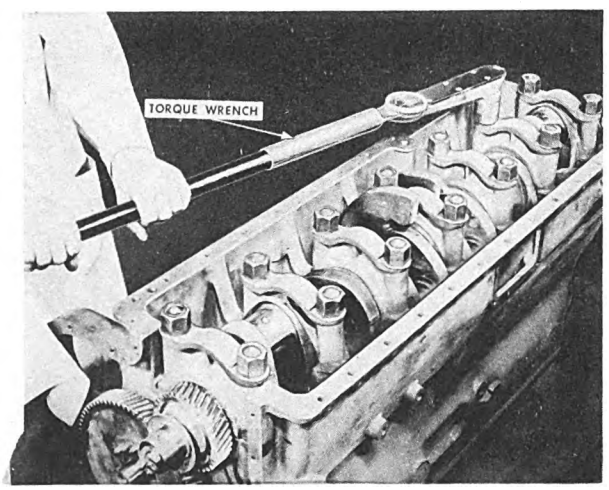


TL-32203
Figure 86. Turning out main bearings.

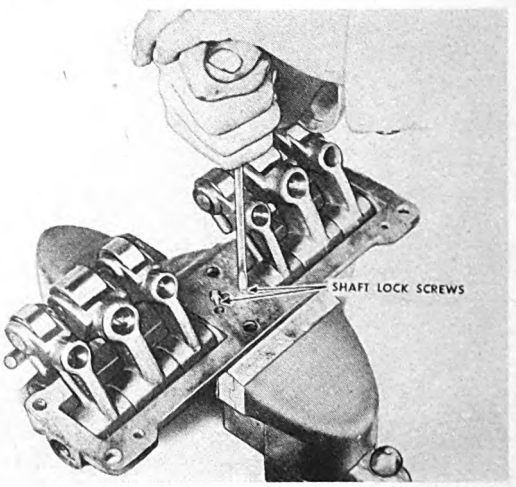
from the crank as shown in the illustration. Roll this pin against the bearing shell and it will be pushed out when the crank is revolved (fig. 86).

(b) Do not fail to remove the plug from the crankshaft after the shell has been removed. If any burr is caused by use of the plug it should be removed with a scraper. Take care to prevent any filings from dropping in the crankshaft hole. New bearings are inserted using the same method. Tighten all main bearing nuts to 310-330 ft. lbs. on torque wrench (fig. 87).

75. CAM ROCKER LEVER ASSEMBLY. Rocker levers with roller running on the camshaft carry the valve and injector push rods at their lower end. To remove these rocker assemblies it is necessary to remove upper valve rocker arm assemblies, (par. 68). The push rods may then be removed from the sockets in the cam rocker levers. The instrument panel and fuel pump must also be removed for access to rocker lever assemblies. Remove cap screws from cam rocker assemblies. Pry off housing and levers from locating dowel pins. The same thickness of gaskets between the cam rocker housing and the cylinder block should be maintained as any variation in these gaskets will change the fuel injection timing. Always order from depot.



TL-32204
Figure 87. Torque wrench on main bearing nut.



TL-32205
Figure 88. Shaft lock screws.

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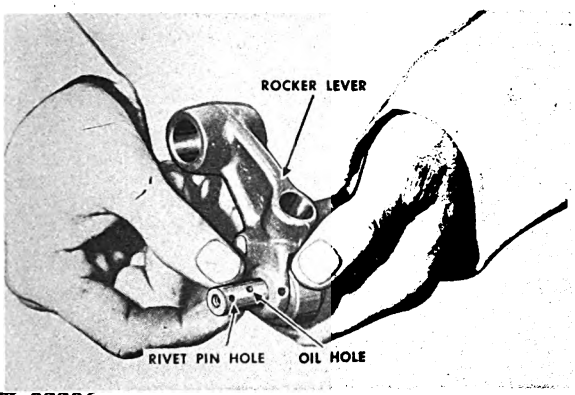


TL-32206
Figure 89. Assembling rocker lever roller pin.

a. Disassembly.

(1) Remove set screws holding shafts in housing (fig. 88).

(2) Drive out expansion plugs. Drive shaft from housing. Use punch to drive through expansion plug and remove plug.

(3) To remove rollers and roller pins, first tap out pin rivet, then tap pin from lever.

(4) If necessary, drive bushings from rockers with suitable drift. Install new bushings making sure oil holes in new bushings are lined up properly. Ream to 0.750".

b. Assembly.

(1) Assemble new pins to rollers in position (fig. 89).

(2) Tap pin through roller and lever, and rivet in place.

(3) Assemble levers and shaft in position, with the injector lever in the center of each assembly (fig. 90).

(4) Assemble shaft lockscrews.

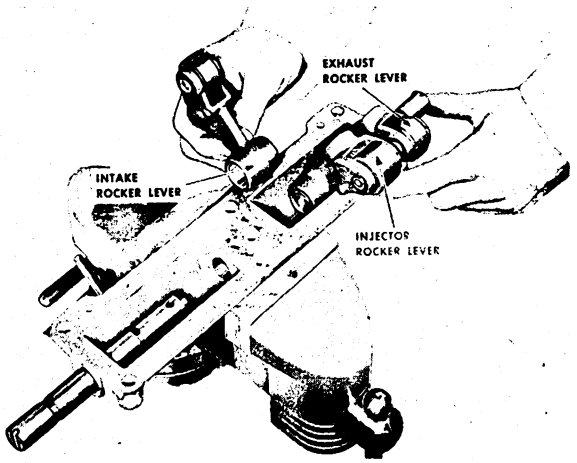
(5) Install new expansion plugs in each end of shaft housing, seating into bore of housing.

(6) Use new gasket and secure to side of cylinder block with lockwashers and capscrews.

(7) Install fuel pump and instrument panel. See paragraph on installing fuel pump on engine.

(8) Replace push rods and upper rocker arm assemblies.

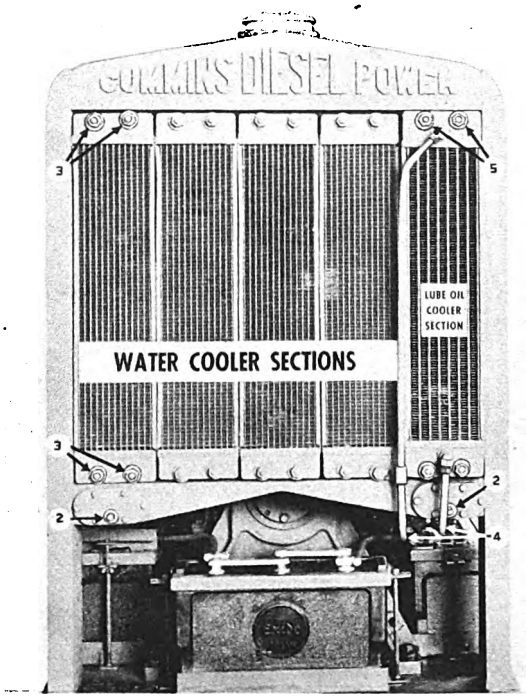
CAUTION: Install push rods in former positions as marked.



TL-32207
Figure 90. Assembling cam rocker lever housing.

76. RADIATOR. Sectional core radiators have four sections for jacket water cooling and one section for lube oil cooling (fig. 91).

a. Repairs. It is recommended that lube oil and water replacement sections be kept on hand and in a repaired condition for exchanging when leaks occur. Do not at any time, try to crimp shut a tube that is leaking. Operators should not endeavor to make repairs except in emergencies.



TL-32208
Figure 91. Radiator sections.

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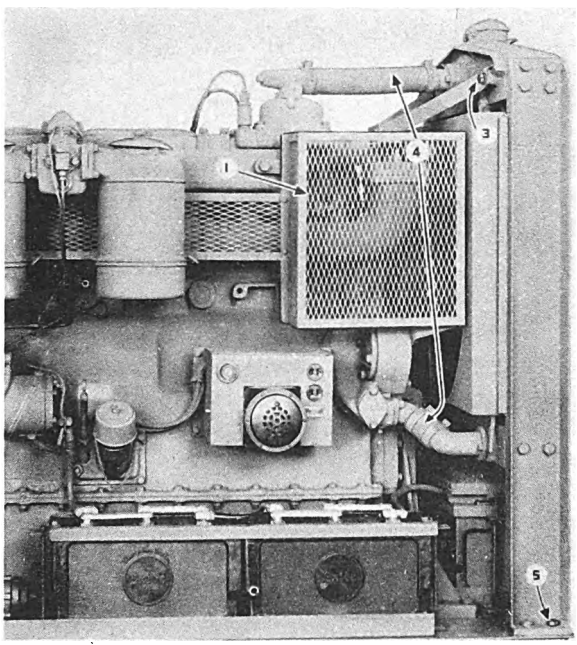
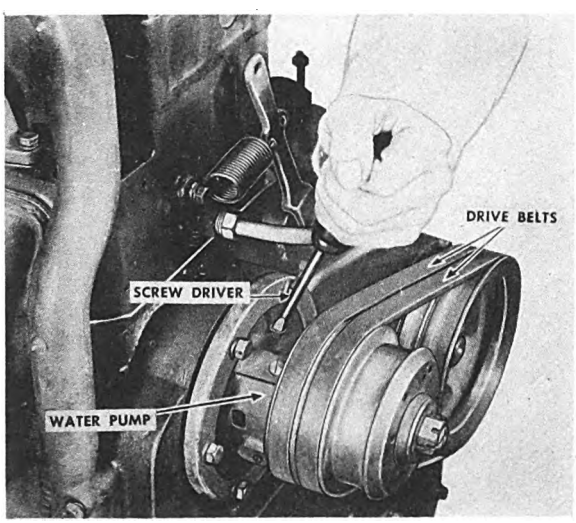
b. Replacement of Jacket Water Cooler Section (fig. 91).
(1) Drain the radiator by removing ¼" plugs (2) at the front bottom of radiator.
(2) Remove jacket water cooler section nuts (3).
(3) Remove jacket water cooler section from radiator assembly.
(4) Scrape off gasket surfaces and reinstall new section with new gaskets.



TL-32209
Figure 92. Radiator connection points.



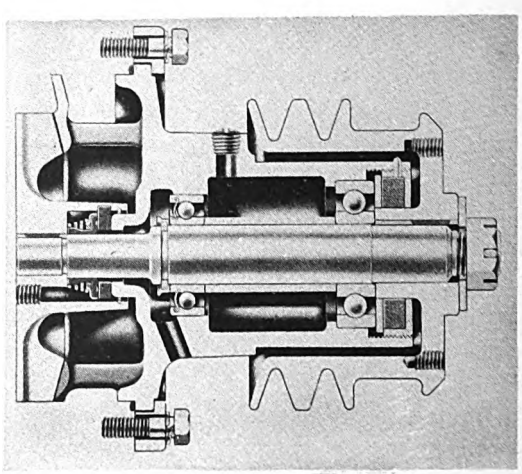
TL-32210
Figure 93. Tightening water pump drive belts.

(5) Tighten bolts, refill with water and check for leaks.

c. Replacement of Lube Oil Cooler Section (fig. 91).
(1) Drain water.
(2) Drain oil out of lube oil section.
(3) Disconnect and remove lube oil lines (4).
(4) Remove section nuts (5).
(5) Remove section from radiator assembly.
(6) Clean gasket surfaces, renew gaskets and install new section.
(7) Reverse procedure when assembling.
(8) Check oil level in crankcase after restarting engine. Check for leaks.

d. Removal of Radiator Assembly. It is necessary to remove radiator to make repairs on fan, water pump, timing gears, and camshaft assemblies.
(1) Drain water and lube oil from radiator.
(2) Disconnect and remove lube oil lines (4) to cooler section as shown in figure 91.
(3) Remove exhaust outlet guard (1) (fig. 92).
(4) Disconnect upper and lower hose connections (4), as shown in fig. 92, from radiator.
(5) Remove fan guard.
(6) Remove bolts (3), fig. 92, from upper radiator bracket.
(7) Remove lower radiator support bolts (5) as shown in figure 92.
(8) Remove radiator from support.

e. Installing Radiator Assembly. Clean off all gasket surfaces and install new gaskets. Replace all connection bolts, lube oil lines,



TL-32211
Figure 94. Cross section of water pump.

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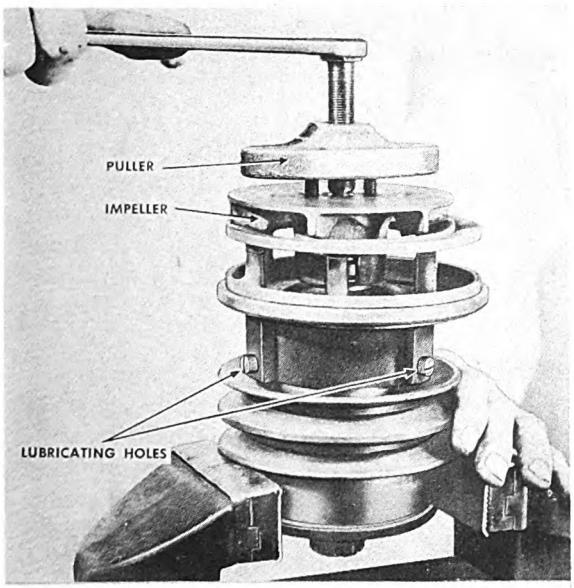
and fan guard. Crank over engine to check that fan does not hit on fan shroud.

NOTE: When replacing radiator on assembly, care must be taken that fan blades are not bent by radiator shroud and fan does not hit against core tubing of radiator sections.

77. WATER PUMP ASSEMBLY.

a. Type. The water pump is of the centrifugal type with the fan mounted on the drive pulley hub. The water pump has no packing. A seal with lapped faces is held in place by spring tension and prevents any leaks. The fan and pump shafts run on two large sealed ball bearings. If the pump leaks due to a scored or broken seal, handle the new seal assembly carefully when replacing to prevent any damage. After these parts are replaced, it is best that the engine be run idle for a short period to see whether or not the seal is seating properly. In most instances you will note that there will be a small water seepage until the seal seats itself. After five or ten minutes the water leak should stop. If the leak does not stop, it is evident that the seal is not assembled correctly and should be dismantled and checked against figure 94.

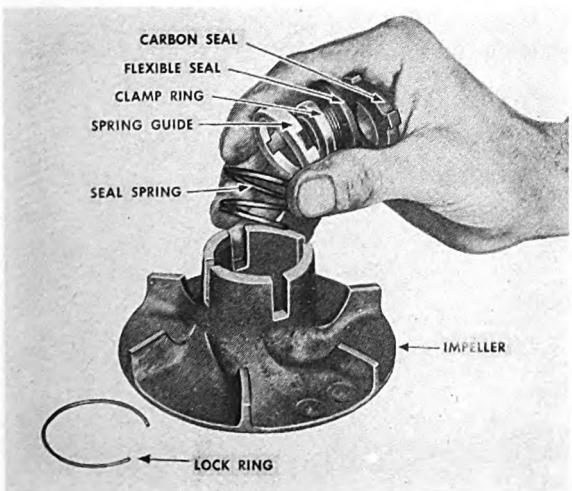


TL-32212
Figure 95. Pulling water pump impeller.

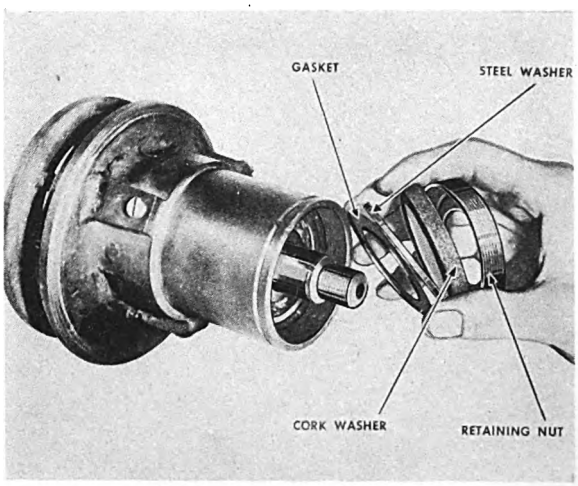
b. **Water Pump Drive Belts.** The unit is driven by two V-type belts. Belt adjustment is obtained by eccentric mounting of pump assembly. To tighten the belt, loosen the capscrews holding the clamp ring, figure 93. These clamp screws should be loosened only enough to permit the pump to turn on the eccentric, or the assembly will bind, causing the pump to break when it is retightened. The unit may be turned until the desired belt tension is obtained and the clamp ring tightened. These belts should be kept tight or fan belt slippage and heating may result.

NOTE: Due to rust conditions within block and water pump casting, pump may bind and refuse to turn. Tapping on pulley with rubber mallet will break loose rust and binding of pump. DO NOT FORCE PUMP.

c. **Water Pump Removal.** Should leakage occur in water pump seal, it will be necessary to remove pump for repairs.



TL-32213
Figure 96. Water pump shaft carbon seal.



TL-32214
Figure 97. Water pump bearing retainer.

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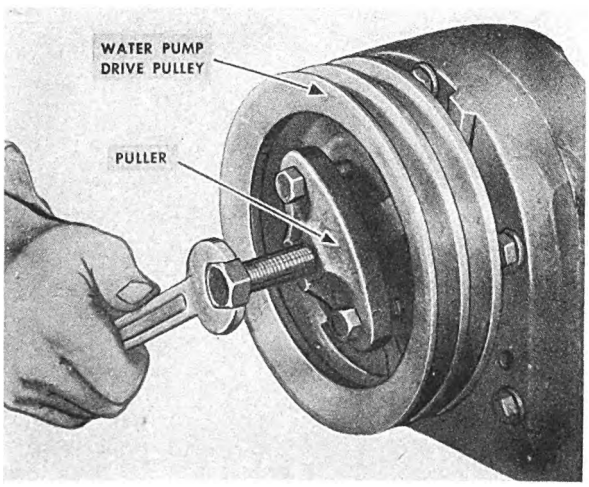
(1) Disconnect radiator connections and remove radiator from pedestal.
(2) Remove fan assembly.
(3) Remove all tension from drive belts, figure 93.
(4) Remove clamp bolts and remove water pump.

WARNING: DO NOT FORCE PUMP OUT OF CYLINDER BLOCK. WORK PUMP OUT BY TAPPING ON HUB PULLEY WITH SOFT MALLET AND WORK PUMP OUTWARD.

d. Disassembly.
(1) With suitable puller, pull impeller from shaft (fig. 95).
(2) To remove seal assembly, remove small seal retaining cup.
(3) Remove cotter pin, nut and washer and pull drive pulley with suitable puller.
(4) Remove lock ring from pump housing and screw out retainer.
(5) Press shaft and bearing assembly from bearing housing.

e. Assembly.
(1) Assemble bearings to shaft with lock ring and retainer.
(2) With gasket and washers inserted, screw retaining nut down flush with face of housing, lining up lock ring hole and inserting lock ring in place (fig. 97).
(3) Assemble Woodruff key to shaft. Press driving pulley on shaft and lock in place with nut and cotter pin.
(4) Assemble carbon seal assembly to impeller and secure in place with seal retainer cup (fig. 96).



TL-32215
Figure 98. Pulling water pump drive pulley.

NOTE: Inspect face of carbon seal and face of housing on which carbon seal rides for any nicks or scratches. If any scratches or marks are present it will be necessary to face the impeller to smooth flat surface for the carbon seal to ride against for proper operation. Check seal over shaft to see that it fits freely on shaft before assembling. This is very important to insure proper operation of seal.

(5) Press impeller in place until it is down against shoulder of shaft.

NOTE: Small plugs, shown in figure 95, are provided for lubrication of the bearings in the water pump. The use of a good ball bearing grease, periodically, is recommended.

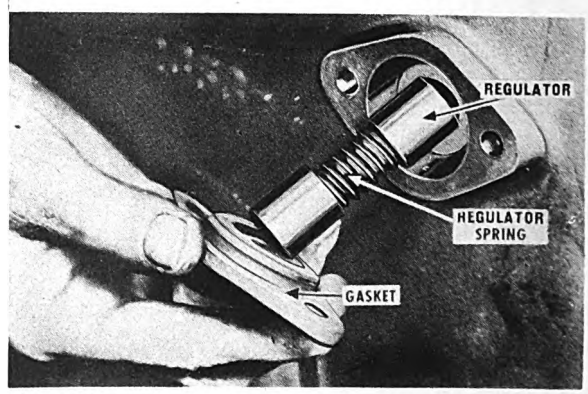
(6) With new ring gasket assemble water pump to the cylinder block with the clamp ring, six lockwashers and capscrews.

NOTE: Tighten capscrews just enough to hold pump in position. Turn pump to low side of eccentric and assemble drive belts to pulleys. Do not force belts over flange of pulley or damage will result.

(7) To tighten water pump drive belts, insert screwdriver and rotate pump body in a counterclockwise direction until belts have acquired proper tension (fig. 93). Then tighten six capscrews.

78. TIMING GEAR CASE. The timing gear case is dowelled and bolted to cylinder block and oil pan. A felt oil seal is provided in the front trunion to prevent seepage of oil along crankshaft. An oil pressure regulator valve thrust plate, is bolted to front of gear case and may be removed for inspection of the pressure regulator valves (fig. 99).

a. Removal of Gear Case Cover.
(1) Remove radiator as previously stated.
(2) Remove fan guards and fan assembly.
(3) Remove water pump drive belts.



TL-32216
Figure 99. Installing lubricating oil pressure regulator.

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(4) Remove water pump drive pulley with suitable puller as shown in figure 98.

NOTE: On engines where it is impossible to use a puller as shown in figure 98, two 7/16" SAE capscrews, 2" long, threaded full length can be used in the two puller holes of the pulley. In using capscrews for pulling the water pump drive pulley, it is very important that a piece of flat iron, ⅛" x 1" be inserted between the water pump drive pulley and gear housing to prevent damage to oil seal. Turn each capscrew alternately one-half turn at a time to insure that the pulley is being pulled from the shaft evenly.

(5) Remove four capscrews in the front of oil pan.

(6) Loosen all capscrews, bolts, and nuts in the lubricating oil pan and insert small wooden wedge at front of pan between cylinder block and oil pan to prevent damage to oil pan gasket when gear case cover is removed.

(7) Remove trunion bolts from front engine support.

(8) Raise front of engine by suitable means and remove front engine support.

(9) Remove all mounting capscrews on face of gear case cover.

(10) Remove the two capscrews from small plate on face of gear cover and remove plate, pressure regulator, and spring (fig. 99).

(11) With large screwdriver pry gear case from the dowel pins.

b. Service and Reassembly of Gear Case Cover.

(1) Inspect oil seals in gear cover and replace if defective.

(2) Assemble new gasket to gear cover.

(3) Assemble gear cover over dowel pins to cylinder block.

(4) Assemble all mounting capscrews and secure in place.

(5) Assemble oil pressure regulator (fig. 99).

(6) Assemble water pump drive pulley to shaft and lock in place with nut and lockwasher.

(7) Assemble water pump drive belts.

(8) Assemble front engine support and lower engine in place. Insert locating dowel pins and bolts and tighten same.

(9) Remove oil pan wedges and tighten oil pan bolts. Install and tighten 4 bolts at bottom of gear cover holding oil pan.

(10) Reassemble radiator as instructed in paragraph 76e.

79. CAMSHAFT. The camshaft is a hollow, one-piece, steel forging running in steel backed, babbit-lined bearings.

a. Camshaft Bushing Sizes. The camshaft bushing sizes are as follows:

(1) Bushing No. 1 is 2-¼" long by 2" bore.

(2) Bushing Nos. 2 and 6 are 1-⅞" long by 2" bore.

(3) Bushing Nos. 3 and 5 are 2-⅜" long and 2" bore.

(4) Bushing No. 7 is 2-11/16" long by 2" bore.

b. Removal of Camshaft and Camshaft Bushings. Camshaft bushing should never need replacing unless the entire engine is being given a thorough overhaul. At that time it is good practice to make a minute inspection and replace any worn bushings.

(1) For removal of camshaft bushings it will be necessary to remove a-c generator, coupling, flywheel, and bell housing from rear of engine. Likewise the radiator, front motor support and timing gear case must be removed from engine. It is also necessary to remove instrument panel, fuel pump, upper valve rockers, push rods, and lower cam rockers.

(2) After removal of the assemblies mentioned above, camshaft may be pried out to release it from the block by turning shaft and drawing forth (fig. 100). To remove camshaft bushing, insert camshaft bearing remover tool into rear end of block and enter tool into recess of bearing. Bearing is then driven out of block by using a ten pound maul on end of tool. Starting with the No. 7 bearing, remove bushing from tool after being driven out of block. Proceed to No. 6 bearing and continue operation as on No. 7.

(3) When installing new bearings be sure proper bearing is being put into proper hole of the block. Starting with bearing No. 1, insert camshaft tool through the block, line up new bearings on tools so that recess of bearing fits in dowel of tool. Insert tool through block and install bearing on tool into bearing hole. Before driving bearing into place take camshaft bearing aligner bracket and install through lower cam rocker hole on fuel pump side of block. This aligner tool is made to fit into camshaft bearing tool keyway which is cut into tool shaft. This bracket is used to

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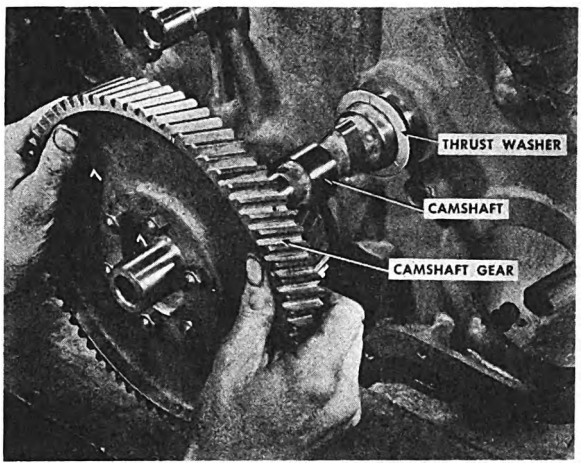
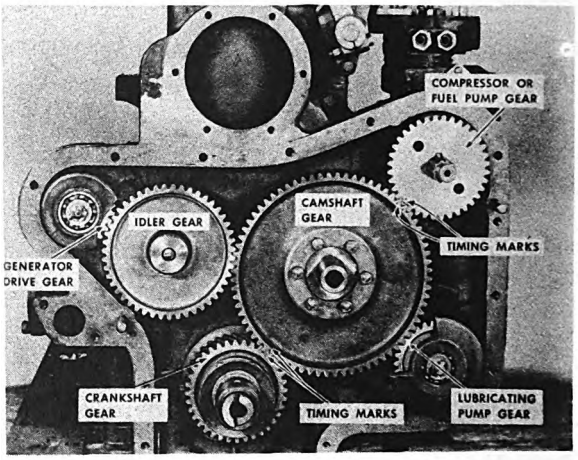


TL-32217
Figure 100. Installing camshaft.

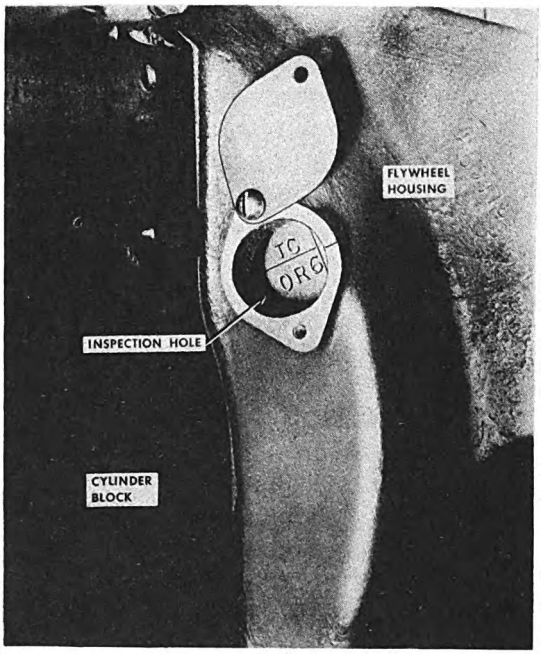


TL-32218
Figure 101. Engine gear train.

line up bearings in the block so that oil holes in the bearings will index with the oil holes leading to the component oil holes. After bracket is inserted in keyway of camshaft tool, it is then bolted on the outside of block in place of lower rocker assembly. The bearing is then driven into place until it comes flush on the opposite side. In case bearing is driven too far, use nut on shaft to drive back bearing. Clean out all oil holes in block and inspect with flashlight. These bushings should not require reaming after installation.

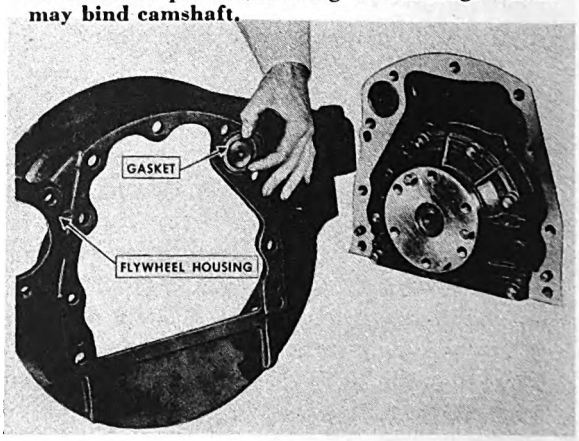
c. Timing Gears. All timing gears are of the helical type and are hardened steel. The camshaft gear is driven from the crankshaft gear. The fuel pump and lubricating pump are driven directly from the camshaft gear. Lubrication for this gear train is supplied by the bypassed oil from the lubricating pump.

d. Valve Timing. To set the valve timing, crank the engine over until the No. 1 top center mark on the flywheel comes up to the indicator hole on the fuel pump side of the flywheel housing (fig. 102). Without moving the crankshaft, slide the cam gear into mesh until the zero mark on the crank gear coincides with the zero mark on the camshaft gear (fig. 101).



TL-32219
Figure 102. Top center mark on flywheel.

CAUTION: When inserting camshaft care should be taken to prevent burring of bushings which may bind camshaft.



TL-32220
Figure 103. Gasket for camshaft bore.

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e. Camshaft Repairs. For removal of camshaft it is not necessary to dismantle engine as described in subparagraph **b.** It is only necessary to remove upper valve rockers, pushrods, radiator, front pedestal mounting and timing gear case. Place jack under front end of engine when removing front pedestal mounting. Lower cam rollers can be held off camshaft by inserting stiff wire down push rod galley and hooking under levers. Bend upper ends of wire over side of cylinder head. Remove camshaft as mentioned previously.
(1) A check should be made on all cam noses for wear on profiles. If badly worn replace with a new camshaft.
(2) Six hardened ream fit bolts connect camshaft flange to camshaft gear. The ends of bolts are peened over. Use small chisel and remove peened ends of bolts. Remove nuts and drive out bolts.
(3) Camshaft gear is timed to camshaft flange and has index marks on camshaft flange and gear as shown in figure 100.
(4) Upon renewal of camshaft to gear every precaution should be taken that gear is properly timed to camshaft flange and when installing bolts, that no chips fall between camshaft flange and gear.
(5) Tap the head end of bolts while tightening nuts. Peen over protruding ends of bolts.
(6) Clean out all passages with compressed air and reinstall in block and retime gears.

NOTE: Always install new special type ream fit bolts and nuts supplied by engine manufacturer when replacing gear or new camshaft.

80. FLYWHEEL HOUSING AND FLYWHEEL.

a. Removal.

(1) The flywheel may be removed by removing engine support bolts and the locating dowel pins. If shims are found under engine legs, they must be replaced under respective legs. These shims are provided for alignment of engine to generator.
(2) Remove generator fan guard.
(3) Remove flexible coupling bolts as shown in figure 26.
(4) Lift engine by suitable means and move engine forward on engine base.
(5) Remove lockwire from flywheel bolts.
(6) Remove flywheel bolts.
(7) In holes provided, use ½"—USS capscrews 2½" long, threaded entire length, to pull flywheel from crankshaft. Removal of flywheel can be aided by inserting two of the exhaust manifold studs in flywheel bolt holes.
(8) Draw flywheel from crankshaft flange by turning each capscrew alternately one-half turn at a time to insure that the flywheel is pulled off the dowel pins evenly. Flywheel may be drawn off inserted studs after being extracted from dowel pins.
(9) Remove mounting capscrews from flywheel housing and with block of wood tap flywheel housing from dowel pins.

b. Assembly of Flywheel Housing and Flywheel.

(1) Shellac new gasket to flywheel housing. This gasket, seals the end of the camshaft and must always be renewed (fig. 103).
(2) Assemble flywheel housing to cylinder block over dowel pins.

NOTE: When installing new housing or cylinder block it will be necessary to remove dowel pins from cylinder block. Mount flywheel housing to cylinder block with mounting capscrews. It will be necessary to use a dial indicator to assemble housing concentric with crankshaft within SAE limits. To do this, it may be necessary to shift housing slightly one way or another. It will be necessary to ream dowel pin holes to an oversize to secure true fit on dowel pins. Secure dowel pins of proper size to fit reamed holes.

NOTE: Flywheel can only be mounted on crankshaft in a position determined by offset dowels inserted in crankshaft flange.

(3) Assemble six lockwashers and capscrews to flywheel and secure in place.
(4) Assemble lockwires to capscrews.
(5) Reinstall engine on base. Be sure to replace any shims formerly removed and insert engine leg bolts and dowels. Connect flexible coupling to engine.
(6) Tighten all bolts and turn over engine by hand to check that no parts are binding.

81. LABYRINTH OIL SEAL. A labyrinth type oil seal is installed between the rear crankshaft bearing and the flywheel to prevent leakage of oil into the flywheel housing (fig. 104). Frequent inspection should be made to determine if any such leakage exists. Should such be the case, the seal will have to be replaced. The procedure for removal and replacement is as follows:

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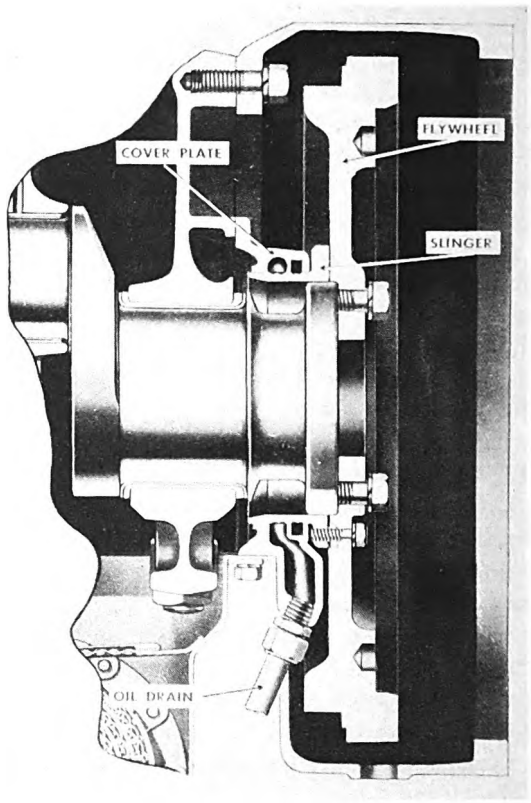
a. Removal.
(1) Remove the flywheel as described in paragraph 80.
(2) Disconnect the oil drain line.
(3) Remove the four capscrews and lock washers from rear flange of oil pan.
(4) Remove the eight capscrews and washers from the cover plate.
(5) Using a screwdriver pry the cover plate off the dowels and remove the gasket.

b. Installation of Oil Seal.
(1) Replace the cover plate gasket.
(2) Assemble the cover plate over the dowel pins.
(3) Install and tighten the eight capscrews in the cover plate.
(4) Install and tighten the four lockwashers and capscrews on the rear flange of the oil pan.
(5) Reconnect the oil drain line.
(6) Loosen slightly the six capscrews which hold the slinger to the flywheel.
(7) Assemble the flywheel and slinger to the crankshaft, using a new gasket.

CAUTION: Do not bump the slinger on the cover plate. The use of two manifold clamp studs as guides (paragraph 80), will prevent this.

(8) Tighten the flywheel securely.
(9) Tighten the six capscrews which hold the slinger to the flywheel.
(10) Make sure that the slinger does not touch the cover plate when the engine is rotated.



TL-32221
Figure 104. Labyrinth type oil seal.

82 FUEL PUMP REPAIRS, (GENERAL).

a. Inspection Recommendation. The repair crew should try to determine cause of faulty pump operation before removing pump for repairs. Causes of failure of pump to deliver fuel may be often remedied by replacement of individual assembly units as gear pump assembly, distributor assembly, or float chamber assembly, governor, etc. To locate trouble in fuel pump refer to suggestions listed below:

b. Fuel Pump Airbound. Caused by air leak in suction fuel line, (suction line of priming pump included).
(1) Examine lines closely for loose fittings, cracked flaring or frayed tubing.
(2) Fittings and tubing may be checked for leaks by shutting off one end with finger and creating suction on other end.
(3) Create suction by sucking on fitting and holding tongue over hole and see if vacuum is good.
(4) Any leaks will immediately show up by this method.

c. Drop in Fuel Pump Pressure. Caused by:
(1) Filter in fuel line stopped up.
(2) Float chamber runs low on fuel due to obstructed passageway or jammed float needle. See repairs on float chamber.
(3) Float chamber gasket broken, creating poor suction for No. 2 gear pump. Remove float chamber and check.
(4) Wear in gear pump.
(5) Scored distributor disks or worn thrust bushing in distributor assembly.
(a) A check may be made to see if items (4) and (5) hold pressure.
(b) With engine shut down, close shut-off valve between gear pump and overspeed assemblies. This stops fuel flow to disks. Try to build up pressure, by working hand priming pump.

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(c) Pressure should easily build up at least 100 lbs. on gauge with slow strokes of priming pump.

(d) If pressure does not build up satisfactorily, renew gear pump assembly.

(e) If pressure build up is good in gear pump, proceed with pressure test in distributor head assembly by opening shut-off valve.

(f) Pressure should still hold steady with valve placed in the open position.

(g) If pressure drops rapidly, fault now lies in either distributor disks or distributor thrust bushing. See instructions on removal.

d. Water in Fuel. In the event water has entered the fuel oil system, it may cause considerable damage to working parts of fuel pump, namely:

(1) Scored distributor disks.
(2) Stuck injectors.
(3) Seized gear pumps, causing sheared drive pin or pump shaft.
(4) Scored thrust bushing in distributor head assembly.
(5) Enlarged injector cup holes.
(6) A corroding condition throughout the fuel pump.

e. Purging Fuel System of Water. To purge system of water the following steps must be taken:

(1) Drain fuel tank.
(2) Drain fuel filter, primary and secondary.
(3) Drain float chamber (⅛" pipe plug at bottom).
(4) Remove pressure dome on gear pump (fig. 14).

(a) Remove pressure regulator valve (fig. 14 and fig. 105).

(b) Remove pressure regulator valve spring (fig. 14).

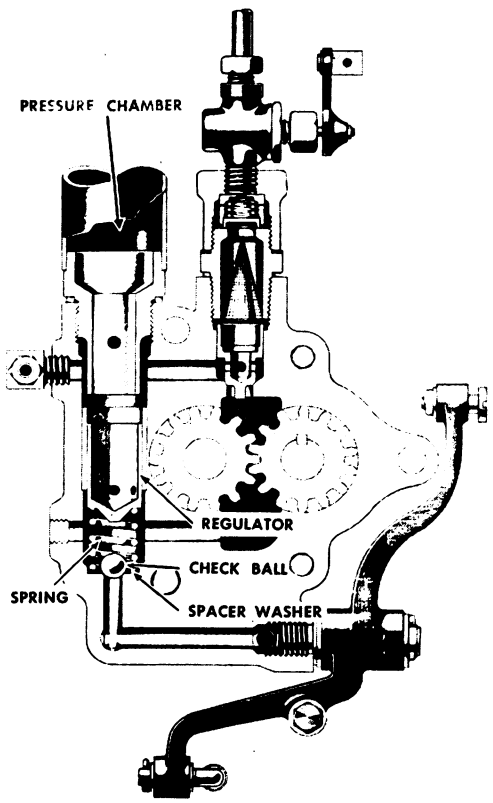
(c) With thin brass rod move check ball (fig. 14 and fig. 105), off seat. This will allow liquid to flow back to float chamber and out through drain plug hole.

(d) Reassemble parts; replace plugs.

(5) Repair or replace all damaged parts.
(6) Reprime engine. Expell all water from fuel lines between pump and injector connections. See priming of engine, paragraph 28.
(7) Fuel oil filter should be drained every half hour following purging of system, until water conditions have cleared. Any particles of water not removed from system will be trapped at these points. Refill both filters before starting engine.

83. CLEANING GEAR PRESSURE PUMP SCREEN.

a. Cleaning. The small conical screen (fig. 105), in the fuel pump should be cleaned every 250 hours. It should also be cleaned in any instances where the engine refuses to start or gives indications of not developing full power. Cleaning of this screen is performed as follows:



TL-32222
Figure 105. No. 2 pressure pump and regulator.

(1) Unscrew pressure chamber dome from pressure pump assembly, taking care not to lose copper asbestos gasket on which it seats.
(2) Remove fuel supply tube from gear pump to secondary filter.
(3) Unscrew the small hexagonal housing by applying the wrench to the lower of the two hex areas of the housing. Be careful not to mislay the copper gasket for this connection.

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(4) Place the upper end of the housing in a vise and unscrew the other half of the housing. The conical screen is located in this part.
(5) Wash screen carefully with cleaning solvent and blow out with compressed air in opposite direction of fuel flow.

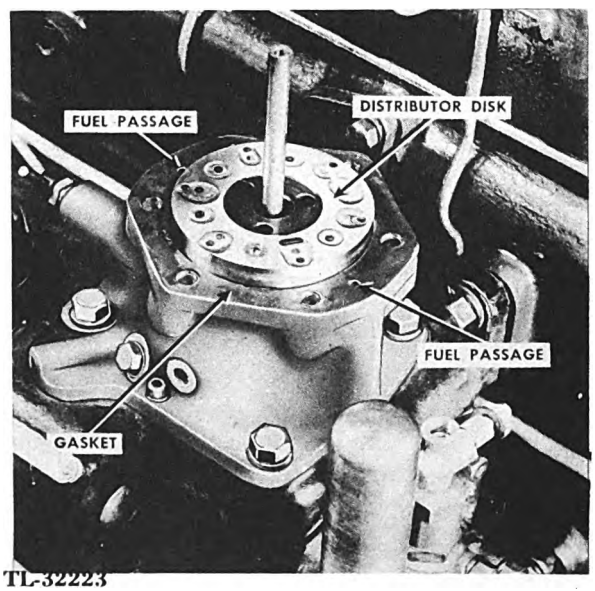
NOTE: Do not remove the small valves in the upper part of the housing. If they should accidently be removed, they should be replaced as follows:

b. Replacing the Small Valves.
(1) Clamp upper valve half of housing in vise with cup upward.
(2) Drop small valve cage into housing with cup end up.
(3) Drop small spring into cup.
(4) Insert valve with flat face next to spring. This should collapse into cup when pushed down.
(5) Reassemble two parts of housing and then proceed with reassembly to pump.
(6) Prime pump before attempting to start engine.

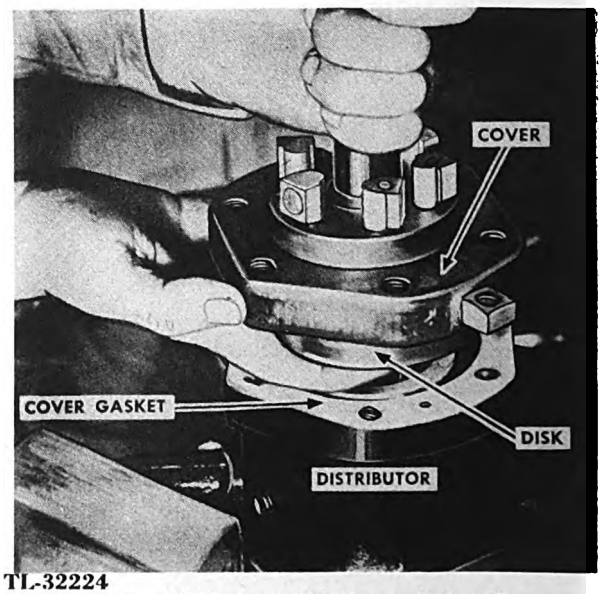
84. FUEL PUMP DISTRIBUTOR ASSEMBLY REPAIRS.

a. Fuel Pump Distributor Disks. If fuel with water or dirt in it is used, the fuel distributor cover and disks become scored and unfit for further service. Scored disks cause engine smoking and loss of power. Disks and cover should be exchanged for a new pair if scored, as the lapped surfaces cannot be repaired with conventional machining. Disks and covers are mated and must always be replaced in pairs.
(1) Thoroughly wash outside of pump with cleaning solvent and brush.
(2) Disconnect and remove tachometer shaft cable if used.
(3) Disconnect fuel supply tube and fuel lines leading to cylinders at both distributor and cylinder connections and remove them to provide room for taking out disks.
(4) Loosen the six capscrews holding distributor cover to distributor, one-half turn at a time, until they can be removed. This procedure is necessary to prevent distortion of distributor disk bearing in the distributor housing.
(5) Lift disk cover up far enough to slide hand under distributor disk, and remove disk and cover together as shown in figure 107. Fuel between these parts causes them to stick together.
(6) Examine disk and cover carefully, and replace if they show scratches or score marks as shown by figure 108.

NOTE: Disk and cover must be kept free of dust or dirt. Never place the lapped faces of these parts on any surface except clean paper or cardboard.



TL-32223
Figure 106. Lubricating distributor disk.



TL-32224
Figure 107. Lifting out distributor disk and cover.

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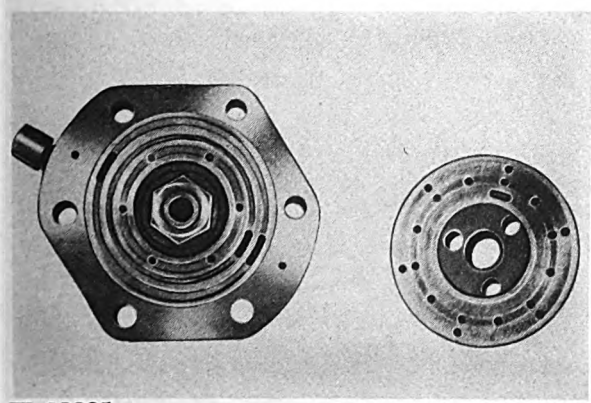
(7) Wash disk and cover thoroughly in cleaning solvent and blow out all fuel passages with clean compressed air.
(8) Place rotating disk in position over the three driving pins. Disk will fit on pins only if installed in correct position.
(9) Fill fuel passages on top of distributor disk with clean lubricating oil (fig. 106) and install gasket and cover. Be sure cover gasket is installed correctly for all fuel passages.
(10) Press cover down and start capscrews (fig. 109). These must be turned down one-half turn in rotation until tight to prevent distortion of distributor disk bushing in housing. Tighten screws securely.

b. Disassembly of Distributor Housing.

(1) To remove distributor housing from main fuel pump housing, it is necessary to remove overspeed stop assembly, see service and repair of overspeed stop assembly.
(2) Remove fuel pump cover and disk.
(3) Lift distributor disk spring from housing.
(4) Remove capscrews that hold distributor housing to main fuel pump housing.
(5) Lift distributor housing, with shaft and gear, from fuel pump housing.
(6) Metering plunger barrel can be removed from distributor housing by unscrewing retaining nut.
(7) Pull gear from distributor shaft (fig. 111) being careful not to apply too much pressure to outer edge of gear, or warped gear will result. Remove Woodruff key from shaft.
(8) Tap lower end of distributor shaft on block of wood, and remove shaft and collar from housing.



TL-32225
Figure 108. Worn distributor disk and cover.

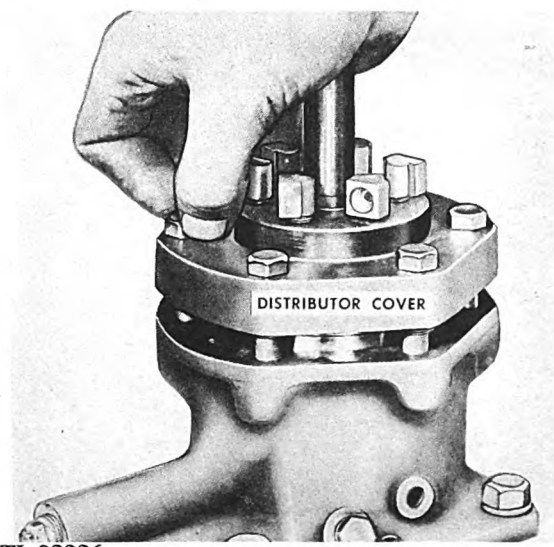
(9) Remove double ball bearing from lower end of housing.

NOTE: Thrust bearing should not be removed unless known to be defective.

(10) Remove priming valve from side of housing and check the point to see that it has not been broken by overtightening.
(11) If priming valve has been broken, make sure all particles have been removed from housing before installing new valve. If valve seat has been damaged, distributor housing must be replaced.
(12) Remove distributor check valve screw, spring, and ball.

c. Assembly of Distributor Housing.

(1) Inspect distributor drive collar and shaft. If there are signs of excessive wear, replace with new parts.
(2) If collar and shaft are worn excessively in the thrust bushing, fuel will leak by the shaft. This causes low fuel pressure, or causes fuel to fill the main housing and run out overflow.
(3) Inspect distributor thrust bushing. If bushing shows excessive wear, replace.
(4) To remove thrust bushing, press from housing from bottom side.
(5) Wash fuel passages and housing thoroughly.
(6) Assemble new bushing to housing. A piece of leather should be used between the tool and bearing to prevent damage to bushing face.



TL-32226
Figure 109. Installing distributor cover and disk.

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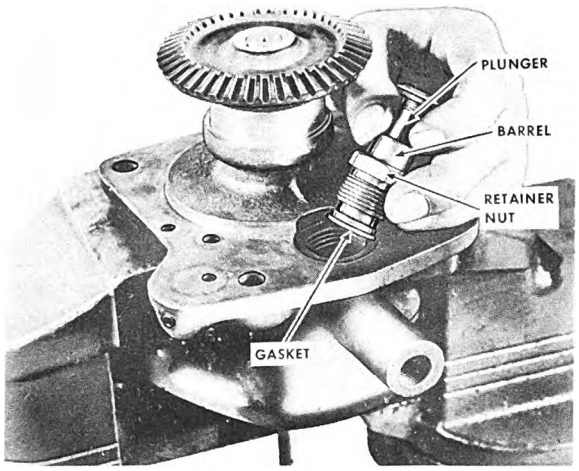
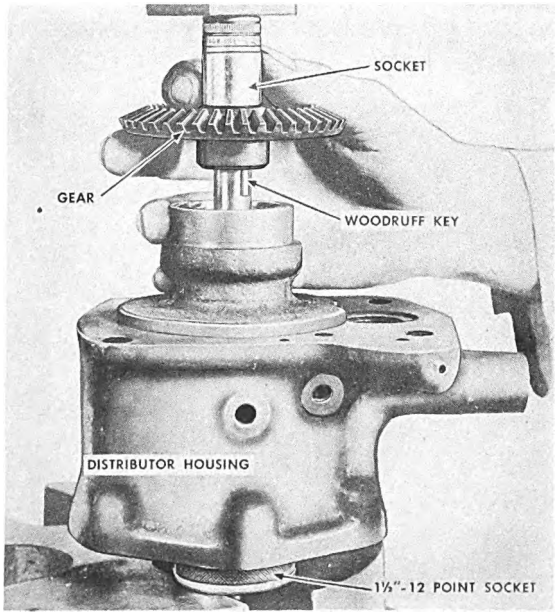


TL-32227
Figure 110. Assembling metering pump.

(7) Ream thrust bushing shaft hole with special line reamer, size 0.812" (fig. 115).
(8) Reface thrust bushing with special cutter. A little oil on the face of the thrust bushing when using the cutter will help prevent chattering.
(9) Inspect ball bearing on lower end of shaft for wear. Replace if worn.
(10) Assemble distributor drive shaft and collar assembly to housing and press gear in place (fig. 112).

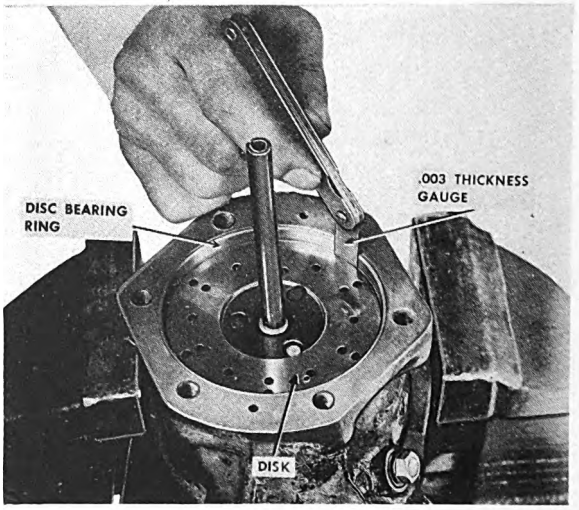


TL-32229
Figure 112. Pressing on distributor drive gear.

TL-32228
Figure 111. Pulling distributor drive gear.

NOTE: A 1½" 12 point socket will fit over drive pins in collar for pressing gear in place.

(11) Inspect the metering plunger and barrel for wear. If the plunger or barrel is scratched or worn, it will be necessary to replace. Be sure to use a new copper gasket on the end of the barrel when replacing (fig. 110).
(12) With a gasket, assemble distributor housing to main fuel pump housing and install capscrews. Back lash of gears should be 0.002". Proper clearance can be obtained by inserting gasket of the proper thickness. Gears shown in figure 116.



TL-32230
Figure 113. Checking distributor disk bearing.

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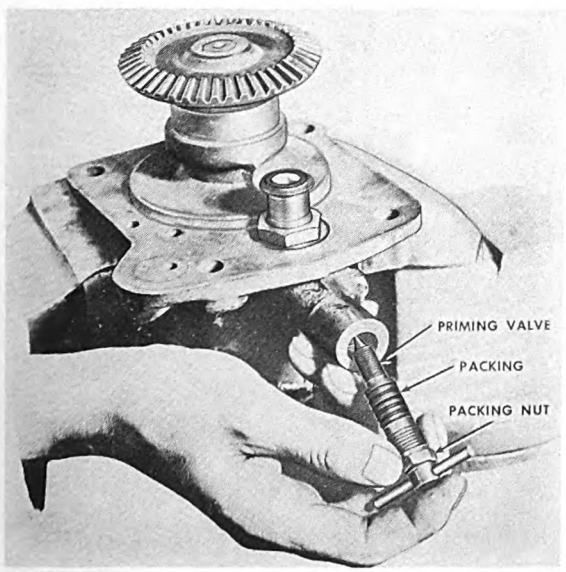
(13) Before assembling the new distributor top and disk, wash all fuel passages with cleaning solvent and blow out with clean compressed air.
(14) Lubricate both the distributor top and disk faces with clean lubricating oil. Set timing mark on distributor drive collar in line with inspection hole in housing (fig. 117).
(15) Place disk thrust spring on collar and locate rotary disk in position on driving pins. This cannot be put on wrong due to one driving pin being offset. The distributor top should only be put on one way to permit the fuel lines to be connected properly. A new gasket of proper design and thickness must be used each time between the distributor top and housing.
(16) Be sure when placing this gasket on housing that the oil passages are properly indexed.
(17) It will be necessary to compress the distributor spring by pushing on the distributor cover (fig. 109) to start the capscrews which hold the distributor top in place.
(18) Start all capscrews by hand and work each one alternately, one-half turn at a time, until the cover is down against the gasket and distributor housing. If the distributor cover is not tightened down evenly, it will likely catch the distributor disk bearing ring (fig. 113) pushing it down on one side. Should this happen, the seal will break between the distributor top and disk when the engine is started and the flow of fuel to the metering pump will be disrupted.
(19) If the distributor disk bearing ring is distorted it will be necessary to replace. Press a new bearing ring into the housing.
(20) To determine clearance between disk and bearing ring, it will be necessary to place the distributor disk on the distributor disk drive pins without the thrust spring. If the distributor disk does not rotate freely in the bushing, it will be necessary to use a bearing scraper to relieve the bearing. A smooth bearing must be maintained and held to 0.003" clearance between the disk and bearing (fig. 113).
(21) The priming valve on the front side of the distributor housing is for the purpose of priming the engine and forms a passage for the fuel around the distributor top and disk to the injector. This is a needle valve and requires only light pressure on the handle to close (fig. 114).

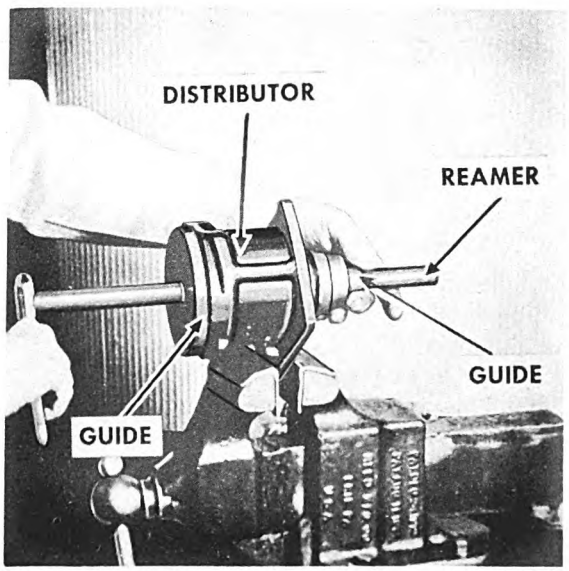
CAUTION: NEVER TIGHTEN THIS PRIMING VALVE WITH A WRENCH.

d. Timing Fuel Pump Distributor Head Assembly.

(1) Crank engine until Nos. 1 and 6 TC mark on fan drive pulley indexes to center



TL-32231
Figure 114. Assembling priming valve.



TL-32232
Figure 115. Reaming thrust bushing.

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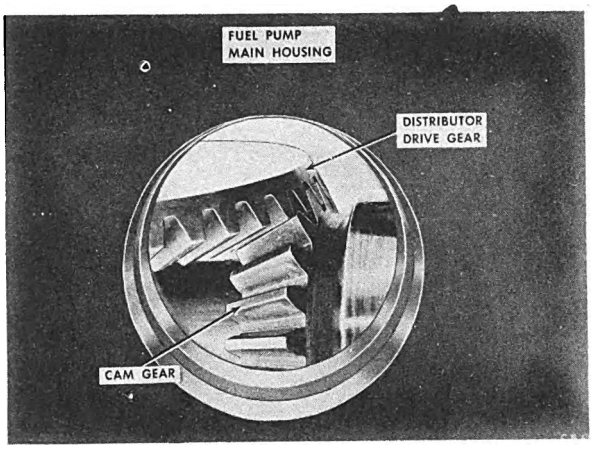
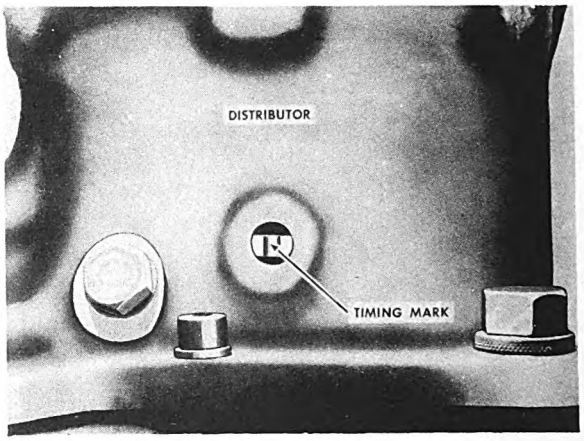


TL-32233
Figure 116. Distributor drive and cam gear.



TL-32234
Figure 117. Distributor collar timing mark.

line mark on gear case (fig. 57). No. 1 cylinder is on firing stroke, both valves being closed.

(2) Set timing mark in distributor housing as shown in figure 117.

(3) Assemble distributor assembly to main pump housing using proper gasket.

CAUTION: Observe that metering plunger spring and link are in proper position.

85. SERVICE AND REPAIR OF OVERSPEED STOP ASSEMBLY.

a. Disassembly.

(1) Remove 7 cover capscrews and remove cover assembly.

(2) With screwdriver remove four assembly mounting capscrews (fillister head), inside of housing.

(3) With screwdriver pry out assembly from main fuel pump housing.

(4) To identify parts see figure 118.

(5) Remove body plug and gasket.

(6) Lift valve spring, and valve from body.

(7) Remove nut and lockplate from end of drive shaft, and pull gear.

(8) Remove Woodruff key from shaft.

(9) Pull shaft from body.

(10) Uncotter weight spring collet and screw collet from weight shaft.

(11) Remove weight and spring.

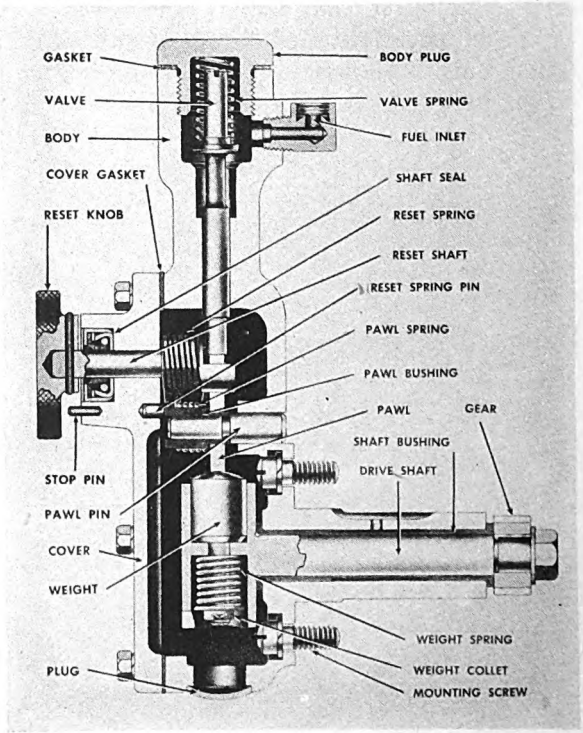
b. Assembly.

(1) Insert weight in shaft; assemble spring and spacers, if used, and install spring collet and cotter key.

NOTE: Turn collet down flush with end of weight shaft before installing cotter pin. It will be necessary to use correct weight and spring combinations for speeds at which the overspeed stop should be operated.

(2) Examine drive shaft bushings in body. If they show signs of wear, replace them and ream with 9/16″ reamer.

(3) Install drive shaft in body and check to see that it has 0.002″ running clearance.



TL-32235
Figure 118. Cross-section of overspeed stop.

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(4) Install Woodruff key in shaft and install drive gear. Lock gear in lockplate and nut.

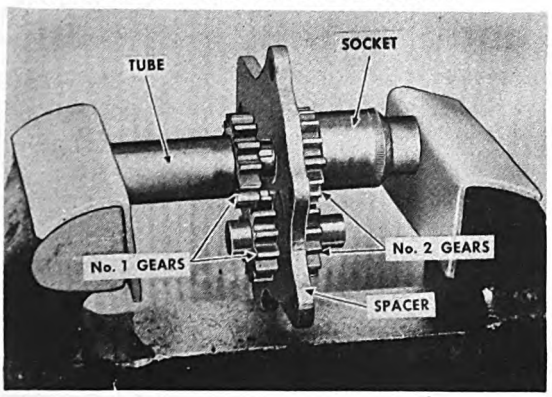
NOTE: Shaft must have 0.004" end play.

(5) Inspect valve and valve seat. If either shows signs of wear or pitting they should be seated to a true seat before installing.
(6) Insert valve spring and install and tighten body plug.
(7) Assemble unit to fuel pump housing and tighten down evenly with four fillister head screws.
(8) Check to be sure there is at least 0.002"-0.003" backlash between drive gear and overspeed stop gear.

WARNING: WHEN CHECKING BACKLASH, HOLD THE SHAFT TIGHT AGAINST THE OVERSPEED STOP BODY. IF THIS IS NOT DONE, THE MOTION FELT MAY BE END PLAY AND NOT BACKLASH.

(9) Before installing the pawl, make sure the nose which holds the valve in running position is not worn or rounded. Should this condition exist, trouble would result.
(10) Assemble pawl to shaft, and install spring.
(11) Assemble cover to body and turn reset knob in clockwise rotation to set valve in running position.
(12) Reconnect fuel lines to fittings.
(13) Start engine.

CAUTION: IT IS VERY IMPORTANT THAT THE CORRECT WEIGHT AND SPRING COMBINATION IS USED FOR OVERSPEED TO OPERATE AT THE SPEED DESIRED.

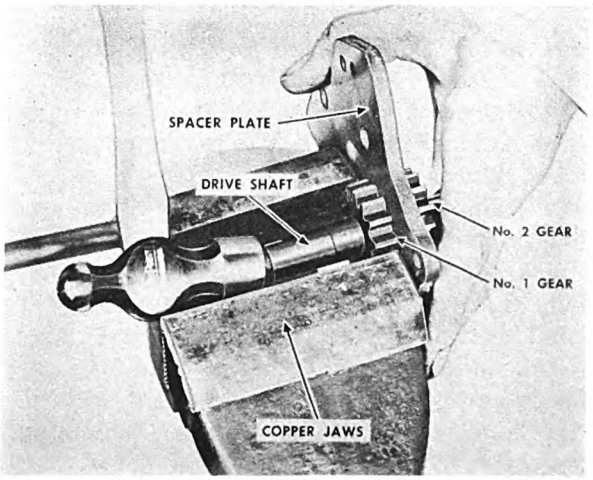


TL-32236
Figure 119. Spacer plate in gear assembly.

86. SERVICE AND REPAIRS OF GEAR PUMP ASSEMBLY.

a. Removal of Gear Pumps.
(1) Remove four capscrews holding gear pump bodies to main fuel pump housing. DO NOT REMOVE NUTS FROM THREE BOLTS ON THIS SAME FACE, AS THESE HOLD THE TWO GEAR PUMP BODIES TOGETHER.
(2) Remove cam rocker lever spring retainer, and spring, from side of fuel pump housing (large hex. nut).
(3) Carefully pry the gear pump assembly from the main fuel pump housing.

b. Disassembly of Gear Pumps. Do not disturb the gear pumps unless pump pressure is below 50 pounds pressure on gauge at idling speed. If necessary, disassemble as follows:
(1) Remove nuts from three bolts holding the two pump bodies together. Tap bolts from bodies with brass drift. The No. 2 body should slip off, leaving gears on shafts with spacer plate.
(2) Remove fillister head screw from front of No. 1 body and slip body from shaft, leaving gears on shaft with spacer plate.
(3) Drive idler shaft from gears, being very careful not to lose oil seal and washer between spacer plate and No. 2 pump gear.
(4) Place No. 1 pump drive gear in a vise fitting with copper jaws, gripping gear by the teeth, and tightening vise only enough to hold (fig. 120).



TL-32237
Figure 120. Removing No. 1 pump gear from shaft.

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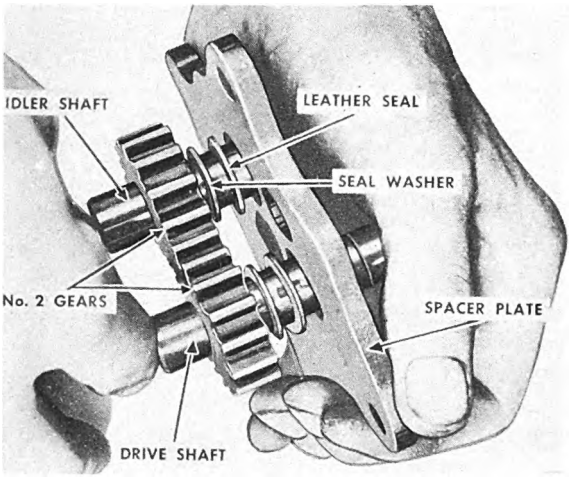
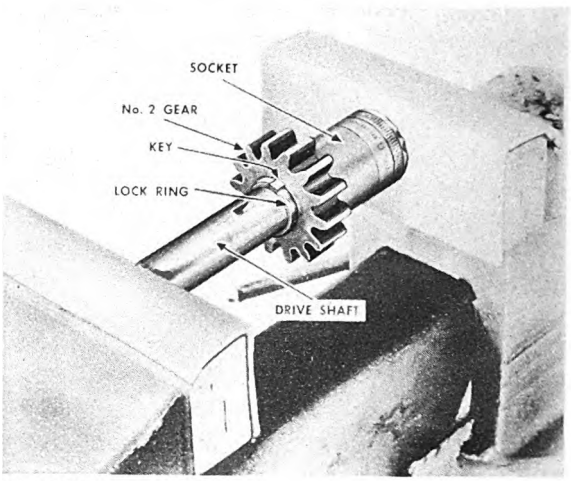


TL-32238
Figure 121. Assembling gear seals.



TL-32239
Figure 122. Assembling No. 2 pump gear to shaft.

(5) Tap lightly on slotted end of shaft to drive out of gear. Pull Woodruff key from shaft.

CAUTION: ANY OTHER METHOD OF REMOVING THIS GEAR WILL CAUSE SMALL WOODRUFF KEY TO BE DRIVEN THROUGH SPACER PLATE, MAKING SPACER PLATE UNFIT FOR FURTHER USE.

(6) Slide gear and shaft out of spacer plate being careful not to damage oil seal and washer between gear and spacer plate (fig. 121).
(7) Press gear away from lock ring to remove from pump shaft. Remove Woodruff key and lock ring from shaft (fig. 122).
(8) Unscrew pressure chamber and remove chamber and gasket.
(9) Remove pressure regulator valve and take out spring and check ball.
(10) Remove fuel supply check valve housing by screwing out check valve seat.
(11) Place the upper end of the fuel supply check valve housing in a vise and unscrew the check valve seat.
(12) Remove housing from vise and take out check valve, spring and guide.

c. Assembly of Gear Pumps. The instructions that follow are for rebuilding the gear pump assembly with new parts. Old parts should be used only if they can be fitted as closely and installed as carefully as described.
(1) Caution must be used when assembling new gears to the spacer plate and shaft, that the shaft seals are assembled properly. These seals are assembled on the No. 2 side of the spacer with the leather seal against the spacer plate and the seal washers against the No. 2 pump gears (fig. 121).
(2) Inspect the drive shaft oil retainer in the No. 1 body to see that it is in good condition. When assembling the No. 1 body on the shaft, precaution must be taken to see that this retainer is not damaged.
(3) Assemble No. 2 pump gear, Woodruff key and snap wire as shown in figure 122. Press gear over snap wire into recess on gear.
(4) Assemble gears to spacer plate (fig. 119).
(5) When assembling the No. 1 body, use only 0.0015" body gasket. Brush a thin coat of shellac on the spacer plate gasket surface only. Assemble gasket in proper position to spacer. Brush thin coat of shellac on gasket, always being careful not to get shellac in gear pockets and fuel passages.
(6) With the No. 1 body on the shaft against the gasket and spacer plate, insert the fillister head screw. Tighten loosely.
(7) Shellac gasket to the No. 2 side of the spacer as previously instructed, lubricate gears and place body over gears in position.
(8) Insert the ream fitted bolts through both pump bodies and attach 3/8" nuts to the protruding ends. Draw these nuts up to pull the pump bodies together, at the same time turning the drive shaft to see that the pump gears continue to turn freely. If necessary, tap edges of bodies to free gears (fig. 123). Ream the two dowel holes with a standard 3/8" reamer, insert the two threaded dowel bolts

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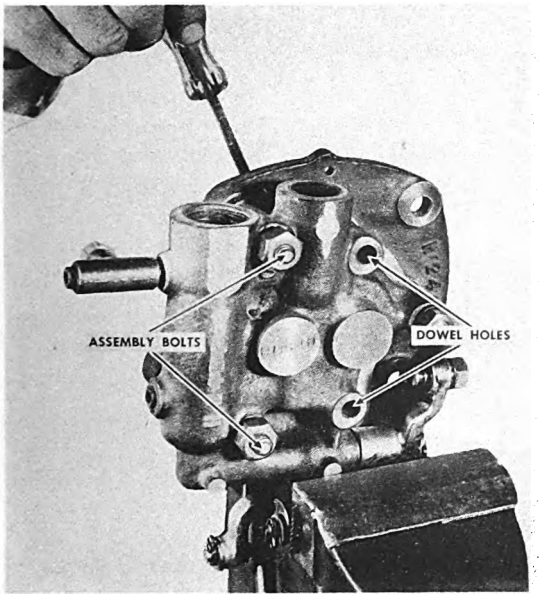

TL-32240
Figure 123. Assembling gear pump bodies and gears.

and attach nuts. Remove the nuts and mounting bolts and install the pump bodies on the main fuel pump housing.

(9) Let shellac dry between gear pump bodies before testing.

(10) Place pressure regulator spring in housing. If a new spring is used, make sure all burrs are removed from both ends of spring to avoid binding or cocking of regulator valve (fig. 105).

(11) Drop check ball into housing.

(12) Slide pressure regulator valve into place with point down toward ball check.

(13) Check to be sure regulator valve is free.

NOTE: If pressure regulator valve sticks open it will cause drop in fuel pressure. If regulator valve sticks closed it will cause excessive fuel pressure.

(14) Screw pressure chamber into housing making sure that gasket is in good condition.

(15) Install gasket or gear pump housing and install gear pressure pump to main housing.

NOTE: Drive slot of gear pump drive shaft must line up with main drive shaft drive pin. DO NOT HAMMER GEAR PUMP INTO MAIN HOUSING.

(16) Check that cam rocker assembly is free in main housing, after tightening gear pressure pump on main housing. Install an additional gasket if cam rocker is not found to be free (fig. 146).

87. GOVERNOR ASSEMBLY REPAIRS AND SERVICE.

a. Governor Service. Governor faults usually show up in speed variations of the engine, but this does not mean that all such speed variations indicate governor faults. When improper speed variations appear, the following procedure should be carried out:

(1) Check the load to be sure that the speed changes observed are not the result of load fluctuations.

(2) If the load is uniform, carefully check the engine to be sure that all cylinders are firing properly.

(3) See that the governor is installed so that no bind exists in any of the governor control mechanisms of the operating linkage between governor and engine; also, that no bind exists in the fuel mechanism in the pump. If neither load nor engine irregularities are found to be the cause of the speed variation, it may be in either the governor or its drive. If the speed changes in regular oscillations (a hunt) a speed droop adjustment can be made internally in the governor to rectify the hunting condition.

b. Speed-Droop Adjustment. Shut down engine and remove governor pulley cable, pulley assembly and cover. Loosen the lockscrew which holds speed droop slider as shown in figure 125, and move slider away from the center of the governor. This increases the speed droop setting. Tighten the lockscrew and replace the cover and pulley assembly. When the slider is pushed toward the center of the governor as far as it will go, the speed droop adjusting lever pin is near the axis of the terminal lever. Consequently, as the power piston moves, there will be but a slight up and down movement of the floating lever. This in turn, results in a minimum change of loading on the speeder spring, or minimum speed droop. As the slider is moved away from the center of the governor speed droop adjusting lever the pin moves away from the axis of the terminal shaft. Consequently, the movement of the power piston, through the floating lever, causes a greater change of loading on the speeder spring, or increased droop. Start the engine and observe if the engine is still hunting. Repeat the procedure outlined until all hunting stops. If the speed

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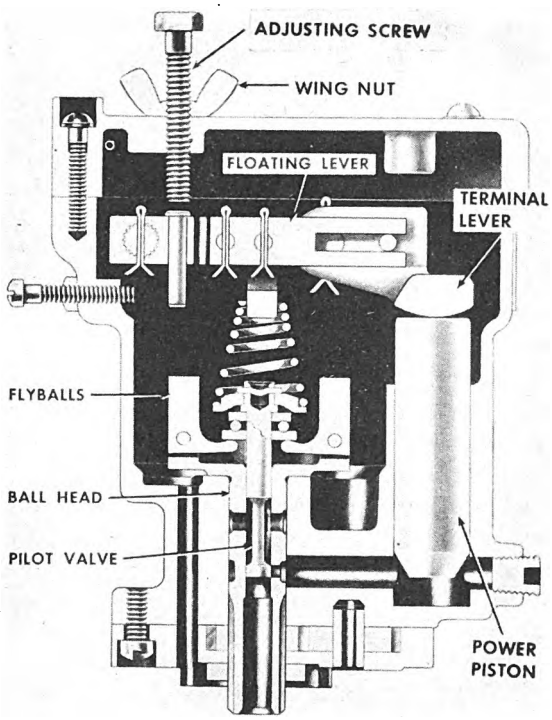
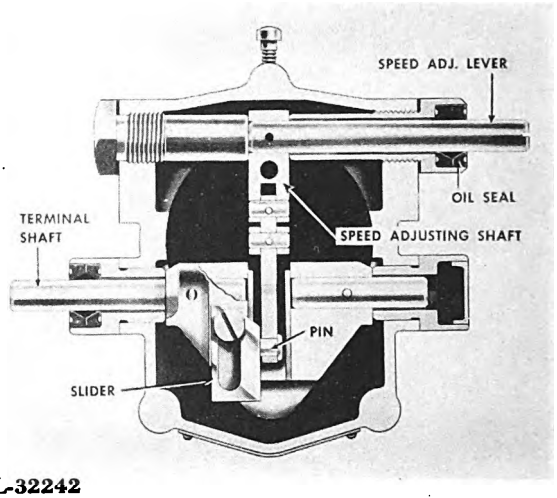


TL-32241

Figure 124. Cross-section, side view of Woodward governor.



TL-32242

Figure 125. Cross-section, top view of Woodward governor.

variations are large and erratic, and unaffected except, perhaps, in magnitude by change of speed-droop adjustment, or if the governor simply fails to control at all, it is probably defective.

c. Governor Repairs. The hydraulic type governor is very sensitive to its setting. Do not disassemble this unit. The governor may be taken off and a spare unit put in its place. The old unit may be sent to the depot for repairs.

(1) To remove governor assembly from fuel pump remove 5/16" copper tubing flare nut from behind governor housing. Unscrew ball joint out of governor control terminal lever. Remove four hex nuts from lower governor housing. Governor assembly may then be lifted from pump housing. Fittings and remote controls are interchangeable with other governor assemblies.

(2) To reassemble governor assembly on fuel pump, reverse procedure.

(3) When the governor is installed, particular care should be exercised to see that it is mounted squarely, and that the splined drive shaft is in exact alignment with the coupling sleeve on the drive from the engine. The hold-down nuts should be securely and evenly tightened. The line between the governor lubricating oil sump and governor should be installed. The linkage connections to the speed adjusting shaft should be assembled. When making up the linkage connections between the terminal shaft and fuel system, care should be taken to insure that when the terminal shaft of the governor is in the off position, the fuel system will also be shut off. The governor control link must be adjusted as described in paragraph on final assembly and adjustment. After checking the foregoing carefully, as far as the governor is concerned, the engine may now be started. After the governor begins to receive oil pressure it will start to open the fuel, and continue in this direction until the engine fires. After the engine is running, it will control the speed at the point for which the governor speed adjustment is set.

d. Lubrication. The governor is lubricated by oil introduced into the governor housing past the power piston, and pilot valve plunger. The oil is broken up into a fine mist by the rotation of the governor flyballs. The oil collects in the bottom of the governor case, and drains through the base by a drain hole.

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handicapped because of pump drive shaft. If a service pump is available, renew pump assembly and repair pump on work bench. (See paragraph on removal of fuel pump.)

(1) Remove vertical lever.

(a) Use small wrench to remove all points from the vertical lever.

(b) Insert socket wrench through hole in top of housing to loosen capscrew which clamps the plunger lever shaft and plunger lever pin in place (fig. 127).

(c) Using small punch, drive through expansion plug at one end of plunger lever shaft until opposite expansion plug falls out. Then drive the shaft out from the opposite end, being careful not to damage bushings.

(d) Lift vertical lever assembly from housing.

(e) Remove vertical lever spring and capscrew.

WARNING: PLACE PARTS ON CLEAN PAPER OR CLOTH ONLY.

(f) Push pin from plunger lever, making sure not to lose any of the 56 needle bearings in which it is mounted.

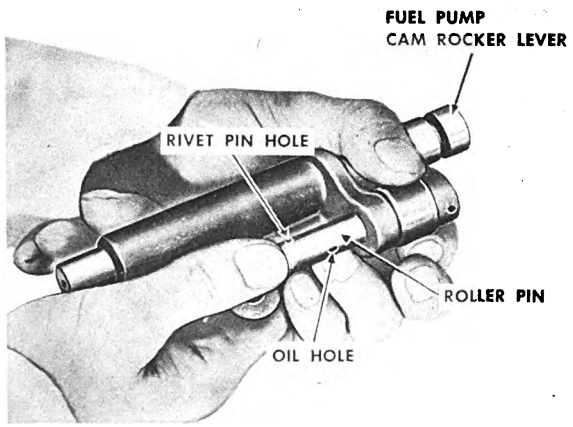
(g) Using a small punch, drive pin from vertical roller, making sure not to lose any of the 22 needle bearings in which it is mounted.

(2) Remove cam rocker lever from housing and disassemble further as follows:

(a) Mount lever firmly in a vise having copper jaws.

(b) Remove rivet pin with small punch.

(c) Using small brass rod as driver, remove roller pin.



TL-32245

Figure 128. Cam rocker lever

CAUTION: IT WILL NOT BE NECESSARY TO REMOVE STOP PINS AS THEY NEVER ENCOUNTER WEAR. REMOVAL OF THESE PINS WILL RESULT IN SERIOUS DAMAGE TO PUMP AND ENGINE.

(3) The governor control shaft as shown in figure 127, is situated in the side of the main housing. If it becomes worn it may be removed as follows:

(a) Remove small governor shaft link from governor control shaft with small wrench (fig. 127).

(b) Remove cotter pin from eccentric collar with a pair of diagonal cutters, and remove collar (fig. 129).

(c) Loosen capscrew at bottom of control lever and remove lever from lower end of eccentric shaft.

(d) Remove governor lever from eccentric shaft.

(e) Lift eccentric shaft from housing.

(f) Loosen the capscrew in the governor control lever and remove the lever and rod (fig. 127).

(g) Remove the Woodruff key from the shaft.

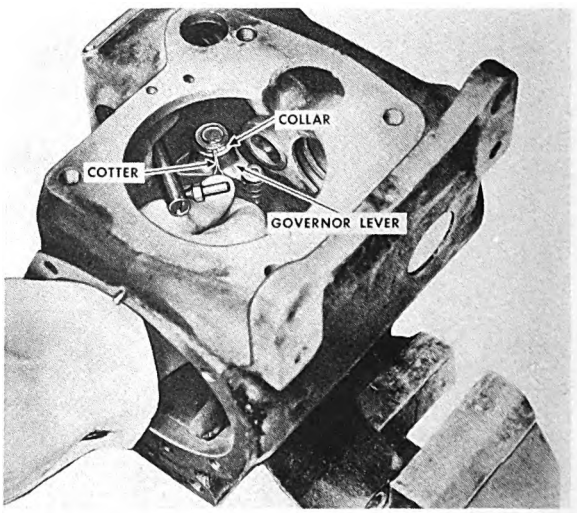
(h) Remove the control lever thrust washer.

(i) The shaft must be removed from inside the fuel pump housing.

b. Assembly of Parts.

(1) Eccentric shaft and governor lever.

(a) Inspect eccentric shaft bushing in main housing. Replace if worn, and ream with a standard 9/16" reamer.



TL-32246

Figure 129. Assembling governor lever collar and pin.

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(b) Inspect control shaft bushing, if worn replace and ream with ½" standard reamer (fig. 127).

(c) Install control shaft in bushing.

(d) Inspect oil retainer carefully. If its condition is at all questionable, replace and seat with a driving mandrel.

(e) Install thrust washer on shaft and insert Woodruff key.

(f) Hold the shaft firmly in place from inside the housing and tap the control lever on to the shaft, making sure the keyway is in line with the key.

(g) Tighten the lever capscrew. Make sure shaft operates freely.

(h) Inspect the ball joints in the vertical lever and governor lever link for wear. Replace if pitted or worn. If ball joints are pitted or worn, bad governor action will result.

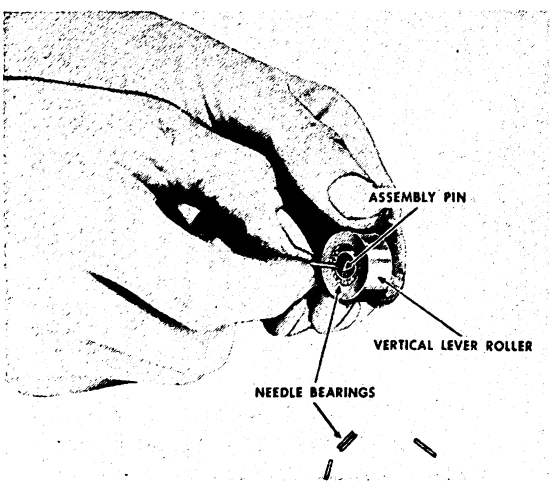
(i) Inspect governor lever bushing. Replace if worn and ream with standard ½" reamer.

(j) Install governor lever to eccentric shaft and place collar over governor lever and insert new cotter pin. Make sure that there is no more than 0.002" thrust on governor lever when assembly is completed (fig. 129).

(k) Attach link from eccentric lever to control shaft.

(2) Cam rocker lever.

(a) Inspect cam rocker lever for wear on ground radius, where vertical lever roller operates. If lever is rough, it will cause bad governor action, and it must be replaced.



TL-32247
Figure 130. Vertical lever roller and needle bearings.

(b) Inspect roller pin for wear; replace if worn.

(c) Inspect roller and replace if worn.

(d) Start roller pin into lever, making sure oil hole in pin is open.

(e) Assemble roller in place and tap pin through roller, making sure lubricating hole in pin indexes with hole in lever (fig. 128).

(f) Lock the roller pin in place with pin lock.

(g) Make sure roller is free and has a 0.006"-0.008" side clearance to allow it to turn freely under tension. If roller should stick, it would cause serious damage.

(h) Inspect cam rocker lever bushings in main housing and No. 1 gear pump body. Replace if worn. When replacing main housing bushing be sure oil hole is lined up properly for lubrication. Ream with 13/16" bottom reamer. Ream bushing in No. 1 gear pump body with ⅝" bottom reamer.

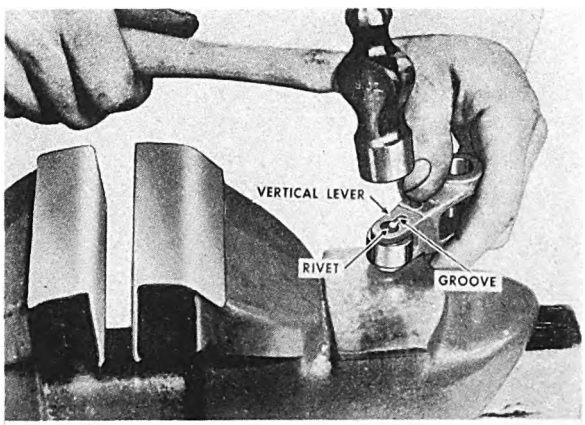
(i) Reinstall cam rocker lever assembly in housing.

(j) At this time it is best to assemble the gear pressure pump to the main housing.

(k) Be sure to use proper gasket between main housing and gear pump. Bolt gear pump in position to body. Check cam rocker lever to see that it rocks freely and that it has at least 0.006" end thrust. If lever is not free, it may be necessary to scrape the bushings slightly so that it will work freely. If this lever does not work freely, it will affect the metering pump fuel delivery.

(3) Vertical lever.

(a) Inspect vertical lever, pin, roller, and roller pin.



TL-32248
Figure 131. Assembling vertical lever and roller.

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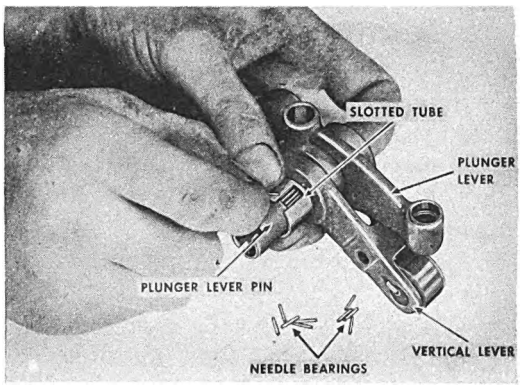
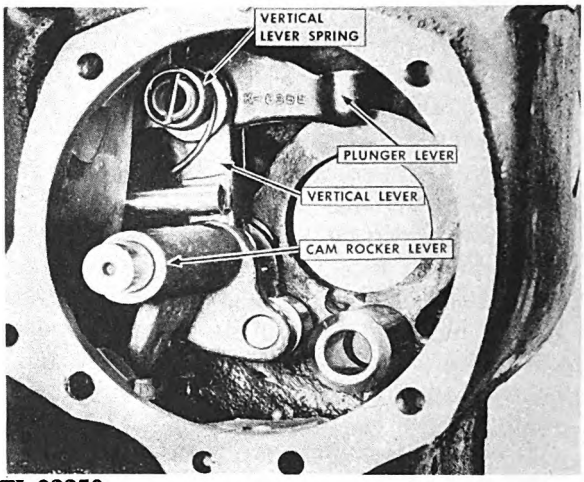


TL-32249
Figure 132. Assembling plunger lever pin and needle bearings.



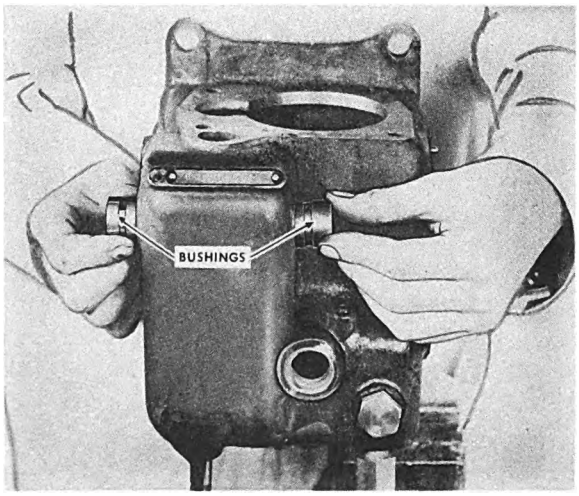
TL-32250
Figure 133. Vertical lever spring in position.

(b) If pitted or worn, replace. If parts are worn or pitted, poor governor action will be encountered. It is always best to replace needle bearings if pins and lever are found to be ridged or pitted.

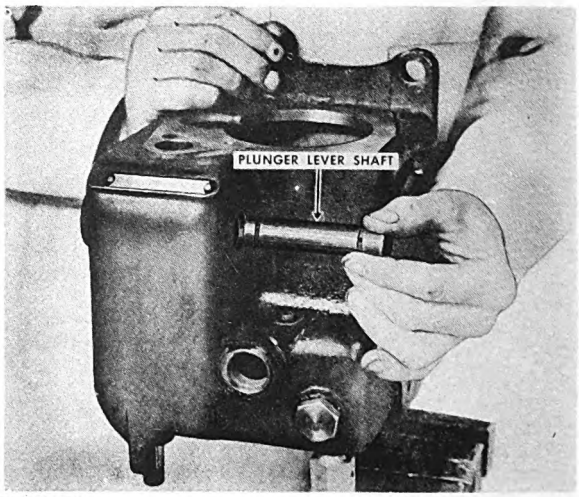
(c) Spread clean cloth on work bench and on it place the parts of the vertical lever to be assembled. Place roller on index finger and put piece of 3/8" rod, 7/16" long, in hole. Fill hole with 22 long needle bearings as shown in figure 130. Place roller in position and push roller pin through. This will force 3/8" rod out on opposite side. Lock in place by riveting copper rivet into grooves on both sides of vertical lever (fig. 131).

(d) When assembling plunger lever pin, use 5/8" inside diameter copper tubing with slot for needle bearings to pass through (fig. 132). Place plunger lever between arms of vertical lever in position. Tap plunger lever pin through vertical lever and plunger lever, leaving the needle bearing race open on one side. Place the slotted tubing over the pin and insert 28 short needle bearings. Tap the plunger lever shaft through far enough to allow the opposite bearing race to be filled with the same number of needle bearings. Tap plunger into position and turn groove in pin to match the capscrew hole in the plunger lever. Run capscrew down loosely to hold the pin in place.

(4) Inspect plunger lever shaft bushings in main housing for wear. If worn, replace in proper position to match up with oil holes in housing as shown in figure 134. Ream with 3/4" standard reamer.



TL-32251
Figure 134. Assembling plunger lever shaft bushings.



TL-32252
Figure 135. Assembling plunger lever shaft.

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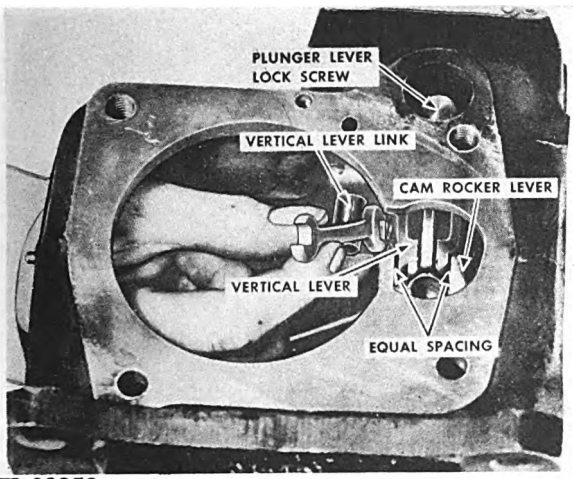
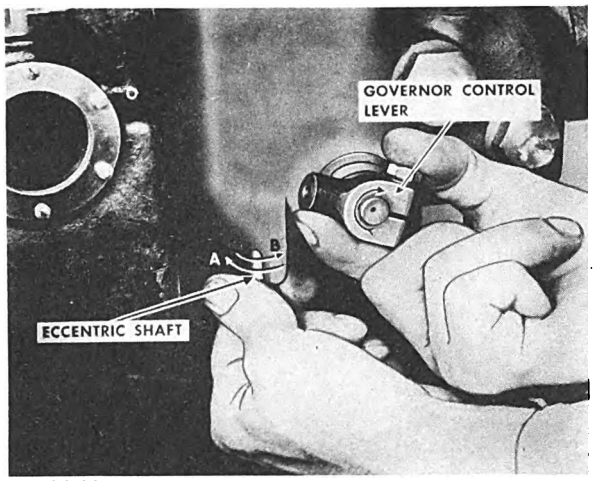


TL-32253
Figure 136. Spacing vertical lever in cam rocker lever race.



TL-32254
Figure 137. Setting control-lever and eccentric shaft.

(5) Place vertical lever in position in housing, insert plunger lever shaft as shown in figure 135. It is necessary that the vertical lever and roller be spaced in the center of the cam rocker lever race when it is in proper working position as shown in figure 136. To space the vertical lever, it may be necessary to shift the plunger lever shaft bushings one way or the other. With socket wrench tighten shaft lockscrew. Insert new expansion plugs on each end of plunger lever shaft. With large flat end punches, wedge in place. Check position of vertical lever and roller in cam rocker lever race to see that it has not shifted while inserting expansion plugs. Check to see that plunger and vertical lever work freely. Place vertical lever spring in position (fig. 133).

(6) Assemble vertical lever link with new lockwasher to vertical lever (fig. 136).

c. Final Assembly and Adjustments.

(1) Assemble gear pressure pump to main housing.

(2) Assemble cam rocker lever spring, gasket and spring retainer.

(3) Turn governor control lever in direction of arrow up, with fingers until vertical lever hits against stop pin of cam rocker (fig. 137 and fig. 138).

(4) Turn eccentric shaft in direction of arrow A in figure 137 with fingers. This will place the eccentric shaft in the full OFF position.

(5) With lever and shaft in this position assemble control lever as shown in figure 138.

(6) Turn stop screw into lever until it just touches stop on housing and lock in place with jam nut (fig. 138).

(7) Turn control lever in a right-hand rotation until vertical lever roller hits top of cam rocker stop position (full ON position).

(8) Turn fuel adjusting screw in until it touches stop on housing.

CAUTION: THIS SCREW MUST BE GIVEN THREE MORE COMPLETE TURNS FOR PROPER FUEL SETTING.

(9) Lock adjusting screw in place with jam nut and seal.

(10) Assemble instrument panel throttle lever rod to fuel pump control lever and place in the full ON position.

NOTE: Throttle lever control must always be in the full ON position when adjusting governor control link to governor and fuel pump proper.

(11) Assemble governor terminal lever to terminal shaft as shown in figure 139 leaving clamp bolt loose.

(12) Assemble governor control link.

(13) With wrench or by hand, hold control lever up to full ON position. Turn terminal shaft of governor in a counterclockwise rotation until it hits the stop inside governor housing cover, figure 139.

(14) Tighten terminal lever lockscrew securely when held in this position.

(15) Install governor control link spring onto spring bracket.

NOTE: If all steps have been followed closely the fuel pump is set for the proper governor action and fuel delivery.

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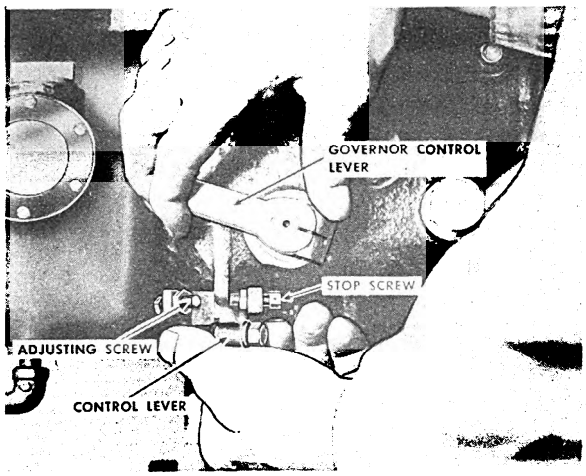
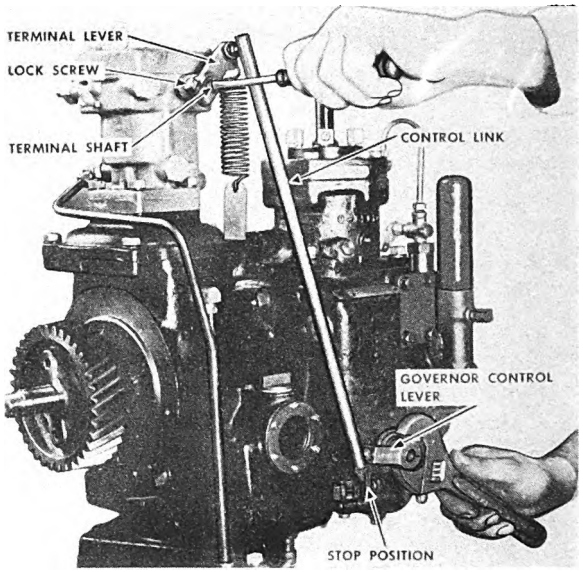


TL-32255
Figure 138. Assembling constant speed fuel pump control lever.



TL-32256
Figure 139. Setting control levers and governor shaft.

90. REMOVAL OF FUEL PUMP ASSEMBLY.

a. Removal of Fuel Pump Assembly. It should only be necessary to remove fuel pump for major repairs to main drive shaft bearings or replacement of pump cam and drive gears. All other parts can be repaired without removing the pump.

b. Removal Procedure. The amount of time for making these repairs will, in some cases, take longer than replacement of a new fuel pump assembly, which is removed as follows:

(1) Disconnect battery terminal connection from battery.

(2) Remove all fuel and lubricating lines leading to fuel pump.

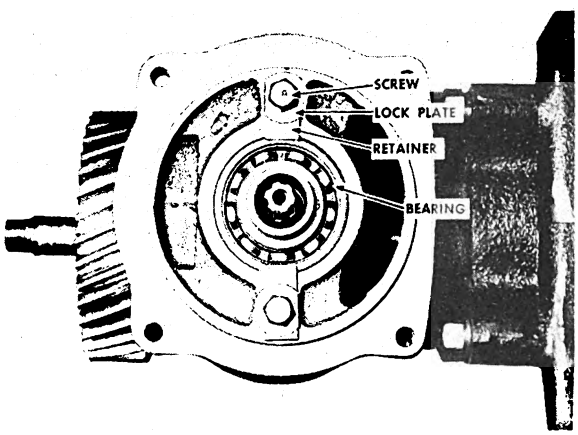
(3) Remove instrument panel throttle lever rod at fuel pump.

(4) Remove instrument panel mounting bolts and swing panel to rear of engine.

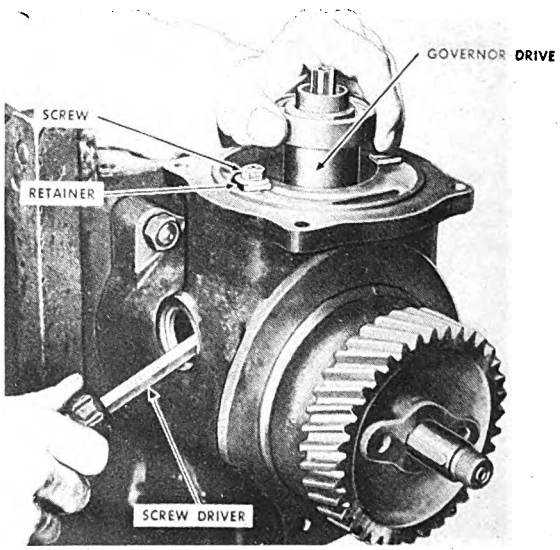
(5) Spot distributor timing marks as shown in figure 117.

NOTE: Timing mark must show in inspection hole of distributor assembly when 1-6 TC timing mark is aligned with index notch on gear case. Turn engine one revolution to same timing mark if notch does not show.

(6) Loosen water pump clamp ring and rotate water pump body to low point of eccentric to loosen drive belts. Remove the belts from the water pump drive pulley.



TL-32257
Figure 140. Hydraulic governor drive-unit retainer.



TL-32258
Figure 141. Removing hydraulic governor drive.

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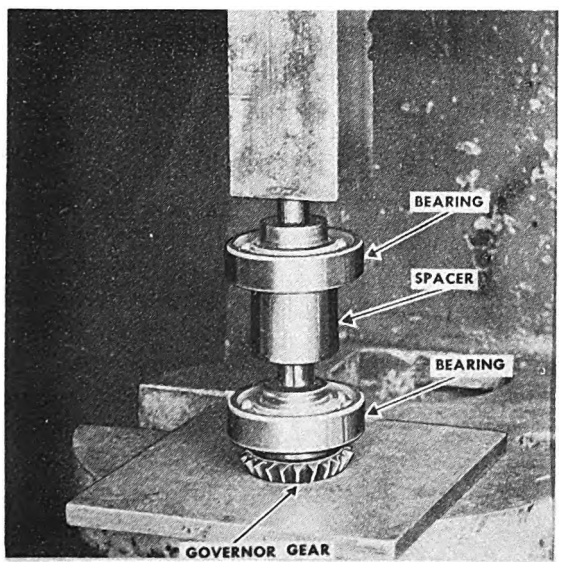
(7) Remove the nut and lock plate holding the water pump drive pulley to the fuel pump shaft.
(8) With a puller as shown in figure 98, remove the water pump drive pulley from the shaft. See note, paragraph 77.
(9) Remove the three capscrews holding the fuel pump to the gear case and the four capscrews holding it to the side of the block. With a slightly backward motion, lift the fuel pump from the engine.

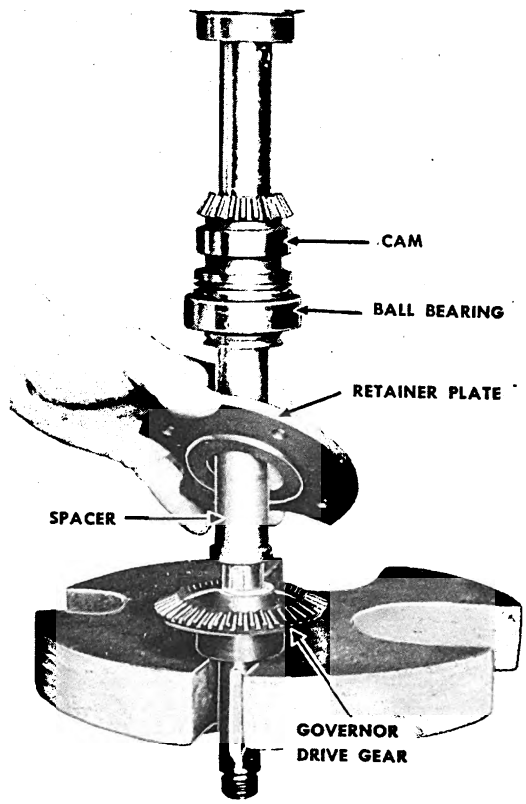
91. REPAIRS TO FUEL PUMP DRIVE SHAFTS.

a. Removal.
(1) Remove fuel pump from engine. Remove control linkage on the side of the pump leading to governor. Remove the four nuts that hold the governor to its adapter plate and lift the governor off.
(2) Remove the four capscrews that hold the adapter plate to the main housing and lift off.
(3) Loosen the two capscrews that hold the retainer plates over the spindle bearing and turn the plates to one side so as to clear the bearing race (fig. 140).
(4) Using a heavy screwdriver, or similar tool, pry the spindle up until the drive assembly can be lifted from housing. This may be accomplished by inserting the screwdriver in the inspection hole in the back of the adapter housing (fig. 141).
(5) Remove the main shaft drive gear from the front of the drive shaft using suitable puller. Remove the three nuts holding the adapter housing to main fuel pump housing.
(6) The governor adapter can now be removed from the main fuel pump housing.
(7) Remove the four capscrews holding the retainer plate, and pull the main shaft from the fuel pump housing.
(8) If necessary press governor drive gear from shaft.
(9) All parts shown in figure 143 can be pressed off shaft for renewal.
(10) Check bearings and gear on governor drive shaft, press off and renew if necessary (fig. 142).

b. Reassembly of Drive Shafts to Fuel Pump.
(1) Assemble main shaft assembly (fig. 143).



TL-32259
Figure 142. Hydraulic governor drive unit assembly.



TL-32260
Figure 143. Main shaft assembly.

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(2) Assemble shaft assembly to main fuel pump housing with a new gasket between bearing shield and main fuel pump housing. Tighten in place with four capscrew lockwashers.
(3) Assemble governor adapter housing over shaft and tighten in place with lockwashers and nuts.
(4) Press driving gear with large ball bearing on shaft over key.
(5) Check main shaft to see that it turns freely in bearings.
(6) Assemble governor shaft drive unit to main housing.
(7) Secure in place with lockplates and capscrews as shown in figure 140, and check gear tooth backlash. This should be 0.004". This backlash can be obtained by inserting thin shim spacer washers below outer race of lower bearing.
(8) Assemble adapter plate to housing and secure in place with four capscrews and lockwashers.
(9) Place the spline coupling on the spindle shaft, first making sure that the coupling fits both the spline on the governor shaft and the spline on the spindle shaft. It should be a slip fit. This is important because faulty governor action will result if either a bind or excessive play exists in the coupling.
(10) Put the governor base gasket in place.

CAUTION: BE SURE IT IS PLACED SO THAT IT DOES NOT COVER THE OIL DRAIN HOLE.

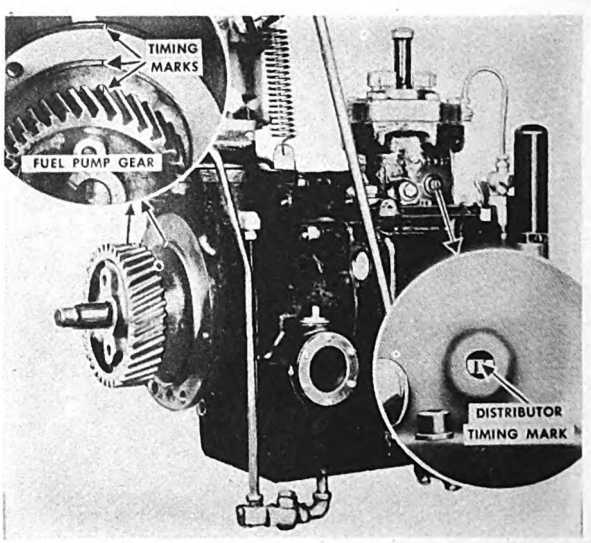
TL-32261
Figure 144. Timing marks on camshaft gear.

(11) Mount the governor in its correct position making sure that it fits level with the adapter plate. Tighten the hold-down nuts with lockwashers evenly and check the governor for freedom of action.
(12) Readjust governor control links and remount pump to engine. Refer to final assembly and adjustments, paragraph 92.

92. INSTALLING FUEL PUMP ON ENGINE.

a. Rotation and Marking.
(1) Rotate the engine until the two punch-marked teeth on the camshaft appear in the fuel pump opening in the gear case (fig. 144).
(2) See that the mark TC 1 & 6 is showing in the flywheel housing index hole (fig. 102).
(3) Rotate the fuel pump until the small notch in drive collar appears in the inspection hole in the distributor housing (fig. 117).
(4) With a piece of chalk or similar substance mark the top surface of each punch-marked tooth on the camshaft gear, and the face of the single punch-marked tooth on the fuel pump gear (fig. 144 and fig. 145).

b. Installation.
(1) Install the copper asbestos gasket for oil drain hole in pump housing holding it in place with cup grease, install new pump flange gasket and lift the fuel pump into place.



TL-32262
Figure 145. Timing marks on fuel pump gear and housing.

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(2) Using the water pump drive pulley hole as an inspection hole, mesh the fuel pump gear with the camshaft gear. The timing will be correct if the single chalk mark on the fuel pump gear is meshed between the two chalk marks on the camshaft gear.
(3) Push the fuel pump tight against the gear case, making sure shoulder of pump flange enters gear case hole.
(4) Install and tighten the three capscrews around the flange.
(5) Install and tighten the four capscrews holding the pump to the block.
(6) Reinstall instrument panel, gauge, lines, and throttle rod.
(7) Reattach all fuel and lubricating lines and prime the fuel system before attempting to start the engine.

93. GENERATOR TEST RECOMMENDATIONS.

a. Checking the Exciter Armature. If difficulty is in the exciter armature, check it. The simplest method for all-around generator check is to use a battery in series with a voltmeter attaching it across opposite sides of the commutator by tying a string around the commutator and inserting test leads under the string which will hold them in place diametrically opposite on the commutator bars. A pair of leads from a voltmeter in series with the battery should now be taken and the ends pointed in some manner, either by attaching to a nail or other sharpened device, or by tinning them with solder and filing them to a point. With these two leads, a drop test can be made from bar to bar. If upon putting them across the first two bars the meter reads too low, it will be necessary to increase the potential by putting more batteries in series. If, however, it reads too high off scale, it will be necessary to reduce the potential by putting fewer batteries in series. With these leads proceed around the commutator touching each pair of bars. If an unusually high reading is secured, a short circuit is occurring in the coil embraced by those two commutator bars. If the meter reads low, the coil is open or poorly soldered into the commutator bar, remove armature for repair. Checks for ground may be made as follows: Connect a voltmeter and battery in series with one lead placed on the armature shaft and the other lead placed on the commutator. If the meter gives a reading, a ground is present and the armature will have to be removed.

b. Checking the Field Coils of the Exciter. Should low voltage develop or the exciter fail to build up voltage, it will be necessary to check not only the armature but the field coils. This can be done by placing battery potential across each. If this is not true, it can readily be determined that trouble exists in the field where the difference in voltage drop appears, and the field coils must be removed and rewound. A similar check for ground as indicated on the armature can be made on the field, one side of the voltmeter-battery combination being connected to the field wire and the other side to the magnet frame. If the meter reads, check each field individually by opening them from the others until you have ascertained which one is the injured coil. This must then be rewound.

c. Checking the Alternator. The same procedure on the fields of the alternator can be used as outlined on the fields of the exciter. When difficulty develops in the alternator, check the field; if no defect is located, check the stator. This must be done with the rotor removed. By running one of the other machines at low potential attached to this machine, through temporary leads, determine by heating which coil is short-circuited, if this is the difficulty. By using the voltmeter-battery combination as previously outlined, grounds may be detected. In the event of a short-circuited or grounded coil, the same may be cut out for such a period as is required until replacement parts can be obtained. However, this is not a good arrangement, since it is not always possible to completely open the short-circuited coil, even though the end leads may be effectively opened. Consequently, it is not recommended that this practice be used, except in case of emergency. Any of the alternator tests outlined will require the removal of the alternator end bracket, which can be done after the exciter is removed, as previously outlined; then remove the exciter armature by disconnecting the solid shaft coupling, after which remove the alternator end bracket. If however, it is desired to slide

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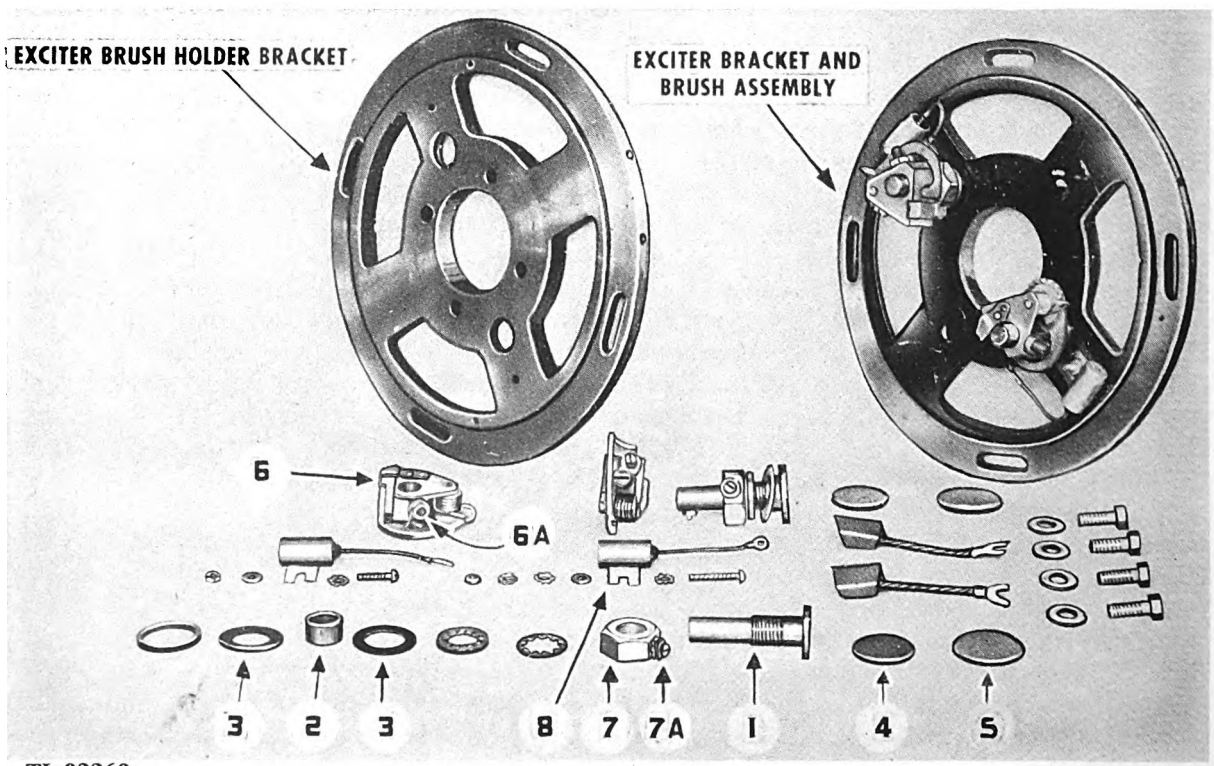
out complete rotor with end bracket in place, for investigation in the stator, remove the fan from the flywheel at the engine end of the generator. Then, remove coupling bolts and allow whole assembly, including the coupling, to come out with the rotating member. In any event the handling of the electrical parts of this machinery requires very careful consideration since bruising of any of the coils may result in short circuits or grounds and prevent the machinery from functioning thereafter until complete repairs are made.

94. EXCITER BRUSH RIGGING. The exciter brush holder bracket, figure 146, is machined steel. This is drilled to take the brass brush holder supports or studs (1) which have no threads for about 2 inches of their length. These studs are insulated from the bracket by a sleeve (2) and insulating washers (3). The head is countersunk in the bracket and a disk (4) of insulating material is placed over the head. Over this an expansion plug (5) is hammered into place resulting in a tight and practically flush joint on the bracket over the heads of the brush holder supports. The brush holders (6) slip over the stud or support on the unthreaded section and are held in position along this stud by a setscrew (6a). This arrangement provides for an adjustment of the brush holder along the axis of the commutators so that it can be correctly set. One surface of the brass nut (7), which holds the support in place, is drilled and tapped for a machine screw (7a) to provide for a connecting wire and connections to small condensers (8), which are installed across the brushes, to reduce radio interference. The bracket is bolted to the exciter frame, the bolt holes being elongated sufficiently to allow the bracket, and consequently the brushes, to be rotated slightly to secure the proper position of the brushes in order to obtain the most satisfactory output of the exciter. The correct position is indicated by marks on the bracket and the frame as shown in figure 147. If the bracket is removed or loosened for any reason it must be installed so that these marks coincide.



TL-32263

Figure 146. Exciter brush rigging.

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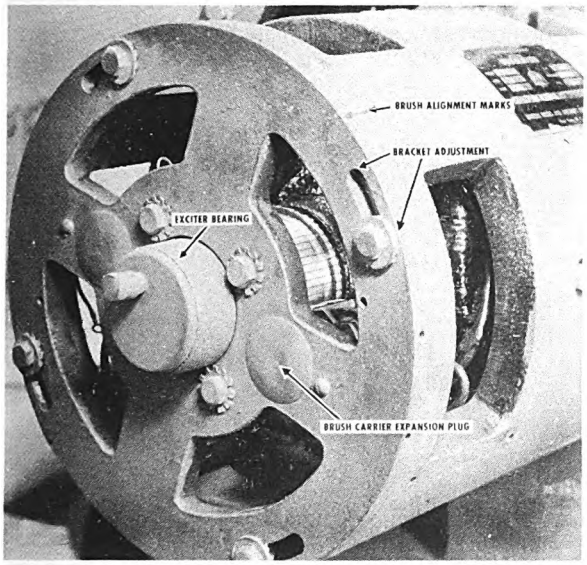


TL-32264
Figure 147. Alignment marks on exciter bracket and frame.

95. EXCITER BALL BEARING.

a. Parts. The exciter ball bearing as shown in figure 148, consists of a housing (1), the ball bearings and races (2), and a housing cover (3). The end of the armature shaft is tapped to take a machine screw (4) which is equipped with a washer (4a). After the bearing and housing are in position, the machine screw and washer are installed and hold the bearing assembly in place. The cover is held in place by two small flush setscrews (5). An Allen wrench (7) is supplied for use on the setscrews. A grease cup (6) screwed in the housing cover, is provided.

b. Exciter Ball Bearing Removal. To remove the exciter ball bearing, proceed as follows:

(1) Remove the condenser and the brush wire terminal connections on the brush holder stud.

(2) Remove the brushes from the brush holders. Note carefully the way the brushes are placed in the holders. The brushes are placed at an angle to the commutator surface and the pigtail wire is not centered on the brush.

(3) Remove the brush holder bracket capscrews and tap off the bracket.

NOTE: Use care in removing the bracket. Do not allow brush holders to bind against the bearing housing.

(4) Use the Allen wrench to loosen the two setscrews which hold the housing cover in place and remove the cover.

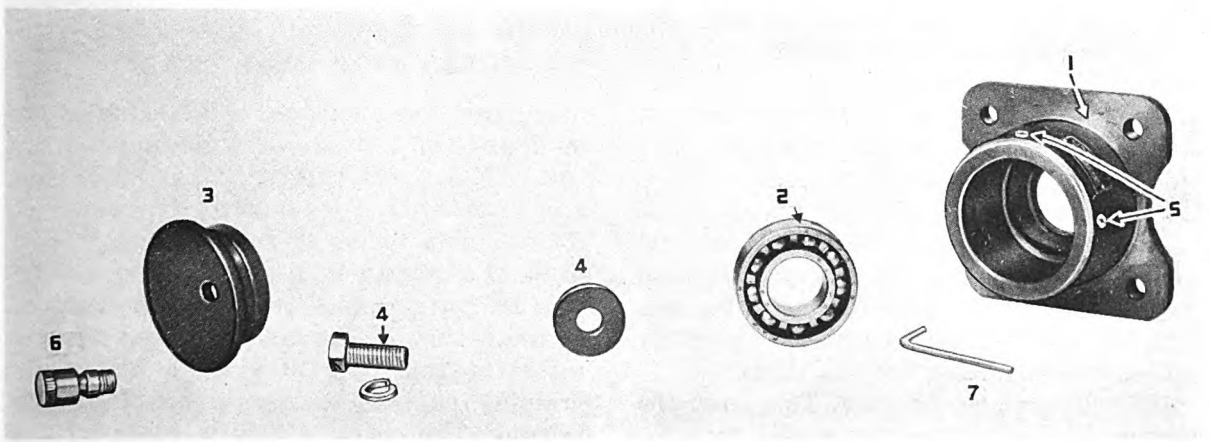
(5) Remove the machine capscrew and washer from the end of the exciter shaft.

(6) Tap off bearing and housing from the exciter shaft with a wooden mallet.

(7) If the bearing binds on the shaft use a puller as shown in figure 149.

c. Installation. To install the exciter ball bearing, reverse the above procedure. If difficulty is encountered in placing the bearing on the shaft, press or drive it on using a block of wood or a brass pipe which will slip over the shaft.

CAUTION: Do not apply any pressure to the bearing outer race. Apply pressure only to the inner race. Pressure applied to the outer race will ruin the bearing.



TL-32265

Figure 148. Exciter ball bearing.

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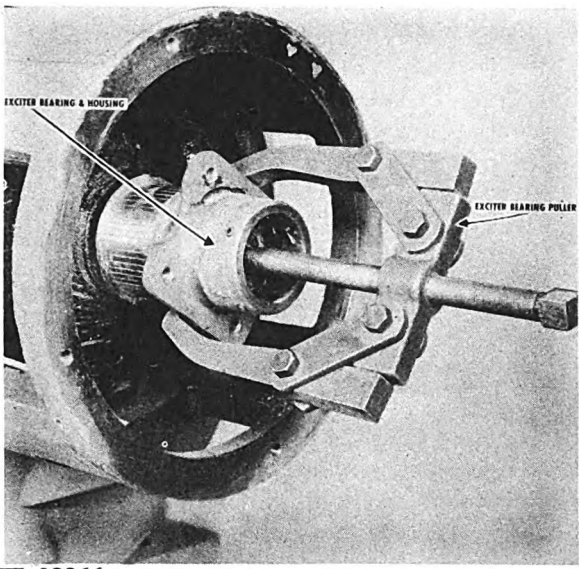
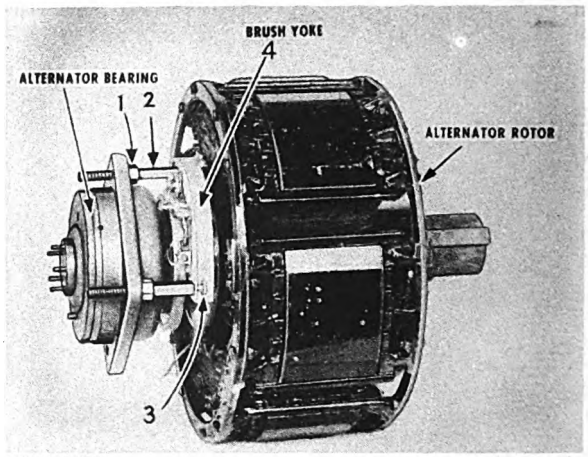


TL-32266
Figure 149. Pulling exciter ball bearing.



TL-32267
Figure 150. Alternator rotor with ball bearing slip-ring brush rigging in place.

96. ALTERNATOR SLIP-RING BRUSH RIGGING.

a. Arrangement of Rigging. The alternator brush rigging consists of a yoke of insulating material on which the brush holders are mounted, and which is supported by three special shouldered studs passing through the corners of the square flange of the ball bearing housing (fig. 150). The brush holder yoke is rigidly fastened to the end of these bolts and is adjustable along the shaft axis, after the bearing is in place, so that the brushes can be set correctly on the slip rings. When this adjustment is attained it can be locked in position. The other ends of the three bolts or studs project through accurately located holes in the bracket which in turn, is accurately located and bolted to the alternator frame. A fourth bolt which does not enter the yoke completes the fastening of the bearing housing to the bracket. This arrangement holds the ball bearing housing in position and determines the radial location of the brushes and provides for an adjustment of the brushes along the shaft so that they will be accurately and securely placed on the slip rings.

b. Adjustment of Brushes. To adjust the position of the brushes across the collector rings refer to figure 150, and proceed as follows:

(1) Back the locking nuts (1) on the special studs (2) away from the ball bearing housing.

(2) Loosen the yoke nuts (3) which hold the brush holder yoke (4) up against the shoulder of the special studs.

(3) Turn the studs, which are threaded in the ball bearing housing, to bring the brushes into the correct alignment position across the collector rings. Do not turn one stud excessively or an undue strain will be put on the yoke.

(4) Tighten the yoke nuts (3) and check the position of the brushes. Be sure the brushes do not over-ride the rings.

(5) Turn the locking nuts (1) up against the bearing housing.

97. ALTERNATOR BALL BEARING.

a. Parts. The alternator ball bearing shown in figure 151 consists of a housing with a square flange; the ball bearing and races and a housing cover. The housing cover is tapped for a grease fitting in such a position that when the bearing is in place, the grease fitting is uppermost. A drain plug is installed at the bottom of the housing cover. The removal of this plug provides a means for draining out any excess grease from the bearing. The cover is held in place by two flush setscrews. The grease fitting includes sufficient piping to bring the grease cup to

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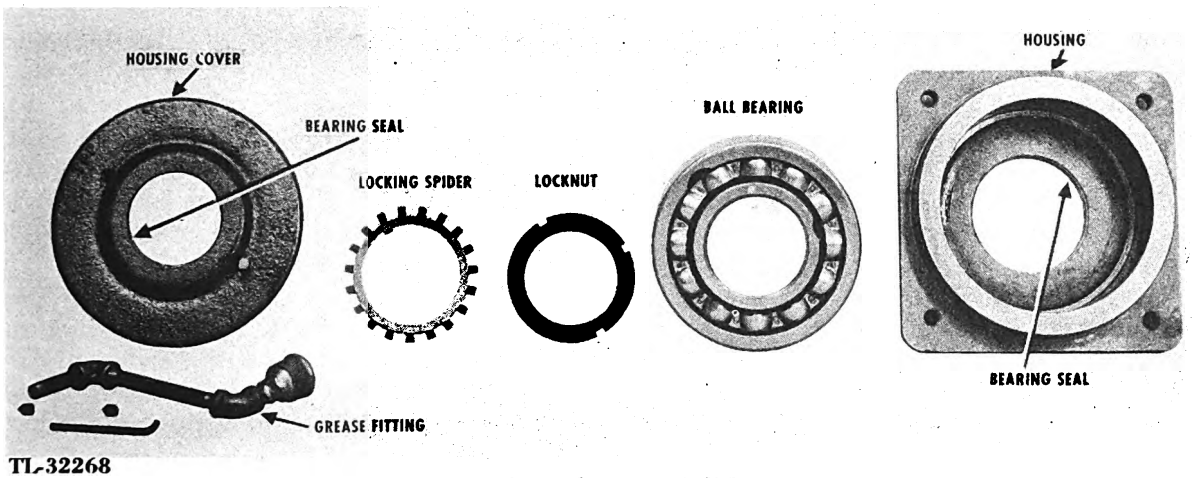
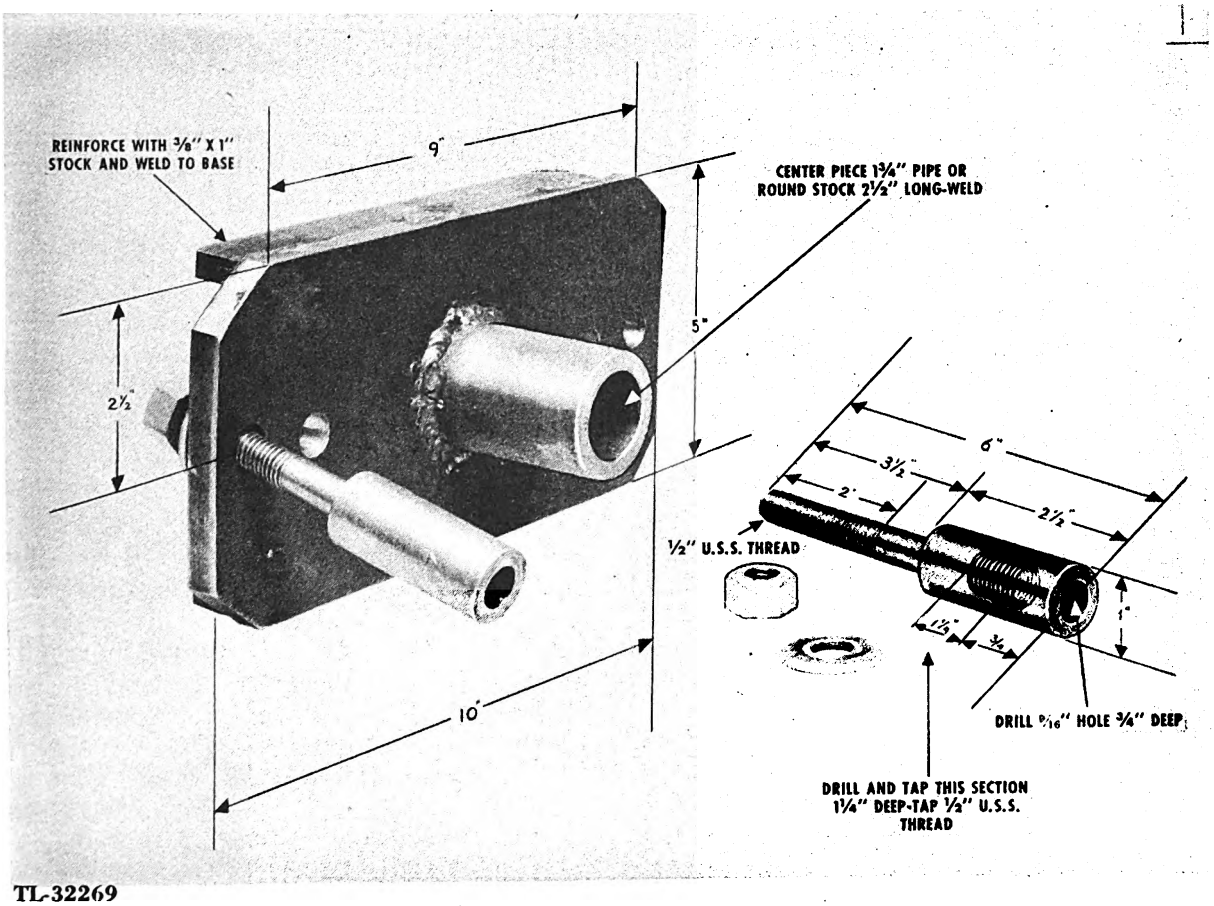


TL-32268

Figure 151. Alternator ball bearing.



TL-32269

Figure 152. Puller for alternator ball bearing.

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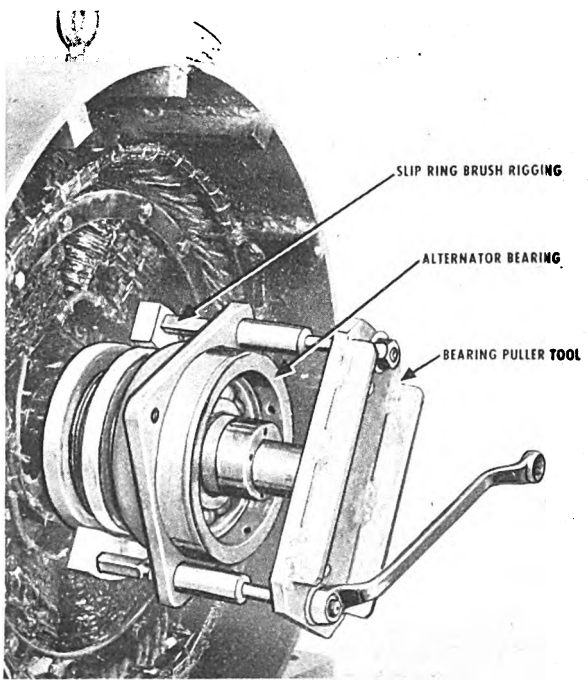
an accessible position. Grease seals and a locking device to hold the bearing in place are part of the assembly.

b. Removal of Alternator Ball Bearing. Before the bearing can be taken off the shaft the seal and locking device will have to be removed. The ball bearing is driven or pressed in place and it will be necessary to use a puller to remove it. A satisfactory puller for this purpose is shown in figure 152, and the application of the puller is shown in figure 153. Referring to figure 152, the inside of the sleeve end of the bolts is threaded to fit the bearing bolts. The thread does not show in the photograph as it is reamed out for a short distance inside the sleeve. Care must be taken in using the puller to draw the nuts up evenly to avoid putting an unnecessary strain on the bearing housing. A small amount of oil rubbed on the alternator shaft assists in the removal of the bearing.

c. Alternator Ball Bearing Installation. As it is necessary to press on or drive on the alternator ball bearing, the rotor will have to be removed. To do this proceed as follows:
(1) Remove the exciter frame and the armature which is coupled to the alternator shaft.
(2) Disconnect the alternator from the engine by separating the flexible coupling.



TL-32270
Figure 153. Pulling alternator ball bearing.

(3) Secure a piece of iron pipe about 4 feet long and large enough to go over the rotor shaft.
(4) If a crane is not available, arrange a block and tackle or equivalent, using at least 5/8 inch rope for looping around the rotor shaft. Chain must not come in contact with the shaft. Bring the tackle up taut to take the weight of the rotor.
(5) Wrap the shaft with cloth and place the iron pipe over the shaft, being sure it goes on far enough so that it will not slip off.
(6) Using the iron pipe as a lever, press down on the end and raise the rotor sufficiently to be able to swing it out of the frame.
(7) If the bearing must be driven on, block the opposite end of the shaft up against a solid surface using care not to injure this end of the shaft.
(8) Drive or press the bearing on the shaft until it comes up against the shoulder on the shaft which locates it properly.

CAUTION: NEVER APPLY ANY PRESSURE TO THE OUTER RACE OF THE BEARING.

98. LUBRICATION OF BEARINGS, ALTERNATOR, AND EXCITER.

a. Inspection of the Bearings. The ball bearings of the alternator and exciter have been sufficiently lubricated before shipment for 5000 or 6000 hours of operation at rated load and temperatures. It is not necessary to add grease to these bearings when the unit is first put in operation. However, during the first run the bearings should be inspected for quietness and any undue heating. The results of this inspection should be satisfactory as all units have passed inspection and test before shipment.

b. Replacement of Grease. After 5000 or 6000 hours of operation the grease should be replaced. The grease used must be a mineral product of the very highest grade and preferably a long fibre type. Remove the exciter and alternator bearings and clean out all old grease using gasoline or a suitable solvent. Also clean the grease cups and fittings. After cleaning, use every precaution to prevent any dirt or dust coming in contact with the bearings. Protect them with clean cloths. Reassemble the bearings on the shafts and then

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force grease around the balls. Fill the bearings about 1/3 full of grease. Do not overgrease. Overgreasing will cause the bearings to overheat. If this occurs, remove the drain plug on the alternator bearing and allow excess grease to drain out while unit is operating. To remove excess grease from the exciter bearing remove the cover and wipe out the excess. Fill the grease cups and turn them down slightly.

99. COLLECTOR RING REMOVAL. The collector ring unit has been forced on the shaft under great pressure and it must be removed with a puller. The method of using such a tool is shown in figure 154. Particular care must be taken to see that the prongs of the puller are exactly opposite each other. Replacement rings must be pressed onto the shaft until they come up against the shoulder on the shaft which locates them properly.

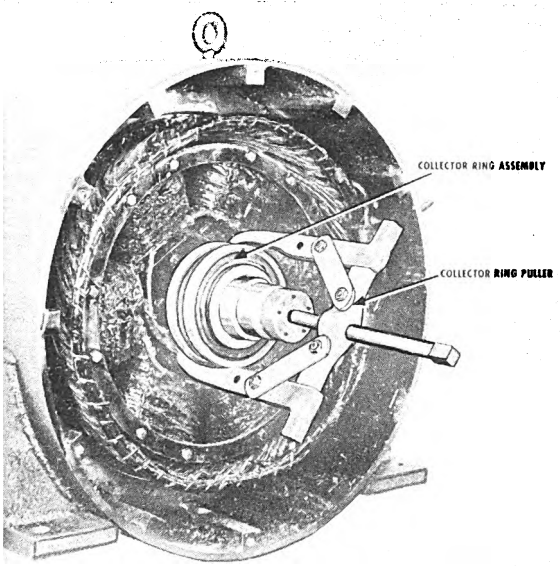

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Figure 154. Pulling collector rings.

100. SWITCHGEAR.

a. Care and Inspection of Switchboard. In order to obtain satisfactory operation from the switchboard, it must have adequate care and periodic and intelligent inspection. The inspection should cover all devices and connections. When making these inspections, extreme care must be exercised that no circuits are shorted or grounded and that the inspector experiences no personal harm. The essence of switchgear maintenance is cleanliness. All dust and dirt should be carefully removed or blown out by compressed air if available. No lubrication is necessary on any of the operating mechanism except where specifically mentioned. Due to the delicate construction of the equipment it is not recommended that major repairs be attempted in the field. Damaged instruments or parts should be returned to the depot for servicing and adjustment.

CAUTION: Always shut down the engine and disconnect the batteries while making inspections or tightening connections.

b. Voltage Regulator. The operation of the voltage regulator is covered in paragraph 41. The vibrating armature is the only moving part and this part requires no lubrication.

(1) If the contacts of the vibrating armature become so irregular as to hinder operation, use about a 600 grade of carborundum paper or cloth and polish the surfaces. After smoothing the contacts blow the dust out and wipe off each contact with a clean cloth. If the contacts cannot be smoothed replace them. If this is necessary use care in removing the screw contact so as not to injure the pivot points.

(2) Regulators are carefully adjusted during the testing of the power units before shipment and they should arrive at their destination in satisfactory operating condition. However, if adjustment has to be made or if a regulator is replaced the following is the procedure:

(a) The a-c voltage is adjusted by turning the voltage adjusting screw, figure 154. With the regulator in operation, set the regulator rheostat in the mid-position and loosen the setscrew in the end of the supporting post thus allowing the adjustment screw to be turned. To increase the voltage, turn the adjusting screw clockwise or in a direction to increase the spring tension. When the correct voltage is obtained, tighten the setscrew. Under this condition movement of the regulator rheostat will adjust the voltage approximately 12 volts either side of the selected value.

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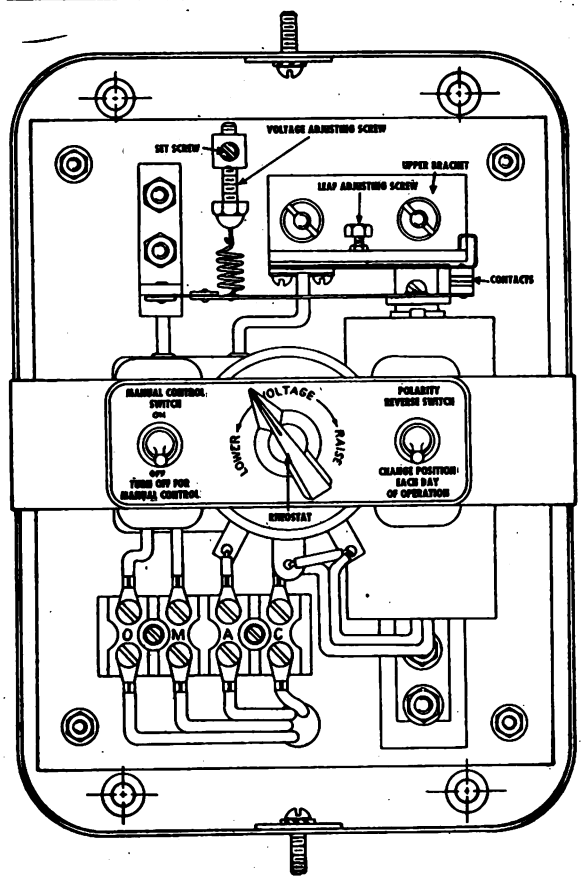

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Figure 155. Voltage regulator.

(b) Adjustment of the bumper leaf spring affects the voltage swing. It is adjusted by turning the small vertical screw on the upper contact bracket while the regulator is in operation. A heavy leaf spring tension causes bouncing of the lower contact while a slight tension causes hunting or swinging of the voltage. The proper tension is that which is barely enough to prevent hunting. This adjustment usually places the bumper spring within 1/32 of an inch of the moving armature.

(c) The position of the upper bracket relative to the vibrating contact and the face of the magnet core is adjustable. The regulator must not be in service during any alteration in the position of this bracket. The two mounting holes are made large so that when the holding screws are loosened the bracket may be moved. The bracket should be located, especially when replacing contacts, in such a manner that the upper and lower contacts butt together evenly and that the distance between contacts is between 0.025 and 0.040 of an inch. To measure this adjustment disconnect the voltage adjusting spring so as to allow the vibrator to rest lightly on the bumper pad on the top of the magnet core. The stop on the end of the leaf spring should be resting on the upper horizontal surface of the bracket.

c. Circuit Breaker. The circuit breaker has been designed with a large factor of safety for interrupting capacity and long life. Under normal operating conditions, adjustment or replacement of parts will not be required. All metal parts are corrosion resistant or are plated with corrosion-resistant material. Contacts are self-wiping and the normal use of the breaker keeps these contacts clean and bright. Inspection should be made occasionally to see that the breaker is clean and all connections are tight. The power unit must be idle during this inspection. The circuit breaker is designed with a thermal trip element which operates as a time delay device and will carry small overloads for a short time. This element is also constructed so that when a dead short or heavy overload occurs the breaker will trip instantaneously, thereby safeguarding the equipment. The trip element is factory sealed and should give service indefinitely but if necessary it can be replaced.

d. Frequency Meter. No repair of this meter is possible. If it is not operating satisfactorily it must be replaced.

e. Ammeter and Voltmeter. The ammeter and voltmeter are high-accuracy instruments of standard switchboard construction. No repair, of these instruments, in the field is possible. A needle adjusting screw is provided which is used to obtain an accurate zero position of the needle.

f. Total Hour Meter. No repair of this instrument is possible while in the field. If it is not operating satisfactorily it must be replaced.

g. Exciter Field Rheostat. Cleanliness of the exciter field rheostat is important. After a long period of service it may show wear. It should be replaced before any such wear results in it being unserviceable.

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101. REPLACEMENT OF RADIO INTERFERENCE-SUPPRESSION MATERIAL. The following radio suppression material is mounted on Power Unit PE-245-A as described and illustrated in the figures referred to. It has been determined under test, that this material as installed and illustrated will effectively eliminate radiated and conducted radio interference within the frequency range of 0.55 mc through 140.0 mc at a distance of 25 feet.

a. Installation of the Metal-Clad Automotive-type Capacitors.

(1) Three metal-clad automotive-type capacitors, rated at 0.01 MFD, 600 volt d-c, are installed as follows (refer to fig. 156): Each phase lead from alternator is bypassed by a capacitor. Capacitor leads are fastened to A, B, and C terminals on output terminal block at left rear of instrument-panel cabinet by existing phase lugs, nuts, and appropriate washers. Capacitor brackets are fastened to metal partition upon which junction-terminal block is mounted by appropriate nuts, bolts, and washers.

(2) Two metal-clad automotive-type capacitors, rated at 0.1 MFD, 600 volt d-c, are applied as follows: (refer to fig. 158). Each of the two d-c exciter brushes is bypassed by a capacitor. Capacitor leads are fastened to exciter brush rigging by existing screws and appropriate washers. Capacitor brackets are fastened to inner surface of exciter and plate by appropriate nuts, bolts, and washers.

(3) Four metal-clad automotive-type capacitors, rated at 0.25 MFD, 600 volt d-c, are installed as follows (refer to fig. 157):

(a) The d-c generator lead from the exciter interpole winding to a-c slip-ring brush terminal is bypassed by a capacitor. Capacitor lead is soldered to interpole winding lead spliced and taped. Capacitor bracket is fastened to inner surface of exciter barrel at exciter end by appropriate nut, screw, and washers.

(b) The d-c generator interpole windings are bypassed by a capacitor. Capacitor lead is soldered to series lead connecting the two field coils and the connection is taped. Capacitor bracket is fastened to inner surface of generator barrel at alternator end by appropriate nut, screw, and washers.

(c) The d-c generator field coils are bypassed by a capacitor. Capacitor lead is connected to series lead connecting the two field coils by existing screws and washers. Capacitor bracket is fastened to inner surface of generator barrel at alternator end by appropriate nut, screw, and washers.

(d) The d-c generator field lead to automotive voltage regulator is bypassed by a capacitor. Capacitor lead is soldered to lead-field winding spliced and taped. Capacitor bracket is fastened to inner surface of generator barrel at alternator end by appropriate nut, screw, and washers.

b. Application of the Flexible Metallic Bond Straps. Flexible metallic bond straps are applied with appropriate nuts, bolts, and washers in the following manner:

(1) Six 15/16" x 7" bonds are fastened between the alternator fan shroud to the engine flywheel housing (fig. 159).

(2) Four similar 15/16" x 7" bonds, are fastened to each corner of the instrument-cabinet frame to the cabinet supporting stand (fig. 159).

(3) One ½" x 3½" bond from alternator housing to neutral wire (fig. 160).

(4) One 2-½" bond of No. 18 stranded wire from automatic voltage-regulator internal filter can to automatic voltage-regulator housing base.

c. Installation of the Toothed Lockwashers. Zinc plated, internal and external toothed lockwashers are installed as a means of bonding as follows:

(1) Four ⅜" washers are installed between the end plate of exciter and exciter frame (fig. 161, section B-B, item 3).

(2) Four 5/16" washers are installed between the exciter shaft-bearing housing and the exciter end plate (fig. 161, section B-B, item 2).

(3) Four ¼" washers are installed between the exciter end plate ventilation shroud and the exciter housing (fig. 161).

(4) Twelve ¼" washers are installed between the exciter housing and the hand-hole covers at commutator end of exciter (fig. 161, section B-B, item 1).

(5) Four ¼" washers are installed between the alternator end plate ventilation shroud and the alternator housing (fig. 161, section A-A).

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(6) Eight ¼" washers are installed between the alternator fan shroud and alternator housing (fig. 161, section C-C).
(7) Four ¼" washers are installed between the upper alternator fan shroud and lower fan shroud (fig. 161).
(8) Eight 5/16" washers are installed between the hinged cover on the alarm relay box and the alarm box (fig. 161, section E-E).
(9) Four No. 10 washers are installed, between the alarm relay box and the relay mounting plate (fig. 161, section F-F).
(10) Two 9/16" washers are installed between the mounting plate of alarm relay box and engine block (fig. 161, section G-G).
(11) Two ⅜" washers are installed between the alarm light panel and the engine block (fig. 161, section H-H).
(12) Eight ¼" washers are installed between the metal partition in the load terminal box and the angle frame (fig. 156, detail A).
(13) Four 5/16" washers are installed between the mounting frame of the copper-oxide rectifier unit and the angle frame of instrument panel (fig. 162, section B-B).
(14) Eight No. 10 washers are installed between the voltage regulator and the instrument panel, and four No. 10 washers are installed on the grounding terminals of the voltage regulator (fig. 163, item 1).
(15) Four No. 10 washers are installed between the manual voltage-control rheostat and instrument panel (fig. 162).
(16) Eight ¼" washers are installed between the instrument panel and the cabinet frame (fig. 162).

d. Contact Bonding.

(1) Contact bonding is acquired by means of prepared surfaces. The automatic voltage regulator cover is bonded to the lips of the rheostat switch mounting by cleaning the regulator cover and tinning the lip cover areas (fig. 163, detail B).
(2) Contact bonding by means of brush bonds:

(a) The exciter armature shaft coupling is bonded to the exciter frame by two low-resistance copper carbon brushes in assemblies which are fastened by appropriate washers and nuts of exciter mounting studs on horizontal centerline of a-c generator end plate (fig. 164).

(b) The alternator-rotating-field shaft is bonded at the fan end to the alternator housing by two low-resistance copper carbon brushes in assemblies that are spot welded to the steel strip extending horizontally across the alternator and above the shaft. Steel strips are fastened to opposite sides of alternator housing by appropriate nuts and bolts. The shaft is grounded by two copper brushes in assemblies, pressure contacting the cleaned surface of the rotating shaft. The brush assemblies are grounded by two 1" x 10" flexible metallic bond straps, one for each brush assembly to a steel strip. The bonds are fastened to the brush assemblies by appropriate bolts and washers and to the steel strip by bolts and washers used in fastening the steel strip to the alternator housing (fig. 165).
(3) Contact bonding by means of dowel pins: Diesel engine-mounting legs bonded to main frame. Holes were drilled through each of the four mounting legs and then taper reamed. Taper pins were inserted to make good contact with all reamed surfaces.

e. Shielding leads. The following current carrying leads are shielded, the shielding being grounded at each terminus of the leads:
(1) Two separate shields of copper braid inclosing leads from O and M terminals of the automatic voltage regulator to the manual voltage-control rheostat, with the shielding grounded to the rheostat and grounded at the regulator end by a common ground lead from regulator to terminal block (fig. 162, item 8, and fig. 163).
(2) A shielded lead is installed from the exciter brush rigging to the alternator slip-ring brush with shielding grounded to the exciter end and to the alternator end plate (fig. 157 and fig. 158).
(3) A shielded lead is installed from the alternator slip-ring brush assembly to the automatic voltage regulator terminal block, with the shielding grounded to the alternator end plate and to the regulator terminal block (fig. 157 and fig. 163).
(4) A shielded lead is installed from the exciter field to the automatic voltage regulator,

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with the shielding grounded to the exciter field at the bolt mounting the exciter field bypass capacitor and grounded at voltage regulator in common connection with lead grounding slip-ring shield to automatic voltage regulator (fig. 157 and fig. 163).

(5) A shielded lead is installed from the exciter interpole winding to the alternator slip-ring assembly, with the shielding grounded to the alternator end plate and to interpole winding (fig. 157).

f. Shielding by Means of Expanded Mesh Metal.

(1) The slotted openings at the alternator end of the exciter housing are shielded by an expanded mesh metal band which is fastened to the exciter frame by appropriate nuts, screws, and washers (fig. 166, detail A).

(2) The lower hand hole opening at the commutator and at the exciter barrel is shielded by an expanded mesh metal band which is welded to the lower edges of left and right exciter hand-hole covers (fig. 166, detail B).

g. In event of the removal of any parts of the power unit which make it necessary to take off any of the special contact washers, these should be replaced with new ones and must be reinstalled exactly as they were originally.

102. PROCEDURE FOR STORING POWER UNITS. When a power unit is not to be used for thirty days or more it should be stored in a dry and protected place. The following procedure should be followed. The lubrication precautions should be repeated every six months.

a. Wash or clean and completely lubricate the engine.

b. Drain the lubricating oil from the governor and refill with new oil.

c. Drain the fuel oil from the primary and secondary fuel oil filters by removing the plugs installed for this purpose. Replace the plugs and fill the two filters with one of the following flushing oils leaving the vents open during this operation: Gulf Oil Corporation No. 301, Shell Latus No. 22 Oil, Formula No. 11326 Standard Oil Co., No. 8504 or E-382 Socony Vacuum Oil Co., and Capella Oil, AA. In emergencies a flushing oil mixture of one half kerosene and one half good grade of light lubricating oil can be used. Vent the secondary fuel oil filter.

d. Connect the drum side of the two-way supply valve to a container of flushing oil of about one gallon capacity.

e. Start and run the engine using the flushing oil for about five minutes to insure a complete flushing operation.

f. Stop the engine and drain the flushing oil from the fuel oil filters and disconnect the supply connection to the flushing oil container.

g. Drain the water from the cooling system.

h. Remove the injection nozzles and pour one tablespoonful of SAE-50 lubricating oil of good grade through the nozzle opening into each cylinder. Replace the injection nozzles.

i. Remove the valve housing cover and spray oil over the valves and valve rocker mechanism and replace the cover.

j. If the exhaust system has been dismantled, cover the manifold opening carefully. If not dismantled, cover the exhaust opening to the atmosphere to prevent moisture from entering the manifold.

k. Apply a complete but thin coating of Light Rust Preventative Compound per U. S. Army Specifications No. 2-84 or equivalent, to all exposed unpainted parts such as threads, nuts, silencer, and exhaust piping. Use a brush to apply the compound being careful not to wet any rubber parts.

l. Remove the storage batteries and check each cell for the charged condition. If the batteries do not show a full charge, have them charged. If the power unit is not to be stored for over 60 days it will be satisfactory to leave the electrolyte in the batteries but after 30 days the condition should be checked again and a charge applied if necessary. If the storage period is to be longer than 60 days, the electrolyte should be drained out of the batteries and each cell rinsed out with water. Preserve the electrolyte in glass or crockery containers, *not metal,* and store it where the temperature will not be less than 0° F. If the electrolyte has not been drained out of the batteries they should be kept well charged and stored where the temperature is not less than 0° F. Note that these tem-

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peratures are satisfactory for an electrolyte in or taken from a fully charged battery. Otherwise batteries containing electrolyte or separate electrolyte must be stored at temperatures not less than 32° F.

m. Place a protective covering over the entire unit.

103. PREPARATION FOR SERVICE AFTER STORAGE. To restore units to service after storage proceed as follows:

a. Remove the injection nozzles and pour about two tablespoonfuls of a mixture of one half fuel oil and one half SAE-10 lubricating oil into each cylinder. Do not replace nozzles. See subparagraph **d** below.

b. Remove the valve housing cover and flush the valves and valve rocker mechanism with the same mixture.

c. Install and connect the storage batteries, checking the charged condition.

d. Crank the engine electrically until the excess oil has been blown out of the nozzle openings. This operation will loosen any tight piston rings and remove any oil that has become gummed.

e. Replace the injection nozzles being sure that they are clean and in good condition. Inspect the tips to see that no carbon deposit is present.

f. Clean the power unit thoroughly.

g. Install new filtering elements in the primary and secondary lubricating oil filters and examine the filtering element in the secondary fuel oil filter and if this element shows any muck or a dirty glaze replace it.

h. Check the oil level in the governor.

i. Fill the cooling system with water or an antifreeze solution to suit operating conditions.

j. Remove all coverings from the exhaust pipe openings.

k. Fill the fuel tank or connect the two-way supply valve to an outside source of fuel oil.

l. Start the engine and let it run slowly. Observe if any valves are sticking and if so pour a small quantity of fuel oil or kerosene on the valve stems until the valves become loose.

m. Replace the valve housing cover.

CAUTION: DO NOT ACCELERATE THE ENGINE RAPIDLY OR OPERATE IT AT HIGH SPEED IMMEDIATELY AFTER STARTING.

103.1 MOISTUREPROOFING AND FUNGIPROOFING.

a. General. Communication failures commonly occur when Signal Corps equipment is operated in tropical areas where temperature and relative humidity are extremely high. Fungus growth can cause trouble where high voltages are present, to coils and to surfaces making an electrical contact. Unfortunately, the varnish used for fungiproofing spray acts as an insulator. Therefore it cannot be used on commutators, slip rings, relay contacts, voltage regulators, cable connectors, outlet connections, etc. These parts will have to be kept clean by the use of sandpaper or crocus cloth. Although generator windings are adequately protected against moisture, it is advisable to use the spray method at monthly intervals, taking precautions to mask the bright surfaces prior to the spraying. The following problems are typical:

(1) Resistors and capacitors fail.

(2) Electrolytic action takes place in coils, chokes, transformer windings, etc., causing eventual breakdown.

(3) Hook-up wire and insulation break down. Fungus growth accelerates deterioration.

(4) Moisture forms electrical leakage paths on terminal boards and insulating strips causing flash-overs.

(5) Moisture provides leakage paths between battery terminals.

b. Treatment. A moistureproofing and fungiproofing treatment has been devised which, if properly applied, provides a reasonable degree of protection against fungus growth, insects, corrosion, salt spray, and moisture. The treatment involves the use of a moisture and fungi-resistant varnish applied by means of a spray gun. A brief description of the method of application follows:

(1) All repairs and adjustments necessary for the proper operation of the equipment are made.

(2) Equipment to be processed is thoroughly cleansed of all dirt, grease, rust, fungus, oil, etc.

(3) Equipment is partially disassembled and certain points, such as points, contacts, bear-

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ings, are covered with masking tape.

(4) Equipment is thoroughly dried by heat to expel moisture which the circuit elements have absorbed.

(5) All circuit elements and all parts of the equipment are sprayed or painted with three coats of moistureproofing and fungiproofing varnish.

(6) The equipment is given a final operational check.

c. Step by step instructions.

(1) **Disassembly.**

(a) Remove 14 screws holding back plate to control panel box.

(b) Remove back plate (to be treated).

(c) Remove 24 screws holding cover to control panel box.

NOTE: If pipe frame interferes with removal of certain screws, pry up or load down box with weights until screws are in position for removal.

(d) Lift off cover from control panel box (to be treated).

(e) Remove leads from battery charging ammeter.

(f) Remove leads from frequency meter.

(g) Remove leads from voltmeter.

(h) Remove leads from ammeter.

(i) Remove leads from elapsed time meter.

(j) Remove nuts holding bridge over battery charging ammeter.

(k) Remove battery charging ammeter (to be treated).

(l) Remove 3 bolts holding frequency meter to panel.

(m) Remove frequency meter (to be treated).

(n) Remove 3 bolts holding voltmeter to panel.

(o) Remove voltmeter (to be treated).

(p) Remove 3 bolts holding ammeter to panel.

(q) Remove ammeter (to be treated).

(r) Remove 3 bolts holding elapsed time meter to panel.

(s) Remove elapsed time meter (to be treated).

(t) Remove upper and lower covers of voltage regulator (to be treated).

(2) **Masking.**

(a) Mask with tape all connecting lugs on lead wires removed in (l) above.

(b) Mask contacts on battery charging switch with tape.

(c) Mask with tape the contact surface of dimming rheostat.

(d) Mask with tape the two contact points in voltage regulator.

(3) **Drying.**

(a) Use infra-red lamps to dry interior of control panel box and voltage regulator.

(b) Dry for 2 to 3 hours at 160° F.

(c) Dry detached parts for 2 to 3 hours at 160° F.

(4) **Varnishing.**

(a) Apply 3 coats of moistureproofing and fungiproofing varnish as follows:

1. Spray reverse side of panel and all components left on it.
2. Spray battery charging rectifiers.
3. Spray voltage regulator.
4. Spray inside of voltage regulator covers.
5. Spray inner surface of control panel box cover and rear plate.
6. Treat meters according to instructions given in TM 11-472.

CAUTION: Varnish spray may have toxic effects. Use respirator if available. Otherwise fasten cheesecloth or other cloth material over nose and mouth.

(5) Reassemble and check operation of unit.

(6) Mark MFP and date of treatment.

d. Reference. For a full description of the varnish spray method of moistureproofing and fungiproofing refer to TB SIG 13.

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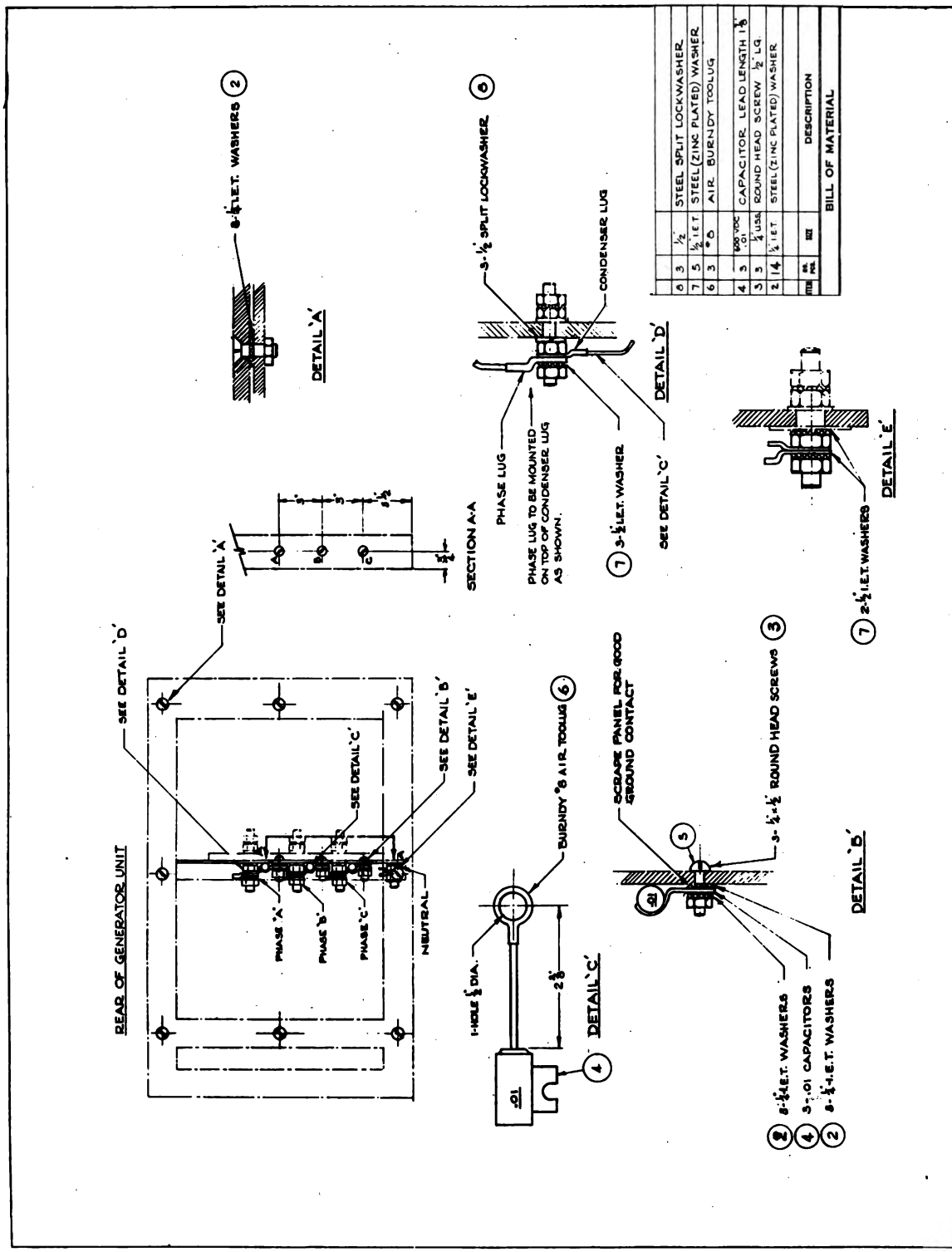

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Figure 156. Application of capacitors to panel terminals to panel grounding.

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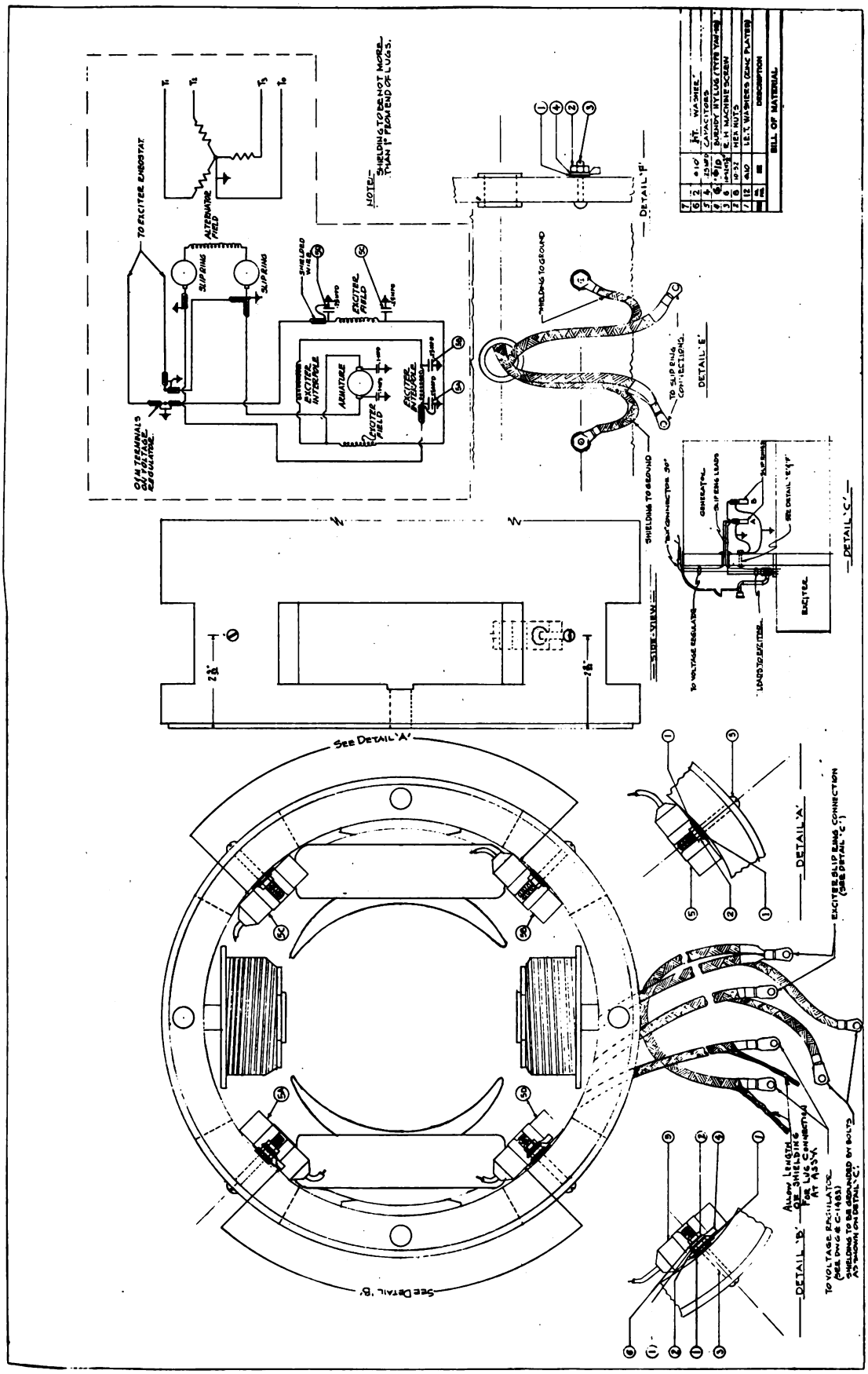

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Figure 157. Exciter components for radio-noise suppression.

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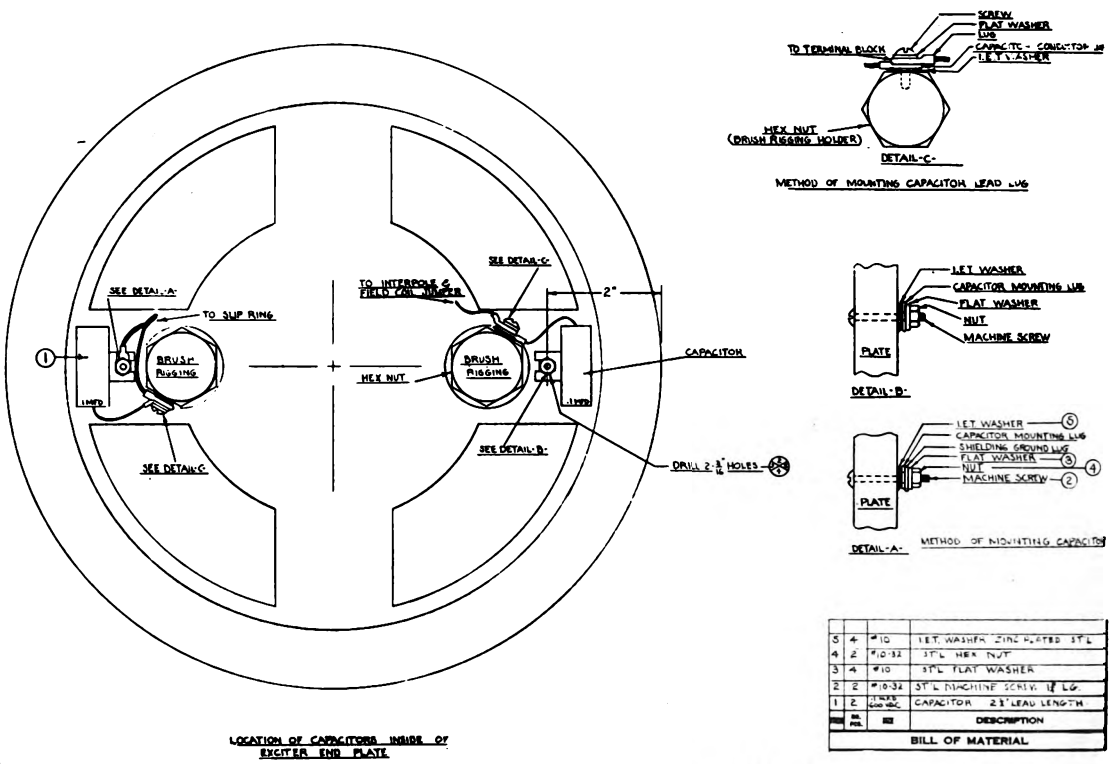

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Figure 158. Application of capacitor to exciter brush holder.

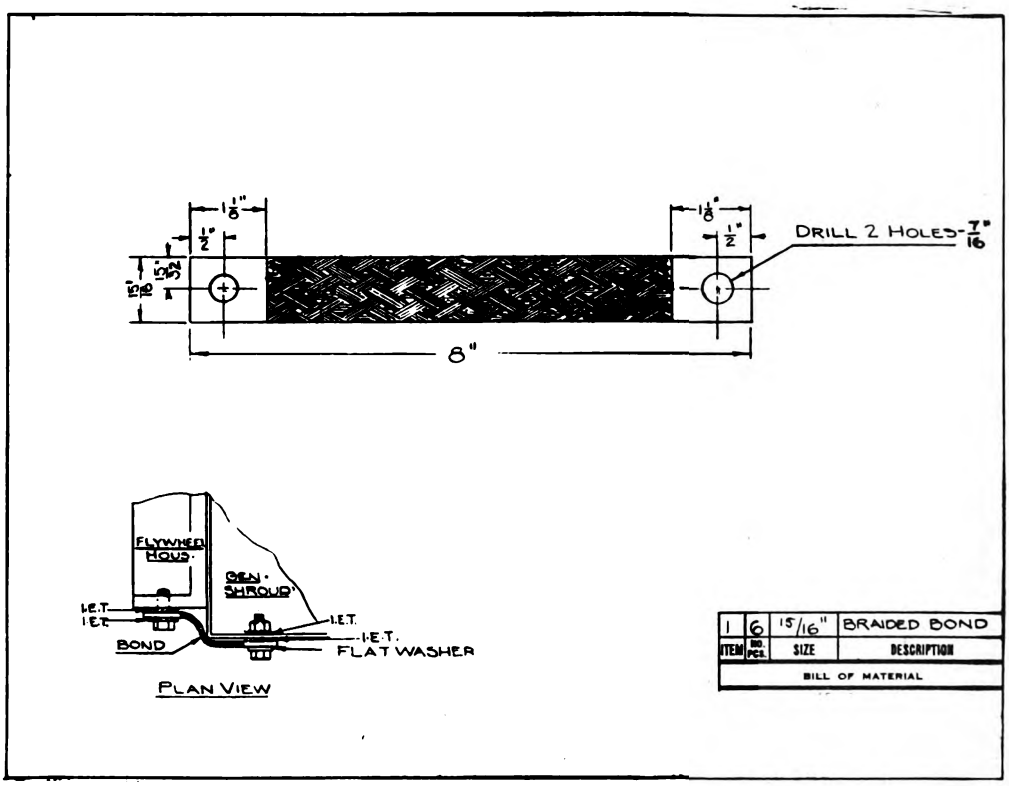

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Figure 159. Ground strap for generator shroud.

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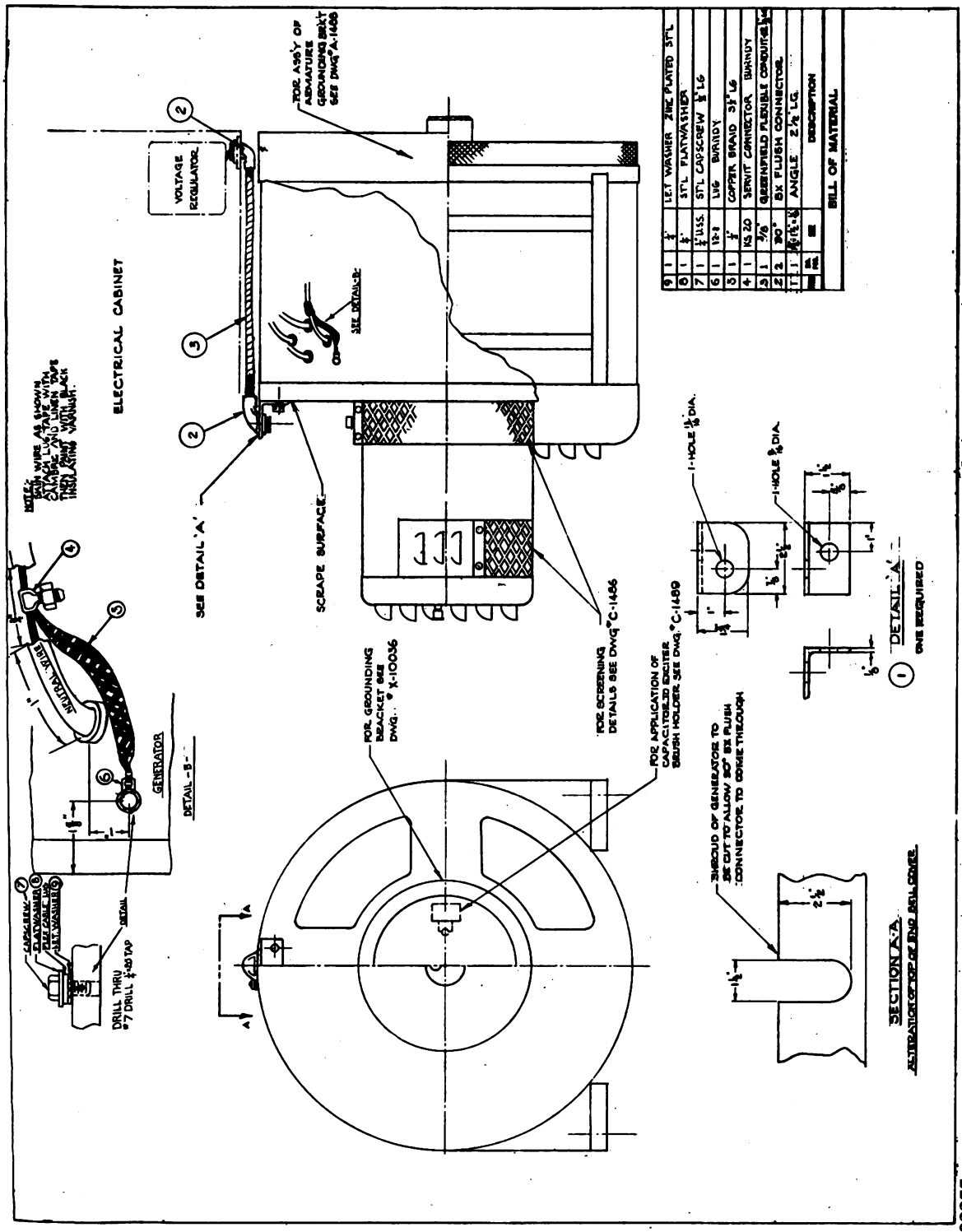

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Figure 160. Exciter-alternator-rollage regulator radio-noise suppression.

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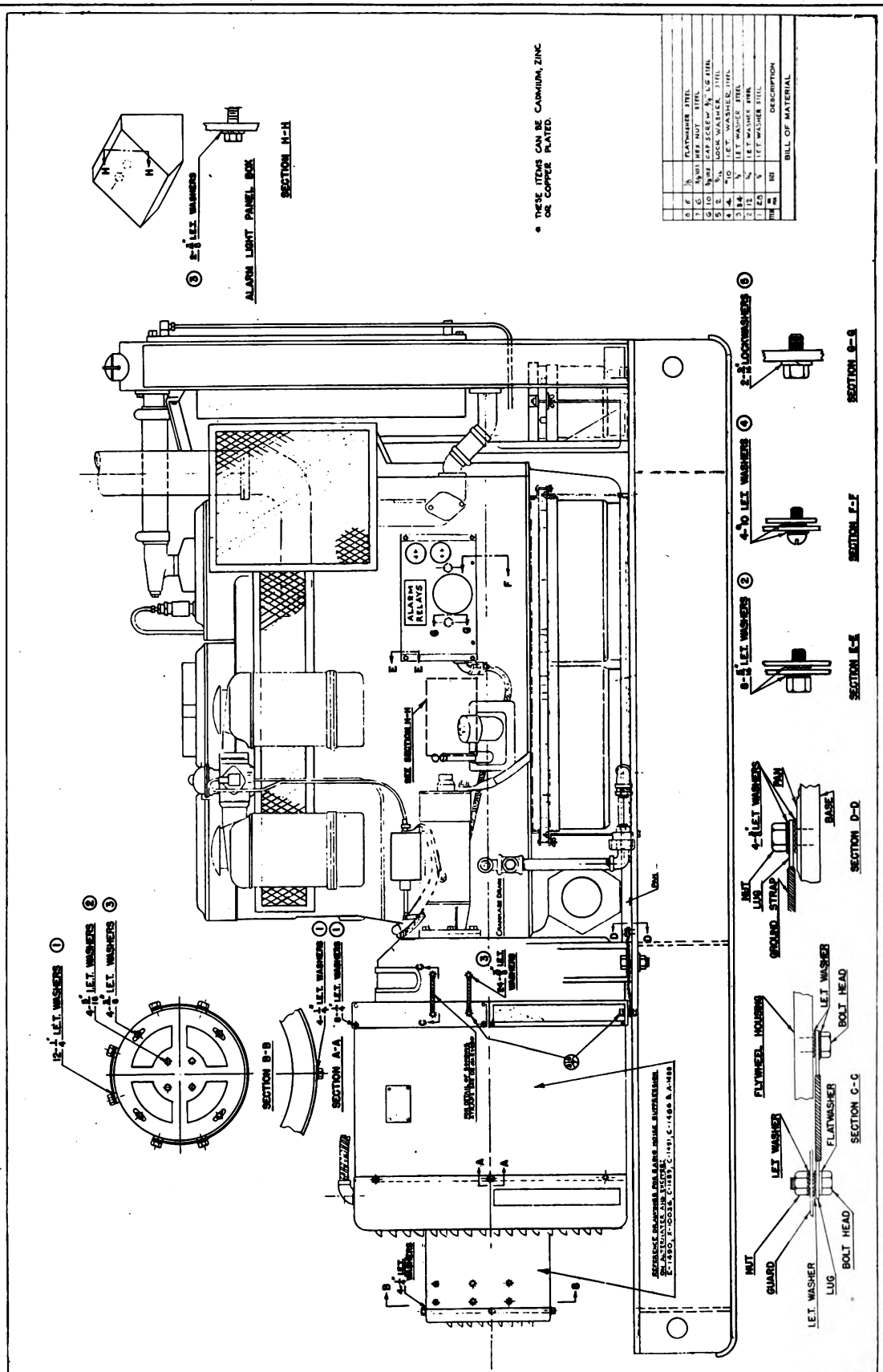

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Figure 161. General external application of I. E. T. washers and bond for radio-noise suppression.

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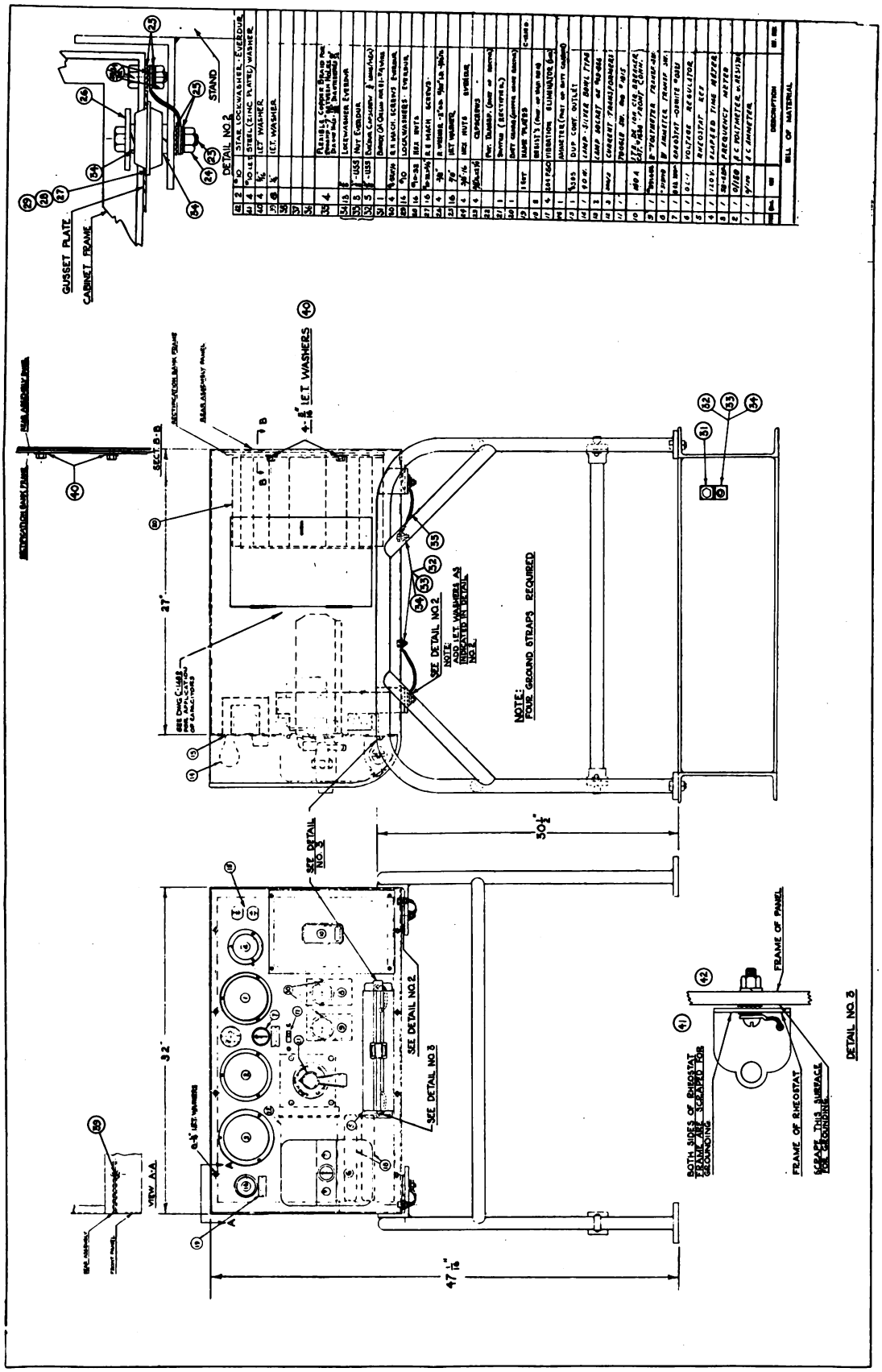

Figure 162. Assembly of switch cabinet with application of radio-noise suppression.

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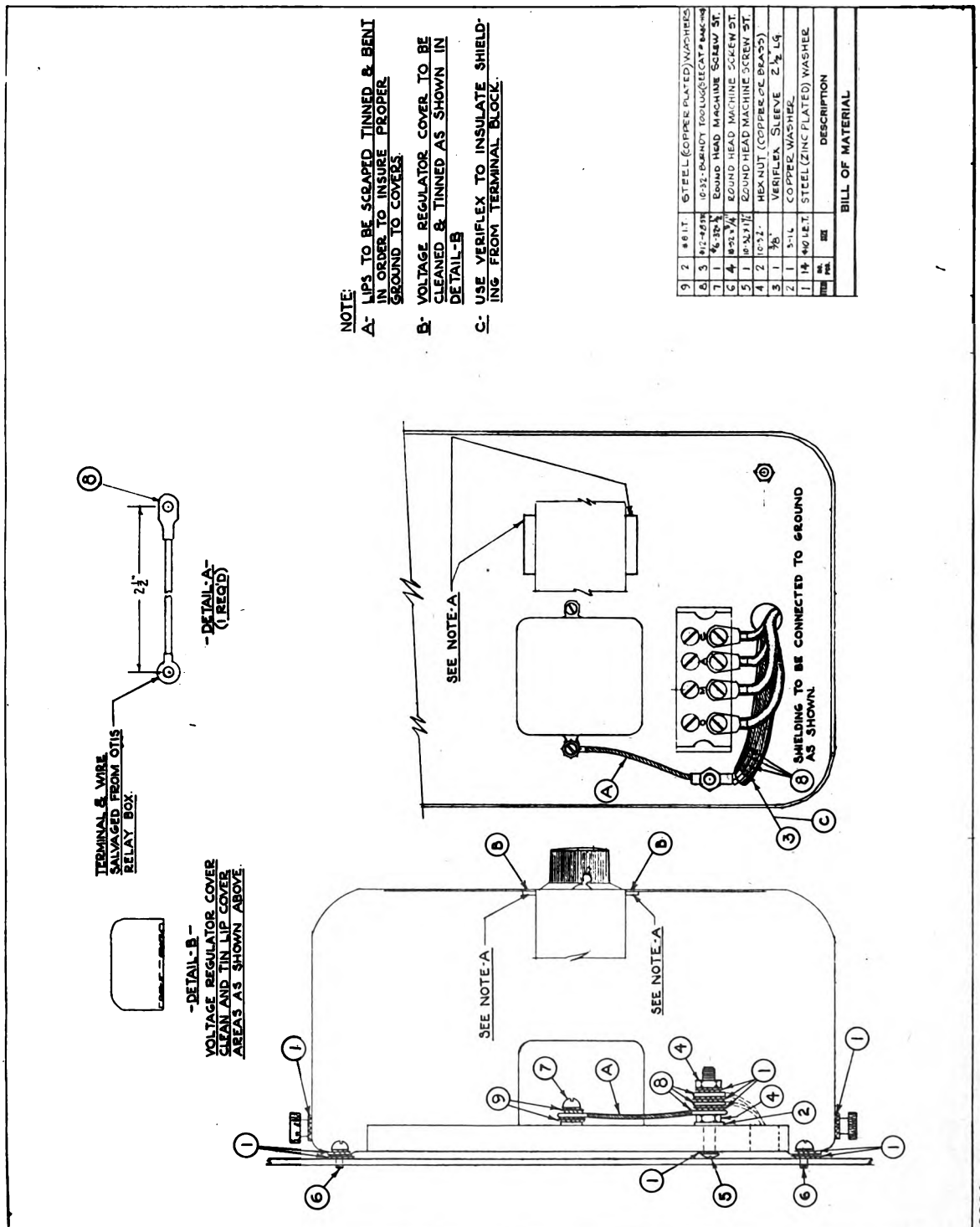

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Figure 163. Grounding of voltage regulator for elimination of radio interference.

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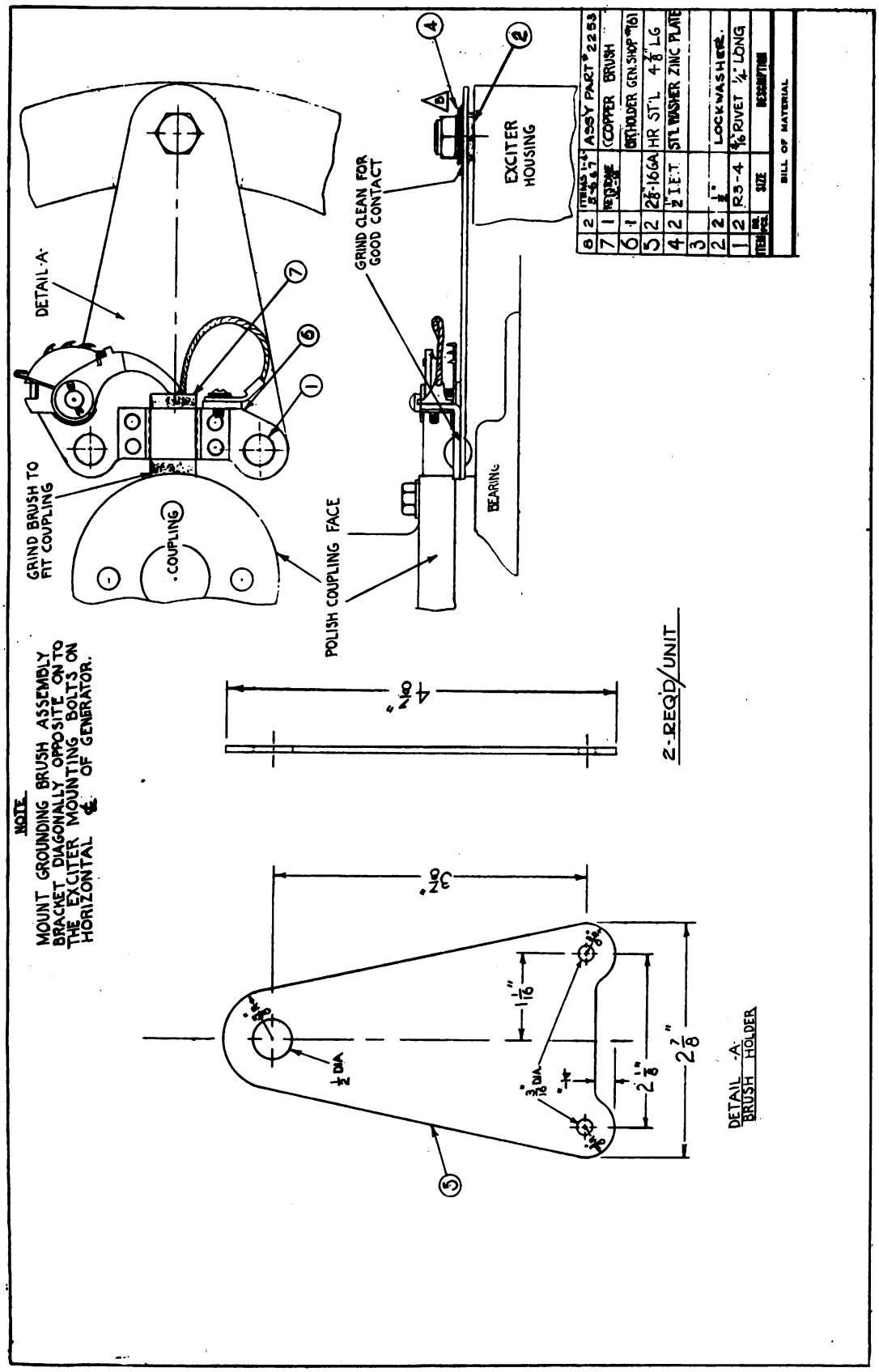

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Figure 164. Assembly and detail of armature ground bracket.

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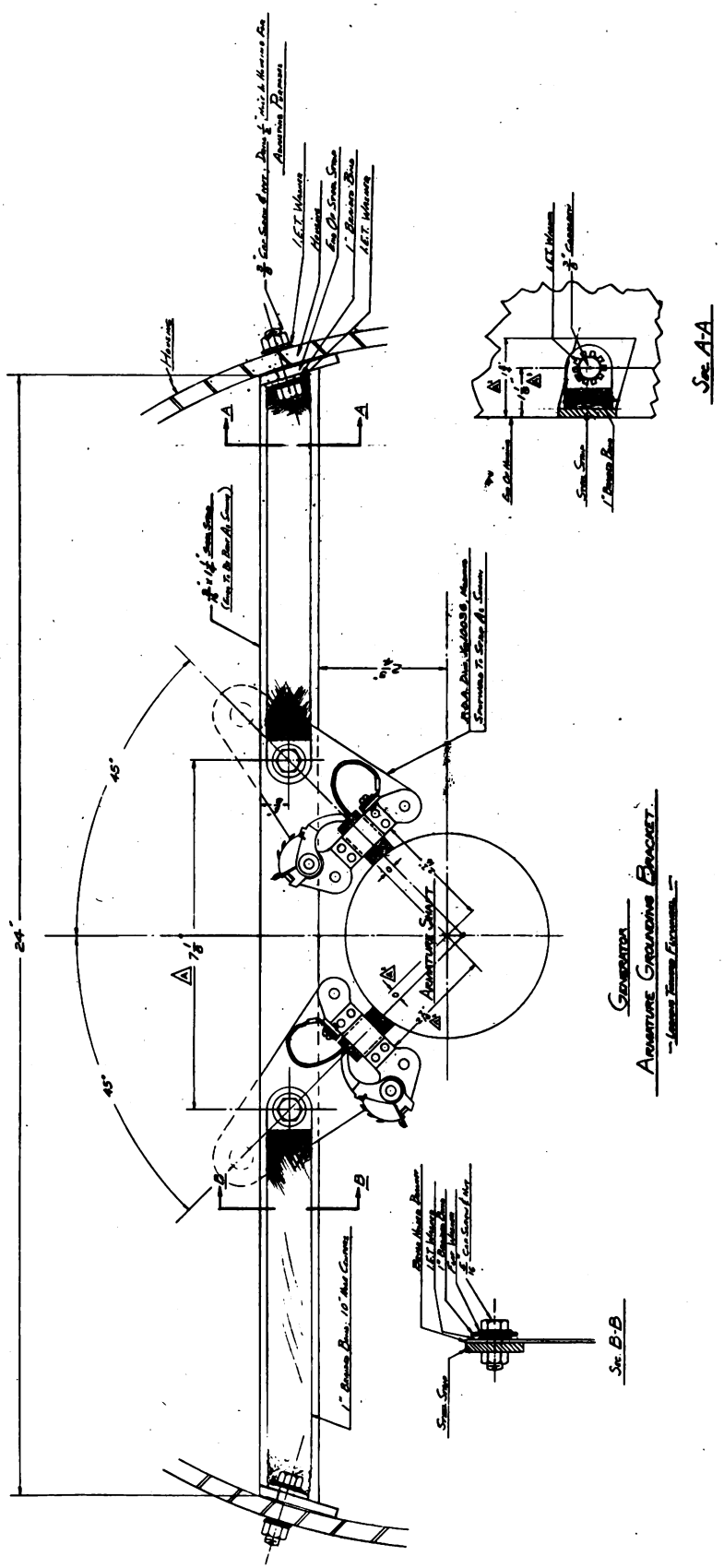

Figure 165. Assembly of generator-armature-grounding bracket.

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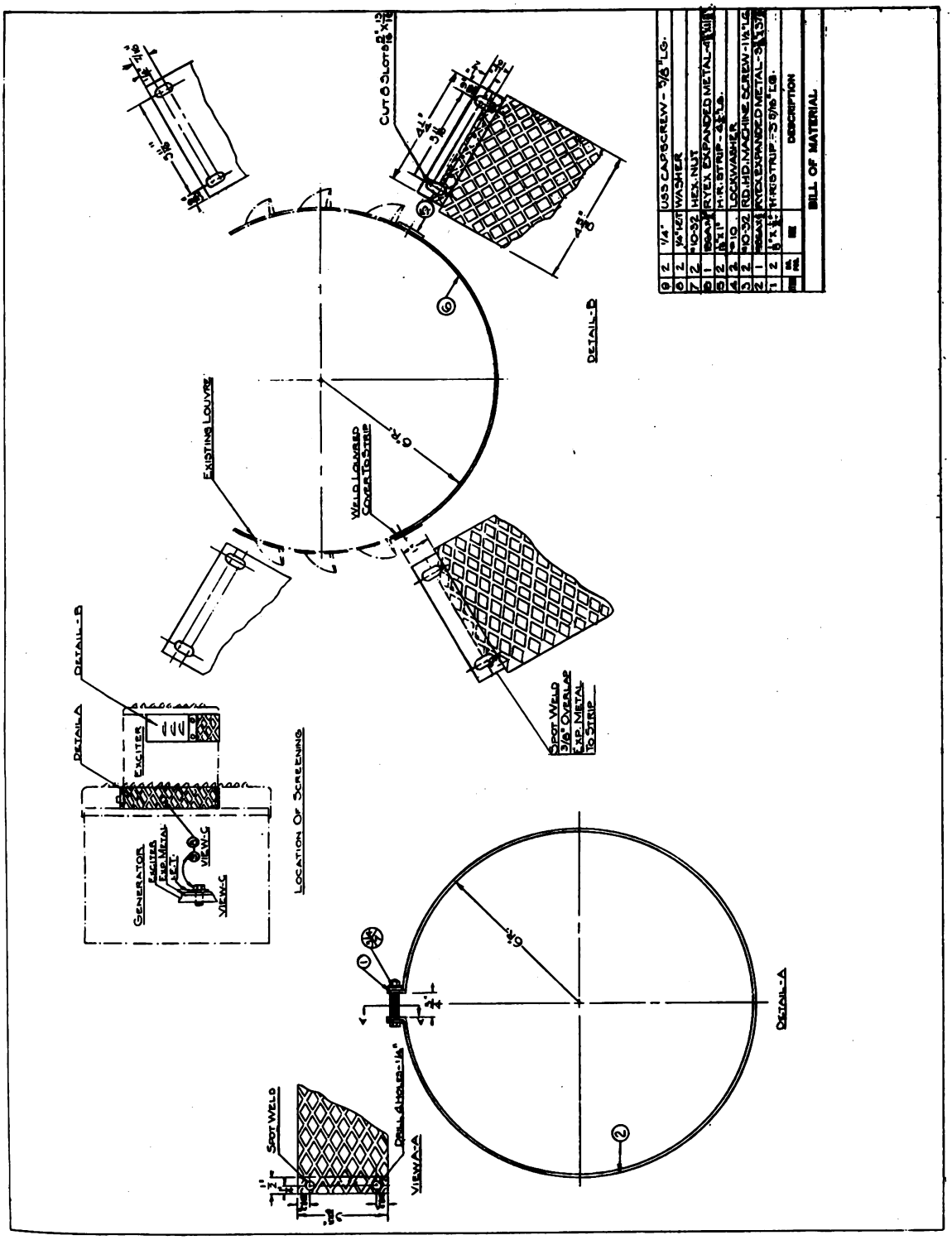

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Figure 166. Screening details for exciter.

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Section V
SUPPLEMENTARY DATA

104. MATERIAL LIST FOR POWER UNIT PE-245-A. The following is a list of standard commercial assemblies incorporated in the power unit. This list also includes the names of the manufacturers of the parts.

Name of Part and Description	*Manufacturer*
Acid, battery, 2 carboys, packed separately.	Electric Storage Battery Co.
Battery, jumpers, and leads, 5 6-volt wet type XHM-25.	Electric Storage Battery Co.
Coupling, flexible, engine to generator, type 312SS.	Thomas Flexible Co.
Engine, model HI-600, spec H-26.	Cummins Engine Co.
Filter, air, oil bath type A-2107.	Donaldson Air Filter Corp.
Filter, fuel oil, primary, edge type D.	Cuno Engineering Co.
Filter, fuel oil, secondary, cartridge type F-10.	Briggs Clarifier Co.
Filter, lube oil, primary, nugent bag type S-1953.	Cummins Engine Co.
Filter, lube oil, secondary, cartridge type DF-2470.	Deluxe Products Corp.
Pump, fuel, distributor type H-90909-5.	Cummins Engine Co.
Generator, type S110, 25 kw A.C.	Rogers Diesel & Aircraft Co.
Governor, type B-SG, model C40305.	Woodward Governor Co.
Hose, auxiliary fuel, 20′ length, flex, with stand pipe.	Rogers Diesel & Aircraft Co.
Radiator, sectional core, type R-1983C.	Perfex Radiator Corp.
Silencer, exhaust, model MUC No. 7.	Maxim Silencer Corp.
Silencer, hose, flexible, 4′ length, 4″ diam.	Rogers Diesel & Aircraft Co.
Packing, silencer flange, ½″, asbestos.	Maxim Silencer Corp.
Motor, starting, model 711.	Delco-Remy Corp.
Switch, alarm, oil pressure, model 2500, type 260AP14X.	Penn Electric Switch Co.
Switch, alarm, water temperature, model 1400, type 262AT04X.	Penn Electric Switch Co.
Switchboard, generator control panel. See parts section for complete list.	Rogers Diesel & Aircraft Co.
Tank, fuel, 21-gallon capacity.	Rogers Diesel & Aircraft Co.

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105. ACCESSORIES.

Amount	*Name of Part and Description*
1	Extinguisher, fire, model 15, hand, carbon dioxide.
1	Lamp, extension, with bulb, Protex A-15'.
1	Can, oil, 2-gallon, portable, lube oil.
1	Can, oil, 5-gallon, portable, fuel oil.
2	Jumpers, battery, 00 cable with lugs, 7" long.
2	Jumpers, battery, 00 cable with lugs, 17" long.
1	Cable, starting, disconnected, negative lead —00 cable.
1	Tubing, copper, ¼", 25-ft roll.
1	Tubing, copper, 5/16", 10-ft roll.

106. **TOOL KIT.** This material is processed and packed in wooden tool box.

Amount	*Name of Part and Description*
1	Box, tool, 15" x 18" x 11¾" (RDA-3-1429).
2	Book, instruction, preliminary TM 11-930.
1	Hydrometer 51B.
1	Wrench, injector cup, spline (CECO H-5437).
1	Wrench, Allen, ¼" (CECO S-33).
1	Kit, cleaning, injector cup, wire brush-pin vise and drill wire ⅝" x 12" (S-17).
1	Pliers, No. 38, 8" slip joint.
1	Screwdriver, 10" blade.
1	Screwdriver, 6" blade.
1	Wrench, adjustable, 10".
1	Can, oil 8-oz, with carving clip.
1	Shellac, 1-pint can, and brush.
1	Pins, cotter, box, assorted sizes.
1	Depressor, spring, valve spring compressor.
1	Hammer, 1-lb, ball peen.
1	Wrench, open end, ⅜" x 7/16" (723).
1	Wrench, open end, ½" x 9/16" (725-B).
1	Wrench, open end, 19/32" x 11/16" (27).
1	Wrench, open end, ⅝" x ¾" (729).
1	Wrench, open end, 25/32" x ⅞" (31).
1	Wrench, open end, 13/16" x 1" (732).
1	Wrench, open end, 15/16" x 1-1/16" (34A).
2	Sandpaper, sheet No. 00.
1	Tape, roll, 1" asbestos tape, 100-ft.
1	Wire, 5-ft length, No. 10 gauge, soft iron.
1	Handle, barring, engine (CECO H-9544).
1	Gauge set, 4" feeler, 0.0015", 0.003", 0.004", 0.006", 0.008", 0.010", 0.013", 0.020".
1	Punch, ⅜" pin.
1	Wrench, box socket, 1-5/16" x 1".

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107. SUPPLEMENTARY TOOL KIT SUPPLIED FOR EACH STATION.

Amount	*Part No.*	*Name of Part and Description*
1	NY6077A	Puller and inserter, bushing, upper valve rocker.
1		Extension, 8" long, ¾" drive, snap-on.
1		Tool, tube flaring ¼" x ½", set with tube cutter.
1		Gear puller, snap-on.
1		Compressor, piston ring.
1		Tee handle, ¾" drive, snap-on sliding.
1		Socket, cylinder-head, 1-¼", ¾" drive.
1		Socket, main bearing, 1-½", ¾" drive.
1		Socket, connecting rod, 15/16", ¾" drive.
1		Chisel, snap-on.
1		Wrench, box, 1-7/16", and open end combination.
1	NY6085	Puller, cylinder liner.
1	NY6109	Pin vise and 24 drill wires.
1	711	Valve grinder, blue point.
1 can		Valve-grinder compound (clover brand).
1		Wrench, torque, 1000 lb.
1		Adapter, snap-on, ¾" male end, 1" female.
1		Feeler strip set 10" long, 0.014", 0.022", 0.006".
2		Bolts, full thread, water pump drive pulley puller.
2		Bolts, full thread flywheel puller bolts.

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109. APPARATUS PARTS LEGEND, ILLUSTRATED.

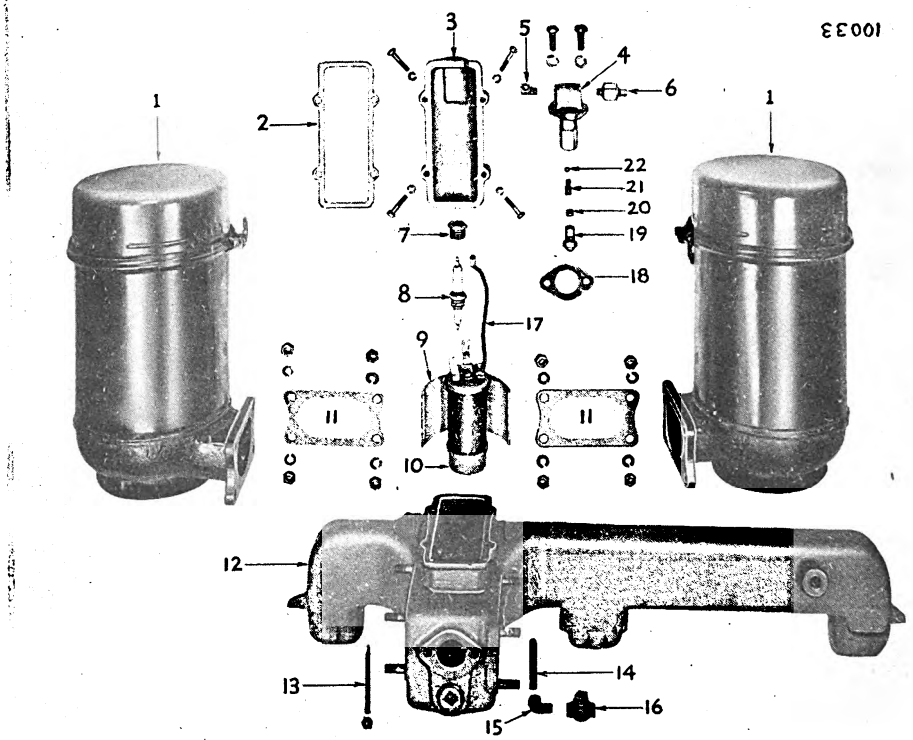

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Figure 167. Air intake manifold.

Item No.	*No. of units*	*Name of part and description*
		AIR INTAKE MANIFOLD (fig. 167)
	1	Cap screw, ⅜"—16 x ¾".
22	1	Ball, nozzle check valve.
17	1	Cable, preheater switch to ignition coil.
	4	Cap screw, ¼"—20 x 1¼", coil cover to manifold.
	2	Cap screw, retainer plate to manifold.
10	1	Coil, preheater ignition.
	1	Connection, coil to ground.
	1	Connection, terminal coil.
3	1	Cover, ignition coil.
5	1	Elbow, preheater.
	1	Elbow, preheater connection to fuel pump.
15	1	Elbow, street, priming pump to preheater tube.
13	1	Electrode, adjustable.
8	1	Electrode, stationary.
9	1	Felt, ignition coil packing.
18	1	Gasket, nozzle retainer plate.
2	1	Gasket, ignition coil cover.
	8	Lockwasher, ⅜" positive lock, air cleaner stud nut.
	1	Lockwasher, ⅝" positive lock, manifold plug.
	1	Lockwasher, No. 10, positive lock, coil ground screw.
	1	Lockwasher, ¼" positive lock, electrode retainer adjusting nut.
	4	Lockwasher, ¼" positive lock, ignition coil cover.
	2	Lockwasher, ⅜" positive lock, retainer plate to manifold.
12	1	Manifold, air intake.
14	1	Nipple, ½" x 2½", pipe.

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Item No.	No. of units	Name of part and description
		AIR INTAKE MANIFOLD (fig. 167) (Continued)
	1	Nipple, ⅛" x 2½", pipe, preheater drain.
19	1	Nozzle, preheater.
	8	Nut, ⅜"—24, air cleaner stud.
7	1	Nut, electrode retainer.
	1	Nut, ¼"—20, electrode retainer adjusting.
4	1	Plate, nozzle retainer.
	1	Plug, pipe, inspection.
	1	Screw, coil ground.
20	1	Screw, spring adjusting.
21	1	Spring, nozzle check valve.
	8	Stud, manifold, to air cleaner.
6	1	Switch, pressure.
16	1	Valve, ball check, priming pump to preheater.
	1	Strap, preheater cable.
11	2	Gasket, air cleaner.
1	2	Cleaner, air.
		CAM FOLLOWER HOUSING (fig. 168)
	3	Assembly, cam follower housing.
111	3	Housing, cam follower.
106	6	Plug, ⅞" expansion.
105	6	Screw, shaft lock.

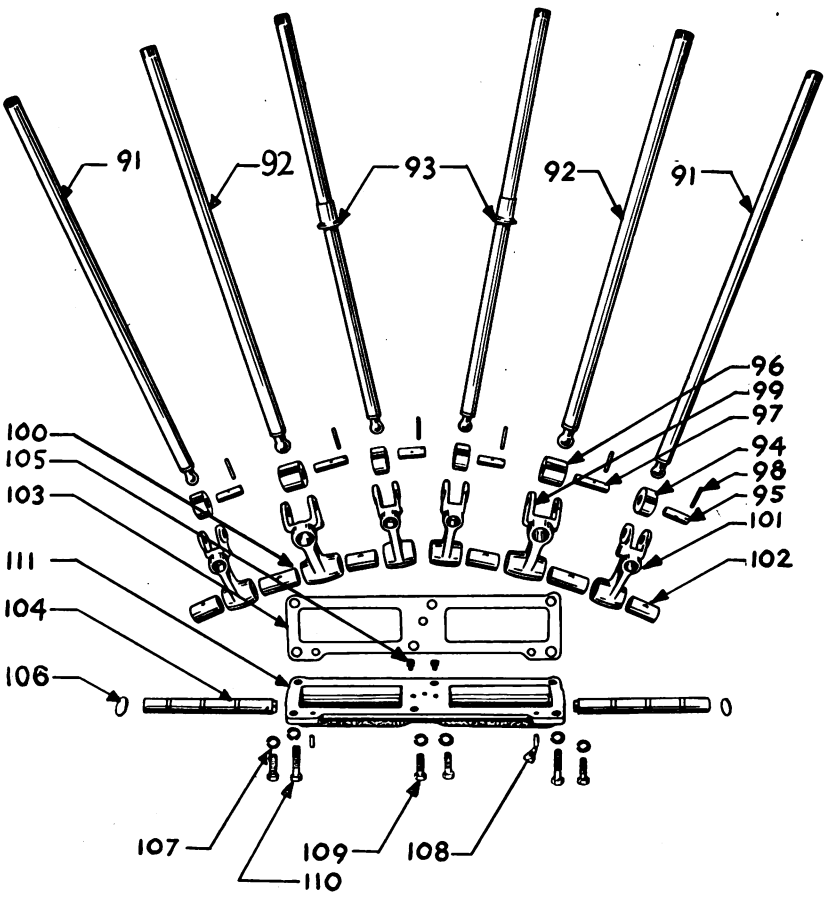

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Figure 168. Cam follower housing.

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Item No.	*No. of units*	*Name of part and description*
		CAM FOLLOWER HOUSING (fig. 168) (Continued)
104	6	Shaft, cam follower lever.
	6	Assembly, injector cam follower (includes items 96-100).
99	6	Lever and bushing, injector cam, H-9161-2 (includes item 100).
100	6	Bushing, injector cam lever.
97	6	Pin, injector cam roller.
98	6	Rivet, injector cam roller pin.
96	6	Roller, injector cam.
	12	Assembly, valve cam follower lever (includes items 94, 95, 98, 101, 102).
101	12	Lever and bushing, valve cam, H-9162-1 (includes item 102).
102	12	Bushing, valve cam lever.
95	12	Pin, valve cam roller.
98	12	Rivet, cam roller pin.
94	12	Roller, valve cam.
		Mounting parts:
109	12	Cap screw, ⅜"—24 x 1".
110	6	Cap screw, ⅜"—24 x 1½".
103	3	Gasket, cam rocker housing.
107	18	Lockwasher, ⅜" positive lock.
108	6	Pin, dowel housing.
		Push rods:
91	6	Rod, exhaust push.
92	6	Rod, injector push.
93	6	Rod, intake push.
		CAMSHAFT ASSEMBLY (fig. 169)
	1	Assembly, camshaft.
37	6	Bolt, camshaft gear.
35	1	Camshaft.
36	1	Gear, camshaft.
38	6	Nut, ⅜"—14, camshaft gear bolt.

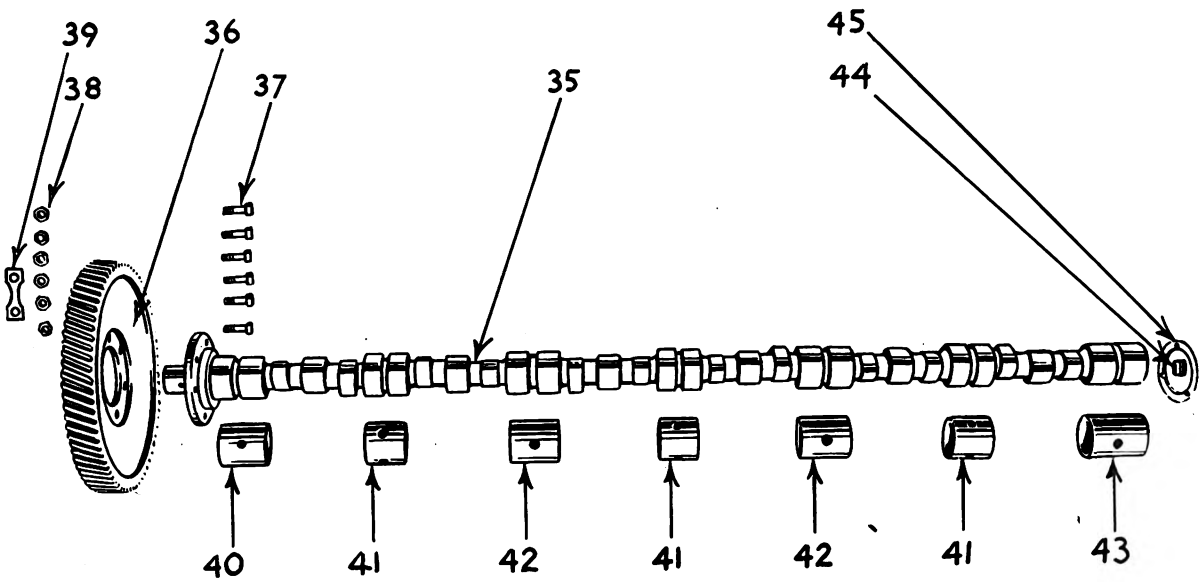

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Figure 169. Camshaft assembly.

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Item No.	No. of units	Name of part and description
		CAMSHAFT ASSEMBLY (fig. 169) (Continued)
44	1	Plug, ⅜" pipe.
39		Lockplate, camshaft gear.
45	1	Ring, camshaft thrust.
40	1	Bushing, camshaft, front.
42	2	Bushing, camshaft 3-5.
41	3	Bushing, camshaft 2-4-6.
43	1	Bushing, camshaft, rear.
		CRANKSHAFT (fig. 170)
	1	Assembly, crankshaft.
20	1	Crankshaft, bare view.
29	1	Key, crankshaft pinion.
32	1	Lock, crankshaft nut.
33	1	Nut, crankshaft.
30	1	Pin, hand cranking.
31	1	Pinion, crankshaft.
34	1	Slinger, oil.
35	3	Dowel, crankshaft flywheel.
		MAIN BEARING SHELLS (fig. 170)
26	7	Dowels, main bearing ring.
22	1	Shells, main bearing lower rear.
21	1	Shells, main bearing upper rear.
24	3	Shells, main bearing lower 2-4-6.
23	2	Shells, main bearing upper 2-6.
28	3	Shells, main bearing lower 1-3-5.
27	3	Shells, main bearing upper 1-3-5.
25	1	Shells, main bearing upper No. 4.

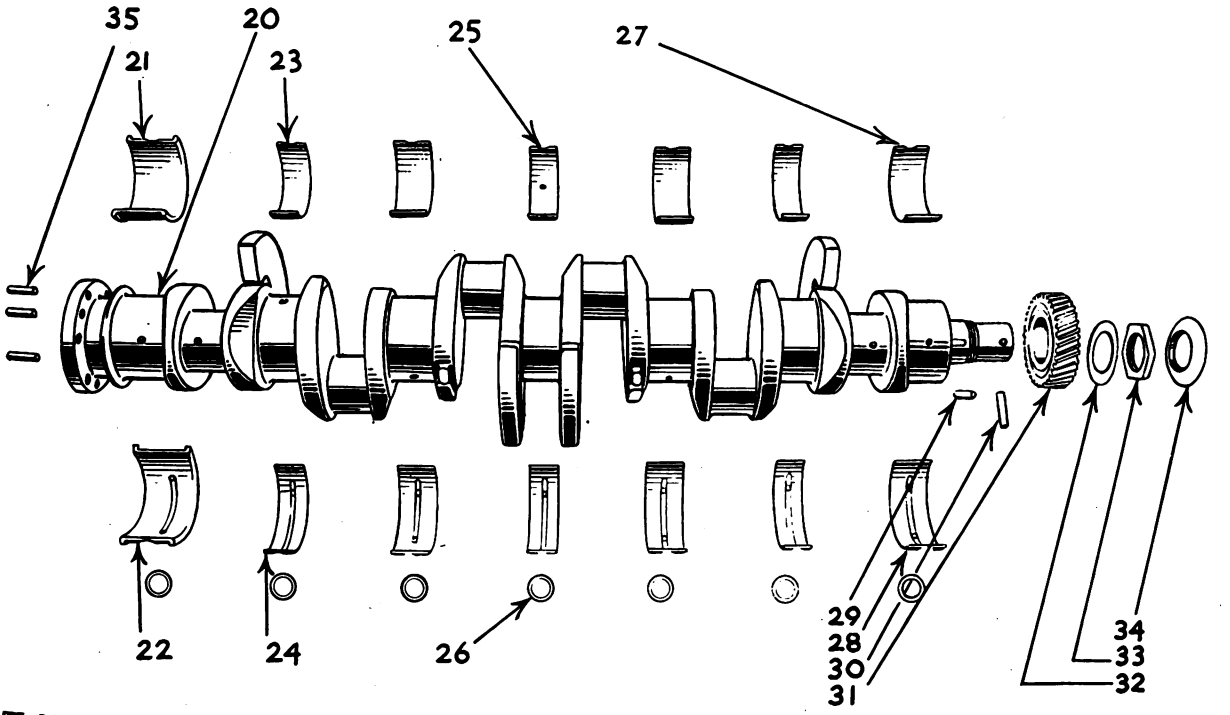

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Figure 170. Crankshaft assembly.

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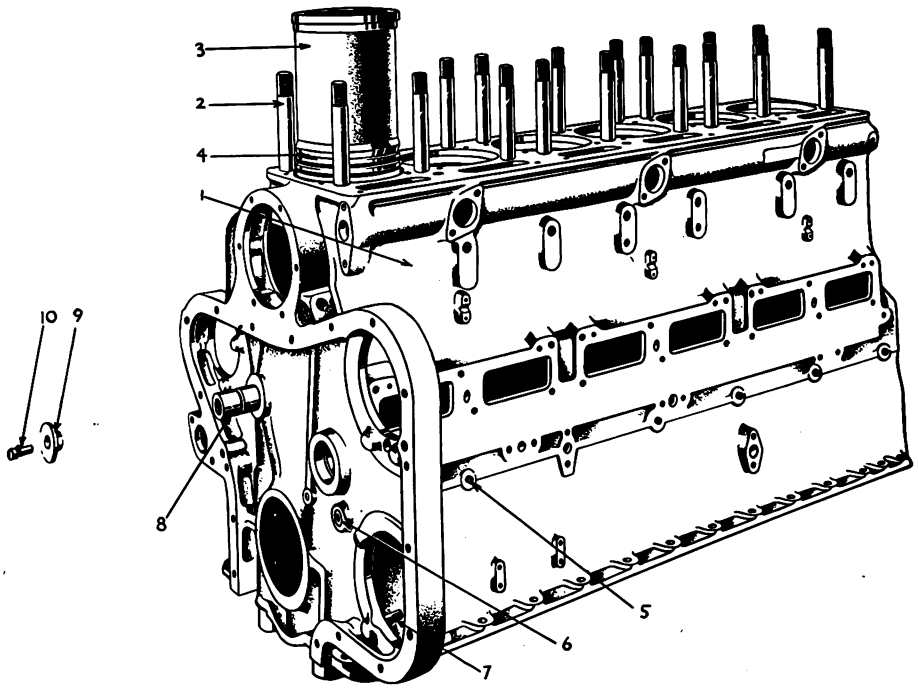

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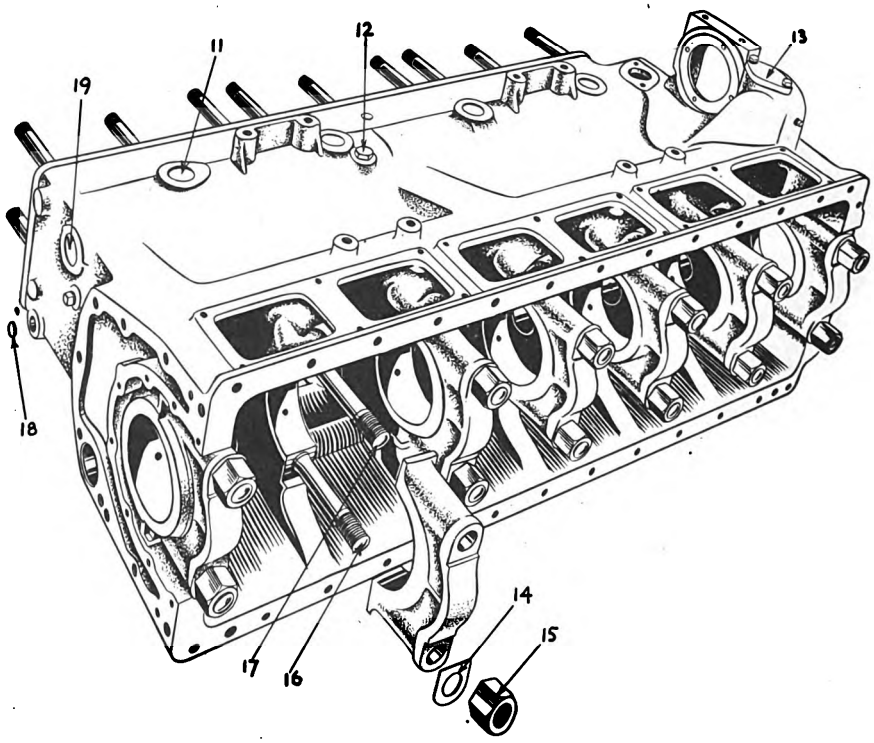
Figure 171A. Cylinder block.



TL-33760

Figure 171B. Engine block.

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Item No.	No. of units	Name of part and description
		CYLINDER BLOCK (fig. 171A) and ENGINE BLOCK (fig. 171B)
1	1	Cylinder, block studded (H-41492).
	2	Cap screw, ⅜"—16 x 1", water blind flange.
	6	Dowel, cylinder head.
	2	Dowel, flywheel housing.
	2	Dowel, gear case cover.
13	1	Flange, water blind, side.
	1	Gasket, water drain plug (for item 12, fig. 171B).
	1	Gasket, water blind flange.
	1	Gasket, generator drive hole.
27	14	Lock, main bearing stud nut.
14	2	Lockwasher, ⅜" positive lock, water blind flange.
15	14	Nut, main bearing stud.
8	1	Pin, idler gear.
18	1	Plug, 1" expansion, compression relief shaft hole.
	1	Plug, ¾" expansion, lubricating oil drain.
19	1	Plug, 1¾" expansion, water header.
11	4	Plug, 1½" expansion, water header.
	1	Plug, ¼" pipe, air discharge hole.
	1	Plug, ¼" pipe, lubricating oil drain.
5	7	Plug, ⅛" pipe, lubricating oil header.
6	2	Plug, ⅜" pipe, lubricating oil header.
	1	Plug, ¼" pipe, water drain.
	1	Plug, ½" pipe, water drain.
12	1	Plug, water header drain.
2	18	Stud, cylinder head.
7	4	Stud, lubricating pump.
17	7	Stud, main bearing.
16	7	Stud, main bearing, slotted.
3	6	Liner, cylinder.
	1	Lockwasher, ⅜" positive lock, idler lockscrew.
4	18	Packing, cylinder liner.
	1	Pin, washer lock.
10	1	Screw, washer.
	3	Tube, lubricating.
9	1	Washer, idler gear pin.
	1	Cover, generator drive hole.
	4	Cap screw, generator drive hole cover.
	4	Lockwasher, generator drive hole cover.
		CYLINDER HEAD ASSEMBLY (fig. 172)
	2	Assembly, cylinder head, valves and studs, (H-1196-5).
	1	Assembly, cylinder head, valves and studs, rear (H-1835).
77	24	Collett, valve.
78	12	Guide, valve spring.
79	12	Spring, valve.
88	6	Valve, exhaust.
89	6	Valve, intake.
84	2	Head, studded (H-1196-5).
84	1	Head, studded (H-1835) rear.
85	6	Dowel, exhaust manifold.
82	12	Guide, valve stem.
86	18	Plug, 1" expansion.
	6	Plug, ⅛" pipe.
	3	Plug, ⅜" pipe.

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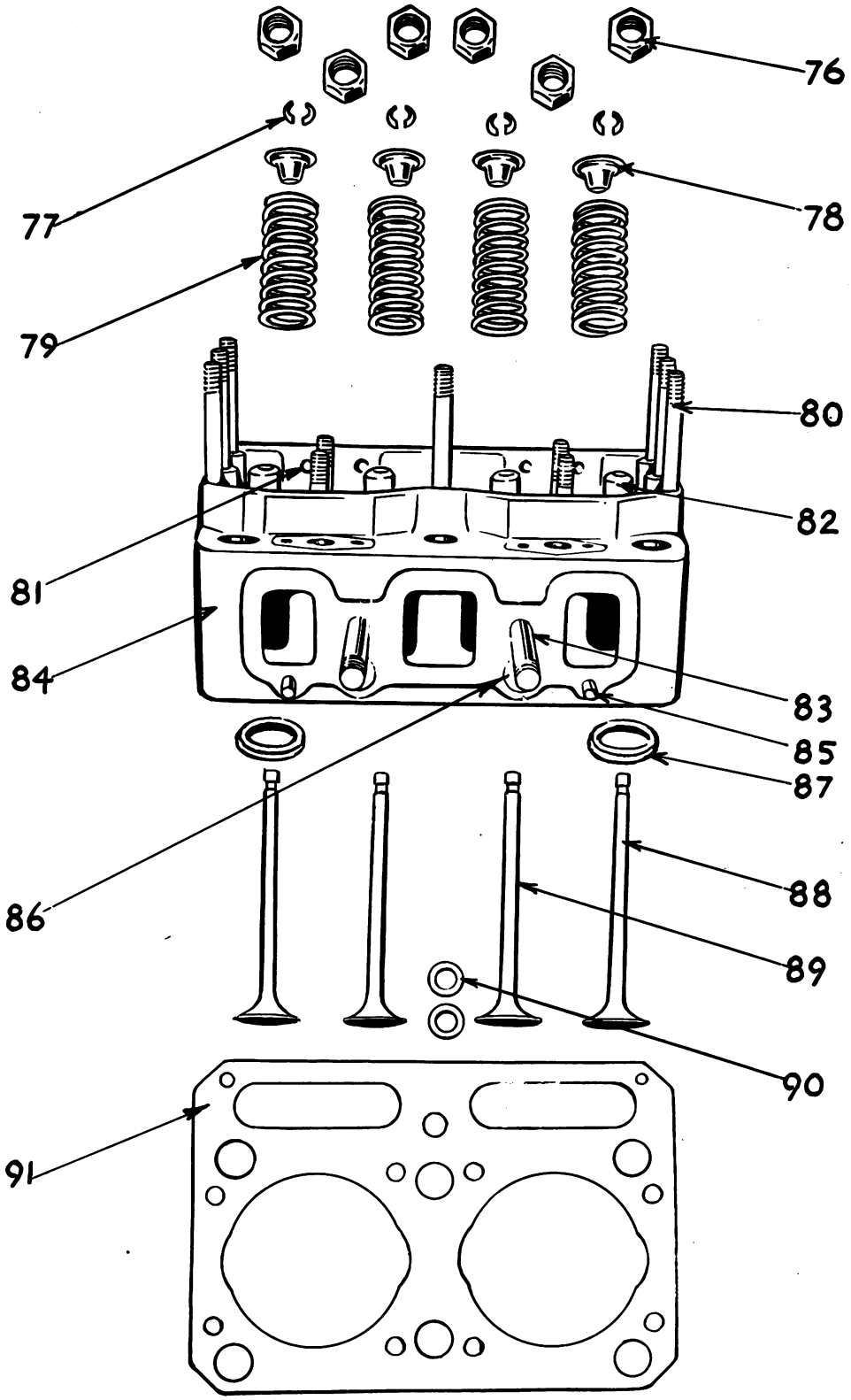

TL-33761

Figure 172. Cylinder head assembly.

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Item No.	No. of units	Name of part and description
		CYLINDER HEAD ASSEMBLY (fig. 172) (Continued)
87	6	Seat, exhaust valve.
83	6	Stud, exhaust manifold.
81	12	Stud, injector.
80	21	Stud, rocker arm housing.
		Mounting parts:
91	3	Gasket, cylinder head.
76	18	Nut, 7/8"—24, cylinder head stud.
90	6	Packing, lubricating pipe.
		COMPRESSION RELEASE ASSEMBLY (fig. 173)
74	3	Bearing, compression release shaft.
71	6	Cap screw, 3/8"—24 x 1", compression release bearing.
65	1	Cap screw, 3/8"—24 x 2", compression release lever.
63	2	Cap screw, 3/8"—24 x 1 1/8", compression release packing gland.
66	1	Cap screw, 5/16"—24 x 5/8", compression release spring.
73	3	Gasket, compression release bearing.
62	1	Gland, compression release packing.
69	1	Lever, compression release.
72	10	Lockwasher, 3/8" positive lock.
67	1	Lockwasher, 5/16" positive lock.
64	1	Nut, 3/8"—24, compression release lever.
70	4	Packing, compression release lever shaft.
75	1	Screw, compression release shaft lock.
61	1	Shaft, compression release.
68	1	Spring, compression release leve

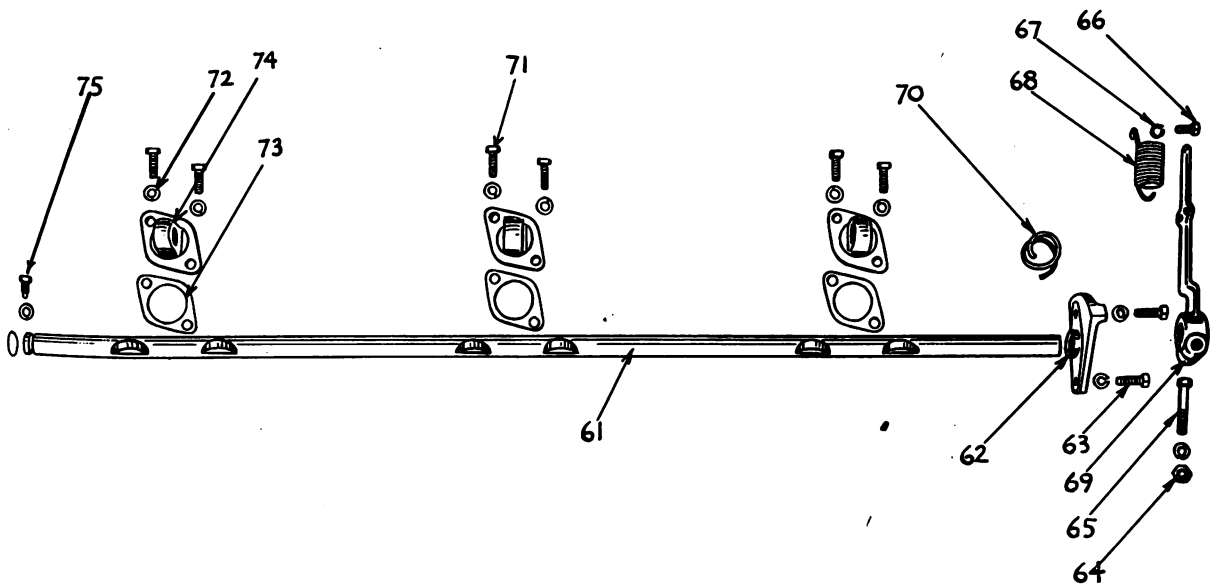

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Figure 173. Compression release assembly.

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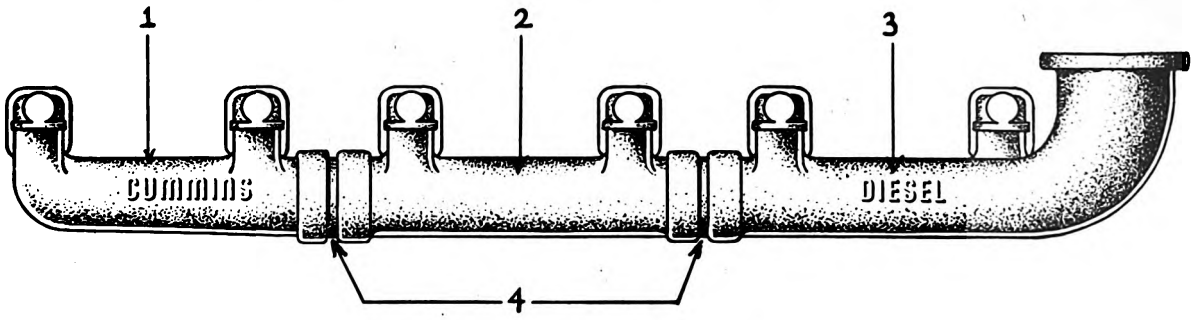

TL-33763

Figure 174. Exhaust manifold.

Item No.	*No. of units*	*Name of part and description*
		EXHAUST MANIFOLD (fig. 174)
	1	Assembly, exhaust manifold.
	3	Gasket, exhaust and intake manifold.
	6	Nut, exhaust manifold, brass.
2	1	Section, exhaust manifold, center.
3	1	Section, exhaust manifold, front.
1	1	Section, exhaust manifold, rear.
4	2	Sleeve, exhaust manifold.
	6	Lockwashers.

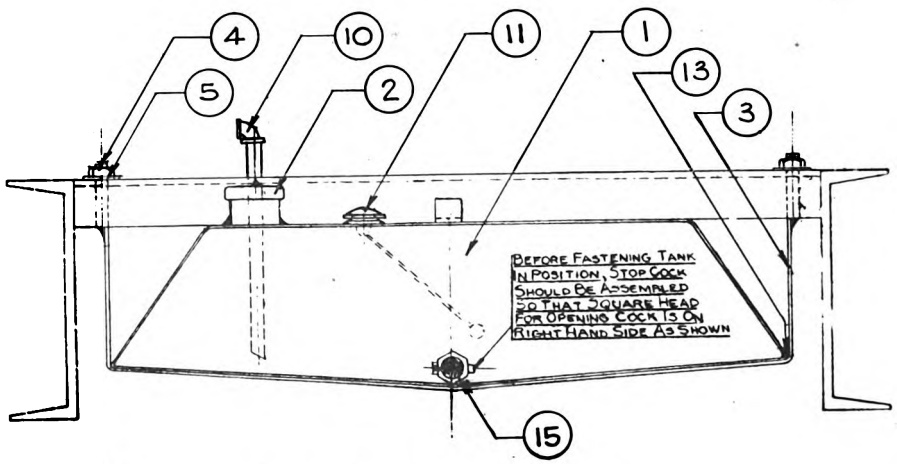

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Figure 175. Fuel tank assembly.

Item No.	*No. of units*	*Name of part and description*
		FUEL TANK ASSEMBLY (fig. 175)
1	1	Assembly, fuel tank.
2	1	Cap, fuel tank.
15	1	Cock, fuel tank drain, ½" IPS.
11	1	Gauge, fuel tank level (C1362E-11).
3	2	Strap, fuel tank supporting.
10	1	Ell, tank suction pipe, ⅜" x 90°.
13	2	Strap, anti-squeak, tank supporting.
4	4	Nut, supporting strap, ⅝" USS.
5	4	Lockwasher, supporting strap, ⅝".

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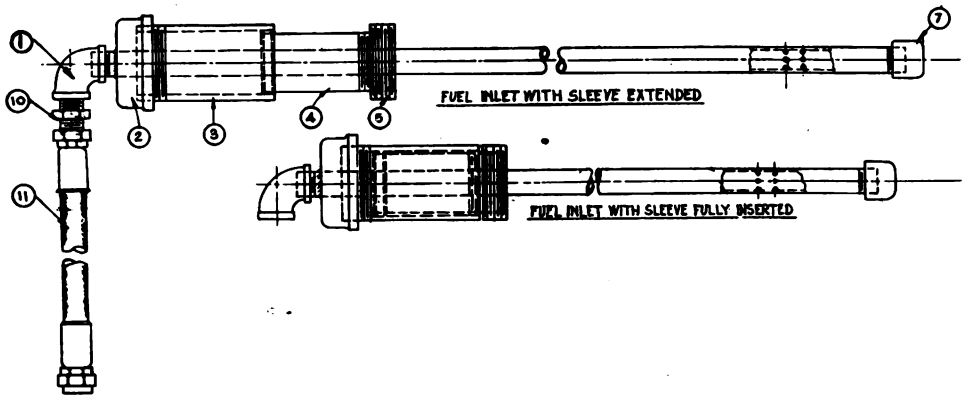

Figure 176. Fuel supply line, auxiliary.

Item No.	*No. of units*	*Name of part and description*
		FUEL SUPPLY LINE, AUXILIARY (fig. 176)
	1	Assembly, auxiliary fuel supply.
1	1	Ell, pipe, ½" x 90°.
2	1	Assembly, stand pipe and cap.
3	1	Sleeve, upper telescope.
4	1	Sleeve, lower telescope.
5	1	Bushing, lower telescope.
7	1	Cap, suction pipe ½" IPS.
10	1	Connector, SAE male, ½" x ⅜" (D1414A-10).
11	1	Hose, flexible, fuel suction (including fittings).

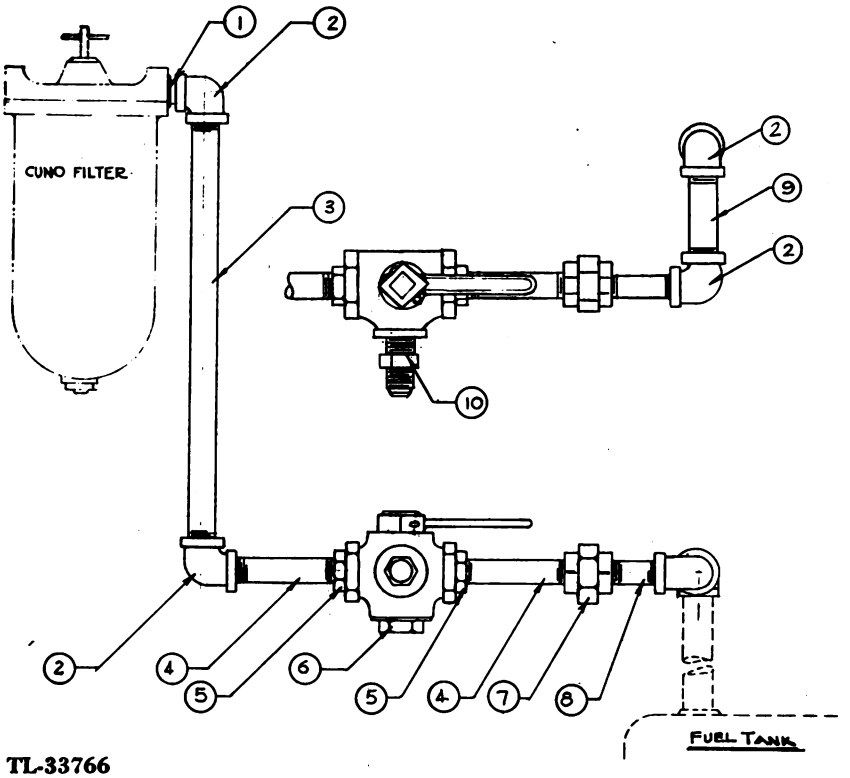

Figure 177. Fuel supply line.

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Item No.	*No. of units*	*Name of part and description*
		FUEL SUPPLY LINE (from tank to primary filter) (fig. 177)
	1	Assembly, tank to filter supply line.
1	1	Nipple pipe, ⅜" close.
2	4	Ell, pipe, ⅜" x 90°.
3	1	Nipple, pipe, ⅜" x 12".
4	2	Nipple, pipe, ⅜" x 3½".
5	3	Bushing, pipe, ½" x ⅜".
6	1	Valve, 3-way (C 1398B-6-11), ½" IPS.
	1	Bracket, valve stop.
	1	Cap screw, stop, bracket, ¼" x 1" USS.
	2	Nut, stop bracket, ¼" USS.
	2	Lockwasher, stop bracket, ¼".
	1	Cap screw, stop bracket, ¼" x 1½" USS.
7	1	Union, pipe, ⅜" IPS.
8	1	Nipple, pipe, ⅜" x 2".
9	1	Nipple, pipe, ⅜" x 2½".
10	1	Connector, SAE male, ½" x ⅜" (C 1398B-10).
	1	Bracket, CUNO filter.
	4	Cap screw, filter bracket, ¼" x ¾" USS.
	4	Nuts, filter bracket, ¼" USS.
	4	Lockwashers, filter bracket, ¼".
		FILTER, FUEL OIL, PRIMARY (fig. 178)
	1	Filter, fuel oil.
	1	Cartridge unit.
6	1	Follower, gland.
10	1	Gasket, head.
2	1	Gasket, vent screw.
	1	Handle.
1	1	Head.
8	2	Lockwasher, cartridge mounting screw.
5	1	Nut, gland.
7	1	Packing.
12	1	Plug, drain.
9	2	Screw, cartridge mounting.
	10	Screw, head.
3	1	Screw, vent.
11	1	Sump and drain plug.
		FILTER, FUEL OIL, ACCESSORIES, SECONDARY (fig. 179)
1	1	Assembly, secondary fuel filter bracket.
2	4	Cap screws, filter bracket, ⅜" x 1" USS.
3	4	Lockwashers, filter bracket, ⅜".
4	4	Nuts, filter bracket, ⅜" USS.
5	1	Tubing, secondary fuel filter, inlet.
6	1	Tubing, secondary fuel filter.
7	1	Clamp, secondary filter tubing.
8	1	Cap screw, tubing clamp, ¼" x ½" USS.
9	1	Nut, tubing clamp, ¼" USS.
10	1	Lockwashers, tubing clamp ¼".

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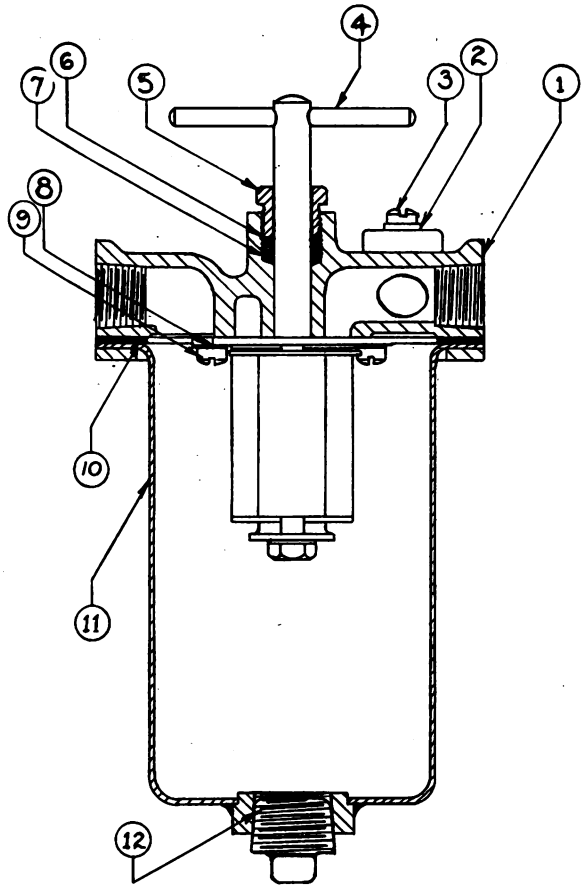

TL-33767

Figure 178. Filter, fuel oil primary.

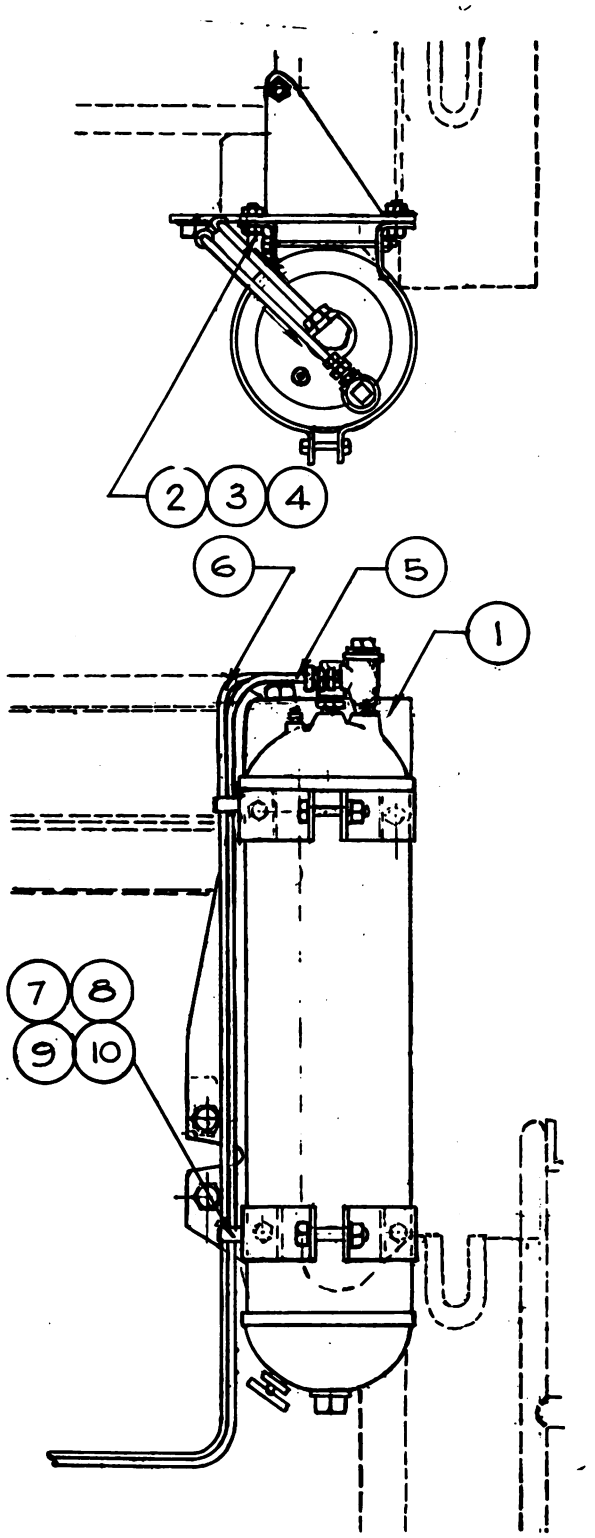

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Figure 179. Filter, fuel oil, accessories, secondary.

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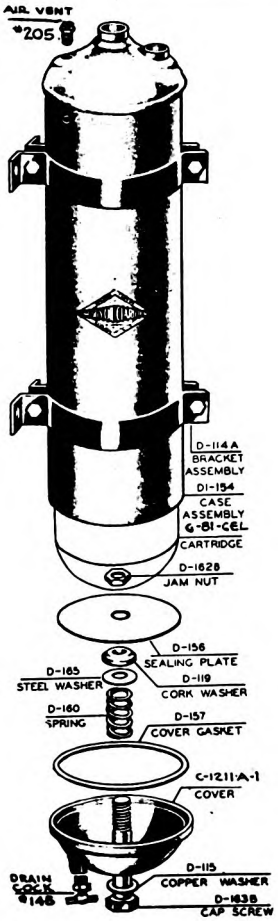

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Figure 180. Filter, fuel oil, secondary.

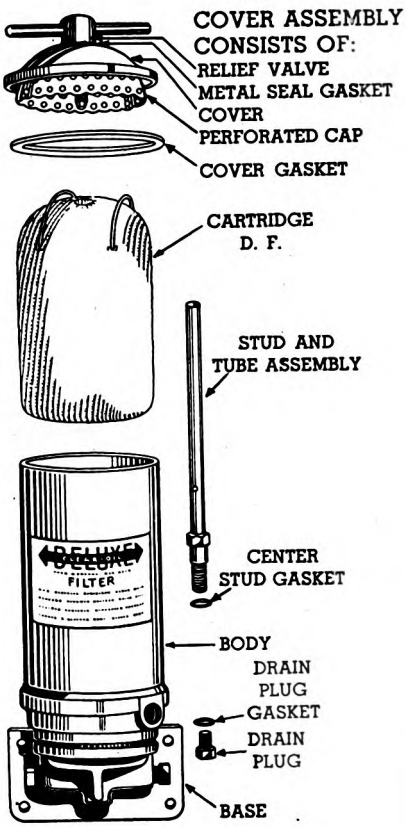

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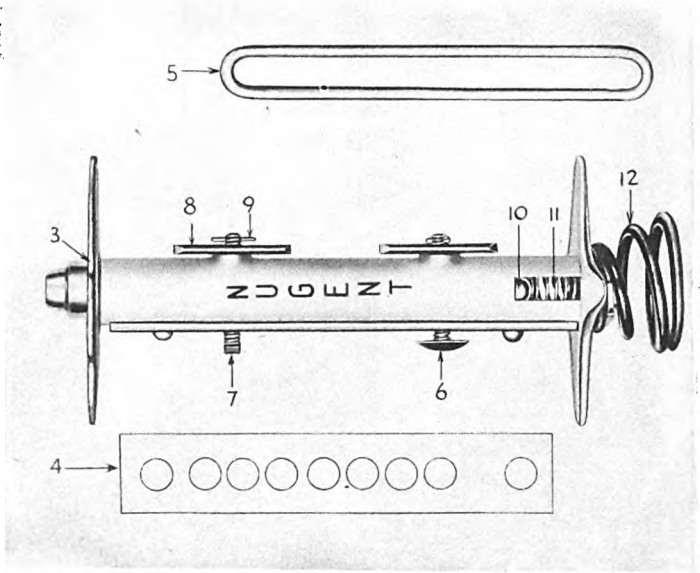
Figure 181. Filter, lubricating oil, secondary.



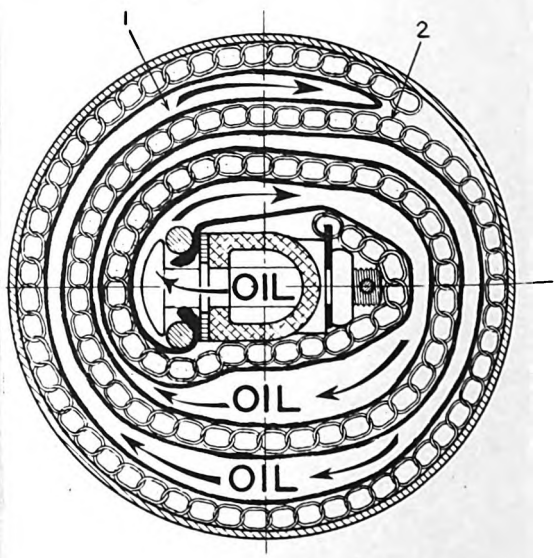


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Figure 182. Filter, lubricating oil, primary.

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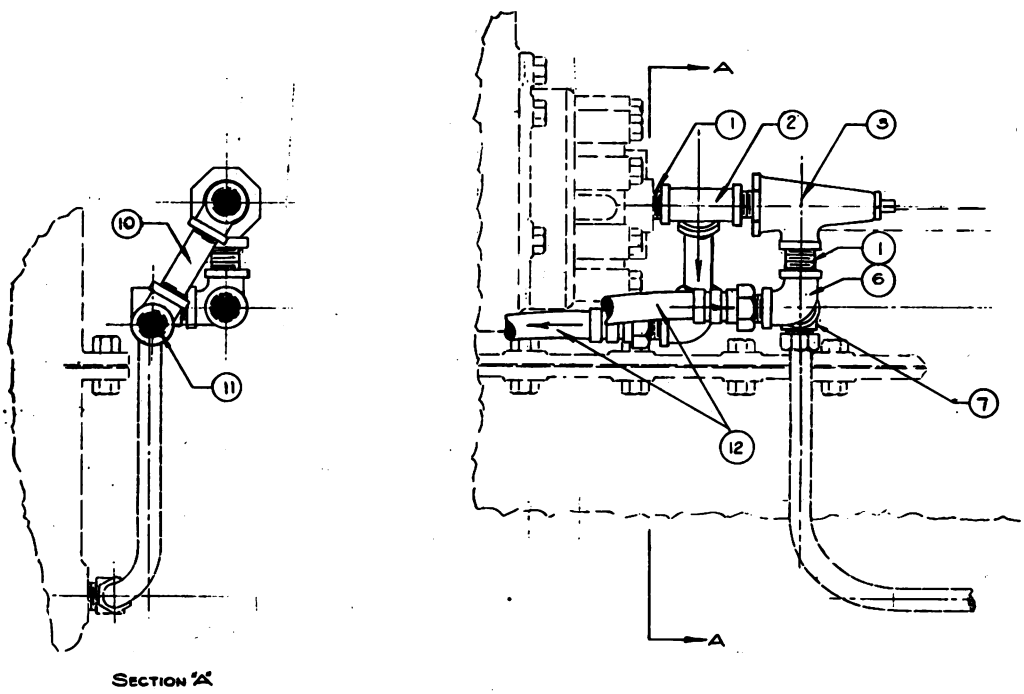
Item No.	No. of units	Name of part and description
		FILTER, LUBRICATING OIL, PRIMARY Bag Type in Pan (fig. 182)
	1	Cover, lubricating oil filter.
1	1	Bag, filter.
10	1	Ball, bypass relief.
6	2	Clamp, bag ring.
4	1	Gasket, bag.
	1	Nut, bypass adjusting.
8	1	Nut, elongated clamp.
	1	Pin, cotter.
9	2	Pin, cross.
5	1	Ring, bag.
2	1	Spacer, wire mat.
3	1	Spool, bag.
7	2	Spring, bag ring clamp.
11	1	Spring, bypass relief.
12	1	Spring, shock



TL-33772

Figure 183. Piping, lubricating oil cooling.

Item No.	No. of units	Name of part and description
		PIPING, LUBRICATING OIL COOLING (fig. 183)
1	2	Nipple, pipe, ½" close.
2	1	Tee, pipe, ½".
3	1	Valve, pressure relief, ½" (A1361A-3).
6	1	Ell, side outlet, ½".
7	2	Ell, inverted male (A1361A-7).
10	1	Nipple, pipe ½" x 2½".
11	1	Ell, pipe, ½" x 90°.
12	2	Tube, flexible (Resisto-Flex) including fittings.

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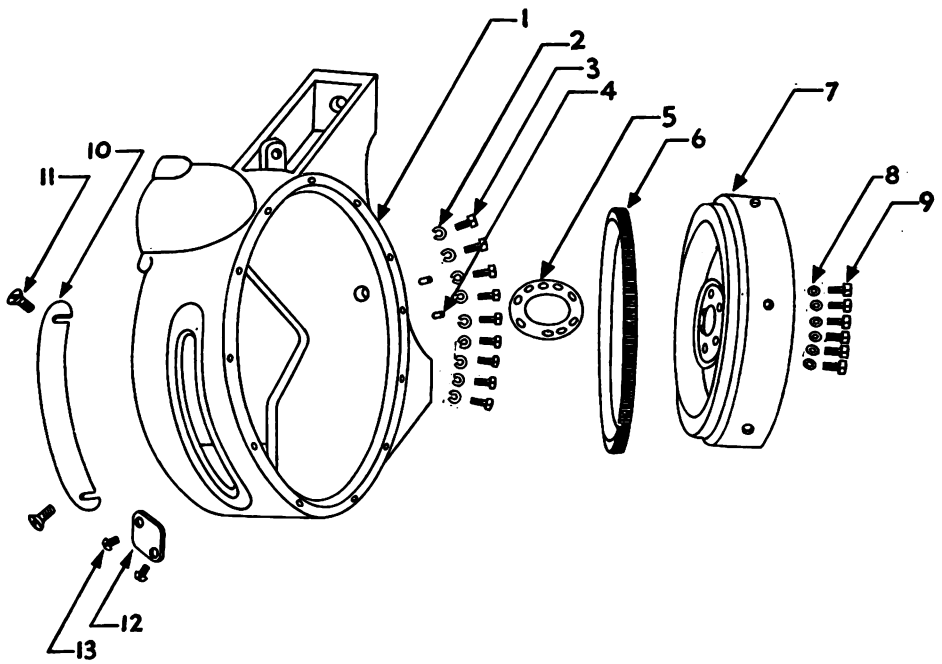

TL-33773

Figure 184. Flywheel and flywheel housing assembly.

Item No.	*No. of units*	*Name of part and description*
		FLYWHEEL AND FLYWHEEL HOUSING ASSEMBLY (fig. 184)
7	1	Flywheel.
6	1	Gear, flywheel ring.
		Mounting parts:
9	6	Cap screw, flywheel to crankshaft.
5	1	Gasket, flywheel to crankshaft.
8	6	Lockwasher, ⅝" everlock flywheel to crankshaft.
4	3	Lockwire, flywheel to crankshaft.
	2	Pins, dowel.
10	1	Cover, barring slot.
12	1	Cover, index hole.
1	1	Housing, flywheel (CECO H-10283).
	2	Lockwasher, ¼" positive lock, index hole cover.
11	2	Screw, barring slot cover.
13	2	Screw, index hole cover.
3	9	Cap screw, ⅝"—18 x 1½", housing to block.
	1	Gasket, housing to block.
2	9	Lockwasher, ⅝" positive lock, housing to block.
		FUEL PUMP
	1	Assembly, fuel pump.
	5	Cap screw, 7/16"—20 x 1", governor flange to block.
	2	Cap screw, ⅜"—24 x 3¼", pump to block, lower.
	2	Cap screw, 9/16"—18 x 1¼", pump to block, upper.
	1	Gasket, governor flange to block.
	1	Gasket, lubricating oil drain.
	5	Lockwasher, 9/16" positive lock, flange to block.
	2	Lockwasher, ⅜", positive lock, pump to block, lower.
	2	Lockwasher, 7/16", positive lock, pump to block, upper.

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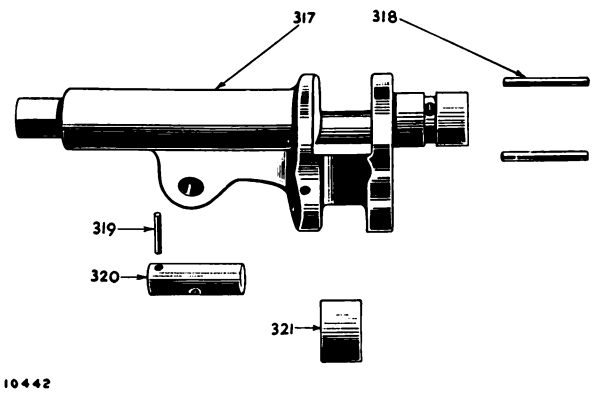

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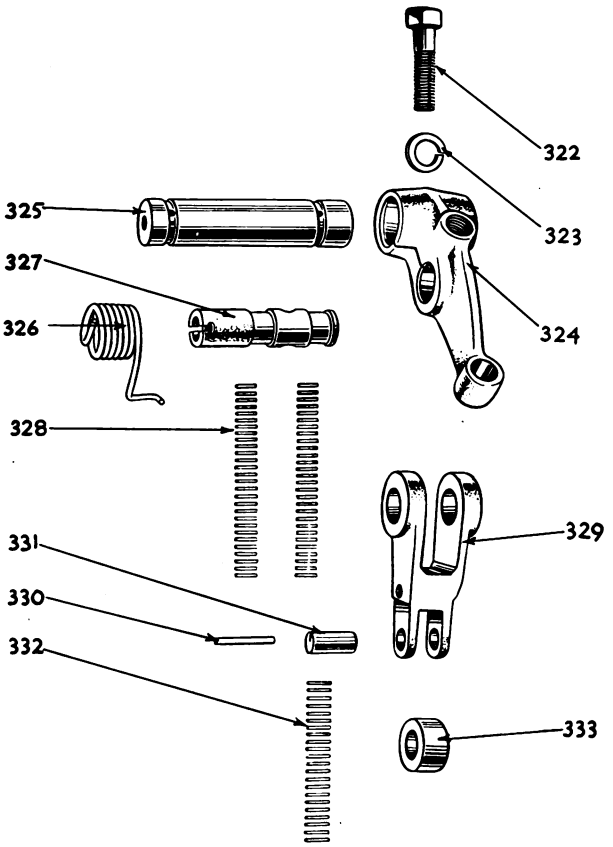
Figure 185. Lever assembly, cam rocker.



TL-33775

Figure 186. Vertical lever assembly.

Item No.	*No. of units*	*Name of part and description*
		FUEL PUMP (Continued)
		Cam Rocker Lever Assembly (fig. 185):
	1	Assembly, cam rocker lever.
317	1	Lever, cam rocker.
320	1	Pin, cam rocker lever roller.
	1	Plug, cam rocker lever.
319	1	Rivet, cam rocker lever roller pin.
321	1	Roller, cam rocker lever.
	1	Sleeve, vertical lever stop.
318	2	Stop, vertical lever.
		Vertical Lever Assembly (fig. 186):
	1	Assembly, vertical lever.
328	56	Bearing, plunger lever pin.
332	22	Bearing, vertical lever roller.
322	1	Cap screw, ⅜"—24 x 1½", plunger lever.
324	1	Lever, plunger.
329	1	Lever, vertical.
323	1	Lockwasher, ⅜" positive lock, plunger lever cap screw.
327	1	Pin, plunger lever.
331	1	Pin, vertical lever, roller.
330	1	Rivet, vertical lever roller pin.
333	1	Roller, vertical lever.
325	1	Shaft, plunger lever.
		Mounting parts:
326	1	Spring, vertical lever.

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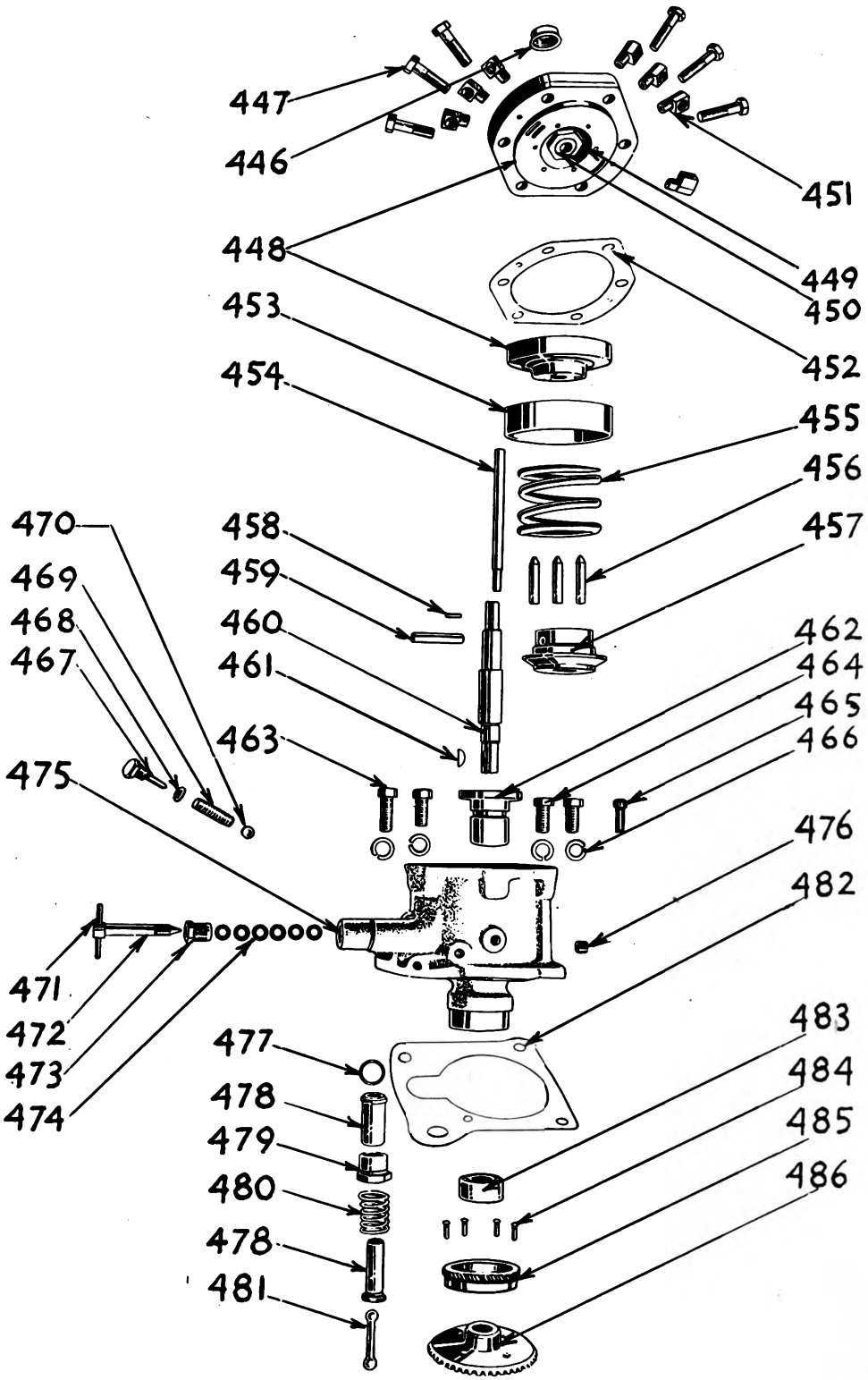

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Figure 187. Distributor assembly.

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Item No.	No. of units	Name of part and description
		FUEL PUMP (Continued)
		Distributor Assembly (fig. 187):
	1	Assembly, distributor.
448	1	Assembly, disk and cover.
446	1	Cap, dust.
451	7	Elbow, tube.
	1	Gasket, tachometer shaft guide.
450	1	Guide, tachometer shaft.
449	1	Nut, tachometer shaft guide.
	1	Packing, tachometer shaft guide.
	1	Assembly, distributor shaft (includes items 454, 456, and 460).
457	1	Collar, distributor disk drive.
456	3	Pin, distributor disk drive.
459	1	Rivet, drive collar.
458	1	Rivet, tachometer shaft.
460	1	Shaft, distributor drive.
454	1	Shaft, tachometer drive.
475	1	Assembly, housing and bushing (includes items 453 and 462).
462	1	Bushing distributor shaft.
453	1	Bushing, distributor disk.
	1	Assembly, priming valve (includes items 471 and 472).
471	1	Pin, priming valve.
472	1	Valve, priming.
470	1	Ball, check.
483	1	Bearing, distributor shaft ball (N.D. 5203).
447	6	Cap screw, ⅜"—24 x 1½", distributor cover.
468	1	Gasket, distributor check valve.
452	1	Gasket, distributor housing cover.
477	1	Gasket, metering pump.
486	1	Gear, distributor drive.
485	1	Gear, overspeed stop drive.
461	1	Key, Woodruff distributor shaft.
479	1	Nut, plunger barrel clamp.
473	1	Nut, priming valve packing.
474	7	Packing, priming valve.
467	1	Plug, distributor check valve.
478	1	Pump, metering (plunger and barrel).
484	4	Rivet, overspeed stop drive gear.
469	1	Spring, distributor check valve.
455	1	Spring, distributor disk.
		Mounting parts:
463	1	Cap screw, 7/16"—14 x 1¼", distributor housing.
464	3	Cap screw, 7/16"—14 x 1", distributor housing.
482	1	Gasket, distributor housing.
481	1	Link, metering pump.
466	4	Lockwasher, 7/16" positive lock, distributor housing.
465	1	Screw, ⅛"—28 x 1", hollow head, distributor housing.
476	1	Plug, ⅛" pipe, timing hole.
480	1	Spring, metering pump.
	1	Tube, gear pump to overspeed stop.
	1	Nut, compression coupling.
	1	Nut, tube.
	1	Tube, overspeed stop to distributor.
	2	Nut, tube.

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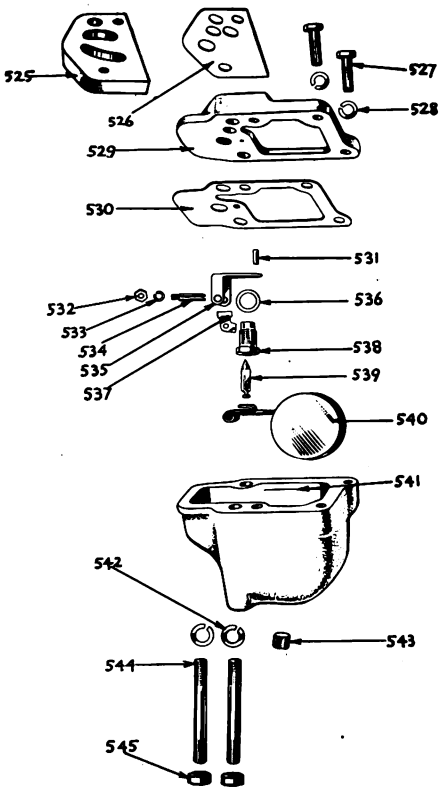

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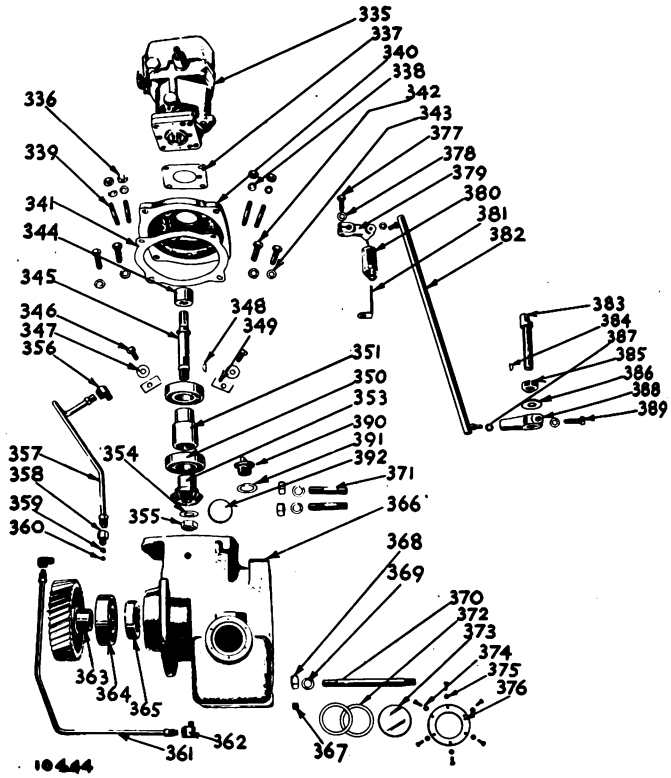
Figure 188. Float chamber assembly.



TL-33778

Figure 189. Governor housing assembly.

Item No.	*No. of units*	*Name of part and description*
		FUEL PUMP (Continued)
		Float Chamber Assembly (fig. 188):
	1	Assembly, float chamber.
535	1	Bracket, float bearing.
527	2	Cap screw, ¼"—28 x ⅞", float chamber top plate.
541	1	Chamber, float.
540	1	Float and lever.
530	2	Gasket, float chamber.
536	1	Gasket, float valve seat.
528	2	Lockwasher, ¼" positive lock, float chamber.
533	1	Lockwasher, float lever bearing pin.
532	1	Nut, float lever bearing pin.
534	1	Pin, float lever bearing.
531	1	Pin, float lever locating dowel.
529	1	Plate, float chamber top.
525	1	Plate, adapter to main housing and float chamber.
543	1	Plug, ⅛" pipe.
538	1	Seat, float valve.
537	1	Stop, float.
539	1	Valve, float.
		Mounting parts:
544	2	Stud, 5/16"—24 x 5¼".
545	2	Nut, 5/16"—24.
526	2	Gasket, float chamber top plate and adapter.
542	2	Lockwasher, 5/16" positive lock.

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Item No.	No. of units	Name of part and description
		FUEL PUMP (Continued)
		Governor Housing Assembly (fig. 189):
335	1	Governor, Woodward Hydraulic.
		Mounting parts:
340	1	Adapter, governor to governor housing.
360	1	Ball, check.
350	2	Bearing, governor spindle ball (N.D. 3206).
364	1	Bearing, drive gear ball (N.D. 1307).
342	4	Cap screw, 3/8"—16 x 1", adapter to governor housing.
346	2	Cap screw, 5/16"—18 x 5/8", ball bearing retainer.
389	1	Cap screw, 5/16"—24 x 1", governor lever, lower.
377	1	Cap screw, 5/16"—24 x 3/4", governor lever, upper.
374	6	Cap screw, No. 6—40 x 3/8", oil level window cover.
344	1	Collar, governor drive.
376	1	Cover, oil level window.
358	1	Connection, lubricating oil tube.
356	1	Elbow, governor oil tube.
362	2	Elbow, governor vent tube.
341	1	Gasket, adapter to governor housing.
391	1	Gasket, governor housing filler plug.
337	1	Gasket, governor to adapter.
	1	Gasket, governor housing to fuel pump housing.
372	2	Gasket, oil level window.
363	1	Gear, fuel pump drive.
353	1	Gear, governor spindle.
366	1	Housing, governor.
384	1	Key, fuel control shaft.
348	1	Key, governor spindle pinion.
388	1	Lever, governor, lower.
379	1	Lever, governor, upper.
382	1	Link, governor control.
347	2	Lockplate, spindle bearing retainer.
354	1	Lock, spindle.
		Mounting parts (fig. 189):
343	4	Lockwasher, 3/8" positive lock, adapter to governor housing.
338	4	Lockwasher, 5/16" positive lock, governor to adapter.
369	3	Lockwasher, 7/16" positive lock, governor housing to fuel pump housing.
387	2	Lockwasher, 1/4" positive lock, governor link.
378	2	Lockwasher, 5/16" positive lock, governor lever.
375	6	Lockwasher, oil level window cover.
336	4	Nut, 5/16"—18, governor adapter.
368	3	Nut, 7/16"—14, governor housing stud.
355	1	Nut, 5/8"—18, governor spindle.
392	1	Plug, governor housing expansion.
390	1	Plug, governor housing oil filler.
367	1	Plug, 1/8" pipe, housing drain.
349	2	Retainer, spindle bearing.
381	1	Retainer, tension spring.
385	1	Seal, control shaft oil.
365	1	Seal, main shaft.
383	1	Shaft, governor control.
351	1	Spacer, governor spindle bearing.
345	1	Spindle, governor.
359	1	Spring, governor check valve.
380	1	Spring, governor lever tension.
339	4	Stud, governor to adapter.

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Item No.	*No. of units*	*Name of part and description*
		FUEL PUMP (Continued)
		Mounting parts (fig. 189) (Continued):
370	1	Stud, governor housing, long.
371	2	Stud, governor housing, short.
357	1	Tube, governor housing to governor.
	2	Nut, tube.
361	1	Tube, governor housing vent.
	2	Nut, tube.
386	1	Washer, governor lever spacer.
373	1	Window, oil level.

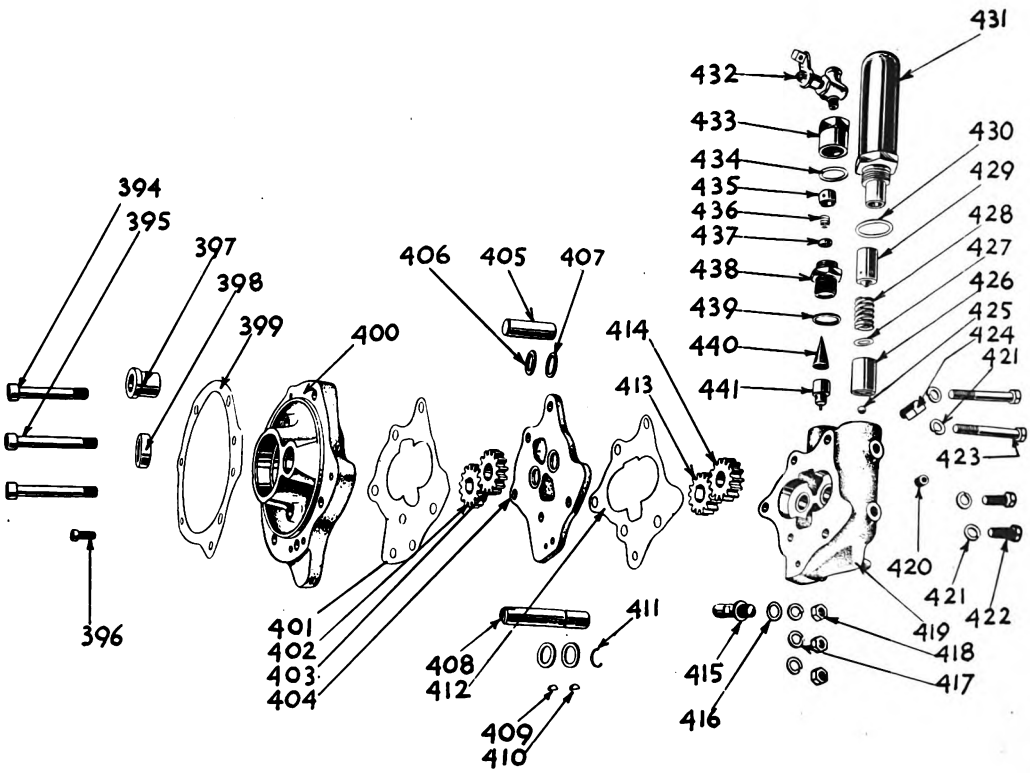

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Figure 190. Gear pump assembly.

Item No.	*No. of units*	*Name of part and description*
		FUEL PUMP (Continued)
		Gear Pump Assembly (fig. 190):
	1	Assembly, gear pump.
438	1	Assembly, check valve seat and screen (includes item 440).
440	1	Screen, check valve seat.
425	1	Ball, check.
400	1	Body, No. 1 gear pump.
419	1	Body, No. 2 gear pump.
395	2	Bolt, gear pump body, long.
394	1	Bolt, gear pump body, short.
397	1	Bushing, cam rocker lever.

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Item No.	No. of units	Name of part and description
		FUEL PUMP (Continued)
		Gear Pump Assembly (fig. 190) (Continued):
431	1	Chamber, pressure.
432	1	Cock, shut-off.
424	1	Elbow, tube.
434	1	Gasket, check valve housing.
439	1	Gasket, fuel supply check valve.
401	1	Gasket, No. 1 gear pump spacer.
412	1	Gasket, No. 2 gear pump spacer.
416	1	Gasket, idling lever shaft.
430	1	Gasket, pressure chamber.
402	1	Gear, No. 1 drive.
413	1	Gear, No. 2 drive.
414	1	Gear, No. 2 idler.
403	1	Gear, No. 1 idler.
435	1	Guide, fuel supply check valve.
433	1	Housing, fuel supply check valve.
409	1	Key, No. 1, drive gear.
410	1	Key, No. 2, drive gear.
417	3	Lockwasher, ⅜", positive lock.
418	3	Nut, ⅜"—24, body bolt.
420	1	Plug, ⅛", pipe No. 2 body.
411	1	Ring, snap.
396	1	Screw, spacer plate.
406	2	Seal, spacer.
398	1	Seal, shaft oil.
408	1	Shaft, gear pump drive.
405	1	Shaft, gear pump idler.
415	1	Shaft, idling lever.
426	1	Sleeve, pressure regulating valve.
404	1	Spacer, gear pump.
436	1	Spring, fuel supply check valve.
428	1	Spring, pressure regulating valve.
441	1	Valve, fuel pump check.
437	1	Valve, fuel supply check.
429	1	Valve, pressure regulating.
407	2	Washer, for oil seals.
427	as req'd	Washer, pressure regulating.
		Mounting parts:
422	2	Cap screw, ⅜"—16 x 1", pump to housing, short.
423	2	Cap screw, ⅜"—16 x 2¾", pump to housing, long.
399	1	Gasket, gear pump to housing.
421	4	Lockwasher, ⅜" positive lock.
		Main Housing Assembly (fig. 191):
263	1	Assembly, fuel pump housing.
278	1	Bushing, cam rocker lever.
276	1	Bushing, control shaft.
279	1	Bushing, hand control eccentric.
261	1	Bushing, plunger lever shaft, short.
264	1	Bushing, plunger lever shaft, long.
	1	Dowel, gear pump housing.
	1	Plug, oil line.
277	1	Plug, ¼", pipe for drain.
	3	Plug, ⅛", pipe for housing.
274	1	Ball, fuel check.
269	1	Coupling, pipe, injector drain.
272	1	Gasket, bypass valve guide.

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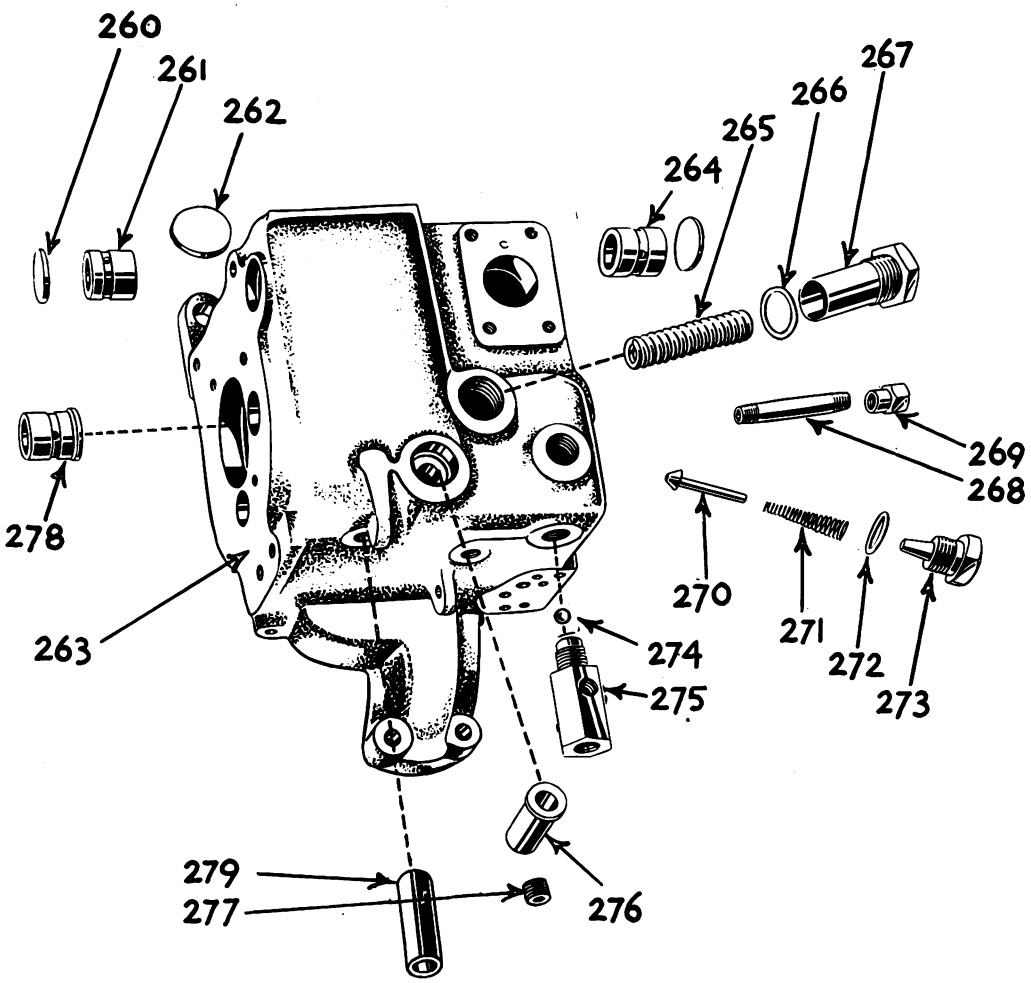

Figure 191. Main housing assembly.

Item No.	*No. of units*	*Name of part and description*
		FUEL PUMP (Continued)
		Main Housing Assembly (fig. 191) (Continued):
266	1	Gasket, cam rocker lever spring retainer.
273	1	Housing, bypass valve.
268	1	Nipple, ⅛" x 2¾" pipe, injector drain.
262	1	Plug, 1½", expansion, peep hole.
260	2	Plug, 1⅛", expansion, plunger lever shaft hole.
275	1	Plug, fuel inlet.
267	1	Retainer, cam rocker lever spring.
271	1	Spring, bypass valve.
265	1	Spring, cam rocker lever.
270	1	Valve, bypass.
		Hand Control Eccentric and Lever Assembly (fig. 192):
	1	Assembly, governor lever and bushing (includes items 281 and 282).
281	1	Bushing, governor lever.
282	1	Lever, governor.
290	1	Cap screw, 5/16"—24 x 1¼", control lever clamping.

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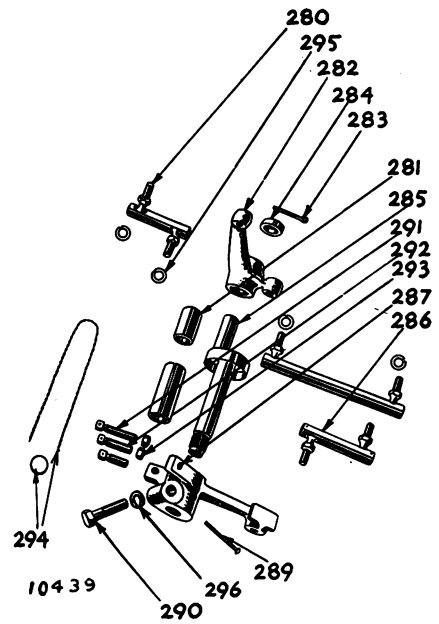

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Figure 192. Hand control eccentric and lever assembly.

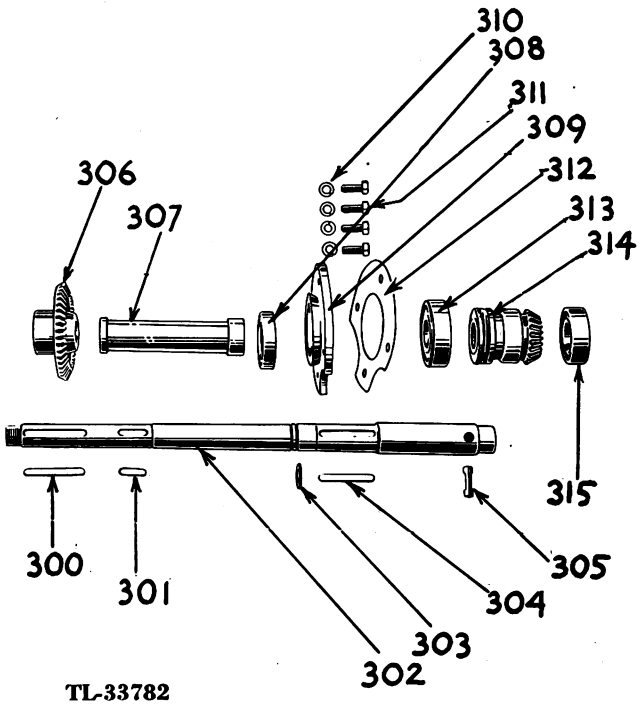

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Figure 193. Main shaft assembly.

Item No.	*No. of units*	*Name of part and description*
		FUEL PUMP (Continued)
		Hand Control Eccentric and Lever Assembly (fig. 192) (Continued):
284	1	Collar, hand control eccentric.
285	1	Eccentric, hand control.
287	1	Lever, control.
286	1	Link, governor, control eccentric.
280	1	Link, vertical lever.
296	1	Lockwasher, 5/16", positive lock, control lever.
295	4	Lockwasher, ¼" positive lock.
293	2	Nut, ¼"—28, control lever adjusting screw.
283	1	Pin, 3/32" x 1" cotter.
289	1	Rivet, control lever.
292	1	Screw, control lever adjusting right side, long.
291	1	Screw, control lever adjusting left side, short.
294	1	Seal, lead, with wire.
		Main Shaft Assembly (fig. 193):
	1	Assembly, fuel pump main shaft.
313	1	Bearing, fuel pump cam ball (N.D. 7305).
315	1	Bearing, fuel pump ball (N.D. 3205).
314	1	Cam, fuel pump main shaft.
306	1	Gear, governor drive.
304	1	Key, main shaft, cam.
300	1	Key, fuel drive main shaft.
301	1	Key, governor drive.
305	1	Pin, gear pump drive.
303	as req'd	Ring, snap No. 0.059".
303	as req'd	Ring, snap No. 0.062".

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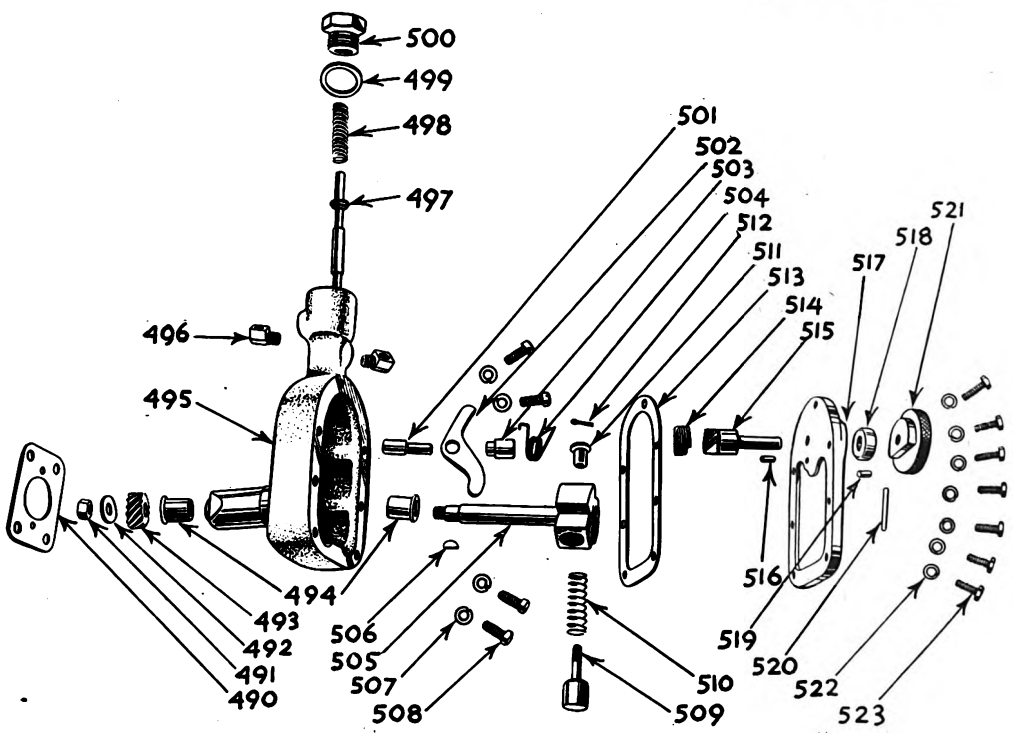
Item No.	*No. of units*	*Name of part and description*
		FUEL PUMP (Continued)
		Main Shaft Assembly (fig. 193) (Continued):
303	as req'd	Ring, snap No. 0.065".
308	1	Seal, ball-bearing oil.
302	1	Shaft, fuel pump main.
309	1	Shield, fuel pump ball bearing.
307	1	Spacer, governor drive gear.
		Mounting parts:
311	4	Cap screw, 5/16"—24 x 1¼", ball bearing shield.
312	1	Gasket, ball bearing shield.
310	4	Lockwasher, 5/16", positive lock ball bearing shield.



TL-33783

Figure 194. Overspeed stop assembly.

Item No.	*No. of units*	*Name of part and description*
		FUEL PUMP (Continued)
		Overspeed Stop Assembly (fig. 194):
	1	Assembly, valve and housing (H-2930) (includes items 495 and 497).
494	2	Bushing, overspeed stop shaft.
503	1	Bushing, overspeed stop pawl.
523	7	Cap screw, ¼"—20 x ¾", overspeed stop cover.
	1	Combination weight and spring, 1200 rpm (items 509-512).
510	1	Spring, overspeed stop.
509	1	Weight, overspeed stop.
511	1	Collett, overspeed stop weight.
517	1	Cover, overspeed stop.

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Item No.	No. of units	Name of part and description
		FUEL PUMP (Continued)
		Overspeed Stop Assembly (fig. 194) (Continued):
496	2	Elbow, tube.
499	1	Gasket, overspeed stop body plug.
513	1	Gasket, overspeed stop cover.
490	1	Gasket, overspeed stop housing.
493	1	Gear, overspeed stop.
495	1	Housing, overspeed body (not sold separate from item 497, see BM232).
506	1	Key, overspeed stop gear.
521	1	Knob, overspeed stop reset.
522	7	Lockwasher, ¼", cover screws.
507	4	Lockwasher, 5/16" positive lock, overspeed stop to main housing.
491	1	Nut, ⅜"—24, overspeed stop shaft.
502	1	Pawl, overspeed stop.
512	1	Pin, cotter.
520	1	Pin, overspeed stop knob.
501	1	Pin, overspeed stop pawl.
519	1	Pin, overspeed stop reset.
516	1	Pin, overspeed stop reset spring.
492	1	Plate, overspeed stop shaft nut lock.
500	1	Plug, overspeed stop body.
	1	Plug, ⅞" brass expansion, overspeed stop body.
508	4	Screw, overspeed stop housing to main housing.
518	1	Seal, reset shaft oil.
505	1	Shaft, overspeed stop drive.
515	1	Shaft, overspeed stop reset.
504	1	Spring, overspeed stop pawl.
514	1	Spring, overspeed stop reset.
498	1	Spring, overspeed stop valve.
497	1	Valve, overspeed stop.
		GEAR CASE COVER ASSEMBLY (fig. 195)
	1	Assembly gear case cover.
147	2	Cap screw, ⅜"—24 x ¾", cam shaft thrust plate.
136	1	Cover, gear case.
145	1	Gasket, camshaft thrust plate.
141	1	Gasket, gear case cover.
148	2	Lockwasher, ⅜" positive lock, thrust plate.
146	1	Plate, camshaft thrust.
144	2	Plunger, lubricating oil pressure regulator.
142	1	Seal, fan pulley oil.
140	1	Seal, crankshaft oil.
143	1	Spring, lubricating oil pressure regulator.
		Mounting parts:
137	17	Cap screw, 7/16"—20 x 2", gear cover to block.
139	2	Dowel, gear cover to block.
138	17	Lockwasher, 7/16" positive lock.

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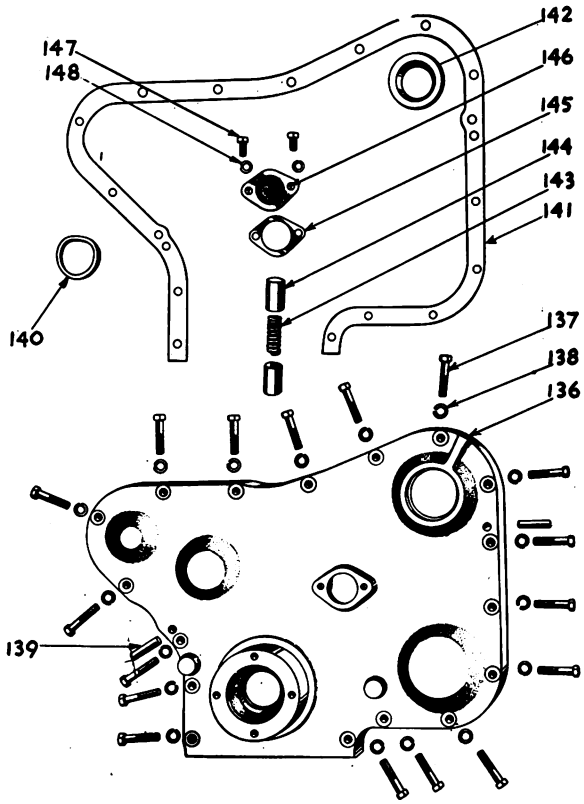
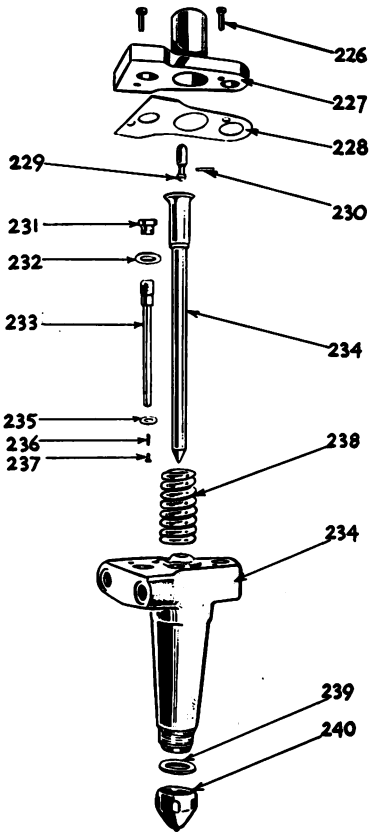


TL-33784

Figure 195. Gear case cover assembly.



TL-33785

Figure 196. Injector assembly.

Item No.	*No. of units*	*Name of part and description*
		INJECTOR ASSEMBLY (fig. 196)
	6	Assembly, injector.
234	6	Assembly, body and plunger.
229	6	Link, injector plunger.
230	6	Pin, injector plunger link.
233	6	Assembly, check valve and seat.
240	6	Assembly, injector cup (includes item 239).
239	6	Gasket, injector cup.
232	6	Gasket, check valve plug.
235	6	Gasket, check valve seat.
228	6	Gasket, top housing.
227	6	Housing, injector top.
231	6	Plug, injector check valve.
226	12	Screw, top housing.
236	6	Spring, injector check valve.
238	6	Spring, injector plunger.
237	6	Stop, injector check valve.
		Mounting parts:
	6	Guards, injector oil.
	12	Nut, ½"—13, injector stud.

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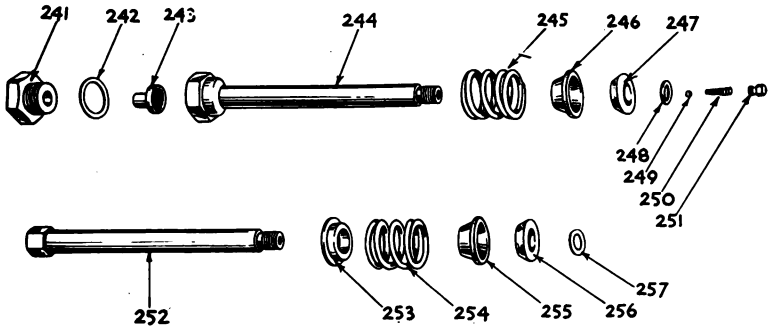

TL-33786

Figure 197. Injector fuel inlet and drain connector assemblies.

Item No.	*No. of units*	*Name of part and description*
		INJECTOR FUEL INLET AND DRAIN CONNECTOR ASSEMBLIES (fig. 197)
	6	Assembly, fuel inlet connection.
249	6	Ball, fuel connection check.
243	6	Cage and screen.
241	6	Cap, fuel connection.
244	6	Connection, fuel inlet.
242	6	Gasket, fuel cap.
248	6	Gasket, fuel connection, copper.
247	6	Gasket, fuel connection, leather.
246	6	Guide, fuel connection spring.
251	6	Plug, inlet connection.
245	6	Spring, fuel connection.
250	6	Spring, fuel check valve.
	6	Assembly, injector fuel drain.
252	6	Connection, injector fuel drain.
257	6	Gasket, injector drain connection, copper.
256	6	Gasket, injector drain connection, leather.
255	6	Guide, fuel connection spring.
253	6	Guide, fuel connection spring.
254	6	Spring, fuel connection.
		LUBRICATING PUMP ASSEMBLY (fig. 198)
	1	Assembly, lubricating pump.
178	1	Bracket and bushing.
177	1	Bushing, lubricating pump bracket.
171	1	Bearing, ball.
185	1	Body, lubricating pump.
170	1	Cage, lubricating pump bearing.
188	8	Cap screw, 5/16"—18 x 2¼", body to bracket.
186	2	Dowel, lubricating pump bracket.
181	1	Gasket, bracket to body.
176	1	Gasket, bracket to cage.
173	1	Gear, lubricating pump drive.
182	1	Gear, lubricating pump drive.
183	1	Gear, lubricating pump idler.

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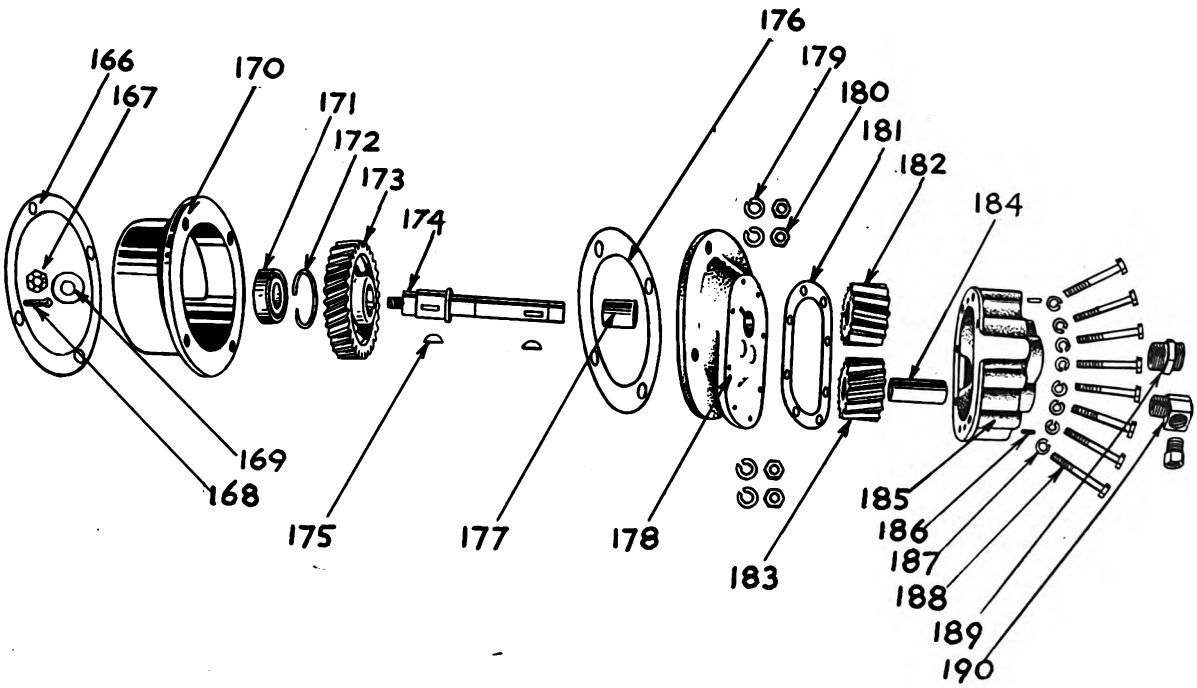

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Figure 198. Lubricating oil pump assembly.

Item No.	*No. of units*	*Name of part and description*
		LUBRICATING PUMP ASSEMBLY (fig. 198) (Continued)
175	2	Key, lubricating pump drive gear.
187	8	Lockwasher, 5/16″ positive lock.
167	1	Nut, retainer.
168	1	Pin, cotter for retainer nut.
172	1	Ring, bearing retainer snap.
174	1	Shaft, lubricating pump drive.
184	1	Shaft, lubricating pump idler.
169	1	Washer, retainer.
		Mounting parts:
189	1	Connection, suction tube.
190	1	Elbow, tube.
166	1	Gasket, lubricating pump.
179	4	Lockwasher, 7/16″ positive lock.
180	4	Nut, 7/16″—20 lubricating pump studs.

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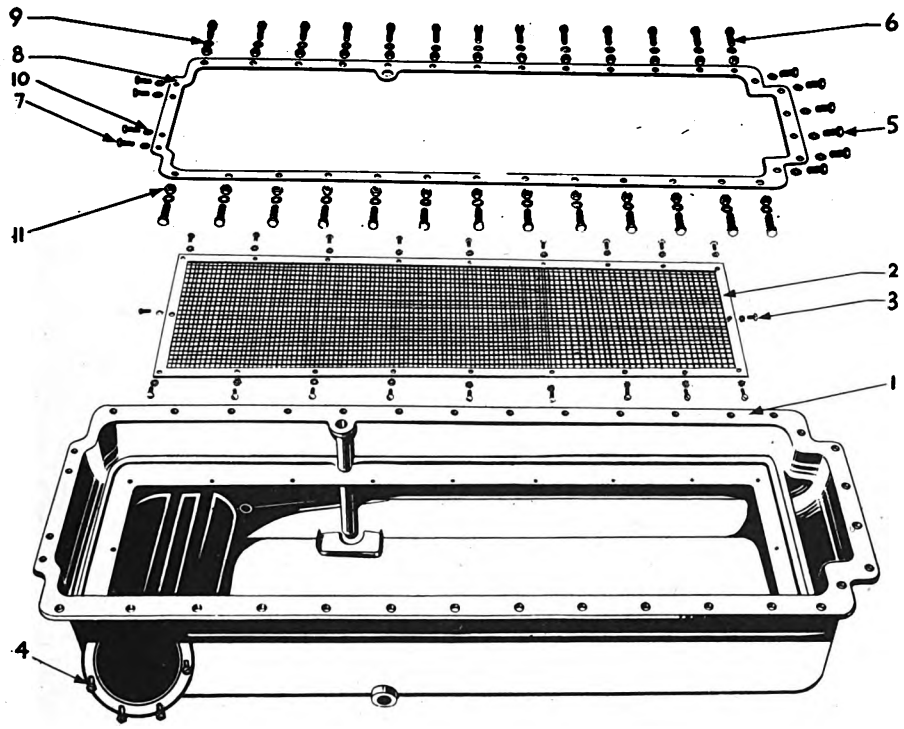

Figure 199. Oil pan.

Item No.	*No. of units*	*Name of part and description*
		OIL PAN (fig. 199)
	18	Lockwasher, ¼" everlock, oil pan screen.
1	1	Pan, oil bare.
2	1	Screen, oil pan.
3	18	Screw, oil pan (Parker Kalan).
4	6	Stud, filter cover.
		Mounting parts:
	1	Bushing, 1 x ½" pipe, lubricating oil temperature gauge.
5	4	Cap screw, 7/16"—14 x 1¼", pan to gear cover.
	3	Cap screw, 7/16"—14 x 1¼", pan to block.
6	27	Cap screw, 7/16"—20 x 1¾", pan to rear cover.
7	4	Cap screw, 5/16"—24 x 1", pan to rear cover.
	2	Elbow, oil tube (filter compartment).
8	1	Gasket, pan to block.
9	34	Lockwasher, 7/16" everlock, pan to block.
10	4	Lockwasher, 5/16" everlock, pan to rear cover.
11	27	Nut, 7/16"—20, oil pan cap screw.
	1	Plug, 1" pipe, oil drain.
	1	Plug, ⅜" pipe, oil drain.
	1	Plug, ½" pipe, oil pan, front.

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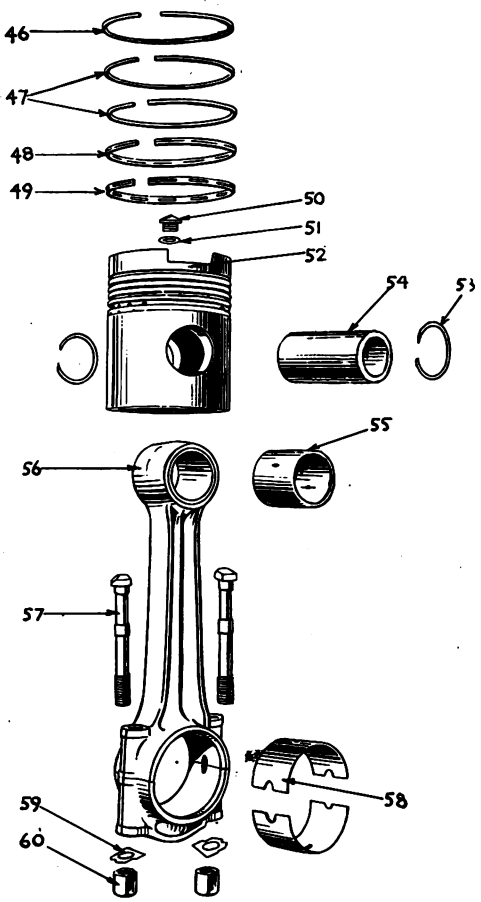

Figure 200. Piston and connecting rod assembly.

Item No.	*No. of units*	*Name of part and description*
		PISTON AND CONNECTING ROD ASSEMBLY (fig. 200)
	6	Assembly, piston (includes items 46-54 inclusive).
47	12	Ring, compression.
46	6	Ring, keystone.
48	6	Ring, oil regulator, narrow.
49	6	Ring, oil regulator, wide.
	6	Assembly, piston and pins (includes items 50-54 inclusive).
51	6	Lock, injector cup wiper (not sold separate with items 50 and 52).
54	6	Pin, piston.
52	6	Piston, bare.
53	12	Ring, piston pin snap.
50	6	Wiper, injector cup (not sold separate with items 51 and 52).
		Pistons and rings may be purchased in std 0.020", 0.030", and 0.040" oversize.
		Piston pins may be purchased in std 0.005" and 0.010" oversize.
56	6	Assembly, connecting rod less shell (including items 55-60).
57	12	Bolt, connecting rod.
55	6	Bushing, piston pin.
60	12	Nut, connecting rod bolt.
59	12	Plate, connecting rod lock.
58	12	Shell, connecting rod bearing.

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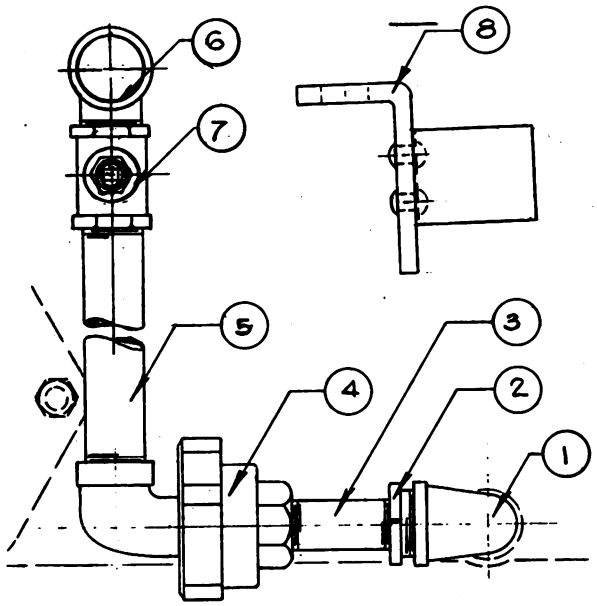
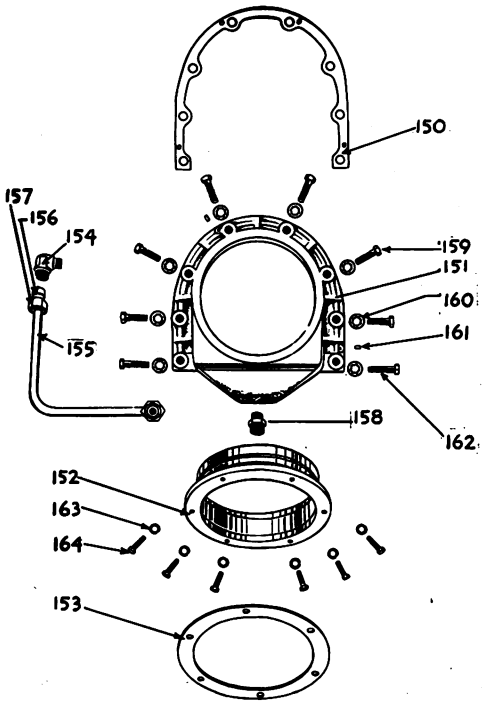


TL-33790

Figure 201. Oil pan drain assembly.



TL-33791

Figure 202. Rear cover and oil slinger assembly.

Item No.	*No. of units*	*Name of part and description*
		OIL PAN DRAIN ASSEMBLY (fig. 201)
	1	Assembly, lubricating oil drain.
1	1	Ell, street, 1" x 90°.
2	1	Bushing, reducer, 1" x ¾".
3	1	Nipple, pipe, ¾" x 2".
4	1	Joint, flexible (C1357D-4).
5	1	Nipple, pipe, ¾" x 9".
6	1	Ell, street, ¾" x 90°.
7	1	Cock, stop (C1357D-7).
8	1	Clamp, drain pipe.
		REAR COVER AND OIL SLINGER ASSEMBLY (fig. 202)
	1	Assembly, rear cover drain tube.
157	2	Nut, flexible tube.
156	2	Sleeve, rubber.
155	1	Tube, rear oil seal drain.
164	6	Cap screw, flywheel to slinger.
159	6	Cap screw, ⅜"—24 x 1¼", rear cover to block.
162	2	Cap screw, ⅜"—24 x 1½", rear cover to block.
151	1	Cover, rear.
150	As req'd	Gasket, rear cover to block 0.010".
150	As req'd	Gasket, rear to block 0.005".
153	1	Gasket, slinger to flywheel.
160	8	Lockwasher, ⅜" everlock, cover to block.
163	6	Lockwasher, 5/16" positive lock, slinger to flywheel.
152	1	Slinger, rear oil.
158	1	Union, rear oil seal tube.
161	2	Dowel, pin for cover.
154	1	Elbow, oil sling drain tube.

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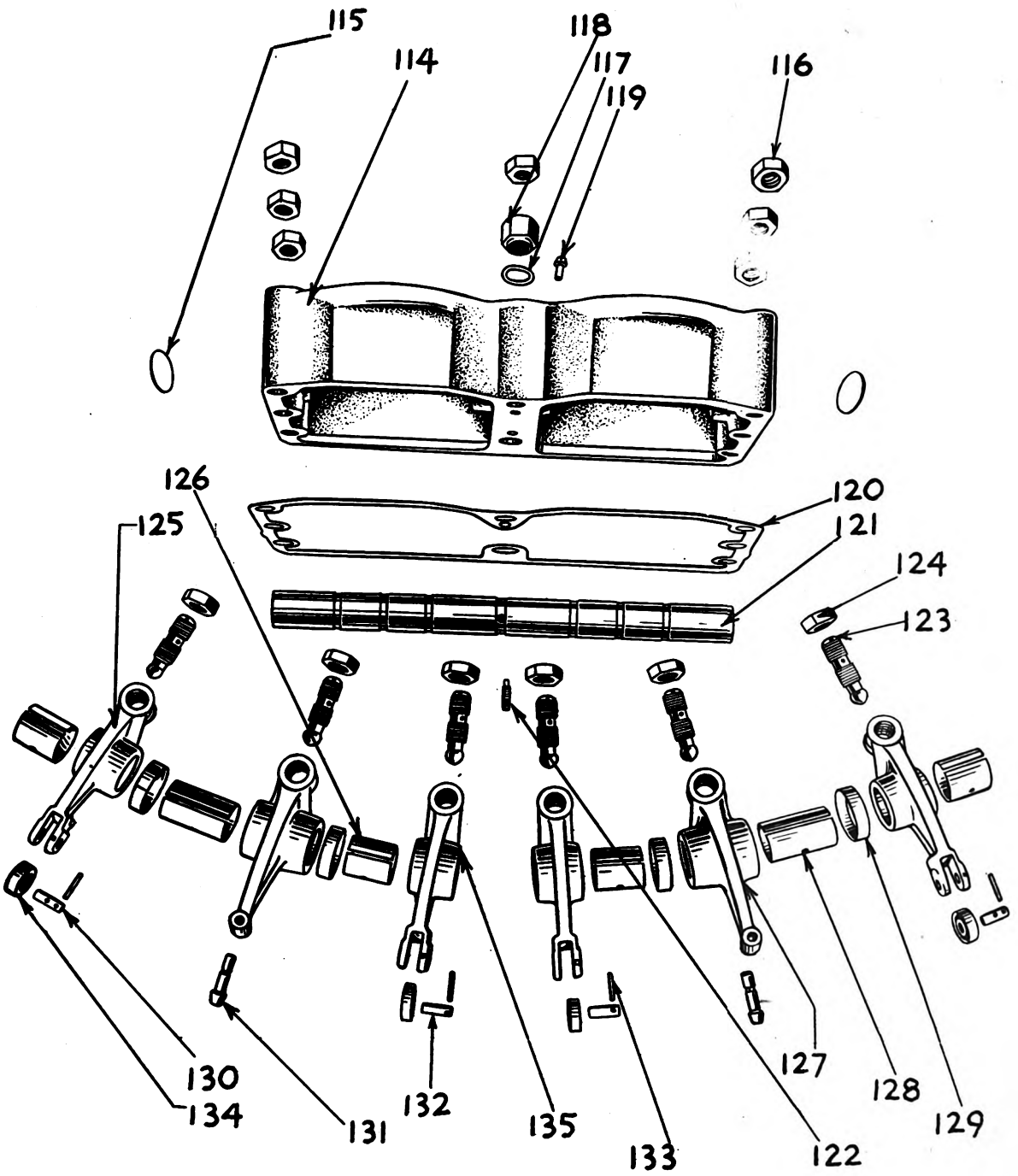

TL-33792

Figure 203. Rocker lever housing assembly.

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Item No.	No. of units	Name of part and description
		ROCKER LEVER HOUSING ASSEMBLY (fig. 203)
	3	Assembly, rocker lever housing.
129	12	Circlip, rocker lever.
114	3	Housing, rocker lever.
115	6	Plug, 1¼" expansion, rocker lever housing.
	3	Plug, ⅛" pipe, rocker housing.
119	3	Plug, rocker housing vent.
122	3	Screw, rocker shaft plug.
121	3	Shaft, rocker lever.
	6	Assembly, exhaust rocker lever (including items 123-126, 130, 133, 134).
125	6	Lever and bushing, exhaust.
126	6	Bushing, valve rocker lever.
124	6	Nut, ⅝"—18, rocker lever adjusting screw.
130	6	Pin, exhaust rocker lever roller.
133	6	Rivet, exhaust rocker lever roller pin.
134	6	Roller, rocker lever.
123	6	Screw, rocker lever adjusting.
	6	Assembly, injector rocker lever (including items 123, 124, 127, 128, 131).
127	6	Lever and bushing, injector.
128	6	Bushing, injector rocker lever.
124	6	Nut, ⅝"—18, rocker lever adjusting screw.
123	6	Screw, rocker lever adjusting.
131	6	Socket, injector rocker lever.
	6	Assembly, intake rocker lever (including items 123-126, 132-134).
135	6	Lever and bushing, intake.
126	6	Bushing, valve rocker lever.
124	6	Nut, ⅝"—18, rocker lever adjusting screw.
132	6	Pin, intake rocker lever roller.
133	6	Rivet, rocker lever roller pin.
134	6	Roller, rocker lever.
123	6	Screw, rocker lever adjusting.
		Mounting parts:
118	3	Cap, lubricating pipe.
117	3	Gasket, lubricating pipe cap.
120	3	Gasket, rocker housing to cylinder head.
116	21	Nut, ½"—13, rocker housing stud.
		ROCKER ARM HOUSING COVERS
	3	Cover, rocker housing.
	3	Gasket, rocker housing cover.
		Mounting parts:
	9	Cap screw, for rocker arm cover.
	9	Lockwasher, for rocker cover.

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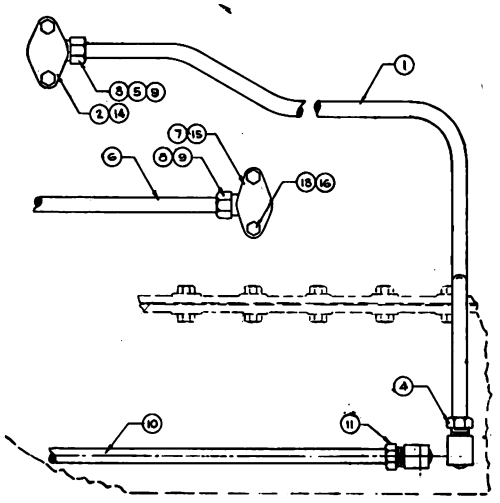
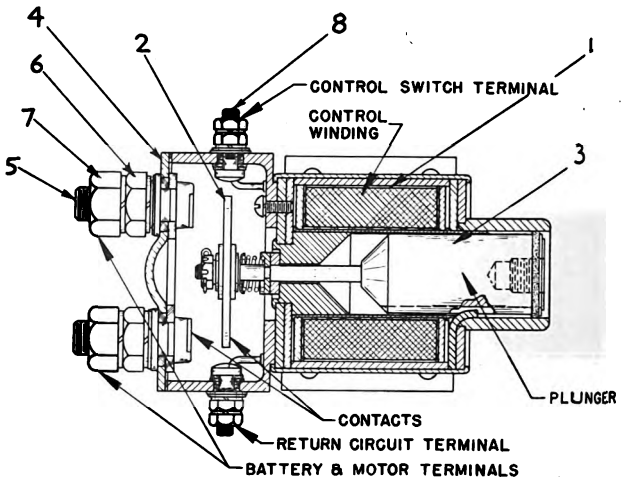


TL-33793

Figure 204. Lubricating oil tubing.



TL-33794

Figure 205. Starting motor solenoid.

Item No.	*No. of units*	*Name of part and description*
		TUBING, LUBRICATING OIL (fig. 204)
1	1	Tube, filter to engine block.
2	1	Flange, lubricating oil discharge tube.
3	1	Nut, packing.
4	1	Nut, tube.
5	1	Sleeve, tube packing.
6	1	Tube, lubricating oil suction.
7	1	Flange, lubricating oil suction tube.
8	2	Nut, packing.
9	2	Sleeve, tube packing.
10	1	Tube, pump to filter.
11	2	Nut, tube.
		Mounting parts:
13	4	Cap screw, ⅜"—24 x 2", lubricating tube flange.
14	1	Gasket, lubricating flange.
15	1	Gasket, suction tube flange.
16	4	Lockwasher, ⅜" positive lock, lubricating tube flange.
		SOLENOID, STARTING MOTOR (fig. 205)
	1	Solenoid switch (25-32 volt).
1	1	Case and coil assembly.
2	1	Contact disk on push rod.
3	1	Terminal and plate assembly.
4	2	Terminal stud, ½"—13.
5	1	Terminal stud insulated strip, inside.
6	2	Terminal stud nut, ½"—13 x 5/16" thick.
7	2	Terminal stud nut, ½"—13 x 7/16" thick.
8	2	Terminal stud, ¼"—20, square shoulder.
		STARTING MOTOR (fig. 206)
	1	Motor, starting.
1	1	Armature.
2	1	Coil, field, left-hand.
3	1	Coil, field, lower.

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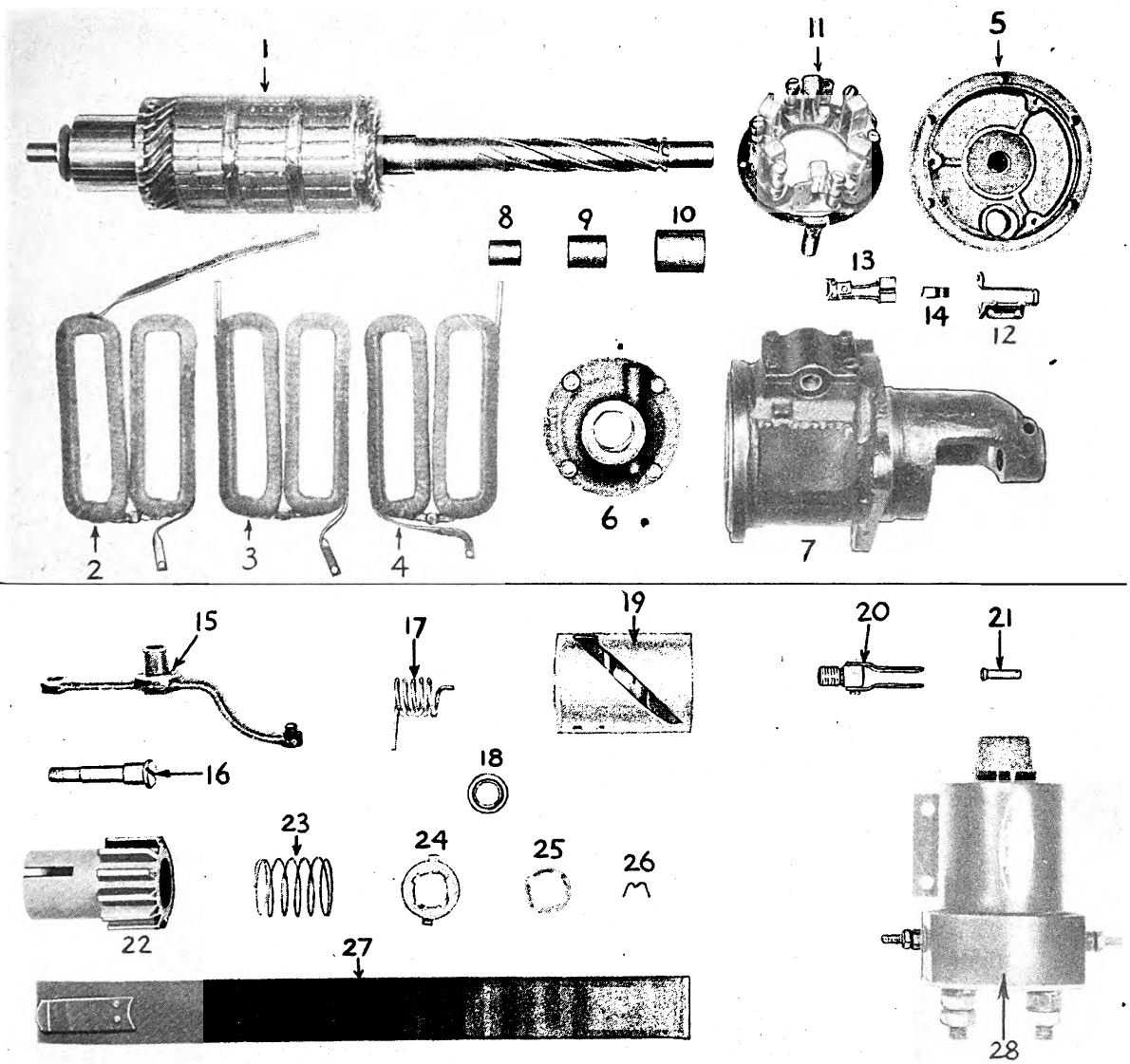

TL-33796

Figure 206. Starting motor.

Item No.	*No. of units*	*Name of part and description*
		STARTING MOTOR (fig. 206) (Continued)
4	1	Coil, field, right-hand.
5	1	End, commutator frame.
6	1	Bearing, center.
7	1	Housing, motor drive.
8	1	Bushing.
9	1	Bushing, drive housing.
10	1	Bushing, center bearing.
11	1	Assembly brush plate, less brushes.
12	1	Holder, brush.
13	12	Brush.
14	12	Spring, brush.
15	1	Lever, shift.

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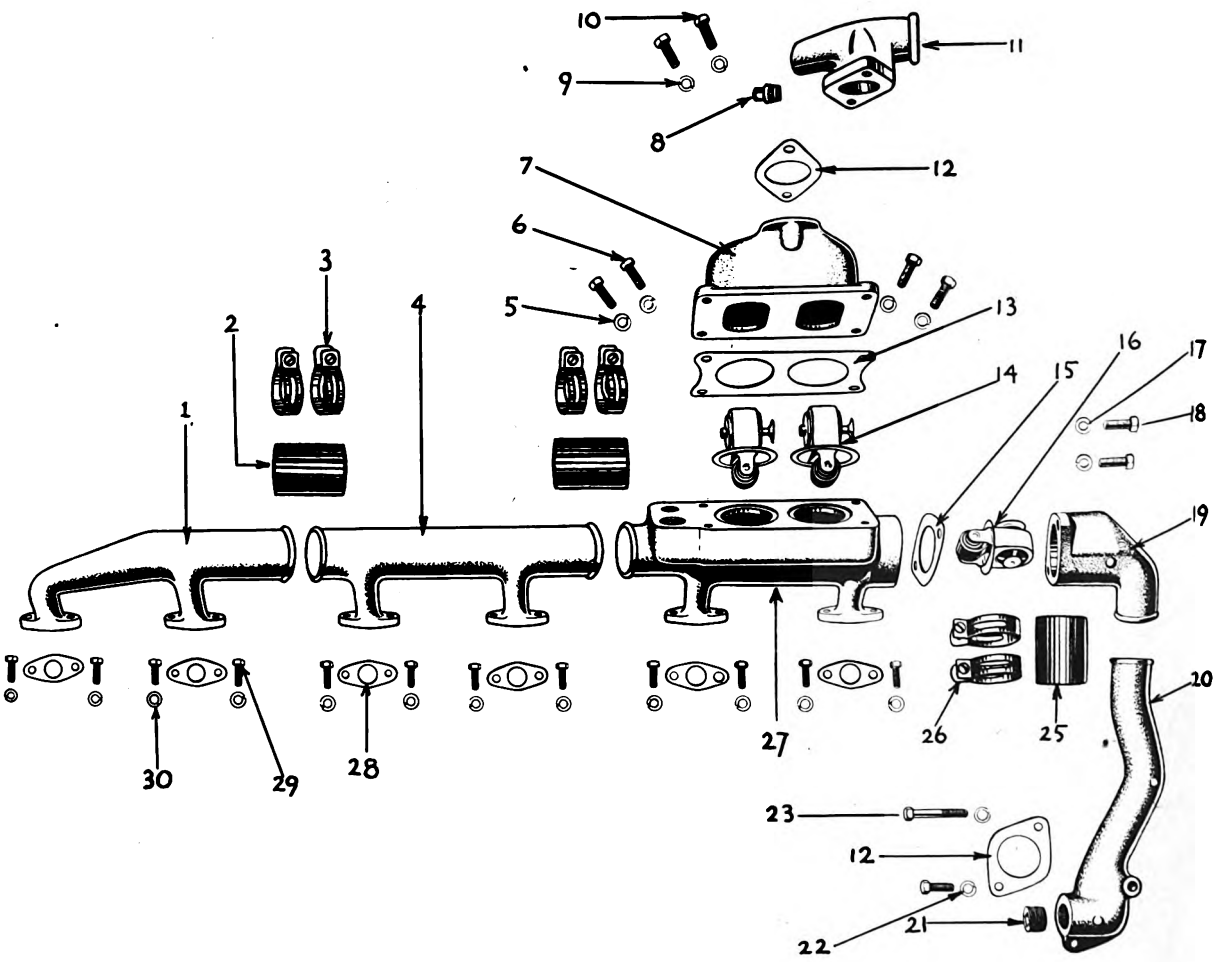
Item No.	*No. of units*	*Name of part and description*
		STARTING MOTOR (fig. 206) (Continued)
17	1	Spring, shift lever return.
19	1	Sleeve, shift.
20	1	Link, shift lever, and adjusting screw.
21	1	Pin, shift lever.
22	1	Pinion, drive.
23	1	Spring, pinion meshing.
24	1	Guide, pinion.
25	1	Collar, pinion stop.
26	1	Lockwire, pinion stop.
27	1	Band, commutator cover.
28	1	Solenoid.



TL-33797

Figure 207. Water manifold assembly.

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Item No.	No. of units	Name of part and description
		WATER MANIFOLD ASSEMBLY (fig. 207)
18	2	Cap screw, ⅜"—16 x 1", bypass connection.
23	1	Cap screw, ⅜"—16 x 2", bypass pipe.
22	1	Cap screw, ⅜"—16 x 1", bypass pipe.
6	4	Cap screw, ⅜"—16 x 1", thermostat housing.
10	2	Cap screw, ⅜"—16 x 1", water outlet connection.
26	2	Clamps, bypass hose.
3	4	Clamps, manifold hose.
19	1	Connection, water bypass.
11	1	Connection, water outlet.
15	1	Gasket, water bypass connection.
12	2	Gasket, water connection.
28	6	Gasket, water manifold to head.
13	1	Gasket, thermostat housing.
25	1	Hose, water bypass.
2	2	Hose, water manifold.
7	1	Housing, thermostat.
17	2	Lockwasher, ⅜" positive lock, bypass connection.
22	2	Lockwasher, ⅜" positive lock, bypass pipe.
9	2	Lockwasher, ⅜" positive lock, outlet connection.
5	4	Lockwasher, thermostat housing.
20	1	Pipe, bypass.
21	1	Plug, ¾" pipe, bypass pipe.
8	1	Plug, ½" pipe, water outlet connection.
4	1	Section, water manifold center.
27	1	Section, water manifold front.
1	1	Section, water manifold rear.
16	1	Thermostat, bypass.
14	2	Thermostat, main.
		Mounting parts:
29	12	Cap screw, 5/16"—24 x ⅞", manifold to head.
28	6	Gasket, manifold to head.
30	12	Lockwasher, 5/16" positive lock, manifold to head.

		WATER PUMP ASSEMBLY (fig. 208)
	1	Pump, water.
201	1	Bearing, inner.
203	1	Bearing, outer.
198	1	Body.
204	1	Gasket, oil.
194	1	Guide, spring.
191	1	Impeller.
209	1	Key, impeller.
212	1	Key, pulley No. 8 Woodruff.
208	1	Lockwire.
214	1	Nut, slotted.
215	1	Pin, cotter.
199	3	Plug, oil, ⅛" std pipe, slotted head.
216	1	Pulley, water pump driven.
207	1	Retainer, cork.
200	1	Retainer, split ring.
193	1	Ring, seal clamp.
210	2	Ring, split.
195	1	Seal, flexible.

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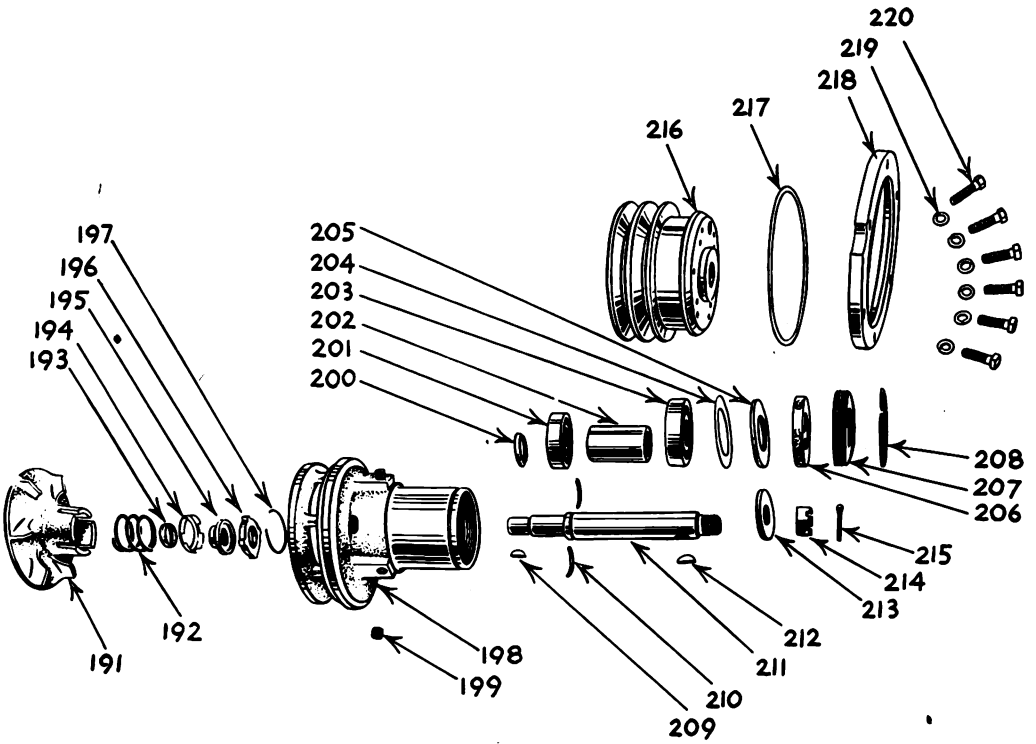

TL-33798

Figure 208. Water pump assembly.

Item No.	*No. of units*	*Name of part and description*
		WATER PUMP ASSEMBLY (fig. 208) (continued)
211	1	Shaft.
197	1	Snap wire.
202	1	Spacer, bearing.
192	1	Spring.
196	1	Washer, carbon.
213	1	Washer, clamp.
206	1	Washer, cork.
205	1	Washer cork retainer.
		Mounting parts:
220	6	Cap screw, ⅜"—24 x 1¼", water pump to block.
217	1	Gasket, water pump to block.
218	1	Ring water pump clamp.
219	6	Lockwasher, ⅜" positive lock pump to block.
		WATER PUMP DRIVE PULLEY AND BELTS
	1	Pulley, water pump drive.
	2	Belts, water pump and fan drive.
	1	Lockwasher, water pump drive pulley.
	1	Nut, ¾"—16, water pump drive pulley.
		FAN
	1	Fan.
	6	Cap screw, 5/16"—18 x ⅞", fan to water pump.
	6	Lockwasher, 5/16" positive lock, fan to water pump.

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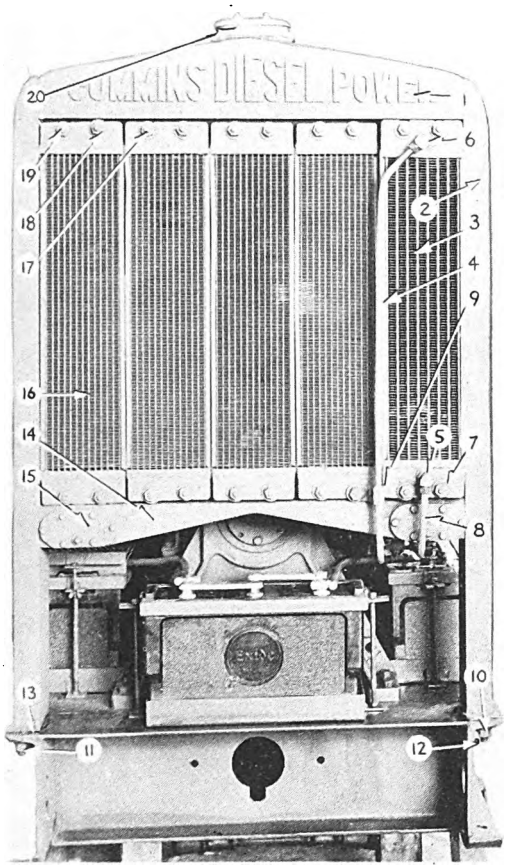
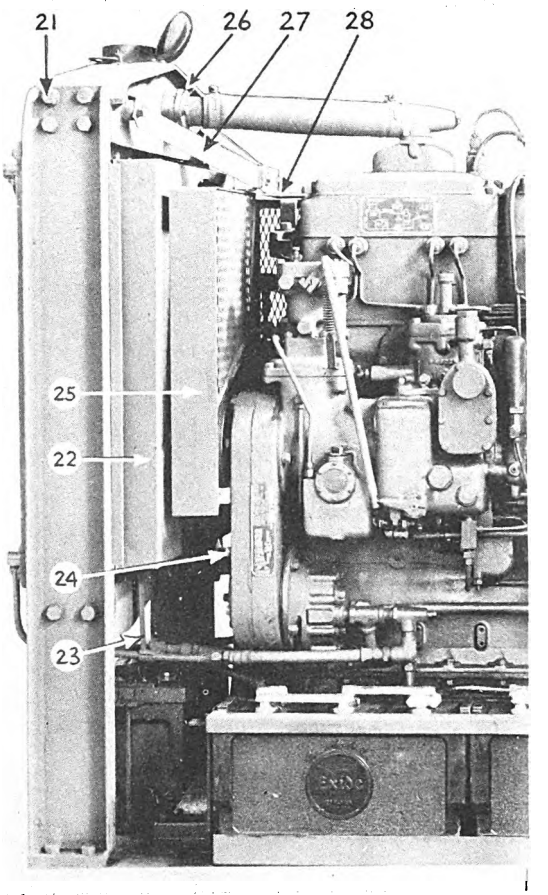


TL-33799

Figure 209. Radiator assembly.



TL-33800

Figure 210. Radiator accessories.

Item No.	*No. of units*	*Name of part and description*
		RADIATOR ASSEMBLY (fig. 209)
	1	Assembly, PERFEX R-1983-C modified.
1	1	Tank, top.
2	2	Support, radiator.
3	1	Section, oil cooler radiator.
4	1	Tubing, lubricating oil, to radiator.
5	2	Bushing, brass, ½" x ⅜".
6	2	Connection, tubing, inverted male ell.
7	4	Bolt, oil section square head.
8	1	Tubing, lubricating oil, from radiator.
9	1	Clamp, oil tube (includes clamp bolt and rubber grommet).
10	4	Washer, beveled, radiator support mounting.
11	4	Nut, radiator support mounting, ⅝" USS.
12	4	Cap screw, radiator support mounting ⅝" x 2½" USS.
	4	Lockwasher, radiator support mounting, ⅝".
13	2	Pad, radiator stand mounting.
14	1	Tank, bottom.
15	2	Plate, bottom cover.
	2	Gasket, bottom cover plate.
	12	Cap screws, bottom cover plate.

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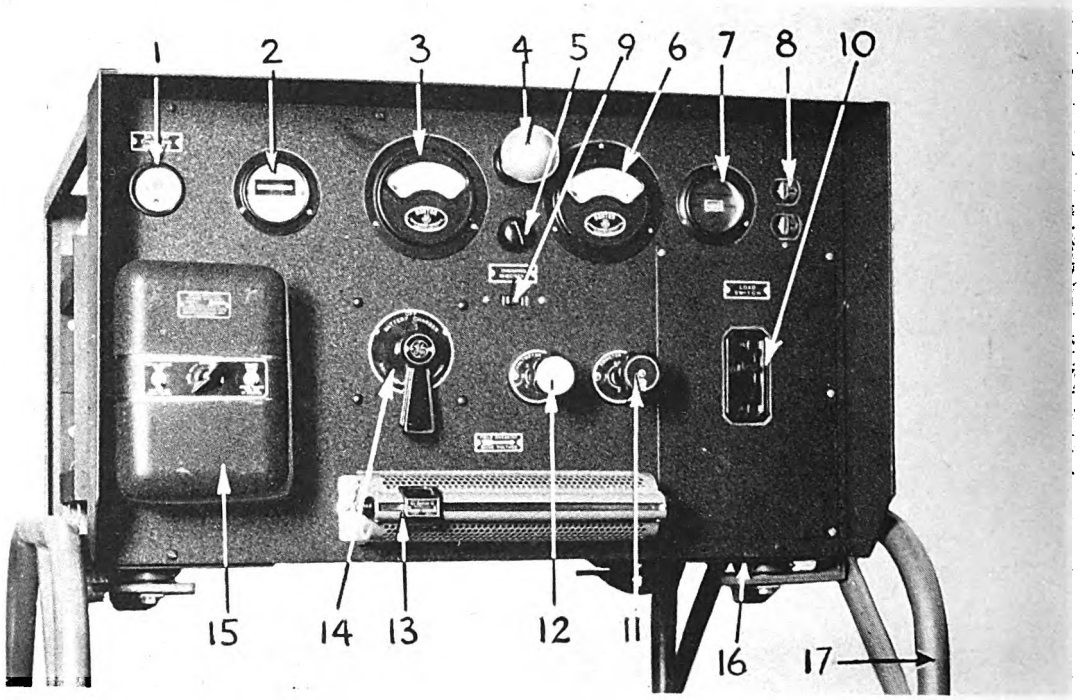
Item No.	*No. of units*	*Name of part and description*
		RADIATOR ASSEMBLY (fig. 209) (Continued)
16	4	Section, water cooler radiator.
17	20	Washer, core section.
18	20	Nut, core section.
19	16	Bolt, square head, water section.
20	1	Assembly, radiator cap.
21	12	Cap screw, support to tanks, ⅝" x 1", USS.
22	1	Shroud, fan (PERFEX FR-1983-C).
		RADIATOR ACCESSORIES (fig. 210)
23	1	Hanger, lubricating oil tube.
24	1	Connection, lower radiator water.
25	1	Guard, fan, right side.
26	1	Connection, upper radiator, water.
27	1	Brace, radiator.
28	1	Bracket, radiator brace.



TL-33801

Figure 211. Switch cabinet instruments.

Item No.	*No. of units*	*Name of part and description*
		SWITCH CABINET INSTRUMENTS (fig. 211)
1	1	Ammeter, battery-charging dc (0-6 amps).
2	1	Meter, reed type, flush mounted frequency (Frahm 58-62 cycles).
3	1	Voltmeter, flush mounted 4¼" diameter ac (0-150v with resistor).
	1	Socket, panel bulb.
4	1	Bulb, silver bowl panel (120-v).
5	1	Rheostat, bulb dimming.
6	1	Ammeter, flush mounted ac (0-150 amp).

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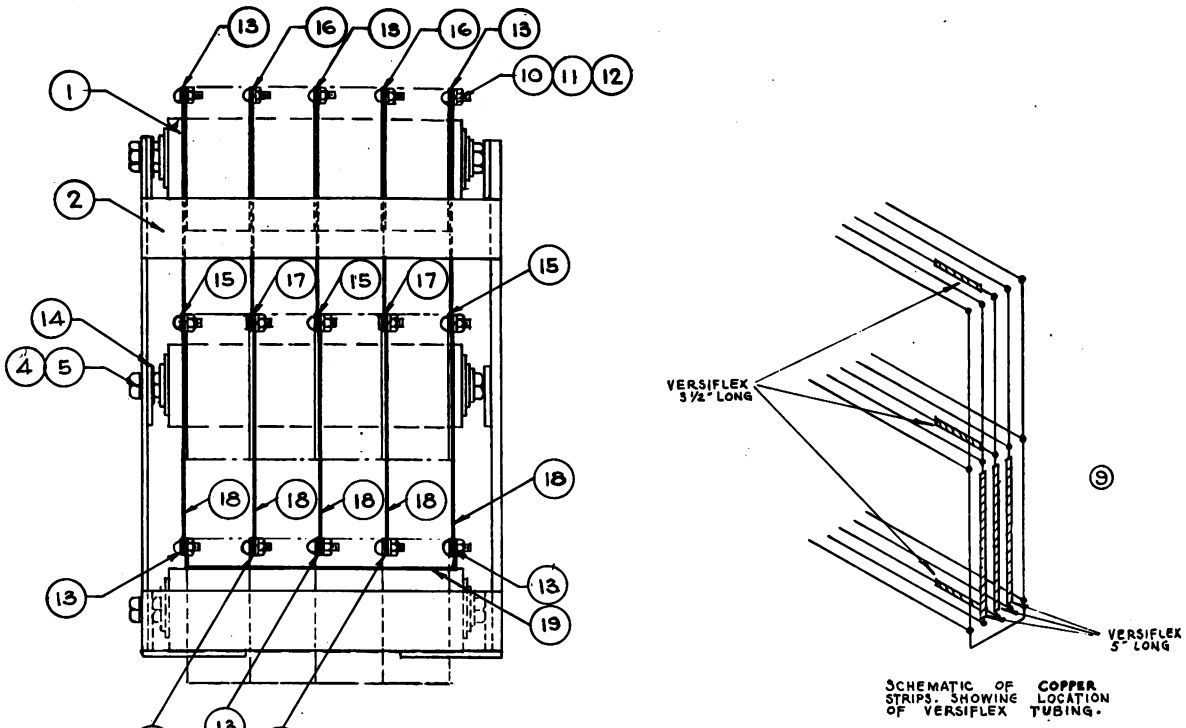

TL-33804

Figure 213. Rectifier, battery charging.

Item No.	*No. of units*	*Name of part and description*
		SWITCH CABINET PARTS (figs. 212A and B) (Continued)
16	4	Stud, generator terminal, ¼" x 3½" USS brass.
17	16	Nut, generator terminal, ¼" USS brass.
18	3	Transformer, current, 300/5 ratio.
19	1	Block, current, transformer mounting.
	3	Clamp, transformer mounting block.
		RECTIFIER, BATTERY CHARGING (fig. 213)
	1	Assembly, battery-charging rectifier.
2	1	Frame, rectifier-mounting.
	1	Frame, rectifier.
	1	Frame, rectifier-supporting.
1	12	Stack, rectifier (A-1232B-1).
4	24	Nuts, battery rectifier, ⅜" USS brass.
5	24	Lockwasher, battery rectifier (shakeproof ⅜").
14	24	Washers, battery rectifier spacer, ⅜" brass.
13	6	Strip, rectifier copper connecting (0.032" x ⅜" x 20-13/16").
15	3	Strip, rectifier copper connecting (0.032" x ⅜" x 19").
16	4	Strip, rectifier copper connecting (0.032" x ⅜" x 17⅝").
17	2	Strip, rectifier copper connecting (0.032" x ⅜" x 15-15/16").
18	5	Strip, rectifier copper connecting (0.032" x ⅜" x 11⅞").
19	1	Strip, rectifier copper connecting (0.032" x ⅜" x 8⅛").
10	13	Screws, rectifier connecting strip (No. 8-32 x ½").
13	13	Nuts, rectifier connecting strip (No. 8-32).
12	13	Lockwasher, rectifier connecting strip (No. 10).
	4	Cap screw, mounting frame, 5/16" x ⅝" USS.
	4	Lockwasher, mounting frame, 5/16".
9	6	Tubing, versiflex, ⅜" ID x 25½".

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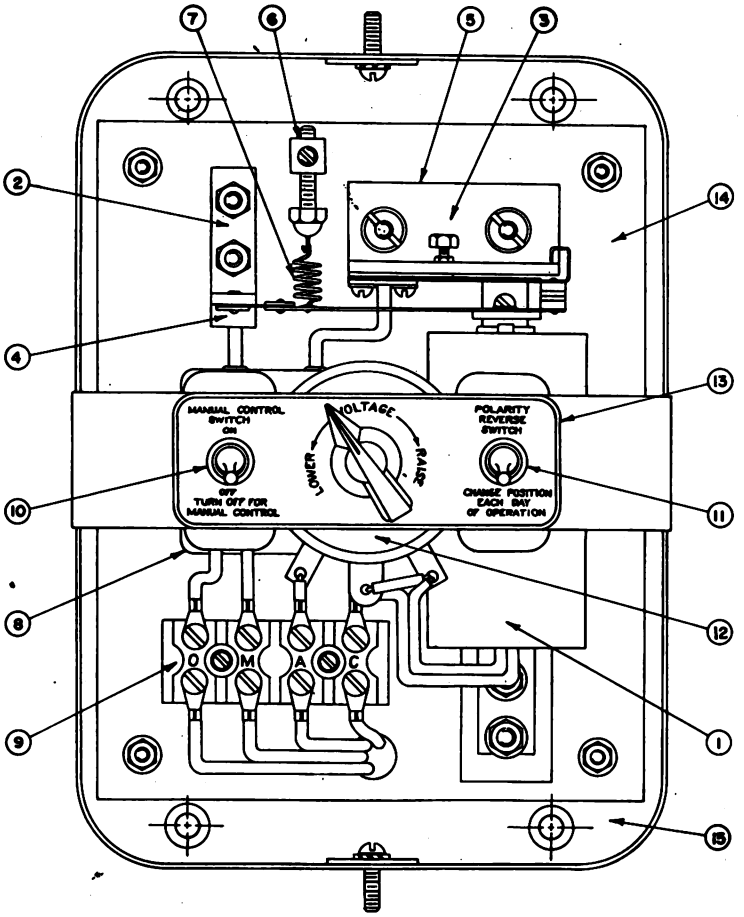

TL-33805

Figure 214. Voltage regulator.

Item No.	*No. of units*	*Name of part and description*
		VOLTAGE REGULATOR (fig. 214)
	1	Regulator, voltage.
1	1	Potential coil assembly, consisting of coil, lamination stack, bumper, coil bracket, coil spacer and screws, nuts, and washers required for mounting assembly.
2	1	Vibrator assembly, with lower contact.
3	1	Upper contact bracket assembly, consisting of upper leaf contact, spring back, contact washer, contact spacer, tension adjustment, angle bracket, and leaf contact screws.
4	1	Vibrator spacer, complete with mounting screws.
5	1	Angle bracket spacer, complete with mounting screws.
6	1	Voltage adjustment screw assembly, consisting of post, mounting screw, adjustment screw, setscrew, and slug.
7	1	Voltage adjustment spring.
8	1	Filter assembly, with leads and mounting screws.
9	1	Terminal block assembly, with mounting screws.
10	1	Regulator control switch assembly, with leads.
11	1	Polarity reverse switch assembly, with leads.
12	1	Voltage adjustment rheostat, with knob.
13	1	Control plate.
14	1	Ebony panel, with mounting screws.
15	1	Regulator case.

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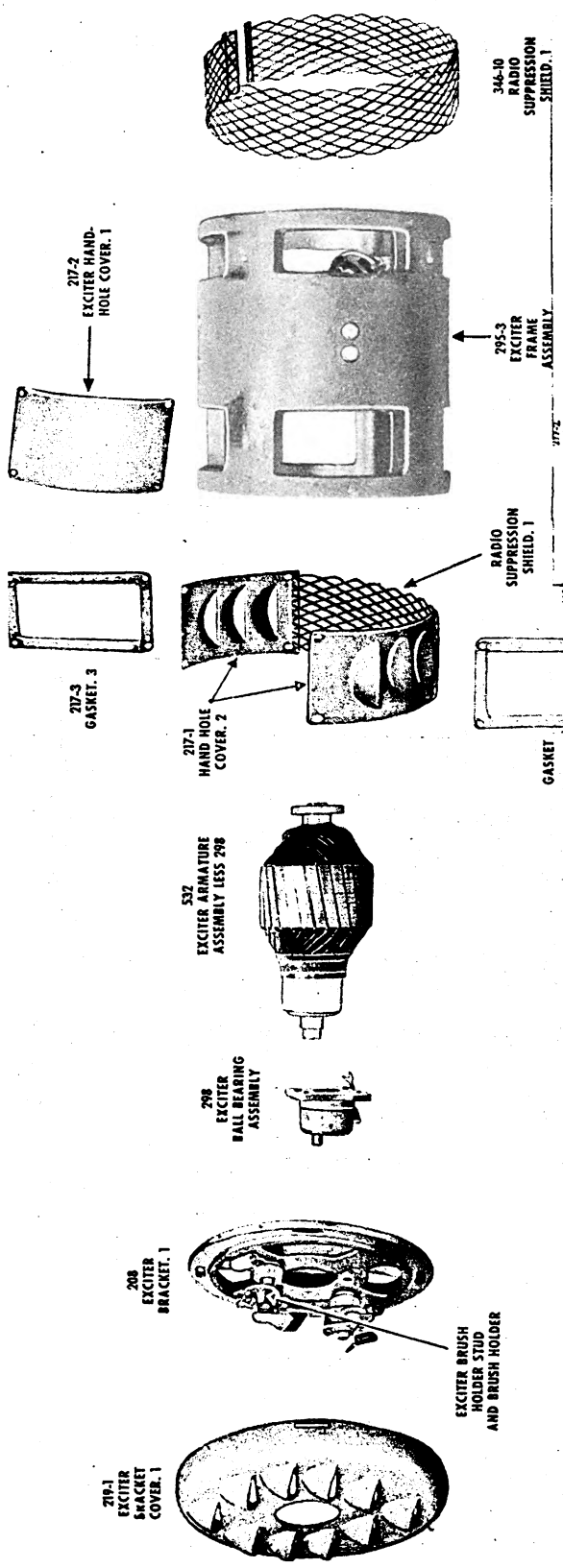
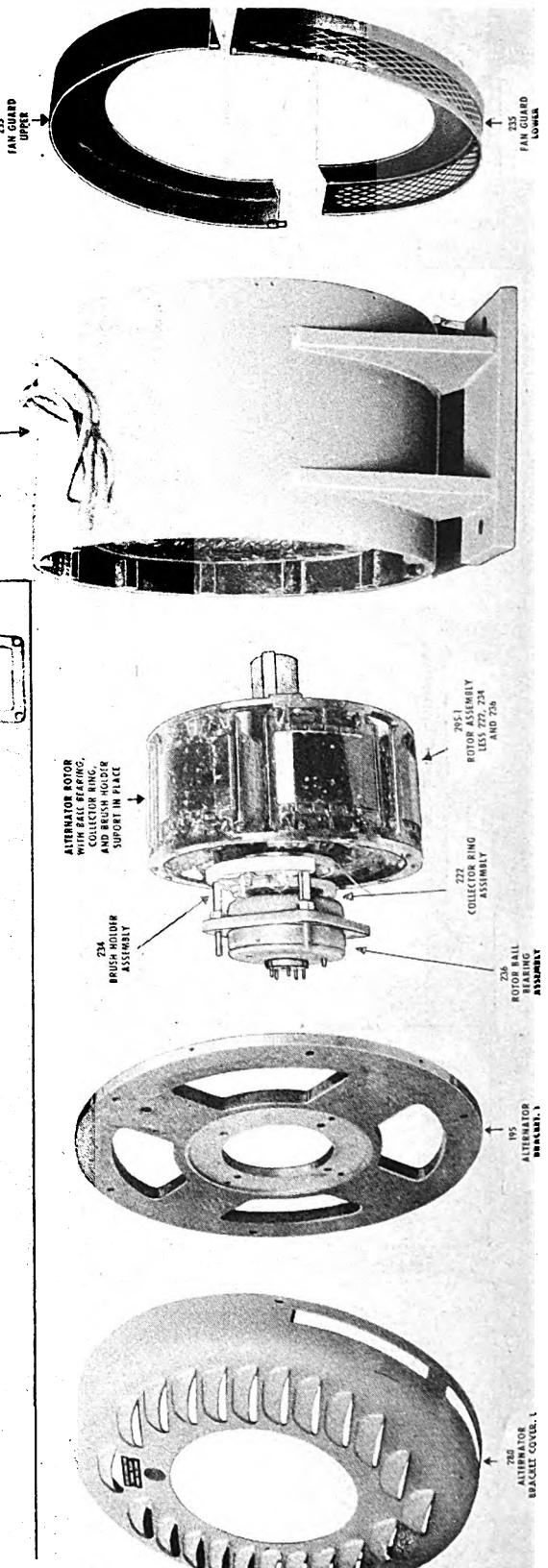


TL-33806

Figure 215. Exciter assembly.



TL-33807

Figure 216. Alternator assembly.

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Item No.	No. of units	Name of part and description
		EXCITER BALL BEARING (fig. 217)
61	1	Assembly complete (includes grease fitting).
73	1	Bearing housing.
74	2	Setscrew, 5/16" USS.
75	1	Closed end cap.
76	1	Grease fitting.
77	1	Ball bearing.
79	1	Clamp plate.
80	1	Cap screw, ⅜" x ¾" USS.
81	1	Lockwasher, ⅜".
137	1	Oil seal.
		EXCITER MAIN POLE (fig. 217)
54	2	Main pole assembly, complete.
51	2	Pole coil.
48	4	Pole piece cap screw.
49	4	Star washers, ⅜".
47	2	Pole shim.
136	2	Main pole.
		EXCITER BRACKET (fig. 217)
62	1	Exciter bracket.
139	4	Cap screw, ⅜" x 1¼" USS.
140	4	Flatwasher, ⅜".
141	4	Cap screw, ⅜" x 1" USS.
100	8	Star washer, ⅜".
		EXCITER INTERPOLE (fig. 217)
135	1	Assembly, complete.
		EXCITER BRUSH HOLDER STUD (fig. 217)
64	2	Insulator plug.
65	2	Insulator bushing.
66	4	Insulator washer.
67	2	Insulator bushing.
68	2	Stud washer, special.
69	2	Brush holder stud, special.
70	2	Expansion plug.
71	2	Jam nut, ¾" USS brass.
72	2	Star washer, ¾" brass.
		EXCITER HAND HOLE COVERS (fig. 217)
3	2	Cap screw, ¼" x ½" USS.
4	4	Star washer, ¼".
52	1	Hand hole cover, solid.
82	2	Hand hole cover, ventilated.
53	3	Gasket.
78	1	Radio interference suppression shield.
		EXCITER BRUSH HOLDER AND BRUSH (fig. 217)
56	2	Brush holder body.
57	2	Brush holder spring.
58	2	Brush holder arm.
59	2	Brush.
161	2	Condenser.
162	2	Machine screw No. 20—1¼" SAE.
165	4	Star washer No. 10.
158	2	Nut, No. 10.
163	6	Star washer No. 10.

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Item No.	*No. of units*	*Name of part and description*
		EXCITER ARMATURE ASSEMBLY (fig. 217)
55	1	Assembly, complete.
		EXCITER FRAME ASSEMBLY (fig. 217)
45	1	Assembly, complete.
46	1	Frame.
		ALTERNATOR BALL BEARING CARTRIDGE UNIT (fig. 217)
60	1	Assembly, complete.
30	1	Bearing housing.
31	2	Setscrew, 5/16" x 7/16" USS.
97	1	Locknut, special.
98	1	Lockwasher, special.
99	1	Ball bearing.
152	1	Oil seal.
153	1	Oil seal.
		ALTERNATOR COLLECTOR RING ASSEMBLY (fig. 217)
120	1	Assembly, complete.
106	2	Slip ring.
107	6	Insulator.
108	1	Sleeve.
109	1	Bushing.
110	1	Stud, special.
111	1	Stud, special.
112	1	Insulator sleeve.
113	4	Jam nut, ¼" USS.
114	2	Star washer, ¼".
		ALTERNATOR BRUSH HOLDER ASSEMBLY (fig. 217)
144	1	Assembly, complete.
115	1	Brush holder support.
116	2	Washer, bakelite.
117	3	Stud, special.
118	3	Nut, 5/16".
119	3	Star washer, 5/16".
42	6	Nut, ½".
121	3	Lockwasher, ½".
122	4	Brush holder.
134	4	Brush (110-4 superseded).
124	6	Round head machine screw No. 10-1½" USS.
125	6	Nut, ⅝".
126	6	Star washer, ⅝".
		ALTERNATOR BRACKET (fig. 217)
22	1	Alternator bracket.
23	6	Cap screw, ½" x 2".
24	8	Star washer, ½".
143	1	Cap screw, ½" x 1⅝".
25	2	Bushing.
40	4	End bell stud, special.

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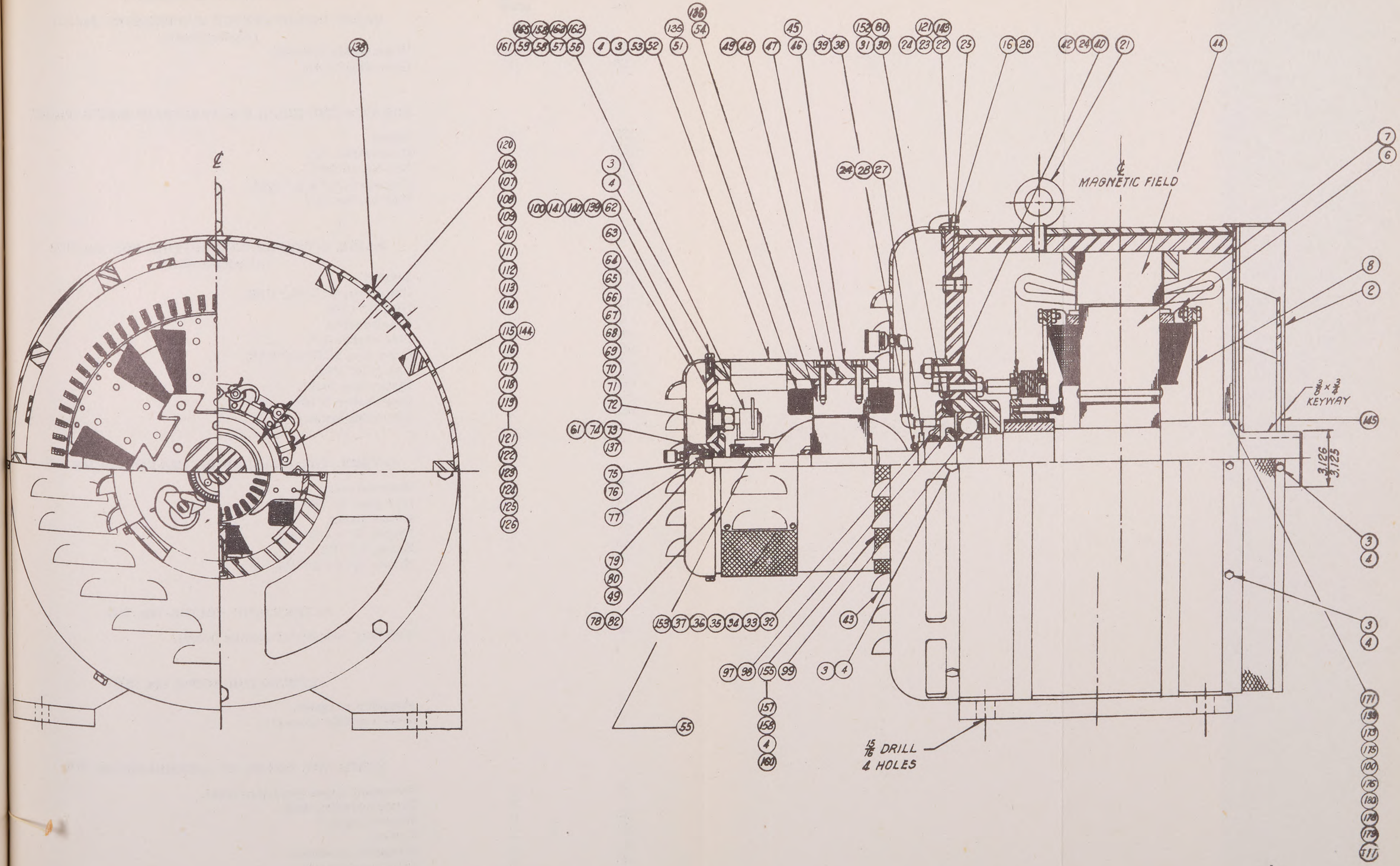

TL-33808

Figure 217. Generator assembly.

Item No.	*No. of units*	*Name of part and description*
		RADIO INTERFERENCE SUPPRESSION (fig. 217) (Exciter Shaft)
27	1	Brush holder assembly.
28	2	Grounding brush.
		RADIO INTERFERENCE SUPPRESSION SHIELD (fig. 217)
155	1	Shield.
157	2	Lockwasher, ⅝".
158	2	Nut No. 10 SAE.
160	2	Cap screw, ¼" x ⅝" USS.
4	2	Star washer, ¼".
		RADIO INTERFERENCE SUPPRESSION (fig. 217) (Alternator Shaft)
171	1	Bracket.
139	4	Cap screw, ⅜" x 1¼" USS.
173	2	Nut, ⅜" USS.
175	2	Braided strap.
100	2	Star washer, ⅜".
176	2	Cap screw, 5/16" x 1" USS.
177	2	Nut, 5/16" USS.
178	2	Flatwasher, 5/16".
179	2	Star washer, 5/16".
180	2	Grounding brush.
		ALTERNATOR BEARING GREASE FITTING (fig. 217)
32	1	Open end cap.
33	1	Pipe plug, ⅛" IPS.
34	1	Grease fitting.
35	1	Nipple, ⅛" x 4½" IPS.
36	2	Elbow, ⅛" IPS.
37	1	Nipple, ⅛" x 1½" IPS.
		ALTERNATOR STATOR (fig. 217)
44	1	Assembly, complete (including frame).
		ALTERNATOR ROTOR (fig. 217)
7	1	Assembly, complete.
6	1	Revolving field assembly.
		PARTS NOT LISTED IN ASSEMBLIES (fig. 217)
2	1	Fan guard, upper and lower (235).
8	2	Damper winding ring.
16	1	Support angle.
21	1	Eyebolt.
26	1	Greenfield connector.
38	5	Shaft coupling stud.
43	1	Alternator bracket cover.
63	1	Exciter bracket cover.
138	4	Bushing.
145	1	Fan.

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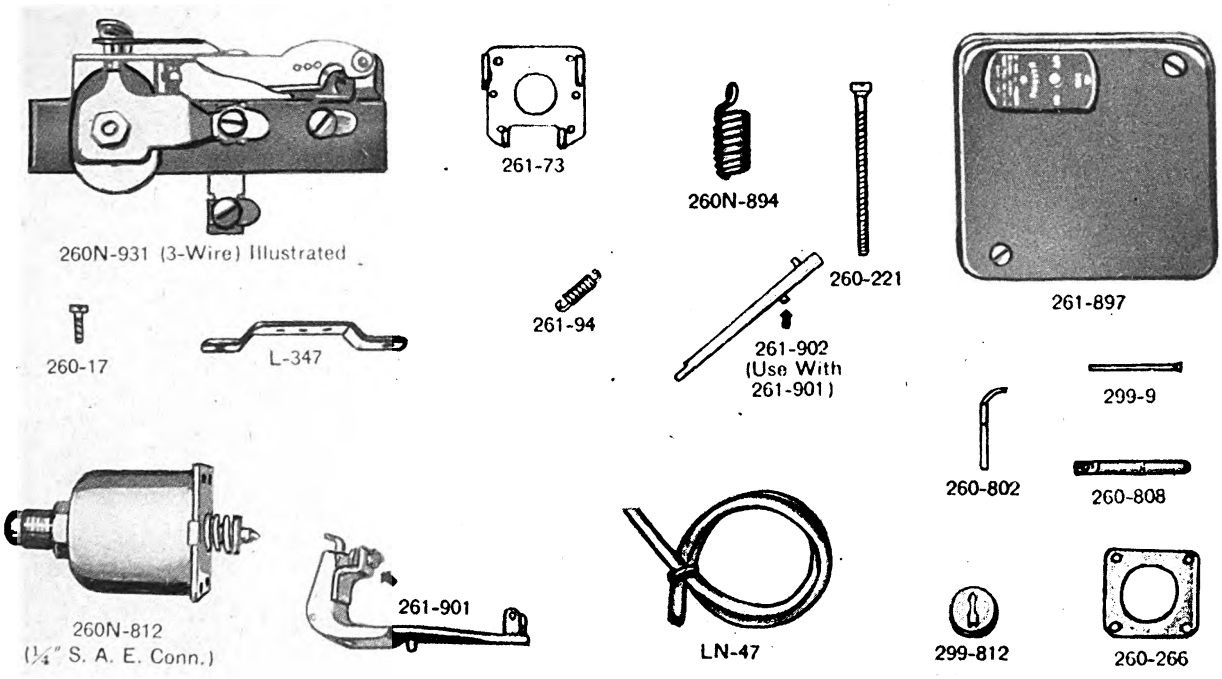

TL-33809

Figure 218. Switch, oil pressure alarm.

No. of units	*Name of part and description*
	SWITCH OIL PRESSURE ALARM (fig. 218)
	Assembly, switch.
1	Screw, connector rod pivot.
1	Screw, adjusting.
1	Gasket, bellows.
1	Hook, connector rod.
1	Ring, bakelite connector rod and sealing.
1	Bellows, pressure, ¼" SAE.
1	Spring, main.
1	Block, complete contact (3-wire).
1	Bracket, main arm.
1	Spring, manual knob return.
1	Assembly, cover and rubber molding.
1	Assembly, main arm.
1	Pins, manual knob and shaft.
1	Pin, main arm pivot.
1	Screw, manual knob and set.
2	Foot, mounting.
1	Molding, cover, rubber.

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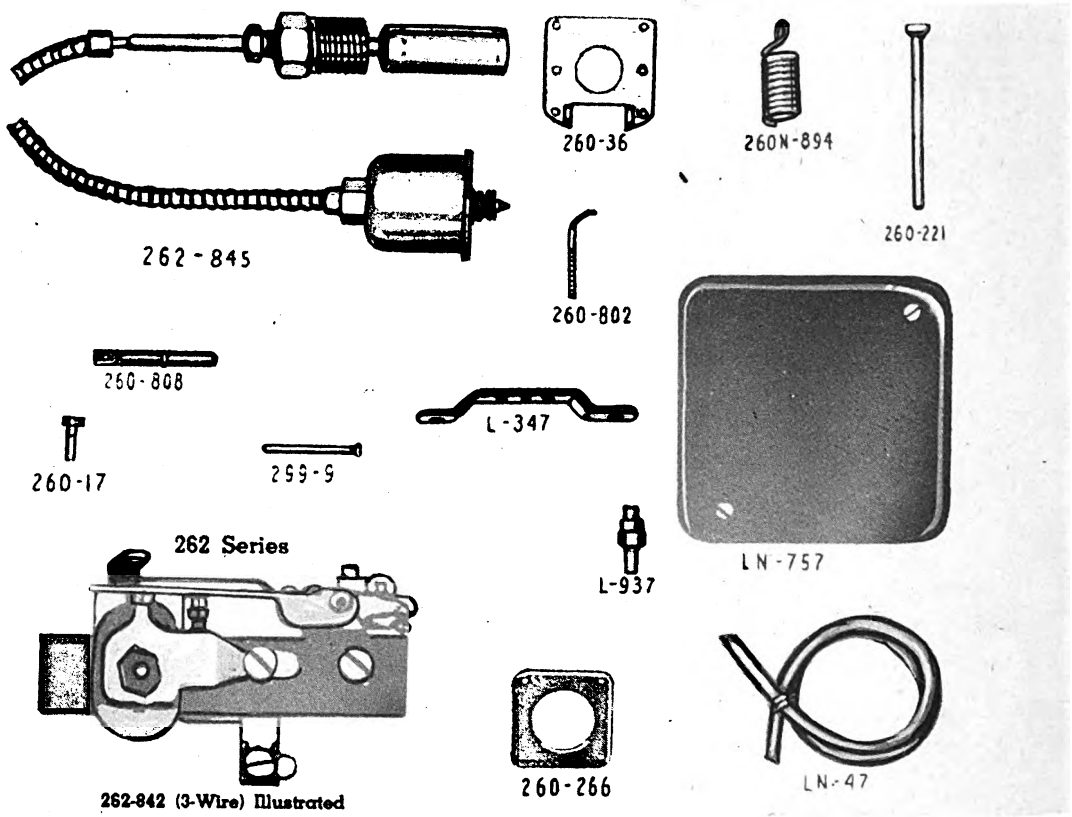

TL-33810

Figure 219. Switch, temperature alarm.

No. of units	*Name of part and description*
	SWITCH, TEMPERATURE ALARM (fig. 219)
	Assembly, switch.
1	Screw, connector rod pivot.
1	Bracket, main arm.
1	Hook, connector rod.
1	Screw, adjusting.
1	Gasket, bellows.
1	Ring, connector rod and sealing.
1	Assembly, main arm.
1	Spring, main.
1	Assembly, complete contact block (3-wire).
1	Element, temperature (4-ft tube).
1	Pin, main arm pivot.
2	Foot, mounting.
1	Assembly, manual reset pin.
1	Molding, cover, rubber.
1	Assembly, cover and rubber molding.

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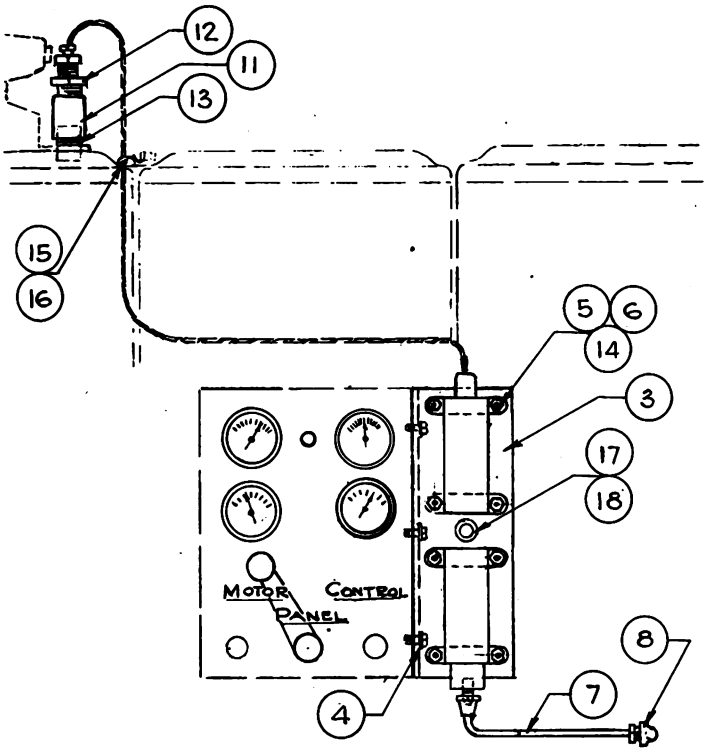
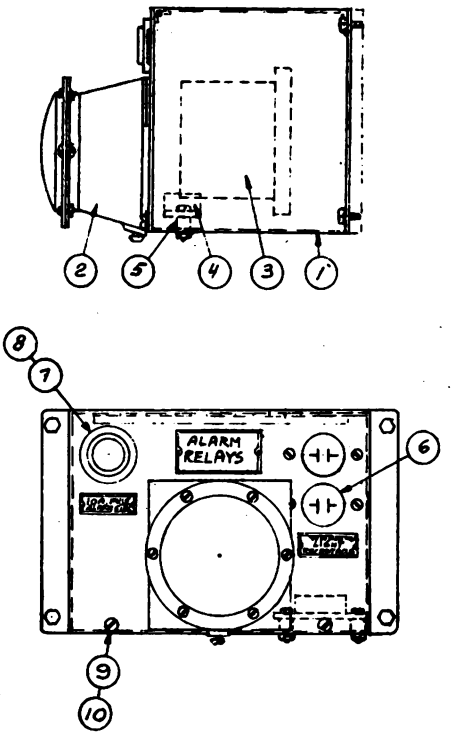


TL-33811

Figure 220. Alarm system accessories.



TL-33812

Figure 221. Alarm relay box.

Item No.	*No. of units*	*Name of part and description*
		ALARM SYSTEM ACCESSORIES (fig. 220)
3	1	Bracket, switch.
4	3	Cap screws, bracket holding, ¼" x ¾" USS.
5	8	Cap screws, switch holding, ¼" x ¾" USS.
6	11	Lockwashers, switch holding, ¼".
7	1	Tubing, oil pressure switch, ¼" OD.
8	1	Ell, inverted male (C1270M-9).
11	1	Coupling, pipe, ¾".
12	1	Bushing, pipe, ¾" x ½".
13	1	Nipple, pipe, ¾" close.
14	8	Nuts, switch holding, ¼" USS.
15	1	Clamp, temperature line.
16	1	Loom, temperature line.
17	1	Bushing, insulating.
18	1	Nut, insulating bushing.
		RELAY BOX, ALARM (fig. 221)
1	1	Box, alarm relay.
2	1	Horn, alarm 24-v, dc (X474-2).
3	1	Panel, alarm box relay.
	2	Machine screws, box panel, ¼" x ⅞" USS.
4	1	Flasher, thermostatic 50-w, 24-v, dc (X474-4).
5	2	Mounting, rubber (X474-5).
6	2	Receptacle, warning light (X474-6).
7	1	Socket, lamp (X474-7).
8	1	Fuse, plug, 10 amp.
12	2	Screws, face panel, No. 10—32 x ¼".
13	2	Washers, panel, No. 10—I.E.T.

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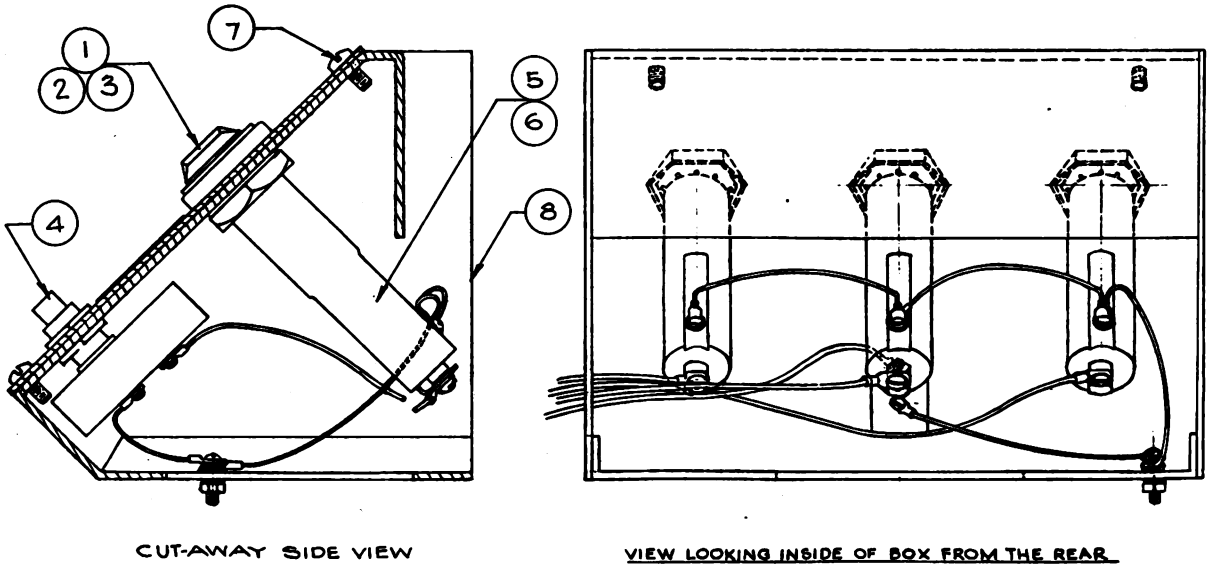
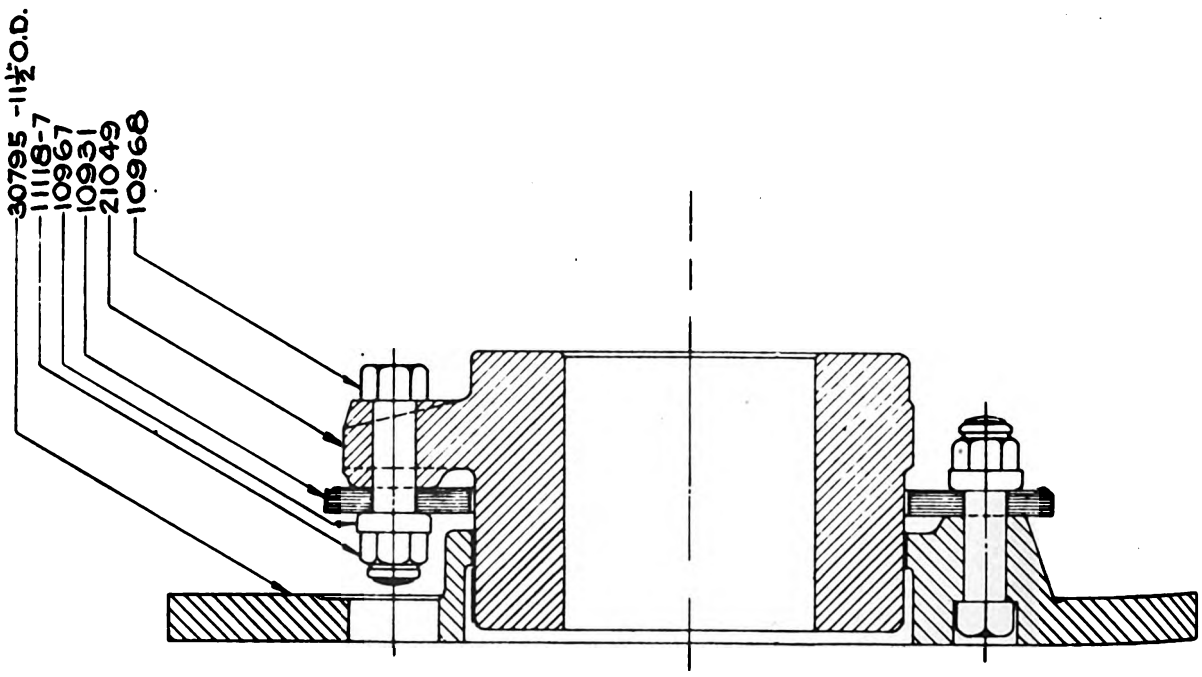


TL-33813

Figure 222. Signal light box.



TL-33814

Figure 223. Coupling, flexible, engine-generator.

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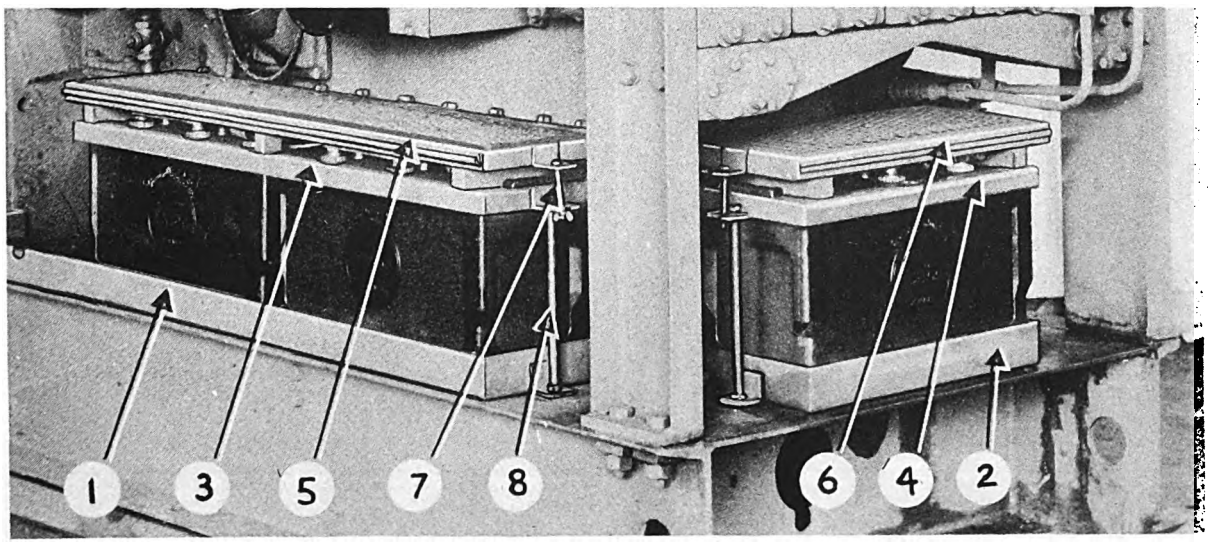
Item No.	No. of units	Name of part and description
		SIGNAL LIGHT BOX (fig. 222)
8	1	Assembly, signal light box.
7	4	Machine screw, box panel, No. 8—32 x ⅜".
5	3	Receptacles, bulb.
6	3	Bulb, signal light (30-v).
1	1	Lens, red signal light.
2	1	Lens, green signal light.
3	1	Lens, amber signal light.
	1	Switch, horn disconnector.
4	1	Switch, Acra snap.
		COUPLING, FLEXIBLE ENGINE-GENERATOR (fig. 223)
	1	Assembly, flexible coupling, stainless steel disks.
1	1	Adapter, flywheel.
2	1	Flange, pilot.
3	1 set	Disks, stainless steel.
4	8	Washers, bevel.
5	4	Bolts, flange.
6	4	Bolts, flywheel adapter special.
7	8	Nuts, lock ½".
		BATTERY, RETAINER, COVER AND PANS (fig. 224)
	5	Battery, 6-v, wet cell.
	1	Assembly, oil drip pan, fuel pump side.
1	1	Assembly, oil drip pan, manifold side.
2	1	Assembly, oil drip pan, front.
3	2	Retainer, battery, sides.
4	1	Retainer, battery, front.
	2	Frame, battery cover, side.
	1	Frame, battery cover, front.
5	2	Cover, battery, side.
6	1	Cover, battery, front.
7	6	Bolt, cover holdown, ¼" x 2½", USS.
	6	Lockwasher, cover holdown, ¼".
	6	Wingnut, cover holdown, ¼" USS.
8	6	Bolt, battery retainer, ⅜" x 9" USS.



TL-33815

Figure 224. Battery retainer, cover and pan.

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110. MAINTENANCE PARTS LIST FOR POWER UNIT PE-245-A.

NOTE: Order maintenance parts by stock number, name, and description. Only maintenance parts can be requisitioned.

Reference symbol	*Signal Corps stock No.*	*Name of part and description*	*Running spares*	*Quan per unit*	*Orgn stock*	*3d ech*	*4th ech*	*Depot stock*
	3H1907	ENGINE, Model HI-600 Cummins (Component).		1				*
		AIR INTAKE MANIFOLD GROUP						
10	3H1907/C35	COIL, preheater ignition.		1				*
22	3H4585A/7	BALL, nozzle-check valve.		1				*
13	3H1907/E15	ELECTRODE, adjustable.		1				*
8	3H1907/E16	ELECTRODE, stationary.		1				*
18	3H1907/G12	GASKET, nozzle retainer plate.		1				*
2	3H1907/G13	GASKET, ignition-coil cover.		1				*
12	3H1907/M11	MANIFOLD, air intake.		1				*
19	3H1907/N20	NOZZLE, preheater.		1				*
21	3H1907/S102	SPRING, nozzle-check valve.		1				*
6	3H1907/S142	SWITCH, pressure.		1				*
16	3H1907/V4	VALVE, ball-check, priming pump to preheater.		1				*
11	3H4585A/83	GASKET, air cleaner.		2			*	*
1	3H4600-245A/C18	CLEANER, air, DAFC-A-2107.		2				*
	3H4585A/110	GASKETS, manifold, intake and exhaust, copper, (also included in kit No. 7).		3		*	*	*
	3H4585A/406	NUTS, brass, 5/8-16 hex.		6			*	*
		CAM FOLLOWER HOUSING GROUP						
	3H4585A/45	ASSEMBLY, cam follower housing, steel.		3			*	*
	3H4585A/155	SHAFT, cam follower lever.		6			*	*
	3H4585A/156	ASSEMBLY, injector cam follower, steel.		6			*	*
	3H4585A/157	ASSEMBLY, valve cam follower lever, steel.		12			*	*
	3H4585F/P11	KIT, REPAIR, lower cam rocker assembly, CECO KIT No. 3.		1			*	*
91	3H4585A/61	ROD, exhaust, push.	3	6			*	*
92	3H4585A/77	ROD, injector, push.	3	6			*	*
93	3H4585A/150	ROD, intake, push.	3	6			*	*

*Indicates stock available.

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110. MAINTENANCE PARTS LIST FOR POWER UNIT PE-245-A (Continued).

NOTE: Order maintenance parts by stock number, name, and description. Only maintenance parts can be requisitioned.

Reference symbol	*Signal Corps stock No.*	*Name of part and description*	*Running spares*	*Quan per unit*	*Orgn stock*	*3d ech*	*4th ech*	*Depot stock*
		CAMSHAFT						
	3H1907/C15	ASSEMBLY, camshaft.		1			*	*
45	3H4585A/209	RING, camshaft thrust.		1			*	*
40	3H4585A/23	BUSHING, camshaft, front, cadmium silver.		1			*	*
42	3H4585A/26	BUSHING, camshaft, 3-5, cadmium silver.		2			*	*
41	3H4585A/25	BUSHING, camshaft, 2-4-6, cadmium silver.		3			*	*
43	3H4585A/646	BUSHING, camshaft, rear, cadmium silver.		1			*	*
		CRANKSHAFT						
	3H1907/C40	ASSEMBLY, crankshaft.		1				*
29	3H4585A/152	KEY, crankshaft pinion.	1	1				*
33	3H1907/N45	NUT, crankshaft.	1	1				*
		MAIN BEARING SHELLS						
26	3H4585A/514	DOWELS, main-bearing ring.	3	7			*	*
22	3H4585A/253	SHELLS, main-bearing, lower rear, alloy.		1		*	*	*
21	3H4585A/252	SHELLS, main-bearing, upper, rear, alloy.		1		*	*	*
24	3H4585A/251	SHELLS, main-bearing, lower, 2-4-6, alloy.		3		*	*	*
23	3H4585A/250	SHELLS, main-bearing, upper, alloy, 2-6.		2		*	*	*
28	3H4585A/249	SHELLS, main-bearing, lower, alloy, 1-3-5.		3		*	*	*
27	3H4585A/312	SHELLS, main-bearing, upper, alloy, 1-3-5.		3		*	*	*
25	3H1907/B10	SHELLS, main-bearing, upper, alloy, No. 4.		1		*	*	*
		CYLINDER BLOCK						
1	3H1907/830	CYLINDER BLOCK, studded, cast.		1				*
	3H1907/614	GASKET, water-drain plug.		1	*	*	*	*
	3H4585A/125	GASKET, water blind flange.		1	*	*	*	*
	3H4585A/193	LOCK, main-bearing stud nut.		14		*	*	*
15	3H4585A/173	NUT, main-bearing stud.	3	14			*	*
17	3H4585A/274	STUD, main-bearing.		7			*	*
16	3H4585A/275	STUD, main-bearing, slotted.		7			*	*
3	3H4585A/56	LINER, cylinder.	3	6			*	*
4	3H4585A/176	PACKING, cylinder liner (also included in gasket kit No. 7).	18	18			*	*

*Indicates stock available.

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110. MAINTENANCE PARTS LIST FOR POWER UNIT PE-245-A (Continued).

NOTE: Order maintenance parts by stock number, name, and description. Only maintenance parts can be requisitioned.

Reference symbol	*Signal Corps stock No.*	*Name of part and description*	*Running spares*	*Quan per unit*	*Orgn stock*	*3d ech*	*4th ech*	*Depot stock*
		CYLINDER HEAD						
	3H1907/H15	ASSEMBLY, cylinder head, valves, and studs.		2		*	*	*
	3H1907/H16	ASSEMBLY, cylinder head, valves, and studs, rear.	1	1			*	*
77	3H4585A/52	COLLET, valve, steel.	6	24			*	*
78	3H4585A/143	GUIDE, valve spring, cast.		12			*	*
79	3H4585A/262	SPRING, valve, steel.	1	12			*	*
88	3H4585A/336	VALVE, exhaust, steel.		6		*	*	*
89	3H4585A/293	VALVE, intake, steel.		6		*	*	*
82	3H4585A/144	GUIDE, valve stem, steel.		12			*	*
91	3H4585A/110	GASKET, cylinder head, copper (also included in gasket kit No. 7).	3	3		*	*	*
		EXHAUST MANIFOLD						
	3H1907/M10	ASSEMBLY, exhaust manifold, cast.		1				*
		FILTER—FUEL OIL—PRIMARY						
	3H4585A/480	FILTER, fuel oil, Cuno D-1400.		1				*
		FILTER—FUEL OIL—SECONDARY						
	3H1907/F17	FILTER, fuel oil, Briggs Model F-10, MODIFIED.		1				*
	3H1905-1/G107	GASKET, cover, vellumoid, Briggs No. D-157.	12	1	*	*	*	*
	3H1905-1/C15	CARTRIDGE, Briggs replacement, Briggs No. G-81-CEL.	12	1	*	*	*	*
		FILTER—LUBRICATING OIL—PRIMARY						
	3H1907/B1	BAG, filter.	12	1	*	*	*	*
	3H4585A/836	CARTRIDGE, De Luxe No. DF-35-48.	8	1	*	*	*	*
	3H4585A/772	GASKET, bag.		1	*	*	*	*
	3H4585A/112	GASKET, lubricating oil filter cover, cork (also included in gasket kit No. 7).		1	*	*	*	*

*Indicates stock available.

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110. MAINTENANCE PARTS LIST FOR POWER UNIT PE-245-A (Continued).

NOTE: Order maintenance parts by stock number, name, and description. Only maintenance parts can be requisitioned.

Reference symbol	*Signal Corps stock No.*	*Name of part and description*	*Running spares*	*Quan per unit*	*Orgn stock*	*3d ech*	*4th ech*	*Depot stock*
		FILTER—LUBRICATING—SECONDARY						
	3H1907/F16	FILTER, De Luxe lubricating oil, De Luxe No. S-2470.		1				*
	3H1907/G15	GASKET, cover, cork, De Luxe No. DF-29.	8	1	*	*	*	*
	3H1907/G16	GASKET, cover stud, De Luxe No. DF-32.		1	*	*	*	*
	3H1907/G17	GASKET, base, cork, De Luxe No. DF-31.		1	*	*	*	*
	3H1907/G18	GASKET, center stud, De Luxe No. DF-33.	2	1	*	*	*	*
	3H1907/G19	GASKET, drain plug, copper, De Luxe No. CS-52.	2	1	*	*	*	*
		FLYWHEEL AND FLYWHEEL HOUSING						
9	6L4910-31-1.18	SCREW, cap, flywheel to crankshaft.		6				*
		FUEL PUMP, LEVER, AND DISTRIBUTION GROUP						
	3H1907/P52	FUEL PUMP, complete.		1		*	*	*
	3H1907/L26	ASSEMBLY, cam rocker lever.		1				*
321	3H1907/R36	ROLLER, cam rocker lever.	1	1				*
	3H4585A/295	ASSEMBLY, vertical lever.	1	1				*
326	3H4585A/364	SPRING, vertical lever.		1			*	*
	3H4585A/932	ASSEMBLY, distributor.		1		*	*	*
448	3H1907-1/D10	ASSEMBLY, disc and cover.	1	1				*
	3H1907/S77	ASSEMBLY, distributor shaft.		1				*
462	3H1907/B43	BUSHING, distributor shaft.		1				*
	3H4585A/75	ASSEMBLY, priming valve.		1			*	*
	3H1907/B15	BALL, check.		1			*	*
452	3H4585A/319	GASKET, distributing housing cover.	3	1	*	*	*	*
477	3H4585A/210	GASKET, metering pump (also included in gasket kit No. 8).		1			*	*
461	3H4585A/330	KEY, Woodruff, distributor shaft.	3	1			*	*
478	3H1907/P51	PUMP, metering.	1	1			*	*
469	3H1907/S100	SPRING, distributor check valve.		1			*	*
	3H1907/L45	LINK, metering pump.		1			*	*
480	3H4585A/258	SPRING, metering pump.		1			*	*
	3H1907/C25	ASSEMBLY, float chamber, complete unit, 16 items.		1		*	*	*
536	3H4585A/318	GASKET, float valve seat, (also included in gasket kit No. 8).	1	1	*	*	*	*
	3H1907/T45	TUBE, injector supply No. 1.		1			*	*
	3H1907/T46	TUBE, injector supply No. 2.		1			*	*

*Indicates stock available.

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110. MAINTENANCE PARTS LIST FOR POWER UNIT PE-245-A (Continued).

NOTE: Order maintenance parts by stock number, name, and description. Only maintenance parts can be requisitioned.

Reference symbol	*Signal Corps stock No.*	*Name of part and description*	*Running spares*	*Quan per unit*	*Orgn stock*	*3d ech*	*4th ech*	*Depot stock*
		FUEL PUMP, LEVER, AND DISTRIBUTION GROUP (Contd.)						
	3H1907/T47	TUBE, injector supply No. 3.		1			*	*
	3H1907/T48	TUBE, injector supply No. 4.		1			*	*
	3H1907/T49	TUBE, injector supply No. 5.		1			*	*
	3H1907/T50	TUBE, injector supply No. 6.		1			*	*
	3H4585A/70	ASSEMBLY, gear pump.	1	1		*	*	*
406	3H4585A/235	SEAL, spacer.		2		*	*	*
		GOVERNOR GROUP						
335	3H4585A/371	GOVERNOR, Woodward Hydraulic WQ-040305.		1			*	*
337	3H4585A/323	GASKET, governor to adapter.		1		*	*	*
388	3H1907/L28	LEVER, governor, lower.		1			*	*
379	3H1907/L29	LEVER, governor, upper.		1			*	*
382	3H4585A/1072	LINK, governor control.		1			*	*
	3H1907/L30	ASSEMBLY, governor lever and bushing.		1			*	*
385	3H4585A/373	SEAL, control shaft, oil.		1			*	*
365	3H1907/S50	SEAL, main shaft.		1			*	*
376	3H1907/W15	COVER, window, oil level.		1			*	*
281	3H4585A/375	BUSHING, governor lever.		1			*	*
278	3H4585A/27	BUSHING, cam rocker lever.		1			*	*
286	3H4585A/372	LINK, governor, control eccentric.		1			*	*
280	3H4585A/159	LINK, vertical lever.		1			*	*
276	3H4585A/32	BUSHING, control shaft.	1	1			*	*
279	3H4585A/374	BUSHING, hand control eccentric.	1	1			*	*
261	3H1907/B42	BUSHING, plunger lever shaft, short, for part 40.	1	1			*	*
264	3H4585A/33	BUSHING, plunger lever shaft, long, for part 40.	1	1			*	*
	6Z3180	CONNECTION, 3/8" x 1/4", Weatherhead 200 x 6.	2	1			*	*
	3H1907/S76	ASSEMBLY, fuel oil main shaft.		1			*	*
	3H4585A/795	ASSEMBLY, injector cup.	6	6		*	*	*
239	3H4585A/325	GASKET, injector cup.	6	6		*	*	*
232	3H1907/G9	GASKET, check valve plug.		6			*	*
235	3H4585A/99	GASKET, check valve seat.		6			*	*
228	3H4585A/321	GASKET, top housing.		6			*	*
236	3H4585A/259	SPRING, injector check valve.	6	6			*	*
237	3H4585A/1395	STOP, injector check valve.	6	6			*	*

*Indicates stock available.

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110. MAINTENANCE PARTS LIST FOR POWER UNIT PE-245-A (Continued).

NOTE: Order maintenance parts by stock number, name, and description. Only maintenance parts can be requisitioned.

Reference symbol	*Signal Corps stock No.*	*Name of part and description*	*Running spares*	*Quan per unit*	*Orgn stock*	*3d ech*	*4th ech*	*Depot stock*
		INJECTOR FUEL INLET AND DRAIN GROUP						
	3H1907/C46	ASSEMBLY, fuel inlet connection.	2	6			*	*
	3H4585A/383	ASSEMBLY, injector fuel drain.	1	6			*	*
		INJECTOR ASSEMBLY						
	3H4585A/148	ASSEMBLY, injector	2	6		*	*	*
233	3H4585A/564	ASSEMBLY, check valve and seat.	6	6			*	*
	3H4585A/78	ASSEMBLY, injector rocker lever.		6				*
132	3H4585A/185	PIN, intake rocker lever roller.		6		*	*	*
133	3H4585A/220	RIVET, rocker lever roller pin.		6		*	*	*
123	3H1907/S30	SCREW, rocker lever adjusting.		18			*	*
	3H4585A/149	ASSEMBLY, intake-rocker lever.	1	6			*	*
117	3H1907/G27	GASKET, lubricating pipe cap.		3			*	*
	3H4585A/122	GASKET, rocker housing to cylinder head (also 3 in gasket kit No. 7).	3	3			*	*
	3H4585A/121	GASKET, rocker housing cover (also 3 in gasket kit No. 7).	3	3		*	*	*
5	3H1907/S90	SLEEVE, tube packing.		1			*	*
14	3H4585A/105	GASKET, lubricating flange (also in gasket kit No. 7).		2			*	*
15	3H1907/G22	GASKET, suction-tube flange (also in gasket kit No. 7).		1			*	*
		INSTRUMENT PANEL						
	3H4585A/129	GAUGE, fuel oil pressure.		1				*
	3H4585A/130	GAUGE, lubricating oil pressure.		1				*
	3H1907/G50	GAUGE, lubricating oil temperature.		1				*
	3H1907/G51	GAUGE, water temperature.		1				*
	3H4585A/203	PUMP, hand priming and preheater.		1		*	*	*
	3Z9829-1.2	SWITCH, push-button.		1			*	*
	3H1907/S32	SCREW, pressure gauge 6-32 x 3/4".	6	6		*	*	*
		LUBRICATING PUMP						
	3H4585A/161	ASSEMBLY, lubricating pump.		1		*	*	*
189	3H1907/C45	CONNECTION, suction tube.		1			*	*
	3H1907/G52	GAUGE, oil level.		1				*
	3H1907/C21	CAP, breather.		1		*	*	*
	3H1907/S15	ASSEMBLY, oil pan and screen.		1				*
	3H1907/G7	GASKET, oil pan to block (also in kit No. 7).		1		*	*	*

*Indicates stock available.

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110. MAINTENANCE PARTS LIST FOR POWER UNIT PE-245-A (Continued).

NOTE: Order maintenance parts by stock number, name, and description. Only maintenance parts can be requisitioned.

Reference symbol	*Signal Corps stock No.*	*Name of part and description*	*Running spares*	*Quan per unit*	*Orgn stock*	*3d ech*	*4th ech*	*Depot stock*
		PISTON AND CONNECTING ROD GROUP						
	3H4585A/1191	ASSEMBLY, piston, complete with pin.	2	6		*	*	*
47	3H4585A/211	RING, piston, compression.	24	12		*	*	*
46	3H4585A/216	RING, piston, keystone.	12	6		*	*	*
48	3H4585A/214	RING, piston, oil regulating, narrow.	12	6		*	*	*
49	3H4585A/213	RING, piston, oil regulating, wide.	12	6		*	*	*
	3H4585A/215	RING, piston, pin snap, H-61508.		12		*	*	*
56	3H1907/R55	ASSEMBLY, connecting rod, less shell.		6				*
57	3H4585A/21	BOLT, connecting rod, special.		12				*
55	3H4585A/42	BUSHING, piston pin.		6				*
60	3H4585A/166	NUT, connecting rod bolt.	6	12				*
59	3H4585A/192	PLATE, connecting rod lock.	12	12		*	*	*
58	3H4585A/64	SHELL, connecting rod bearing.	12	12		*	*	*
150	3H4585A/903	GASKET, rear cover to block, 0.005".		as req'd			*	*
	3H4585A/360	ASSEMBLY, rocker-lever housing.		3			*	*
115	3H4585A/1217	PLUG, 1-1/4", expansion rocker-lever housing.	6	6			*	*
	3H4585A/357	ASSEMBLY, exhaust rocker lever.	1	6			*	*
	3H1907/S120	ASSEMBLY, overspeed stop, complete.		1			*	*
	3H4585A/459	GASKET KIT, fuel pump gaskets, CECO gasket kit No. 8.		1	*	*	*	*
	3H4585A/208	SEAL, fan pulley, oil.	1	1			*	*
		STARTING MOTOR						
	3H3114-15	MOTOR, starting, Delco No. 711.		1		*	*	*
13	3H3114-B1	BRUSH, starting motor, Delco No. 38367.	12	12		*	*	*
22	3H3114-15/P15	PINION, drive, Delco No. 1856842.		1		*	*	*
	3H3114-15/S25	SPRING, pinion meshing, Delco No. 1869565.		1		*	*	*
24	3H3114-15/G35	GUIDE, pinion, Delco No. 1856840.		1		*	*	*
25	3H3114-15/C20	COLLAR, pinion stop, Delco No. 1860724.		1		*	*	*
28	3H3114-15/S20	SOLENOID, Delco No. 1118043.		1		*	*	*
		WATER CONNECTIONS AND HOSE						
3	3H4585A/313	CLAMP, hose, 2-1/2".	8	4	*	*	*	*
	3H4585A/329	GASKET, engine, water-inlet connection.	4	1	*	*	*	*
	3H4585A/326	GASKET, radiator water connection.		2	*	*	*	*
26	3H4585A/395	HOSE, radiator, 2" x 18" upper.	6	1	*	*	*	*
	3H1907-1/H16	HOSE, radiator, 2" x 6" lower.	2	1	*	*	*	*

*Indicates stock available.

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110. MAINTENANCE PARTS LIST FOR POWER UNIT PE-245-A (Continued).

NOTE: Order maintenance parts by stock number, name, and description. Only maintenance parts can be requisitioned.

Reference symbol	Signal Corps stock No.	Name of part and description	Running spares	Quan per unit	Orgn stock	3d ech	4th ech	Depot stock
		WATER MANIFOLD GROUP						
26	3H4585A/310	CLAMP, by-pass hose.	2	2	*	*	*	*
3	3H4585A/313	CLAMP, manifold hose.	8	4	*	*	*	*
15	3H1907/G20	GASKET, water by-pass connection.		1		*	*	*
12	3H4585A/125	GASKET, water connection.		2		*	*	*
28	3H4585A/126	GASKET, water manifold to head (also 6 in gasket kit No. 7).		6	*	*	*	*
13	3H1907/G21	GASKET, thermostat housing.		1		*	*	*
25	3H1907-1/H16	HOSE, water by-pass.	2	1	*	*	*	*
2	3H1907/H37	HOSE, water manifold.	4	2	*	*	*	*
4	3H1907/S65	SECTION, water manifold, center.		1				*
27	3H1907/S66	SECTION, water manifold front.		1				*
1	3H1907/S67	SECTION, water manifold rear.		1				*
16	3H1907/T15	THERMOSTAT, by-pass.		1		*	*	*
14	3H1907/T16	THERMOSTAT, main.		2		*	*	*
		WATER PUMP						
	3H1907/P50	PUMP, water.	1	1		*	*	*
201	3H320-34	BEARING, inner.	1	1			*	*
203	3H3404/3	BEARING, outer.	1	1				*
204	3H4585A/111	GASKET, oil.	1	1			*	*
194	3H4585A/394	GUIDE, spring.	1	1			*	*
	3H1907/J20	IMPELLER, water pump.		1			*	*
209	3H1907/J21	KEY, impeller.	3	1			*	*
212	6L995-8	KEY, pulley, Woodruff No. 8.	1	1			*	*
207	3H4585A/207	RETAINER, cork.		1			*	*
200	3H1907/R20	RETAINER, split ring.		1			*	*
210	3H1907/R26	RING, split.		2			*	*
193	3H1907/R25	RING, seal clamp.	1	1			*	*
195	3H4585A/234	SEAL, flexible.	3	1			*	*
211	3H1907/S75	SHAFT, water pump.		1				*
192	3H4585A/255	SPRING.	1	1			*	*
196	3H4585A/296	WASHER, carbon.	1	1			*	*
206	3H4585A/298	WASHER, cork.	1	1			*	*
217	3H4585A/128	GASKET, water pump to block.	3	1	*	*	*	*
	3H4585A/19	BELT, "V" water pump drive.	6	2	*	*	*	*

*Indicates stock available.

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110. MAINTENANCE PARTS LIST FOR POWER UNIT PE-245-A (Continued).

NOTE: Order maintenance parts by stock number, name, and description. Only maintenance parts can be requisitioned.

Reference symbol	*Signal Corps stock No.*	*Name of part and description*	*Running spares*	*Quan per unit*	*Orgn stock*	*3d ech*	*4th ech*	*Depot stock*
		MISCELLANEOUS GROUP						
	3H1907/R1	RADIATOR, sectional core, assembly (Perfex R-1983-C modified).		1				*
	3H1907/S85	SILENCER, exhaust, maxim		1				*
	3H1907/H35	HOSE, flexible, silencer, RDA E-1271.		1			*	*
	3H1907/S140	SWITCH, lube oil pressure alarm, Penn Electric Switch Co. 260-API 4X.		1				*
	3H1907/S141	SWITCH, water temperature alarm, Penn 262-ATO-4X.		1				*
	3H1907/H36	HOSE, tank, auxiliary fuel supply, RDA A-1361-A-12.		1		*	*	*
	3H1907/J10	JUMPER, battery, 7" length, Exide No. 27652-7.		2			*	*
	3H1907/J11	JUMPER, battery, 17" length, Exide No. 24497-17.		2			*	*
	3H1907/K15	GASKET KIT No. 7, complete set gaskets.		1 set		*	*	*
	3H4600-245A/C25	COUPLING, flexible, assembly, Thomas Flexible Coupling Co., C-10132.		1				*
	3H4600-245A/D20	DISCS, Coupling, flexible, Thomas Flexible Coupling Co., part 10931.		1 set			*	*
	3B200.1	BATTERY, storage, lead acid, 6 volt, Exide XHM-25.		5				*
		GENERATOR GROUP						
27	3H2418-1/H15	BRUSHHOLDER ASSEMBLY, grounding.		1				*
134	3H2418-1/B20	BRUSH ASSEMBLY, slip ring brush rigging.		1				*
	3H307	BEARING, BALL, alternator.		1				*
77	3H1901-A/B2	BEARING, BALL, exciter.		1				*
59	3H2418-1/B21	BRUSH, exciter.	2 sets	2	*	*	*	*
28	3H2418-1/B22	BRUSH, grounding, generator.		4	*	*	*	*
	3H2418-1/B23	BRUSH, alternator.	2 sets	4	*	*	*	*
56	3H2418-1/B15	BODY, brushholder.		2				*
6	3F1150-10	AMMETER, AC 0-150 A Westinghouse type H 4-1/4" diameter, flush mounting.		1				*
10	3H900-100-3	CIRCUIT BREAKER, 3-pole, 100 amperes, 250 volt, front connected with thermal overload trip, I.T.E. No. ET1638.		1				*
	3F2787	FREQUENCY METER, Frahm 58-62 cycles 3-1/2" diameter, reed type, flush mounted, Biddle Co.		1				*

*Indicates stock available.

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110. MAINTENANCE PARTS LIST FOR POWER UNIT PE-245-A (Continued).

NOTE: Order maintenance parts by stock number, name, and description. Only maintenance parts can be requisitioned.

Reference symbol	Signal Corps stock No.	Name of part and description	Running spares	Quan per unit	Orgn stock	3d ech	4th ech	Depot stock
		GENERATOR GROUP (Continued)						
	3H4960-1	VOLTAGE REGULATOR, Burlington type GL-1.		1			*	*
2	3H4960-1/V15	VIBRATOR ASSEMBLY, voltage regulator, with lower contact, Burlington part 218-VL.	1	1			*	*
3	3H4960-1/C10	UPPER CONTACT BRACKET ASSEMBLY, voltage regulator, includes upper leaf contact, spring back, contact washer, contact spacer, tension adjustment, angle bracket, and leaf contact screws, Burlington part 249-VL.	1	1			*	*
13	3Z7275-3	RHEOSTAT, field, exciter, 750 ohms, 0.29 amperes, Rex Rheostat Co. No. B2.		1			*	*
	3Z9825-74.23	SWITCH, battery-charging, 14-point dial, G.E. Co. No. 4865639.		1				*
9	3Z9858-8.72	SWITCH, toggle, H. Hubbell Co. No. 1815D.		1				*
12	3Z9825-71.4	SWITCH, voltmeter, Westinghouse style No. 591454.		1				*
18	2Z9900.7	TRANSFORMER, current 300/5 ratio, Westinghouse No. OC-133.		1				*
3	3F8150-92	VOLTMETER, AC, 0-150 volts, 4-1/4" diameter, flush mounted, Westinghouse type H; calibrated for No. 10-gauge sheet steel mounting.		1				*
6	3Z2606	FUSE, renewable link, 6 ampere, 250 volt.	6	2		*	*	*
7	3Z2608.2	FUSE, renewable link, 8 ampere, 250 volt.	6	2		*	*	*
8	3Z1931	FUSE, renewable link, 10 ampere, 250 volt.	6	2		*	*	*
	3Z3006	LINKS, renewable fuse, 6 ampere.	10	2	*	*	*	*
	3F3008-1	LINKS, renewable fuse, 8 ampere.	10	2	*	*	*	*
	3Z3010	LINKS, renewable fuse, 10 ampere.	10	2	*	*	*	*
	4C5424.7	LAMP, signal light, 30 volt, Westinghouse style 1124156.	6	3			*	*
	6Z6896-2	LAMP, Protex A, red, 25 watt, 30 volt.	2	1			*	*
	3Z2610.15	FUSE PLUG, 10 ampere, 125 volt.	6	1			*	*

*Indicates stock available.

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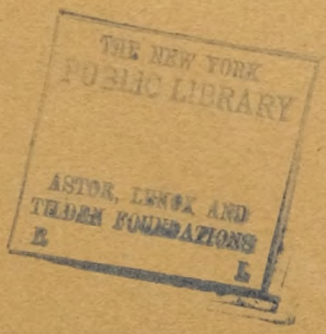
WAR DEPARTMENT TECHNICAL MANUAL

POWER UNIT

PE-245-A



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WAR DEPARTMENT TECHNICAL MANUAL

TM 11-930

This manual supersedes TM 11-930, 16 August 1943

POWER UNIT
PE-245-A

WAR DEPARTMENT • 6 JUNE 1944

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WAR DEPARTMENT,
WASHINGTON 25, D. C., May 16, 1944.

TM 11–930, Power Unit PE–245–A, is published for the information and guidance of all concerned.

[A. G. 300.7 (8 Sept 43).]

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
Chief of Staff.

OFFICIAL:

J. A. ULIO,
Major General,
The Adjutant General.

DISTRIBUTION:

As prescribed in paragraph 9a, FM 21–6; **IBn 11 (2); IC 11 (4); Armies (Sig) (5); Corps (Sig) (5); Sv C (Sig) (5); Depts (5); Def C (2); **Arm & Sv Boards (2); Sig C Rep Shs (2); ASF Deps (Sig Sec) (2); Sig Deps (Oversea) (10); Gen Deps (Sig Sec) (10); PE (2).

Sig C Inspec Zones (2); Sig C Proc Dists (2).

IBn 11; T/O & E 11–400 Sig AW Orgn (A) Bn Hq.

IC 11; T/O 11–107, 11–237, 11–287, 11–400 Sig AW Orgn (C) Radar Rep Plat, 11–500 Sig Sv Orgn (EC) Radar Maint Team, 11–587, 11–592, 11–597, 11–617.

For explanation of symbols, see FM 21–6.

**Symbols.

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DESTRUCTION NOTICE

WHY–To prevent the enemy from using or salvaging this equipment for his benefit.

WHEN–When ordered by your commander.

HOW–1. Smash–Use sledges, axes, handaxes, pickaxes, hammers, crowbars, heavy tools.
2. Cut–Use axes, handaxes, machetes.
3. Burn–Use gasoline, kerosene, oil, flame throwers, incendiary grenades.
4. Explosives–Use firearms, grenades, TNT.
5. Disposal–Bury in slit trenches, fox holes, other holes. Throw in streams. Scatter.

USE ANYTHING IMMEDIATELY AVAILABLE FOR DESTRUCTION OF THIS EQUIPMENT.

WHAT–1. Shear off all knobs and controls.
2. Smash–Engine block, magneto, carburetor, radiator, cylinder heads, manifold, and fuel tanks.
3. Smash–Generator casting, armature windings, brushes, commutator. Armature winding can be short circuited.
4. Smash–Switchboard meters, relays, switches, wiring.
5. Cut–Connecting wires, cables.
6. Burn–Manuals, records.
7. Bury or scatter–Any or all of the above pieces after destroying their usefulness.

DESTROY EVERYTHING

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SAFETY NOTICE

Operation of this equipment involves the use of voltages dangerous to human life. Observe all normal precautions and safety regulations. Avoid making any adjustments or connections while the unit is operating unless absolutely necessary.

Carbon dioxide, contained in exhaust gases, will cause illness. Make certain that all exhaust connections are gas tight and the room in which the unit is installed is properly ventilated.

WARNING

HIGH VOLTAGE

is used in the operation of Power Unit PE-245-A.

DEATH ON CONTACT

may result if operating personnel fail to observe safety precautions.

OBSERVE ALL POSSIBLE PRECAUTIONS

FIRST-AID TREATMENT FOR ELECTRIC SHOCK

Electric shock is caused by the passage of electric current through the body. If current of sufficient magnitude passes through the breathing center at the base of the brain, breathing stops and the victim loses consciousness. The pulse becomes very weak or ceases entirely and the body turns blue or very white. Occasionally the body becomes stiff. This condition is caused by the electricity and is not an indication of death.

In most cases of electric shock, the victim's life may be saved by the prompt and continued application of artificial respiration. By this means air is supplied to the body until the breathing center resumes its normal function. Resuscitation may take a long time; cases are recorded in which recovery occurred after 8 hours of artificial respiration.

RESCUE

To rescue a person from a live source of electric current, first shut off the current if a switch can be reached without loss of time. If shutting off the current will cause delay, use a dry nonconductor, such as a rope, a board, or rubber gloves, to prevent contact, and free the victim or remove the live conductor. Do not use metal or any moist material. Should it be necessary to cut a live wire, use an ax or a hatchet with a dry wooden handle and turn away to avoid the resulting flash.

Never allow any part of your body to come in contact with the victim's body or the live conductor. Do not attempt a rescue at the hazard of your own life.

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RESUSCITATION

Begin artificial respiration at once, as near the scene of the accident as possible. Every minute counts. Do not wait to loosen the patient's clothing, but do remove false teeth, chewing gum, or tobacco from his mouth, as any such obstruction interferes with the passage of air. Wrap the patient in a blanket, coat, or anything available, since warmth is very important. While one person starts artificial respiration, another should go at once for the nearest physician.

The procedure for artificial respiration follows:

1. Lay the patient face downward, with one arm bent at the elbow and placed so that the patient's cheek rests on the hand or forearm. The face is turned outward to leave the nose and mouth free for breathing. The other arm is extended overhead (figure 1).
2. Kneel straddling the patient's thighs, with your knees placed far enough from the hip bones to allow you to assume the position shown in figure 2. If the patient is a large, heavy person, it may be more convenient to straddle only one leg. Place the palms of your hands on the small of the patient's back, with the little fingers just touching the lowest ribs. The thumbs and fingers should be in a natural position as shown in figure 2.
3. With arms held straight, swing forward slowly, so that a gradual pressure is brought to bear upon the patient. At the end of the forward swing, your shoulders should be directly over the heels of your hands. Do not bend your elbows. The forward swing should take about two seconds.
4. Immediately on completing the forward swing, release the pressure and swing backward to the position shown in figure 3. Wait 2 seconds; then swing forward as before.

Repeat this cycle of pressure and release, which creates a complete respiration, 12 to 15 times a minute. Continue without interruption until natural breathing is restored, or until a physician declares the patient dead. If no physician can be reached, continue until you are sure there is no chance of recovery. Remember that artificial respiration often has to be kept up for hours.

While artificial respiration is being given, some one other than the operator should loosen the clothing about the patient's neck, chest, and waist. Keep the patient warmly wrapped. Apply hot-water bottles, hot bricks or stones, if possible. Do not give the patient liquids until he is fully conscious.

The first attempt to breathe may be a gasp, a faint sigh, or a catch of the breath. Artificial respiration should be withheld when the first breathing begins. Be very careful not to exert pressure as the first spontaneous breath occurs. Continue to watch the patient carefully, as he may stop breathing again after a temporary recovery. In that case, artificial respiration must be resumed at once.

When the patient revives, he must be kept warm and quiet. Do not allow him to sit or stand. If no physician has arrived, give the patient a teaspoonful of aromatic spirits of ammonia in a small glass of water, or a drink of hot coffee or tea, as a stimulant.

If possible, avoid moving the patient until he is breathing normally. Even then, he should be moved only in a lying position. If extreme weather conditions or other hazards make it necessary to move a patient before normal breathing has been restored, continue artificial respiration while he is being moved.

It may be necessary to change operators while administering artificial respiration. The change must be made without interrupting the rhythm of respiration. The relief operator should kneel beside the person giving the artificial respiration. As the pressure is released, the operator falls aside, the relief operator takes his place, and the cycle of pressure and release continues without interruption.

—Adapted from The American Red Cross First-Aid Textbook.

RESUSCITATION DRILLS SHOULD BE HELD REGULARLY BY ALL OPERATING PERSONNEL

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FIRST AID TREATMENT FOR ELECTRIC SHOCK

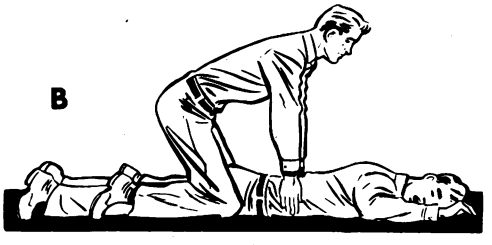
I. FREE THE VICTIM FROM THE CIRCUIT IMMEDIATELY.

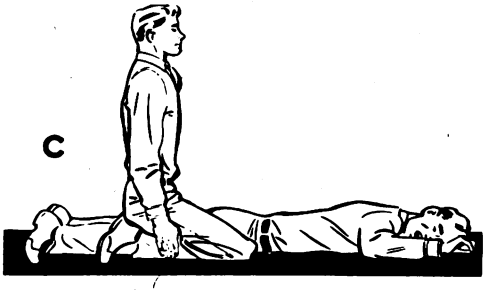
Shut off the current. If this is not immediately possible, use a dry nonconductor (rubber gloves, rope, board) to move either the victim or the wire. Avoid contact with the victim. If necessary to cut a live wire, use an axe with a dry wooden handle. Beware of the resulting flash.

II. ATTEND INSTANTLY TO THE VICTIM'S BREATHING.

Begin resuscitation at once on the spot. Do not stop to loosen the victim's clothing. Every moment counts. Keep the patient warm. Wrap him in any covering available. Send for a doctor. Remove false teeth or other obstructions from the victim's mouth.

Resuscitation





POSITION

1. Lay the victim on his belly, one arm extended directly overhead, the other arm bent at the elbow, the face turned outward and resting on hand or forearm, so that the nose and mouth are free for breathing (fig. A).

2. Straddle the patient's thighs, or one leg, with your knees placed far enough from his hip bones to allow you to assume the position shown in figure A.

3. Place your hands, with thumbs and fingers in a natural position, so that your palms are on the small of his back, and your little fingers just touch his lowest ribs (fig. A).

FIRST MOVEMENT

4. With arms held straight, swing forward slowly so that the weight of your body is gradually brought to bear upon the victim. Your shoulders should be directly over the heels of your hands at the end of the forward swing (fig. B). Do not bend your elbows. The first movement should take about 2 seconds.

SECOND MOVEMENT

5. Now immediately swing backward, to remove the pressure completely (fig. C).

6. After 2 seconds, swing forward again. Repeat this pressure-and-release cycle 12 to 15 times a minute. A complete cycle should require 4 or 5 seconds.

CONTINUED TREATMENT

7. Continue treatment until breathing is restored or until there is no hope of the victim's recovery. Do not give up easily. Remember that at times the process must be kept up for hours.

8. During artificial respiration, have someone loosen the victim's clothing. Wrap the victim warmly; apply hot bricks, stones, etc. Do not give the victim liquids until he is fully conscious. If the victim must be moved, keep up treatment while he is being moved.

9. At the first sign of breathing, withhold artificial respiration. If natural breathing does not continue, immediately resume artificial respiration.

10. If operators must be changed, the relief operator kneels behind the person giving artificial respiration. The relief takes the operator's place as the original operator releases the pressure.

11. Do not allow the revived patient to sit or stand. Keep him quiet. Give hot coffee or tea, or other internal stimulants.

HOLD RESUSCITATION DRILLS REGULARLY

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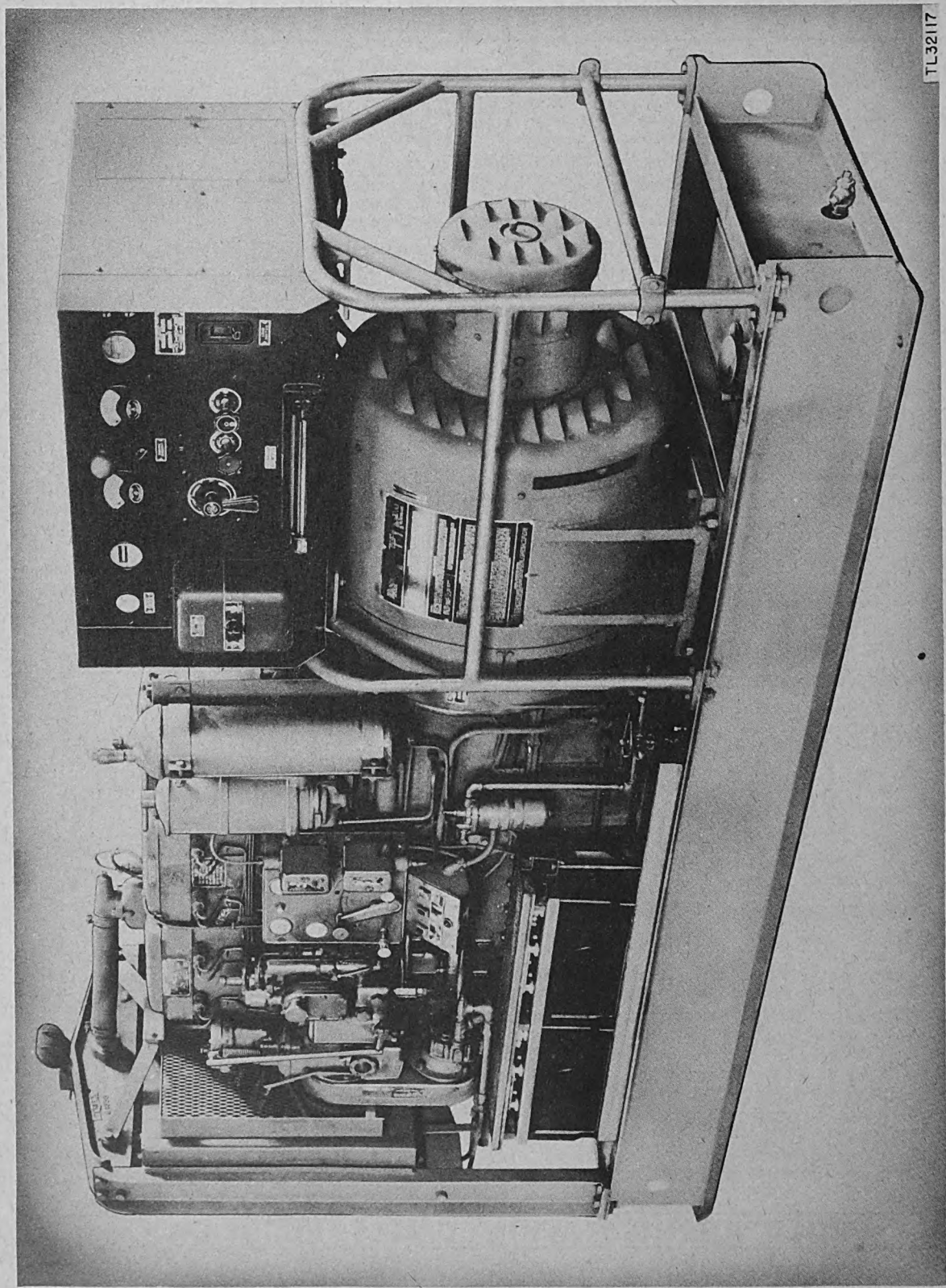

Figure 1. Power Unit PE-245-A.

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Section I
DESCRIPTION

1. POWER SUPPLY. Power Unit PE-245-A consists of a six-cylinder Diesel engine directly connected to a 25-kw, 120/208-volt, 4-wire, 60-cycle, 3-phase generator. The assembly is mounted on a rigid structural-steel sub-base (fig. 1). The weight and dimensions of the power unit are as follows:

a. Net weight, 5,900 lbs.; overall dimensions, uncrated, 36½" by 62½" by 104".

b. Gross weight, 8,000 lbs.; overall dimensions, crated, 50" by 75" by 137".

2. DESCRIPTION OF ENGINE. The engine is of the four-stroke-cycle, Diesel, overhead-valve type, similar to most other overhead-valve engines but with much higher compression. No carburetor or electrical ignition of any kind is used. It is equipped with one fuel pump for all cylinders and a separate injector for each cylinder. The mechanism for measuring the charge of fuel is contained within the fuel pump mounted on the side of the engine. After the pump has measured the proper fuel charge and delivered it to the injectors, the fuel is forced into the injector-cup and, on the compression-stroke, it is partially gasified. Then, with the piston near top-center, the plunger is suddenly depressed by proper cam action, driving this charge of gaseous vapor through the cup into the combustion chamber where ignition takes place and the working stroke is completed. Lubrication is of the force-feed type. Every bearing on the engine proper is fed by the force-feed gear pump mounted on the rear end of the gear cover. The lubricating oil is carried in the crankcase.

3. ENGINE SPECIFICATIONS.

Cylinders	6 (number).
Bore	4-⅞ inches.
Stroke	6 inches.
Displacement	672 cubic inches.
Compression ratio	17 to 1.
Firing order	1-5-3-6-2-4.
Horsepower at 1,200 rpm.	90 hp maximum.
Fuel system	One-for-all distribution and injector system.
Cylinders	Cast enbloc with removable wet liners.
Cylinder heads	Detachable cast in pairs.
Valves—intake and exhaust	Heat-resisting alloy steel, diameter 1-15/16 inches.
Valve location	Overhead.
Pistons	Chrome-nickel iron, cam-ground.
Piston pins	Full-floating.
Piston pin bearings	2 inches diameter.
Piston rings (compression)	3 (quantity), each ⅛ inch wide.
Piston rings (oil)	2 (quantity), one 3/16 inch and one ¼ inch wide.
Connecting rods	Forged alloy steel, 12 inches long, center to center.

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Connecting rod bearings	Copper-lead, steel-backed removable shells, diameter 3-⅛ inches.
Crankshaft	Nickel-molybdenum steel.
Main bearings	7 (number).
Main bearings	Copper-lead, steel-backed removable shells, diameter 4-½ inches.
Area main bearing surface	62.1 square inches.
Camshaft	Special chrome-steel forging.
Camshaft bearings	7 (number).
Crankcase and cylinder block	Iron alloy.
Crankcase oil capacity	12 gallons.
Lubrication	Forced-feed to all bearings.
Engine cooling system capacity	15 gallons.
Governor	Woodward hydraulic.
Governor housing oil capacity	3 pints.
Fan drive	Double V-belt.
Starting method	Electric.
Net weight with standard accessories	2,360 lbs.

4. COOLING SYSTEM. A belt-driven centrifugal pump is mounted on the front of the engine. A six-blade fan is mounted on the water pump pulley and circulates air through a sectional core radiator. Cool water is drawn from the bottom of the radiator by the action of the centrifugal pump, is circulated through the engine into the cylinder heads discharged from the cylinder heads to a water manifold assembly. Two thermostats are mounted in the discharge connection to the radiator and control the flow of water to the radiator. A thermostat located in the bypass connection controls the flow of water back to the suction side of the water pump which recirculates it through the engine. The thermostats control the operating temperature of the circulating water (fig. 8).

5. FUEL SYSTEM.

a. Supply. A 21-gallon fuel tank is located in the sub-base below the main generator. A two-position supply valve is used in the system for changing the fuel supply from this tank to an outside fuel supply. The outside fuel supply can be arranged by use of a 20-foot flexible hose connection between the two-position valve and a standard 55-gallon oil drum. A 20-foot flexible hose with suction pipe is provided for this purpose. The suction pipe may be installed in a standard 55-gallon oil drum by connecting the 20-foot flexible hose between the two-position valve and the suction pipe of oil drum. The position of the fuel valve will designate the source of supply. With the fuel supply valve placed in the position marked TANK, fuel will be drawn from unit fuel tank. With the supply valve placed in the position marked DRUM, fuel will be drawn from the external 55-gallon oil drum.

NOTE: Fuel cannot be drawn from both tanks at the same time.

b. Drawing of Fuel. Fuel is drawn through a primary filter (edge type) by action of a small gear pump in the main fuel pump assembly and is discharged into and through the secondary filter (replaceable element type). From the secondary filter the fuel flows into a small float-regulated fuel chamber. A secondary fuel pump draws the fuel from the float chamber and delivers the fuel under pressure, through an overspeed trip-valve-device into the distributor and metering arrangement, and then to the injector (fig. 10 and the schematic fuel flow diagram, fig. 2).

6. LUBE OIL SYSTEM.

a. Oil Flow. Lubricating oil is drawn up from the oil pan by the action of a gear-type pump driven by the timing gear train (fig. 3), to an oil cooler section of the radiator and back into the filter section of the oil pan. From the filter section of the oil pan the oil

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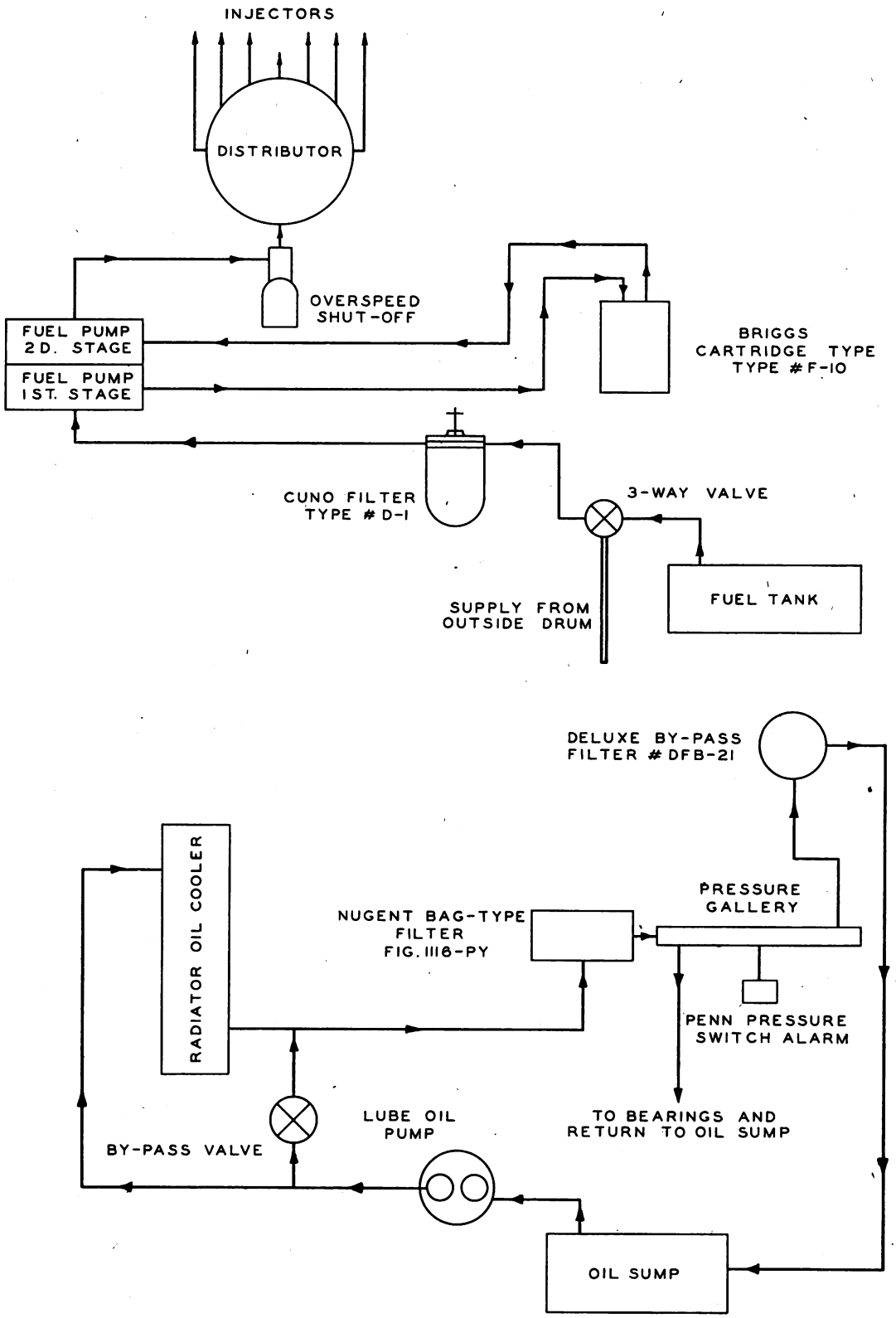

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Figure 2. Lubricating and fuel flow schematics.

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flows into the lubricating oil connection on the engine at the side of the block which leads into an oil galley. From the oil galley the oil flows into the hollow camshaft which has a pressure-regulating valve in the front end. Oil pressure is built up therein by resistance of the pressure-regulating valve, and oil under this pressure is distributed from the oil galley to the bearings, crankshaft, and rockers (fig. 2).

b. Filter. A secondary or replaceable element type filter is mounted on the side of the engine and is connected to the oil galley of the engine. Oil under pressure from the oil galley flows through the element of the filter which removes grit and contamination from the oil. The clean oil returns to the oil pan by a drain line connected between the filter and the engine (fig. 3).

7. AIR INTAKE SYSTEM. Air for combustion is drawn in through two oil bath air cleaners. An air preheater element is incorporated within the air manifold and can be used for heating of air during the initial start of the engine. By manual operation of a hand pump on the instrument panel, a high-tension spark is formed across a pair of electrodes in the air manifold and fuel is forced through a spray valve which sprays it against this spark. The spark ignites the fuel, thereby heating intake air drawn through the manifold when the engine is started. Refer to paragraph 36. The preheating of air is needed only for temperatures below 40 degrees Fahrenheit and eliminates the drain on the batteries which is normally encountered during cold weather starting (figs. 4 and 8).

8. EXHAUST SYSTEM. The exhaust gases leave the engine at the 3½-inch upturned elbow and pass through a four-foot length of corrugated flexible steel pipe into the silencer and out through the tail pipe to the atmosphere.

9. STARTING SYSTEM. The engine is equipped with a 24-volt starting motor connected to five 6-volt starting batteries with cables connected to the engine starter motor, which is in turn connected to the hand-starting switch, cranking contactor, and alarm switches (figs. 4 and 4a).

10. ALARM AND PROTECTIVE SYSTEM. The engine is equipped with two safety alarm contact switches which close independently on falling lube oil pressure or high water jacket temperature. When either of the alarm switches closes, a circuit will be made through to the alarm circuit box relays. Closing of the relays will cause the howler horn to sound. The cause of alarm will be indicated by the lighting of a jeweled light on the alarm circuit box. A 15-foot droplight extension line is supplied for connection to the outlet on the alarm circuit box (fig. 8) for a warning signal outside of the operating station. A red light is used and will blink continually when alarm conditions activate a flasher element within the alarm circuit box. The engine is equipped with an overspeed device which trips a fuel shut-off valve between the fuel gear pump and the distributor assembly, and shuts down the engine in the event that overspeeding occurs. The overspeed trip device is set for approximately 100 revolutions per minute above governed operating speed (fig. 3). The alarm circuit is automatically in operation when the throttle lever is moved. The howler will sound until the engine is started. The push button below the warning light panel may be held down to prevent the howler from sounding.

11. INSTRUMENT PANEL. Centrally located on the engine is an instrument panel upon which is mounted the necessary equipment for setting the fuel throttle and starting the engine. The equipment mounted thereon is shown in figure 10. The function and purpose of each is as follows:

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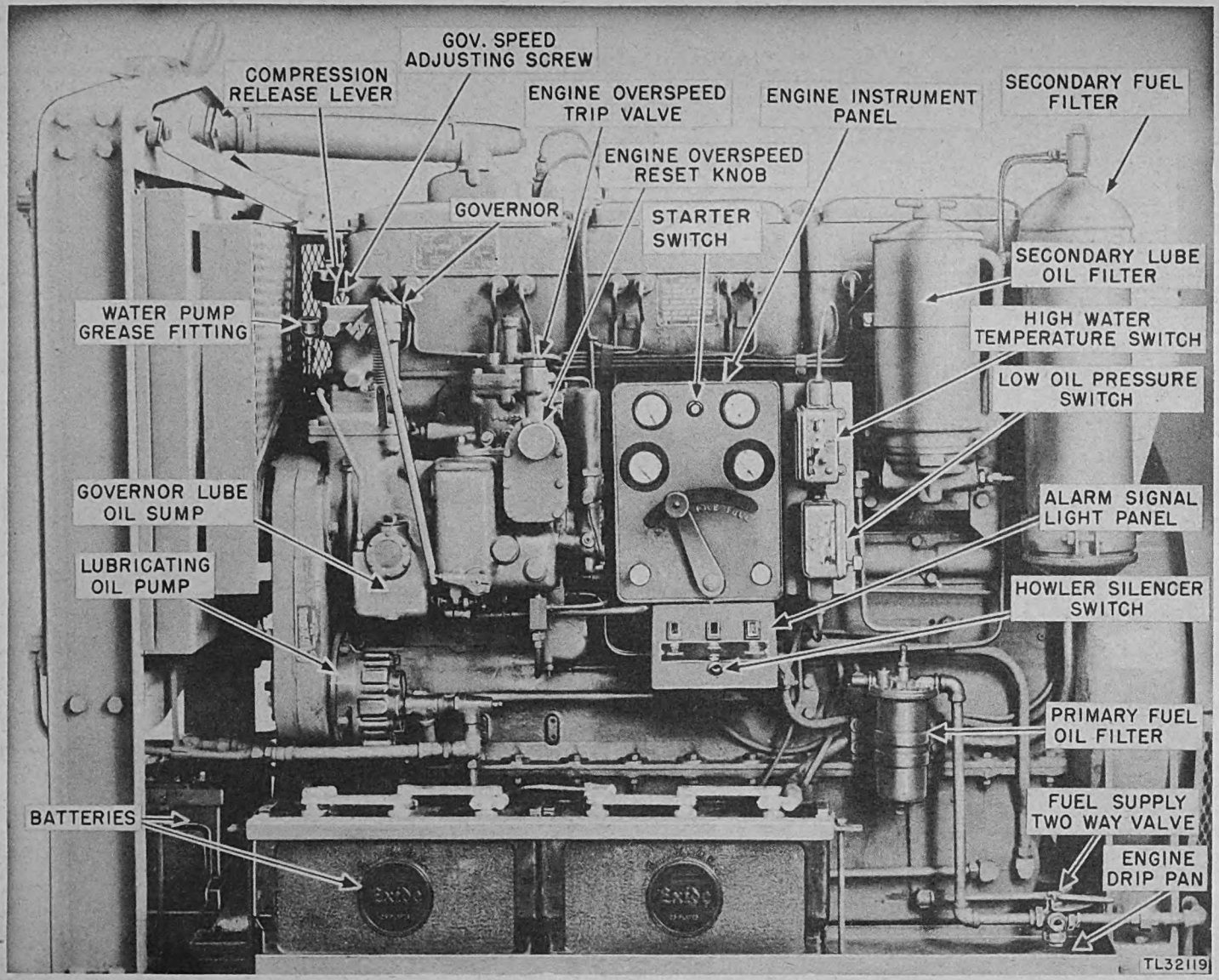

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Figure 3. Engine, fuel pump side.

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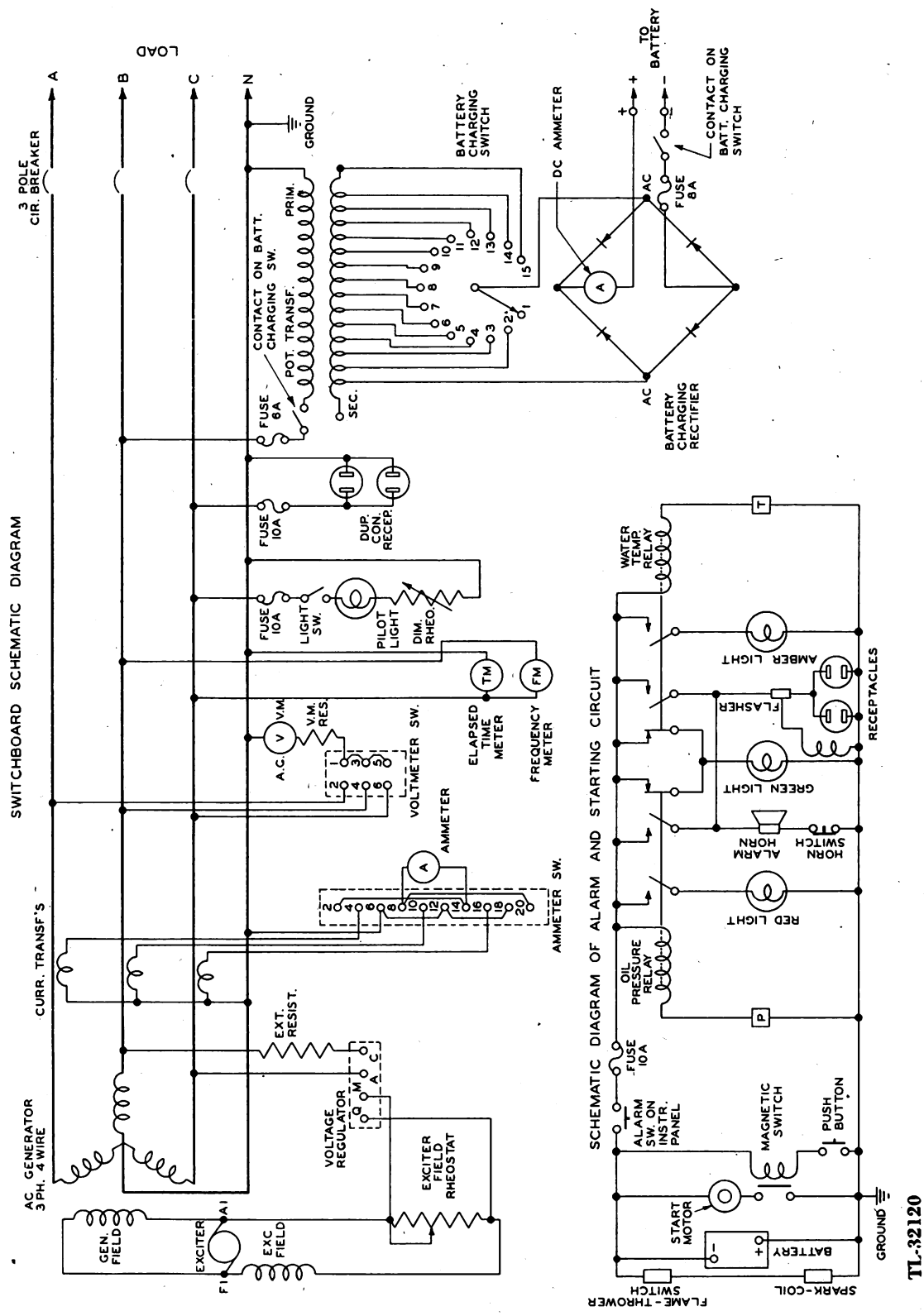

Figure 4. Switchboard schematic diagram.

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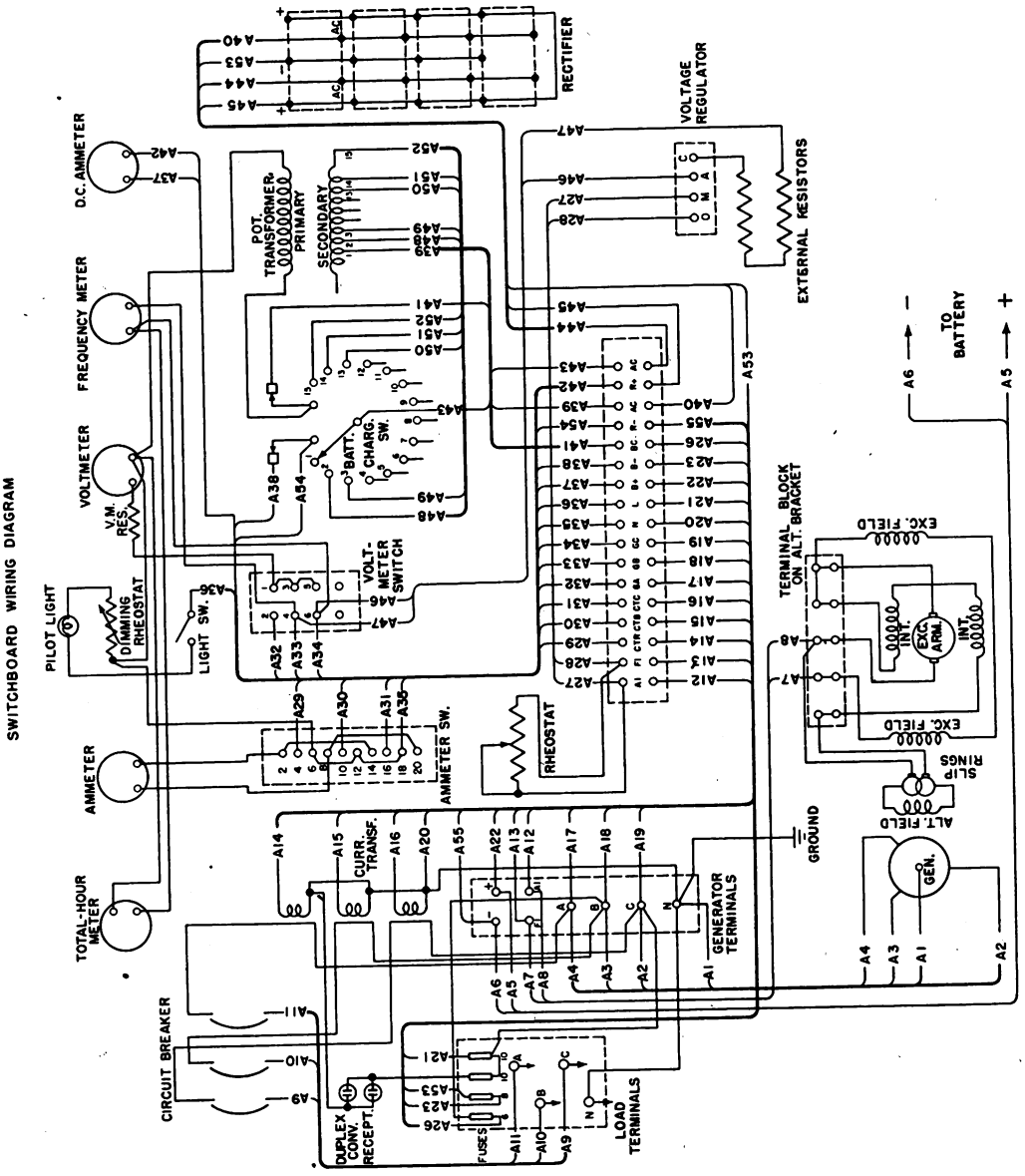

Figure 4a. Switchboard wiring diagram.

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Item	*Function*	*Purpose*
Fuel pump throttle control.	Setting of fuel control within fuel pump to full delivery position, and setting alarm circuit in operating position. Howling of horn designates circuit operating. Horn stops howling as engine starts and oil pressure reaches 15 lbs. reading on gauge.	Manual fuel setting for starting and stopping of engine and making circuit in alarm safety system.
Engine priming pump.	Manual operation of pump bleeds all air from fuel system (par. 28).	Priming of engines and testing pressures in fuel system.
Flame thrower hand pump.	Manual operation of pump causes fuel to be sprayed within air manifold and causes pressure switch to make contact for spark ignition of fuel spray.	Freezing temperature heating of air in manifold.
Alarm light panel.	Green light indicates normal operation. Red light indicates low oil pressure. Amber light indicates high water temperature. Howler stops if lower push button is held down. Prevents static on radio equipment when horn sounds.	To indicate cause of alarm.
Starting switch.	Circuit connection between batteries and solenoid of starter motor.	Manual control for energizing the starter solenoid coil.
Fuel oil pressure gauge.	Register fuel oil pressure from No. 2 gear pump to distributor disks.	Determine fuel oil pressure in lbs/sq. in. of No. 2 gear pump.
Lubricating oil pressure gauge.	Register lube oil pressure.	Determine oil pressure within engine in lbs/sq. in.
Lubricating oil temperature gauge.	Register lube oil temperature.	Determine oil temperature of circulating oil in degrees Fahrenheit.
Water temperature gauge.	Register water temperature.	Determine water temperature of circulating water in degrees Fahrenheit.
Lubricating oil safety pressure switch.	Make and break circuit for alarm control.	Notify operator when low oil pressure exists.
Water temperature safety thermo switch.	Make and break circuit for alarm control.	Notify operator when high water temperature exists in engine.

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12. GUARDS AND COVERS. A mesh wire screen guard is provided over the exhaust manifold and the radiator cooling fan. In addition, a perforated cover and drip cover are arranged over the fan on the generator.

13. GENERATING EQUIPMENT.

Specifications	*Alternator*	*Exciter*
Type	S-110	E 500
Kva	31.2	
Kw	25	1.
Volts	120/208	125
Amperes	79	8
Poles	6	2
Type-winding	Wye	Shunt
Inclosure	Drip-proof	Drip-proof
Temperature rise	40° C. Cont.	
Speed	1,200 rpm	1,200

The generator is driven at 1,200 revolutions per minute. It is a six-pole, salient-pole, single-bearing, ball-bearing alternator. The exciter is direct-connected, the connection between the exciter and generator being a solid shaft coupling. A pilot is provided in the exciter and shield to assist in the support of the direct current armature. A fan is attached to the engine flywheel for cooling of the generator windings.

14. SUB-BASE AND BASE. The supporting member of this generating set consists of a pair of 10-inch by 2-¾-inch cold rolled channels set on end and cross-braced with I beams for rigidity and torsional vibrations. The lower lip of each longitudinal channel is evenly drilled with four 13/16-inch holes to accommodate the foundation bolts. Holes in each end of the channel are provided for insertion of lifting sling bolts or other lifting devices (figs. 5 and 6).

15. COUPLING. The single engagement coupling consists of a semi-steel flange bolted into the engine flywheel with drilled bosses carrying the bolts which attach through four holes in the laminated circular steel disks. Four additional holes are provided in the steel disks to take the drilled bosses of the hub of the coupling which is attached to the generator. For protective purposes the generator hub is lengthened and fits into the flange section in the flywheel with very small clearance so that, in the event of disk failure, the rotor will not drop on the stator.

16. SWITCHBOARD.

a. Generator Control Panel. The generator control panel is rubber mounted on a frame over the generator (fig. 11). This panel provides the necessary controlling equipment and instruments for operating the generator. The generator is connected to the control panel by means of a terminal box within the control panel. A triple connection terminal lug is provided for each phase connection of the generator for individual loads. A battery-charging rectifier is incorporated in the control panel for recharging the engine batteries.

b. Main Assemblies. The main assemblies mounted on the control panel, their functions and ratings are as follows:

Assembly	*Function*	*Classification*
Bulb panel.	Panel light.	40 watt, silver tip.
Circuit breaker.	Disconnect generator from load.	De-ion, 3-pole, 100-ampere, 250-volt thermal overload trip.
Fuse, 10-ampere.	Safety for drop line service.	Renewable cartridge type.
Fuse, 8-ampere.	Safety for battery charging circuit.	Renewable cartridge type.
Outlet convenience.	For 120-volt utility service.	Duplex-double outlet.

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Assembly	*Function*	*Classification*
Meter, a-c ammeter.	Register current flow.	0-150 amperes.
Meter, a-c voltmeter.	Register alternator voltage.	0-150 volts.
Meter, d-c ammeter, battery charging.	Resistor charging rate to storage batteries.	0-6 amperes.
Meter, frequency.	Register cycles of operation.	90-130 volts, 58-62 cycles.
Meter, total hour.	Register total running time.	0-9999 hours.
Regulator, voltage.	Automatic voltage control.	Type-G.L.-1.
Rheostat, panel bulb.	Dimming control for panel bulb.	Ohmite.
Rheostat, exciter field.	Resistance for exciter field.	Slider type, 800 ohms, 2.9 amperes.
Switch, ammeter selector.	To connect ammeter to load circuit.	3 position on. 1 position off.
Switch, battery charger.	To connect and regulate charging rate of current to batteries.	14 point dial.
Switch, panel bulb.	Disconnect switch for panel bulb.	Toggle switch.
Switch voltmeter selector.	To connect voltmeter to generator circuit of individual phases.	3 position on. 1 position off.

17. CONDENSED DESCRIPTION OF EQUIPMENT.

a. Power Unit PE-245-A. The power unit herein described is a complete Diesel-engine-driven electric generating set designed to generate alternating current of 25 kw capacity, 120/208 volts, 3 phase, 60 cycle at 1,200 revolutions per minute. This power unit consists primarily of the following major components.

b. Engine. Cummins Diesel, Model HI-6, six cylinder, 4-⅞ inch bore, by 6 inch stroke, 672 cubic inch displacement. The engine is completely described in paragraphs 1 through 16 in this manual.

c. Generator. Made by Rogers Diesel and Aircraft Corp. of New York City, on their frame No. 193, rated at 25 kw, 120/208 volts, 60 cycle, 3 phase, 1,200 rpm with direct-connected exciter on frame No. 225. The generator is directly connected through a flexible coupling of the stainless steel disk type to the Diesel engine. The comp.. te engine-generator set is mounted on a substantial structural-steel base of welded construction. The generator is completely described in paragraph 13.

d. Control Panel. The control panel, mounted on the unit over the generator is an all steel panel. The panel equipment is completely described in paragraph 16.

e. Batteries and Electrolyte. Five 6-volt, 3 cell batteries are furnished, dry charged, with electrolyte packed separately. See paragraphs 9 and 22.

f. Exhaust Silencer. The exhaust silencer is a Maxim MUC #7, spark arrestor type (par. 8).

g. Fuel Tank and Fittings. A 21-gallon fuel oil tank is mounted on the sub-base. Twenty feet of flexible tubing and a standpipe for inserting it into an outside source of supply is supplied. A two-way valve permits the use of either supply of fuel oil.

h. Dimensions and Weights.

	Length	*Width*	*Height*	*Weight*
Uncrated	104″	36-½″	62-½″	5,900 lbs.
Crated	137″	50″	75″	8,000 lbs.

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Section II
INSTALLATION AND OPERATION

18. UNCRATING.

a. Procedure. The unpacking procedure is as follows:

(1) Remove both ends, the top and sides of the crate.

(2) Remove the cross bracing and steel straps from the accessory boxes, spare parts, silencer, etc.

(3) Cut open the airtight cover which surrounds the power unit and remove the eight bags of moisture absorbent material. Discard these.

(4) Remove the nuts from the hold-down bolts.

(5) Lift the unit from the bolts.

(6) Remove all processing, rustproofing, and protective tape from the unit.

(7) Inspect the unit for damage and check all material against the packing list.

CAUTION: Whenever practical, the generator set should be moved as a complete unit. Care should be taken not to spring the generator shaft and sub-base by attaching hooks or slings improperly. Unnecessary handling of the equipment at low temperature should be avoided as far as possible, because castings are easily broken at low temperature.

b. Exposure to Low Temperature. If the power unit has been exposed to low temperature do not open the protective covering until sufficient time has elapsed for the unit to attain the temperature of the locality where it is to operate. It is suggested that the unit be allowed to stand at least 24 hours. Failure to take this precaution will result in sweating which may prove injurious to equipment.

19. INSPECTION OF GENERATOR SET.

a. Make a visual overall inspection of the unit to see that no connections, instruments, tubing, or accessories are damaged.

b. Check the radiator fins and tubes for damage and clean out all air passages.

c. Check to see that no foreign objects are inside the generator and that there is no corrosion on the slip-rings or commutator. Resurface, if necessary, with fine (000) sandpaper. Check the air gap clearance between the pole pieces and windings to see that no foreign matter, such as bolts, nuts, or chips of wood, has fallen into the lower section of the generator windings.

d. Check for broken or tight brushes in the holders and set the spring tension properly if necessary. Inspect for loose terminal connections.

e. Remove the rear panel of the switchboard, clean, and check for loose connections.

f. Remove the barring slot cover on the top of the flywheel housing and crank the engine over by hand to be sure that the engine turns over without binding. Engine compression may be released by holding open the compression release lever (fig. 3).

20. INSTALLATION.

a. Foundation Installation. The power unit may be installed on a foundation or a trailer. To install on a foundation make a template or installation jig as shown in figure 6. Mark foundation holes in the template to the dimensions as illustrated. Drill ¼-inch holes through the template for installation hole markings. This template may then be used for marking the holes necessary for bolting the power unit to its foundation. After placing the template in the proposed installation position, the ¼-inch drill may be run through the template holes previously drilled thereby marking the foundation bolt holes. Care must be taken to see that holes are drilled vertically. Enlarge the ¼-inch holes to the size needed for making the installation. Foundation holes on the sub-base are drilled 13/16 inch. Secure the bolts in position by any of the conventional methods such as molten lead or a grout mixture of cement. Place the unit and bolt it securely to the foundation.

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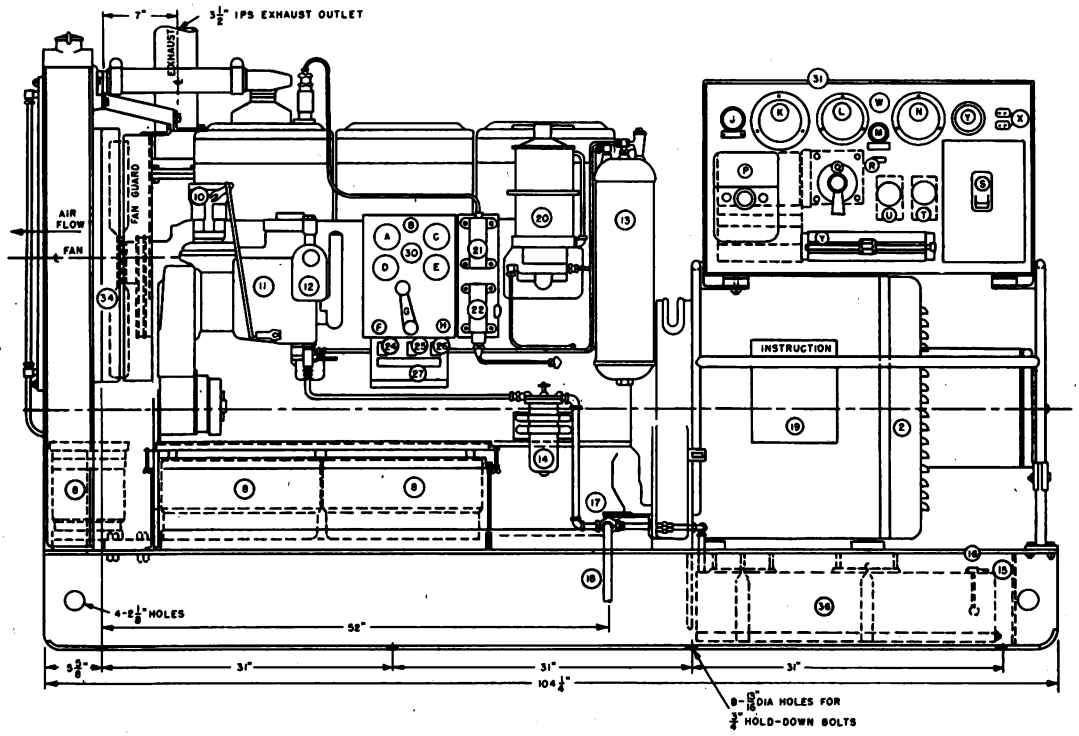

Figure 5. Fuel pump, side elevation.

BILL OF MATERIAL

ITEM	PCS	DESCRIPTION
1	1	CUMMING HI-600 (6 CYL) ENGINE
2	1	R.D.E.A. 25 KW AC GENERATOR-5 PHASE 1200 R.P.M. 4 WIRE, 120-208 VOLTS, DRIP PROOF COVER
3	1	24-30 VOLT STARTING MOTOR-DELCO-REMY
4	1	SOLENOID STARTER, SHIFT AND SWITCH
5	1	TUBE OIL FILTER CAP
6	1	BAYONET OIL INDICATOR
7	2	DONALDSON AIR CLEANER
8	5	EXIDE X-HM 25 BATTERIES
9	1	ELECTRICAL CONTACT CABINET
10	1	WOODWARD GOVERNOR
11	1	FUEL PUMP
12	1	OVERSPEED SHUT-OFF
13	1	FUEL OIL FILTER- BRIGGS CARTER TYPE F-10
14	1	FUEL OIL FILTER-CUNO TYPE D-1
15	1	FUEL GUAGE
16	1	FUEL INLET TO TANK
17	1	FUEL 3-WAY VALVE
18	1	FUEL INTAKE FROM DRUM
19	1	INSTRUCTION PANEL
20	1	LUBE OIL FILTER DELUXE BY PASS TYPE DFB-2
21	1	PENN ALARM SWITCH-HIGH WATER TEMP
22	1	PENN ALARM SWITCH-LOW OIL PRESSURE
23	1	EDWARDS HORN NO. 311
24	1	LOW OIL PRESSURE INDICATING LIGHT
25	1	NORMAL OPERATING LIGHT
26	1	HIGH TEMP INDICATING LIGHT
27	1	ALARM HORN SHUT-OFF SWITCH
28	1	PLUG FUSE
29	1	WARNING LIGHT RECEPTACLES

ITEM	PCS	DESCRIPTION
30	1	ENGINE INSTRUMENT CONTROL PANEL
A	1	WATER TEMP
B	1	STARTER BUTTON
C	1	OIL TEMP
D	1	FUEL OIL PRESSURE
E	1	LUBE OIL PRESSURE
F	1	ENGINE PRIMING PUMPS
G	1	THROTTLE CONTROL
H	1	FLAME THROWER HAND PUMP
31	1	ELECTRICAL CONTROL PANEL
J	1	AMMETER
K	1	FREQUENCY METER
L	1	AC VOLTMETER
M	1	RHEOSTAT
N	1	AC AMMETER
P	1	VOLTAGE REGULATOR
Q	1	BATTERY CHARGER SWITCH
R	1	TOGGLE SWITCH
S	1	CIRCUIT BREAKER
T	1	AMMETER TRANSFORMER SWITCH
U	1	VOLTMETER TRANSFORMER SWITCH
V	1	RHEOSTAT
W	1	40W LAMP-SILVER BOWL TYPE
X	1	DOUBLE CONVENIENCE OUTLET
Y	1	ELAPSED TIME METER
32	1	RADIATOR PERFLEX R-1983-C
33	1	RADIATOR OIL COOLER SECTION
34	1	SCHWITZER CUMMINS FAN F-O 1446
35	1	FLAME THROWER PREHEATER
36	1	FUEL TANK
37	1	LUBE OIL FILTER NUGENT BAG TYPE NO. 116

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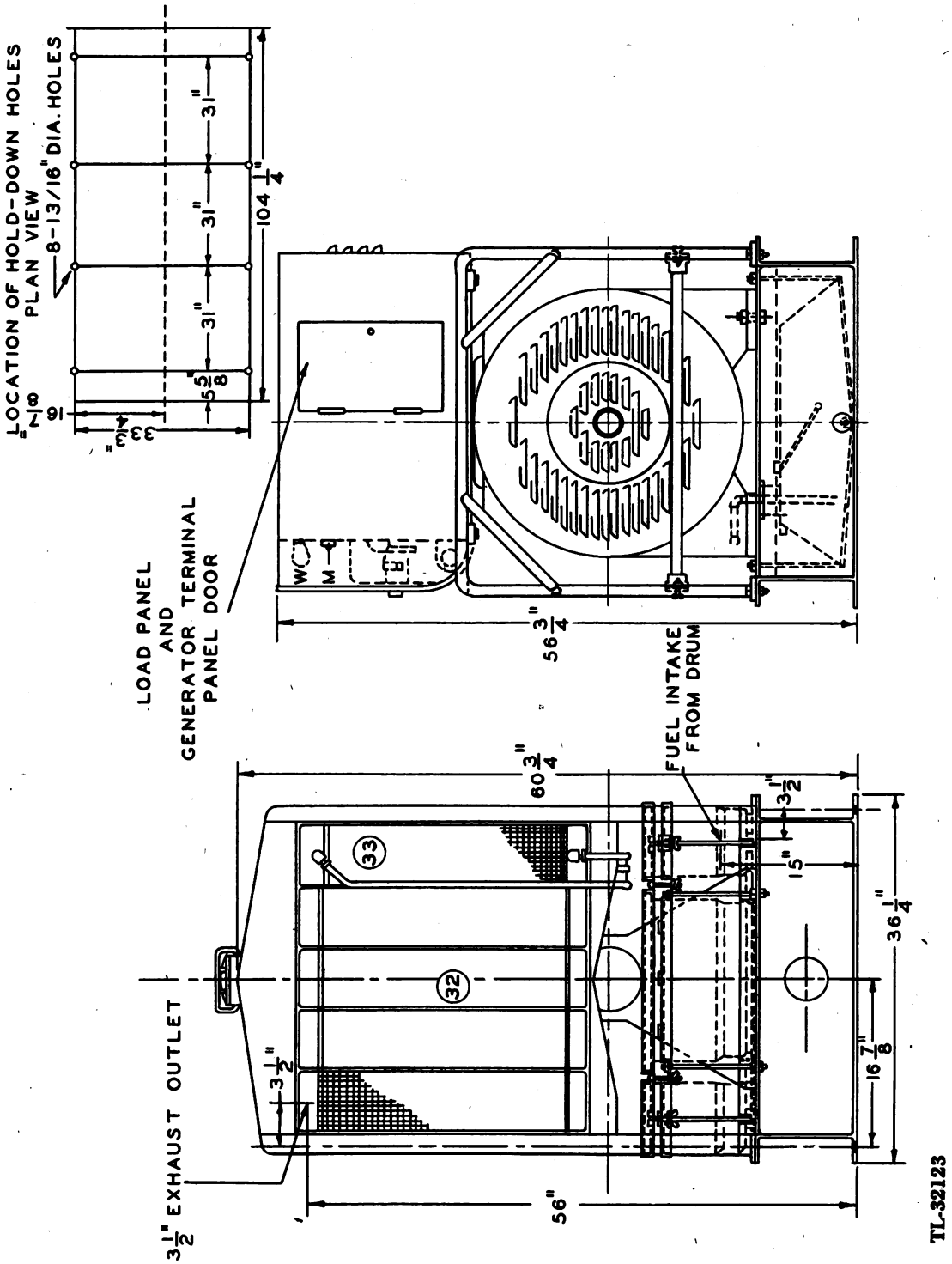

Figure 6. Generating unit, end elevations.

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b. Truck or Trailer Installation. If the unit is installed on a truck or a trailer, metal plates must be used on the bolts to prevent them from pulling through the truck or trailer floor.

NOTE: When making the installation, and before securing the unit to its foundation, it must be ascertained that no high or low spots exist at points where the engine skids rest on the foundation.

21. EXHAUST CONNECTIONS. After the unit is bolted down, connect the flexible pipe provided to the engine exhaust outlet flange (fig. 8). The silencer is attached to this pipe and the tail pipe runs from this to the atmosphere. Care should be taken to brace the silencer when hanging it so that the weight of the silencer and tail pipe will not be imposed upon the flexible steel tubing. It is also necessary that this flexible steel tubing have a slight offset in order to perform properly. The outlet tail pipe must be provided with protection against rain.

22. BATTERY PREPARATIONS AND CARE.

a. Inspection. The batteries with drip covers are mounted on the engine base (fig. 3). Inspect the batteries for damage and check to see that all vent plugs are intact. All contact surfaces should be scraped bright and clean before connecting. Apply a film of heavy grease or vaseline to the connections to prevent corrosion. The batteries are shipped dry with the plates in a partly charged condition. The vent plugs must be left tightly in place until ready to fill with electrolyte (battery acid). Batteries should be filled with acid as soon as possible and at least one hour allowed to elapse before they are placed in service.

CAUTION: Acid should be poured from the container into a glass or porcelain receptacle. Flush the skin with fresh water if acid splashes on the body.

b. Preparation for Service. To prepare the battery for service, proceed as follows:

(1) Unscrew the vent plugs. Remove the temporary paper disks from the filling holes and discard them.

(2) Fill each cell with the prepared electrolyte. The battery is equipped with a nonflooding vent plug and cover. The proper filling level is ⅜ inch above the top of the separators, or at the bottom of the filling well of the cover. The valve or lead ring which normally limits filling to the bottom of the well may not function until thoroughly wetted by the first charge. Excess electrolyte above this point, either on first filling or level adjustment, should be removed.

(3) Allow the battery to stand at least one hour after filling with electrolyte. If the level falls during this time, add electrolyte to restore it. Replace vent plugs in cells. If any electrolyte was spilled on the battery, remove it by means of a cloth slightly dampened with a solution of bicarbonate of soda and water, and rinse with water.

(4) Give freshening charges after placing the battery in service. Make certain that the positive terminal of the battery (marked POS or +, or painted red) is connected to the positive of the charge circuit, and that the negative terminal (marked NEG or –, or painted black) is connected to the negative of the charge circuit.

(5) Gas bubbles cause the electrolyte level to rise on charge. With the vent plug tightly in place, a vent is opened on the under side of the cover which allows normal expansion of the electrolyte and prevents flooding of the cells. When the plug is removed for hydrometer readings during the charge, the electrolyte may rise in the filling well. Take the hydrometer reading promptly. To return electrolyte to the cell, it may be necessary to open the valve by pressing down and tilting the lead ring in the well with a small piece of wood. Replace the vent plug promptly.

(6) Charge the battery until four consecutive hourly readings show no rise in specific gravity for the lowest cell. If the above rate is maintained, the charging time will be at least 12 hours. Lower rates will increase the time proportionately. If the temperature exceeds 110 degrees Fahrenheit, reduce the charging rate. If necessary to restore the electrolyte level during charge, use only approved water. For setting of the charging rate see paragraph 35.

(7) After completion of charge, the gravity should be as shown in the table below, corrected to 77F, and with the level ⅜ inch

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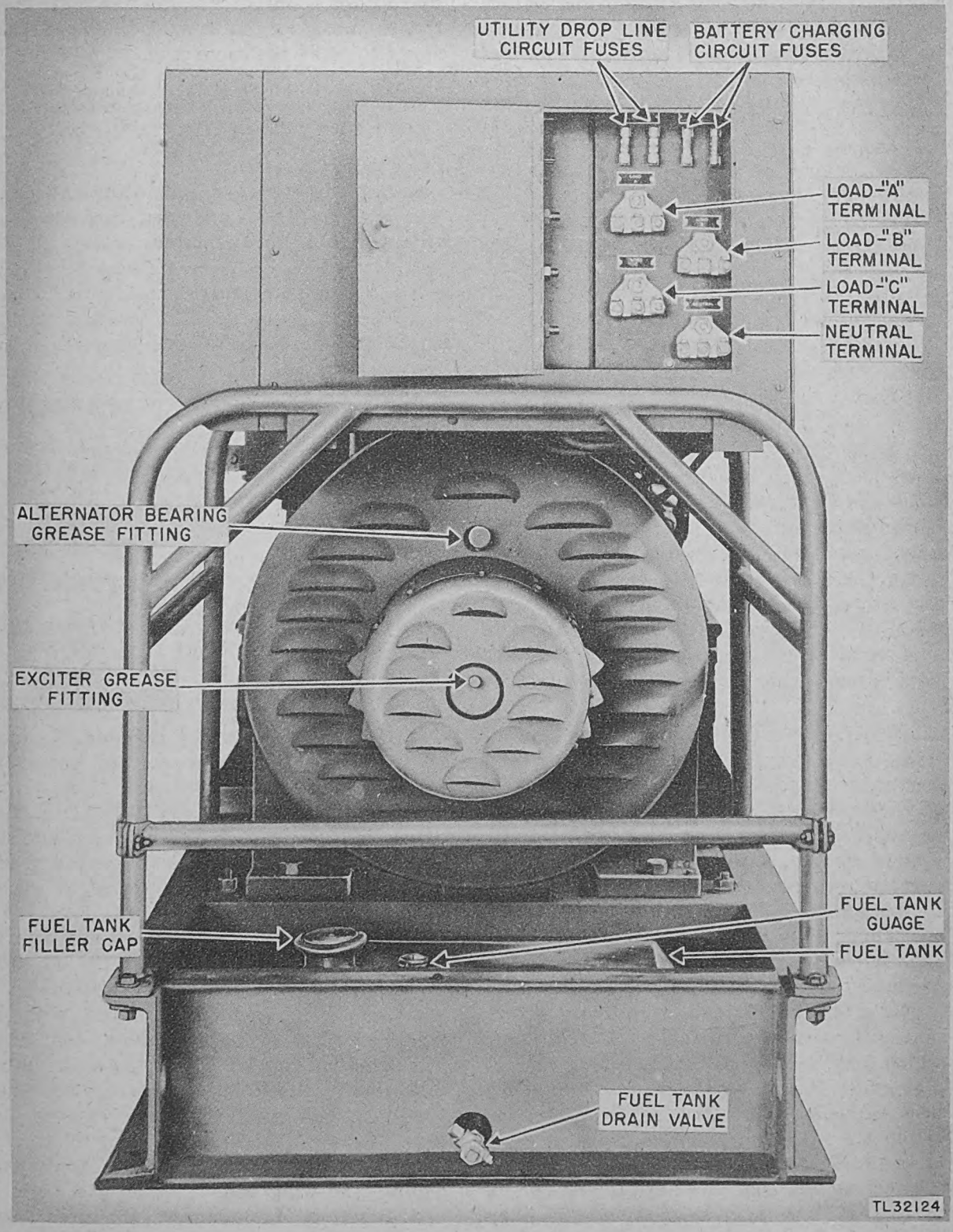

Figure 7. Power Unit PE-245-A, rear view.

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above the top of the separators. If it is not, adjust by removing some solution and replacing with clean drinking water or electrolyte as required. Charge to mix the solution before testing again.

	Temperate climate	**Tropical climate*
Filling gravity	1.270	1.210
Maximum temperature	110° F.	125° F.
Final gravity	1.270-1.285	1.200-1.220

**A tropical climate is one in which water never freezes.*

(8) After adding water, wipe the battery clean and dry. Have vent plugs in place at all times. Wash and clean the hydrometer barrel and float.

23. ELECTRICAL CONNECTIONS. Insulated load connections may be brought in below the switchboard terminal box and connected to the respective load and neutral terminal posts located at the rear of the switchboard (fig. 7). A connection between neutral and one of the load terminals will give 120 volts. A connection between any pair of the load terminals will give a voltage of 208 volts (figs. 4 and 4A).

24. FUEL CONNECTIONS. All fuel connections between the main fuel tank and the fuel pump are factory installed. The capacity of the tank is 21 gallons, sufficient for approximately 8 hours of full load operation. If desired for the initial run, the unit can be operated without making further connections to the outside fuel system. If an additional fuel supply is needed for longer operation, the standby flexible fuel equipment may be connected to the two-way valve connection provided (fig. 3). A stand-pipe adaptor is provided (for standard 55-gallon oil drum only) which may be screwed into the large hole of a 55-gallon fuel oil supply drum. The flexible hose provided must then be connected between the oil drum and the two-way valve on the fuel tank. It is desirable when making this connection that the flexible line be full of fuel oil. This may be obtained either by pouring fuel down the flexible line connected to the oil drum or by siphoning oil from the oil drum through the flexible hose before making the connection at the fuel tank. Hold the thumb over the end of the hose until ready to make the connection.

NOTE: The fuel lift from the oil drum to the fuel pump should be less than 6 feet; otherwise suction difficulties may be encountered.

25. LUBRICATION.

a. Engine Crankcase. Remove the filler cap from the crankcase and pour in a grade of oil as recommended in tables below (fig. 8). *Use clean containers when handling lubricating and fuel oils.* The oil pan capacity is 12 gallons. The oil level must be checked on the dip stick before and after adding oil in the crankcase.

OIL SELECTION BY AIR TEMPERATURE

Ambient Temperature	*SAE NO.*	*Army Spec. NO.*
90° F.	50	OE-50
32°-90° F.	30	OE-30
0°-32° F.	10	OE-10
Below 0° F.		Special

OIL SELECTION BY OIL TEMPERATURE

Oil Operating Temperature	*SAE NO.*	*Army Spec. NO.*
200-220° F.	50	OE-50
180-200° F.	30	OE-30
140-180° F.	10	OE-10

b. Fuel Pump Governor Housing. A small oil reservoir for the governor oil supply is provided in fuel pump housing (fig. 3). A sight glass window indicates the oil level. Remove the filler cap above the sump and fill the governor housing with an engine grade of oil to the center line of the sight glass. Replace the filler cap.

c. Air Cleaners. Air for combustion is drawn into the engine through the oil bath air cleaners which should be filled to the bead mark shown in the lower reservoir, with lubricating oil of the same grade as that used in the engine (fig. 9). To fill these air cleaners, remove the lower section by loosening the wing bolt until the lower reservoir is loose. Remove the reservoir and fill to the mark. Attach reservoir to the filter and tighten the wing bolt.

d. Starting Motor. Insert not more than five drops of engine oil through the hinge cap on the starter.

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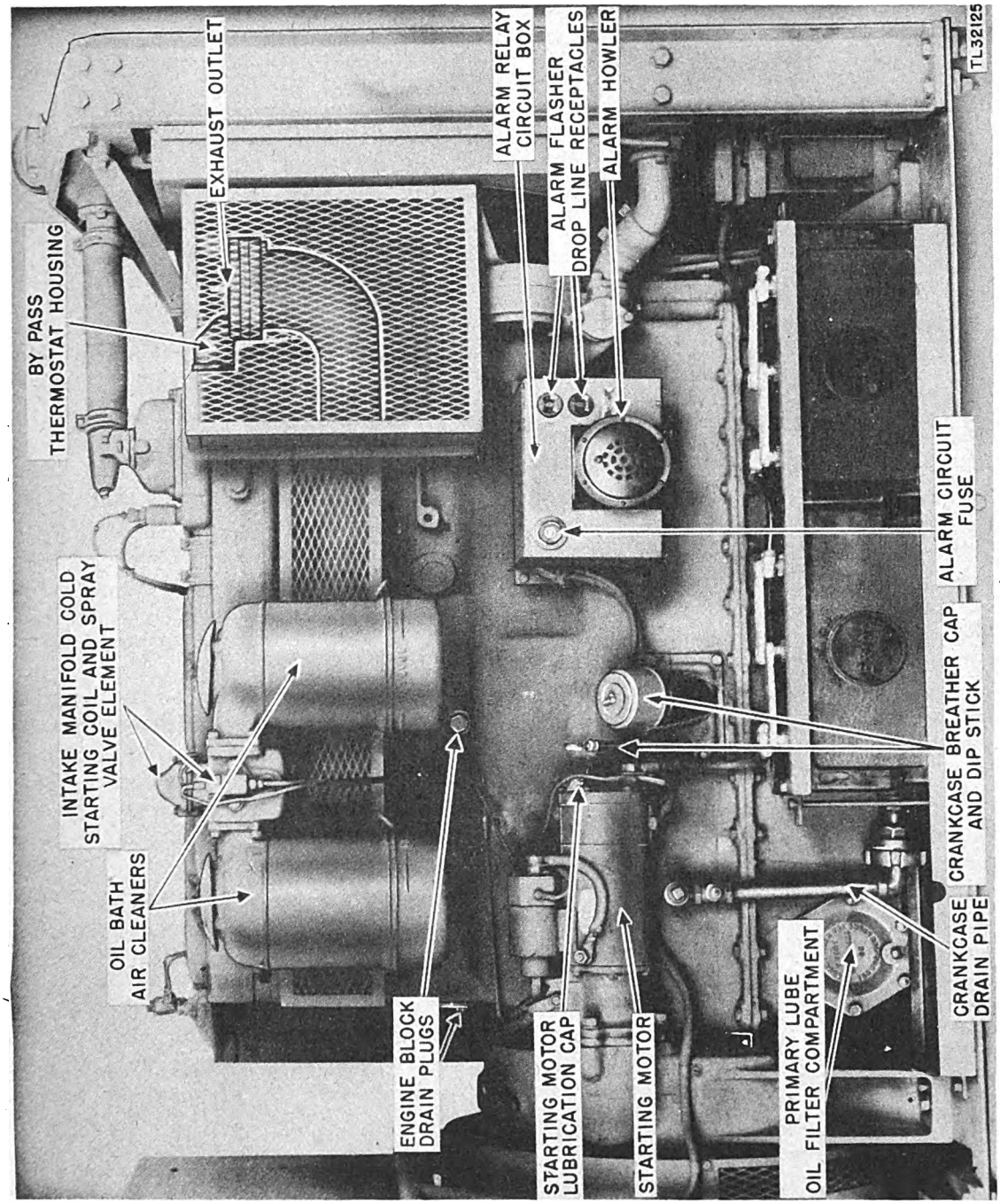

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Figure 8. Engine, manifold side.

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e. Water Pump. The water pump bearings are grease lubricated through a grease-cup connection behind the radiator (fig. 3). Unscrew and fill the grease cup with WB-2 general purpose grease. Screw the cup half way down. Repeat this operation at least once a week, and more often if unit is being run continuously.

f. Main Generator and Exciter. Two grease-cup connections are located at the rear of the generator for lubrication of two roller bearings of the generator shaft (fig. 7). Fill each cup with WB-2 grease and screw down the cups on the fittings. The generator bearings are packed with grease when shipped, and do not require a complete packing of grease when the unit is first put into operation.

26. COOLING SYSTEM.

a. Checking.

(1) Check to see that all drain plugs in the engine block are tight.

(2) Close the drain cock on the radiator.

(3) Fill the radiator through the filler cap with clean drinking water. Approximately 15 gallons of water are required.

(4) In cold weather, partially cover the radiator and add alcohol or antifreeze to the water in the following proportions:

PERCENTAGE BY VOLUME

Pure Methyl Wood Alcohol	*Denatured Wood Alcohol*	*Ethylene Glycol (Prestone)*	*Radiator Glycerine (G.P.A.)*	*Freezes at Degrees F.*	*C.*
13%	17%	16%	37%	20	−7
20%	26%	25%	55%	10	−12
27%	34%	33%	70%	0	−18
32%	40%	39%	81%	−10	−23
37%	46%	44%	92%	−20	−29
40%	53%	48%	100%	−30	−35

NOTE: If an engine has been standing in subfreezing weather for any length of time with the jackets and the radiator drained, never put water into it without a concentrated antifreeze added because, even if the water is warm, there is great danger of its freezing before the engine can be started.

b. Freezing Precautions. Add a small amount of antifreeze from time to time to take care of evaporation. Use a hydrometer daily to check the freezing temperature of the radiator solution during cold weather conditions. If alcohol is used to make the antifreeze solution, frequent checks with a hydrometer will be necessary as evaporation of the alcohol will be rapid.

CAUTION: Before using antifreeze, replace all worn or leaky hoses and repair all leaks.

27. CHECKING THE FUEL SYSTEM.

a. Properties of the Fuel Oil. Fuel oil should be neutral distillate petroleum oil, free from suspended matter, and not a mixture of light oil and heavy residue. Chemical properties should approximate the following requirements: Viscosity (Saybolt Universal Viscosimeter at 100 degrees Fahrenheit) not less than 34 seconds. Gravity from 26 to 36 Baume. Viscosity is more important than gravity. If the gravity is higher than 32, be sure that the viscosity is at least 34 seconds. Fuel must be free from water and grit, with not over 1 percent sulphur and not over 1 percent asphaltum content. Cetane rating should be not under 50. Not less than 10 percent of the fuel should distill below 460 degrees Fahrenheit. Not less than 90 percent of the fuel should distill below 675 degrees Fahrenheit; the end point not to exceed 725 degrees. Minimum recovery should be 98 percent.

b. Use of Light Oils. Extremely light oils, such as kerosene, will burn satisfactorily, but there is no lubricating value in light oils and their use will result in damage to parts which depend upon fuel oil for lubrication.

28. PRIMING THE ENGINE.

a. Cranking the Engine. Fill the fuel tank or tanks with the recommended fuel oil. Crank the engine over by hand, using the crank bar provided. This bar is to be inserted in the recess holes of the flywheel after removing the cover from the top of the flywheel housing. Rotate the flywheel in a clockwise direction, i.e., toward the fuel pump when inserting the bar at the top of the flywheel. To crank the engine easily, pull the compression release and insert the head of a ⅜-inch cap screw behind the release lever (fig. 3). When it has been ascertained that all is free, that no parts are rubbing or bearing on one another, and that the fans and guards are all clear, proceed with the other

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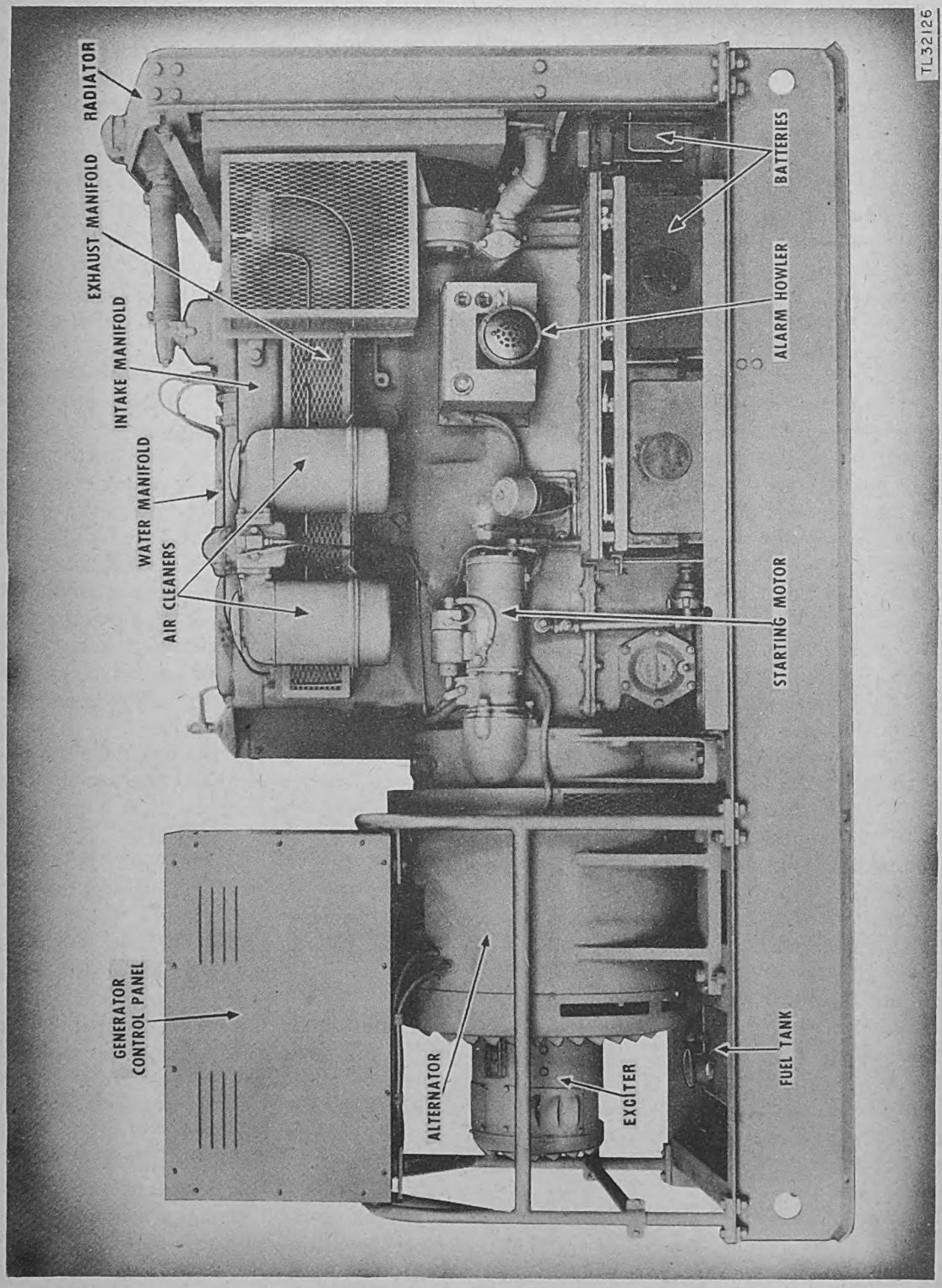

Figure 9. Power Unit PE-245-A, manifold side.

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operations necessary to prepare the engine for starting.

CAUTION: Always remove the cranking bar from the flywheel after turning flywheel to the position desired.

b. Priming the Fuel System. When the engine is started for the first time or if the fuel tank has been run dry, prime the fuel system by removing all air from the lines as described in the following paragraphs. The secondary fuel oil filter as shown in figure 10, must be filled with fuel oil. To do this open the filter vent valve, then remove the plug at the top of the inlet fitting and, using a funnel, fill the filter until oil flows out of the vent valve. Close this valve and replace the plug. Release the compression by pulling the lever on the front of the engine block next to the governor. This may be held open as described above. The capscrew used to hold the lever in the open position must always be removed before starting the engine.

(1) Check and tighten all fuel lines leading from the fuel tank to the fuel pump, including the ¼-inch line leading from the bottom of the fuel pump to the priming pump.

(2) If the oil drum fuel tank is to be used for the fuel supply, make connections as instructed in paragraph 24.

(3) Place the fuel supply valve on the fuel tank at the fuel supply position desired.

(4) Disconnect the ¼-inch fuel line A at the rear of the fuel pump. This line is the discharge of the engine priming pump (fig. 10).

(5) Work the left-hand priming pump plunger on the instrument panel which draws fuel from the fuel tank and discharges it out of the disconnected fitting. Continue the operation of the priming pump until solid fuel, free of air, is discharged from the connection. Reconnect the line.

(6) Loosen all six injector inlet lines at strainer connections B.

(7) Open the priming needle valve C on the fuel pump. This is accomplished by first loosening the packing gland nut and turning the valve one turn.

(8) Engine timing and priming marks are indicated on the inside face of the pulley mounted on the front shaft extension of the fuel pump. Three index notches are cut on the outer edge of the pulley for timing and adjusting of the valves. Three additional priming index lines (marked PR) are etched on the inside face of the pulley. These index marks are between the outer valve notches of the pulley. The priming marks when individually lined up with the priming and timing index notch of the timing gear case, point D, line up the fuel passages in the distributor disk of the fuel pump.

(9) Turn the flywheel with the barring device until one of the PR marks on the inside face of the pulley lines up with the index notch of the timing gear case.

(10) Work the hand priming pump until the fuel, free of air, leaks out of one of the loosened connections.

(11) Retighten the fuel line of the primed injector and give the primer one or two strokes only.

(12) Turn the flywheel over until the next PR mark on the fan drive pulley comes up to the center line mark on the gear housing. This brings the cylinder listed next on the firing order chart to the correct position for priming. Work the hand pump as directed for No. 1 cylinder. Continue to turn the engine to the next PR mark and prime the next cylinder listed on the firing order chart. Follow this procedure until all cylinders have been primed.

(13) Before starting the engine, close needle valve C. Never attempt to operate the engine with valve C open.

29. STARTING INSTRUCTIONS. Before starting the engine for initial operation of the unit, check to see that:

a. The engine has been primed and the fuel supply valve is properly set for the tank in use.

b. The lubricating oil is at the high mark on the dip stick in the crankcase and at the center of the sight glass in the governor housing (fig. 3).

c. The cooling system is full of clean water or antifreeze solution, if necessary.

d. All switchboard switches are in a neutral (off) position, and the control rheostats are set with resistance all-in (no voltage setting).

e. The governor speed control screw as shown in figure 3, is set for speed operation.

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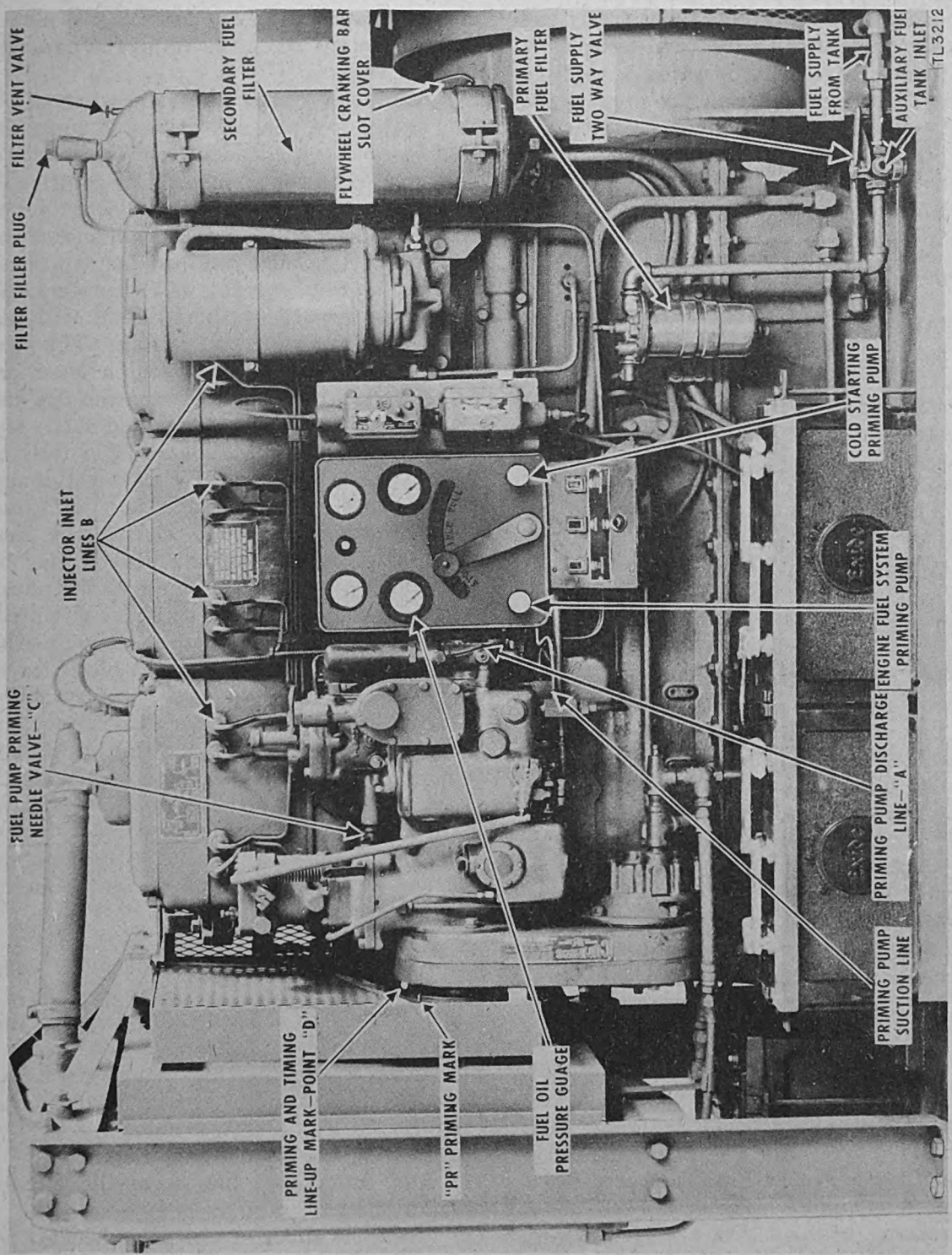

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Figure 10. Priming, engine fuel system.

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Turn the screw approximately five turns in a clockwise position from the slack position.

f. The power unit is properly connected for initial operation. Engine turns freely and all safety precautions have been taken.

g. The alarm circuit operates by pulling out the throttle lever from the stop recess hole. A red light should register on the lower alarm light panel when the howler sounds. Test the lower push button which should disconnect the howler circuit.

NOTE: Remove the generator inspection cover to observe the brush contacts during the initial run of the unit.

30. STARTING THE ENGINE.

a. Place the lever on the instrument panel to the FULL position.

b. Press the starter button firmly until the engine fires. Release it immediately after engine fires.

c. Control the engine speed with the fuel throttle lever. If desired, place the fuel throttle to the FULL position and lower the engine speed by means of the governor speed adjusting screw (fig. 3). The gauge readings should register as follows: oil pressure 40-60 pounds, and fuel pressure 80-150 pounds.

d. For the initial run operate the power unit for at least one-half hour before placing under load. During this time inspect the unit for local overheating, fuel, water, and lubricating oil leaks. Inspect the generator for local overheating and brush contact operation. If rough contact is noticed, stop the unit and polish irregularities as outlined in paragraph 54.

e. When the unit is in operating order, increase the engine speed in gradual stages and recheck the operation. Operating speed at no load is 61-cycle reading on the frequency meter.

NOTE: See paragraph 36 for cold weather starting.

31. SWITCHBOARD CONTROL (refer to fig. 11).

a. To Obtain Proper Engine Speed. Place the voltmeter phase selector switch to a phase-reading position. Voltage is obtained by placing the slider of the hand control rheostat gradually to the right. Note the increase of voltage on the voltmeter. The frequency meter should register 61 cycles with a voltage reading of 120 volts for proper control of generator speed and voltage. The engine governor speed controls frequency meter readings when the voltage is adjusted for 120 volts.

b. Ammeter Phase Selector Switch. Turn this switch to a phase position and apply the load by closing the load switch. The load will be indicated on the ammeter. The rotation of ammeter selector switch will indicate the difference in load on each phase winding of the generator. A normal full load for one phase winding on the generator is 78 amperes. An excessive overload or short circuit will trip the circuit breaker (load switch). This will be noticed when the load switch lever assumes a center position between the ON and OFF position. The operator should notify the officer in charge if the load switch fails to hold in the ON position. By placing the ammeter phase selector switch in a different phase position each time, closing the load switch, and reading the ammeter, it may be determined whether one or all of the phase windings are overloaded or short circuited. If one phase lead is overloaded, determine the cause and divide the load on the phase leads. If possible, operate the unit under a light load and inspect the unit for satisfactory operation. Increase load until a full load is obtained. If required, the unit will operate under 25 percent overload for 2 consecutive hours without overheating or damage to the unit. This is the equivalent of approximately 100 amperes on any or all of the ammeter phase positions.

32. VOLTAGE REGULATOR.

The voltage regulator is described in paragraph 43. Its purpose is to automatically regulate the voltage of the alternator which is accomplished by controlling the amount of excitation delivered to the alternator field by the exciter.

a. Putting the Regulator in Service.

(1) Run the engine but leave the circuit breaker open.

(2) Move the slider of the field rheostat to reduce the alternator voltage to about 25 percent of the normal operating voltage or about 30 volts.

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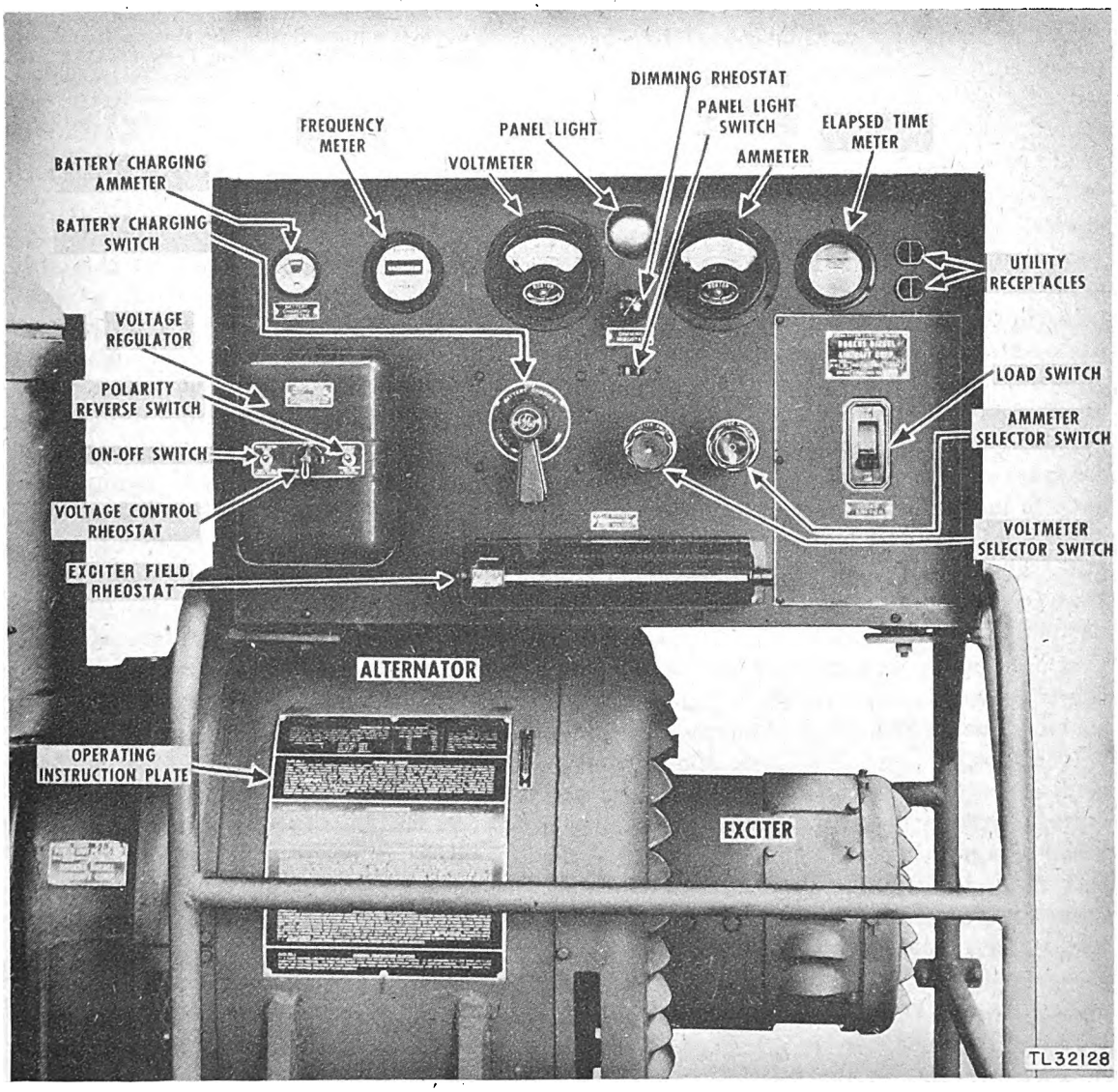

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Figure 11. Switchboard panel controls.

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(3) Close the voltage regulator switch and adjust the voltage regulator rheostat to give an operating voltage of 120 volts. If this cannot be obtained with this rheostat, readjust the exciter field rheostat and then make a further adjustment of the voltage regulator to obtain the required voltage. After this final adjustment is made mark the position of the slider on the exciter field rheostat.

(4) The load may now be added by closing the circuit breaker and the regulator should automatically keep the voltage at the adjusted value.

(5) The voltage regulator may be left in service becoming operative each time the unit is started.

b. Automatic to Manual Control. To change from automatic to manual control without interrupting the service, move the slider on the exciter field rheostat to increase the voltage to about 10 percent above normal or about 132 volts. Then turn off the voltage regulator switch and the alternator will be on manual control and it will then be necessary to maintain the required operating voltage by adjustment of the exciter field rheostat. Under this condition it may be found that frequent adjustment of the exciter field rheostat is necessary.

c. Manual to Automatic Control. To place the regulator in use without interrupting the service, move the exciter field rheostat slider to reduce the normal voltage about 10 percent or about 108 volts and then close the voltage regulator switch and immediately move the slider to the marked position referred to above. Make any necessary adjustment of the voltage regulator rheostat.

d. Polarity Reverse Switch. The position of the polarity reverse switch should be changed daily in order to prevent pitting of the contacts of the vibrator. It is usually found to be good practice to change the polarity each day before starting the unit.

e. Adjustment. Adjustment of the voltage regulator is covered in paragraph 100.

33. STOPPING OF UNIT.

a. To remove the load, place the load switch in the OFF position. Do not change the voltage regulator adjustment.

b. Shut down the engine (do not change the governor speed setting) by placing the fuel throttle in the STOP position. Be sure that the throttle lever knob snaps into the recess hole of the STOP position; otherwise the howler will sound when the oil pressure drops below the setting of the oil pressure safety switch.

NOTE: If the circuit breaker or load switch is opened automatically the setting handle returns only to the mid position between OFF and ON. It will be necessary to move this handle to the full OFF position, in order to engage the latch, before the breaker can be again closed.

34. NORMAL OPERATING PROCEDURES.

a. Checking.

(1) Check the water, oil, fuel, battery, and load switches before starting the engine.

(2) Place the throttle lever to the FULL position and engage the starter switch. When the engine fires, decrease the engine speed with the throttle control and warm up the engine for at least 5 minutes (15 minutes in cold climate). Note the gauge readings and increase the engine speed gradually.

(3) Check the voltage reading on the switchboard. If it is normal (120 volts), close the load switch. Take the meter and gauge readings as required.

b. Engine Gauge Readings. After one hour of operation under a full load, the engine gauge readings should register as follows:

	Min.	*Normal*	*Max.*
Fuel oil—lbs/sq. in.	70	80-140	150
Lube oil—lbs/sq. in.	25	40-55	60
Lube oil temperature °F.	120	140-180	195
Water temperature °F.	130	140-170	190

c. Removal of Load. To remove the load, open the load switch to OFF position. Place the fuel throttle in the stop position.

NOTE: If the unit has been operating in tropical climates, let the engine operate for five minutes without a load. This prevents internal hot spots in the engine.

35. BATTERY CHARGING CONTROL OPERATION.

a. Hydrometer Readings.

(1) Do not charge the batteries unless hydrometer readings have been taken and it has been determined that the batteries need a freshening charge. Always add water before charging when needed.

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(2) Charge the batteries if the readings register below 1.226 specific gravity. The maximum reading is 1.280 specific gravity.

b. Rate of Charge. Place the battery charger switch to a position for a charging rate of 6 amperes on meter (fig. 11). Do Not Charge Above Six Amperes. Check for a blown fuse in the fuse box at the rear of the switchboard if the rectifier fails to operate (fig. 7).

NOTE: For care of batteries, see paragraph 22.

36. FREEZING TEMPERATURE OPERATION.

a. Cold Weather Operation. The power unit should be given careful consideration for cold weather operation. Use antifreeze in the cooling system, a lighter grade of lubricating oil in the crankcase and the governor, keep the batteries well charged, cover the oil and water sections of the radiator to obtain normal operating temperatures, and set the engine governor control for slow speed operation. *Do not start the engine in cold climates at full operating speeds.* Warm up the engine for 15 minutes at a slow speed and gradually increase the speed until full operating temperatures are reached. In emergencies, the foregoing may be disregarded although it should be carried out as far as possible. Observation of this rule will prolong the life of the unit and prevent numerous repairs.

b. Heating the Air. A preheater or flame thrower is provided in the intake manifold for heating the air during cold weather operation. This is accomplished by forcing the fuel through an atomizer nozzle and across a continuous electric spark into the air stream. The pressure needed to force the fuel through the nozzle is obtained from a hand pump on the instrument panel. This pump draws fuel from the inlet connection on the engine fuel pump and delivers it to the nozzle housing (fig. 10). Within the housing is a small check valve which aids in holding pressure in the system. After the pressure has become sufficient to open this check valve, the fuel travels to the nozzle and into the chamber. A 24-volt vibrator type spark coil furnishes the high voltage necessary to jump the spark across a gap between a fixed insulated electrode and a grounded adjustable electrode. A pressure switch mounted on the nozzle housing acts as a circuit breaker in the primary circuit of the coil. This switch operates solely by fuel pressure and makes or breaks the circuit when the pressure exceeds or drops below 45 pounds. When the circuit is closed, a spark is present at the electrodes. When it is broken there is no spark. No manual method of turning the spark on or off is provided. The excess fuel that does not burn is carried from the housing by a one-way drain line. The batteries must be well up to charge (1.275-1.300 S.G. after allowances for temperature) or sufficient cranking speed will not be obtained.

c. Starting the Engine. To start the engine, perform the following operations in the order given:

(1) Prime the engine fuel system, if necessary.

(2) Operate the flame thrower hand pump on the instrument panel (right-hand pump) to maintain fuel pressure by slow even strokes of the hand pump.

(3) Set the governor speed adjusting screw for half-speed and place the throttle in the FULL position.

(4) Engage the starter switch.

(5) Operate the flame thrower pump for approximately 20 seconds (30-40 seconds for temperatures of 10 degrees Fahrenheit and lower).

(6) Stop the flame thrower pump, but continue to crank the engine. The engine should start in approximately five seconds. Should it refuse to start immediately, continue to crank and at the same time give the flame thrower pump a few additional strokes. It may be necessary to perform this operation two or three times. If the engine still refuses to start, it is useless to continue cranking.

(7) Check the fuel system for stoppage caused by freezing of water in the fuel.

37. TYPICAL TEST REPORT. Figure 12 shows a typical test report taken during the inspection and acceptance of the equipment.

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ENGINE AND GENERATOR TEST HEAT RUN

	VOLTS			AMPERES			SW. BOARD					ENGINE						Lube Oil oF	Start and Stop Tests, Seconds
LOAD	A	B	C	A	B	C	Freq.	Elap. Time	Time	Power Factor	Gen. Frame	Kilo-watt	Exhaust oF	Ambient	Jacket oF	PRESSURE Lube	PRESSURE Fuel		
OL	119	119	119	100	105	100	59.5	0.1	9:50		20			18.5	140	50	120	70	1. 2
OL	120	120	120	90	95	90	60	0.6	10:20		23		no	20	140	45	120	100	2. 3
OL	120	120	120	92	97	92	60	1.1	10:50		27			22	140	45	118	120	3. 2
OL	120	120	120	95	100	95	60	1.6	11:20		29		gauge	22	140	45	118	120	4. 1
OL	120	120	120	93	98	94	60	2.1	11:50		28			21	140	45	118	120	5. 2
FL	120	120	120	86	88	86	60			.8		25							
3/4	120	120	120	67	69	86	60			.8		18							
1/2	121	121	121	45	47	46	60.5			.8		12.5							
1/4	121	121	121	25	27	27	61			.8		6.5							

	REGULATION						SWITCHBOARD							Check
	Volts	Amps.	K. V. A.	K. W.	P. F.	Freq.	A.C. Ammeter ST.	A.C. Ammeter Panel	Voltmeter ST.	Voltmeter Panel	Circuit Breakers Phase	Circuit Breakers Current	Circuit Breakers Time	Frequency Meter 59.5
Full Load	120	100		29	87	89.75								Dimmer Switch o.k
No Load	125					61	40	41	100	100	A	200	130	Rectifier o.k
Full Load							60	61	120	119	B	200	156	Charging Meter o.k
Maximum Volt swing	130						80	81	140	138	C	200	129	Emergency Lights o.k
¼ Load	124	30		8	80	60.8	100	101						Time Meter o.k

VOLTAGE REGULATION	o.k	FL to NL 62.5		
FREQUENCY REGULATION	o.k	NL to FL 59.1		
% MAXIMUM VOLTAGE SWING	o.k	Shim Marks	dowel	Overspeed Stop o.k
STEADY IN SECONDS		Term. Marks	------	Oil Pressure Stop 25
		Water Temp. Stop	o.k	Oil Pressure 47

DIELECTRIC TESTS			
Generator Field	Generator Stator	Exciter Field	Exciter Armature
OK	OK	OK	OK

R.D.A. TESTER

S.C. INSPECTOR

REMARKS:

TL32129

Figure 12. Typical test report.

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Section III
FUNCTIONING OF PARTS

38. ENGINE AND INJECTOR.

a. Type and Equipment. The six-cylinder engine is of the four-stroke cycle, Diesel, overhead valve type. No carburetor or electrical ignition is used, the charge of fuel oil being ignited by the temperature of air in the cylinders, created by the high-cylinder compression. It is equipped with one metering pump for all cylinders and a cam actuated injector for each cylinder.

b. Cycle of Operation. The cycle of operation is as follows:

Air is drawn into a cylinder through an open intake valve on the downward stroke of the piston. The following upstroke compresses the air thus raising its temperature. Shortly before top dead center of this upward stroke, the correct amount of fuel oil is injected into the cylinder in such a manner that it is mixed with the air. The high temperature of compression fires this mixture and supplies the power for downward stroke of the piston. The next upstroke of the piston forces the burnt gases out through the exhaust valve and manifold into the silencer. This cycle of operation is then repeated.

c. Injector.

(1) The function of the injector is to atomize and thoroughly mix fuel oil with the air in the cylinder. The Cummins fuel injection system differs from the usual type in which the high pressure necessary to atomize and force the oil properly into the cylinders, is supplied by either a single plunger or by a plunger for each cylinder. Such a system requires high pressure tubing from the injection pump to the spraying nozzles.

(2) In the Cummins fuel injection system, used on Power Unit PE-245-A, the fuel charge is measured or metered at low pressure, that is about 50 pounds, and is delivered, at this pressure, to the injector by which it is forced into the cylinder. The injector consists of a forged body fitted with a mechanically operated plunger. An injector cup which is perforated with six spray holes, is mounted on the end of the body (fig. 13).

(3) On the intake stroke of the piston, the fuel pump delivers a measured charge of fuel to the injector. The mechanically operated plunger of the injector, at the same time, moves upward so that fuel oil can be moved along into the open recess occupying some of the space formerly taken by the plunger. A small check valve in the end of the injector prevents the fuel from flowing back in the line. The fuel is also prevented from flowing out through the six holes in the injector tip by the pressure developing in the cylinder during the upward or compression stroke of the piston. During the compression stroke, the hot compressed air enters the nozzle through the small holes and vaporizes the heated fuel oil. Just before the end of the compression stroke, the injector plunger is forced downward by cam action and expels the vaporized fuel into the firing chamber where it is immediately ignited (fig. 13 illustrates this action).

39. FUEL PUMP (all references to figure 14, DWG A-152). The fuel pump on the Model H engine is divided into five separate assemblies as follows: governor assembly, distributor disk housing assembly, metering or fuel pump housing proper, gear pump transfer No. 1 and gear pressure pump No. 2, and the float chamber assembly.

a. Governor Assembly. The duty of the governor is to keep the engine speed constant within its load range. The operation of the governor is described in paragraph 41.

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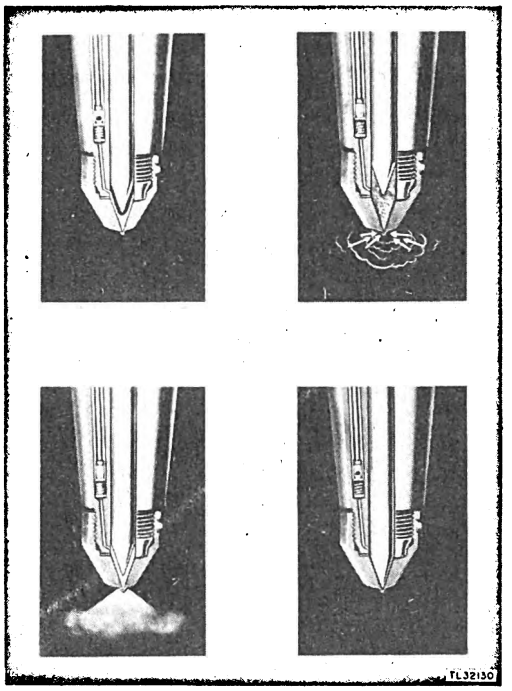

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Figure 13. Fuel injection cycle.

b. Distributor Disk Housing. The purpose of the distributor disks and housing is to transfer a charge of metered fuel, to the cylinders in proper sequence, at the desired point of piston travel.

(1) The distributor disk assembly consists of a set of mated disks drilled with a series of holes, when properly indexed, form passages for the transfer of fuel from pressure pump to metering pump and injectors. A shaft drives the lower distributor disks which rotate against the upper disk cover. A heavy tension spring holds these disks together. A thrust bushing and bearing are provided for shaft thrusts. A mated metering plunger and barrel, item Q, are included in this assembly and the plunger is actuated by means of a dumbbell link. A needle valve, item P, is located in distributor housing for the purpose of obtaining a through priming passage around the disks when valve is open.

(2) When the priming valve is closed and the engine is in operation, a metered amount of fuel is constantly being displaced by the metering plunger. Fuel oil under pressure from No. 2 gear pump is transferred across the upper disk passage leading to metering plunger, filling up whatever space is available by simultaneous downward stroke of metering plunger. On discharge or upward stroke of metering plunger, the lower distributor disk has turned to line up the transfer holes and displaces fuel into injector. The disks are highly polished for the purpose of maintaining a thin film of fuel under pressure. All spill off of fuel oil drains onto and into lower housing and further lubricates the working parts of the pump housing proper.

c. Fuel Pump Housing Proper. The duty of assembled parts in the fuel pump housing is to transmit and control a reciprocating motion to the metering plunger. This metering action must be in coordination with the distributor disk transfer holes and likewise timed with engine camshaft action of injectors. The fuel pump housing consists of a number of subassemblies, namely:

(1) Fuel pump cam, item Y.
(2) Cam rocker assembly, item X.
(3) Vertical lever assembly, item W.
(4) Eccentric assembly, item S.
(5) Control connecting links, items BB and T.

d. Fuel Pump Cam, Item Y. The purpose of the fuel pump cam is to start a cam action upon which the metering plunger is actuated. This action is timed with injector plunger travel.

(1) The fuel pump cam assembly is a one-piece forging with three cam profiles for actuating the cam rocker assembly, item X.

(2) A bevel drive gear for distributor drive shaft and two slinger-ring grooves are machined at forward end of cam forging. The slinger-ring grooves prevent fuel oil splash from entering governor housing.

(3) The fuel pump cam is keyed and pressed on fuel pump main shaft.

(4) The turning of the fuel pump cam relays its cam profiles to the cam rocker assembly, item X, and thereby transmits motion to metering pump plunger.

e. Cam Rocker Assembly, Item X. The purpose of the cam rocker assembly is to change the rotary motion of the fuel pump cam, item Y, into a rocking motion.

(1) The cam rocker assembly consists of a horizontal rocker shaft, supported in fuel pump housing by two bronze bushings.

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(2) At right angles and protruding from both sides of rocker shaft is a quadrant carriage and roller carrier fork.

(3) The upper quadrant carriage consists of a smooth machined surface upon which rides the vertical lever roller, item U. Two stop pins limit travel of roller.

(4) The lower carrier fork is machined to receive a roller, pin and pin rivet. Passages are drilled in casting, to supply fuel oil lubrication.

(5) The quadrant carriage, carrier fork and horizontal rocker shaft is cast and machined as one unit.

(6) Cam roller, pin, pin rivet, and upper carriage stop pins are added to make a complete assembly.

(7) This assembly is supported at both ends in the fuel pump housing at shaft center, item X, which coincides with center line of vertical lever roller, item U, when roller is in full OFF position, designated on figure 14.

(8) Rocker cam roller bears against fuel pump cam, item Y, by spring tension, which prevents the cam roller from jumping at high speeds.

(9) Any motion of fuel pump cam, item Y, will transfer its irregularities to cam rocker roller, item U, this in turn, will give a rocker action to the assembly, because cam roller, item Z, is off center from rocker shaft center line of suspension.

(10) The cam rocker assembly rocker motion is constant, regardless of control linkage, but with vertical lever roller, item U, in full OFF position, no rocker motion will be imparted to this roller since center of cam rocker and vertical lever assembly lie on same horizontal line. The rocker motion of the cam can result only in horizontal motion of the vertical lever roller. As vertical lever roller, item U, moves outward, away from rocker assembly shaft center line mounting, rocker motion impulses will be transferred and increase until a maximum motion is reached at full ON position.

(11) The transfer of rocker impulses from cam rocker assembly, item X, to vertical lever roller, item U, impart and transform the rocker action into reciprocating motion of vertical lever assembly, item W.

f. Vertical Lever Assembly, Item W. Vertical lever assembly, item W, is for the purpose of transmitting reciprocating motion to the metering pump plunger and to vary the amount of motion. The amount of motion is controlled by the governor, through linkage.

(1) The vertical lever assembly consists of a vertical lever supported by needle bearings at its upper end, item V. Its lower end terminates in a needle bearing roller, which rides on the smooth surface of the cam rocker carriage. Vertical lever is connected to a horizontal plunger, which has its fulcrum at item WI. This fulcrum shaft is clamped solidly by means of a cap screw, which also holds the vertical lever shaft and needle bearings at item V. The fulcrum shaft is free floating and supported by two bronze bushings in fuel pump housing. A cup-shaped socket is located at end of horizontal plunger lever. A dumbbell link rides in the cup, and actuates the metering pump plunger.

(2) Any reciprocating motion transferred to vertical lever will in turn, move horizontal plunger lever in a like manner, because of its fulcrum at item WI. It will, therefore, transmit this motion to the metering pump, by way of the dumbbell link which fits into sockets of the horizontal plunger lever and of the metering pump plunger.

(3) The stroke of reciprocating motion is determined by the position or setting of the vertical lever on the cam rocker carriage. The vertical lever is controlled by the governor, and is free to move across the machined surface of the cam rocker carriage within the limits of FULL ON and FULL OFF position, according to load requirements.

g. Eccentric Assembly, Item S. Eccentric assembly, item S, is for the purpose of changing the ON and OFF position of the vertical lever roller U.

(1) The eccentric assembly consists of a shaft upon which is centered a disk with an upper shaft placed off center. The assembly is machined as one piece.

(2) By referring to item S, it may be seen that any movement of this eccentric assembly will change the fulcrum position for the bell crank which can swivel on the upper shaft that is off-center.

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(3) Eccentric position is actuated only by movement of throttle lever R, and is unchanged once a setting is made.

h. Control Connecting Links, Items BB and T. These items are for the purpose of connecting the vertical lever to the governor control rod.

(1) The connecting links are spring loaded ball joints. Link action must be smooth in order to transmit governor reactions.

(2) By link connections the governor action is transmitted through eccentric governor link, BB, to lower end of bell crank, which pivots on the eccentric assembly shaft. The long arm of the bell crank is, therefore, moved a like amount and transmits this motion to connecting vertical lever link T. This action changes the setting of vertical lever and thereby changes the stroke of metering pump plunger.

i. Gear Pump Assembly, No. 1 Transfer and No. 2 Pressure Pump. This in reality, is one assembly. It is shown on schematic print as two separate assemblies for clarity. The purpose of this assembly is to transfer fuel oil free from air and with sufficient pressure in its discharge to overcome losses, regardless of speed. The assembly transfers fuel oil from fuel tank to the metering pump.

(1) The gear pump assembly consists of two sets of gears separated by a spacer plate (not shown) and proper shaft seals, which prevent leakage between pump housings.

(2) The drive gears of each pump are keyed to a common drive shaft.

(3) The gear pump drive shaft extends beyond the gear assembly housing and fits into recess of fuel pump main drive shaft.

(4) The gear pump drive shaft extension is slotted and fits into a drive pin riveted in fuel pump main drive shaft making a positive drive coupling.

(5) The gear pump assembly housing is centered and doweled on fuel pump housing proper, and held in place by four cap screws and may be replaced independently from the fuel pump housing.

j. No. 1 Gear Pump. This pump is for the purpose of transferring and maintaining a constant supply of fuel from the fuel tank to a filter, and then into a small float chamber.

(1) This assembly consists of a set of gears on proper shafting, riding in bushings enclosed in its housing.

(2) A bypass valve assembly, item B, is a working part of No. 1 gear pump, though it is located in the main housing. Cored passageways connect the gear pump with the bypass valve. The bypass valve assembly is a light spring loaded valve in a guide socket.

(3) Fuel inlet ball check valve, item A, and seat are not part of the gear pump assembly, and are also located in main fuel pump housing. For purpose of clarity they are shown schematically attached to No. 1 gear pump.

(4) The turning of gears in No. 1 gear pump assembly creates a suction at item A, lifting the ball check from its seat and allowing oil to flow past the bypass valve chamber, up and around gear pockets of gears. Fuel oil is then discharged into passageway leading into the filter and the float chamber assembly.

(5) When float chamber is filled this passage is closed by action of float needle valve C; pressure built up in discharge passageway will force open the bypass valve and allow oil to flow back into suction side of gear pump.

(6) This balancing of fuel flow, is constantly in action during normal operations and furnishes a sufficient supply of air-free fuel in float chamber.

k. No. 2 Gear Pump. This pump is for the purpose of maintaining a constant supply of fuel under pressure to the metering pump. This transfer of fuel is performed in a manner whereby its pressure will maintain a film of oil between distributor disk faces, regardless of speed. No. 2 gear pump consists of a similar set of gears, as in No. 1 gear pump, enclosed in its housing with drilled and machined passageways for proper distribution of fuel. No. 2 gear pump has additional component parts as follows:

(1) Ball check valve F, is for the purpose of retaining fuel oil in pump housing when unit is inoperative.

(2) Pyramid check valve G. The valve acts as a check valve and will prevent grit from screen K, from falling back into pump gears when unit is inoperative.

(3) Pressure regulator valve H, is for the purpose of controlling pressure of No. 2 gear pump.

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(a) Six small holes are drilled in its lower end which functions as spill off medium for oil. This spill off occurs when regulator valve holes pass beyond end of regulator valve guide sleeve, item H1.

(b) The oil that spills out from pressure regulator valve holes, returns into suction passageway of the gear pump housing.

(c) The pressure regulator valve works upon a spring of precalibrated tension.

(d) This spring tension must be overcome by oil pressure working upon inside of regulator valve and thereby pushing valve downward against the spring tension before a spill off point of valve is reached. In performing this work, the fuel oil pressure build up in housing is approximately 100 to 140 lbs. at full speed.

(4) Pressure regulator valve sleeve H1 is for the purpose of acting as a guide for pressure regulator valve. The sleeve is pressed in housing to a predetermined depth for the purpose of obtaining spill off of regulator valve.

(5) Pressure chamber dome J, is for the purpose of preventing rapid pressure drop in assembly under sudden speed changes.

(a) The pressure dome is a steel tubing with a cap soldered on one end and threaded into gear pump housing.

(b) Whatever air is trapped in this chamber will be compressed by oil pressure rise and chamber will act as an accumulator or pressure retainer for rapid speed changes.

(6) Fuel supply check valve screen K, is to prevent any abrasives from entering into distributor disk assembly. The screen is of 200 mesh gauge and soldered in the fuel supply chamber housing.

(7) Fuel supply chamber check valve L, is for the purpose of retaining fuel oil in line leading to the distributor disk assembly when unit is inoperative. It also acts as a safety pressure valve for distributor disk lubrication.

(a) The check valve assembly consists of a check valve guide, spring and check valve cup, enclosed in a housing.

(b) The lower valve cup seats on the fuel supply screen housing.

(c) Spring tension holds this valve against its seat.

(d) The check valve guide acts as a spring retainer and valve guide. The guide prevents check valve from opening an excessive amount and jamming in assembly.

(e) Fuel pressure will work against closed spring loaded valve. Pressure must build up to approximately 50 lbs. before valve will open fully.

(f) A minimum pressure of 50 lbs. must be maintained between disks for proper lubrication.

(g) In the event of excessive wear in gear pump, pressure will not build up beyond 50 lbs., fuel supply check valve will close and prevent a transfer of oil to metering pump. The engine will automatically stop, due to lack of fuel and will not operate until repairs have been made to increase fuel oil pressure.

(h) If the check valve assembly is removed and unit operated with less than 50 lbs. oil pressure, disk scoring will occur from lack of sufficient pressure lubrication.

(i) Fuel oil flow through this valve is as follows: Fuel pressure forces fuel supply valve off its seat and the fuel flows under edge of valve. Fuel then flows up and into the side holes of valve guide up through inside of the valve to emergency shut valve by way of the hole drilled in center of check valve guide.

(8) Emergency shut off valve M, is for the purpose of manually closing the fuel supply from gear pump assembly to metering pump. In the event engine should refuse to stop in a normal manner or overspeed, the valve can be manually closed, shutting off fuel supply and preventing damage. Valve is ground to assure an airtight fit and has a stop provision.

(9) The action of No. 1 and No. 2 gear pump assemblies as a unit is as follows:

(a) Fuel is drawn from fuel tank and through the primary filter by action of gears in No. 1 gear pump housing. No. 1 gear pump also forces the fuel through the secondary filter. Fuel flows up through suction passageway of housing and around pockets of gear teeth, then discharges into float chamber. Excess fuel is returned to suction passage by action of bypass valve.

(b) No. 2 gear pump draws fuel from float chamber assembly through suction tube E,

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past ball check valve F, to suction side of gear pump. On discharge side of gear pump pressure will be built up by action of the pressure regulator valve. Spill off from this valve will return to suction side of gear pump. Due to action of pressure regulator valve, pressure will build up from 80 to 140 lbs., regardless of speed. This pressure will be sufficient to lubricate and transfer oil through disk transfer holes to the metering pump.

l. Float Chamber Assembly. This assembly is for the purpose of maintaining a constant supply of fuel oil, free of air, for the use of No. 2 gear pump assembly.

(1) The float chamber assembly consists of a small supply chamber with a suction tube cast integral with the chamber casting.

(2) A cover is provided for the float chamber which supports the float D, through float lever arm to a float lever hanger and float needle valve.

(3) The float needle valve seat and seat gasket are threaded in float chamber cover.

(4) The float cover is provided with a gasket and bolted to the float chamber.

(5) The float assembly is provided with a gasket and is actually bolted to the bottom of fuel pump housing proper; cored passageways lead to gear pump assembly.

(6) The float cover, upon examination, will have numerous holes, the purpose of each is as follows:

(a) The two holes on outside edge are for 5/16" cap screws.

(b) The smallest hole on outside edge adjoining cap screw hole is suction passage for No. 2 gear pump assembly.

(c) The large hole in the center of cover is fuel inlet passage from No. 1 gear pump discharge.

(d) The one large hole adjacent to the center hole is for fuel oil drain from fuel pump main housing and injector return lines.

(e) The remaining large hole is for air vent purposes of float chamber, allowing free flow of fuel into float chamber.

40. OPERATION OF COMPLETE FUEL PUMP ASSEMBLY.

a. Priming Fuel Flow. The fuel pump and injector assemblies must be primed in order to obtain satisfactory operation of engine.

(1) Inspection of the fuel pump, will show a brass fitting connection at the bottom side of the fuel pump housing. This connection has two openings, the larger opening is made by flexible tubing, direct to the fuel supply, through a suitable filter, the smaller opening connects with the suction side of the priming pump.

(2) The discharge line of priming pump is connected to No. 2 gear pump assembly fitting I. With these three connections, it is now possible to prime fuel pump and injector assemblies.

(3) On suction stroke of priming pump fuel oil will be drawn directly from fuel tank, passing through the primary filter.

(4) On discharge stroke of priming pump, fuel will flow into fitting I, of No. 2 gear pump assembly, across top passage into fuel supply screen K, check valve assembly L, and emergency shut-off valve M, through feed line to disks.

(5) With priming valve P open, fuel will then flow through tubing into lower passage N2 of distributor disk housing, across and into metering pump chamber. From this point the disk transfer hole alignment will present free passage to injector assembly for priming.

b. Normal Fuel Flow. After unit has been primed and fuel pump priming valve has been closed, operation of fuel pump is as follows:

(1) Suction created by No. 1 fuel pump draws fuel oil from a tank and delivers it to the primary filter and then to the float chamber assembly. Excess fuel is bypassed back to suction side of gear pump, by closing of float needle valve C, and the automatic opening of bypass valve B. The No. 1 fuel pump also forces fuel oil through the secondary filter.

(2) Suction created by No. 2 gear pump draws fuel oil from float chamber assembly through passage E, up to and past ball check F, and around gear teeth. At discharge of gears, fuel opens pyramid check valve G, and flows across the pressure regulator valve F, forcing valve downward against pressure regulator valve spring, located directly below

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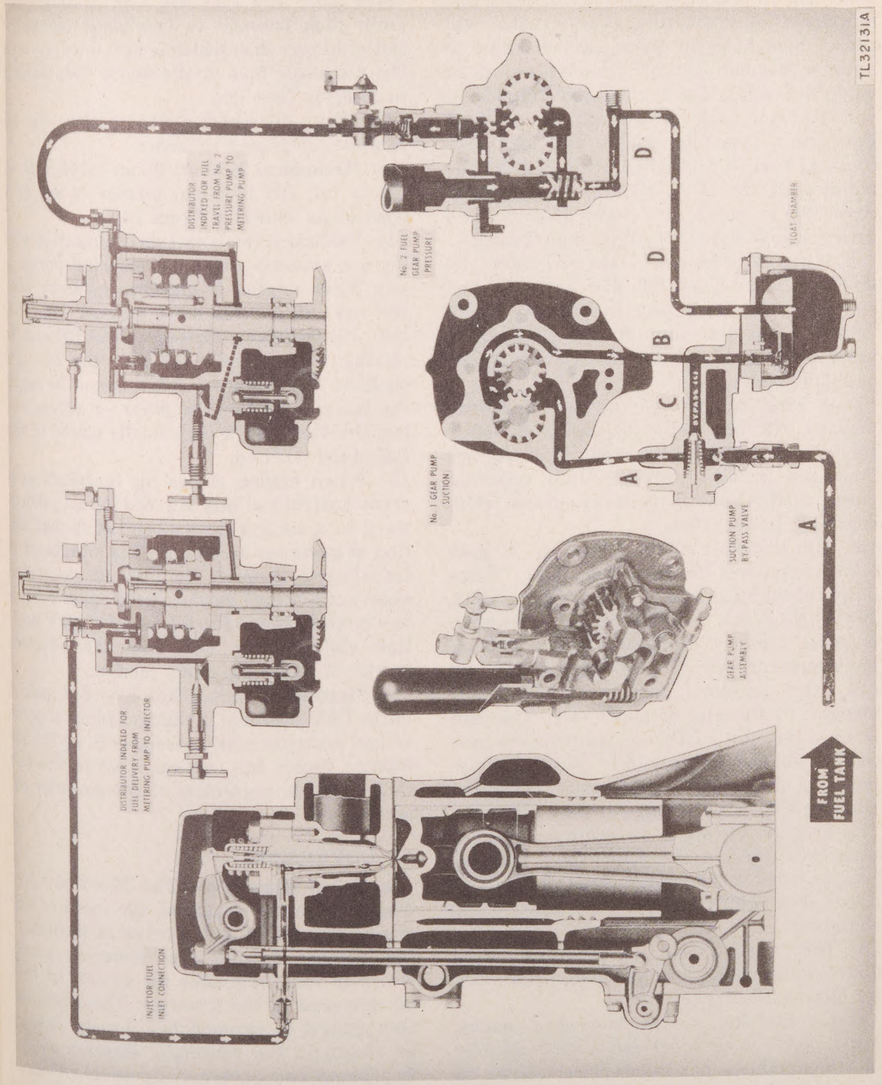

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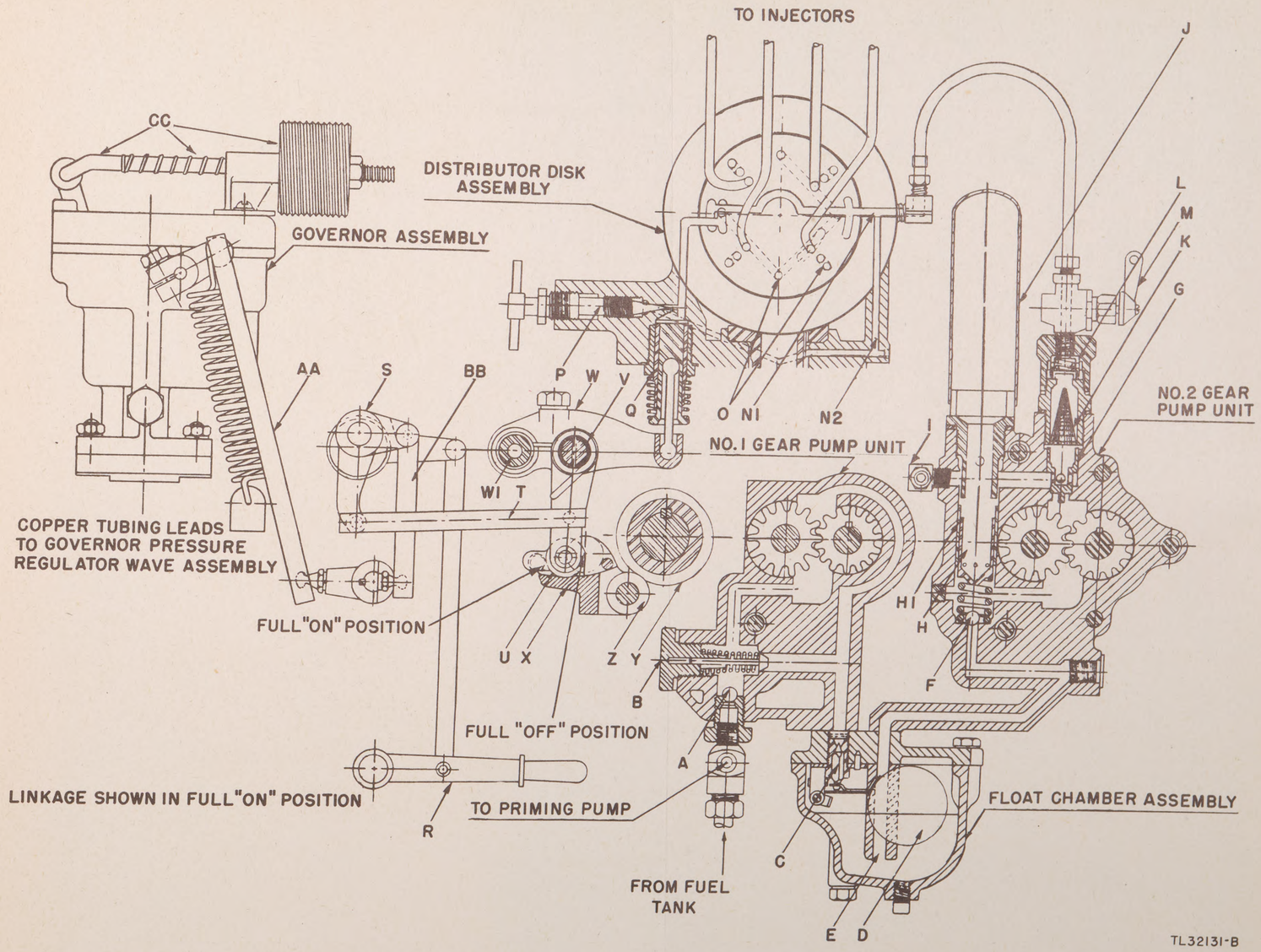

Figure 14. Fuel flow diagram and fuel pump schematic.

valve. As oil pressure is increased, continued movement of pressure regulator valve will cause small holes in lower part of valve to uncover beyond end of pressure regulator valve sleeve H1. The fuel oil under pressure will then spill back into suction side of No. 2 gear pump assembly, and in this manner a constant fuel oil pressure feed to disk will be maintained. The fuel oil pressure gauge is connected in series with priming pump from fitting I, and shows pressures maintained.

(3) When a pressure of approximately 50 lbs. is reached fuel will flow through fuel supply screen K, lifting fuel supply check valve L, and flow through emergency stop valve M, into distributor disks and housing assembly passages.

(4) A small amount of fuel will flow into passage N2, for the lubrication of lower thrust bushing and drive shaft. Fuel will not flow past priming valve P, into metering pump, as this passage is always closed when engine is in operation.

(5) The transfer of fuel from No. 2 gear pump assembly to metering pump takes place through passage N1, across upper disk.

(6) Fuel oil flow from gear pump assembly, is under pressure of 80 to 140 lbs. This oil under pressure will flow into passage N1, and can exert pressure on lower disk of first elongated outer slot of upper disk. This slot is not a medium for fuel oil transfer. Its purpose is for lubrication and to counterbalance lower disk pressure of opposite elongated transfer slot on outer edge of upper disk.

(7) Transfer of fuel to metering pump takes place when one of the double hole transfer jumper holes O, line up with transfer slots of upper disk which leads to metering pump chamber.

(8) The indexing of the holes as stated above, takes place when metering pump is on its downward stroke.

(9) By the end of its downward stroke, lower disk has revolved and a new indexing of transfer holes has taken place (shown on fig. 14).

(10) The discharge stroke of the metering pump forces fuel out of same passage that fuel entered and into new transfer hole of lower disk. One of the single holes O, of the lower disk is now lined up with inner slot of upper disk and fuel will flow through the lower disk passage to innermost elongated slot of blower disk which is now lined up with the discharge hole of the upper disk leading to injector feed line.

(11) This distribution takes place to all cylinders in proper sequence.

c. Mechanical Motion. When throttle R, is set in full ON position, linkage is set in a position as shown in figure 14.

(1) Vertical lever is in full ON position giving a maximum stroke to metering pump.

(2) When engine is started, governor control rod link AA will move upward. This motion will be relayed through links BB and T, placing vertical lever roller in the full ON position. Vertical lever roller cannot be set in the full ON position, by governor action, unless throttle lever R is manually placed in the full speed position.

(3) When engine comes up to speed, governor control rod link AA counteracts downward to a setting determined by fly-ball action in governor assembly. This movement is transferred through its linkage, as stated above, and brings vertical lever roller setting to a point between full ON and full OFF position and thereby decreases the effective stroke of metering pump plunger.

d. Stopping of Unit. When lever R, is placed in the OFF position, it changes fulcrum point of fuel pump eccentric assembly S, and by its linkage forces the vertical lever to the full OFF position, regardless of the governor reaction.

41. GOVERNOR.

a. Speed Regulation. The Woodward hydraulic governor regulates the speed of the engine by controlling the travel of the metering plunger in the fuel metering pump, which in turn, regulates the amount of fuel oil delivered to the injectors. The control of this plunger is accomplished through linkage as shown in the schematic diagram of the fuel pump and governor, figure 14. A schematic diagram of the governor is shown in figure 15.

b. Principal Parts. The principal parts of the governor are:

(1) A speed measuring element, generally called the governor head.

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(2) A power piston which when acted upon by the governor head, performs the work of changing the amount of fuel oil supplied to the injectors.
(3) A stabilizing element that prevents surge of the engine.

c. Integral Gear Pump. An integral gear pump incorporated in the assembly supplies the hydraulic feature by creating pressure on the oil drawn from the sump. The pressure created by the gear pump is maintained by a relief valve which allows surplus oil to be bypassed back to the suction passage. A pilot valve controls the admission of oil to the power piston. The action of the pilot valve plunger is controlled by the centrifugal force of flyweights reacting against the speeder spring which may be manually adjusted. If the engine speed drops below that corresponding to the tension setting of the speeder spring, the flyweights fall inward and lower the pilot valve plunger. This allows oil to be admitted to the piston chamber which raises the piston and so, through linkage, increases the fuel oil travel of the metering pump plunger, thus increasing the fuel supply to the engine. If the engine speed increases over the governed setting, the flyweights move outward and raise the pilot valve plunger. This cuts off the fuel oil supply to the piston chamber. The power piston drops and the fuel oil supply is reduced until the engine has again arrived at the set RPM. Under balanced conditions the pilot valve allows a sufficient amount of oil in the piston chamber to maintain the piston in a given position and to provide for leakage.

d. Speed Droop Adjustment. Speed droop adjustment is obtained by changing the position of the slider shown in figure 15. This is done by loosening the machine screw which holds it in place. Its position controls or limits the movement of the floating lever, the movement of which regulates the engine speed. The droop range of the slider adjustment is from 1½ percent to 7 percent. The correct setting results in a droop of 3 percent.

e. Oil Supply. The governor is provided with an oil supply, for operation and lubrica-

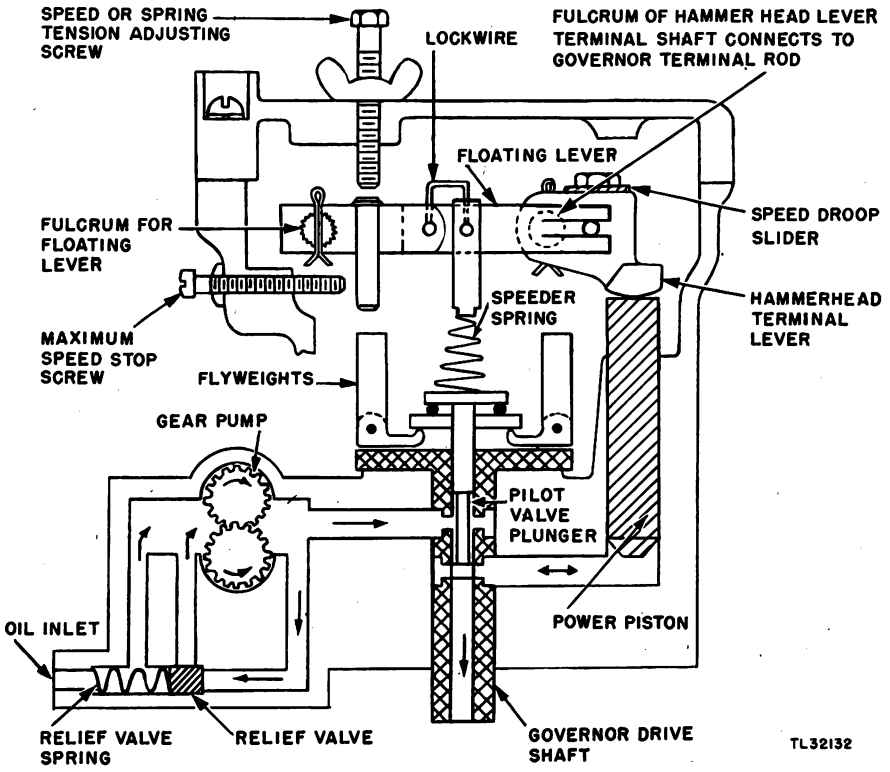

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Figure 15. Governor schematic.

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tion, independent of the engine lubricating system.

42. PREHEATER.

a. Preheating. In order to facilitate starting the engine, if it is operated in a cold location, a preheater or flame thrower is provided in the intake manifold. Preheating is accomplished by forcing fuel oil through an atomizing nozzle and across a continuous electric spark, into the air intake stream. A manually operated pump on the engine instrument panel supplies the pressure to force the fuel oil through the nozzle. A small check valve in the system aids in maintaining the pressure.

b. Spark Coil. A 24-volt vibrator type spark coil produces the high voltage necessary to jump the spark across an adjustable gap in front of the nozzle.

c. Pressure Switch. A pressure switch on the nozzle housing operates to make or break the primary circuit of the coil.

43. VOLTAGE REGULATOR.

a. Function. The voltage regulator is a Burlington, type GL-1. Its function is to automatically regulate the voltage of the alternator.

b. Main Parts. The main parts consist of an alternating current coil with a fixed core, a vibrating type switch which cuts in or shorts out the exciter field rheostat, a rheostat to adjust the voltage on the regulator, and a polarity reverse switch.

c. Alternator Voltage. The alternator voltage is imposed across the regulator coil and series voltage dropping resistor. The series resistor decreases the voltage error due to frequency changes. The magnetism of the core which is varied by the current in the surrounding coil opens the contacts of the vibrator type switch. These contacts, when closed, short out the exciter field rheostat and when open, cut in the previously set resistance in the exciter field circuit. When the alternator voltage is normal, the contacts are in a position to alternately cut the exciter field rheostat into and out of the circuit; the a-c voltage being determined by the average resistance or the ratio of the time contacts are closed to the time they are opened. Since this floating core tends to follow the a-c voltage regulation, these contacts open and close 120 times per second. The regulator response to a given load change is therefore ½ cycle or 1/120 of a second.

d. Stationary Contact. The stationary contact is mounted on a light leaf spring which absorbs the rapid vibration of the moving contact and overcomes the clinging or bouncing which would result if no spring were used.

44. RADIO INTERFERENCE SUPPRESSION.

a. Controlling Static Electricity. Provision is made to control all static electricity, that may be collected in the component parts of the power unit, so that it may be dissipated to the ground.

(1) Grounding brushes of copper graphite, supported on special brackets bear on the exciter and the alternator shaft. The supporting brackets fastened to the frames of the alternator and the exciter, are held rigidly in place by bolts equipped with positive grounding contact washers. The washers are toothed to insure a perfect electrical contact with the frames. These washers and all those used in the static electricity control system, are the Illinois Tool Company's No. 40-IET, Internal, External, Shakeproof type and are rustproofed by plating. The grounding brushes are interchangeable, but will have to be shaped to the shafts.

(2) Electrical contact between the alternator frame and the engine is assured by using flexible, braided, copper straps. These are held in place by machine screws equipped with toothed washers.

(3) The exciter leads to the voltage regulator and to the exciter field rheostat are covered with a woven wire shielding which is grounded.

(4) The contact surface of the cover of the voltage regulator is tinned in spots to attain a positive grounding contact of these parts.

(5) Condensers, to suppress static voltage charges, are installed at critical points.

b. Details Regarding Equipment. Details regarding this equipment are covered in Section IV.

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Section IV
MAINTENANCE, OPERATION AND REPAIR

45. OPERATORS MAINTENANCE SCHEDULE.

a. Obtaining Satisfactory Operation. The following schedule must be adhered to in order to obtain satisfactory operation of the equipment:

b. Daily Schedule.

(1) Check lube oil level in oil pan and governor housing.
(2) Check water level in cooling system.
(3) Reverse polarity switch on voltage regulator.
(4) Turn handle on primary fuel oil filter.
(5) Read and record all instruments.
(6) Check that alarm and starting system is in working order and that horn and signal lights function.
(7) Wipe down generator set and switchboard.
(8) Change oil in air cleaners.

c. Weekly Schedule.

(1) Tighten engine, generator set, hold-down and foundation bolts.
(2) Grease engine water pump.
(3) Check and clean slip rings, commutator, and brushes.
(4) Clean generator.
(5) Make ground test on all electrical equipment.
(6) Check voltage regulator contacts.
(7) Clean switchboard.
(8) Check battery gravity and level of electrolyte.
(9) Check battery connections.
(10) Check engine starter and alarm circuit connections.
(11) Check for fuel, lube and water leaks.
(12) Renew crankcase oil every 200 hours and change filter bag in oil pan. This renewal of the crankcase oil is dependent upon climate and location. In dusty areas, oil should be changed more often.
(13) Drain water and sediment from fuel filters.

d. Monthly Schedule.

(1) Clean oil breather on crankcase.
(2) Clean out air passages in radiator and clean fan blades.
(3) Tighten all engine electrical connections.
(4) Check all switchboard terminal connections.
(5) Drain and renew oil in governor housing.
(6) Replace lubricating oil secondary filter element.
(7) Check voltage regulator contacts.
(8) Check coupling bolts.
(9) Clean battery terminals.
(10) Tighten water pump drive belts.
(11) Check and clean alarm switch contacts.
(12) Check overspeed stop. Overspeed engine to check that valve trips and shuts down engine.
(13) Adjust valve roller and injector settings.
(14) Oil starting motor, sparingly.

46. ADJUSTMENTS.

a. Instructions. The following instructions cover the adjustments necessary for maintaining the unit in an operating condition. By keeping the unit clean inside and out, a high percentage of the causes of poor engine performance may be eliminated. The complete power unit should be wiped down and polished daily. All fuel, oil, or water leaks must be attended to immediately.

b. Determining Cause of Failure. If unusual noise or vibration develops in the engine at any time, the cause of failure should be determined by removing the load from the unit, and consulting the methods for diagnosing troubles as outlined in paragraph 57.

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47. LUBRICATION SYSTEM.

a. Lube Oil Level. Before starting the engine each day and after shutting it down, check the oil level with the dip stick. This stick is marked for the operating level. If the engine is running the oil level should come to the H line. Add oil when necessary to maintain this level. During continuous operation of the engine, check the oil level and pressure two or three times a day. If the oil level is at the low mark on the dip stick, lube oil must be added immediately. The engine oil capacity is sufficient for 200 hours of operation. Full capacity should be maintained at all times.

b. Changing Oil. The oil in the engine should be changed every 200 working hours. Check the oil level and the consistency of the oil daily in order to be sure that no serious dilution is occurring from fuel oil contamination. Renew the crankcase oil when serious dilution (thinning of oil) is found. When this is done, it is also necessary to renew the filter bag in the filter compartment of the oil pan. (See par. 46c.) If the lubricating oil pressure drops below 25 pounds at full speed, check the condition of the lubricating oil. If new oil does not raise the pressure, it is an indication either that the bearings are worn and in need of adjustment, or that suction lines are leaking between the lubricating oil pump and the oil pan.

c. Lubricating Oil Filters. The lubricating oil filters are placed in the system for the purpose of removing contaminations from the lubricating oil. Proper periodic servicing of the filters will improve the performance of the engine. The formation of carbon and sludge in the oil passages will, if neglected, restrict the oil flow to such a degree that bearing surfaces will become etched and overheated, causing serious damage.

d. Primary Filter Element. The primary filter is a replaceable cloth bag filter located in the rear section of the oil pan (fig. 8). The oil drawn from the oil pan is discharged by the oil pump into and through the primary filter before it is circulated through the engine. A safety ball check is incorporated in the filter housing for bypassing the oil around the element when the filter becomes clogged.

e. Changing Primary Lube Oil Filter. Change the primary oil filter every 200 hours, equivalent to every time the engine crankcase oil is changed.

(1) Remove the drain plug from the filter housing cover and drain the oil from the filter compartment.

NOTE: If the engine crankcase is badly sludged with gummy oil residue, it is recommended that the old oil be drained from the crankcase and filters when they are hot. Insert flushing oil or fuel oil in the crankcase to wash out sludge from the oil passages in the engine. When flushing out the engine, leave the old filter elements intact and remove after the flushing process has been completed.

(2) Fill the oil pan with ten gallons of fuel oil and run the engine for five minutes at slow speed. Install new primary and secondary filters.

(3) Redrain the oil pan and the filter compartment and remove the filter cover by removing the nuts which hold it in place.

(4) To change the filter bag, proceed as follows (fig. 16): After the cover is removed, pull out the entire filter element. Unroll the bag and remove it from the spool. To remove the bag from the spool, unscrew the flat nuts on the two clamp screws. Depress the clamp screws and turn them one-fourth turn; i.e., the pins in the clamp screws will stand across the spool. When this is done, the bag with its clamp bar can be pulled off readily. Remove the clamp bar and insert the new bag on the clamp bar so that the lips of the bag may be rolled over the clamp bar. Place the clamp bar with the bag on the spool, depress the clamp screws and turn them back one-fourth turn so that the pins point parallel with the axis of the spool. Tighten the flat clamp nuts, being sure that the clamp screws do not turn or twist when doing so, as this would have a tendency to cut the bag. Place the spacing mat on the bag and roll on the spool with a spacing mat rolling inside next to the spool. With the filter element properly rolled up, place it in the filter housing, being sure that the conical spring on the end of the filter, which holds the entire filter firmly in place, is properly attached to the filter element. Replace the cover, making sure that the cover and the copper gasket in the recess are clean and in good condition.

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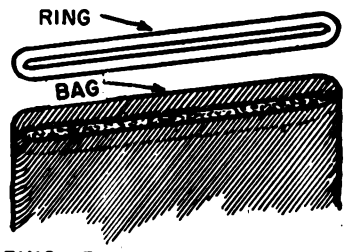
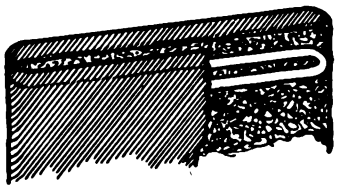
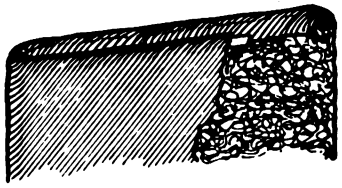


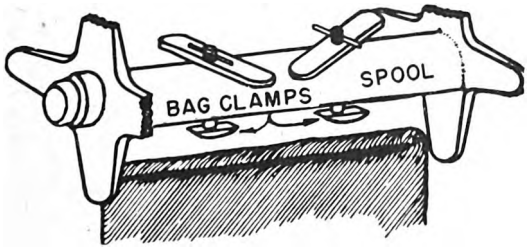
BAG & RING READY FOR ASSEMBLING



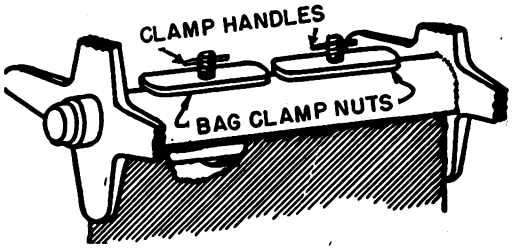
PLACE RING INSIDE OF BAG



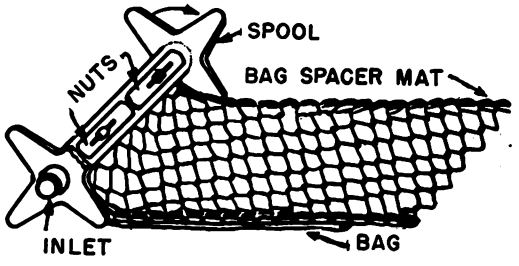
FOLD TOP OF BAG INWARD OVER RING ABOUT 1/2" STARTING WITH THE ENDS AND THEN THE SIDES.



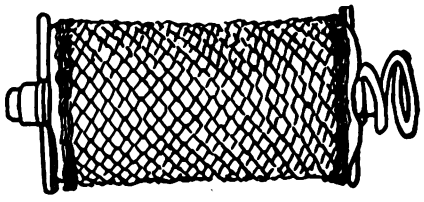
BEFORE APPLYING BAG TO SPOOL TURN BAG-CLAMPS LENGTHWISE SO THAT THEY WILL ENTER BAG OPENING



HOLD BAG FIRMLY AGAINTS POOL & GIVE 1/4 TURN TO BAG CLAMP HANDLES WHICH BRINGS THEM INTO LENGTHWISE POSITION. HOLDS HANDLES THUS WHILE TURNING BAG CLAMP NUTS TO A HAND TIGHT LENGTHWISE POSITION.



WITH INLET END FACING YOU, PLACE SPOOL WITH BAG ON A CLEAN FLAT SURFACE, THEN LAY BAG SPACER MAT ON BAG MAKING SURE THEY ARE FLAT & THAT THE LEFT END OF THE MAT COMES UP CLOSE TO THE SPOOL. THEN ROLL MAT WITH BAG AROUND SPOOL CLOCKWISE.



ASSEMBLED FILTERING ELEMENT READY TO INSERT INTO SHELL.

TL32133

Figure 16. Changing primary lube oil filter bag.

Tighten the nuts evenly, so that no leak will occur at this cover. Make sure that the lock washer under the nuts is not left off.

CAUTION: The bags in this filter are made of specially treated material, and only bags made of this material should be used.

f. Changing Secondary Lube Oil Filter. The secondary filter is a cotton-waste-type cartridge replaceable element. The filter receives oil under pressure and allows a steady flow of oil which drains into the oil pan without reducing the oil pressure within the engine (fig. 17). Remove the filter cover by turning the handle at the top counterclockwise until the threads disengage. Remove the drain plug to drain the accumulation in the sump. Pull out the dirty cartridge by the wire handle. Insert the new cartridge and replace the drain plug. Check the top gasket carefully and if doubtful, replace with a new

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gasket. With the filter completely assembled, check for leakage by running the engine until the filter is warm.

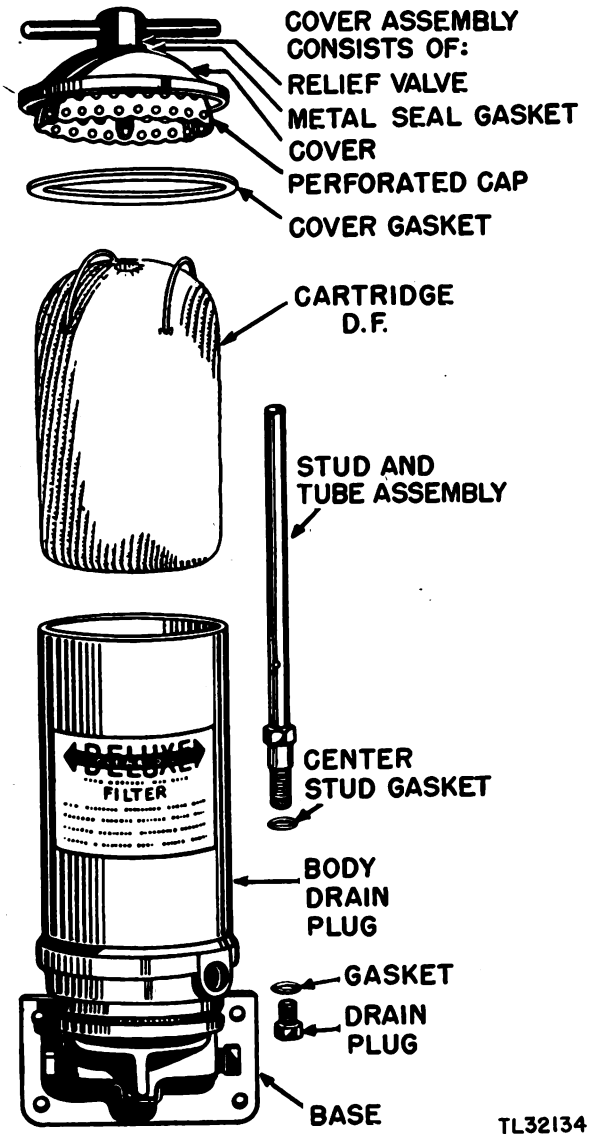

Figure 17. Changing secondary lube oil filter element.

g. Causes for Poor Oil Filtering. If the oil being filtered does not clean up or filter fast enough, check the following:

(1) The primary filter bypass valve may leak.

(2) There may be a leak under the oval bag ring or a hole in the bag.

(3) The bag may need changing.

(4) The bag spool may not seat properly in the cover.

CAUTION: Do not attempt to clean an old filter bag or cartridge element. Replace with a new one. Whenever a new bag or element is installed, put one additional gallon of lubricating oil into the crankcase, as each filter housing contains one gallon of oil.

h. Care of Lube Oil Cooler and Bypass Valve.

(1) Remove the lube oil cooler and flush it out with fuel oil once a year. This may have to be done more frequently depending on the condition of lube oil. The need for flushing will be made known by increasing lube oil temperatures from day to day.

(2) The bypass valve, which protects the lube oil cooler if stoppage of oil through cooler should occur, is located back of the lubricating oil pump on the fuel pump side of the engine. Remove this valve every six months, clean thoroughly and reinstall. Do not change the spring adjustment of the relief valve. This valve is set for 15 pounds pressure.

48. COOLING SYSTEM.

a. Checking the System. Lift the radiator cap once a day and check to see that the cooling system is full. Add soft clean water as needed to restore the level to the top. Excess water overflows through the drain pipe.

CAUTION: Never use kersosene for cooling purposes as it will cut the rubber from the hose and clog the water passages.

b. Water Pump Drive Belts. The unit is driven by two V-type belts. The belt adjustment is obtained by eccentric mounting of the pump assembly. To tighten the belt, loosen the cap screws holding the pump clamp ring. These clamp screws should be loosened only enough to permit the pump to turn on the eccentric, or the assembly will bind, causing the pump to break when it is retightened. The unit may be turned until the desired belt tension is obtained and the clamp ring tightened. Fan belt slippage and heating may result unless these belts are tight.

NOTE: Because of rust conditions within the block and water pump casting, the pump may bind and refuse to turn. Tapping on the pulley with a rubber mallet will loosen rust and binding. Do not force the pump.

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c. Water Manifold Thermostats. Three thermostats control the temperature of the cooling system. Two thermostats are located in the discharge housing which leads to the radiator. A bypass thermostat is located in the bypass housing at the front end of the water manifold (fig. 8). The bypass thermostat is normally open until operating temperature is reached. At this point the manifold thermostats open and the bypass closes. In the event that overheating of the engine occurs, the thermostats should be removed, cleaned and inspected for damage. They may be tested for point of opening by placing them in a container of water, with a thermometer, heating the water to 160 degrees Fahrenheit at which point the thermostats should start to open and should attain full opening at 170 degrees. If operation is unsatisfactory they should be replaced as no adjustment is possible. If the results of the test are satisfactory reinstall the thermostats in the housing and note whether binding exists when opening and closing the valves.

49. AIR INTAKE SYSTEM.

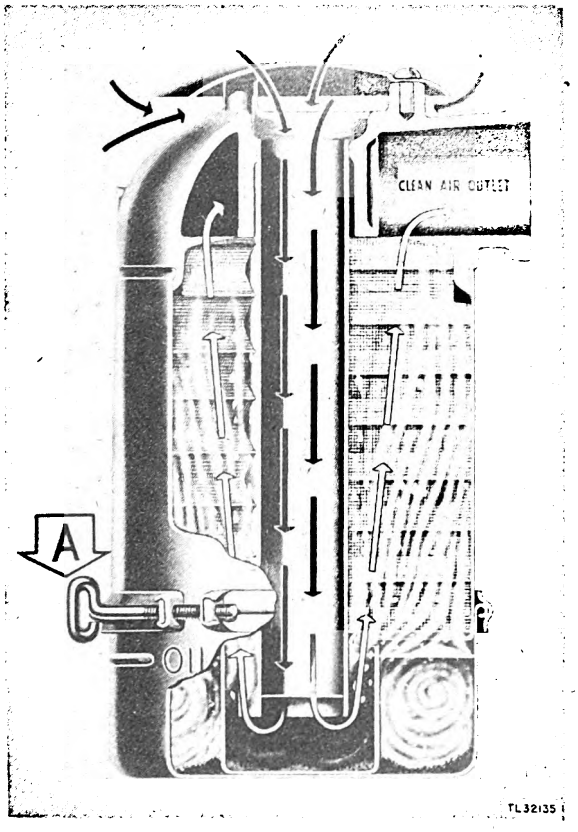
a. Air Filters. Two air filters are provided on the engine to remove the dust and dirt which would otherwise be pulled into the engine and increase cylinder wear by their abrasive action (fig. 9). Keep the filters clean. If allowed to clog up with dirt, insufficient air will pass into the combustion chamber to support combustion of the injected fuel.

CAUTION: Never run the engine with the air cleaner disconnected. Never run the engine with the air stopped up.

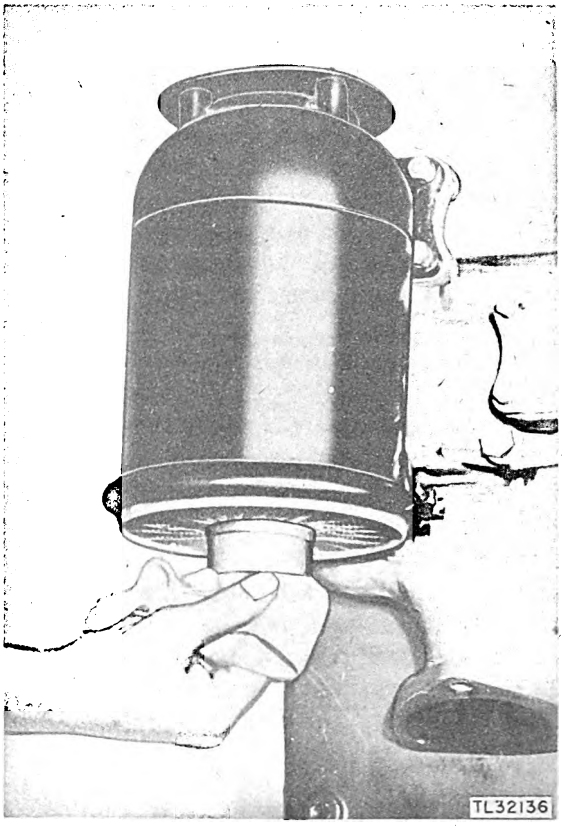
b. Cleaning the Filter. To clean the air filter, proceed as follows:

(1) Remove the lower oil cup by loosening the wing nuts, or the clamp screw A, as shown in figure 18, which holds the cup in place on the lower part of the cleaner. Empty the oil from the cup and wash thoroughly with clean fuel oil or kerosene.

(2) Wash the inside of the air inlet tube with a clean rag or brush and cleaning fluid (fig. 18). If this is neglected, dirt will gradually collect on the inside of the tube and pre-



TL-32135
Figure 18. Cross section of air cleaner.



TL-32136
Figure 19. Air cleaner servicing.

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vent the passage of a sufficient quantity of air for proper combustion and good engine performance.

(3) Fill the oil cup to the level bead indicated on its side with clean fresh oil and assemble the cleaner.

(4) Clean the screens inside the body of the cleaner after every 1,000 hours of operation. Remove the entire cleaner from the engine. When it has been disassembled for cleaning, flush the inside of the cleaner body with fuel oil or equivalent.

(5) After thorough flushing, blow the screens out well with compressed air. When the cleaner is replaced on the engine, be sure that all connections are air tight.

50. EXHAUST SYSTEM.

a. Spark-Arrestor-Type Silencer. The spark-arrestor-type silencer is designed for vertical or horizontal installation. A tail pipe if desired, can be installed on the outlet end to obtain the additional silencing.

b. Inspection and Cleaning. Inspect and clean the silencer periodically so that it will operate with the utmost efficiency at all times. Interior cleaning of the silencer probably will not be required more frequently than once or twice a year unless the engine is operated continuously, or if the carbon deposits are oily. To clean the interior of the silencer, remove all hand-hole covers and scrape out accumulated carbon.

CAUTION: If any connections in the exhaust system are broken be sure that all joints are tight when reassembling. This is important as any carbon monoxide contained in the exhaust gases is a deadly poison.

51. STARTING SYSTEM.

a. Starting Motor. The care and operation of the starting motor for the diesel engine cannot be too highly stressed. Every precaution must be taken that it is in working condition. The load demand on these motors is 100 percent greater than on motors used on conventional gasoline engines. Check the following:

(1) Check and inspect the battery voltages and the circuit terminal connections daily.

(2) Put two or three drops of clean lubricating oil in each oil cup about every one hundred times the engine is cranked. If the bearings appear to run dry before one hundred crankings, lubricate more often.

b. Brush Spring Position. Observe and mark the notch used when new. As the brush wears, it is advisable to tighten the spring end one or two more notches. Remove the brush opening band and observe the brushes when the motor is cranking the engine. If there is destructive arcing between the brushes and the commutator, increase the spring pressure by moving the spring end one or more notches. If insufficient spring pressure causes destructive arcing and the solder is melted from the commutator risers due to the intense heat of the arcing, it may be necessary to resurface the commutator. Replace the springs or holders if the springs become weak from intense heat.

c. Brush-Dust and Dirt. At regular periods, blow brush-dust and -dirt out of the motor, especially at the commutator end, with dry compressed air or hand bellows, in order to prevent short circuits, grounding, and sticking brushes. To take worn brush out of the holder, lift up the lever to relieve spring pressure. The brush can then be removed. Do NOT pull on the brush pigtail against spring pressure. Do NOT snap the lever down on the brush. Inspect brushes regularly and replace when too short. Grind in new brushes with No. 00 (fine) sandpaper, never emery. Clean the commutator with No. 00 sandpaper when replacing brushes. Brushes must move freely in holders to avoid sticking. If brushes are caked with any substance, remove with fine sandpaper laid on a flat surface. Clean brush holders.

d. Motor Commutator. If the commutator becomes slightly rough or coated, clean it while rotating with No. 00 (fine) sandpaper held against it by means of a flat piece of wood or fiber, not metal. DO NOT USE EMERY on the commutator at any time. If the commutator is too rough or out of round, it should be resurfaced. After resurfacing, undercut the mica between the copper segments to the full width of the mica and as deep as its thickness.

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52. FLAME THROWER INSPECTION AND REPAIRS (fig. 20).

a. Inspection. The flame thrower will not require periodic inspection unless it is constantly used in cold climates. For determining if flame thrower operates, remove the inspection plug, in the lower part of the flame thrower housing and operate its pump. A good flame should be visible. If no flame is visible, inspect the nozzle and strainer to see that they have not become plugged with dirt. It is highly important to remember that so long as a flame is burning in the manifold, the engine will not start. This is due to the fact that the flame burns up the available supply of oxygen that is necessary to fire the engine. For this reason, continue to crank the engine after ceasing to operate the flame thrower pump.

WARNING: DO NOT PUT FACE NEAR INSPECTION HOLE.

b. Checking the Electrodes. Check the electrodes. They may be carboned to the extent that a good spark is not present when the circuit is made. Measure the gap between the electrodes. The adjustable electrode may have come loose and increased the gap too much for a spark to jump. The correct gap is 0.094" plus or minus 0.015". Make sure all wiring connections are clean and tight. If adjustments do not restore proper operation, replacement of electrodes, coil, or pressure switch may be required.

53. GOVERNOR.

a. Type. The governor is of the hydraulic type, using lubricating oil under pressure as an energy medium.

b. Oil Supply. The governor is provided with an independent oil supply to prevent the entrance of sludge from the engine lube oil system. A small sump for the governor oil supply has been cast as part of the fuel pump body (fig. 3). A glass window is provided to show the oil level. Oil from this sump is drawn into the governor gear pump through a 5/16-inch copper supply line. There is a check valve at the lowest point of this line to prevent the oil from draining back into the sump from the governor gear pump. A ¼-inch copper vent line is also provided to prevent pressure build-up in the governor housing. This line vents into the engine crankcase.

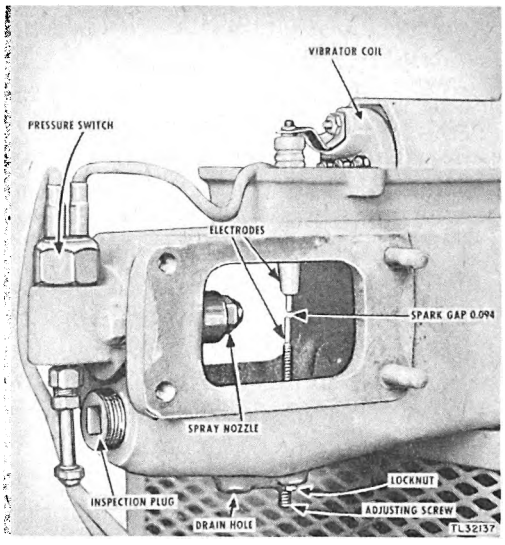

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Figure 20. Flame thrower.

c. Oil Change. Change the oil in the sump after every 30 days of continuous operation. To drain the oil, remove the ⅛-inch pipe plug located on the right-hand side of the sump at the rear lower corner. After draining, replace the plug and refill the sump until the oil level reaches the center of the glass window. Use the same grade of oil as that used in the engine lube oil system.

54. GENERATOR.

a. Lubrication. The major point of maintenance on the generator is lubrication. Lubricate periodically, depending on the degree of service and the temperature. In summer temperatures, check the lubrication once a month. In winter temperatures, every two or three months is sufficient. In all cases it is sufficient to take the plug out of the generator bearing, on the opposite side from grease cup, screw the grease cup down one full turn and allow the equipment to run for one hour to see that excess grease flows out of the opening made by the removal of the plug opposite the grease fitting. The exciter bearing is similarly lubricated with its grease cup. Inspection can be made by removing the rear housing cover.

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b. Brushes, Commutator, and Slip Rings. Use no grease or lubricant on the brushes or the commutator. The commutator and slip ring surface should always be clean and well polished, but they should require only occasional cleaning under normal conditions. Clean them with a piece of canvas or similar hard-woven non-linting material. A roughened commutator or slip ring may need to be polished with a sandstone hone fitted to the curvature. If this is not available, No. 0 sandpaper, followed by No. 4/0, may be used by pressing it against the commutator or slip ring with a block of wood having the same curvature. All of the brushes should be lifted and the commutator or slip ring should be run at full speed while the polishing block is moved slowly back and forth along the surface parallel to the shaft. All grit should be carefully wiped off before the brushes are lowered. NEVER USE EMERY OR CARBORUNDUM CLOTH on a commutator or brushes. Make sure that the brush yoke in the exciter is rigidly locked in its proper position. It is absolutely necessary that the brushes be equally spaced around the commutator. The correctness of the brush setting cannot be judged from the position of the brushes with respect to the pole pieces as this depends upon the exact form of the leads of the armature coils. However, the brushes should be approximately opposite the centers of the main field poles. Each machine has its brushes set, and the brush yoke is locked in the proper position. Do not change this position.

c. Causes of Sparking. Under normal conditions of operation there should be no sparking at the brushes. Injurious sparking should never be permitted to continue. The causes of sparking are:

(1) Brushes not set at the proper place.
(2) Brushes not having proper pressure.
(3) Some brushes having excessive pressure, thus taking more than their share of the current.
(4) Brushes being burned at contact surface due to excessive overloads.
(5) Rough commutator or slip ring.
(6) Loose, high, or low commutator bar, or high mica.
(7) Dirty or oily commutator or slip ring.
(8) Loose connection between the armature conductors and the commutator bars or slip ring or an open circuit in the armature winding.
(9) Short or worn brushes.

d. Causes of Overheating Commutator. Overheating of the commutator or slip rings may be caused by overloads, excessive brush pressure, or excessive sparking. Red hot brush tips may be caused by particles of copper imbedded in the contact surface of the carbon. Such particles should be removed, and the brush refitted with fine sandpaper.

e. Replacing Brushes. When ordering new brushes, give the serial number of the generator, which is stamped on the nameplate, and the size and number of brushes required. Keep a spare set of brushes on hand. After placing new brushes in the holders, carefully fit the rubbing or contact surface of the brushes to the curvature of the commutator or slip ring by means of strips of flintpaper or sandpaper, first using No. 1 and then a finer grade, such as No. 00. NEVER use emery or carborundum cloth or paper. Cut the sandpaper into strips slightly wider than one brush. Insert a strip under a brush with the smooth side of the paper next to the commutator or slip ring and draw the strip back and forth around the commutator or slip ring in the manner of a slipping belt. The final sanding in of the brush should be made by drawing the sandpaper under the brush in the direction of rotation of the commutator or slip ring. On the return stroke the brush should be lifted. This will prevent a rounded brush which is caused by the brush being loose in the holder. Blow out all carbon dust, wipe off the contact surfaces, the connections, and the carbon brushes. If, after polishing the rings with sandpaper, it is detected that they are running out of true, it may be necessary to remove the rotor and turn the rings in a lathe so that they run concentric with the shaft. If this is not done when the rings are running out, trouble will be caused by sparking, and the consequent burning of slip rings and brushes.

f. Arrangement of the Exciter Brushes. The exciter brushes are so arranged that those on a positive stud are staggered with relation to those on the opposite positive

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stud, and those on a negative stud are staggered with relation to those on the other negative stud. This arrangement must be maintained to avoid the wearing of ridges on the commutator. The brush-holder springs should be so adjusted that all brushes will have the same pressure.

g. Inspection and Fitting the Contact. Examine the contact that the brushes make after a short period of operation and continue this inspection and fitting until a thoroughly good contact of the full surface of the brush is obtained.

h. Checking and Cleaning. The brush holders, brushes, and springs should be checked at least twice a week to see that the spring tension is correct, that the brushes are free in the holders, and that the brushes are of sufficient length to bear properly on the commutator or slip rings. Clean the generator at least once each week. All protective covers should be removed from the generator and any accumulation of dust and dirt removed, using an air hose if air is available. If not, use a rag to wipe it out.

55. FUEL OIL PIPING.

a. Checking for Leakage. Check and tighten all fuel lines for leakage. Do not make any changes of any fuel lines from the original installation.

b. Prevention of Dirt in Fuel Tank. When filling the fuel tank, use caution to prevent dirt, water, or lint from entering the tank. If any fuel line connections are removed from the pump, clean them before reinstalling to prevent any dirt from entering the pump.

56. CARE OF FUEL STRAINERS.

a. Primary Filter. It is necessary to drain the sediment and water from the fuel strainer frequently (fig. 10). If this water is allowed to remain in the strainer, it collects on the filtering element and prevents the fuel from passing through. In cold weather this water will freeze, shutting off all fuel entering the engine. If the fuel lines have any low points and the engine is allowed to remain idle for a short period of time, any water in the lines will run to the low spot and freeze in cold weather. This will cause the pressure on the pump to drop and the engine will stop. Be sure that all connections on tanks and strainers are tight. The primary fuel oil filter is easily maintained by turning the handle at the top one turn per day. After six months, the entire unit must be removed and taken apart by removing the cover bolts and gasket. The element should be removed from case and blown out with air. If air is not available, a stiff brush with fuel oil may be used to remove any accumulation of dirt. The container should be wiped dry. The plug should be removed from the bottom of the container before wiping.

NOTE: Reprime the fuel lines to the discharge side of the priming pump fitting whenever fuel lines or filters are drained.

b. Secondary Fuel Filter. When 5000 gallons of fuel have passed through the filter, it is recommended that the filter cover be removed and visual inspection of the cartridge made without removing the cartridge from the filter (fig. 10). If there is any muck whatever inside the filter cover, or if the visible end of the cartridge has a dirty glaze, a new cartridge must be installed. The procedure in changing cartridges is as follows:
(1) Unscrew the cover cap screw and remove the clarifier cover assembly.
(2) Remove and discard the used cartridge from the clarifier case.
(3) Clean all parts of the assembly.
(4) Reverse the procedure to install a new Briggs cartridge.

NOTE: Be sure that the clarifier cover gasket is in good condition and that the clarifier cover is drawn tight.

(5) After the cartridge is changed, fill the filter with fuel oil before the engine is started. After the filter is put back in service, open the air bleed valve and remove all air from the filter.

57. INJECTOR PLUNGER AND VALVE ADJUSTMENT.

a. Clearances and Adjustments. Keep the valve clearances properly adjusted. This assures clean engine operation and long life to the valves. Improper valve clearance causes

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sticking valves, warped valves, pitted valve seats, sluggish engine operation, and wasted fuel. Proper adjustment of the injectors prevents poor combustion and subsequent lack of power and dirty exhaust, as well as carboning of the injector nozzles. Too tight an adjustment causes strain on the injector plungers, connecting linkage, and camshaft profiles. Too loose an adjustment causes late injection which results in poor combustion. The injectors and valves can be adjusted by removing the valve covers on the top of the engine. Over each cylinder are three rocker arms which actuate the valves and injector stems (six rockers per cylinder head). Movement of these rockers will be noted when the engine is cranked by hand. The forward rocker of No. 1 cylinder actuates the exhaust valve. The center rocker actuates the injector rocker. The third rocker actuates the intake valve. On No. 2 cylinder, the rocker order is as follows: Intake (No. 4 rocker), injector (No. 5 rocker), and exhaust (No. 6 rocker). The two additional cylinder head rockers follow the same order, i.e., exhaust, injector, intake, intake, injector, exhaust.

b. Adjustment Procedure. To adjust, carry out the following procedure:

(1) Release engine compression as described in paragraph 28, and crank over the engine slowly in its operating direction. Observe when the injector rocker lever of the No. 1 cylinder (the center rocker) starts to move downward, pushing the injector plunger down with it.

(2) When this lever starts its downward movement, continue to crank the engine over slowly for approximately ⅛ turn until a notch marked 1 and 6 VS on the outside edge of the fan drive pulley registers with the center line mark on the gear housing, marked priming and timing index notch (fig. 57).

(3) The No. 1 cylinder is now in position to set the injector. Loosen the locknut on the injector lever adjusting screw. Back the locknut off two turns to prevent a false adjustment.

(4) With a 10-inch screwdriver provided with unit, tighten the adjusting screw as far as it will go, seating it firmly. No clearance is permitted on the injector plunger setting.

(5) Do not slack off this adjustment. All of the fuel that lies in the injector cup must be expelled, and the plunger tip must bottom firmly on the injector plunger seat of the cup. This setting prevents dribbling of fuel and entrance of gases into the injector cup at the wrong time. The plunger must be made to seat firmly and whenever clearance occurs it must be readjusted to a firm seat again. Tighten the adjusting screw locknut securely after making adjustments.

(6) The same position is used for setting the intake and exhaust valves. Close the compression release lever and set the valves with 0.014 intake and 0.022 exhaust clearance. Ascertain that the compression release is in running position before setting the intake valve. Adjust valves when the engine is warm. Before setting the injectors, check the following points to make sure that the engine is in correct position for the adjustment.

(a) Both intake and exhaust valves of the cylinder being adjusted must be at closed position (valve rollers turn), when the injector plunger adjustment is made.

(b) The VS notch on the fan drive pulley must register with the center line on the gear housing. Turn the engine over until the next VS notch cut in the fan drive pulley indexes with the center line mark on the gear housing. This brings the cylinder listed next in the firing order to the correct position for injector and valve setting.

(c) Follow the procedure and continue in this manner until all cylinders are set. Adjust injector plunger settings after the first 50 hours of service. Reset after each 250 hours of service thereafter. The firing order is 1-5-3-6-2-4.

58. LOCATING ENGINE TROUBLES. To determine and remedy as quickly as possible troubles that may occur in the engine, the following list of symptoms, causes, and remedies is given. When the remedy is not within the scope of the operator, it is so indicated. In such cases the engine requires the attention of the maintenance shop which has the necessary tools, skill, and data.

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ENGINE TROUBLE CHART.

Symptom	*Probable cause*	*Remedy*
a. Failure to start or sudden stopping of engine.	(1) No fuel.	Check fuel tank and shut-off valve. Check for dirty filters, deteriorating flexible lines, insufficient fuel, and inoperative fuel transfer pump or air leak in suction line.
	(2) Insufficient flow of fluel.	
	(3) Air traps.	Bleed the fuel injection system of air.
	(4) Dirt in fuel.	Inspect the secondary fuel filter for clogging. Drain primary filter of sediment.
	(5) Water in fuel.	Drain the filters, the tank, and the fuel injection pump. Reprime engine.
	(6) Plugged line.	Clean the fuel lines and examine for deterioration.
	(7) Overheating of engine.	Check the water and oil. Also check for clogged radiator, stuck thermostat or other restrictions in the cooling system, loose or broken fan belt.
	(8) Low oil pressure.	Check oil level in crankcase. Loose or broken suction line. Broken pressure line. Check for dilution of oil in crankcase.
	(9) Transfer pump failure.	Replace the transfer pump as a unit, sending the old one to the maintenance repair shop where trouble will be corrected.
	(10) No oil in governor housing.	Check and fill to proper oil level.
	(11) No fuel pressure.	Caused by scoring of distributor disk. This is a job for maintenance repair.
	(12) Fuel throttle does not open control at bottom of fuel pump.	Move throttle lever back and forth, notice action of bottom lever control on fuel pump.
	(13) Overspeed valve tripped.	Reset valve control.
	(14) Broken or loose connections in governor or fuel pump linkage.	Check outside control rod of governor when restarting engine. Check for tightness of clamp bolt on control levers. Call maintenance repair if linkage is broken.
b. Loss of power.	(1) Insufficient fuel.	Check fuel tank.
	(2) Air in fuel lines.	Vent or bleed the fuel injection system and check for air leaks.
	(3) Restrictions in fuel line.	See paragraph a(2).
	(4) Weak or misfiring cylinders.	Check valve and injector settings.

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ENGINE TROUBLE CHART (Continued)

Symptom	*Probable cause*	*Remedy*
b. Loss of power (contd.).		**NOTE: To determine if engine is misfiring, loosen slightly the nut of injection line at the injector, no more than half a turn, so that the fuel leaks from loose fitting. If there is no appreciable change in the engine performance that cylinder is not operating. Removal of injector is a job for maintenance repair who will install a service injector or repair faulty injector.**
	(5) Stuck injector plunger.	See paragraph b(4).
	(6) Excessive wear in fuel pump.	Call maintenance repair who will replace with service assembly and repair faulty pump.
	(7) Sticking valves.	This is a job for maintenance repair.
	(8) Bad compression.	This is a job for maintenance repair who will check for pitted, burned or warped valves, insufficient valve clearance, worn piston rings or stuck rings.
	(9) Clogged air cleaner.	Remove air cleaner and wash the air filtering element in fuel oil. Wash out oil cup and refill with oil to the correct level.
	(10) Valve and injector settings out of adjustment.	Adjust valve and injector settings.
	(11) Clogged exhaust.	Remove dust catcher and inspect interior of silencer.
c. Overheating.	(1) Lack of cooling water.	Check water in radiator. **CAUTION: Do not add cold water to an overheated engine. (See paragraph a(7).)**
	(2) Sediment or salt in water jackets or clogged radiator.	Flush out cooling system.
	(3) Water pump damaged by ice or other substance.	Check water pump.
	(4) Fuel injection too late or too soon.	Pump should be timed by maintenance repair.
	(5) Fan belts loose or broken.	Tighten fan belts. Call maintenance repair for installing new belts.

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ENGINE TROUBLE CHART (Continued)

Symptom	*Probable cause*	*Remedy*
c. Overheating (contd.).	(6) Stuck thermostat.	Remove thermostat housing on the top of the exhaust manifold and free the thermostat.
	(7) Improper lubrication.	See Lubrication Specifications.
d. Knocking.	Knocks in the Diesel engine can be divided into fuel knocks and those which cannot be directly assigned to the injection process. Knocks other than fuel knocks are either from loose bearings, pistons, flywheel, improperly adjusted valve mechanism, or blow-by due to sticking piston rings. Excessive fuel knocks are caused by too early injection of the fuel with the speed and load on the engine. This may be due to too great an advance of the injection or improper timing of the fuel pump in servicing, also plugged injector nozzles. Trouble from knocking, other than fuel knocks, can usually be found by sounding the knocks out under different load conditions and by cutting out one cylinder at a time. When the loose or incorrectly adjusted part is found, the remedy is usually obvious, and because these corrections should be made by an experienced mechanic, the operator should report any of the mentioned conditions to the maintenance repair.	
e. Excessive smoking.	This may be caused by sticking or worn nozzles, leaky inlet or exhaust valves, stuck or worn piston rings, or scored cylinders. Check the inlet and exhaust valve clearance and make sure that the valve is not sticking in the guide. Check for a dirty air cleaner. As a last resort, assume the trouble to be in the fuel injection pump. If the latter is the case, this becomes a job for the maintenance repair.	

59. LOCATING GENERATOR TROUBLES. The following chart is given to assist in remedying troubles in the generator. When the remedy is not within the scope of the operator it should be turned over to a maintenance shop for repair.

MAIN GENERATOR TROUBLE CHART.

Symptom	*Probable cause*	*Remedy*
a. Exciter overheats.	(1) Shorted or grounded alternator shunt field.	This is a job for maintenance repair.
	(2) Shorted or grounded exciter shunt field or armature.	This is a job for maintenance repair.
	(3) Bearing worn out or defective.	This is a job for maintenance repair.
	(4) Ventilation openings blocked or clogged.	Clear ventilation openings.
b. Alternator overheats.	(1) Shorted or grounded stator or rotor coils.	This is a job for maintenance repair.
	(2) Worn out or defective bearings.	This is a job for maintenance repair.

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MAIN GENERATOR CHART (Continued)

Symptom	*Probable cause*	*Remedy*
b. Alternator overheats (contd.).	(3) Ventilation openings blocked or clogged.	Clear ventilation openings.
	(4) Alternator overloaded.	Reduce line load until control panel ammeter registers normal amperes. See nameplate amperes.
c. Generator noisy.	(1) Exciter or alternator bearings worn out.	This is a job for maintenance repair.
	(2) Exciter or alternator bearings improperly lubricated.	Open drain holes and release surplus grease.
	(3) Alternator stator shorted or grounded.	This is a job for maintenance repair.
	(4) Alternator overloaded.	Reduce line load until control panel ammeter registers normal amperes.
d. No voltage registers on control panel voltmeter.	(1) Voltmeter defective.	This is a job for maintenance repair.
	(2) Exciter commutator dirty or brushes not making good contact.	Clean commutator and free brushes in holders.
	(3) Collector rings dirty or brushes not making good contact.	Clean rings and free brushes in holders.
	(4) Exciter shunt field circuit has an open or poor connection.	This is a job for maintenance repair.
	(5) Alternator shunt field has one or more coils open circuited.	This is a job for maintenance repair.
	(6) Exciter armature short circuited.	This is a job for maintenance repair.
e. Control panel voltmeter registers abnormally low voltage.	(1) Exciter rheostat improperly set.	Turn exciter handle to the right until voltage registers normal. If this fails, it becomes a job for maintenance repair.
	(2) Defective voltage regulator.	This is a job for maintenance repair.
	(3) Alternator field shorted or grounded.	This is a job for maintenance repair.
	(4) Exciter shunt field shorted or grounded.	This is a job for maintenance repair.
	(5) Exciter armature shorted or grounded.	This is a job for maintenance repair.

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MAIN GENERATOR CHART (Continued)

Symptom	*Probable cause*	*Remedy*
e. Control panel voltmeter registers abnormally low voltage (contd.).	(6) Exciter commutator or alternator collector rings dirty or rough.	Clean and polish commutator and rings.
	(7) Engine speed below normal 60-cycle speed, 1200 RPM.	If ammeter on control panel does not indicate extreme overload, check the engine governor.
	(8) Alternator stator winding shorted or grounded.	This is a job for maintenance repair.

60. MAINTENANCE REPAIR SCHEDULE.

a. View of Engine and Parts. A working view of engine and parts are shown in figure 21 and figure 22.

b. Repair Recommendations. The following maintenance and repair recommendations are made so that equipment may be kept in proper operating order at all times. By keeping the tools and working benches clean while making repairs, a high percentage of the causes of poor engine performance can be eliminated. Engine, generator, and switchboard should be repaired inside a building, where possible. If unusual noise or vibration develops in the engine at any time, *start up standby unit immediately and transfer load.* Shut down faulty engine and determine cause of trouble and method of making repairs, by consulting methods described on the following pages.

(1) QUARTERLY.

(a) Clean out carbon residue from silencer.

(b) Check generator and exciter bearing lubrication.

(c) Check circuit breaker contacts.

(d) Check slider contact or rheostat.

(e) Check meters.

(f) Change secondary fuel oil filter.

(g) Clean air filter screens.

(h) Remove and clean fuel injectors and fuel pump screen.

(i) Check and clean voltage regulator and contacts.

(2) SEMI-ANNUALLY.

(a) Minor engine overhaul. Remove heads, grind valves, inspect connecting rod bearings.

(b) Tighten circuit breaker connections.

(c) Clean cooling system. Replace hose if necessary.

(d) Remove starting motor and check bendix drive. Lubricate end bearing.

(e) Remove injectors and clean cups. Replace if necessary.

(f) Remove and clean primary filter.

(3) ANNUALLY.

(a) Major engine overhaul. Complete tear down, renew all worn parts.

(b) Clean soot from exhaust lines and silencer.

(c) Check fuel lines and check-valves in fuel system.

(d) Clean main fuel tanks.

(e) Check governor for sludge conditions. Drain oil from governor sump, fill with fuel oil and operate engine for ½ hour. Drain and refill with new engine oil.

61. TABLE OF CLEARANCES. The following table should be consulted when making adjustments or replacements:

Part	*Minimum*	*Maximum*
Camshaft bearing clearance	0.002″	0.003″
Connecting rod bearing	0.003″	0.005″
Connecting rod end clearance	0.008″	0.012″
Crankshaft end thrust	0.008″	0.010″
Crankshaft main bearings	0.005″	0.008″
Gear cover clearance around crankshaft	0.004″	0.006″

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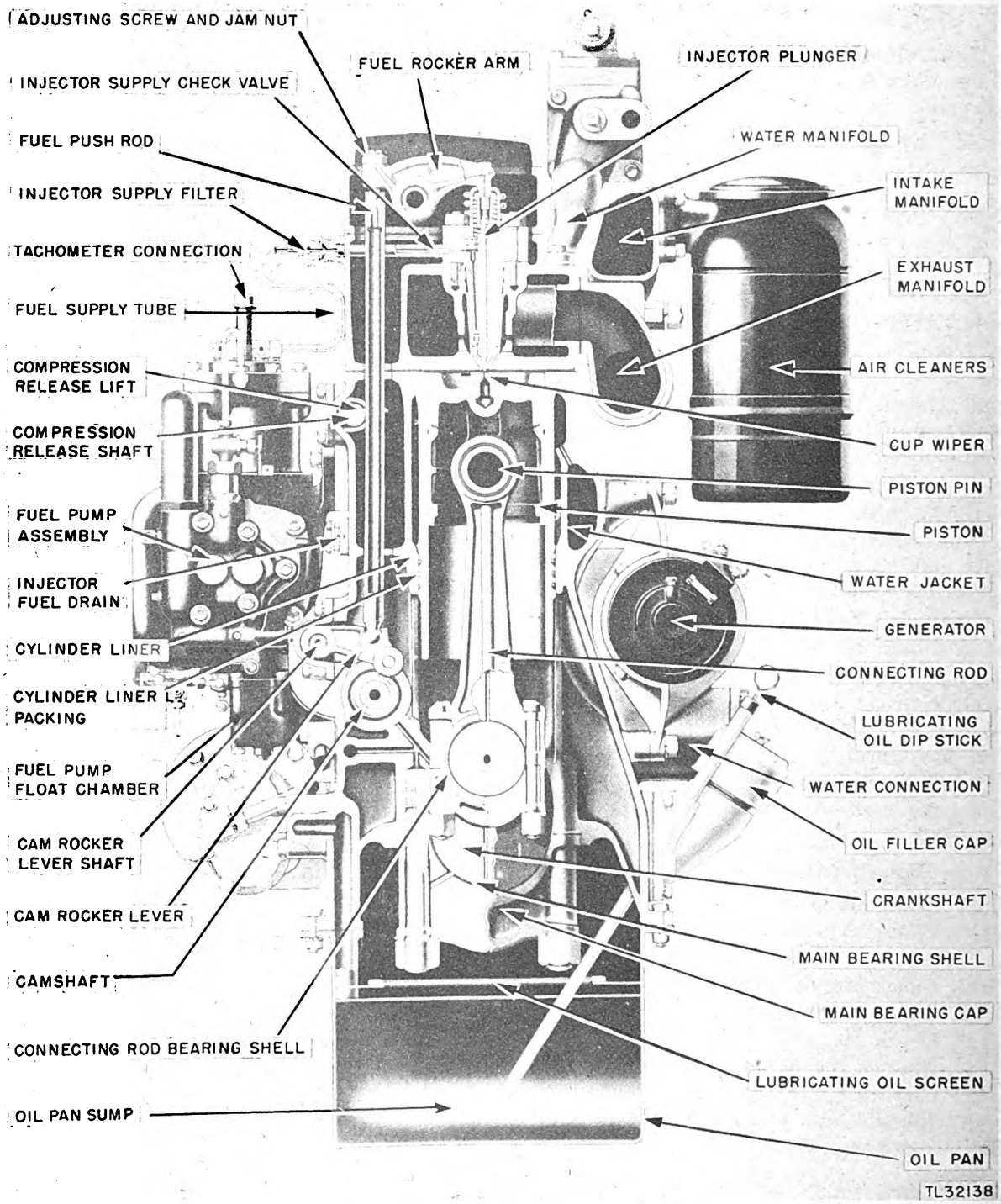

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Figure 21. Cross-section of engine, end view.

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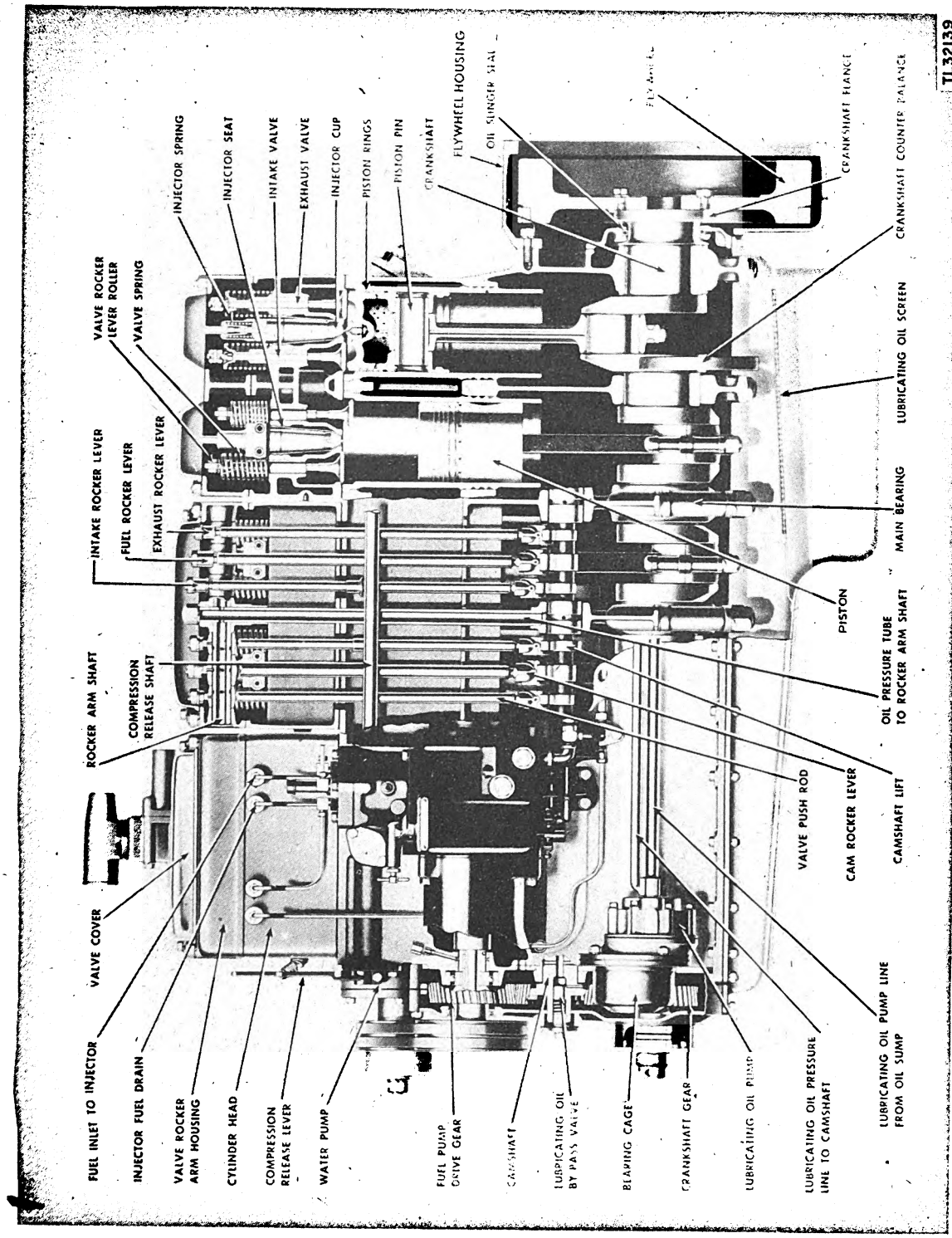

Figure 22. Cross-section of engine, side view.

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Part	*Minimum*	*Maximum*
Piston pin clearance in piston	0.0005″	0.001″
Piston pin clearance in rod	0.0015″	0.002″
Piston clearance	0.008″	0.012″
Ring gap clearance	0.012″	0.018″
Ring land clearance	0.002″	0.005″
Rear oil seal cover housing	0.006″	
Valve seat angle	30° angle	
Valve seat face width-intake and exhaust	1/8″	5/32″
Valve stem clearance	0.0015″	0.003″
Valve tappet clearance intake (HOT)	0.014″	0.014″
Valve tappet clearance exhaust (HOT)	0.022″	0.022″

NOTE: If crankshaft should become scored or out of round it can be ground 0.010, 0.020, 0.030, 0.040, on main journals; on connecting rod journals, 0.010, 0.020, 0.030, 0.040, 0.050, 0.060. Bearings can be furnished in these sizes.

62. LUBRICATING OIL PUMP. The lubricating oil pump is of the gear type consisting of two small hardened gears running in a cast-iron case. It is driven directly off the camshaft gear and can be taken off by removing the four nuts holding it to the gear housing.

a. Removal from Engine.

(1) Remove oil tubes leading from pump to cylinder block.

(2) Remove the four nuts and lockwashers holding assembly to the block and pull the complete pump assembly free.

b. Disassembly for Servicing.

(1) Remove the eight cap screws and lockwashers that hold the pump body to pump bracket, and lift body from bracket.

(2) The idler gear stud can easily be removed by pressing from the pump body.

(3) To remove the pump drive gear, use a puller, using the two threaded holes in the gear shown in figure 23.

(4) Remove the Woodruff key from the shaft.

(5) To remove the bracket, tap the edge with a soft hammer.

(6) Uncotter hex nut on end of drive shaft, and remove the nut and retaining washer from the shaft.

(7) Press pump drive gear and shaft from ball bearing.

(8) Press drive gear from shaft and remove Woodruff key.

(9) Remove snap ring from bearing cage and tap bearing from cage.

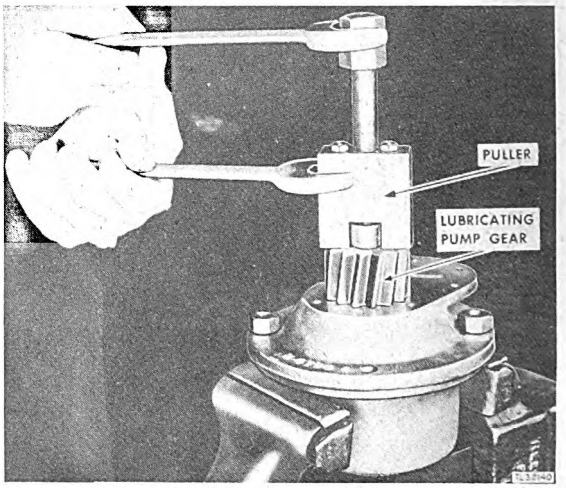

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Figure 23. Pulling lube oil pump gear.

c. Reassembly.

(1) Install Woodruff key in drive end of drive shaft and press driving gear on shaft until it is snug against shoulder.

(2) Press ball bearing into bearing cage and lock in place with snap ring.

(3) Insert end of shaft in cage and install retaining washer, nut, and cotter pin on end of shaft.

(4) Press new bushing in place in pump bracket, and ream with 7/8″ reamer.

(5) Using new gasket, insert pump bracket over bearing cage. Install Woodruff key in shaft and press pump gear on until shaft gear has a clearance of 0.0015″ between gear and bracket, figure No. 24.

(6) Press idler gear shaft into pump body so that shaft is slightly below face of gear body.

(7) Attach pump body to pump bracket with eight cap screws and lockwashers, using new

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gasket to avoid leakage. Turn drive gear to see that pump gears are free.

(8) Again using new gasket, install pump assembly to rear face of timing gear case, meshing drive gear carefully to camshaft gear and tightening the four nuts securely.

(9) Prime oil pump by applying clean oil through one of the oil line connections in the pump.

(10) Replace external oil lines, tightening all connections securely.

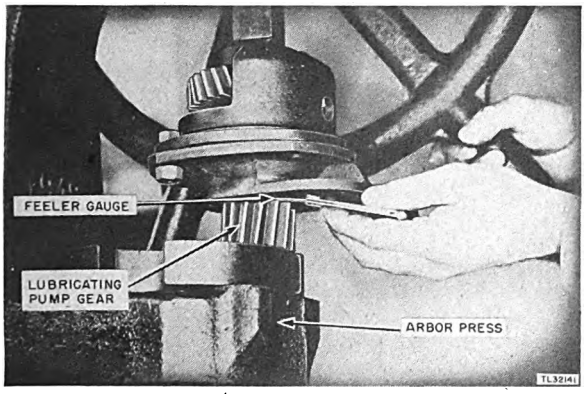

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Figure 24. Assembling lube oil pump gear.

63. EXHAUST AND AIR INTAKE MANIFOLDS. The exhaust manifold is held to the side of the cylinder head by clamps which also hold the intake manifold. Alignment of manifolds is maintained by dowels placed just below the exhaust ports. These must never be removed. The clamps are held in place by studs. Gaskets are installed between the exhaust manifold and the cylinder head and these must be maintained in good condition. Usually a leaking gasket will be evident and tightening the studs which hold the clamps will frequently overcome a slight leak. This operation must be done carefully or the manifold may be cracked. If any gasket is in a leaky condition and needs replacement, a complete new set should be installed as a single new gasket may be thicker than the remaining ones. Taking up on the clamp studs under this condition would be likely to crack the manifold. If for any reason, the manifold is removed, the interior should be thoroughly cleaned before reinstalling. To remove the manifold clamps it will be necessary first to take off the air cleaners.

64. ALARM SYSTEM.

a. Safety Switches. The contacts of the low oil pressure and the high water temperature switches must be kept clean and free from any pitting. At least once a month remove the covers of these switches and insert fine folded sandpaper between the contacts and slide it back and forth, holding the contacts together, until they are clean. Use a non-conductor to hold the contacts together unless the battery has been disconnected.

b. Oil Pressure Switch Adjustment, figure 25. The necessity for adjustment of the engine shut down pressure point can be determined by stopping the engine using the fuel control lever but not allowing knob to snap into the recess hole (par. 33), and as the lubricating oil pressure drops, note at what pounds pressure the howler sounds. Referring to figure 25, turning nut (4) to increase the tension on the spring (2) will raise the alarm pressure point and conversely reducing the spring tension will result in the switch being kept in service by a lower oil pressure. By repeating the above, noting each time the point at which the howler sounds, the desired shut down point of 25 pounds can be obtained.

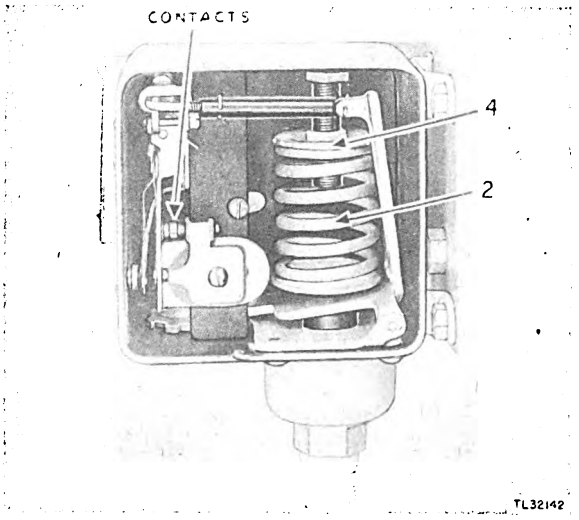

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Figure 25. Alarm pressure switch.

c. Water Temperature Switch Adjustment, figure 25. To adjust this switch it is necessary to place a wooden wedge between the contacts of the oil pressure switch so that

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the alarm howler will not sound. Remove the temperature bulb from the engine and place it in a container of water heated to 160° F. Continue heating the water and note the temperature at which the alarm howler sounds. The howler should sound when a temperature of 195° F is reached. If howler does not sound at the proper temperature, it will be necessary to remove the switch cover and increase or decrease the spring tension with the adjusting nut to obtain the point of contact closure.

65. COUPLING MAINTENANCE AND REPAIR, figure 26.

a. Checking. Remove the fan from the flywheel at the engine end of the generator each month and with a box or socket wrench check all the bolts in the coupling for proper tightness. At this time check and make sure that all disks in the coupling are intact.

b. Replacement of Broken Disks. If any of the disks become broken, remove and replace them as follows: With the fan removed, unbolt the coupling from the engine flywheel, remove the two tapered dowels and four hold-down bolts on the generator, and slide the complete unit back, removing the coupling from the flywheel, after which bolts may be removed from the coupling disks and the new disks inserted and the bolts again pulled up, the unit moved back, rebolt into the flywheel, and the tapered dowels and hold-down bolts re-inserted and tightened to the base.

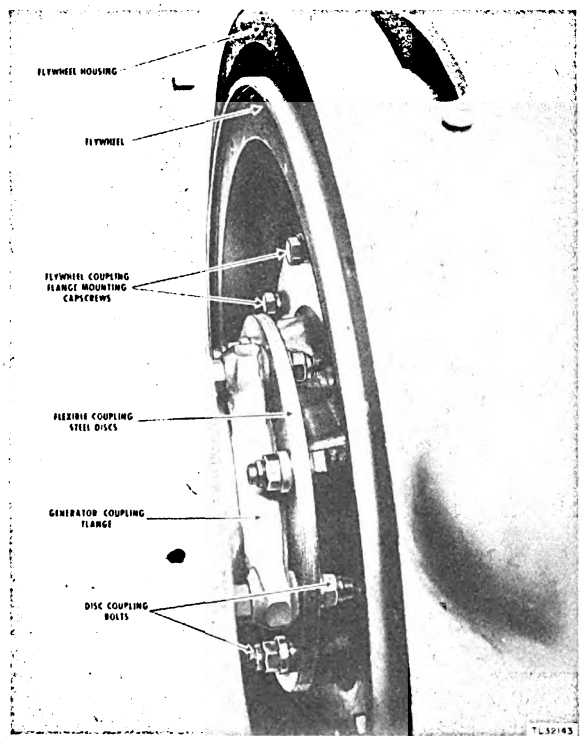

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Figure 26. Generator flexible coupling.

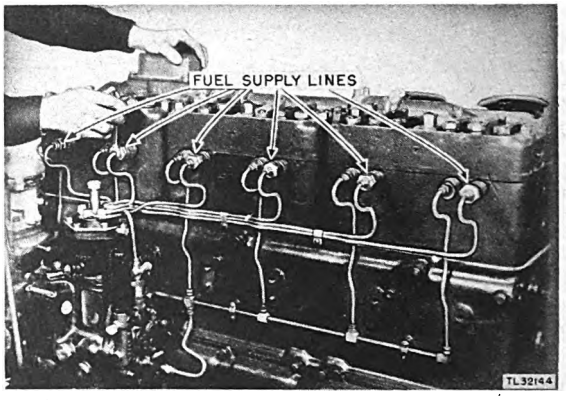

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Figure 27. Removal of injector fuel tubing.

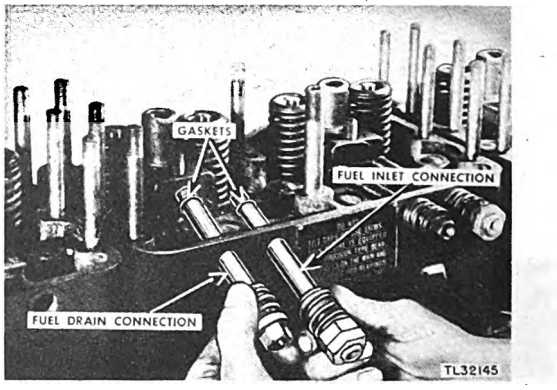

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Figure 28. Removal of fuel and drain connections.

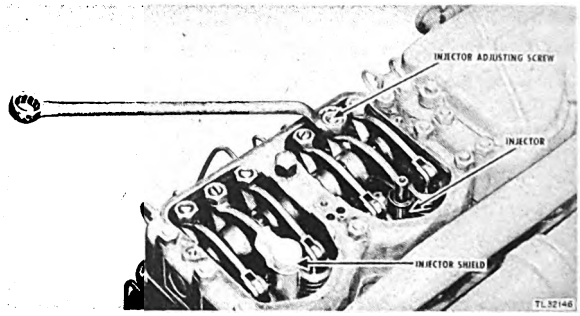

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Figure 29. Removal of injector rocker arm adjusting screw.

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66. FUEL INJECTION SYSTEM.

a. Operation. The operation of the fuel injection system is covered in section III.

b. To Remove Injector From Engine.

(1) Disconnect fuel tubing (fig. 27).

(2) Unscrew fuel strainer and drain connections (fig. 28).

(3) The small copper gaskets on the ends of the connections are threaded so they will not pull off the connections and drop into the crankcase. When renewing these gaskets it is necessary to use special threaded gaskets supplied by the engine manufacturers.

(4) Loosen locknut and remove injector rocker arm adjusting screw (fig. 29). Move push tube aside and tilt rocker lever away from injector as far as it will go or to a vertical position. Keep each adjusting screw with its respective lever.

(5) Remove the oil shield from around the injector. This shield is pushed on the injector top and may be easily pulled off. This shield prevents the lubricating oil from the rocker lever going into the injector overflow. Remove the two nuts which hold injector in the cylinder head (fig. 30).

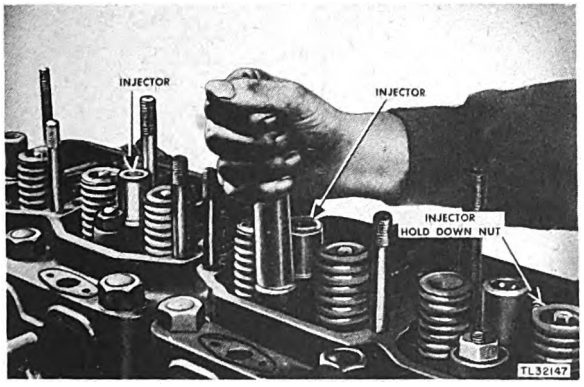

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Figure 30. Removal of injector holding nuts.

(6) Lift injector from cylinder head. Use care to prevent the spray tip end of injector from becoming bruised or damaged (fig. 31).

c. To Check Leakage of Injector Check Valve and Other Fuel Leaks. Have separate clean containers for washing the injector and its working parts. Use clean kerosene or some suitable cleaning solvent and thoroughly wash the outside of the injector. Dry the injector with clean compressed air.

(1) Place injector in fixture similar to the one shown in figure 32 with cup end down. Do not clamp directly in vise or damage will result.

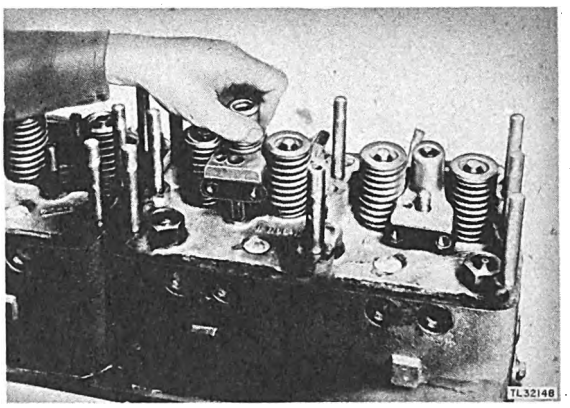

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Figure 31. Removal of injector.

(2) Remove the fillister head screws holding top housing in place. After removing the top housing, wash the inside of the housing, plunger, and spring before the plunger is removed from the body (fig. 33).

(3) Remove the injector plunger and spring. Fill the injector plunger hole about two-thirds full of clean fuel oil (fig. 34). Hold injector spray tip firmly against a piece of rubber. Insert plunger in place and exert as much pressure on the plunger as possible. If the check valve has a leak, it will show at fuel inlet connection indicated by arrow A (fig. 35).

(4) At same time check leakage between injector plunger and injector body, point B (fig. 35). This leakage should not be excessive.

(5) Check for leakage around injector cup threads, C (fig. 35). If no leakage shows with this test, remove injector from rubber block and spray fuel out of cup by compressing plunger in barrel. At this time fuel spray and angular spray can be noted.

(6) Then draw plunger almost out of barrel and place thumb over tip of cup and lightly compress plunger. Note the leakage of air out of inlet of injector body. If there is no restricting action of plunger in barrel, the check valve is leaking. If a slight leakage of air is perceptible, and by putting in a drop of fuel oil in the barrel and repeated operations do not show leaks, injector check valve will operate satisfactorily under load.

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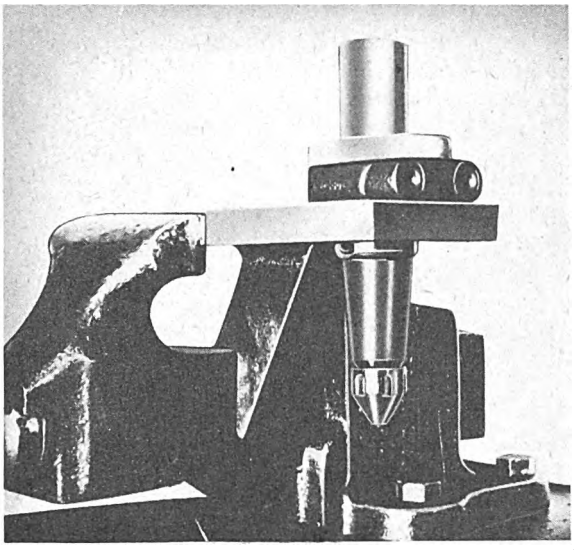
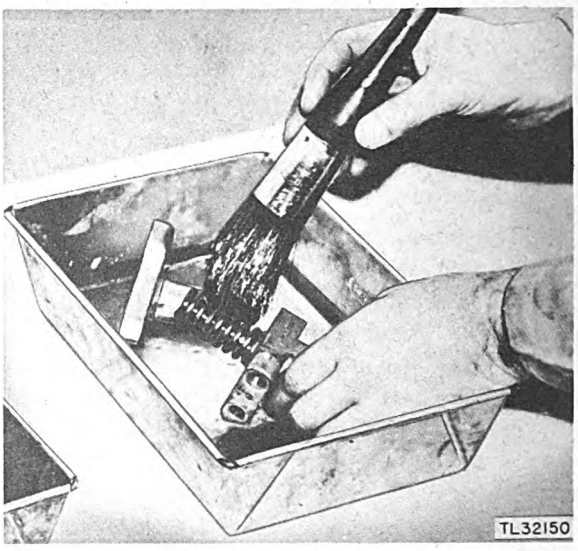
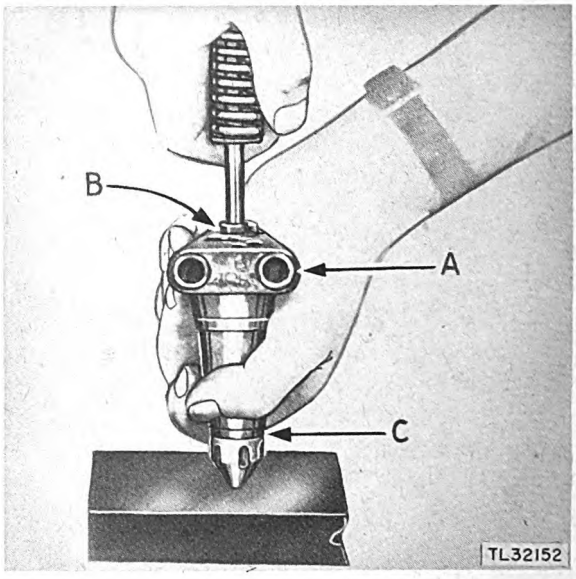


TL-32149
Figure 32. Injector held in fixture.



TL-32150
Figure 33. Washing injector.

TL-32151
Figure 34. Putting fuel oil in injector.



TL-32152
Figure 35. Testing for leaks in injector.

d. Checking Injector Fuel Spray.
(1) With cleaning brush furnished with each engine, brush the injector tip clean of carbon. To lengthen the life of the brush it is always best to pull the brush across the tip. DO NOT USE ANY OTHER METHOD IN DOING THIS (fig. 43).
(2) Refill the injector body with clean fuel as previously instructed. Holding injector in hand, push the fuel out with the plunger and check the fuel spray at the injector cup tip. If six clean even sprays can be seen, it is needless to remove the cup unless the injector has been removed due to dilution (fig. 36).

e. Inspection and Cleaning of Injector Cup Spray Holes. The following illustrations will show what to look for, when inspecting the injector cup. It is recommended that a magnifying glass be used to give the cup a thorough inspection.

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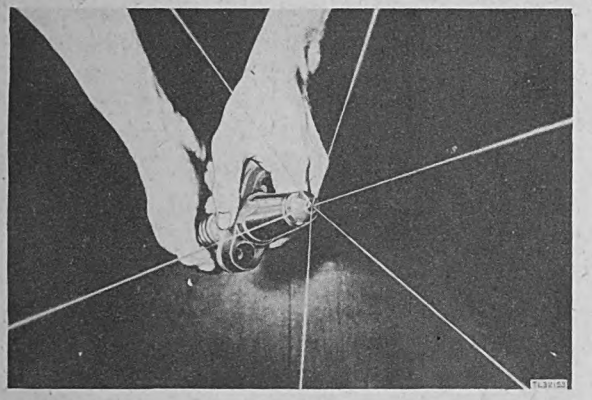
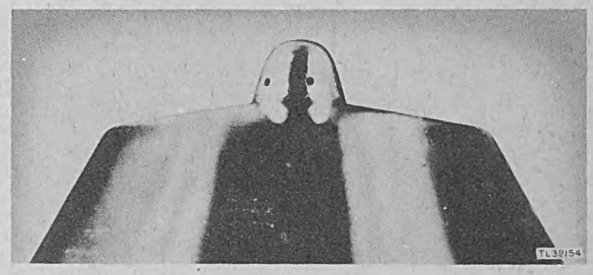
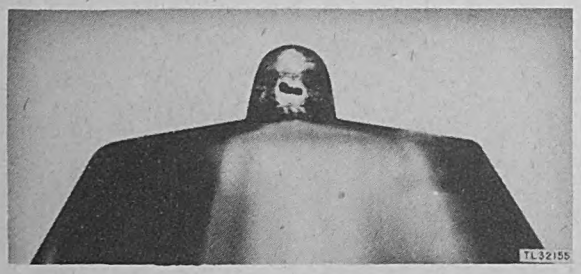


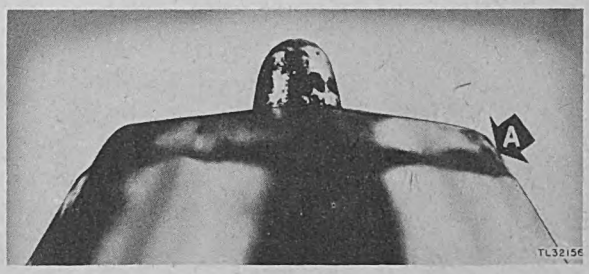
TL-32153
Figure 36. Clean injector cup spray holes.



TL-32154
Figure 37. Perfect injector cup, magnified.



TL-32155
Figure 38. Damaged injector cup, magnified.



TL-32156
Figure 39. Damaged injector cup, magnified.

(1) Figure 37 shows a new injector cup under the magnifying glass.
(2) Figure 38 shows an injector cup damaged by fine abrasives in fuel, such as dust, dirt, etc., which have a sand blasting effect and usually cause this type of cup failure. This damage can also be caused by the improper use of a cup cleaning drill of improper size for the spray hole. Such a condition is frequently caused by breaking the drill off in spray hole and failing to remove it before putting the injector back in the engine. The extreme pressures that are created in the injector cup have a tendency to start cutting out some place around the drill, wearing the metal away.
(3) Figure 39 shows the effect of high acid or sulphur content in the fuel, as well as the effect of excessive heat which could be caused by an overload condition. On the bottom of this cup at A the metal has been eaten away.
(4) The spray holes of the injector cups must be kept free and open at all times. To continue to operate with holes obstructed will cause damage to the engine and loss of power. The cup is so designed that the preheated charge of fuels is injected into the cylinder in a fan shaped spray in order to bring the fuel into contact with all available air.
(5) Figure 40 shows that, in case one injector cup spray hole is plugged with dirt or metal, part of the available air in the cylinder chamber is not in contact with fuel and, over-rich mixture is present in the other part of the cylinder. This causes a falling off in power because of slow burning of the fuel.

f. Injector Cup Cleaning. If the fine fuel spray holes of the injector cup become clogged, it is usually caused by improper setting of the injector plunger, dirt in the fuel, operating the engine at overload, or an overheated engine. A cup cleaning kit is furnished, consisting of the file card brush, with two open-

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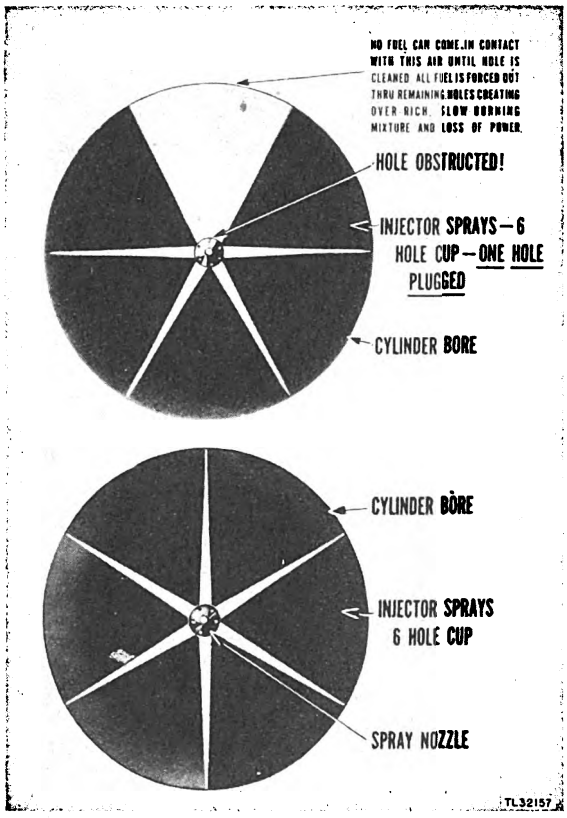
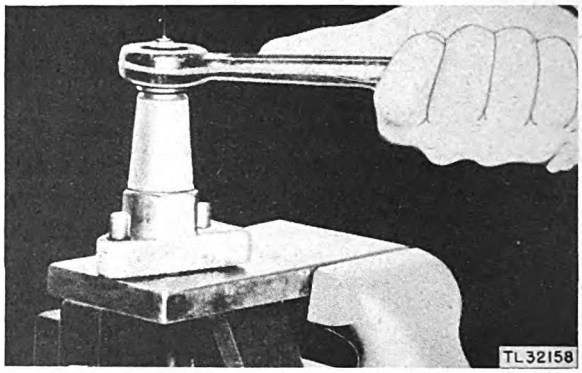
ings in the brush end in which will be found a small drill, several very small wire drills, and a pin vise for holding the small wire drills.

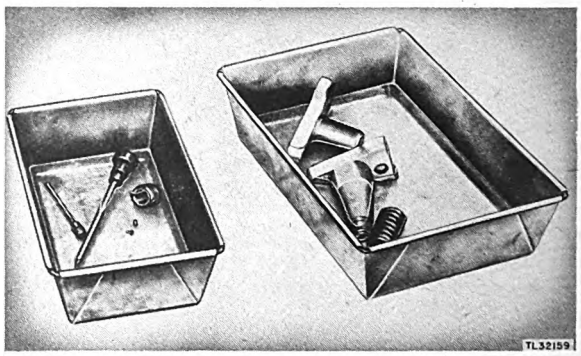


TL-32157
Figure 40. Injector spray diagram.

(3) Before using the small wire drills, furnished for cleaning the spray holes, place the wire in the pin vise, letting it project about 1/16" from the end of the vise. With a very



TL-32158
Figure 41. Removal of injector cup.



TL-32159
Figure 42. Washing injector parts.

(1) Place the injector in the holding fixture as shown in figure 41 with cup end up. Apply the splined wrench, furnished with each engine, on the injector cup, and, with a sharp rap of the hand in a counterclockwise rotation, loosen the cup. When starting these operations, it is very important to have a separate clean container with clean fuel oil or cleaning solvent to wash all parts as they are removed from the injector (fig. 42).

(2) As indicated by B, figure 43, hold the injector cup upside down when using the large drill in order that any foreign matter may fall out of the cup. NEVER USE A DRILL OTHER THAN THE ONE FURNISHED BY THE ENGINE MANUFACTURER. This drill is ground to the proper taper to fit the cup.

fine hone sharpen the end of the drill (fig. 43). This must be done every time a new drill is used or the old one is broken. When a wire drill is cut off or broken, burrs are always present to scratch the inside of the spray holes in the cup. This will cause deflection of spray and poor combustion.

(4) Hold the cup in the fingers as shown by D, figure 43. Be sure to hold the drill to the proper angle as indicated by E, figure 43. This will be at a right angle to the tip so that the drill will follow the hole as it was originally drilled.

(5) A caustic lye or anti-carbon solution may be used to facilitate loosening of carbon in plugged injector cup. Boiling the cup in this solution for one hour will soften carbon to such an extent that drill will easily open hole

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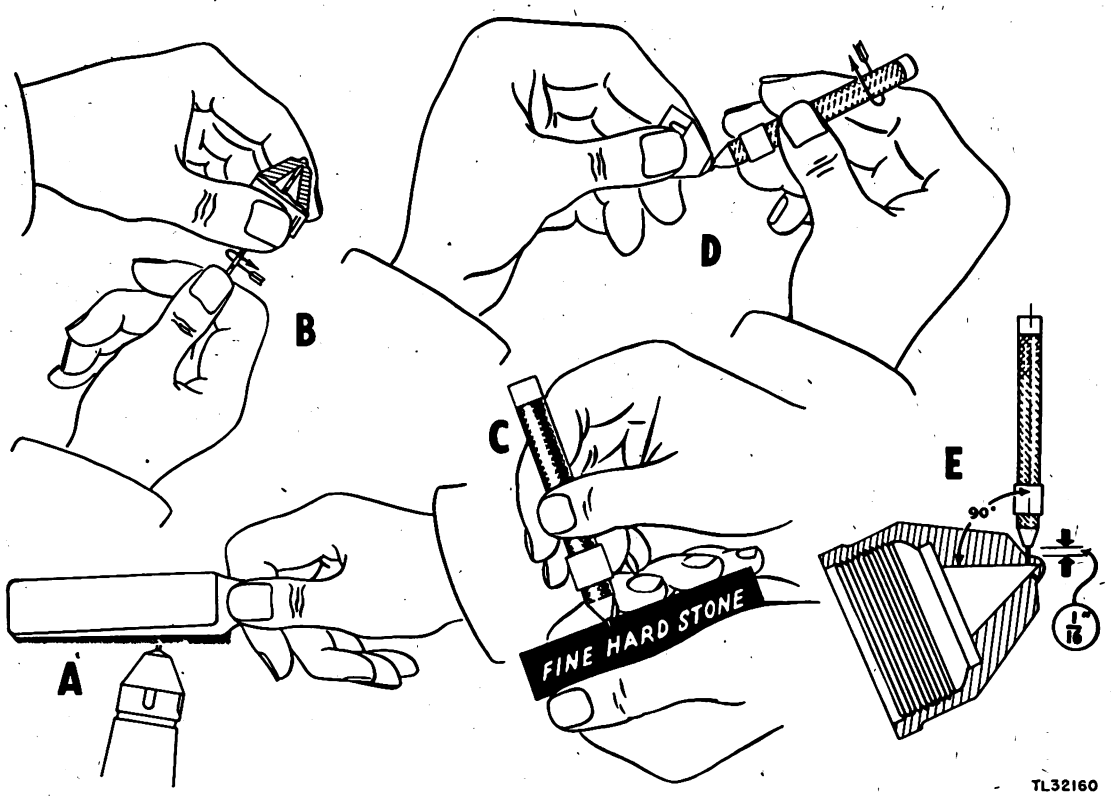


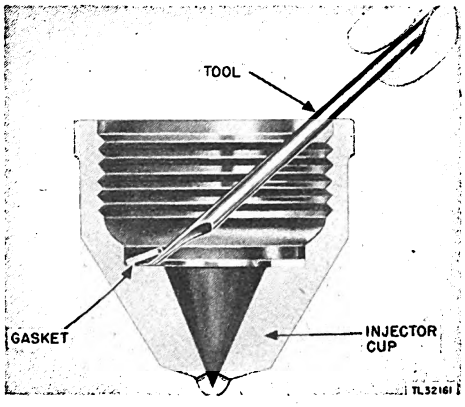
TL-32160

Figure 43. Cleaning injector cup.

without excessive reaming or enlarging of hole.

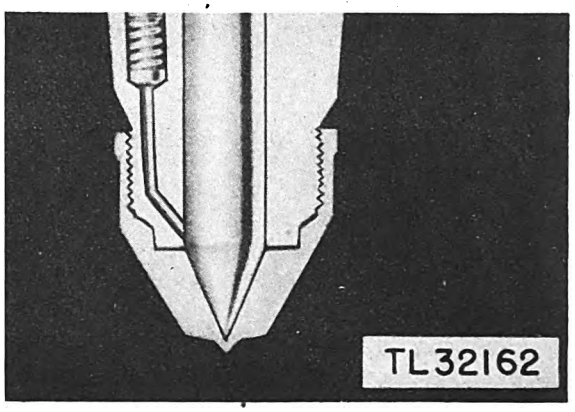
CAUTION: Care should be taken in using solution. Use a wooden stick or long nose pliers and wash cup in fresh water before handling.

g. Assembling Injector Cup. Never assemble an injector cup to the body unless a new cup gasket is used. A tool similar to the one shown in figure 44 will enable you to remove the gasket without damage to the cup. (1) Lubricate the injector plunger, remove spring and insert in body of injector. Have plunger tip protrude beyond end of body. Holding plunger in this position, install cup gasket over plunger tip and screw cup onto injector body. Tighten injector cup with spline wrench. Injector plunger must seat in injector cup as shown in figure 45.



TL-32161

Figure 44. Removing cup gasket.



TL-32162

Figure 45. Injector plunger in cup.

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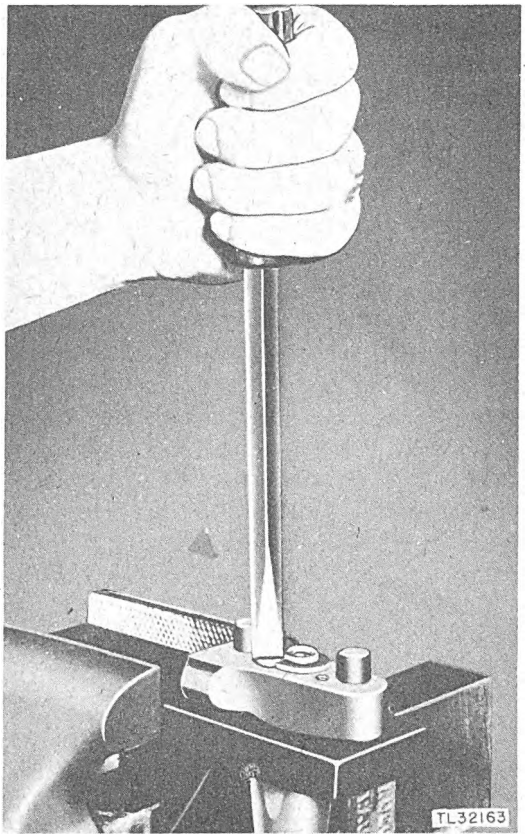
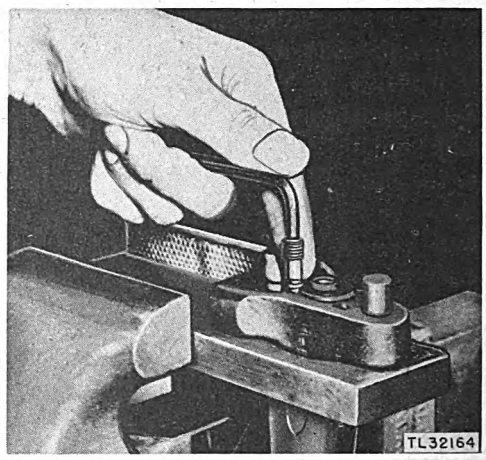


TL-32163
Figure 46. Removing plug over check valve.

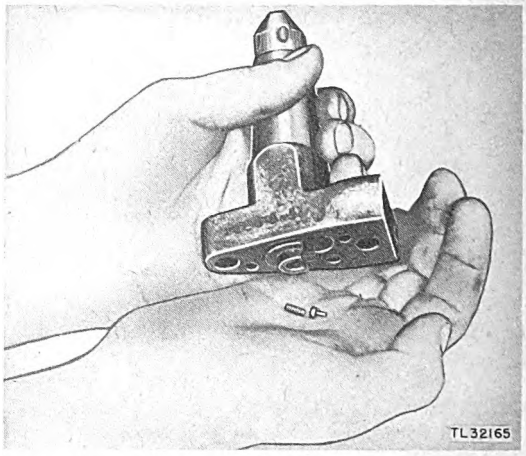
(2) To check for binding of plunger in cup force plunger into cup by tapping lightly with palm of hand. No binding should occur when withdrawing plunger from cup seat.
(3) The above method will help eliminate injector plunger sticking. If the taper of the plunger does not fit freely in the taper of the cup, sticking of the plunger will result. TIGHTENING OF THE CUP WITH A HAMMER WILL AGGRAVATE THIS CONDITION.

NOTE: Use only gaskets furnished by the engine manufacturers. Old or improper gaskets will result in leakage around the cup, causing dilution of lubricating oil.

h. Servicing Injector Check Valve. When servicing injector check valve it is recommended to remove injector cup as previously instructed.
(1) Place the injector in the holding fixture as shown in figure 46. With screwdriver, remove body plug. With allen wrench remove check valve (fig. 47).



TL-32164
Figure 47. Removing injector check valve.



TL-32165
Figure 48. Removing injector valve spring and stop.

(2) Turn the injector body over and tap in the palm of the hand to remove the check valve spring and stop (fig. 48).
(3) If the check valve is stuck in the valve seat, it indicates that the valve has worn through the hardness of the seat and must be replaced. Check valve and seat are supplied only in pairs and must be installed that way.
(4) The check valve gasket must be replaced each time the check valve is removed. The gasket can be removed with a tool made from an old check valve seat as shown in figure 49. It may be necessary to tap the tool a few times with a bronze punch and hammer to enable you to pull the gasket out. DO NOT

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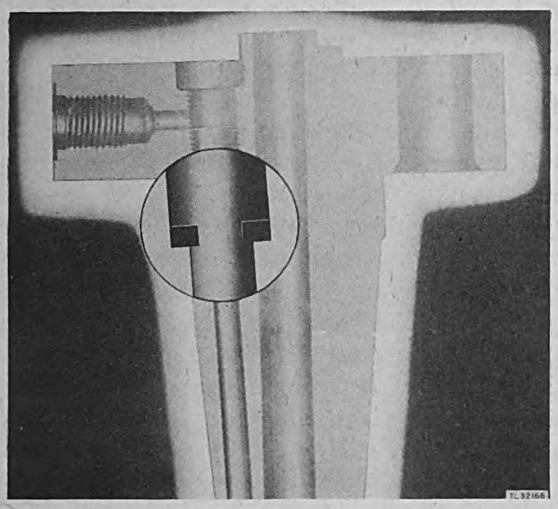
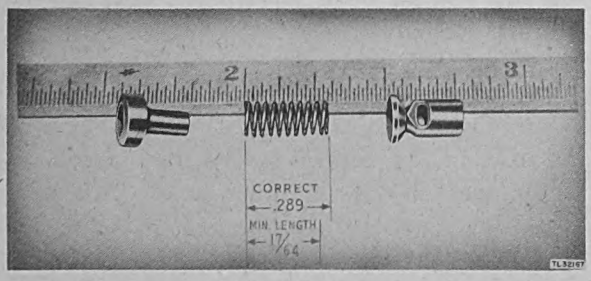
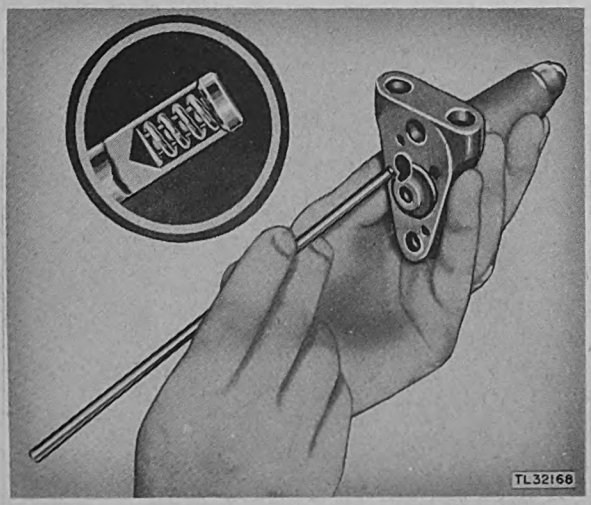
USE A CHISEL TO REMOVE GASKET OR DAMAGE WILL RESULT TO INJECTOR BODY.



TL-32166
Figure 49. Removing injector check valve seat gasket.



TL-32167
Figure 50. Length of check valve spring.

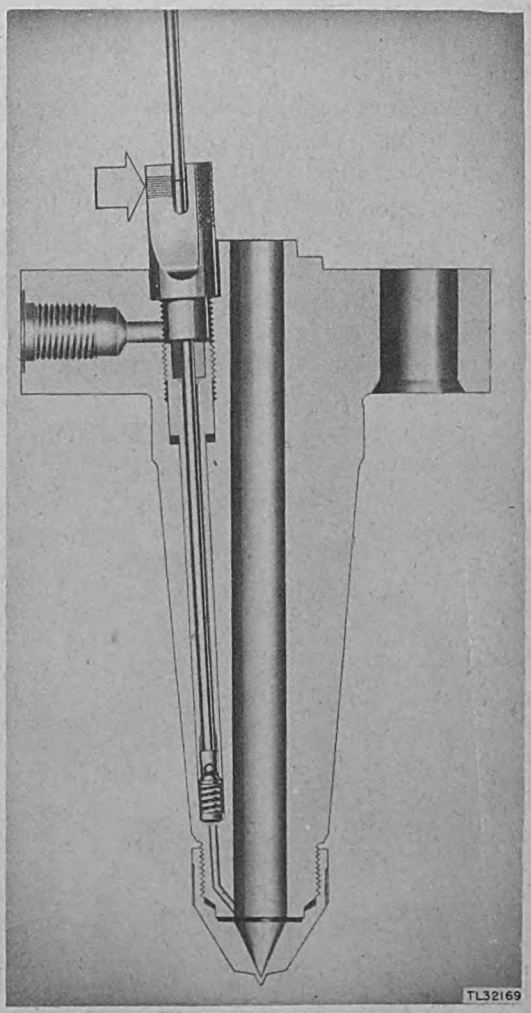


TL-32168
Figure 51. Inserting injector check valve spring.

(5) With clean fuel or cleaning solvent wash the injector body thoroughly and dry with clean compressed air. If the check valve spring is shorter than 17/64", it must be replaced (fig. 50).

(6) Use a small inserting tool as shown in figure 51. With check valve spring and stop in position, hold the injector upside down and insert check valve spring and stop to its working position (fig. 52). Reverse the position of the injector and remove the tool. Be sure the tool and parts are free from oil or the stop and spring may pull out of place when the tool is removed.

(7) Place new gasket on check valve seat stem (fig. 49). With a little clean cup grease or vasoline on the check valve, assemble very carefully to body. With allen wrench, screw



TL-32169
Figure 52. Injector cross section.

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check valve assembly until it bottoms on check valve stem gasket lightly. No binding of assembly should be encountered when screwing in place. Check with travel tool (fig. 52) for spring action of check valve. Then tighten check assembly securely if spring action is found satisfactory.

i. Check Valve Travel. The check valve travel tool (fig. 52) should be used to determine the check valve opening. Limits are from 0.015″ to 0.025″. Too much travel will cause early failure of check valve spring and too little travel will deprive the cylinder of fuel. The tool has graduations of 0.020 each and, if the check valve opens one graduation, the opening is correct.

(1) If the travel is under 0.015″, it may be that the check valve seat gasket has collapsed too much, and it will be necessary to replace with a new gasket. If there is too much travel, the seat should be tightened more.

(2) Insert screw plug and screw it down very tightly using a small wrench on the bit of the screwdriver to assist in tightening it. Be sure its copper gasket is in place and in good condition. This plug seals the fuel from possible leakage.

(3) Be clean in handling injector parts.

(4) Wash all parts with clean kerosene and blow off with air before reassembling.

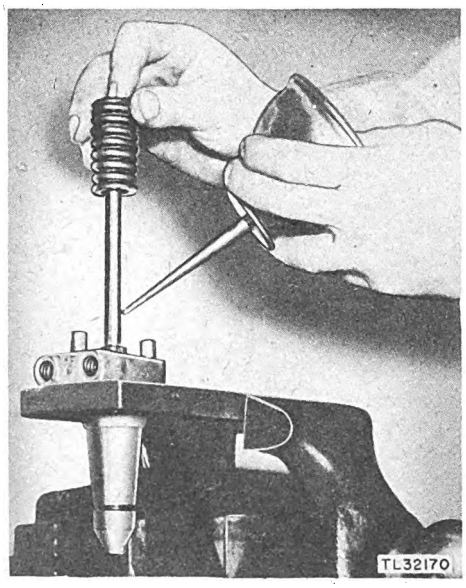
(5) Always use new gaskets when making inspection or repairs.

(6) Before installing cup on body, air should be blown through inlet of injector body or connect injector to priming pump of engine. This can be done by connecting injector fuel strainer to injector and then to tubing on priming pump. Work priming pump and fuel will squirt out of drilled hole in bottom of injector. This will clean out grease and any metal chips from drilled hole. Then, install injector cup and check back on your work as per paragraph *checking leakage of injector check valve and other fuel leaks.*

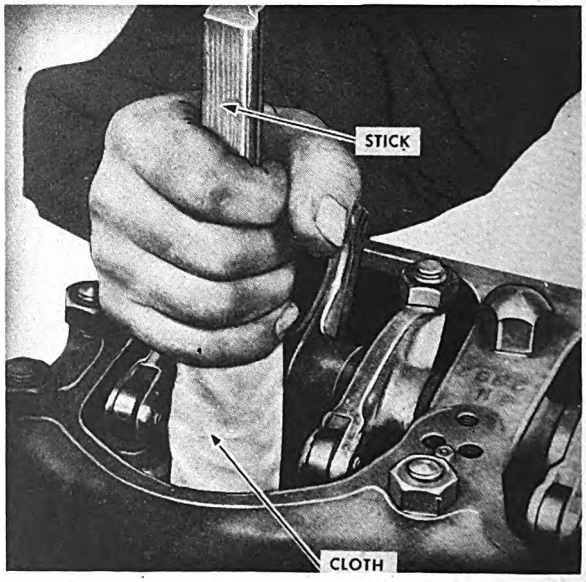
j. Finished Assembly. Install injector cup as previously instructed. Lubricate injector plunger with clean oil and assemble top body with plunger spring in place as shown in figure 53. Assemble housing gasket in place so that the plunger drain hole will be open. Assemble top housing to body and tighten the two fillister head screws in place.

k. To Reinstall Injector.

(1) Wash all parts with clean kerosene or diesel oil and blow off with air before reassembling. With rag and soft pinestick, wipe the seat in the copper sleeve into which injector seats in the cylinder head. This seat must be clean. NEVER ATTEMPT TO SCRAPE OR REAM IT (fig. 54). Place injector into cylinder head (fig. 55).



TL-32170
Figure 53. Replacing injector plunger.



TL-32171
Figure 54. Cleaning injector sleeve.

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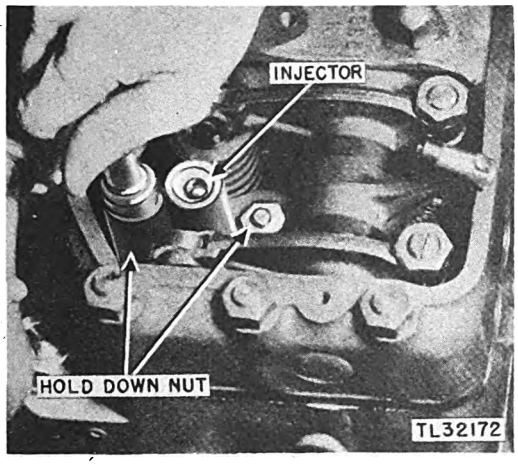
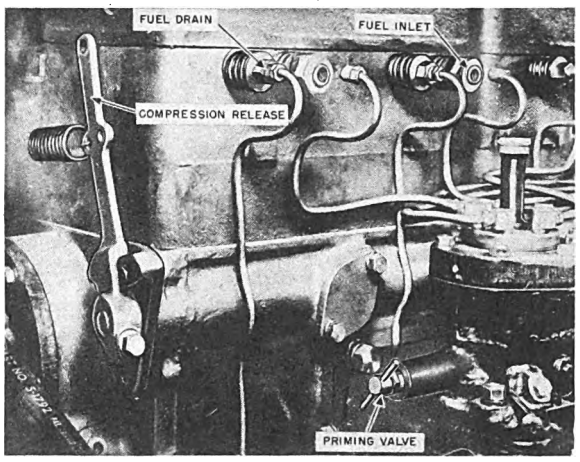


TL-32172
Figure 55. Tightening injector hold-down nut.



TL-32173
Figure 56. Fuel and drain connections.

(2) Screw fuel strainer or drain connections in about two threads to line up injector. Be sure each has a good copper gasket on the shoulder where it screws into the injector (fig. 59). Screw on the injector hold-down nuts. Tighten first one and then the other alternately, pull down both with an even tension. These nuts should be pulled tight enough to seat the injector firmly in the head but not tight enough to strain the injector. Tilt rocker arm into operating position. Screw in adjusting screw enough to hold rod in place (fig. 58).

(3) Tighten fuel inlet and drain connections firmly to prevent any leaks (fig. 28). Then connect the fuel and drain lines to inlet and drain connections (fig. 56).

(4) Whenever an injector is installed in the engine, it is always necessary to spot the engine and set the adjustment of the plunger as directed under *injector plunger adjustment*, paragraph 57.

l. Injector Plunger and Valve Adjustment.

(1) Release compression with lever (fig. 3) and crank over the engine slowly in its operating direction until the injector rocker lever, the center lever, starts moving downward, pushing the injector plunger down with it.

(2) When this lever starts its downward movement, continue to crank the engine over slowly for approximately ⅛″ turn until a notch marked 1 and 6 VS on the fan drive pulley registers with the center line mark on the gear housing (fig. 57).

(3) Number one cylinder is now in position to set the injector. Loosen the locknut on the injector lever adjusting screw. Back the locknut off several turns to prevent a false adjustment.

(4) With a screwdriver provided with unit, screw the adjusting screw down as far as it will go, firmly seating it. No clearance is permitted on the injector plunger setting (fig. 58).

(5) Do not slack off this adjustment. All the fuel that lies in the injector cup must be expelled, and the plunger tip must bottom firmly on injector plunger seat of cup. This setting prevents dribbling of fuel and entrance of gases in the injector cup at the wrong time. The plunger must be made to seat firmly and whenever clearance occurs it must be readjusted to a firm seat again. Tighten the adjusting screw locknut securely.

(6) The same position is used for setting intake and exhaust valves. Close compression relief and set valves with 0.014 intake and 0.022 exhaust clearance.

NOTE: Ascertain that compression relief lever is in running position before setting intake valve. Adjust valves when engine is warm.

(7) Before setting injectors, check the following points to make sure the engine is in correct position for the adjustment.

(a) Both intake and exhaust valves of the cylinder being adjusted must be at closed position (valve rollers turn), when the injector plunger adjustment is made.

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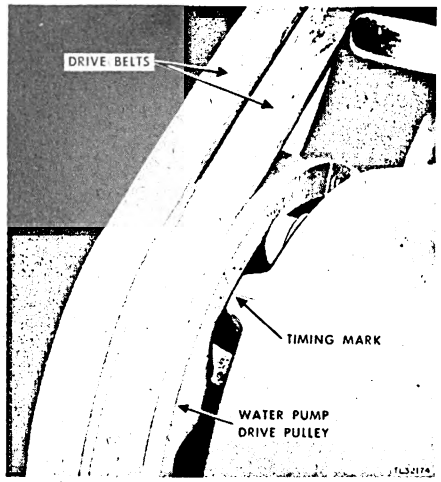
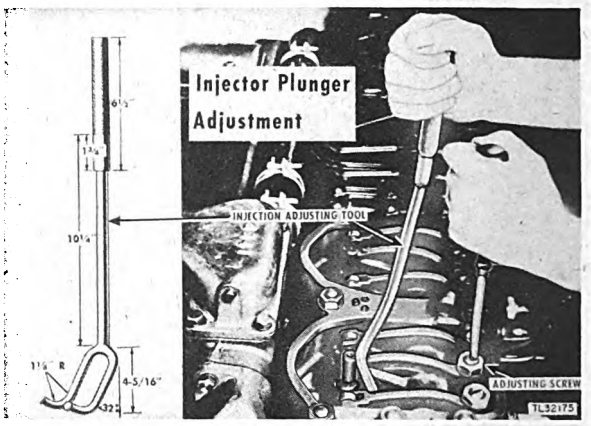


TL-32174
Figure 57. Index timing marks on fan drive pulley.



TL-32175
Figure 58. Setting the injector.

(b) The VS notch on the fan drive pulley must register with the center line on the gear housing. Turn the engine over until the next VS notch cut in the fan drive pulley indexes with the center line mark on the gear housing. This brings the cylinder listed next in the firing order to the correct position for injector and valve setting.

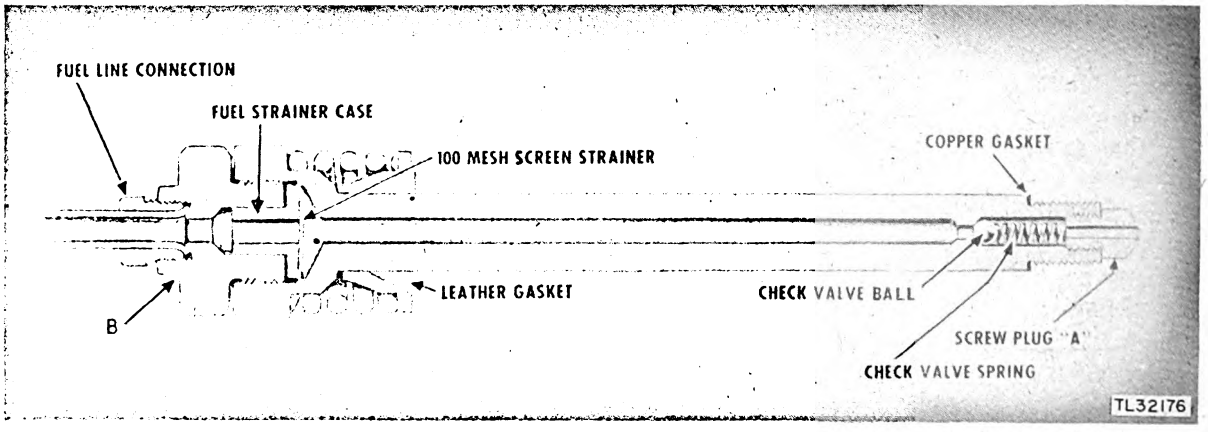
(c) Follow the procedure and continue in this manner until all cylinders are set. Adjust injector plunger settings after the first 50 hours of service. Reset each 250 hours of service thereafter.

m. Injector Filter Check Valves.

(1) There are two check valves in the fuel line between the fuel pump and the injector cup. One is in the fuel strainer connection and the other is in the injector body, near the fuel nozzle. These check valves open when the fuel pump forces fuel through them, admitting the fuel to injector cup and then closing when the pump delivery has finished.

(2) The check in the strainer connection should be checked occasionally for leaks. To check for leaking of check valve, drain out tube by removal of plug A, figure 59. Replace plug A and suck on fitting, and create a vacuum in tube by holding tongue over hole. Check valve is leaking if no vacuum is created. Renew valve and spring if leaking. Tap the old ball on seat with brass rod if new ball will not seat. Replace with new ball check.

(3) Located in the strainer connection is a small strainer. This strainer is accessible by removing the brass hexagon nut from the



TL-32176

Figure 59. Injector inlet connection.

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body. This should be cleaned occasionally. If the screen is replaced, a mesh of not less than 100 to the inch should be used.

(4) The small copper gaskets on the strainer and drain connection are very important. Should these gaskets leak or be left off, dilution will be encountered. These gaskets should be renewed if they show signs of cutting out. These gaskets are threaded and screw on to the ends of these connections. Threaded gaskets should be used when renewing.

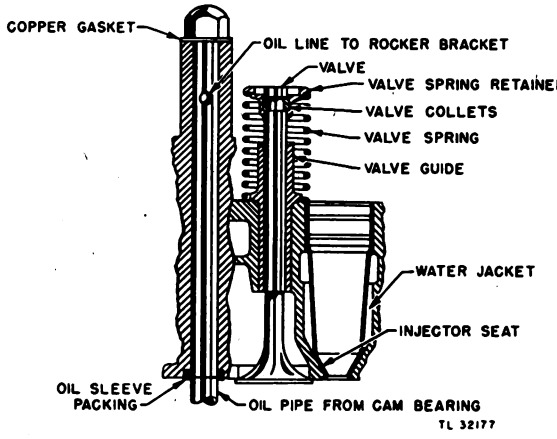
67. CYLINDER HEADS. The cylinder heads are cast in pairs and seat upon a copper asbestos gasket, which is provided with holes to permit the cooling water to pass from the block to the head. This gasket has a soft solid copper ring insert around each cylinder bore which holds the compression. THIS GASKET SHOULD BE REPLACED BY A NEW ONE WHEN ONCE REMOVED OR COMPRESSION, OIL, AND WATER LEAKS WILL RESULT. When the cylinder heads are removed, care must be taken not to nick or mar the face of the head. Any small nick or dent in the gasket seat will make the gasket useless.

a. Disassembly. Place cylinder head on bench and compress valve spring with tool supplied (fig. 61). Take out valve spring locks, retainers, springs, and valves. The valve guides are pressed into the cylinder head and the valve stems have 0.002 to 0.003 clearance when installed. When renewing these guides, they should be driven in with the valve guide inserter to prevent any distortion and reamed to size with a standard ½" reamer. If valve guide bushings require replacement, they can be driven out from under side of head. Use tool supplied with unit. It is not necessary to remove the head to install a new valve spring. Turn the engine over until the piston in the cylinder to be changed comes to top center. The valve spring can then be compressed and the new spring installed.

b. Valve Stem Guide Repairs. Place cylinder head on work bench with smooth face up; insert valve guide knockout tools into guide of valve port. Use press if available or heavy hammer to knock out guide. To insert guide, place cylinder head face down on a smooth wooden bench. Line up new guides in hole by light taps with hammer. Use inserter tool in guides and drive guides until they bottom on head. Use one-half inch reamer furnished with tool kit to ream out guides. Always reface valve seats after inserting new valve guides.

CAUTION: USE A FLAT SURFACE HAMMER TO PREVENT SLIPPAGE OF HAMMER OFF TOOLS AND DAMAGING VALVE SEAT.

c. Injector Seat. The injector seat in the cylinder head is at the lower end of a copper sleeve and should always be wiped clean with a rag on a soft pine stick when changing injectors. If this seat becomes scratched or nicked, the compression will blow through and trouble will result (fig. 60). This copper sleeve is in direct contact with the cooling water and is rolled in place. This sleeve should never be removed unless proper facilities are available to perform the necessary operations on it. When the head is removed, do not set it face down on any hard surface or damage will result to this sleeve.



TL 32177

Figure 60. Valve and lube tube.

d. Valve Grinding.

(1) Valves should be refaced only when warped or leaking. If the valves show a good seat all around and are only slightly pitted they should not be ground. These pits are small particles driven into the seat and would appear again after a few hours run. Repeated grinding counts on the life of the valve and seat so they should only be ground when

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found warped or leaking. The valve seat should be as narrow as possible as a narrow seat will catch less carbon and stand up much longer. The valves have a 30° seat with a ½" diameter valve stem.

(2) In grinding valves in the cylinder head, it is of utmost importance that the valve stems and guides are free from carbon. If a motor driven valve guide cleaning brush is available, use it, if not, the valve guides can be cleaned by wrapping a piece of emery cloth on a round rod and rotating until all carbon is removed. Valve stems can be cleaned by rubbing lightly with emery cloth. Be sure to remove all emery residue.

(3) Remove all carbon from the cylinder head and valve parts by scraping. Insert valves in cylinder head and be sure that they are free in guides. Remove one valve and coat lightly with grinding compound and insert in cylinder head, insert valve grinding tool in slot and rotate 30 to 40 turns, lifting valve occasionally to prevent ridging. Remove valve from head and wipe grinding compound from valve face and seat. CLEAN THOROUGHLY.

(4) Examine valve seat and valve face for carbon pits. Proper seating can be checked by making light, soft pencil marks (fig. 62) across valve face at intervals and then rotating the valve under pressure part of a turn. The rubbing or smearing of all pencil marks indicates proper seating. If seats are not smooth or do not prove out as indicated, repeat regrinding operation until properly finished.

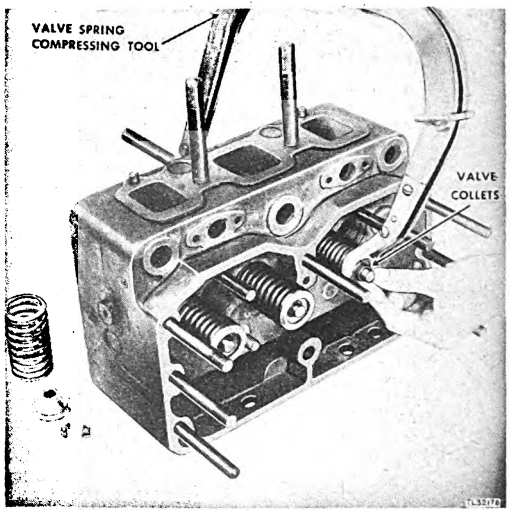
(5) If, in the removal of the valves from the cylinder head when engine is disassembled, the valve faces are found to have a ridge, replace these valves with new ones and grind into cylinder head as outlined above.

(6) If carbon forms on stem of intake valve, it may be due to lubricating oil catching dirt passed through improperly cleaned air filter.

(7) After thorough cleaning of all parts, reinstall valves, springs, retainers, and locks, using valve spring tool shown in figure 61.

NOTE: Always use valves marked CECO. Use valves marked EX in the exhaust.

e. Installing of Cylinder Head Gaskets. Wipe block face clean of all dirt and grit. Scrape down any uneven surfaces and clean cylinder head studs and oil tube. Clean and install new cylinder head gaskets. On top of cylinder head gaskets screw on and slide down over lube oil pipe, two leather packing rings (fig. 63). Clean off and install cylinder head.



TL-32178
Figure 61. Assembling valve springs and locks.

f. Oil Pipe Packing. On the bottom face of the cylinder head, next to the block, where the oil pipe comes through to the rocker arm bracket, there is a counter bore for two leather packing rings. This packing prevents the oil from coming out under the head and should be replaced when the head is reinstalled (fig. 63).

g. Tightening Cylinder Head. Blow out cylinder head with air pressure and clean surfaces before installing. When reinstalling cylinder heads, it is very necessary that all nuts are cleaned, oiled and pulled down evenly, in rotation shown in figure 64. All nuts should be tightened a little at a time, going from one to another in turn and continuing by this method until the nuts are all pulled up tight. Use heavy duty wrench supplied with tool kit. Try to maintain a steady tension on all nuts while drawing down cylinder heads. Use this heavy duty wrench until no more tension can be taken. Use torque wrench and pull each nut down in graduation of 30 ft. lbs. until all nuts are pulled down to 425-450 ft. lbs. tension (fig. 65). Do not use a long piece of pipe on the wrench or damage may result to the cylinder block due to the strain set up.

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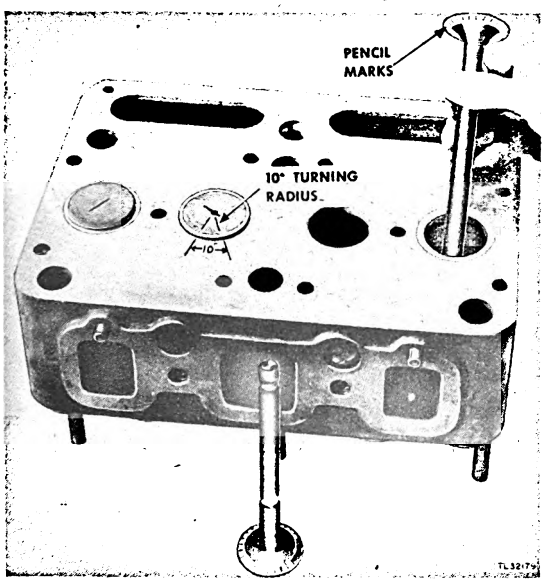
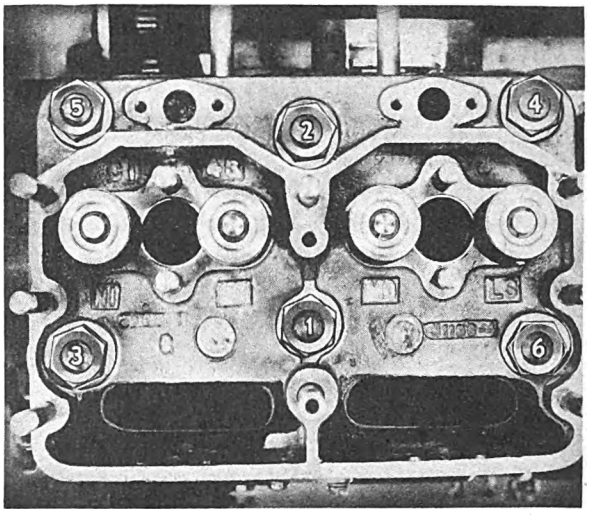
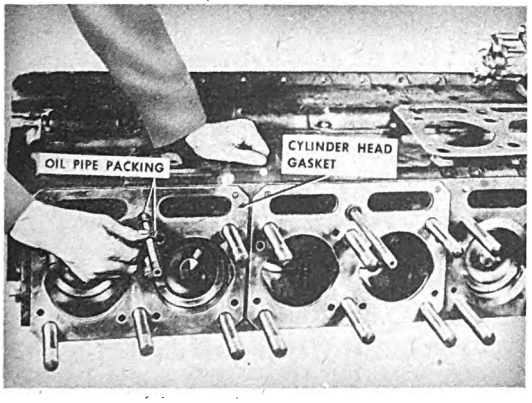


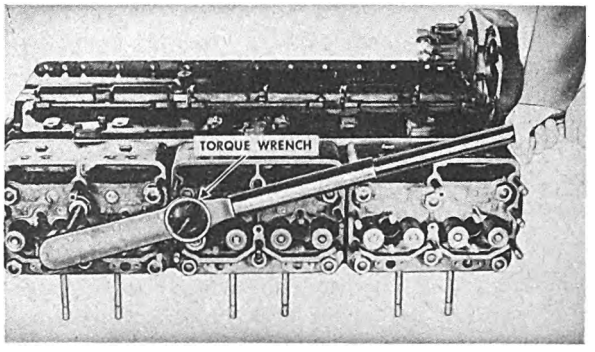
TL-32179
Figure 62. Checking valve seat and valve.



TL-32181
Figure 64. Routine for tightening cylinder head nuts.



TL-32180
Figure 63. Installing cylinder head gasket and lube pipe packing.



TL-32182
Figure 65. Torque wrench on cylinder head nuts.

68. UPPER VALVE ROCKER ASSEMBLY.

a. Rocker Arm Housing. The rocker arm housing contains two sets of levers of three each. One lever in each set is for the exhaust valve, one for the intake valve, and the third or center lever is the injector lever.

b. Removal of Rocker Assembly.

(1) To remove rocker assembly, loosen injector and valve adjusting screws three turns.

(2) Remove seven nuts and oil pipe cap and gasket.

(3) Lift housing assembly from engine.

(4) When removing push rods or any other parts, see that they go back in the same place from which they were removed. This is very important on the intake valve push rod. The heavy rod is for the injector lever or center lever. Do not use this for the exhaust lever (fig. 66).

c. Valve Push Rods. Each cylinder has three push rods. The two outside ones operate the intake and exhaust valves and the center one is the injector push rod. The intake push rod has a collar on it which works in a notch in the compression relief shaft running through the cylinder block. When the compression relief lever is held back the intake valve is held open by the notch in the shaft and the engine may be turned over easily, as it is then not working against compression (fig. 66).

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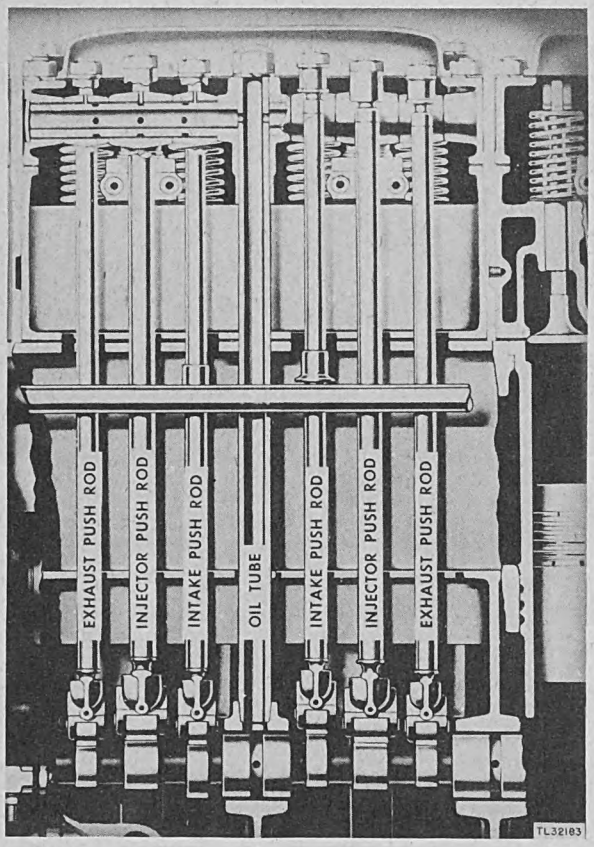


TL-32183
Figure 66. Push rods.

d. Servicing Rocker Assembly.

(1) Take out set screw that holds rocker arm shaft in housing (fig. 67).

(2) Remove expansion plugs at each end of housing. With sharp pointed punch, drive through plug on one end and drive shaft far enough to remove plug from opposite end.

(3) Drive shaft out of housing from either end, and remove rocker arms.

(4) Drive bushings out of levers with suitable drift.

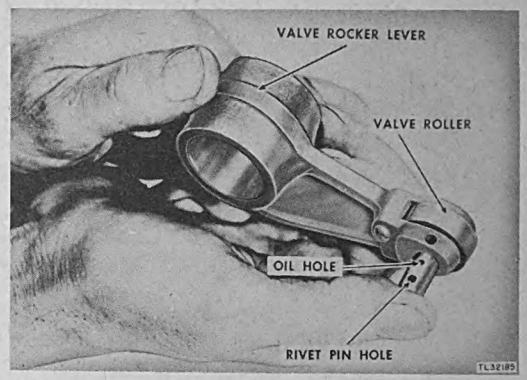
(5) To remove rocker arm roller, tap out rivet and remove pin and roller.

(6) To remove injector rocker socket, press out from top side of lever.

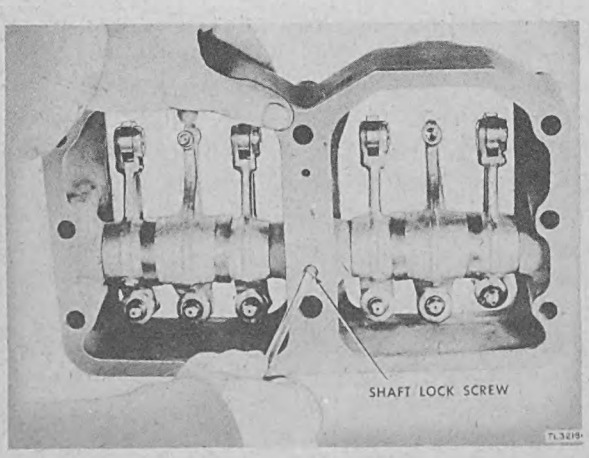
(7) Remove jam nuts and adjusting screws, wash all parts thoroughly and check for wear and open lubrication passages.

(8) Install new rollers and roller pins, if required, and rivet in place with new rivets. Only exhaust rocker levers are drilled for lubrication to valve rollers (fig. 68).

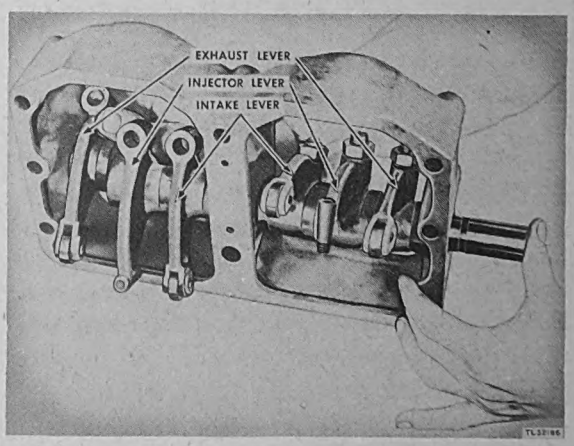
(9) Press new bushings into rocker levers. Observe that the bushings used for levers must be installed so that the holes for lubri-



TL-32185
Figure 68. Assembling rocker lever roller pin.



TL-32184
Figure 67. Valve rocker assembly.



TL-32186
Figure 69. Upper rocker housing.

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cation are correctly lined up. Ream bushing to 1.125".
(10) Assemble injector rocker lever socket.
(11) Assemble the levers in the housing, and push rocker shaft in place (fig. 69).
(12) Install lock screw holding shaft and tighten securely.
(13) Install new expansion plugs in each end of housing.
(14) Install circlips between rocker levers.
(15) Place new gasket over studs to cylinder head.
(16) Install rocker housing over studs to cylinder head. Align push rods with adjusting screws.
(17) Install seven nuts and tighten securely.
(18) Install oil pipe line cap with new gasket.
(19) Readjust valves and injectors.

69. WATER MANIFOLD ASSEMBLY. The manifold connects the cylinder head discharge ports to a thermostat and bypass housing assembly which leads the discharged water to the radiator for cooling or back to the suction side of water circulating pump. Capscrew connections are made at each cylinder discharge port to water manifold flanges. Hose connections are made between manifold and radiator and bypass pipe connections, which lead back to water pump.

70. OIL PAN. The capacity of the oil pan is 12 gallons and is fastened to the engine block with 7/16" capscrews and bolts. In order to remove the oil pan from the unit, the following procedure should be followed:

a. Remove the batteries and battery trays from the engine base.

b. Clean the outside of the unit thoroughly with brush and cleaning solvent.

c. Drain oil pan.

d. Drain and remove lube oil filter in pan housing.

e. Remove lube oil drain piping from the oil pan and the oil filler spout and dip-stick housing assembly from the side of cylinder block.

f. Disconnect lube oil lines on fuel pump side of engine including the rear oil seal drain line.

g. Remove all mounting capscrews and bolts from oil pan, with the exception of two, one on each side. Loosen the two bolts enough to drop the pan three-eighths of an inch.

h. Slide a 1" wooden plank across base under pan.

i. Brace pan with plank on one side and remove bolt and lower pan on plank. Proceed to the other side and repeat operation. Pan may then be slid out on plank and removed for cleaning.

j. Remove screen from pan and flush out thoroughly.

k. Reassemble screen and install new filter bag.

l. To reassemble pan to engine reverse procedure.

NOTE: Do not destroy pan gasket unless a replacement gasket is available. It is recommended that a new gasket be installed when replacing oil pan. Ascertain that gasket does not fold over when installing pan on engine block.

71. GENERAL BEARING INSTRUCTIONS.

a. Type of Bearings. Main and connecting rod bearings either standard or under size, are precision type and are provided with the recommended clearance for the oil film on the shaft. UNDER NO CIRCUMSTANCES SHOULD ANY ATTEMPT BE MADE TO SCRAPE OR REAM THESE BEARINGS.

b. Method of Measuring. The method of measuring a bearing shell as shown in figure 70 is to use a micrometer in conjunction with the steel ball, the latter of which will rest on the inside of the bearing shell. Bearing wear can be found by checking the dimensions of a new bearing shell against that of the old one. As bearing shells are in halves, it will be necessary to take the worn dimension of the bearing shell in the bottom half of the shell. A properly fitted bearing, after a reasonable period of service, will show a dull gray appearance indicating running on an oil film. Bright spots indicate metal to metal contact and black spots, excessive clearance.

c. Tightening and Regrinding. Tighten all connecting rod bearing nuts to 105-115 ft. lbs. on torque wrench. If it becomes necessary to regrind the crankshaft, finish grind to standard undersizes; −0.010", −0.020", −0.030", and −0.040" undersize bearings are available in these sizes.

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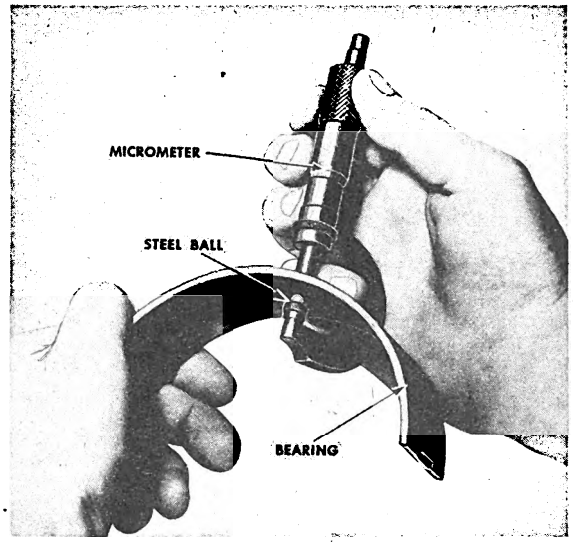


TL-32187
Figure 70. Method of checking bearing wear.

72. CONNECTING ROD AND PISTON. The piston and connecting rod are so closely associated from a service standpoint that the two will be collectively explained in the instructions covering the operations for repairs.

a. Inspection of Connecting Rod Bearings. Straighten lock plates for nuts on connecting rod cap, remove nuts and take off cap. Connecting rod bearings may be examined or replaced without removing rods from engine. Particular care should be exercised that rod caps are not interchanged. Matched numeral marks stamped on the connecting rod and cap must face camshaft side of engine. Small lip projecting from bearing shell fits in the groove of rod and cap for the purpose of doweling it in place (fig. 72).

(1) Before fitting new bearings, clean the crankpin carefully. The back of bearings and bearing seats must be smooth and clean, otherwise the bearings will not fit the shaft properly. Be certain the oil feed holes from the main bearings are open and clean.

(2) Check condition of crankpin surface for out-of-round, wear and taper. Shaft limits when new are 3.125" diameter and 0.0005" for out-of-round and taper.

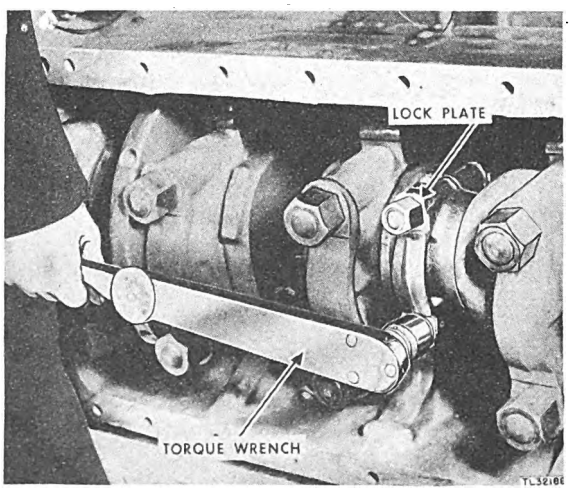
(3) It is very important, when installing the new Bohn lead bronze bearing and connecting rods, that the clearances should be not less than 0.003", and not more than 0.005".

(4) Never file connecting rod or bearing caps. This will cause bearing failure and replacement of parts filed.

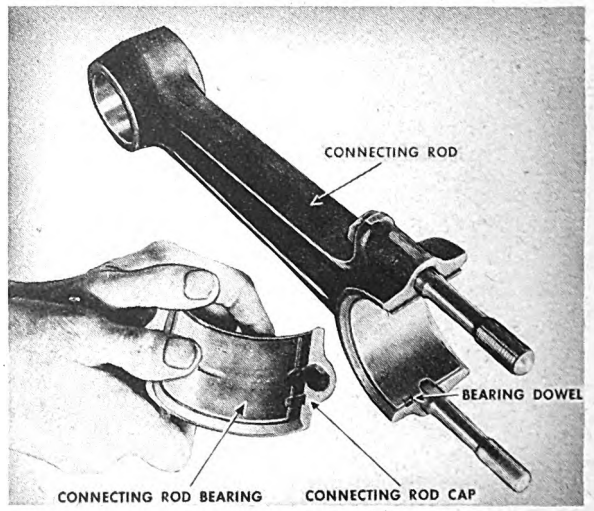
(5) Working from below, place rod and bearing on crankpin, and install bearing shells in position (fig. 71). NUMBER ON ROD AND CAP MUST BE TOWARD CAMSHAFT.

(6) Install lock plates and nuts and turn nuts up tightly to 105 to 115 ft. lbs. on torque wrench before locking with lock plates.

(7) When pulling up the connecting rod nuts, the last 30 lbs. should be applied by pulling steadily on the handle of the wrench until the proper reading is reached. Do not jerk on wrench or reading will be incorrect.



TL-32188
Figure 71. Torque wrench on connecting rod nut.



TL-32189
Figure 72. Connecting rod bearing and dowel.

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b. Inspection of Connecting Rod and Piston. Removal of piston and connecting rod assembly can be made as one unit, by removing lower bearing cap and bearings, and scraping all carbon from inside of cylinder. Push connecting rod up from below and remove piston and rod assembly from top of engine.

(1) The connecting rod is rifle drilled from the crankpin hole to the piston pin hole to distribute oil under pressure to the wrist pin and bushing. The upper end of a new connecting rod contains a hard bronze bushing which is pressed into connecting rod and bored and honed to an accurate size of 2.0015". The hole in the larger end of connecting rod is finished by grinding to provide a smooth backing support for the bearing shells and accurate alignment with the piston pin hole.

(2) Pistons are made of special alloy iron and carefully balanced. Whenever a piston needs replacing be sure to obtain the same weight of piston that is being renewed in the engine. All weights are stamped on top of piston.

(a) Remove snap ring from each end of piston pin and push pin out by hand or use a soft wooden drift.

(b) Remove piston rings, using expanding type pliers.

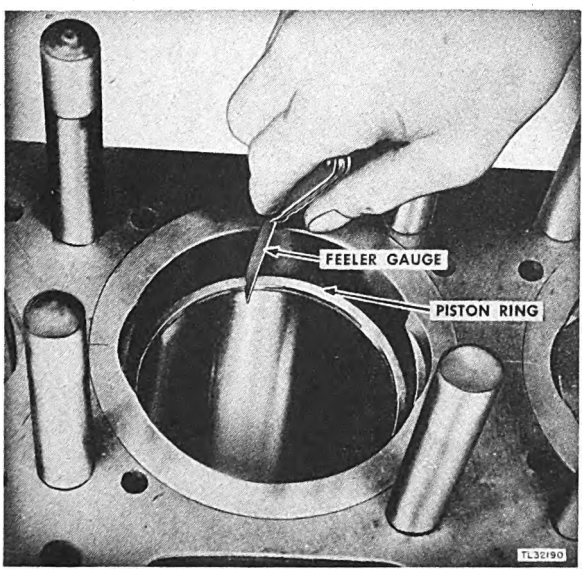
(c) Piston ring grooves must be carefully cleaned of all carbon particles. Polish up piston crown, skirt and piston pin bore with crocus cloth. Clear out all carbon from drain holes in piston oil grooves. Chip out any carbon formation inside of piston. Flush out piston in fuel oil and dry down with air.

(d) Wipe piston dry with clean rag, not waste, and remove any burrs or carbon scores with a fine grain file, finish with a honing stone. Score marks on piston crown or ring lands will not necessarily affect combustion or efficiency of engine. Blow down with clean dry air after cleaning and servicing of piston has been completed. Give piston a detailed inspection for any cracks, hot spots or irregularities in ring grooves.

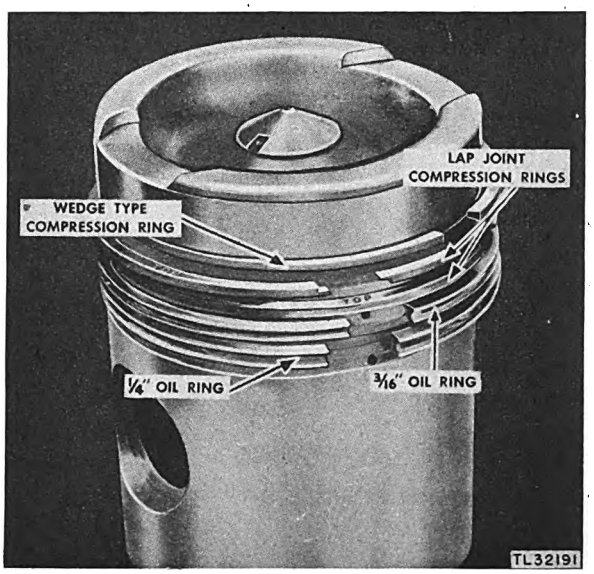
(e) Check wear of piston with a micrometer or by the difference of clearance, when inserting piston in a new liner and rechecking with a new piston in same liner.

NOTE: Piston diameter must be checked at right angle to piston pin hole on skirt of piston for largest diameter.

(3) The piston pin is of the full floating type and is held in place by two snap rings which fit into grooves machined in the piston. The piston pin is fitted to the piston with 0.0005" clearance or until it can be pushed in with the fingers. After the snap rings are in place, the pin should be able to turn in the piston, and connecting rod.



TL-32190
Figure 73. Checking piston ring gap clearance.



TL-32191
Figure 74. Assembling piston rings.

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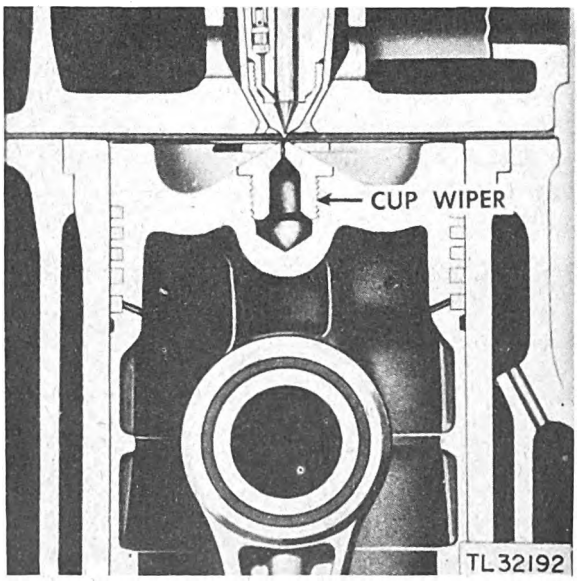
(4) The piston pin bushing is of special bronze and is a press fit in the rod. Three oil grooves with holes leading into the oil groove turned on the outer circumference of the bushing furnish lubrication. A clearance of 0.0015″ is allowed between the pin and bushing.

(5) The cup wiper located in the center of the piston is installed to give better combustion and to prevent carbon from forming on the end of the spray nozzle. The cup wiper should never be removed unless found in a damaged state. There is no wear to this part.

(6) The cup wiper is locked into place by the washer under the head. A ⅛″ hole is drilled in the piston head under the outside edge of the washer. Sink the washer into this hole with a small punch. Turn up one side of the washer in the slot on the cup wiper to lock it securely in place (fig. 75).

(7) The top compression ring is a wedge type ring and should be fitted to the cylinder liner with a minimum of 0.015″ and a maximum of 0.025″ joint clearance when new (fig. 74).



TL-32192

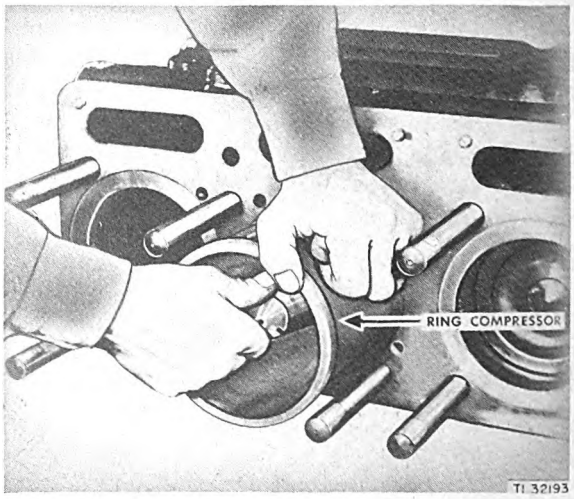
Figure 75. Injector cup wiper.

The next two compression rings are lap joint rings and are marked TOP as shown in figure 74. Always put this side up and do not file joints of these rings. Use a feeler gauge to measure ring joint clearance (fig. 73). The oil rings should be fitted to a minimum of 0.015″ and a maximum of 0.018″ joint clearance. These clearances should be adhered to closely. It is very important that all carbon and sludge deposits be removed from the piston, ring grooves and oil holes before assembling with new rings. Install piston rings, staggering their gaps so that they are not in line with each other or with the piston pin hole. Install each piston ring so that gaps are 180° apart.

(8) Assemble bolts to connecting rod with ends in locked position and insert connecting rod and piston in top of block. While compressing piston rings with ring tool, push piston down into block (fig. 76).

NOTE: Pistons, rings, pins and rod bearings must be fitted as explained in the preceding paragraphs before beginning installation.

73. CYLINDER LINERS. The engine is built with renewable cylinder liners, which should only be removed for cleaning of jacket water passages, scored liner, or excessive wear in liners.



TL-32193

Figure 76. Inserting piston.

a. Cylinder Wear. Cylinder liner wear can be checked by means of an inside micrometer as shown in figure 77. Measurement should be taken as shown in figure 78, dimension points A to G inclusive. If cylinder liner wear exceeds 0.015″ from diameter of new liner at

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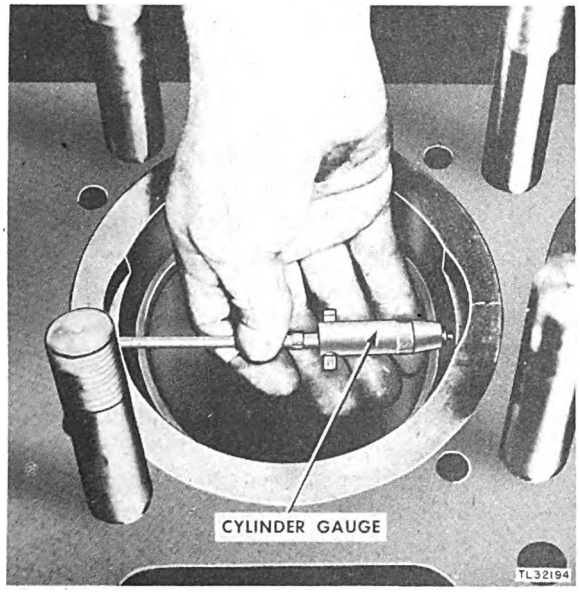
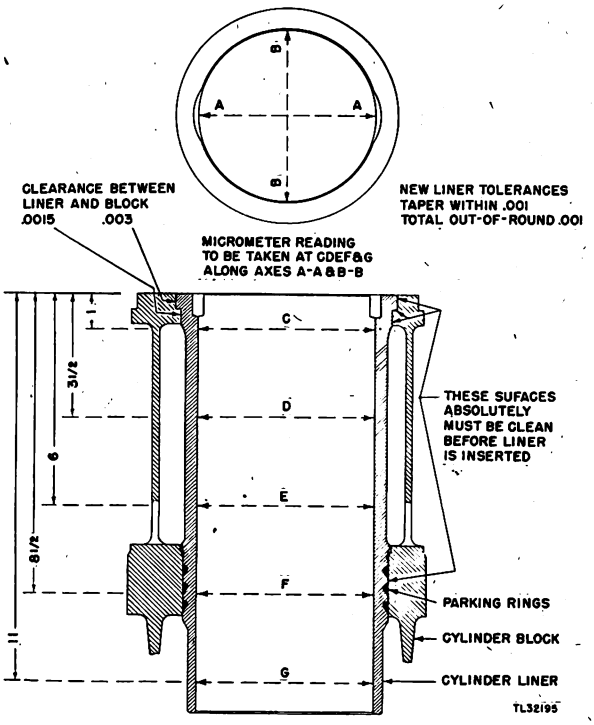
point C, or a difference of 0.005″ at points A and B on measurement line D, the cylinder liner should be replaced. A new standard liner has a diameter of 4.875″ to 4.876″ at all points of measurements.

NOTE: In measuring oversize liners add oversize to standard dimensions.

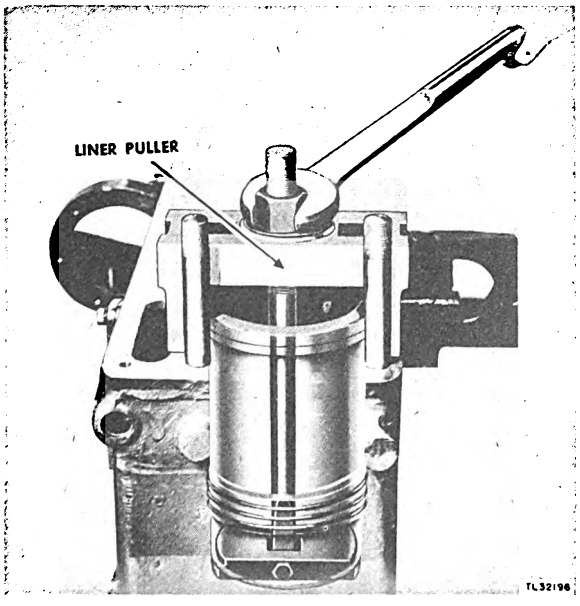
b. Removing of Cylinder Liners. The cylinder liners are held in place by the cylinder head. They are made water tight at the bottom of the liner by three endless rubber packing rings. They may be removed by taking off the head and removing the connecting rod and piston from the engine. A liner puller tool, provided in tool kit, must be inserted



TL-32194
Figure 77. Checking cylinder liner.



TL-32195
Figure 78. Cylinder liner gauge marks.



TL-32196
Figure 79. Pulling cylinder liner.

TL-32197
Figure 80. Cylinder liner.

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and set up as shown in figure 79. Tightening of nut on puller stud will draw out liner from block.

WARNING: COVER CRANKSHAFT WITH A PADDING OF RAGS WHEN PULLING LINER. THIS PREVENTS RUST AND WATER FALLING DIRECTLY ON CRANK JOURNAL. CARE MUST BE TAKEN THAT PULLER DOES NOT FALL ONTO CRANK JOURNAL.

c. Installation of Cylinder Liners.

(1) Scrape rust and scale from liner packing seat and shoulder at top of block.

(2) Try fit of sleeve in engine block without rubber packing rings to assure free fit.

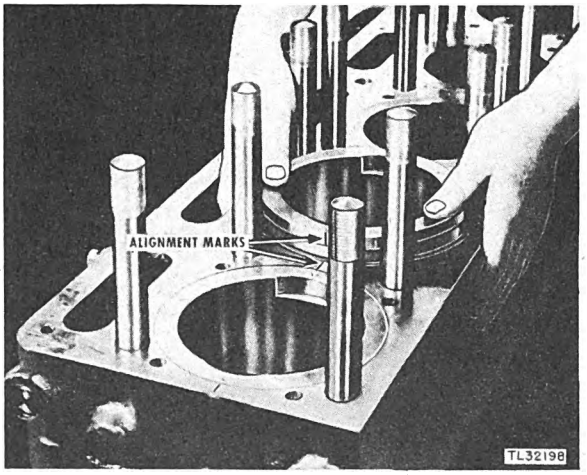
(3) Install the three packing rings in the grooves on the bottom of the sleeve and coat them with soft soap to prevent damage (fig. 80).

CAUTION: Do not use white lead, grease or oil on these rings or serious damage will result.

(4) Insert liner in block with recesses for valves properly located. This is done by locating the line on the side of the liner with the punch mark on top of the block (fig. 81).

(5) Push liner down into block by hand.

CAUTION: Do not drive liner in with hammer, as it should enter by hand pressure only.



TL-32198

Figure 81. Installing cylinder liner.

(6) With cylinder gauge (fig. 77) check inside diameter of cylinder liner for out-of-round as soon as it is placed in the cylinder block. If more than one thousandths out-of-round, or taper from top to bottom is found, pull the cylinder liner and check the bore in the cylinder block for excessive dirt or scale. Reinstall the cylinder liner and recheck at all points with cylinder gauge as indicated in figure 76.

74. CRANKSHAFT AND BEARINGS. The crankshaft is mounted in the cylinder block in seven main bearings. The crankshaft is drilled for oil passage to the connecting rod. Both ends of the crankshaft are provided with an oil sling to prevent the lubricating oil from leaking out. Asbestos seals are placed in the double plates around the crank between the flywheel and rear main bearing on the rear end of the shaft. A metal oil sling is mounted directly behind the crankshaft gear on the front of the shaft. If the flywheel is removed and reinstalled, the zero mark on the flywheel should match with the zero on the crank flange. The crankshaft is counterbalanced and the unit is statically and dynamically balanced.

a. Main Bearings. The main bearing shells are steel backed, precision type and copper lead lined.

(1) Oil is introduced to the main bearings by a drilled passageway from the cam bearings at the point where the load and thrust upon it is the greatest. As the bearing wears and the crankshaft settles down into it, the lubricating oil pressure is thus maintained. This method of lubrication prolongs the life of the bearing shell.

(2) An oil groove is provided in the lower half of bearing shells with holes leading through to index with holes drilled in lower bearing caps. The oil passage continues through in main bearing cap and recess of main bearing stud, into block through keyway groove cut in this same stud, leading into passageway of block (figs. 21 and 22, cross-section of engine).

(3) Number three, upper main bearing shell is drilled to obtain an oil passage to both sides of crankshaft main journal simultaneously. This provides sufficient lubrication for this journal which is not drilled to feed a connecting rod.

b. Bearing Clearance. Main bearings are fitted with a minimum clearance of 0.0055". No shims are provided for adjustments due to the long life of this type of bearing.

(1) Upper and lower main bearing shells are not interchangeable.

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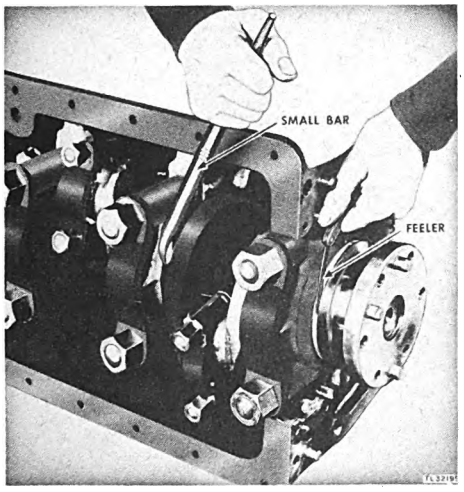


TL-32199
Figure 82. Checking crankshaft end thrust.

(2) The rear main bearing, which is designed to take the crankshaft thrust, must have 0.006" to 0.008" end clearance between the bearing and the thrust flange of the crankshaft. This should be gauged as shown in fig. 82.

(3) To check bearing wear use the method prescribed in general bearing instructions.

c. Renewal of Main Bearing Shells. Should the bearings become worn to a point where they are in need of adjustment, they should be replaced by new shells. Should a bearing burn out, remove melted bearing carefully from the oil holes in the block, bearing caps and crankshaft. Failure to do this will result in another burned bearing. If the remaining bearings have had considerable service, it is recommended that all be replaced.

(1) To change the main bearing shells in the engine it is not necessary to remove the crankshaft from the block.

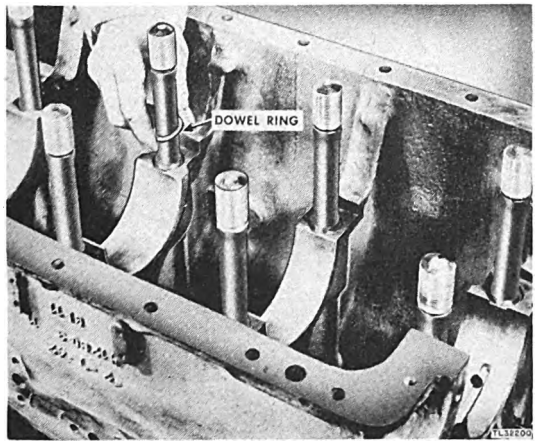
(2) Main bearing shells are positioned in the cylinder block and lower bearing caps by a dowel ring on each stud opposite the camshaft side of the engine (fig. 83). This prevents turning of the bearings in the block. A recess is provided in bearing shells for butting of shell against dowel rings (fig. 86).

(3) Main bearing caps can not be interchanged or turned end for end. Numbers stamped on the caps in line with corresponding numbers stamped on the web of the crankcase, are matched marks and these marks must coincide. Caps are machined at the sides to fit locator shoulder in the block and prevent sideway movement (fig. 84).

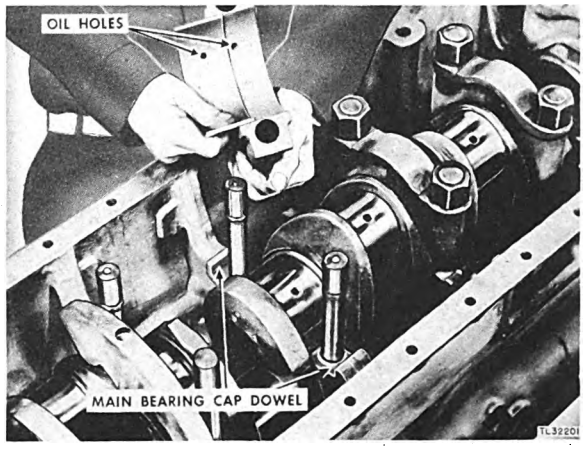
(4) Do not file caps. Main bearing caps should not be filed at any time, as filing the cap changes the shape of the bearing hole.

(5) Holes in the crankcase for main bearings are line bored to close limits and have a smooth finish to provide firm support for the main bearing shells.

(a) First remove the lower bearing cap and shell. Then turn the crankshaft slightly; the upper bearing shell should roll out with the crank as it turns. Should the shell be stuck in the block, a small piece of brass 5/16" diameter and about ½" in length may be used in the oil hole in the crankshaft (fig. 85). It should only extend out about ⅛"



TL-32200
Figure 83. Main bearing dowel ring.



TL-32201
Figure 84. Registry of oil hole in main bearing and cap.

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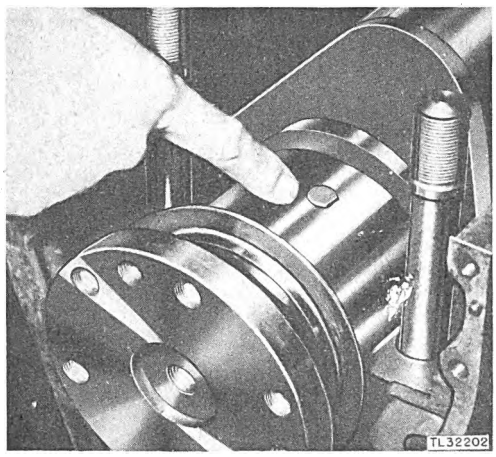
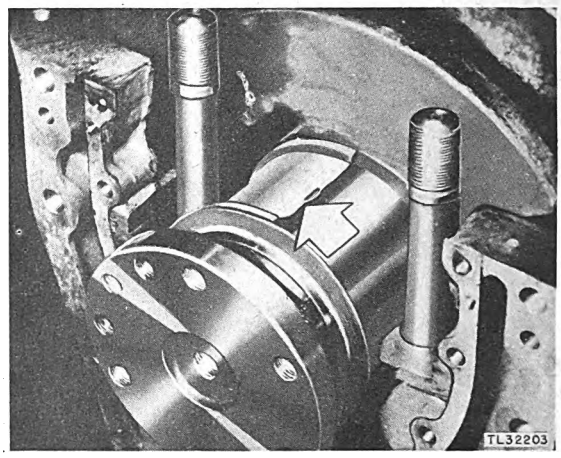


TL-32202
Figure 85. Pin for turning out main bearings.

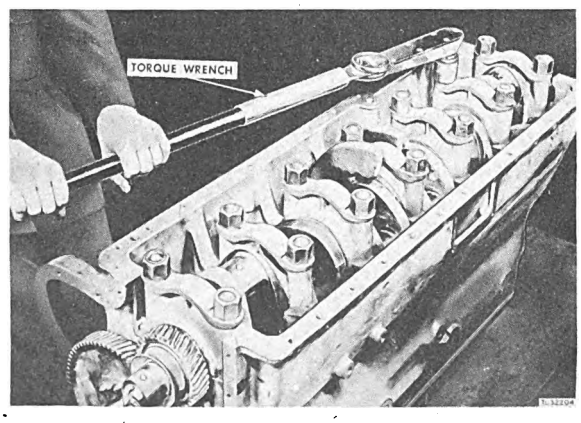


TL-32203
Figure 86. Turning out main bearings.

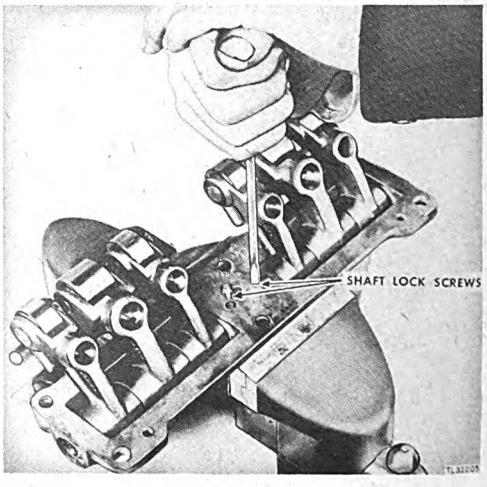
from the crank as shown in the illustration. Roll this pin against the bearing shell and it will be pushed out when the crank is revolved (fig. 86).

(b) Do not fail to remove the plug from the crankshaft after the shell has been removed. If any burr is caused by use of the plug it should be removed with a scraper. Take care to prevent any filings from dropping in the crankshaft hole. New bearings are inserted using the same method. Tighten all main bearing nuts to 310-330 ft. lbs. on torque wrench (fig. 87).

75. CAM ROCKER LEVER ASSEMBLY. Rocker levers with roller running on the camshaft carry the valve and injector push rods at their lower end. To remove these rocker assemblies it is necessary to remove upper valve rocker arm assemblies, (par. 68). The push rods may then be removed from the sockets in the cam rocker levers. The instrument panel and fuel pump must also be removed for access to rocker lever assemblies. Remove cap screws from cam rocker assemblies. Pry off housing and levers from locating dowel pins. The same thickness of gaskets between the cam rocker housing and the cylinder block should be maintained as any variation in these gaskets will change the fuel injection timing. Always order from depot.



TL-32204
Figure 87. Torque wrench on main bearing nut.



TL-32205
Figure 88. Shaft lock screws.

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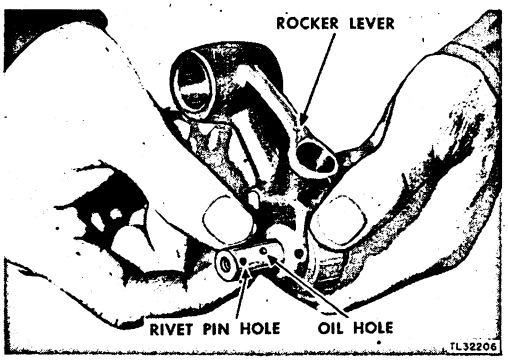


TL-32206
Figure 89. Assembling rocker lever roller pin.

a. Disassembly.

(1) Remove set screws holding shafts in housing (fig. 88).

(2) Drive out expansion plugs. Drive shaft from housing. Use punch to drive through expansion plug and remove plug.

(3) To remove rollers and roller pins, first tap out pin rivet, then tap pin from lever.

(4) If necessary, drive bushings from rockers with suitable drift. Install new bushings making sure oil holes in new bushings are lined up properly. Ream to 0.750".

b. Assembly.

(1) Assemble new pins to rollers in position (fig. 89).

(2) Tap pin through roller and lever, and rivet in place.

(3) Assemble levers and shaft in position, with the injector lever in the center of each assembly (fig. 90).

(4) Assemble shaft lockscrews.

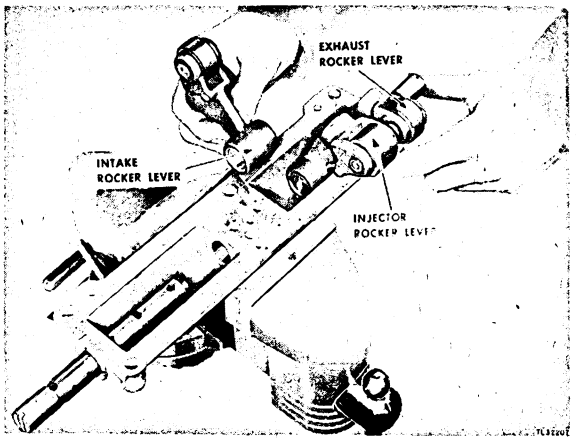
(5) Install new expansion plugs in each end of shaft housing, seating into bore of housing.

(6) Use new gasket and secure to side of cylinder block with lockwashers and capscrews.

(7) Install fuel pump and instrument panel. See paragraph on installing fuel pump on engine.

(8) Replace push rods and upper rocker arm assemblies.

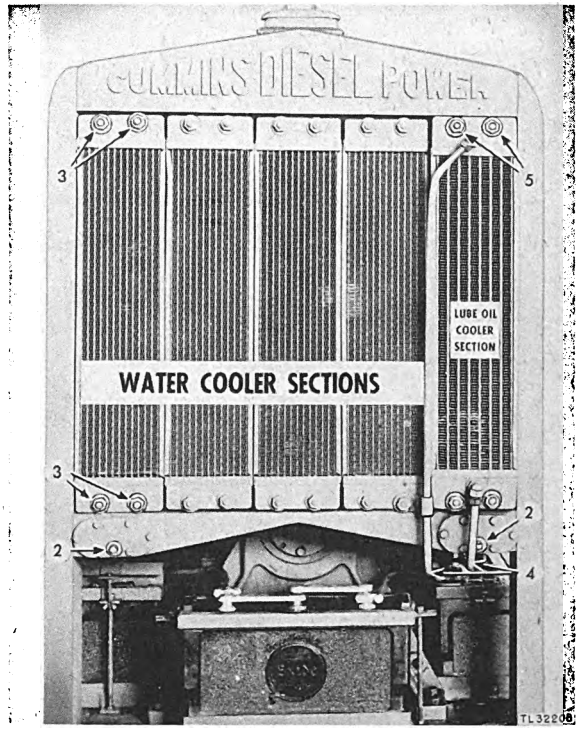
CAUTION: Install push rods in former positions as marked.



TL-32207
Figure 90. Assembling cam rocker lever housing.

76. RADIATOR. Sectional core radiators have four sections for jacket water cooling and one section for lube oil cooling (fig. 91).

a. Repairs. It is recommended that lube oil and water replacement sections be kept on hand and in a repaired condition for exchanging when leaks occur. Do not at any time, try to crimp shut a tube that is leaking. Operators should not endeavor to make repairs except in emergencies.



TL-32208
Figure 91. Radiator sections.

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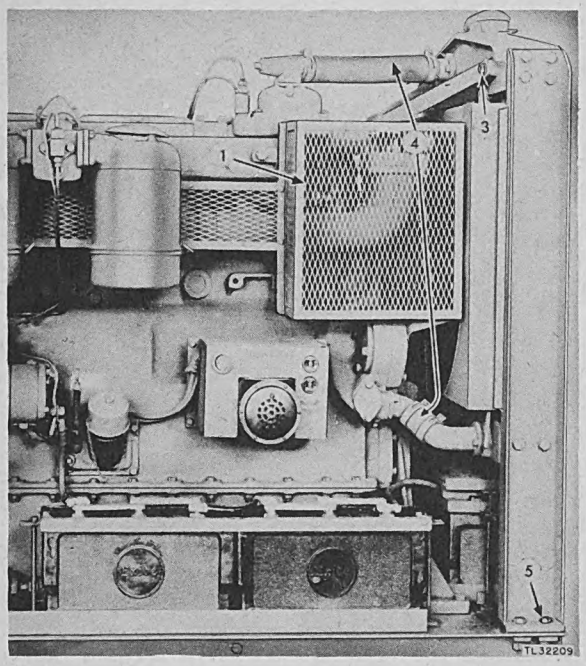
b. Replacement of Jacket Water Cooler Section (fig. 91).
(1) Drain the radiator by removing ¼" plugs (2) at the front bottom of radiator.
(2) Remove jacket water cooler section nuts (3).
(3) Remove jacket water cooler section from radiator assembly.
(4) Scrape off gasket surfaces and reinstall new section with new gaskets.



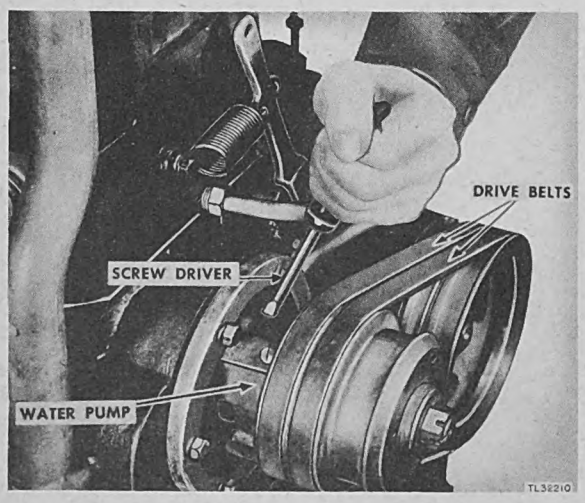
TL-32209
Figure 92. Radiator connection points.

(5) Tighten bolts, refill with water and check for leaks.

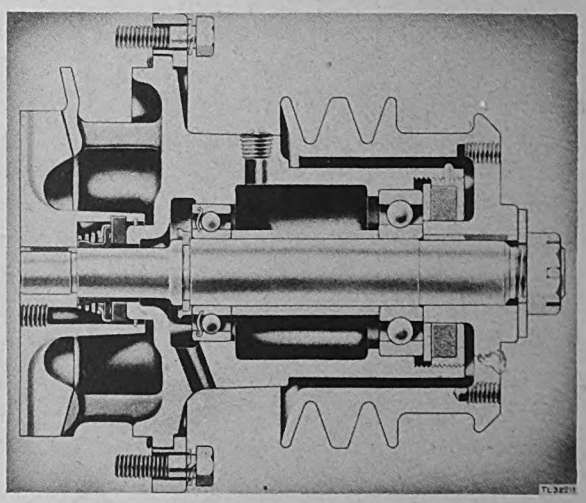
c. Replacement of Lube Oil Cooler Section (fig. 91).
(1) Drain water.
(2) Drain oil out of lube oil section.
(3) Disconnect and remove lube oil lines (4).
(4) Remove section nuts (5).
(5) Remove section from radiator assembly.
(6) Clean gasket surfaces, renew gaskets and install new section.
(7) Reverse procedure when assembling.
(8) Check oil level in crankcase after restarting engine. Check for leaks.

d. Removal of Radiator Assembly. It is necessary to remove radiator to make repairs on fan, water pump, timing gears, and camshaft assemblies.
(1) Drain water and lube oil from radiator.
(2) Disconnect and remove lube oil lines (4) to cooler section as shown in figure 91.
(3) Remove exhaust outlet guard (1) (fig. 92).
(4) Disconnect upper and lower hose connections (4), as shown in fig. 92, from radiator.
(5) Remove fan guard.
(6) Remove bolts (3), fig. 92, from upper radiator bracket.
(7) Remove lower radiator support bolts (5) as shown in figure 92.
(8) Remove radiator from support.

e. Installing Radiator Assembly. Clean off all gasket surfaces and install new gaskets. Replace all connection bolts, lube oil lines,



TL-32210
Figure 93. Tightening water pump drive belts.



TL-32211
Figure 94. Cross section of water pump.

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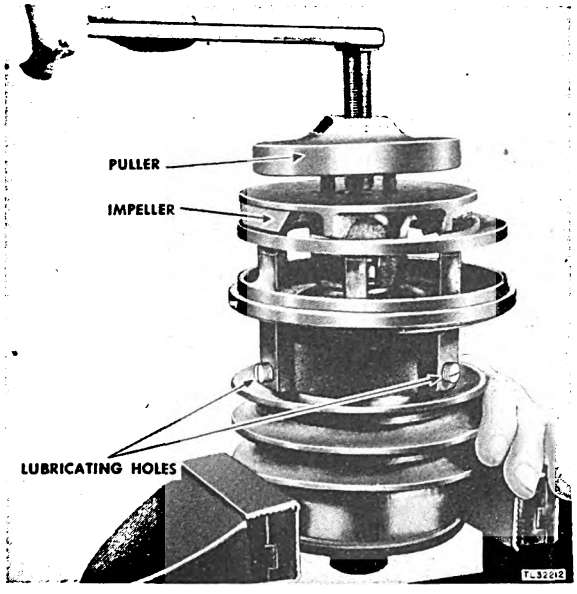
and fan guard. Crank over engine to check that fan does not hit on fan shroud.

NOTE: When replacing radiator on assembly, care must be taken that fan blades are not bent by radiator shroud and fan does not hit against core tubing of radiator sections.

77. WATER PUMP ASSEMBLY.

a. Type. The water pump is of the centrifugal type with the fan mounted on the drive pulley hub. The water pump has no packing. A seal with lapped faces is held in place by spring tension and prevents any leaks. The fan and pump shafts run on two large sealed ball bearings. If the pump leaks due to a scored or broken seal, handle the new seal assembly carefully when replacing to prevent any damage. After these parts are replaced, it is best that the engine be run idle for a short period to see whether or not the seal is seating properly. In most instances you will note that there will be a small water seepage until the seal seats itself. After five or ten minutes the water leak should stop. If the leak does not stop, it is evident that the seal is not assembled correctly and should be dismantled and checked against figure 94.

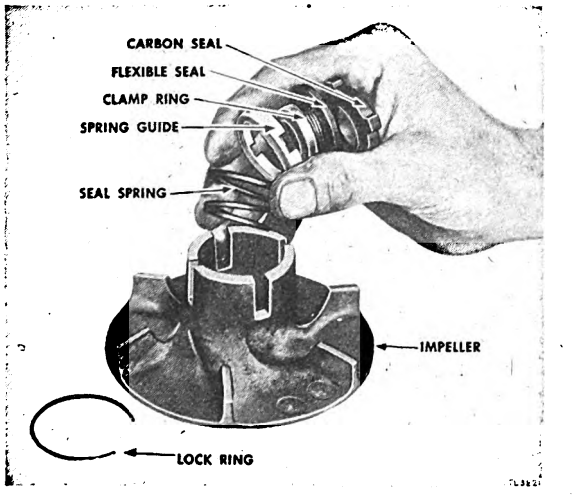


TL-32212
Figure 95. Pulling water pump impeller.

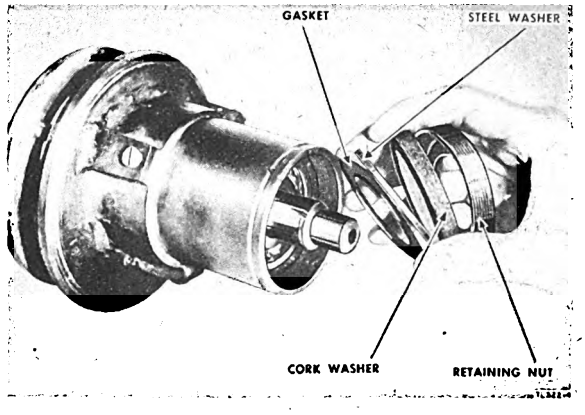
b. Water Pump Drive Belts. The unit is driven by two V-type belts. Belt adjustment is obtained by eccentric mounting of pump assembly. To tighten the belt, loosen the capscrews holding the clamp ring, figure 93. These clamp screws should be loosened only enough to permit the pump to turn on the eccentric, or the assembly will bind, causing the pump to break when it is retightened. The unit may be turned until the desired belt tension is obtained and the clamp ring tightened. These belts should be kept tight or fan belt slippage and heating may result.

NOTE: Due to rust conditions within block and water pump casting, pump may bind and refuse to turn. Tapping on pulley with rubber mallet will break loose rust and binding of pump. DO NOT FORCE PUMP.

c. Water Pump Removal. Should leakage occur in water pump seal, it will be necessary to remove pump for repairs.



TL-32213
Figure 96. Water pump shaft carbon seal.



TL-32214
Figure 97. Water pump bearing retainer.

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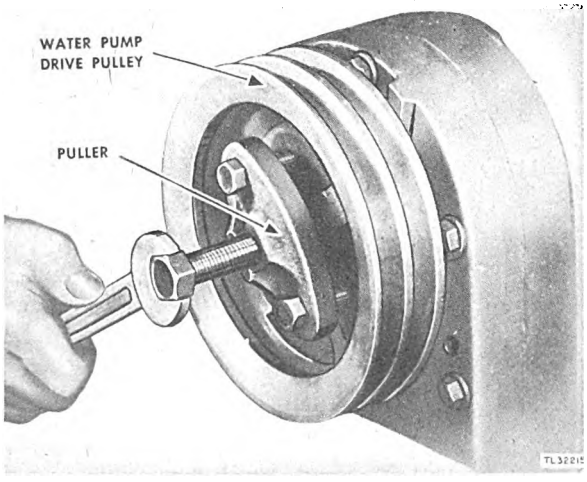
(1) Disconnect radiator connections and remove radiator from pedestal.
(2) Remove fan assembly.
(3) Remove all tension from drive belts, figure 93.
(4) Remove clamp bolts and remove water pump.

WARNING: DO NOT FORCE PUMP OUT OF CYLINDER BLOCK. WORK PUMP OUT BY TAPPING ON HUB PULLEY WITH SOFT MAL LET AND WORK PUMP OUTWARD.

d. Disassembly.
(1) With suitable puller, pull impeller from shaft (fig. 95).
(2) To remove seal assembly, remove small seal retaining cup.
(3) Remove cotter pin, nut and washer and pull drive pulley with suitable puller.
(4) Remove lock ring from pump housing and screw out retainer.
(5) Press shaft and bearing assembly from bearing housing.

e. Assembly.
(1) Assemble bearings to shaft with lock ring and retainer.
(2) With gasket and washers inserted, screw retaining nut down flush with face of housing, lining up lock ring hole and inserting lock ring in place (fig. 97).
(3) Assemble Woodruff key to shaft. Press driving pulley on shaft and lock in place with nut and cotter pin.
(4) Assemble carbon seal assembly to impeller and secure in place with seal retainer cup (fig. 96).



TL-32215
Figure 98. Pulling water pump drive pulley.

NOTE: Inspect face of carbon seal and face of housing on which carbon seal rides for any nicks or scratches. If any scratches or marks are present it will be necessary to face the impeller to smooth flat surface for the carbon seal to ride against for proper operation. Check seal over shaft to see that it fits freely on shaft before assembling. Th.s is very important to insure proper operation of seal.

(5) Press impeller in place until it is down against shoulder of shaft.

NOTE: Small plugs, shown in figure 95, are provided for lubrication of the bearings in the water pump. The use of a good ball bearing grease, periodically, is recommended.

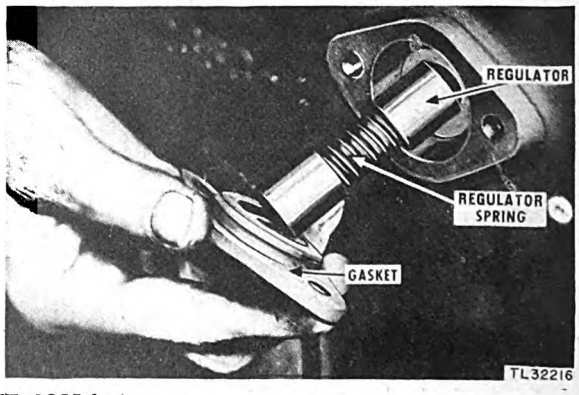
(6) With new ring gasket assemble water pump to the cylinder block with the clamp ring, six lockwashers and capscrews.

NOTE: Tighten capscrews just enough to hold pump in position. Turn pump to low side of eccentric and assemble drive belts to pulleys. Do not force belts over flange of pulley or damage will result.

(7) To tighten water pump drive belts, insert screwdriver and rotate pump body in a counterclockwise direction until belts have acquired proper tension (fig. 93). Then tighten six capscrews.

78. TIMING GEAR CASE. The timing gear case is dowelled and bolted to cylinder block and oil pan. A felt oil seal is provided in the front trunion to prevent seepage of oil along crankshaft. An oil pressure regulator valve thrust plate, is bolted to front of gear case and may be removed for inspection of the pressure regulator valves (fig. 99).

a. Removal of Gear Case Cover.
(1) Remove radiator as previously stated.
(2) Remove fan guards and fan assembly.
(3) Remove water pump drive belts.



TL-32216
Figure 99. Installing lubricating oil pressure regulator.

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(4) Remove water pump drive pulley with suitable puller as shown in figure 98.

NOTE: On engines where it is impossible to use a puller as shown in figure 98, two 7/16" SAE capscrews, 2" long, threaded full length can be used in the two puller holes of the pulley. In using capscrews for pulling the water pump drive pulley, it is very important that a piece of flat iron, ⅛" x 1" be inserted between the water pump drive pulley and gear housing to prevent damage to oil seal. Turn each capscrew alternately one-half turn at a time to insure that the pulley is being pulled from the shaft evenly.

(5) Remove four capscrews in the front of oil pan.

(6) Loosen all capscrews, bolts, and nuts in the lubricating oil pan and insert small wooden wedge at front of pan between cylinder block and oil pan to prevent damage to oil pan gasket when gear case cover is removed.

(7) Remove trunion bolts from front engine support.

(8) Raise front of engine by suitable means and remove front engine support.

(9) Remove all mounting capscrews on face of gear case cover.

(10) Remove the two capscrews from small plate on face of gear cover and remove plate, pressure regulator, and spring (fig. 99).

(11) With large screwdriver pry gear case from the dowel pins.

b. Service and Reassembly of Gear Case Cover.

(1) Inspect oil seals in gear cover and replace if defective.

(2) Assemble new gasket to gear cover.

(3) Assemble gear cover over dowel pins to cylinder block.

(4) Assemble all mounting capscrews and secure in place.

(5) Assemble oil pressure regulator (fig. 99).

(6) Assemble water pump drive pulley to shaft and lock in place with nut and lockwasher.

(7) Assemble water pump drive belts.

(8) Assemble front engine support and lower engine in place. Insert locating dowel pins and bolts and tighten same.

(9) Remove oil pan wedges and tighten oil pan bolts. Install and tighten 4 bolts at bottom of gear cover holding oil pan.

(10) Reassemble radiator as instructed in paragraph 76e.

79. CAMSHAFT. The camshaft is a hollow, one-piece, steel forging running in steel backed, babbit-lined bearings.

a. Camshaft Bushing Sizes. The camshaft bushing sizes are as follows:

(1) Bushing No. 1 is 2-¼" long by 2" bore.

(2) Bushing Nos. 2 and 6 are 1-⅞" long by 2" bore.

(3) Bushing Nos. 3 and 5 are 2-⅜" long and 2" bore.

(4) Bushing No. 7 is 2-11/16" long by 2" bore.

b. Removal of Camshaft and Camshaft Bushings. Camshaft bushing should never need replacing unless the entire engine is being given a thorough overhaul. At that time it is good practice to make a minute inspection and replace any worn bushings.

(1) For removal of camshaft bushings it will be necessary to remove a-c generator, coupling, flywheel, and bell housing from rear of engine. Likewise the radiator, front motor support and timing gear case must be removed from engine. It is also necessary to remove instrument panel, fuel pump, upper valve rockers, push rods, and lower cam rockers.

(2) After removal of the assemblies mentioned above, camshaft may be pried out to release it from the block by turning shaft and drawing forth (fig. 100). To remove camshaft bushing, insert camshaft bearing remover tool into rear end of block and enter tool into recess of bearing. Bearing is then driven out of block by using a ten pound maul on end of tool. Starting with the No. 7 bearing, remove bushing from tool after being driven out of block. Proceed to No. 6 bearing and continue operation as on No. 7.

(3) When installing new bearings be sure proper bearing is being put into proper hole of the block. Starting with bearing No. 1, insert camshaft tool through the block, line up new bearings on tools so that recess of bearing fits in dowel of tool. Insert tool through block and install bearing on tool into bearing hole. Before driving bearing into place take camshaft bearing aligner bracket and install through lower cam rocker hole on fuel pump side of block. This aligner tool is made to fit into camshaft bearing tool keyway which is cut into tool shaft. This bracket is used to

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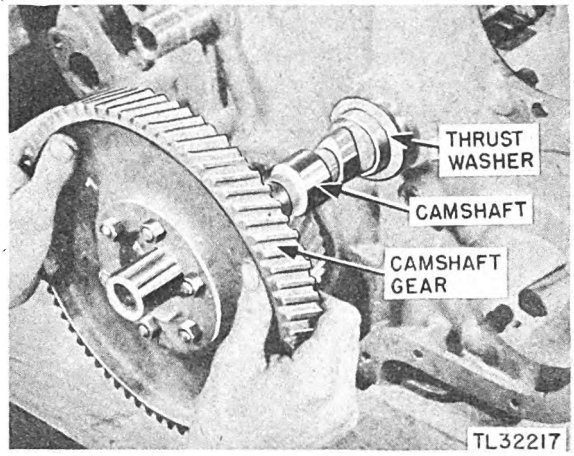
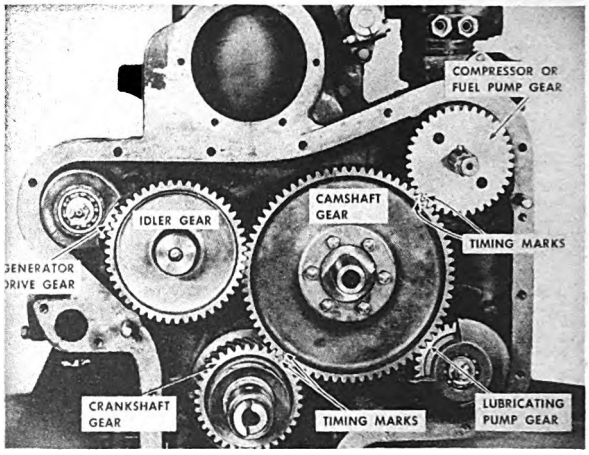


TL-32217
Figure 100. Installing camshaft.



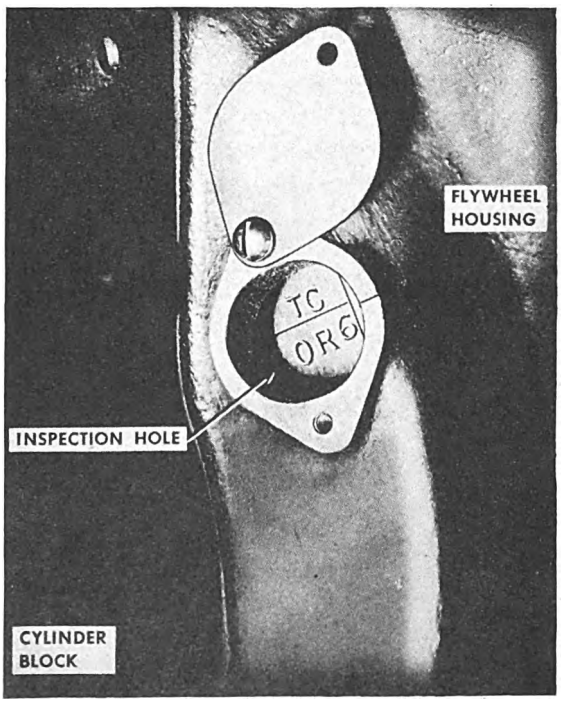
TL-32218
Figure 101. Engine gear train.

line up bearings in the block so that oil holes in the bearings will index with the oil holes leading to the component oil holes. After bracket is inserted in keyway of camshaft tool, it is then bolted on the outside of block in place of lower rocker assembly. The bearing is then driven into place until it comes flush on the opposite side. In case bearing is driven too far, use nut on shaft to drive back bearing. Clean out all oil holes in block and inspect with flashlight. These bushings should not require reaming after installation.

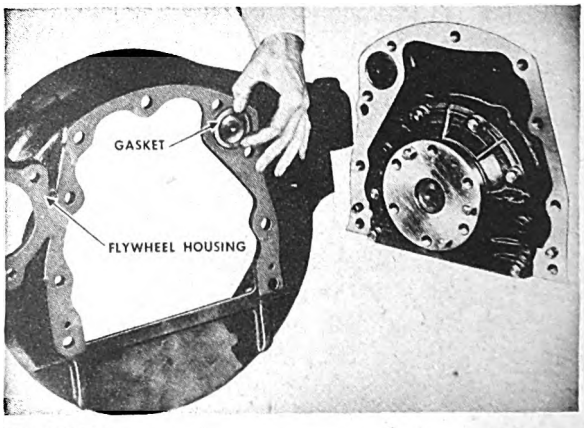
c. Timing Gears. All timing gears are of the helical type and are hardened steel. The camshaft gear is driven from the crankshaft gear. The fuel pump and lubricating pump are driven directly from the camshaft gear. Lubrication for this gear train is supplied by the bypassed oil from the lubricating pump.

d. Valve Timing. To set the valve timing, crank the engine over until the No. 1 top center mark on the flywheel comes up to the indicator hole on the fuel pump side of the flywheel housing (fig. 102). Without moving the crankshaft, slide the cam gear into mesh until the zero mark on the crank gear coincides with the zero mark on the camshaft gear (fig. 101).

CAUTION: When inserting camshaft care should be taken to prevent burring of bushings which may bind camshaft.



TL-32219
Figure 102. Top center mark on flywheel.



TL-32220
Figure 103. Gasket for camshaft bore.

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e. Camshaft Repairs. For removal of camshaft it is not necessary to dismantle engine as described in subparagraph **b.** It is only necessary to remove upper valve rockers, pushrods, radiator, front pedestal mounting and timing gear case. Place jack under front end of engine when removing front pedestal mounting. Lower cam rollers can be held off camshaft by inserting stiff wire down push rod galley and hooking under levers. Bend upper ends of wire over side of cylinder head. Remove camshaft as mentioned previously.
(1) A check should be made on all cam noses for wear on profiles. If badly worn replace with a new camshaft.
(2) Six hardened ream fit bolts connect camshaft flange to camshaft gear. The ends of bolts are peened over. Use small chisel and remove peened ends of bolts. Remove nuts and drive out bolts.
(3) Camshaft gear is timed to camshaft flange and has index marks on camshaft flange and gear as shown in figure 100.
(4) Upon renewal of camshaft to gear every precaution should be taken that gear is properly timed to camshaft flange and when installing bolts, that no chips fall between camshaft flange and gear.
(5) Tap the head end of bolts while tightening nuts. Peen over protruding ends of bolts.
(6) Clean out all passages with compressed air and reinstall in block and retime gears.

NOTE: Always install new special type ream fit bolts and nuts supplied by engine manufacturer when replacing gear or new camshaft.

80. FLYWHEEL HOUSING AND FLYWHEEL.

a. Removal.

(1) The flywheel may be removed by removing engine support bolts and the locating dowel pins. If shims are found under engine legs, they must be replaced under respective legs. These shims are provided for alignment of engine to generator.
(2) Remove generator fan guard.
(3) Remove flexible coupling bolts as shown in figure 26.
(4) Lift engine by suitable means and move engine forward on engine base.
(5) Remove lockwire from flywheel bolts.
(6) Remove flywheel bolts.
(7) In holes provided, use ½"—USS capscrews 2½" long, threaded entire length, to pull flywheel from crankshaft. Removal of flywheel can be aided by inserting two of the exhaust manifold studs in flywheel bolt holes.
(8) Draw flywheel from crankshaft flange by turning each capscrew alternately one-half turn at a time to insure that the flywheel is pulled off the dowel pins evenly. Flywheel may be drawn off inserted studs after being extracted from dowel pins.
(9) Remove mounting capscrews from flywheel housing and with block of wood tap flywheel housing from dowel pins.

b. Assembly of Flywheel Housing and Flywheel.

(1) Shellac new gasket to flywheel housing. This gasket, seals the end of the camshaft and must always be renewed (fig. 103).
(2) Assemble flywheel housing to cylinder block over dowel pins.

NOTE: When installing new housing or cylinder block it will be necessary to remove dowel pins from cylinder block. Mount flywheel housing to cylinder block with mounting capscrews. It will be necessary to use a dial indicator to assemble housing concentric with crankshaft within SAE limits. To do this, it may be necessary to shift housing slightly one way or another. It will be necessary to ream dowel pin holes to an oversize to secure true fit on dowel pins. Secure dowel pins of proper size to fit reamed holes.

NOTE: Flywheel can only be mounted on crankshaft in a position determined by offset dowels inserted in crankshaft flange.

(3) Assemble six lockwashers and capscrews to flywheel and secure in place.
(4) Assemble lockwires to capscrews.
(5) Reinstall engine on base. Be sure to replace any shims formerly removed and insert engine leg bolts and dowels. Connect flexible coupling to engine.
(6) Tighten all bolts and turn over engine by hand to check that no parts are binding.

81. LABYRINTH OIL SEAL. A labyrinth type oil seal is installed between the rear crankshaft bearing and the flywheel to prevent leakage of oil into the flywheel housing (fig. 104). Frequent inspection should be made to determine if any such leakage exists. Should such be the case, the seal will have to be replaced. The procedure for removal and replacement is as follows:

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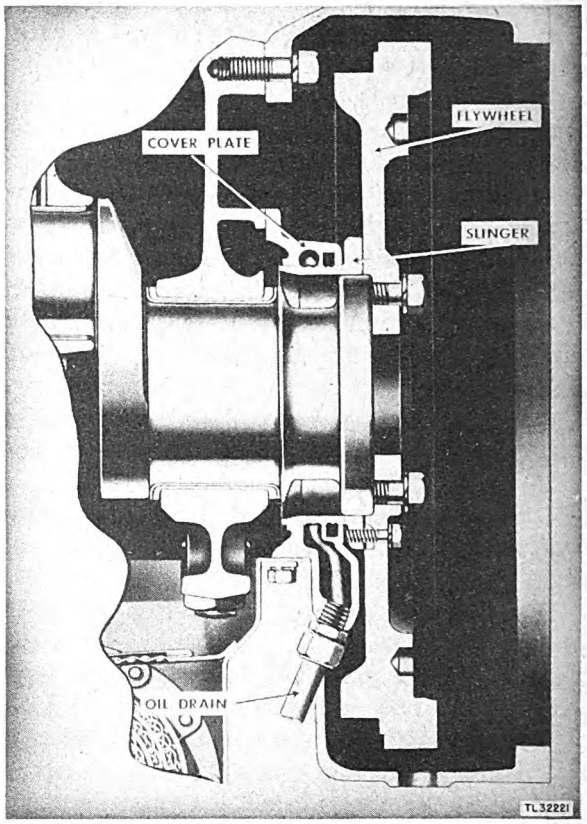
a. Removal.
(1) Remove the flywheel as described in paragraph 80.
(2) Disconnect the oil drain line.
(3) Remove the four capscrews and lock washers from rear flange of oil pan.
(4) Remove the eight capscrews and washers from the cover plate.
(5) Using a screwdriver pry the cover plate off the dowels and remove the gasket.

b. Installation of Oil Seal.
(1) Replace the cover plate gasket.
(2) Assemble the cover plate over the dowel pins.
(3) Install and tighten the eight capscrews in the cover plate.
(4) Install and tighten the four lockwashers and capscrews on the rear flange of the oil pan.
(5) Reconnect the oil drain line.
(6) Loosen slightly the six capscrews which hold the slinger to the flywheel.
(7) Assemble the flywheel and slinger to the crankshaft, using a new gasket.

CAUTION: Do not bump the slinger on the cover plate. The use of two manifold clamp studs as guides (paragraph 80), will prevent this.

(8) Tighten the flywheel securely.
(9) Tighten the six capscrews which hold the slinger to the flywheel.
(10) Make sure that the slinger does not touch the cover plate when the engine is rotated.



TL-32221
Figure 104. Labyrinth type oil seal.

82 FUEL PUMP REPAIRS, (GENERAL).

a. Inspection Recommendation. The repair crew should try to determine cause of faulty pump operation before removing pump for repairs. Causes of failure of pump to deliver fuel may be often remedied by replacement of individual assembly units as gear pump assembly, distributor assembly, or float chamber assembly, governor, etc. To locate trouble in fuel pump refer to suggestions listed below:

b. Fuel Pump Airbound. Caused by air leak in suction fuel line, (suction line of priming pump included).
(1) Examine lines closely for loose fittings, cracked flaring or frayed tubing.
(2) Fittings and tubing may be checked for leaks by shutting off one end with finger and creating suction on other end.
(3) Create suction by sucking on fitting and holding tongue over hole and see if vacuum is good.
(4) Any leaks will immediately show up by this method.

c. Drop in Fuel Pump Pressure. Caused by:
(1) Filter in fuel line stopped up.
(2) Float chamber runs low on fuel due to obstructed passageway or jammed float needle. See repairs on float chamber.
(3) Float chamber gasket broken, creating poor suction for No. 2 gear pump. Remove float chamber and check.
(4) Wear in gear pump.
(5) Scored distributor disks or worn thrust bushing in distributor assembly.
(a) A check may be made to see if items (4) and (5) hold pressure.
(b) With engine shut down, close shut-off valve between gear pump and overspeed assemblies. This stops fuel flow to disks. Try to build up pressure, by working hand priming pump.

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(c) Pressure should easily build up at least 100 lbs. on gauge with slow strokes of priming pump.

(d) If pressure does not build up satisfactorily, renew gear pump assembly.

(e) If pressure build up is good in gear pump, proceed with pressure test in distributor head assembly by opening shut-off valve.

(f) Pressure should still hold steady with valve placed in the open position.

(g) If pressure drops rapidly, fault now lies in either distributor disks or distributor thrust bushing. See instructions on removal.

d. Water in Fuel. In the event water has entered the fuel oil system, it may cause considerable damage to working parts of fuel pump, namely:

(1) Scored distributor disks.
(2) Stuck injectors.
(3) Seized gear pumps, causing sheared drive pin or pump shaft.
(4) Scored thrust bushing in distributor head assembly.
(5) Enlarged injector cup holes.
(6) A corroding condition throughout the fuel pump.

e. Purging Fuel System of Water. To purge system of water the following steps must be taken:

(1) Drain fuel tank.
(2) Drain fuel filter, primary and secondary.
(3) Drain float chamber (⅛" pipe plug at bottom).
(4) Remove pressure dome on gear pump (fig. 14).

(a) Remove pressure regulator valve (fig. 14 and fig. 105).

(b) Remove pressure regulator valve spring (fig. 14).

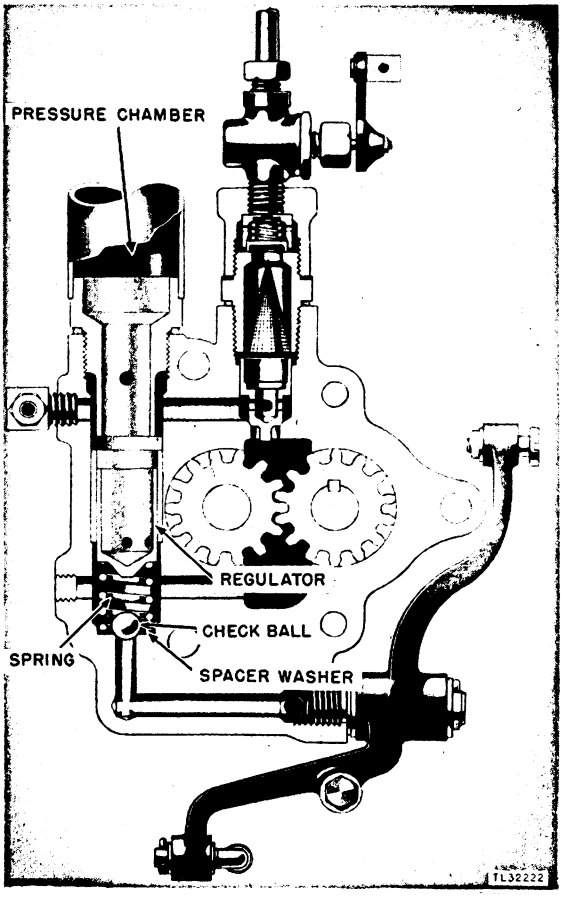
(c) With thin brass rod move check ball (fig. 14 and fig. 105), off seat. This will allow liquid to flow back to float chamber and out through drain plug hole.

(d) Reassemble parts; replace plugs.

(5) Repair or replace all damaged parts.
(6) Reprime engine. Expell all water from fuel lines between pump and injector connections. See priming of engine, paragraph 28.
(7) Fuel oil filter should be drained every half hour following purging of system, until water conditions have cleared. Any particles of water not removed from system will be trapped at these points. Refill both filters before starting engine.

83. CLEANING GEAR PRESSURE PUMP SCREEN.

a. Cleaning. The small conical screen (fig. 105), in the fuel pump should be cleaned every 250 hours. It should also be cleaned in any instances where the engine refuses to start or gives indications of not developing full power. Cleaning of this screen is performed as follows:



TL-32222
Figure 105. No. 2 pressure pump and regulator.

(1) Unscrew pressure chamber dome from pressure pump assembly, taking care not to lose copper asbestos gasket on which it seats.
(2) Remove fuel supply tube from gear pump to secondary filter.
(3) Unscrew the small hexagonal housing by applying the wrench to the lower of the two hex areas of the housing. Be careful not to mislay the copper gasket for this connection.

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(4) Place the upper end of the housing in a vise and unscrew the other half of the housing. The conical screen is located in this part.
(5) Wash screen carefully with cleaning solvent and blow out with compressed air in opposite direction of fuel flow.

NOTE: Do not remove the small valves in the upper part of the housing. If they should accidently be removed, they should be replaced as follows:

b. Replacing the Small Valves.

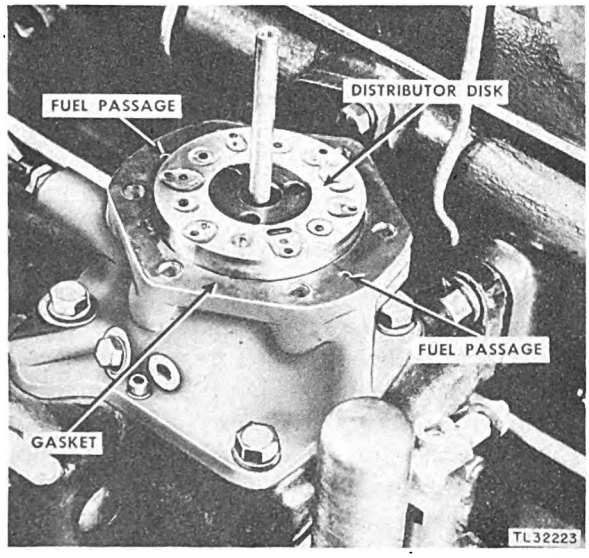
(1) Clamp upper valve half of housing in vise with cup upward.
(2) Drop small valve cage into housing with cup end up.
(3) Drop small spring into cup.
(4) Insert valve with flat face next to spring. This should collapse into cup when pushed down.
(5) Reassemble two parts of housing and then proceed with reassembly to pump.
(6) Prime pump before attempting to start engine.

84. FUEL PUMP DISTRIBUTOR ASSEMBLY REPAIRS.

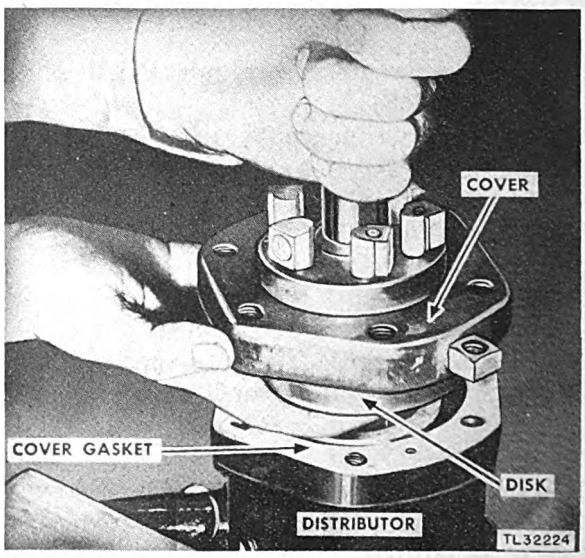
a. Fuel Pump Distributor Disks. If fuel with water or dirt in it is used, the fuel distributor cover and disks become scored and unfit for further service. Scored disks cause engine smoking and loss of power. Disks and cover should be exchanged for a new pair if scored, as the lapped surfaces cannot be repaired with conventional machining. Disks and covers are mated and must always be replaced in pairs.

(1) Thoroughly wash outside of pump with cleaning solvent and brush.
(2) Disconnect and remove tachometer shaft cable if used.
(3) Disconnect fuel supply tube and fuel lines leading to cylinders at both distributor and cylinder connections and remove them to provide room for taking out disks.
(4) Loosen the six capscrews holding distributor cover to distributor, one-half turn at a time, until they can be removed. This procedure is necessary to prevent distortion of distributor disk bearing in the distributor housing.
(5) Lift disk cover up far enough to slide hand under distributor disk, and remove disk and cover together as shown in figure 107. Fuel between these parts causes them to stick together.
(6) Examine disk and cover carefully, and replace if they show scratches or score marks as shown by figure 108.

NOTE. Disk and cover must be kept free of dust or dirt. Never place the lapped faces of these parts on any surface except clean paper or cardboard.



TL-32223
Figure 106. Lubricating distributor disk.



TL-32224
Figure 107. Lifting out distributor disk and cover.

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(7) Wash disk and cover thoroughly in cleaning solvent and blow out all fuel passages with clean compressed air.
(8) Place rotating disk in position over the three driving pins. Disk will fit on pins only if installed in correct position.
(9) Fill fuel passages on top of distributor disk with clean lubricating oil (fig. 106) and install gasket and cover. Be sure cover gasket is installed correctly for all fuel passages.
(10) Press cover down and start capscrews (fig. 109). These must be turned down one-half turn in rotation until tight to prevent distortion of distributor disk bushing in housing. Tighten screws securely.

b. Disassembly of Distributor Housing.

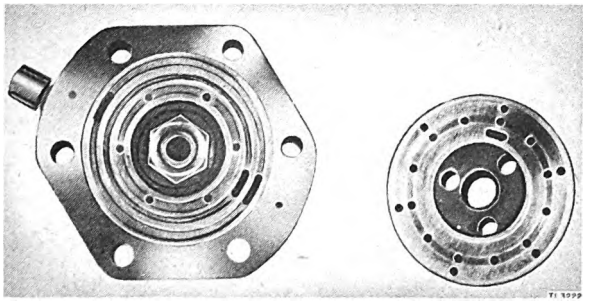
(1) To remove distributor housing from main fuel pump housing, it is necessary to remove overspeed stop assembly, see service and repair of overspeed stop assembly.
(2) Remove fuel pump cover and disk.
(3) Lift distributor disk spring from housing.
(4) Remove capscrews that hold distributor housing to main fuel pump housing.
(5) Lift distributor housing, with shaft and gear, from fuel pump housing.
(6) Metering plunger barrel can be removed from distributor housing by unscrewing retaining nut.
(7) Pull gear from distributor shaft (fig. 111) being careful not to apply too much pressure to outer edge of gear, or warped gear will result. Remove Woodruff key from shaft.
(8) Tap lower end of distributor shaft on block of wood, and remove shaft and collar from housing.
(9) Remove double ball bearing from lower end of housing.

NOTE: Thrust bearing should not be removed unless known to be defective.

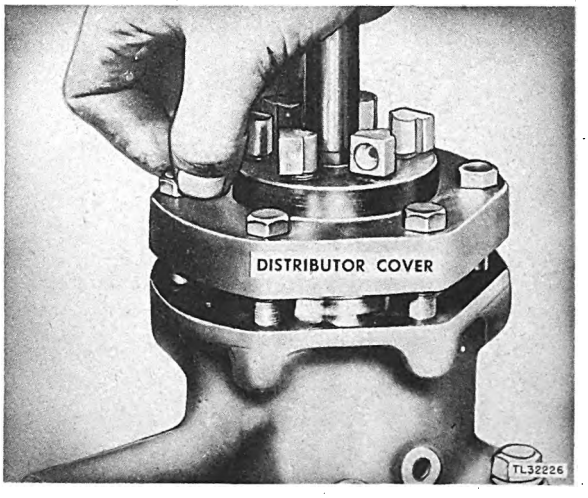
(10) Remove priming valve from side of housing and check the point to see that it has not been broken by overtightening.
(11) If priming valve has been broken, make sure all particles have been removed from housing before installing new valve. If valve seat has been damaged, distributor housing must be replaced.
(12) Remove distributor check valve screw, spring, and ball.

c. Assembly of Distributor Housing.

(1) Inspect distributor drive collar and shaft. If there are signs of excessive wear, replace with new parts.
(2) If collar and shaft are worn excessively in the thrust bushing, fuel will leak by the shaft. This causes low fuel pressure, or causes fuel to fill the main housing and run out overflow.
(3) Inspect distributor thrust bushing. If bushing shows excessive wear, replace.
(4) To remove thrust bushing, press from housing from bottom side.
(5) Wash fuel passages and housing thoroughly.
(6) Assemble new bushing to housing. A piece of leather should be used between the tool and bearing to prevent damage to bushing face.



TL-32225
Figure 108. Worn distributor disk and cover.



TL-32226
Figure 109. Installing distributor cover and disk.

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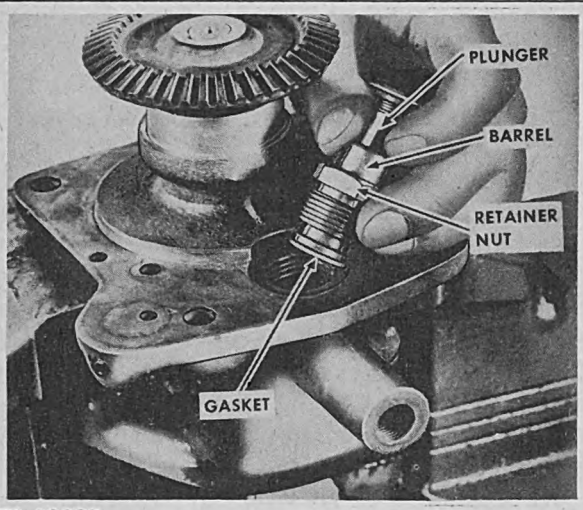
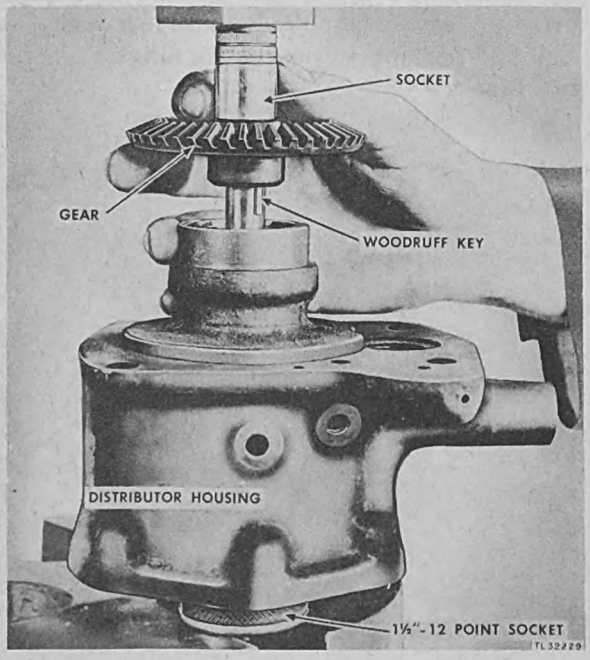


TL-32227
Figure 110. Assembling metering pump.

(7) Ream thrust bushing shaft hole with special line reamer, size 0.812″ (fig. 115).
(8) Reface thrust bushing with special cutter. A little oil on the face of the thrust bushing when using the cutter will help prevent chattering.
(9) Inspect ball bearing on lower end of shaft for wear. Replace if worn.
(10) Assemble distributor drive shaft and collar assembly to housing and press gear in place (fig. 112).

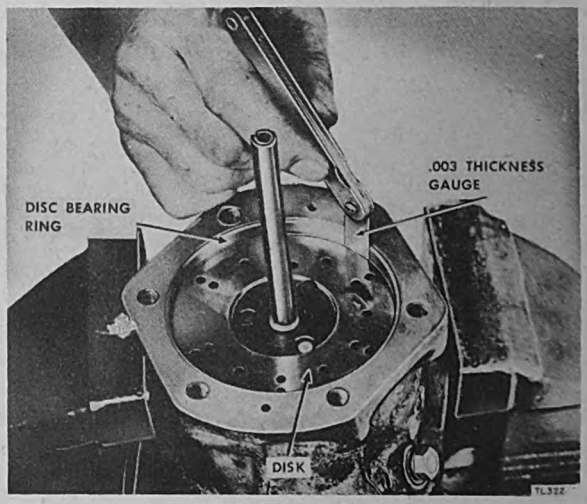


TL-32229
Figure 112. Pressing on distributor drive gear.

TL-32228
Figure 111. Pulling distributor drive gear.

NOTE: A 1½″ 12 point socket will fit over drive pins in collar for pressing gear in place.

(11) Inspect the metering plunger and barrel for wear. If the plunger or barrel is scratched or worn, it will be necessary to replace. Be sure to use a new copper gasket on the end of the barrel when replacing (fig. 110).
(12) With a gasket, assemble distributor housing to main fuel pump housing and install capscrews. Back lash of gears should be 0.002″. Proper clearance can be obtained by inserting gasket of the proper thickness. Gears shown in figure 116.



TL-32230
Figure 113. Checking distributor disk bearing.

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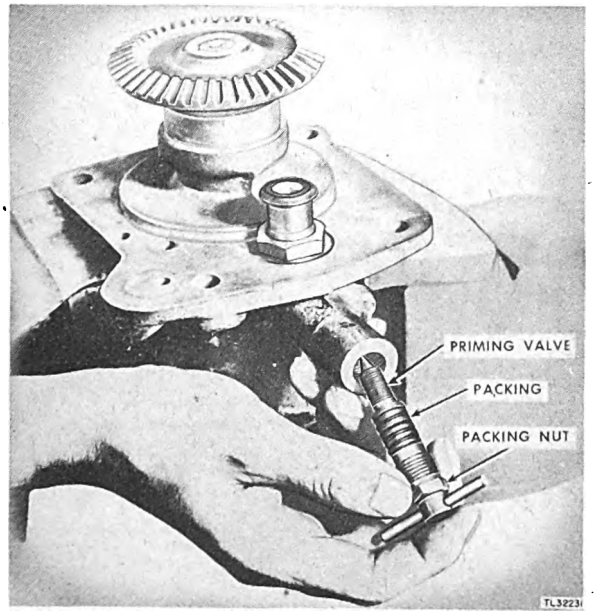
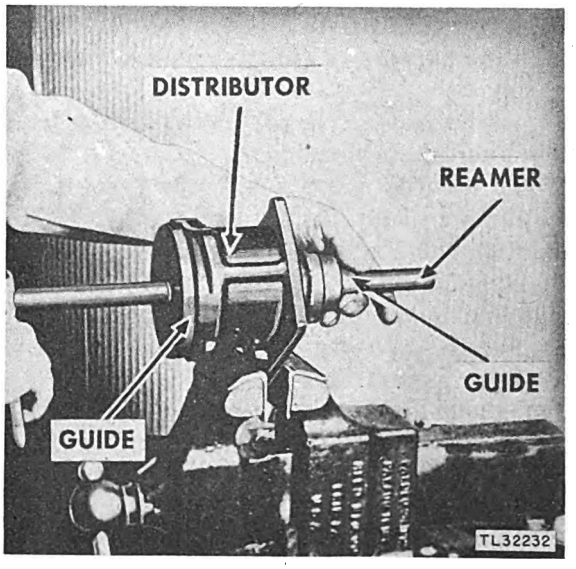
(13) Before assembling the new distributor top and disk, wash all fuel passages with cleaning solvent and blow out with clean compressed air.
(14) Lubricate both the distributor top and disk faces with clean lubricating oil. Set timing mark on distributor drive collar in line with inspection hole in housing (fig. 117).
(15) Place disk thrust spring on collar and locate rotary disk in position on driving pins. This cannot be put on wrong due to one driving pin being offset. The distributor top should only be put on one way to permit the fuel lines to be connected properly. A new gasket of proper design and thickness must be used each time between the distributor top and housing.
(16) Be sure when placing this gasket on housing that the oil passages are properly indexed.
(17) It will be necessary to compress the distributor spring by pushing on the distributor cover (fig. 109) to start the capscrews which hold the distributor top in place.
(18) Start all capscrews by hand and work each one alternately, one-half turn at a time, until the cover is down against the gasket and distributor housing. If the distributor cover is not tightened down evenly, it will likely catch the distributor disk bearing ring (fig. 113) pushing it down on one side. Should this happen, the seal will break between the distributor top and disk when the engine is started and the flow of fuel to the metering pump will be disrupted.
(19) If the distributor disk bearing ring is distorted it will be necessary to replace. Press a new bearing ring into the housing.
(20) To determine clearance between disk and bearing ring, it will be necessary to place the distributor disk on the distributor disk drive pins without the thrust spring. If the distributor disk does not rotate freely in the bushing, it will be necessary to use a bearing scraper to relieve the bearing. A smooth bearing must be maintained and held to 0.003" clearance between the disk and bearing (fig. 113).
(21) The priming valve on the front side of the distributor housing is for the purpose of priming the engine and forms a passage for the fuel around the distributor top and disk to the injector. This is a needle valve and requires only light pressure on the handle to close (fig. 114).

CAUTION: NEVER TIGHTEN THIS PRIMING VALVE WITH A WRENCH.

d. Timing Fuel Pump Distributor Head Assembly.
(1) Crank engine until Nos. 1 and 6 TC mark on fan drive pulley indexes to center



TL-32231
Figure 114. Assembling priming valve.



TL-32232
Figure 115. Reaming thrust bushing.

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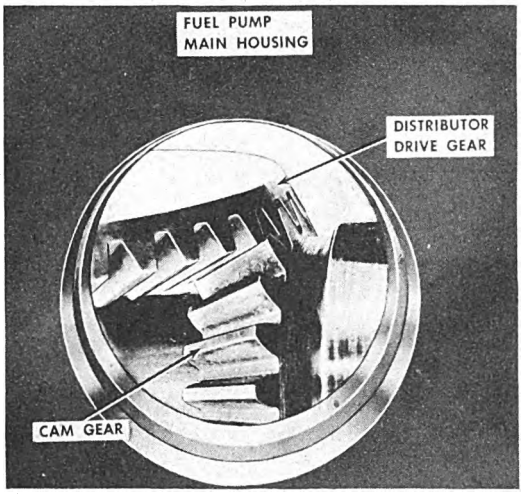
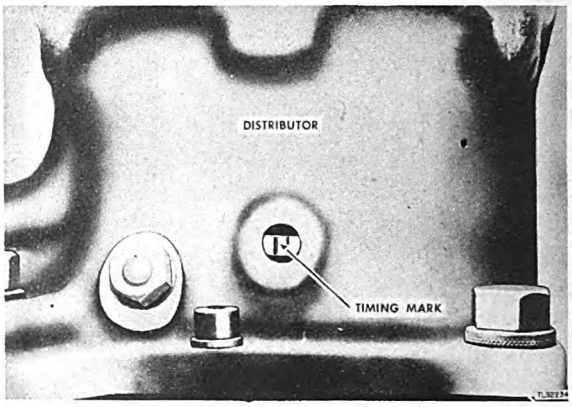


TL-32233
Figure 116. Distributor drive and cam gear.



TL-32234
Figure 117. Distributor collar timing mark.

line mark on gear case (fig. 57). No. 1 cylinder is on firing stroke, both valves being closed.

(2) Set timing mark in distributor housing as shown in figure 117.

(3) Assemble distributor assembly to main pump housing using proper gasket.

CAUTION: Observe that metering plunger spring and link are in proper position.

85. SERVICE AND REPAIR OF OVERSPEED STOP ASSEMBLY.

a. Disassembly.

(1) Remove 7 cover capscrews and remove cover assembly.

(2) With screwdriver remove four assembly mounting capscrews (fillister head), inside of housing.

(3) With screwdriver pry out assembly from main fuel pump housing.

(4) To identify parts see figure 118.

(5) Remove body plug and gasket.

(6) Lift valve spring, and valve from body.

(7) Remove nut and lockplate from end of drive shaft, and pull gear.

(8) Remove Woodruff key from shaft.

(9) Pull shaft from body.

(10) Uncotter weight spring collet and screw collet from weight shaft.

(11) Remove weight and spring.

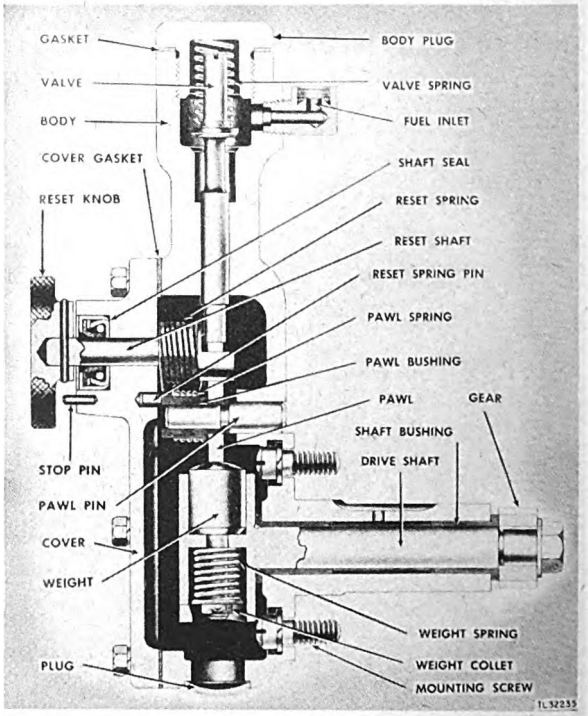
b. Assembly.

(1) Insert weight in shaft; assemble spring and spacers, if used, and install spring collet and cotter key.

NOTE: Turn collet down flush with end of weight shaft before installing cotter pin. It will be necessary to use correct weight and spring combinations for speeds at which the overspeed stop should be operated.

(2) Examine drive shaft bushings in body. If they show signs of wear, replace them and ream with 9/16" reamer.

(3) Install drive shaft in body and check to see that it has 0.002" running clearance.



TL-32235
Figure 118. Cross-section of overspeed stop.

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(4) Install Woodruff key in shaft and install drive gear. Lock gear in lockplate and nut.

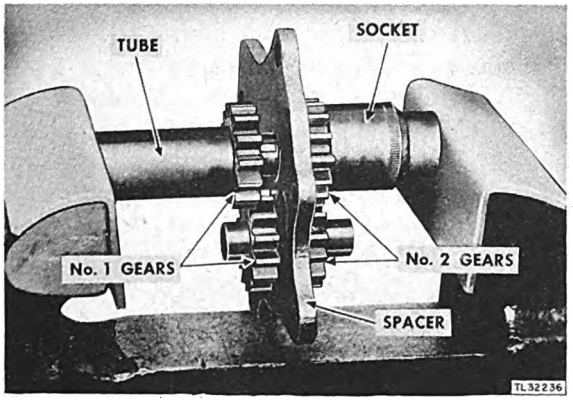
NOTE: Shaft must have 0.004" end play.

(5) Inspect valve and valve seat. If either shows signs of wear or pitting they should be seated to a true seat before installing.
(6) Insert valve spring and install and tighten body plug.
(7) Assemble unit to fuel pump housing and tighten down evenly with four fillister head screws.
(8) Check to be sure there is at least 0.002"-0.003" backlash between drive gear and overspeed stop gear.

WARNING: WHEN CHECKING BACKLASH, HOLD THE SHAFT TIGHT AGAINST THE OVERSPEED STOP BODY. IF THIS IS NOT DONE, THE MOTION FELT MAY BE END PLAY AND NOT BACKLASH.

(9) Before installing the pawl, make sure the nose which holds the valve in running position is not worn or rounded. Should this condition exist, trouble would result.
(10) Assemble pawl to shaft, and install spring.
(11) Assemble cover to body and turn reset knob in clockwise rotation to set valve in running position.
(12) Reconnect fuel lines to fittings.
(13) Start engine.

CAUTION: IT IS VERY IMPORTANT THAT THE CORRECT WEIGHT AND SPRING COMBINATION IS USED FOR OVERSPEED TO OPERATE AT THE SPEED DESIRED.

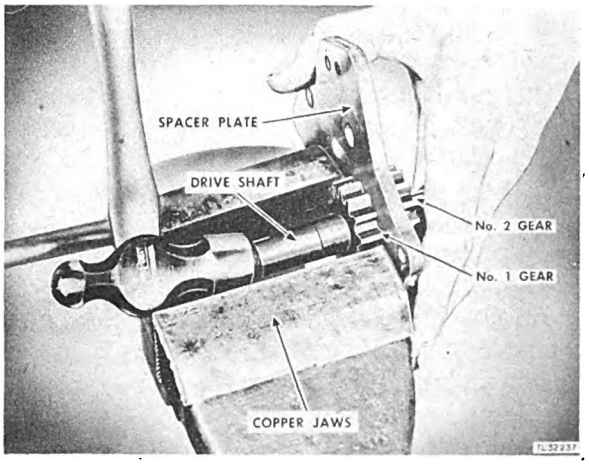


TL-32236
Figure 119. Spacer plate in gear assembly.

86. SERVICE AND REPAIRS OF GEAR PUMP ASSEMBLY.

a. Removal of Gear Pumps.
(1) Remove four capscrews holding gear pump bodies to main fuel pump housing. DO NOT REMOVE NUTS FROM THREE BOLTS ON THIS SAME FACE, AS THESE HOLD THE TWO GEAR PUMP BODIES TOGETHER.
(2) Remove cam rocker lever spring retainer, and spring, from side of fuel pump housing (large hex. nut).
(3) Carefully pry the gear pump assembly from the main fuel pump housing.

b. Disassembly of Gear Pumps. Do not disturb the gear pumps unless pump pressure is below 50 pounds pressure on gauge at idling speed. If necessary, disassemble as follows:
(1) Remove nuts from three bolts holding the two pump bodies together. Tap bolts from bodies with brass drift. The No. 2 body should slip off, leaving gears on shafts with spacer plate.
(2) Remove fillister head screw from front of No. 1 body and slip body from shaft, leaving gears on shaft with spacer plate.
(3) Drive idler shaft from gears, being very careful not to lose oil seal and washer between spacer plate and No. 2 pump gear.
(4) Place No. 1 pump drive gear in a vise fitting with copper jaws, gripping gear by the teeth, and tightening vise only enough to hold (fig. 120).



TL-32237
Figure 120. Removing No. 1 pump gear from shaft.

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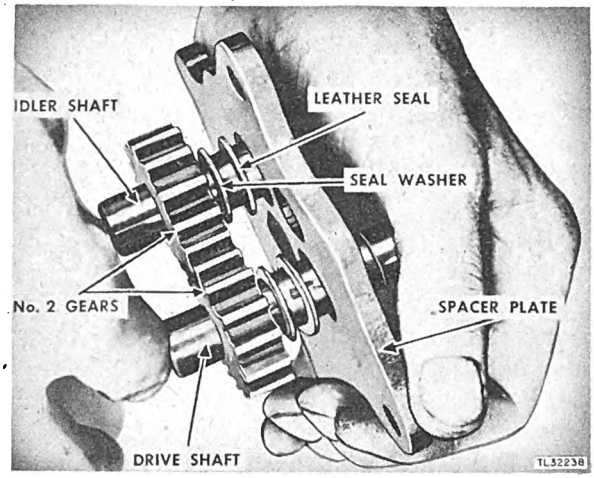
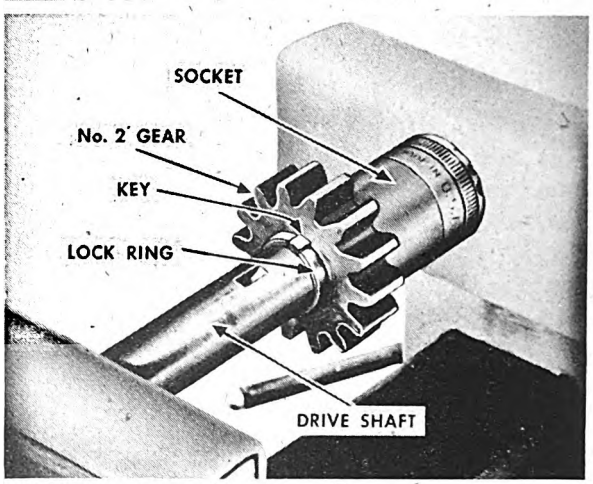


TL-32238
Figure 121. Assembling gear seals.



TL-32239
Figure 122. Assembling No. 2 pump gear to shaft.

(5) Tap lightly on slotted end of shaft to drive out of gear. Pull Woodruff key from shaft.

CAUTION: ANY OTHER METHOD OF REMOVING THIS GEAR WILL CAUSE SMALL WOODRUFF KEY TO BE DRIVEN THROUGH SPACER PLATE, MAKING SPACER PLATE UNFIT FOR FURTHER USE.

(6) Slide gear and shaft out of spacer plate being careful not to damage oil seal and washer between gear and spacer plate (fig. 121).
(7) Press gear away from lock ring to remove from pump shaft. Remove Woodruff key and lock ring from shaft (fig. 122).
(8) Unscrew pressure chamber and remove chamber and gasket.
(9) Remove pressure regulator valve and take out spring and check ball.
(10) Remove fuel supply check valve housing by screwing out check valve seat.
(11) Place the upper end of the fuel supply check valve housing in a vise and unscrew the check valve seat.
(12) Remove housing from vise and take out check valve, spring and guide.

c. Assembly of Gear Pumps. The instructions that follow are for rebuilding the gear pump assembly with new parts. Old parts should be used only if they can be fitted as closely and installed as carefully as described.
(1) Caution must be used when assembling new gears to the spacer plate and shaft, that the shaft seals are assembled properly. These seals are assembled on the No. 2 side of the spacer with the leather seal against the spacer plate and the seal washers against the No. 2 pump gears (fig. 121).
(2) Inspect the drive shaft oil retainer in the No. 1 body to see that it is in good condition. When assembling the No. 1 body on the shaft, precaution must be taken to see that this retainer is not damaged.
(3) Assemble No. 2 pump gear, Woodruff key and snap wire as shown in figure 122. Press gear over snap wire into recess on gear.
(4) Assemble gears to spacer plate (fig. 119).
(5) When assembling the No. 1 body, use only 0.0015" body gasket. Brush a thin coat of shellac on the spacer plate gasket surface only. Assemble gasket in proper position to spacer. Brush thin coat of shellac on gasket, always being careful not to get shellac in gear pockets and fuel passages.
(6) With the No. 1 body on the shaft against the gasket and spacer plate, insert the fillister head screw. Tighten loosely.
(7) Shellac gasket to the No. 2 side of the spacer as previously instructed, lubricate gears and place body over gears in position.
(8) Insert the ream fitted bolts through both pump bodies and attach 3/8" nuts to the protruding ends. Draw these nuts up to pull the pump bodies together, at the same time turning the drive shaft to see that the pump gears continue to turn freely. If necessary, tap edges of bodies to free gears (fig. 123). Ream the two dowel holes with a standard 3/8" reamer, insert the two threaded dowel bolts

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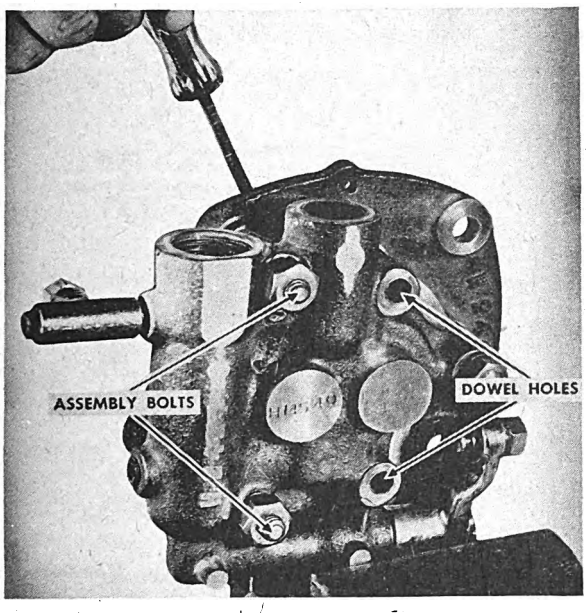

TL-32240
Figure 123. Assembling gear pump bodies and gears.

and attach nuts. Remove the nuts and mounting bolts and install the pump bodies on the main fuel pump housing.

(9) Let shellac dry between gear pump bodies before testing.

(10) Place pressure regulator spring in housing. If a new spring is used, make sure all burrs are removed from both ends of spring to avoid binding or cocking of regulator valve (fig. 105).

(11) Drop check ball into housing.

(12) Slide pressure regulator valve into place with point down toward ball check.

(13) Check to be sure regulator valve is free.

NOTE: If pressure regulator valve sticks open it will cause drop in fuel pressure. If regulator valve sticks closed it will cause excessive fuel pressure.

(14) Screw pressure chamber into housing making sure that gasket is in good condition.

(15) Install gasket or gear pump housing and install gear pressure pump to main housing.

NOTE: Drive slot of gear pump drive shaft must line up with main drive shaft drive pin. DO NOT HAMMER GEAR PUMP INTO MAIN HOUSING.

(16) Check that cam rocker assembly is free in main housing, after tightening gear pressure pump on main housing. Install an additional gasket if cam rocker is not found to be free (fig. 146).

87. GOVERNOR ASSEMBLY REPAIRS AND SERVICE.

a. Governor Service. Governor faults usually show up in speed variations of the engine, but this does not mean that all such speed variations indicate governor faults. When improper speed variations appear, the following procedure should be carried out:

(1) Check the load to be sure that the speed changes observed are not the result of load fluctuations.

(2) If the load is uniform, carefully check the engine to be sure that all cylinders are firing properly.

(3) See that the governor is installed so that no bind exists in any of the governor control mechanisms of the operating linkage between governor and engine; also, that no bind exists in the fuel mechanism in the pump. If neither load nor engine irregularities are found to be the cause of the speed variation, it may be in either the governor or its drive. If the speed changes in regular oscillations (a hunt) a speed droop adjustment can be made internally in the governor to rectify the hunting condition.

b. Speed-Droop Adjustment. Shut down engine and remove governor pulley cable, pulley assembly and cover. Loosen the lockscrew which holds speed droop slider as shown in figure 125, and move slider away from the center of the governor. This increases the speed droop setting. Tighten the lockscrew and replace the cover and pulley assembly. When the slider is pushed toward the center of the governor as far as it will go, the speed droop adjusting lever pin is near the axis of the terminal lever. Consequently, as the power piston moves, there will be but a slight up and down movement of the floating lever. This in turn, results in a minimum change of loading on the speeder spring, or minimum speed droop. As the slider is moved away from the center of the governor speed droop adjusting lever the pin moves away from the axis of the terminal shaft. Consequently, the movement of the power piston, through the floating lever, causes a greater change of loading on the speeder spring, or increased droop. Start the engine and observe if the engine is still hunting. Repeat the procedure outlined until all hunting stops. If the speed

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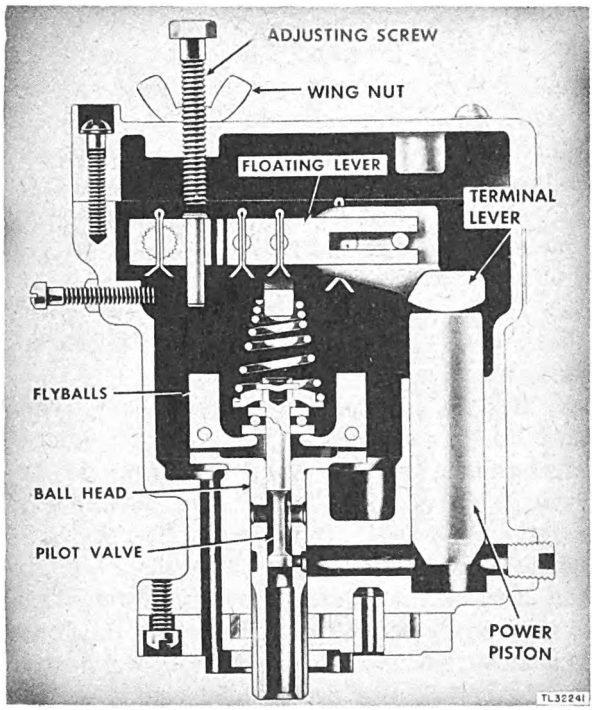
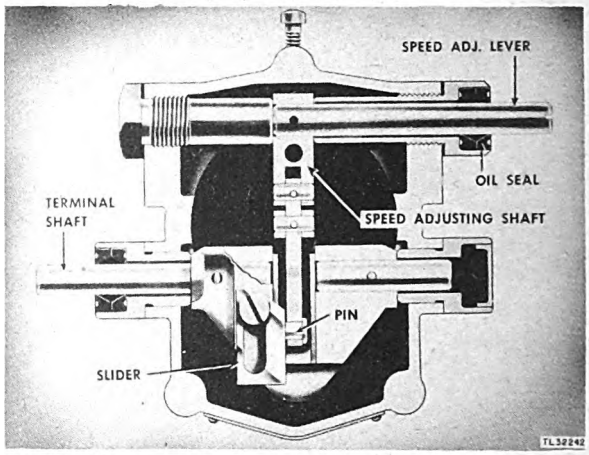


TL-32241

Figure 124. Cross-section, side view of Woodward governor.



TL-32242

Figure 125. Cross-section, top view of Woodward governor.

variations are large and erratic, and unaffected except, perhaps, in magnitude by change of speed-droop adjustment, or if the governor simply fails to control at all, it is probably defective.

c. Governor Repairs. The hydraulic type governor is very sensitive to its setting. Do not disassemble this unit. The governor may be taken off and a spare unit put in its place. The old unit may be sent to the depot for repairs.

(1) To remove governor assembly from fuel pump remove 5/16" copper tubing flare nut from behind governor housing. Unscrew ball joint out of governor control terminal lever. Remove four hex nuts from lower governor housing. Governor assembly may then be lifted from pump housing. Fittings and remote controls are interchangeable with other governor assemblies.

(2) To reassemble governor assembly on fuel pump, reverse procedure.

(3) When the governor is installed, particular care should be exercised to see that it is mounted squarely, and that the splined drive shaft is in exact alignment with the coupling sleeve on the drive from the engine. The hold-down nuts should be securely and evenly tightened. The line between the governor lubricating oil sump and governor should be installed. The linkage connections to the speed adjusting shaft should be assembled. When making up the linkage connections between the terminal shaft and fuel system, care should be taken to insure that when the terminal shaft of the governor is in the off position, the fuel system will also be shut off. The governor control link must be adjusted as described in paragraph on final assembly and adjustment. After checking the foregoing carefully, as far as the governor is concerned, the engine may now be started. After the governor begins to receive oil pressure it will start to open the fuel, and continue in this direction until the engine fires. After the engine is running, it will control the speed at the point for which the governor speed adjustment is set.

d. Lubrication. The governor is lubricated by oil introduced into the governor housing past the power piston, and pilot valve plunger. The oil is broken up into a fine mist by the rotation of the governor flyballs. The oil collects in the bottom of the governor case, and drains through the base by a drain hole.

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88. FLOAT CHAMBER ASSEMBLY SERVICE AND REPAIRS.

a. Disassembly of Float Chamber.

(1) Remove two capscrews holding float chamber to fuel pump housing.
(2) Remove two capscrews holding top plate to float chamber.
(3) Remove nut and washer from float bearing pin and remove pin. This allows float, float stop, and float valve to come free.
(4) With small wrench, remove float valve seat from top plate. Be careful not to lose gasket under seat.

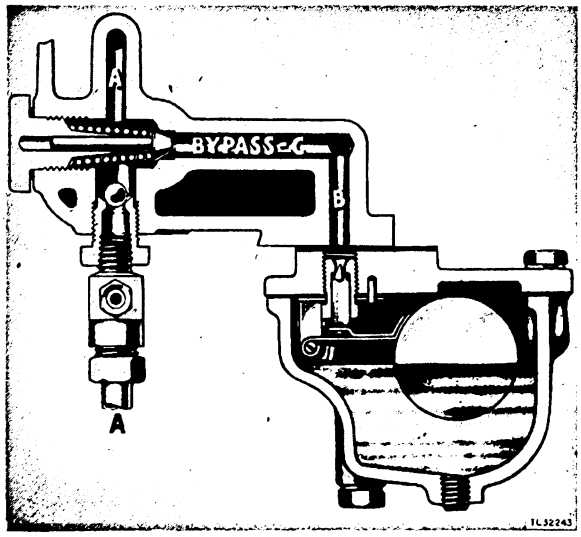
NOTE: It will not be necessary to remove the fuel lines or the adapter spacer from the fuel pump unless inspecting for clogged passages. Always install gasket between spacer and fuel pump housing.

b. Assembly of Float Chamber.

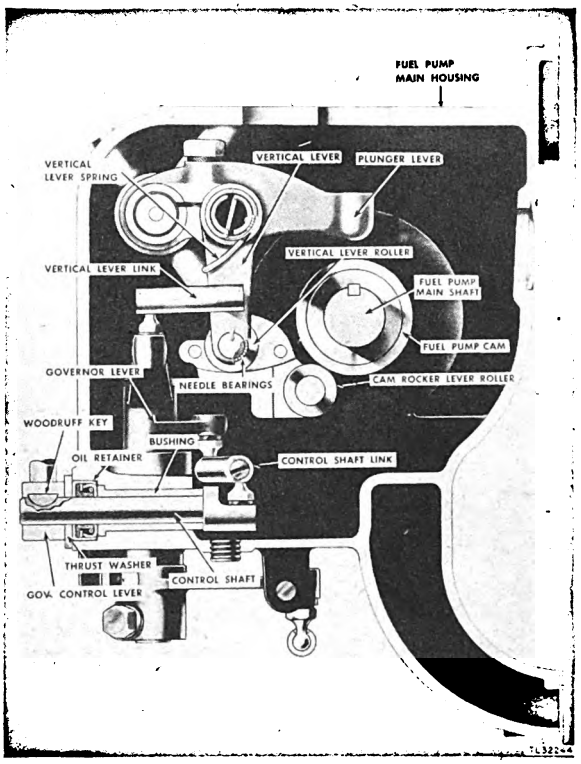
(1) Reinstall check valve and seat at main fuel inlet, if removed (fig. 126).
(2) Place small dowel pin in float chamber top plate, making sure that it is tight enough that it will not drop out.
(3) Place gasket in position on top plate.
(4) Place float bearing bracket in position on dowel pin.
(5) Install float valve seat with new gasket and tighten securely.
(6) Make sure that float valve is free of burrs and in good condition; drop into place.
(7) Place float in position and insert bearing pin.
(8) Place float stop in position and assemble lockwasher and nut to bearing pin.
(9) Make sure float and valve are absolutely free and that float contacts head of valve, holding it firmly on seat in closed position, otherwise fuel will overflow at bottom of pump.
(10) Assemble top plate to float bowl, making sure that float has adequate clearance in chamber.
(11) Assemble chamber with new gasket to fuel pump housing and bolt securely in place.
(12) Install and tighten drain plug, or recheck tightness if it was not removed.

89. FUEL PUMP MAIN HOUSING REPAIRS.

a. Disassembly of Parts. Remove overspeed stop, distributor, gear pumps, and float chamber assemblies, as described in preceding paragraphs. The following repairs can be made with pump mounted on engine, however, accessibility to parts described will be



TL-32243
Figure 126. Fuel pump float chamber and bypass.



TL-32244
Figure 127. Cross-section of hydraulic-type fuel pump main housing.

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handicapped because of pump drive shaft. If a service pump is available, renew pump assembly and repair pump on work bench. (See paragraph on removal of fuel pump.)

(1) Remove vertical lever.

(a) Use small wrench to remove all points from the vertical lever.

(b) Insert socket wrench through hole in top of housing to loosen capscrew which clamps the plunger lever shaft and plunger lever pin in place (fig. 127).

(c) Using small punch, drive through expansion plug at one end of plunger lever shaft until opposite expansion plug falls out. Then drive the shaft out from the opposite end, being careful not to damage bushings.

(d) Lift vertical lever assembly from housing.

(e) Remove vertical lever spring and capscrew.

WARNING: PLACE PARTS ON CLEAN PAPER OR CLOTH ONLY.

(f) Push pin from plunger lever, making sure not to lose any of the 56 needle bearings in which it is mounted.

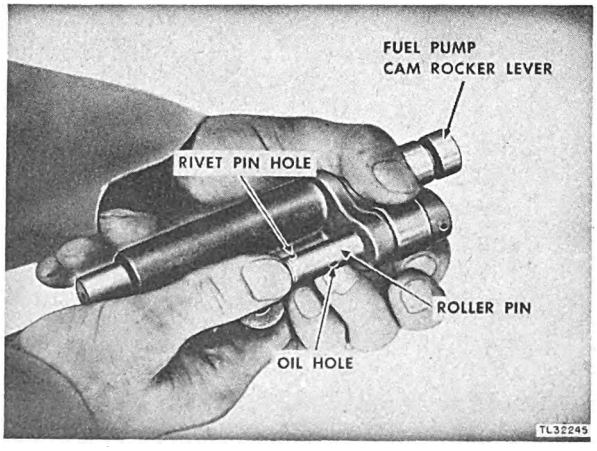
(g) Using a small punch, drive pin from vertical roller, making sure not to lose any of the 22 needle bearings in which it is mounted.

(2) Remove cam rocker lever from housing and disassemble further as follows:

(a) Mount lever firmly in a vise having copper jaws.

(b) Remove rivet pin with small punch.

(c) Using small brass rod as driver, remove roller pin.



TL-32245

Figure 128. Cam rocker lever

CAUTION: IT WILL NOT BE NECESSARY TO REMOVE STOP PINS AS THEY NEVER ENCOUNTER WEAR. REMOVAL OF THESE PINS WILL RESULT IN SERIOUS DAMAGE TO PUMP AND ENGINE.

(3) The governor control shaft as shown in figure 127, is situated in the side of the main housing. If it becomes worn it may be removed as follows:

(a) Remove small governor shaft link from governor control shaft with small wrench (fig. 127).

(b) Remove cotter pin from eccentric collar with a pair of diagonal cutters, and remove collar (fig. 129).

(c) Loosen capscrew at bottom of control lever and remove lever from lower end of eccentric shaft.

(d) Remove governor lever from eccentric shaft.

(e) Lift eccentric shaft from housing.

(f) Loosen the capscrew in the governor control lever and remove the lever and rod (fig. 127).

(g) Remove the Woodruff key from the shaft.

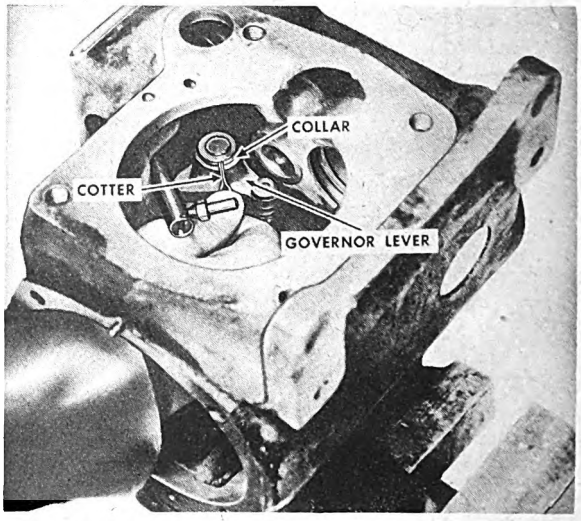
(h) Remove the control lever thrust washer.

(i) The shaft must be removed from inside the fuel pump housing.

b. Assembly of Parts.

(1) Eccentric shaft and governor lever.

(a) Inspect eccentric shaft bushing in main housing. Replace if worn, and ream with a standard 9/16" reamer.



TL-32246

Figure 129. Assembling governor lever collar and pin.

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(b) Inspect control shaft bushing, if worn replace and ream with ½" standard reamer (fig. 127).

(c) Install control shaft in bushing.

(d) Inspect oil retainer carefully. If its condition is at all questionable, replace and seat with a driving mandrel.

(e) Install thrust washer on shaft and insert Woodruff key.

(f) Hold the shaft firmly in place from inside the housing and tap the control lever on to the shaft, making sure the keyway is in line with the key.

(g) Tighten the lever capscrew. Make sure shaft operates freely.

(h) Inspect the ball joints in the vertical lever and governor lever link for wear. Replace if pitted or worn. If ball joints are pitted or worn, bad governor action will result.

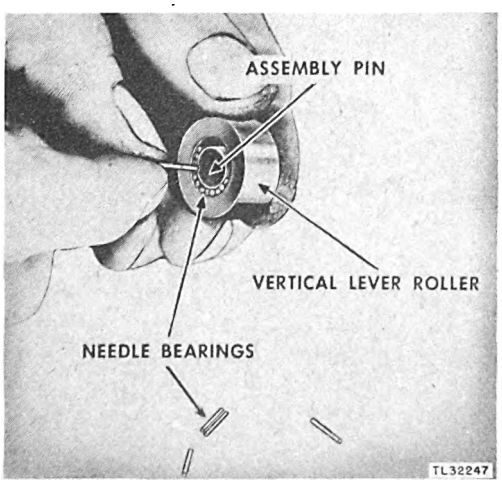
(i) Inspect governor lever bushing. Replace if worn and ream with standard ½" reamer.

(j) Install governor lever to eccentric shaft and place collar over governor lever and insert new cotter pin. Make sure that there is no more than 0.002" thrust on governor lever when assembly is completed (fig. 129).

(k) Attach link from eccentric lever to control shaft.

(2) Cam rocker lever.

(a) Inspect cam rocker lever for wear on ground radius, where vertical lever roller operates. If lever is rough, it will cause bad governor action, and it must be replaced.



TL-32247
Figure 130. Vertical lever roller and needle bearings.

(b) Inspect roller pin for wear; replace if worn.

(c) Inspect roller and replace if worn.

(d) Start roller pin into lever, making sure oil hole in pin is open.

(e) Assemble roller in place and tap pin through roller, making sure lubricating hole in pin indexes with hole in lever (fig. 128).

(f) Lock the roller pin in place with pin lock.

(g) Make sure roller is free and has a 0.006"-0.008" side clearance to allow it to turn freely under tension. If roller should stick, it would cause serious damage.

(h) Inspect cam rocker lever bushings in main housing and No. 1 gear pump body. Replace if worn. When replacing main housing bushing be sure oil hole is lined up properly for lubrication. Ream with 13/16" bottom reamer. Ream bushing in No. 1 gear pump body with ⅝" bottom reamer.

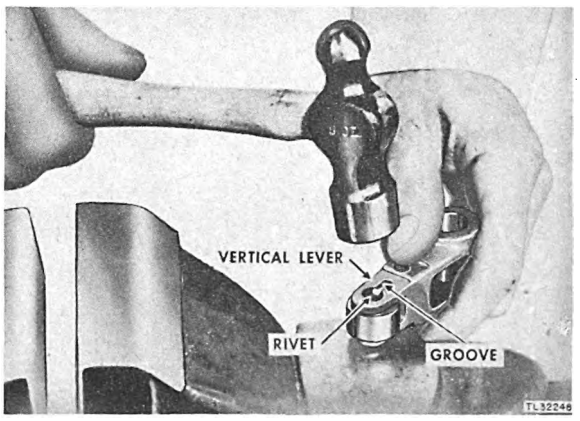
(i) Reinstall cam rocker lever assembly in housing.

(j) At this time it is best to assemble the gear pressure pump to the main housing.

(k) Be sure to use proper gasket between main housing and gear pump. Bolt gear pump in position to body. Check cam rocker lever to see that it rocks freely and that it has at least 0.006" end thrust. If lever is not free, it may be necessary to scrape the bushings slightly so that it will work freely. If this lever does not work freely, it will affect the metering pump fuel delivery.

(3) Vertical lever.

(a) Inspect vertical lever, pin, roller, and roller pin.



TL-32248
Figure 131. Assembling vertical lever and roller.

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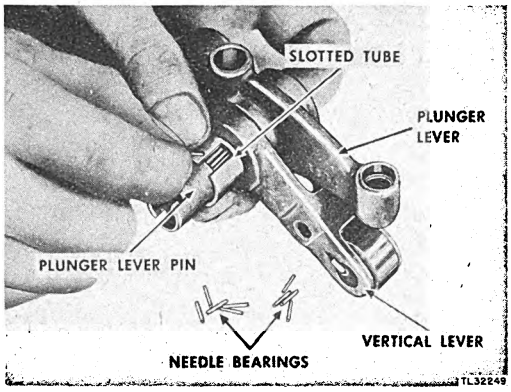
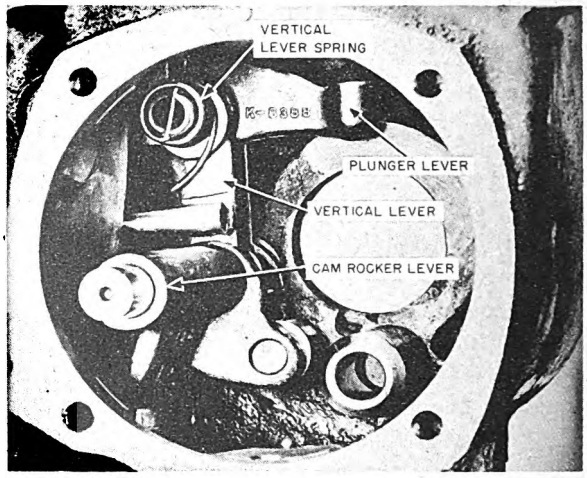


TL-32249
Figure 132. Assembling plunger lever pin and needle bearings.



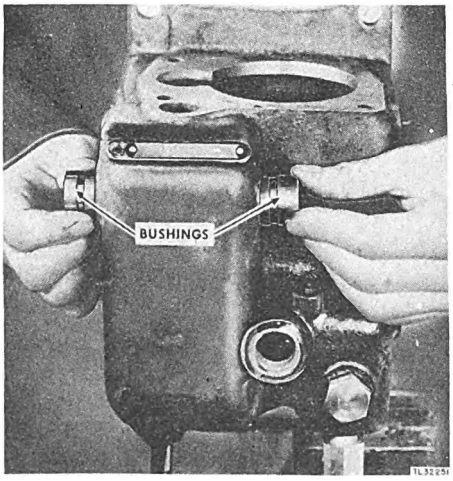
TL-32250
Figure 133. Vertical lever spring in position.

(b) If pitted or worn, replace. If parts are worn or pitted, poor governor action will be encountered. It is always best to replace needle bearings if pins and lever are found to be ridged or pitted.

(c) Spread clean cloth on work bench and on it place the parts of the vertical lever to be assembled. Place roller on index finger and put piece of ⅜" rod, 7/16" long, in hole. Fill hole with 22 long needle bearings as shown in figure 130. Place roller in position and push roller pin through. This will force ⅜" rod out on opposite side. Lock in place by riveting copper rivet into grooves on both sides of vertical lever (fig. 131).

(d) When assembling plunger lever pin, use ⅝" inside diameter copper tubing with slot for needle bearings to pass through (fig. 132). Place plunger lever between arms of vertical lever in position. Tap plunger lever pin through vertical lever and plunger lever, leaving the needle bearing race open on one side. Place the slotted tubing over the pin and insert 28 short needle bearings. Tap the plunger lever shaft through far enough to allow the opposite bearing race to be filled with the same number of needle bearings. Tap plunger into position and turn groove in pin to match the capscrew hole in the plunger lever. Run capscrew down loosely to hold the pin in place.

(4) Inspect plunger lever shaft bushings in main housing for wear. If worn, replace in proper position to match up with oil holes in housing as shown in figure 134. Ream with ¾" standard reamer.



TL-32251
Figure 134. Assembling plunger lever shaft bushings.

TL-32252
Figure 135. Assembling plunger lever shaft.

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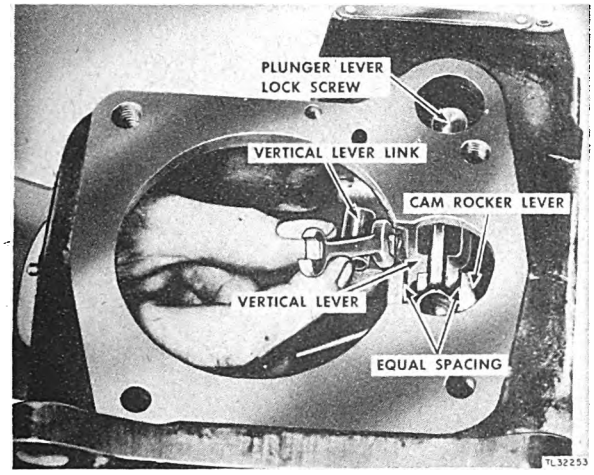
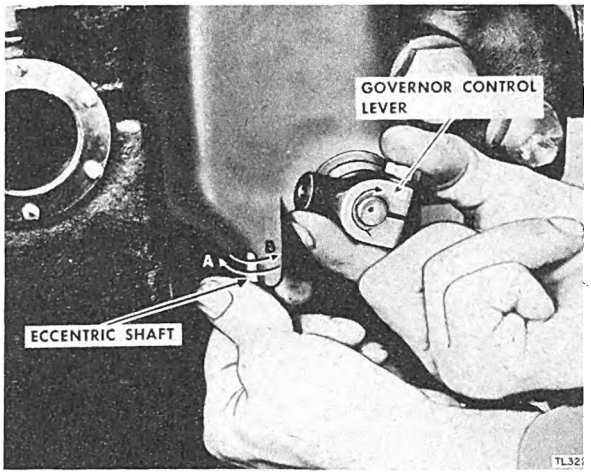


TL-32253
Figure 136. Spacing vertical lever in cam rocker lever race.



TL-32254
Figure 137. Setting control lever and eccentric shaft.

(5) Place vertical lever in position in housing, insert plunger lever shaft as shown in figure 135. It is necessary that the vertical lever and roller be spaced in the center of the cam rocker lever race when it is in proper working position as shown in figure 136. To space the vertical lever, it may be necessary to shift the plunger lever shaft bushings one way or the other. With socket wrench tighten shaft lockscrew. Insert new expansion plugs on each end of plunger lever shaft. With large flat end punches, wedge in place. Check position of vertical lever and roller in cam rocker lever race to see that it has not shifted while inserting expansion plugs. Check to see that plunger and vertical lever work freely. Place vertical lever spring in position (fig. 133).

(6) Assemble vertical lever link with new lockwasher to vertical lever (fig. 136).

c. Final Assembly and Adjustments.

(1) Assemble gear pressure pump to main housing.

(2) Assemble cam rocker lever spring, gasket and spring retainer.

(3) Turn governor control lever in direction of arrow up, with fingers until vertical lever hits against stop pin of cam rocker (fig. 137 and fig. 138).

(4) Turn eccentric shaft in direction of arrow A in figure 137 with fingers. This will place the eccentric shaft in the full OFF position.

(5) With lever and shaft in this position assemble control lever as shown in figure 138.

(6) Turn stop screw into lever until it just touches stop on housing and lock in place with jam nut (fig. 138).

(7) Turn control lever in a right-hand rotation until vertical lever roller hits top of cam rocker stop position (full ON position).

(8) Turn fuel adjusting screw in until it touches stop on housing.

CAUTION: THIS SCREW MUST BE GIVEN THREE MORE COMPLETE TURNS FOR PROPER FUEL SETTING.

(9) Lock adjusting screw in place with jam nut and seal.

(10) Assemble instrument panel throttle lever rod to fuel pump control lever and place in the full ON position.

NOTE: Throttle lever control must always be in the full ON position when adjusting governor control link to governor and fuel pump proper.

(11) Assemble governor terminal lever to terminal shaft as shown in figure 139 leaving clamp bolt loose.

(12) Assemble governor control link.

(13) With wrench or by hand, hold control lever up to full ON position. Turn terminal shaft of governor in a counterclockwise rotation until it hits the stop inside governor housing cover, figure 139.

(14) Tighten terminal lever lockscrew securely when held in this position.

(15) Install governor control link spring onto spring bracket.

NOTE: If all steps have been followed closely the fuel pump is set for the proper governor action and fuel delivery.

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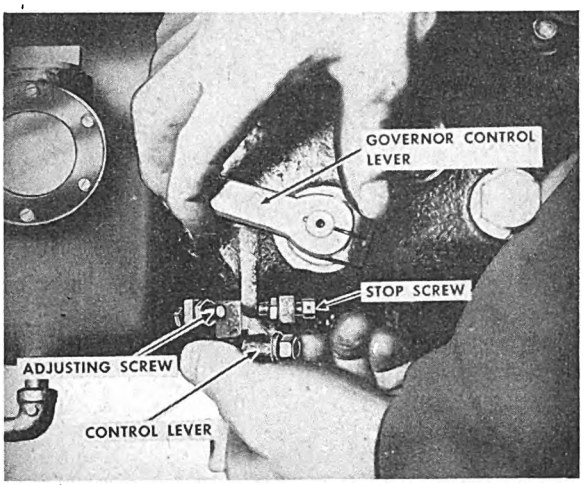
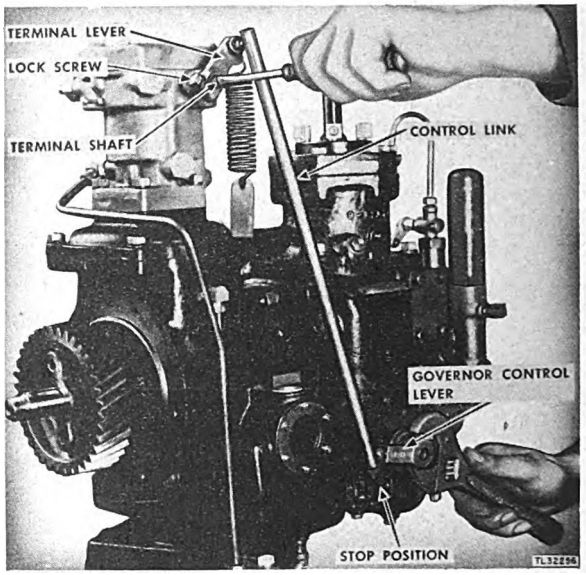


TL-32255
Figure 138. Assembling constant speed fuel pump control lever.



TL-32256
Figure 139. Setting control levers and governor shaft.

90. REMOVAL OF FUEL PUMP ASSEMBLY.

a. Removal of Fuel Pump Assembly. It should only be necessary to remove fuel pump for major repairs to main drive shaft bearings or replacement of pump cam and drive gears. All other parts can be repaired without removing the pump.

b. Removal Procedure. The amount of time for making these repairs will, in some cases, take longer than replacement of a new fuel pump assembly, which is removed as follows:

(1) Disconnect battery terminal connection from battery.

(2) Remove all fuel and lubricating lines leading to fuel pump.

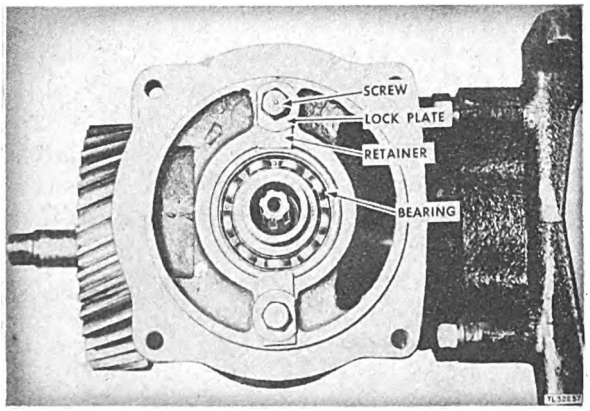
(3) Remove instrument panel throttle lever rod at fuel pump.

(4) Remove instrument panel mounting bolts and swing panel to rear of engine.

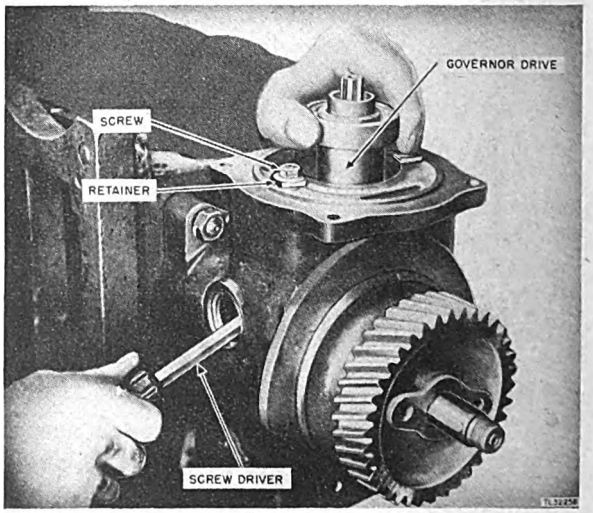
(5) Spot distributor timing marks as shown in figure 117.

NOTE: Timing mark must show in inspection hole of distributor assembly when 1-6 TC timing mark is aligned with index notch on gear case. Turn engine one revolution to same timing mark if notch does not show.

(6) Loosen water pump clamp ring and rotate water pump body to low point of eccentric to loosen drive belts. Remove the belts from the water pump drive pulley.



TL-32257
Figure 140. Hydraulic governor drive-unit retainer.



TL-32258
Figure 141. Removing hydraulic governor drive.

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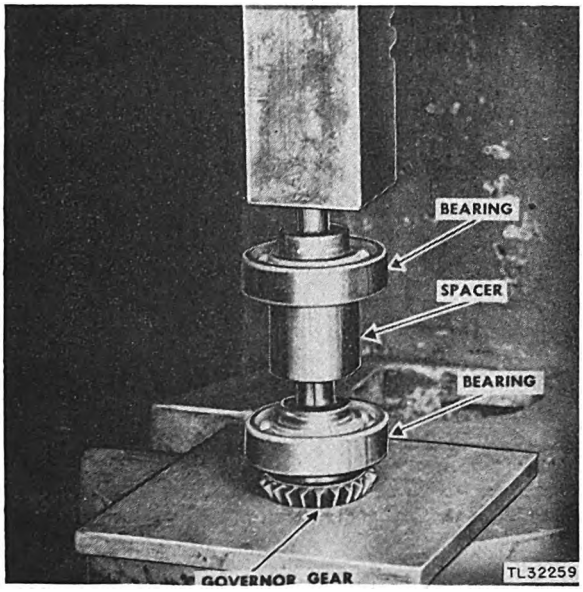
(7) Remove the nut and lock plate holding the water pump drive pulley to the fuel pump shaft.
(8) With a puller as shown in figure 98, remove the water pump drive pulley from the shaft. See note, paragraph 77.
(9) Remove the three capscrews holding the fuel pump to the gear case and the four capscrews holding it to the side of the block. With a slightly backward motion, lift the fuel pump from the engine.

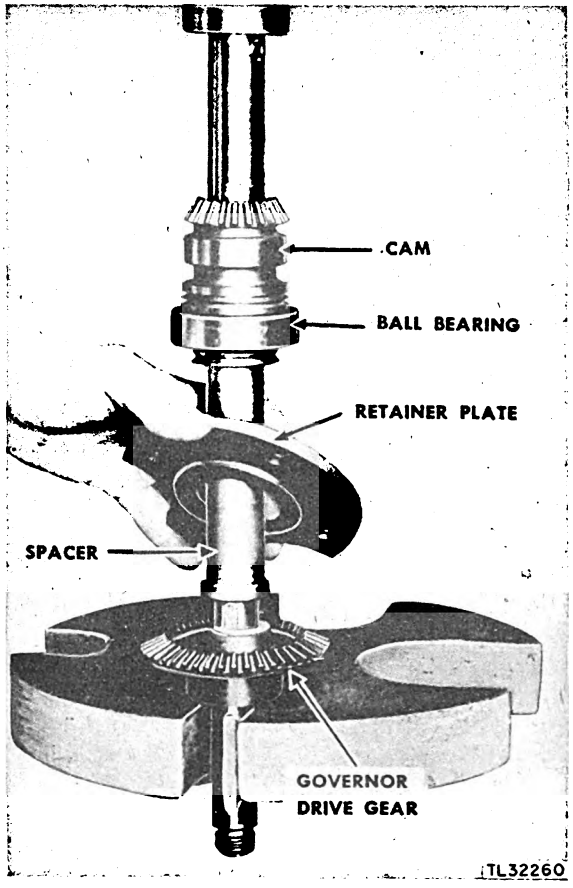
91. REPAIRS TO FUEL PUMP DRIVE SHAFTS.

a. Removal.
(1) Remove fuel pump from engine. Remove control linkage on the side of the pump leading to governor. Remove the four nuts that hold the governor to its adapter plate and lift the governor off.
(2) Remove the four capscrews that hold the adapter plate to the main housing and lift off.
(3) Loosen the two capscrews that hold the retainer plates over the spindle bearing and turn the plates to one side so as to clear the bearing race (fig. 140).
(4) Using a heavy screwdriver, or similar tool, pry the spindle up until the drive assembly can be lifted from housing. This may be accomplished by inserting the screwdriver in the inspection hole in the back of the adapter housing (fig. 141).
(5) Remove the main shaft drive gear from the front of the drive shaft using suitable puller. Remove the three nuts holding the adapter housing to main fuel pump housing.
(6) The governor adapter can now be removed from the main fuel pump housing.
(7) Remove the four capscrews holding the retainer plate, and pull the main shaft from the fuel pump housing.
(8) If necessary press governor drive gear from shaft.
(9) All parts shown in figure 143 can be pressed off shaft for renewal.
(10) Check bearings and gear on governor drive shaft, press off and renew if necessary (fig. 142).

b. Reassembly of Drive Shafts to Fuel Pump.
(1) Assemble main shaft assembly (fig. 143).



TL-32259
Figure 142. Hydraulic governor drive unit assembly.



TL-32260
Figure 143. Main shaft assembly.

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(2) Assemble shaft assembly to main fuel pump housing with a new gasket between bearing shield and main fuel pump housing. Tighten in place with four capscrew lockwashers.
(3) Assemble governor adapter housing over shaft and tighten in place with lockwashers and nuts.
(4) Press driving gear with large ball bearing on shaft over key.
(5) Check main shaft to see that it turns freely in bearings.
(6) Assemble governor shaft drive unit to main housing.
(7) Secure in place with lockplates and capscrews as shown in figure 140, and check gear tooth backlash. This should be 0.004". This backlash can be obtained by inserting thin shim spacer washers below outer race of lower bearing.
(8) Assemble adapter plate to housing and secure in place with four capscrews and lockwashers.
(9) Place the spline coupling on the spindle shaft, first making sure that the coupling fits both the spline on the governor shaft and the spline on the spindle shaft. It should be a slip fit. This is important because faulty governor action will result if either a bind or excessive play exists in the coupling.
(10) Put the governor base gasket in place.

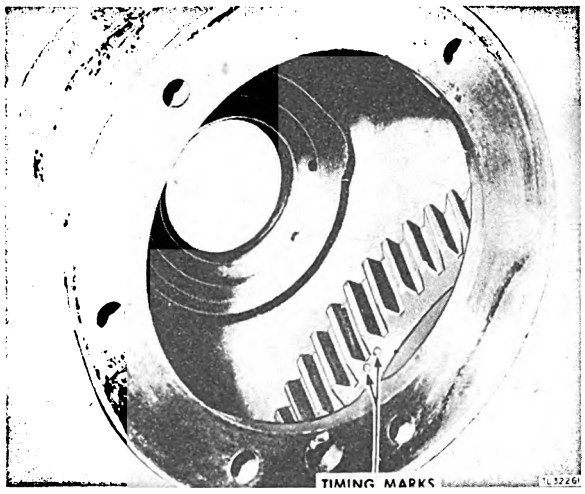
CAUTION: BE SURE IT IS PLACED SO THAT IT DOES NOT COVER THE OIL DRAIN HOLE.

(11) Mount the governor in its correct position making sure that it fits level with the adapter plate. Tighten the hold-down nuts with lockwashers evenly and check the governor for freedom of action.
(12) Readjust governor control links and remount pump to engine. Refer to final assembly and adjustments, paragraph 92.

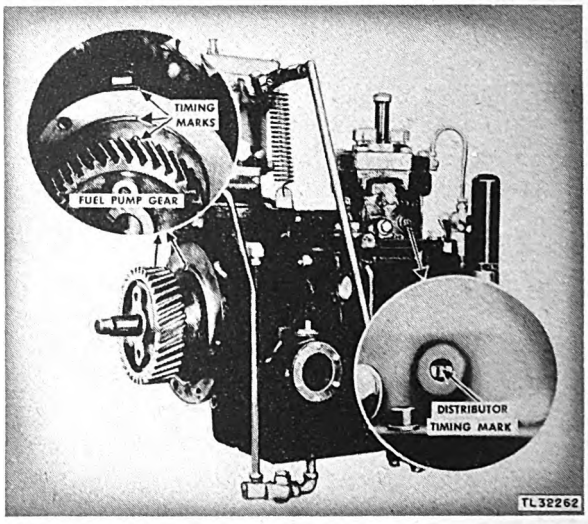
92. INSTALLING FUEL PUMP ON ENGINE.

a. Rotation and Marking.
(1) Rotate the engine until the two punch-marked teeth on the camshaft appear in the fuel pump opening in the gear case (fig. 144).
(2) See that the mark TC 1 & 6 is showing in the flywheel housing index hole (fig. 102).
(3) Rotate the fuel pump until the small notch in drive collar appears in the inspection hole in the distributor housing (fig. 117).
(4) With a piece of chalk or similar substance mark the top surface of each punch-marked tooth on the camshaft gear, and the face of the single punch-marked tooth on the fuel pump gear (fig. 144 and fig. 145).

b. Installation.
(1) Install the copper asbestos gasket for oil drain hole in pump housing holding it in place with cup grease, install new pump flange gasket and lift the fuel pump into place.



TL-32261
Figure 144. Timing marks on camshaft gear.



TL-32262
Figure 145. Timing marks on fuel pump gear and housing.

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(2) Using the water pump drive pulley hole as an inspection hole, mesh the fuel pump gear with the camshaft gear. The timing will be correct if the single chalk mark on the fuel pump gear is meshed between the two chalk marks on the camshaft gear.
(3) Push the fuel pump tight against the gear case, making sure shoulder of pump flange enters gear case hole.
(4) Install and tighten the three capscrews around the flange.
(5) Install and tighten the four capscrews holding the pump to the block.
(6) Reinstall instrument panel, gauge, lines, and throttle rod.
(7) Reattach all fuel and lubricating lines and prime the fuel system before attempting to start the engine.

93. GENERATOR TEST RECOMMENDATIONS.

a. Checking the Exciter Armature. If difficulty is in the exciter armature, check it. The simplest method for all-around generator check is to use a battery in series with a voltmeter attaching it across opposite sides of the commutator by tying a string around the commutator and inserting test leads under the string which will hold them in place diametrically opposite on the commutator bars. A pair of leads from a voltmeter in series with the battery should now be taken and the ends pointed in some manner, either by attaching to a nail or other sharpened device, or by tinning them with solder and filing them to a point. With these two leads, a drop test can be made from bar to bar. If upon putting them across the first two bars the meter reads too low, it will be necessary to increase the potential by putting more batteries in series. If, however, it reads too high off scale, it will be necessary to reduce the potential by putting fewer batteries in series. With these leads proceed around the commutator touching each pair of bars. If an unusually high reading is secured, a short circuit is occurring in the coil embraced by those two commutator bars. If the meter reads low, the coil is open or poorly soldered into the commutator bar, remove armature for repair. Checks for ground may be made as follows: Connect a voltmeter and battery in series with one lead placed on the armature shaft and the other lead placed on the commutator. If the meter gives a reading, a ground is present and the armature will have to be removed.

b. Checking the Field Coils of the Exciter. Should low voltage develop or the exciter fail to build up voltage, it will be necessary to check not only the armature but the field coils. This can be done by placing battery potential across each. If this is not true, it can readily be determined that trouble exists in the field where the difference in voltage drop appears, and the field coils must be removed and rewound. A similar check for ground as indicated on the armature can be made on the field, one side of the voltmeter-battery combination being connected to the field wire and the other side to the magnet frame. If the meter reads, check each field individually by opening them from the others until you have ascertained which one is the injured coil. This must then be rewound.

c. Checking the Alternator. The same procedure on the fields of the alternator can be used as outlined on the fields of the exciter. When difficulty develops in the alternator, check the field; if no defect is located, check the stator. This must be done with the rotor removed. By running one of the other machines at low potential attached to this machine, through temporary leads, determine by heating which coil is short-circuited, if this is the difficulty. By using the voltmeter-battery combination as previously outlined, grounds may be detected. In the event of a short-circuited or grounded coil, the same may be cut out for such a period as is required until replacement parts can be obtained. However, this is not a good arrangement, since it is not always possible to completely open the short-circuited coil, even though the end leads may be effectively opened. Consequently, it is not recommended that this practice be used, except in case of emergency. Any of the alternator tests outlined will require the removal of the alternator end bracket, which can be done after the exciter is removed, as previously outlined; then remove the exciter armature by disconnecting the solid shaft coupling, after which remove the alternator end bracket. If however, it is desired to slide

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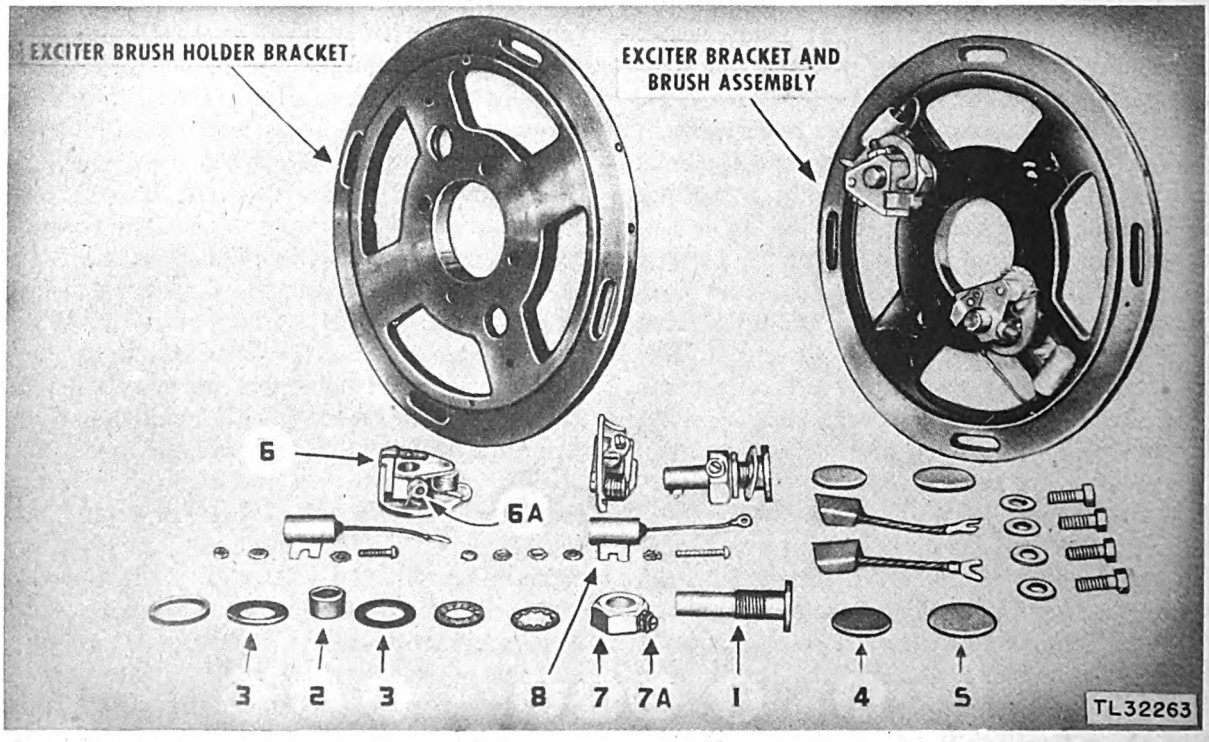
out complete rotor with end bracket in place, for investigation in the stator, remove the fan from the flywheel at the engine end of the generator. Then, remove coupling bolts and allow whole assembly, including the coupling, to come out with the rotating member. In any event the handling of the electrical parts of this machinery requires very careful consideration since bruising of any of the coils may result in short circuits or grounds and prevent the machinery from functioning thereafter until complete repairs are made.

94. EXCITER BRUSH RIGGING. The exciter brush holder bracket, figure 146, is machined steel. This is drilled to take the brass brush holder supports or studs (1) which have no threads for about 2 inches of their length. These studs are insulated from the bracket by a sleeve (2) and insulating washers (3). The head is countersunk in the bracket and a disk (4) of insulating material is placed over the head. Over this an expansion plug (5) is hammered into place resulting in a tight and practically flush joint on the bracket over the heads of the brush holder supports. The brush holders (6) slip over the stud or support on the unthreaded section and are held in position along this stud by a setscrew (6a). This arrangement provides for an adjustment of the brush holder along the axis of the commutators so that it can be correctly set. One surface of the brass nut (7), which holds the support in place, is drilled and tapped for a machine screw (7a) to provide for a connecting wire and connections to small condensers (8), which are installed across the brushes, to reduce radio interference. The bracket is bolted to the exciter frame, the bolt holes being elongated sufficiently to allow the bracket, and consequently the brushes, to be rotated slightly to secure the proper position of the brushes in order to obtain the most satisfactory output of the exciter. The correct position is indicated by marks on the bracket and the frame as shown in figure 147. If the bracket is removed or loosened for any reason it must be installed so that these marks coincide.



TL-32263

Figure 146. Exciter brush rigging.

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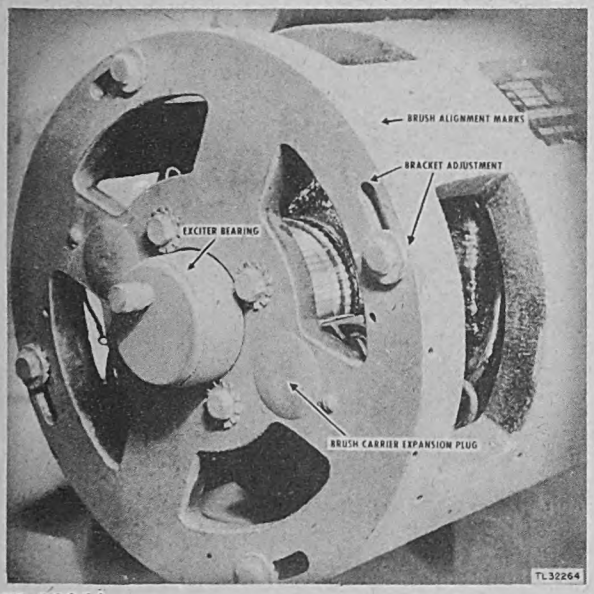


TL-32264

Figure 147. Alignment marks on exciter bracket and frame.

95. EXCITER BALL BEARING.

a. Parts. The exciter ball bearing as shown in figure 148, consists of a housing (1), the ball bearings and races (2), and a housing cover (3). The end of the armature shaft is tapped to take a machine screw (4) which is equipped with a washer (4a). After the bearing and housing are in position, the machine screw and washer are installed and hold the bearing assembly in place. The cover is held in place by two small flush setscrews (5). An Allen wrench (7) is supplied for use on the setscrews. A grease cup (6) screwed in the housing cover, is provided.

b. Exciter Ball Bearing Removal. To remove the exciter ball bearing, proceed as follows:

(1) Remove the condenser and the brush wire terminal connections on the brush holder stud.

(2) Remove the brushes from the brush holders. Note carefully the way the brushes are placed in the holders. The brushes are placed at an angle to the commutator surface and the pigtail wire is not centered on the brush.

(3) Remove the brush holder bracket capscrews and tap off the bracket.

NOTE: Use care in removing the bracket. Do not allow brush holders to bind against the bearing housing.

(4) Use the Allen wrench to loosen the two setscrews which hold the housing cover in place and remove the cover.

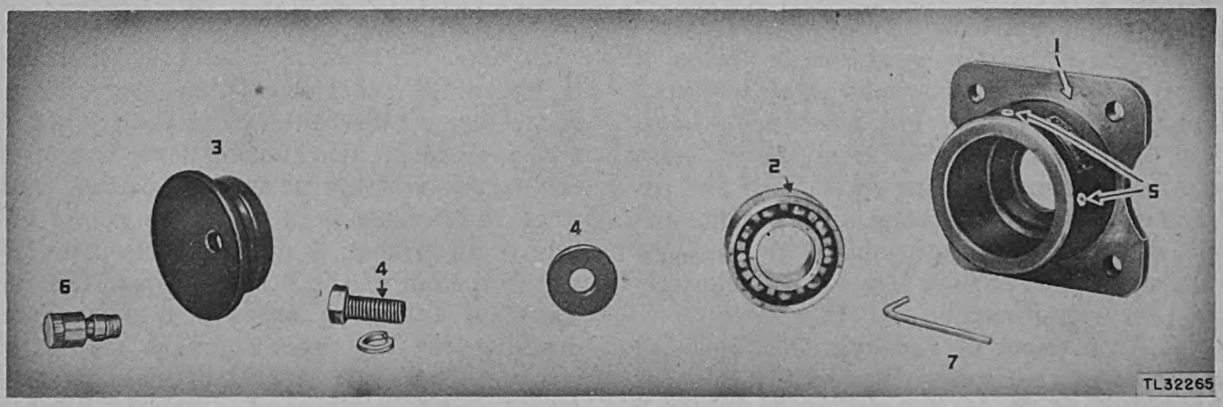
(5) Remove the machine capscrew and washer from the end of the exciter shaft.

(6) Tap off bearing and housing from the exciter shaft with a wooden mallet.

(7) If the bearing binds on the shaft use a puller as shown in figure 149.

c. Installation. To install the exciter ball bearing, reverse the above procedure. If difficulty is encountered in placing the bearing on the shaft, press or drive it on using a block of wood or a brass pipe which will slip over the shaft.

CAUTION: Do not apply any pressure to the bearing outer race. Apply pressure only to the inner race. Pressure applied to the outer race will ruin the bearing.



TL-32265

Figure 148. Exciter ball bearing.

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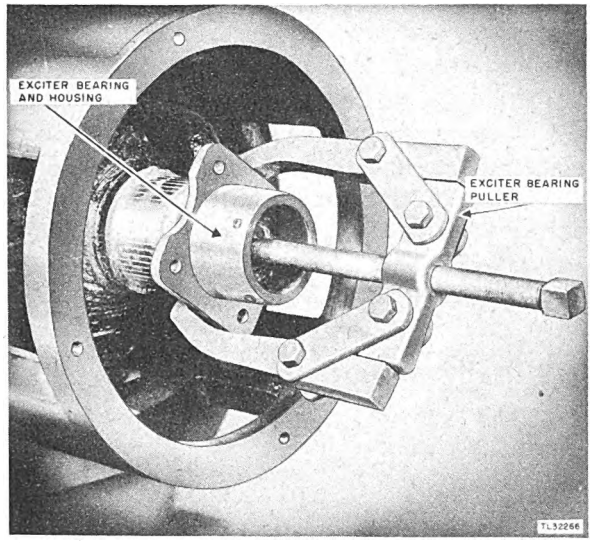
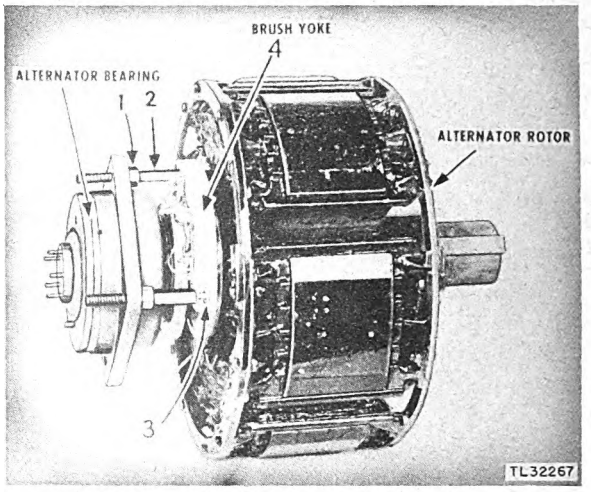


TL-32266
Figure 149. Pulling exciter ball bearing.



TL-32267
Figure 150. Alternator rotor with ball bearing slip-ring brush rigging in place.

96. ALTERNATOR SLIP-RING BRUSH RIGGING.

a. Arrangement of Rigging. The alternator brush rigging consists of a yoke of insulating material on which the brush holders are mounted, and which is supported by three special shouldered studs passing through the corners of the square flange of the ball bearing housing (fig. 150). The brush holder yoke is rigidly fastened to the end of these bolts and is adjustable along the shaft axis, after the bearing is in place, so that the brushes can be set correctly on the slip rings. When this adjustment is attained it can be locked in position. The other ends of the three bolts or studs project through accurately located holes in the bracket which in turn, is accurately located and bolted to the alternator frame. A fourth bolt which does not enter the yoke completes the fastening of the bearing housing to the bracket. This arrangement holds the ball bearing housing in position and determines the radial location of the brushes and provides for an adjustment of the brushes along the shaft so that they will be accurately and securely placed on the slip rings.

b. Adjustment of Brushes. To adjust the position of the brushes across the collector rings refer to figure 150, and proceed as follows:

(1) Back the locking nuts (1) on the special studs (2) away from the ball bearing housing.
(2) Loosen the yoke nuts (3) which hold the brush holder yoke (4) up against the shoulder of the special studs.
(3) Turn the studs, which are threaded in the ball bearing housing, to bring the brushes into the correct alignment position across the collector rings. Do not turn one stud excessively or an undue strain will be put on the yoke.
(4) Tighten the yoke nuts (3) and check the position of the brushes. Be sure the brushes do not over-ride the rings.
(5) Turn the locking nuts (1) up against the bearing housing.

97. ALTERNATOR BALL BEARING.

a. Parts. The alternator ball bearing shown in figure 151 consists of a housing with a square flange; the ball bearing and races and a housing cover. The housing cover is tapped for a grease fitting in such a position that when the bearing is in place, the grease fitting is uppermost. A drain plug is installed at the bottom of the housing cover. The removal of this plug provides a means for draining out any excess grease from the bearing. The cover is held in place by two flush setscrews. The grease fitting includes sufficient piping to bring the grease cup to

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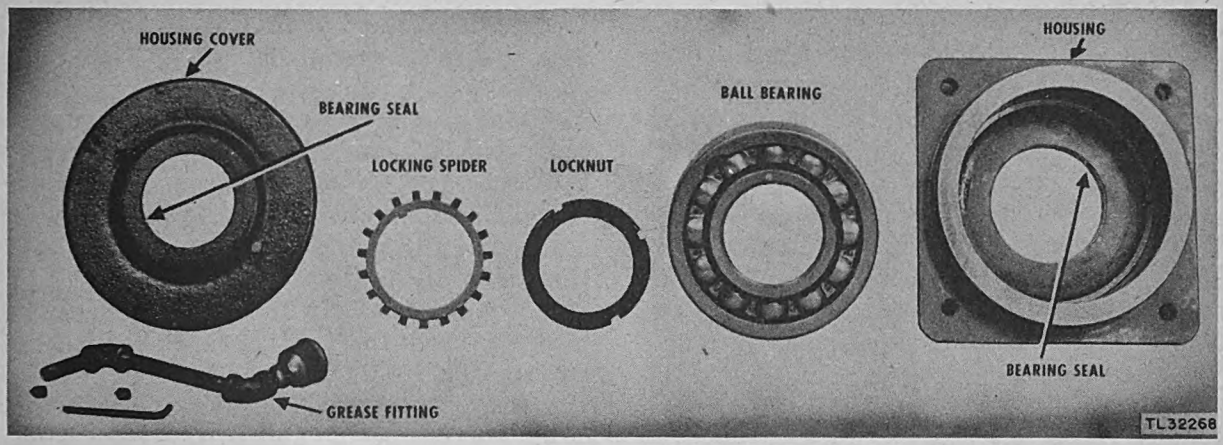
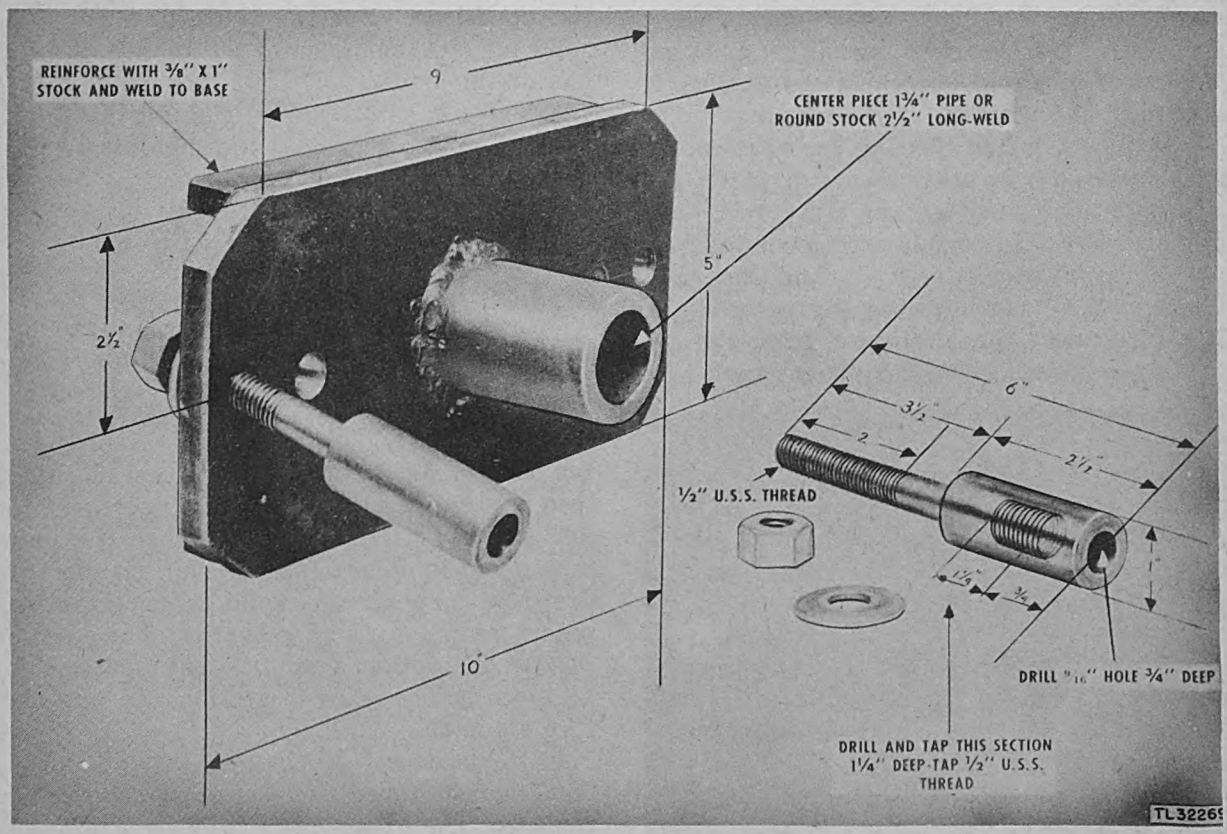


TL-32268

Figure 151. Alternator ball bearing.



TL-32269

Figure 152. Puller for alternator ball bearing.

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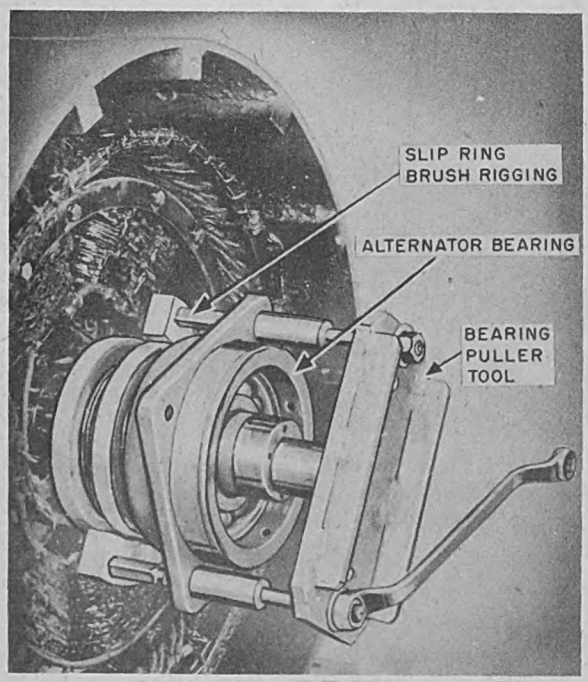
an accessible position. Grease seals and a locking device to hold the bearing in place are part of the assembly.

b. Removal of Alternator Ball Bearing. Before the bearing can be taken off the shaft the seal and locking device will have to be removed. The ball bearing is driven or pressed in place and it will be necessary to use a puller to remove it. A satisfactory puller for this purpose is shown in figure 152, and the application of the puller is shown in figure 153. Referring to figure 152, the inside of the sleeve end of the bolts is threaded to fit the bearing bolts. The thread does not show in the photograph as it is reamed out for a short distance inside the sleeve. Care must be taken in using the puller to draw the nuts up evenly to avoid putting an unnecessary strain on the bearing housing. A small amount of oil rubbed on the alternator shaft assists in the removal of the bearing.

c. Alternator Ball Bearing Installation. As it is necessary to press on or drive on the alternator ball bearing, the rotor will have to be removed. To do this proceed as follows:
(1) Remove the exciter frame and the armature which is coupled to the alternator shaft.
(2) Disconnect the alternator from the engine by separating the flexible coupling.



TL-32270
Figure 153. Pulling alternator ball bearing.

(3) Secure a piece of iron pipe about 4 feet long and large enough to go over the rotor shaft.
(4) If a crane is not available, arrange a block and tackle or equivalent, using at least 5/8 inch rope for looping around the rotor shaft. Chain must not come in contact with the shaft. Bring the tackle up taut to take the weight of the rotor.
(5) Wrap the shaft with cloth and place the iron pipe over the shaft, being sure it goes on far enough so that it will not slip off.
(6) Using the iron pipe as a lever, press down on the end and raise the rotor sufficiently to be able to swing it out of the frame.
(7) If the bearing must be driven on, block the opposite end of the shaft up against a solid surface using care not to injure this end of the shaft.
(8) Drive or press the bearing on the shaft until it comes up against the shoulder on the shaft which locates it properly.

CAUTION: NEVER APPLY ANY PRESSURE TO THE OUTER RACE OF THE BEARING.

98. LUBRICATION OF BEARINGS, ALTERNATOR, AND EXCITER.

a. Inspection of the Bearings. The ball bearings of the alternator and exciter have been sufficiently lubricated before shipment for 5000 or 6000 hours of operation at rated load and temperatures. It is not necessary to add grease to these bearings when the unit is first put in operation. However, during the first run the bearings should be inspected for quietness and any undue heating. The results of this inspection should be satisfactory as all units have passed inspection and test before shipment.

b. Replacement of Grease. After 5000 or 6000 hours of operation the grease should be replaced. The grease used must be a mineral product of the very highest grade and preferably a long fibre type. Remove the exciter and alternator bearings and clean out all old grease using gasoline or a suitable solvent. Also clean the grease cups and fittings. After cleaning, use every precaution to prevent any dirt or dust coming in contact with the bearings. Protect them with clean cloths. Reassemble the bearings on the shafts and then

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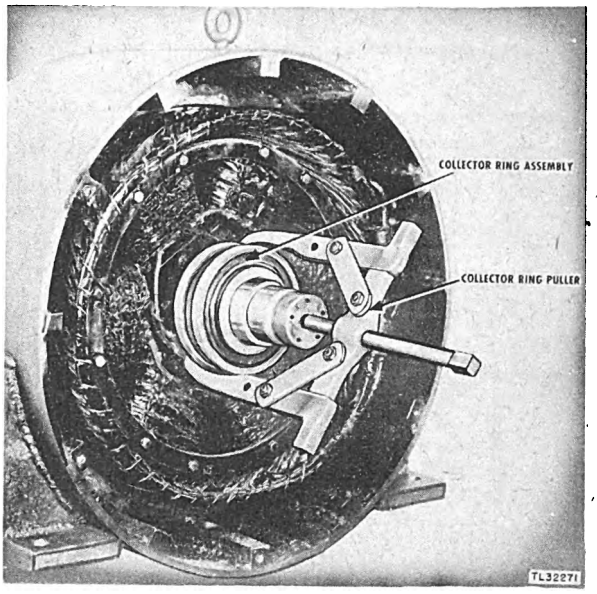
force grease around the balls. Fill the bearings about 1/3 full of grease. Do not overgrease. Overgreasing will cause the bearings to overheat. If this occurs, remove the drain plug on the alternator bearing and allow excess grease to drain out while unit is operating. To remove excess grease from the exciter bearing remove the cover and wipe out the excess. Fill the grease cups and turn them down slightly.

99. COLLECTOR RING REMOVAL. The collector ring unit has been forced on the shaft under great pressure and it must be removed with a puller. The method of using such a tool is shown in figure 154. Particular care must be taken to see that the prongs of the puller are exactly opposite each other. Replacement rings must be pressed onto the shaft until they come up against the shoulder on the shaft which locates them properly.



TL-32271

Figure 154. Pulling collector rings.

100. SWITCHGEAR.

a. Care and Inspection of Switchboard. In order to obtain satisfactory operation from the switchboard, it must have adequate care and periodic and intelligent inspection. The inspection should cover all devices and connections. When making these inspections, extreme care must be exercised that no circuits are shorted or grounded and that the inspector experiences no personal harm. The essence of switchgear maintenance is cleanliness. All dust and dirt should be carefully removed or blown out by compressed air if available. No lubrication is necessary on any of the operating mechanism except where specifically mentioned. Due to the delicate construction of the equipment it is not recommended that major repairs be attempted in the field. Damaged instruments or parts should be returned to the depot for servicing and adjustment.

CAUTION: Always shut down the engine and disconnect the batteries while making inspections or tightening connections.

b. Voltage Regulator. The operation of the voltage regulator is covered in paragraph 41. The vibrating armature is the only moving part and this part requires no lubrication.

(1) If the contacts of the vibrating armature become so irregular as to hinder operation, use about a 600 grade of carborundum paper or cloth and polish the surfaces. After smoothing the contacts blow the dust out and wipe off each contact with a clean cloth. If the contacts cannot be smoothed, replace them. If this is necessary use care in removing the screw contact so as not to injure the pivot points.

(2) Regulators are carefully adjusted during the testing of the power units before shipment and they should arrive at their destination in satisfactory operating condition. However, if adjustment has to be made or if a regulator is replaced the following is the procedure:

(a) The a-c voltage is adjusted by turning the voltage adjusting screw, figure 154. With the regulator in operation, set the regulator rheostat in the mid-position and loosen the setscrew in the end of the supporting post thus allowing the adjustment screw to be turned. To increase the voltage, turn the adjusting screw clockwise or in a direction to increase the spring tension. When the correct voltage is obtained, tighten the setscrew. Under this condition movement of the regulator rheostat will adjust the voltage approximately 12 volts either side of the selected value.

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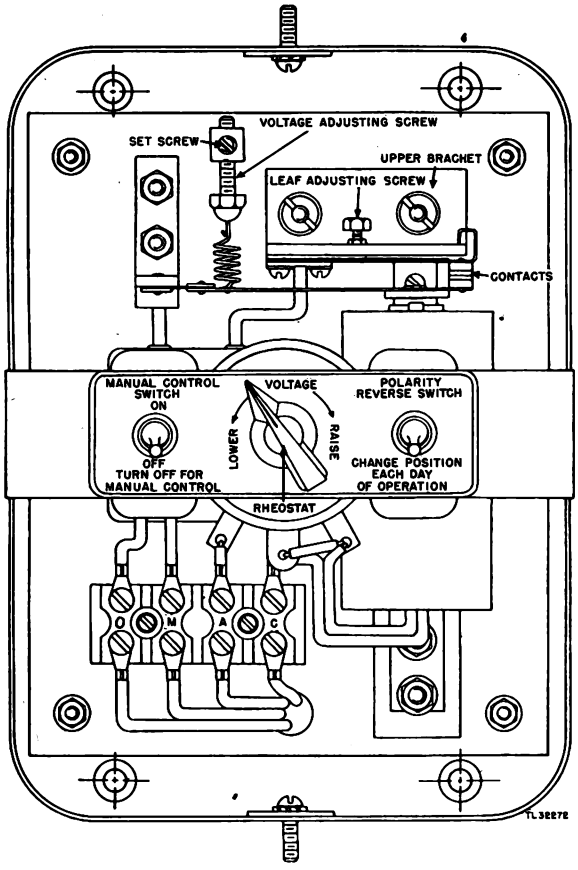

TL-32272

Figure 155. Voltage regulator.

(b) Adjustment of the bumper leaf spring affects the voltage swing. It is adjusted by turning the small vertical screw on the upper contact bracket while the regulator is in operation. A heavy leaf spring tension causes bouncing of the lower contact while a slight tension causes hunting or swinging of the voltage. The proper tension is that which is barely enough to prevent hunting. This adjustment usually places the bumper spring within 1/32 of an inch of the moving armature.

(c) The position of the upper bracket relative to the vibrating contact and the face of the magnet core is adjustable. The regulator must not be in service during any alteration in the position of this bracket. The two mounting holes are made large so that when the holding screws are loosened the bracket may be moved. The bracket should be located, especially when replacing contacts, in such a manner that the upper and lower contacts butt together evenly and that the distance between contacts is between 0.025 and 0.040 of an inch. To measure this adjustment disconnect the voltage adjusting spring so as to allow the vibrator to rest lightly on the bumper pad on the top of the magnet core. The stop on the end of the leaf spring should be resting on the upper horizontal surface of the bracket.

c. Circuit Breaker. The circuit breaker has been designed with a large factor of safety for interrupting capacity and long life. Under normal operating conditions, adjustment or replacement of parts will not be required. All metal parts are corrosion resistant or are plated with corrosion-resistant material. Contacts are self-wiping and the normal use of the breaker keeps these contacts clean and bright. Inspection should be made occasionally to see that the breaker is clean and all connections are tight. The power unit must be idle during this inspection. The circuit breaker is designed with a thermal trip element which operates as a time delay device and will carry small overloads for a short time. This element is also constructed so that when a dead short or heavy overload occurs the breaker will trip instantaneously, thereby safeguarding the equipment. The trip element is factory sealed and should give service indefinitely but if necessary it can be replaced.

d. Frequency Meter. No repair of this meter is possible. If it is not operating satisfactorily it must be replaced.

e. Ammeter and Voltmeter. The ammeter and voltmeter are high-accuracy instruments of standard switchboard construction. No repair, of these instruments, in the field is possible. A needle adjusting screw is provided which is used to obtain an accurate zero position of the needle.

f. Total Hour Meter. No repair of this instrument is possible while in the field. If it is not operating satisfactorily it must be replaced.

g. Exciter Field Rheostat. Cleanliness of the exciter field rheostat is important. After a long period of service it may show wear. It should be replaced before any such wear results in it being unserviceable.

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101. REPLACEMENT OF RADIO INTERFERENCE-SUPPRESSION MATERIAL. The following radio suppression material is mounted on Power Unit PE-245-A as described and illustrated in the figures referred to. It has been determined under test, that this material as installed and illustrated will effectively eliminate radiated and conducted radio interference within the frequency range of 0.55 mc through 140.0 mc at a distance of 25 feet.

a. Installation of the Metal-Clad Automotive-type Capacitors.

(1) Three metal-clad automotive-type capacitors, rated at 0.01 MFD, 600 volt d-c, are installed as follows (refer to fig. 156): Each phase lead from alternator is bypassed by a capacitor. Capacitor leads are fastened to A, B, and C terminals on output terminal block at left rear of instrument-panel cabinet by existing phase lugs, nuts, and appropriate washers. Capacitor brackets are fastened to metal partition upon which junction-terminal block is mounted by appropriate nuts, bolts, and washers.

(2) Two metal-clad automotive-type capacitors, rated at 0.1 MFD, 600 volt d-c, are applied as follows: (refer to fig. 158). Each of the two d-c exciter brushes is bypassed by a capacitor. Capacitor leads are fastened to exciter brush rigging by existing screws and appropriate washers. Capacitor brackets are fastened to inner surface of exciter and plate by appropriate nuts, bolts, and washers.

(3) Four metal-clad automotive-type capacitors, rated at 0.25 MFD, 600 volt d-c, are installed as follows (refer to fig. 157):

(a) The d-c generator lead from the exciter interpole winding to a-c slip-ring brush terminal is bypassed by a capacitor. Capacitor lead is soldered to interpole winding lead spliced and taped. Capacitor bracket is fastened to inner surface of exciter barrel at exciter end by appropriate nut, screw, and washers.

(b) The d-c generator interpole windings are bypassed by a capacitor. Capacitor lead is soldered to series lead connecting the two field coils and the connection is taped. Capacitor bracket is fastened to inner surface of generator barrel at alternator end by appropriate nut, screw, and washers.

(c) The d-c generator field coils are bypassed by a capacitor. Capacitor lead is connected to series lead connecting the two field coils by existing screws and washers. Capacitor bracket is fastened to inner surface of generator barrel at alternator end by appropriate nut, screw, and washers.

(d) The d-c generator field lead to automotive voltage regulator is bypassed by a capacitor. Capacitor lead is soldered to lead-field winding spliced and taped. Capacitor bracket is fastened to inner surface of generator barrel at alternator end by appropriate nut, screw, and washers.

b. Application of the Flexible Metallic Bond Straps. Flexible metallic bond straps are applied with appropriate nuts, bolts, and washers in the following manner:

(1) Six 15/16" x 7" bonds are fastened between the alternator fan shroud to the engine flywheel housing (fig. 159).

(2) Four similar 15/16" x 7" bonds, are fastened to each corner of the instrument-cabinet frame to the cabinet supporting stand (fig. 159).

(3) One ½" x 3½" bond from alternator housing to neutral wire (fig. 160).

(4) One 2-½" bond of No. 18 stranded wire from automatic voltage-regulator internal filter can to automatic voltage-regulator housing base.

c. Installation of the Toothed Lockwashers. Zinc plated, internal and external toothed lockwashers are installed as a means of bonding as follows:

(1) Four ⅜" washers are installed between the end plate of exciter and exciter frame (fig. 161, section B-B, item 3).

(2) Four 5/16" washers are installed between the exciter shaft-bearing housing and the exciter end plate (fig. 161, section B-B, item 2).

(3) Four ¼" washers are installed between the exciter end plate ventilation shroud and the exciter housing (fig. 161).

(4) Twelve ¼" washers are installed between the exciter housing and the hand-hole covers at commutator end of exciter (fig. 161, section B-B, item 1).

(5) Four ¼" washers are installed between the alternator end plate entilation shroud and the alternator housing (fig. 161, section A-A).

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(6) Eight ¼" washers are installed between the alternator fan shroud and alternator housing (fig. 161, section C-C).
(7) Four ¼" washers are installed between the upper alternator fan shroud and lower fan shroud (fig. 161).
(8) Eight 5/16" washers are installed between the hinged cover on the alarm relay box and the alarm box (fig. 161, section E-E).
(9) Four No. 10 washers are installed, between the alarm relay box and the relay mounting plate (fig. 161, section F-F).
(10) Two 9/16" washers are installed between the mounting plate of alarm relay box and engine block (fig. 161, section G-G).
(11) Two ⅜" washers are installed between the alarm light panel and the engine block (fig. 161, section H-H).
(12) Eight ¼" washers are installed between the metal partition in the load terminal box and the angle frame (fig. 156, detail A).
(13) Four 5/16" washers are installed between the mounting frame of the copper-oxide rectifier unit and the angle frame of instrument panel (fig. 162, section B-B).
(14) Eight No. 10 washers are installed between the voltage regulator and the instrument panel, and four No. 10 washers are installed on the grounding terminals of the voltage regulator (fig. 163, item 1).
(15) Four No. 10 washers are installed between the manual voltage-control rheostat and instrument panel (fig. 162).
(16) Eight ¼" washers are installed between the instrument panel and the cabinet frame (fig. 162).

d. Contact Bonding.

(1) Contact bonding is acquired by means of prepared surfaces. The automatic voltage regulator cover is bonded to the lips of the rheostat switch mounting by cleaning the regulator cover and tinning the lip cover areas (fig. 163, detail B).
(2) Contact bonding by means of brush bonds:

(a) The exciter armature shaft coupling is bonded to the exciter frame by two low-resistance copper carbon brushes in assemblies which are fastened by appropriate washers and nuts of exciter mounting studs on horizontal centerline of a-c generator end plate (fig. 164).

(b) The alternator-rotating-field shaft is bonded at the fan end to the alternator housing by two low-resistance copper carbon brushes in assemblies that are spot welded to the steel strip extending horizontally across the alternator and above the shaft. Steel strips are fastened to opposite sides of alternator housing by appropriate nuts and bolts. The shaft is grounded by two copper brushes in assemblies, pressure contacting the cleaned surface of the rotating shaft. The brush assemblies are grounded by two 1" x 10" flexible metallic bond straps, one for each brush assembly to a steel strip. The bonds are fastened to the brush assemblies by appropriate bolts and washers and to the steel strip by bolts and washers used in fastening the steel strip to the alternator housing (fig. 165).
(3) Contact bonding by means of dowel pins: Diesel engine-mounting legs bonded to main frame. Holes were drilled through each of the four mounting legs and then taper reamed. Taper pins were inserted to make good contact with all reamed surfaces.

e. Shielding leads. The following current carrying leads are shielded, the shielding being grounded at each terminus of the leads:
(1) Two separate shields of copper braid inclosing leads from O and M terminals of the automatic voltage regulator to the manual voltage-control rheostat, with the shielding grounded to the rheostat and grounded at the regulator end by a common ground lead from regulator to terminal block (fig. 162, item 8, and fig. 163).
(2) A shielded lead is installed from the exciter brush rigging to the alternator slip-ring brush with shielding grounded to the exciter end and to the alternator end plate (fig. 157 and fig. 158).
(3) A shielded lead is installed from the alternator slip-ring brush assembly to the automatic voltage regulator terminal block, with the shielding grounded to the alternator end plate and to the regulator terminal block (fig. 157 and fig. 163).
(4) A shielded lead is installed from the exciter field to the automatic voltage regulator,

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with the shielding grounded to the exciter field at the bolt mounting the exciter field bypass capacitor and grounded at voltage regulator in common connection with lead grounding slip-ring shield to automatic voltage regulator (fig. 157 and fig. 163).

(5) A shielded lead is installed from the exciter interpole winding to the alternator slip-ring assembly, with the shielding grounded to the alternator end plate and to interpole winding (fig. 157).

f. Shielding by Means of Expanded Mesh Metal.

(1) The slotted openings at the alternator end of the exciter housing are shielded by an expanded mesh metal band which is fastened to the exciter frame by appropriate nuts, screws, and washers (fig. 166, detail A).

(2) The lower hand hole opening at the commutator and at the exciter barrel is shielded by an expanded mesh metal band which is welded to the lower edges of left and right exciter hand-hole covers (fig. 166, detail B).

g. In event of the removal of any parts of the power unit which make it necessary to take off any of the special contact washers, these should be replaced with new ones and must be reinstalled exactly as they were originally.

102. PROCEDURE FOR STORING POWER UNITS. When a power unit is not to be used for thirty days or more it should be stored in a dry and protected place. The following procedure should be followed. The lubrication precautions should be repeated every six months.

a. Wash or clean and completely lubricate the engine.

b. Drain the lubricating oil from the governor and refill with new oil.

c. Drain the fuel oil from the primary and secondary fuel oil filters by removing the plugs installed for this purpose. Replace the plugs and fill the two filters with one of the following flushing oils leaving the vents open during this operation: Gulf Oil Corporation No. 301, Shell Latus No. 22 Oil, Formula No. 11326 Standard Oil Co., No. 8504 or E-382 Socony Vacuum Oil Co., and Capella Oil, AA. In emergencies a flushing oil mixture of one half kerosene and one half good grade of light lubricating oil can be used. Vent the secondary fuel oil filter.

d. Connect the drum side of the two-way supply valve to a container of flushing oil of about one gallon capacity.

e. Start and run the engine using the flushing oil for about five minutes to insure a complete flushing operation.

f. Stop the engine and drain the flushing oil from the fuel oil filters and disconnect the supply connection to the flushing oil container.

g. Drain the water from the cooling system.

h. Remove the injection nozzles and pour one tablespoonful of SAE-50 lubricating oil of good grade through the nozzle opening into each cylinder. Replace the injection nozzles.

i. Remove the valve housing cover and spray oil over the valves and valve rocker mechanism and replace the cover.

j. If the exhaust system has been dismantled, cover the manifold opening carefully. If not dismantled, cover the exhaust opening to the atmosphere to prevent moisture from entering the manifold.

k. Apply a complete but thin coating of Light Rust Preventative Compound per U. S. Army Specifications No. 2-84 or equivalent, to all exposed unpainted parts such as threads, nuts, silencer, and exhaust piping. Use a brush to apply the compound being careful not to wet any rubber parts.

l. Remove the storage batteries and check each cell for the charged condition. If the batteries do not show a full charge, have them charged. If the power unit is not to be stored for over 60 days it will be satisfactory to leave the electrolyte in the batteries but after 30 days the condition should be checked again and a charge applied if necessary. If the storage period is to be longer than 60 days, the electrolyte should be drained out of the batteries and each cell rinsed out with water. Preserve the electrolyte in glass or crockery containers, *not metal*, and store it where the temperature will not be less than 0° F. If the electrolyte has not been drained out of the batteries they should be kept well charged and stored where the temperature is not less than 0° F. Note that these tem-

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peratures are satisfactory for an electrolyte in or taken from a fully charged battery. Otherwise batteries containing electrolyte or separate electrolyte must be stored at temperatures not less than 32° F.

m. Place a protective covering over the entire unit.

103. PREPARATION FOR SERVICE AFTER STORAGE. To restore units to service after storage proceed as follows:

a. Remove the injection nozzles and pour about two tablespoonfuls of a mixture of one half fuel oil and one half SAE-10 lubricating oil into each cylinder. Do not replace nozzles. See subparagraph **d** below.

b. Remove the valve housing cover and flush the valves and valve rocker mechanism with the same mixture.

c. Install and connect the storage batteries, checking the charged condition.

d. Crank the engine electrically until the excess oil has been blown out of the nozzle openings. This operation will loosen any tight piston rings and remove any oil that has become gummed.

e. Replace the injection nozzles being sure that they are clean and in good condition. Inspect the tips to see that no carbon deposit is present.

f. Clean the power unit thoroughly.

g. Install new filtering elements in the primary and secondary lubricating oil filters and examine the filtering element in the secondary fuel oil filter and if this element shows any muck or a dirty glaze replace it.

h. Check the oil level in the governor.

i. Fill the cooling system with water or an antifreeze solution to suit operating conditions.

j. Remove all coverings from the exhaust pipe openings.

k. Fill the fuel tank or connect the two-way supply valve to an outside source of fuel oil.

l. Start the engine and let it run slowly. Observe if any valves are sticking and if so pour a small quantity of fuel oil or kerosene on the valve stems until the valves become loose.

m. Replace the valve housing cover.

CAUTION: DO NOT ACCELERATE THE ENGINE RAPIDLY OR OPERATE IT AT HIGH SPEED IMMEDIATELY AFTER STARTING.

103.1 MOISTUREPROOFING AND FUNGIPROOFING.

a. General. Communication failures commonly occur when Signal Corps equipment is operated in tropical areas where temperature and relative humidity are extremely high. Fungus growth can cause trouble where high voltages are present, to coils and to surfaces making an electrical contact. Unfortunately, the varnish used for fungiproofing spray acts as an insulator. Therefore it cannot be used on commutators, slip rings, relay contacts, voltage regulators, cable connectors, outlet connections, etc. These parts will have to be kept clean by the use of sandpaper or crocus cloth. Although generator windings are adequately protected against moisture, it is advisable to use the spray method at monthly intervals, taking precautions to mask the bright surfaces prior to the spraying. The following problems are typical:

(1) Resistors and capacitors fail.

(2) Electrolytic action takes place in coils, chokes, transformer windings, etc., causing eventual breakdown.

(3) Hook-up wire and insulation break down. Fungus growth accelerates deterioration.

(4) Moisture forms electrical leakage paths on terminal boards and insulating strips causing flash-overs.

(5) Moisture provides leakage paths between battery terminals.

b. Treatment. A moistureproofing and fungiproofing treatment has been devised which, if properly applied, provides a reasonable degree of protection against fungus growth, insects, corrosion, salt spray, and moisture. The treatment involves the use of a moisture and fungi-resistant varnish applied by means of a spray gun. A brief description of the method of application follows:

(1) All repairs and adjustments necessary for the proper operation of the equipment are made.

(2) Equipment to be processed is thoroughly cleansed of all dirt, grease, rust, fungus, oil, etc.

(3) Equipment is partially disassembled and certain points, such as points, contacts, bear-

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ings, are covered with masking tape.

(4) Equipment is thoroughly dried by heat to expel moisture which the circuit elements have absorbed.

(5) All circuit elements and all parts of the equipment are sprayed or painted with three coats of moistureproofing and fungiproofing varnish.

(6) The equipment is given a final operational check.

c. Step by step instructions.

(1) **Disassembly.**

(a) Remove 14 screws holding back plate to control panel box.

(b) Remove back plate (to be treated).

(c) Remove 24 screws holding cover to control panel box.

NOTE: If pipe frame interferes with removal of certain screws, pry up or load down box with weights until screws are in position for removal.

(d) Lift off cover from control panel box (to be treated).

(e) Remove leads from battery charging ammeter.

(f) Remove leads from frequency meter.

(g) Remove leads from voltmeter.

(h) Remove leads from ammeter.

(i) Remove leads from elapsed time meter.

(j) Remove nuts holding bridge over battery charging ammeter.

(k) Remove battery charging ammeter (to be treated).

(l) Remove 3 bolts holding frequency meter to panel.

(m) Remove frequency meter (to be treated).

(n) Remove 3 bolts holding voltmeter to panel.

(o) Remove voltmeter (to be treated).

(p) Remove 3 bolts holding ammeter to panel.

(q) Remove ammeter (to be treated).

(r) Remove 3 bolts holding elapsed time meter to panel.

(s) Remove elapsed time meter (to be treated).

(t) Remove upper and lower covers of voltage regulator (to be treated).

(2) **Masking.**

(a) Mask with tape all connecting lugs on lead wires removed in (l) above.

(b) Mask contacts on battery charging switch with tape.

(c) Mask with tape the contact surface of dimming rheostat.

(d) Mask with tape the two contact points in voltage regulator.

(3) **Drying.**

(a) Use infra-red lamps to dry interior of control panel box and voltage regulator.

(b) Dry for 2 to 3 hours at 160° F.

(c) Dry detached parts for 2 to 3 hours at 160° F.

(4) **Varnishing.**

(a) Apply 3 coats of moistureproofing and fungiproofing varnish as follows:

1. Spray reverse side of panel and all components left on it.
2. Spray battery charging rectifiers.
3. Spray voltage regulator.
4. Spray inside of voltage regulator covers.
5. Spray inner surface of control panel box cover and rear plate.
6. Treat meters according to instructions given in TM 11-472.

CAUTION: Varnish spray may have toxic effects. Use respirator if available. Otherwise fasten cheesecloth or other cloth material over nose and mouth.

(5) Reassemble and check operation of unit.

(6) Mark MFP and date of treatment.

d. Reference. For a full description of the varnish spray method of moistureproofing and fungiproofing refer to TB SIG 13.

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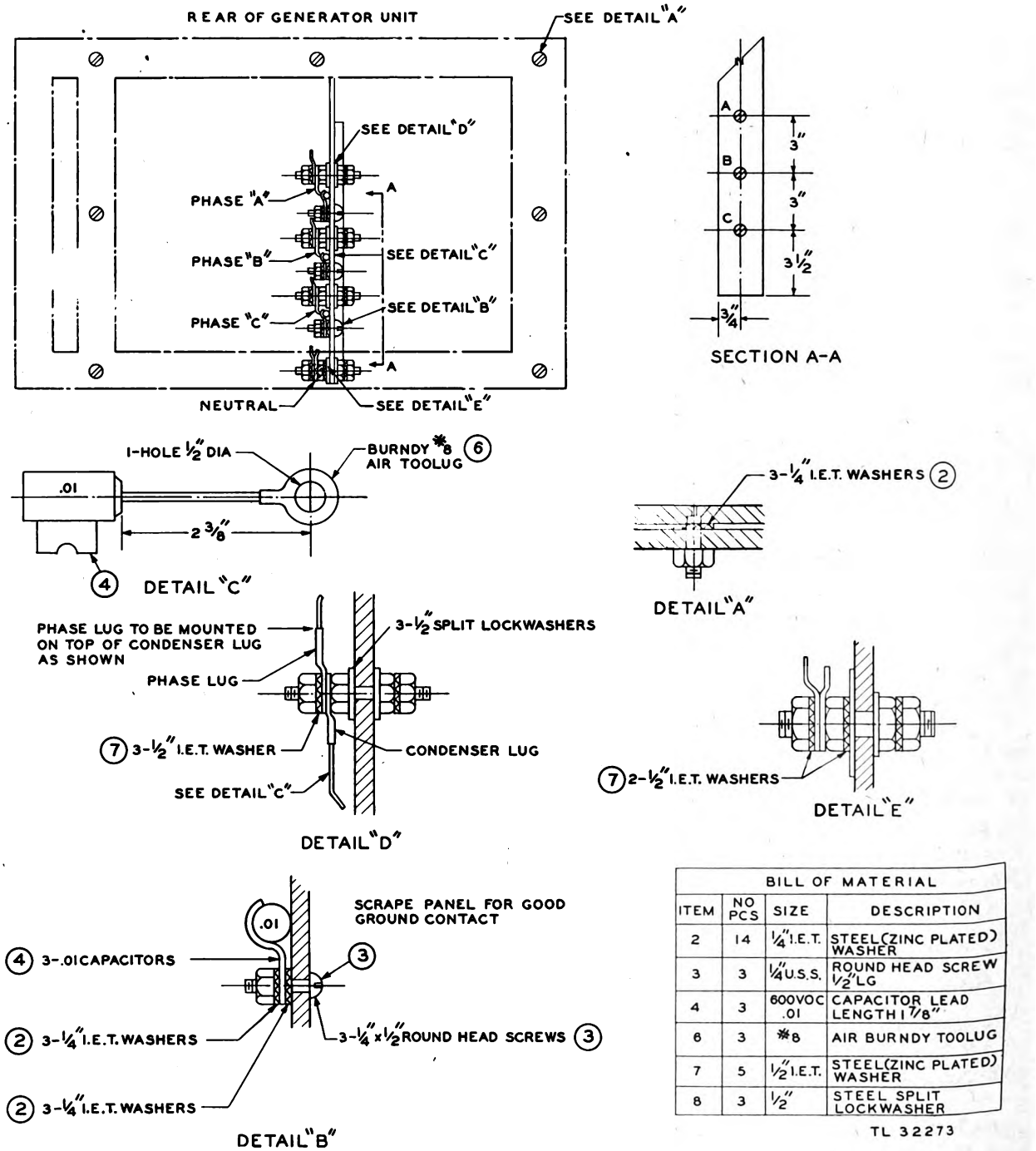

BILL OF MATERIAL			
ITEM	NO PCS	SIZE	DESCRIPTION
2	14	1/4" I.E.T.	STEEL (ZINC PLATED) WASHER
3	3	1/4" U.S.S.	ROUND HEAD SCREW 1/2" LG
4	3	600VOC .01	CAPACITOR LEAD LENGTH 1 7/8"
6	3	*8	AIR BURNDY TOOLUG
7	5	1/2" I.E.T.	STEEL (ZINC PLATED) WASHER
8	3	1/2"	STEEL SPLIT LOCKWASHER

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Figure 156. Application of capacitors to panel terminals to panel grounding.

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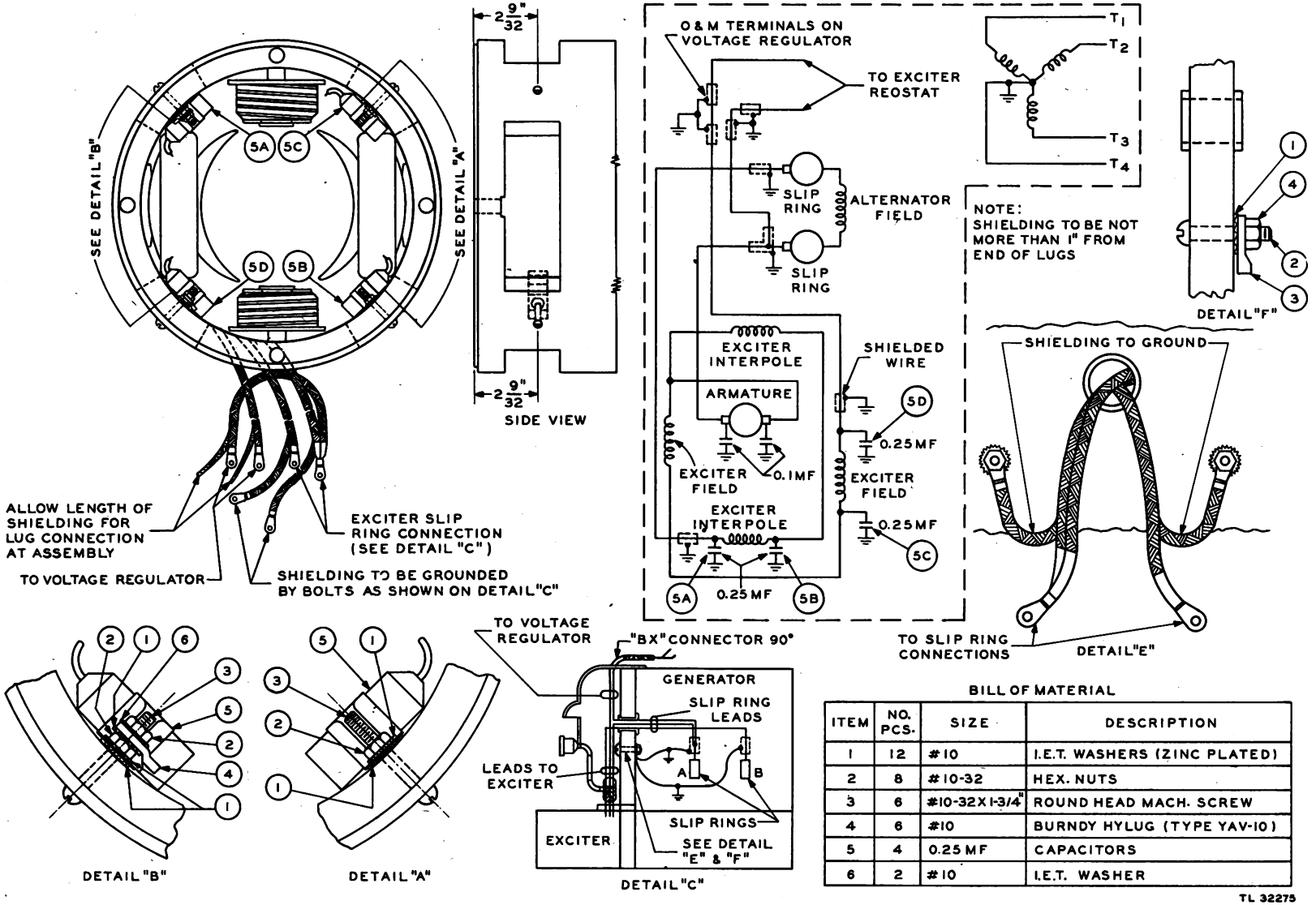

BILL OF MATERIAL

ITEM	NO. PCS.	SIZE	DESCRIPTION
1	12	#10	I.E.T. WASHERS (ZINC PLATED)
2	8	#10-32	HEX. NUTS
3	6	#10-32 X 1-3/4"	ROUND HEAD MACH. SCREW
4	6	#10	BURNDY HYLUG (TYPE YAV-10)
5	4	0.25 MF	CAPACITORS
6	2	#10	I.E.T. WASHER

TL 32275

TL-32275

Figure 157. Exciter components for radio-noise suppression.

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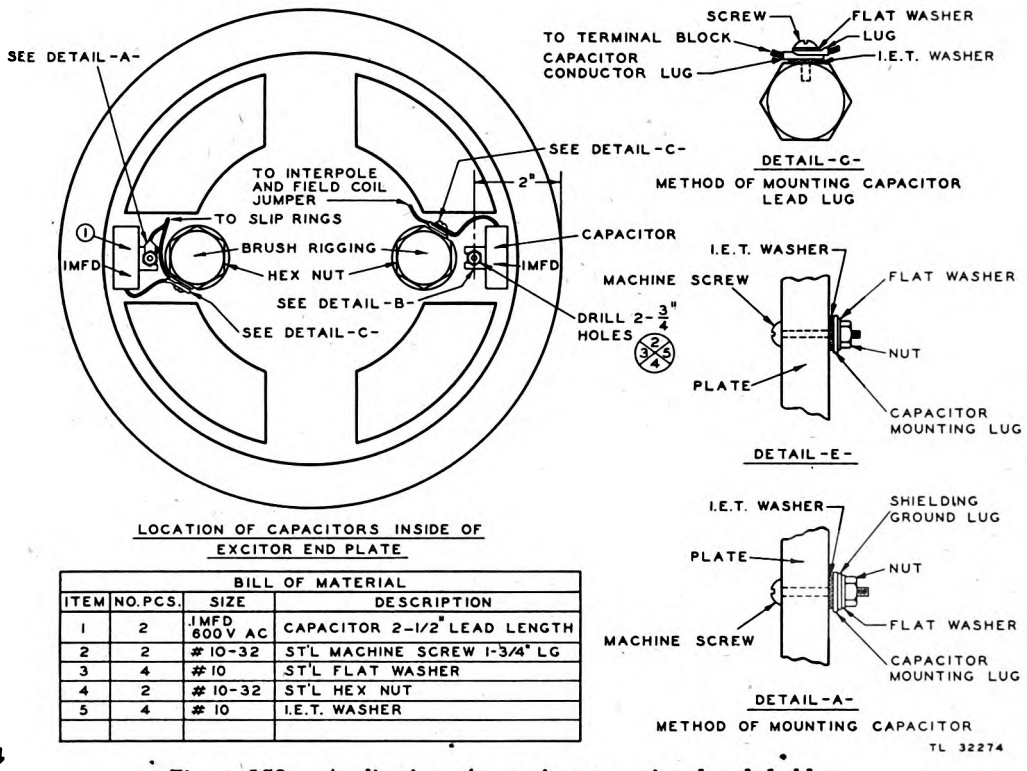
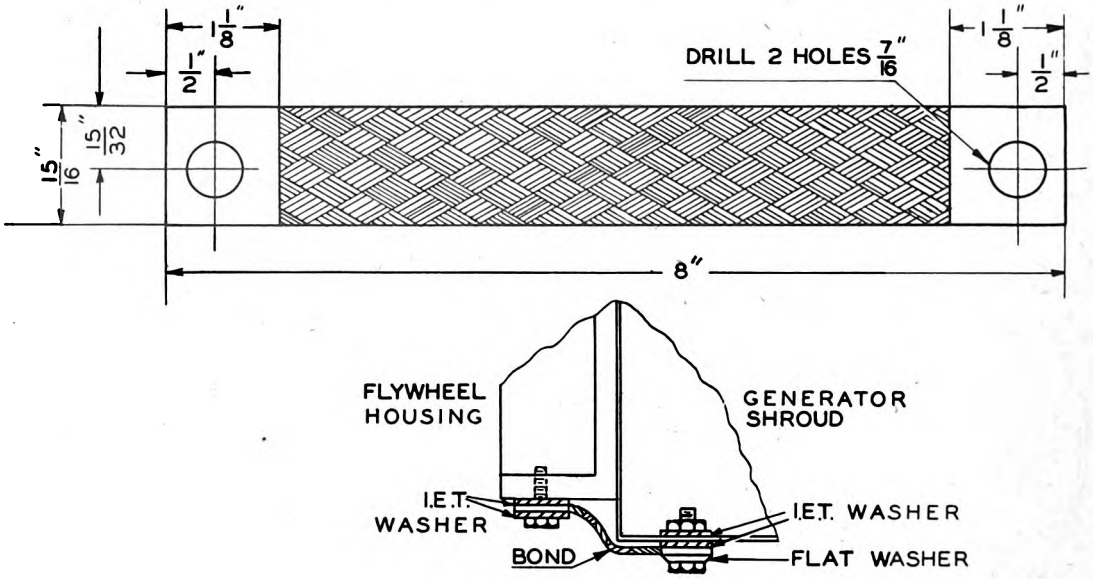


BILL OF MATERIAL			
ITEM	NO. PCS.	SIZE	DESCRIPTION
1	2	.1MFD 600V AC	CAPACITOR 2-1/2" LEAD LENGTH
2	2	# 10-32	ST'L MACHINE SCREW 1-3/4" LG
3	4	# 10	ST'L FLAT WASHER
4	2	# 10-32	ST'L HEX NUT
5	4	# 10	I.E.T. WASHER

TL-32274

Figure 158. Application of capacitor to exciter brush holder.



BILL OF MATERIAL			
ITEM	NO. PCS	SIZE	DESCRIPTION
1	6	15/16"	BRAIDED BOND

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TL-32276

Figure 159. Ground strap for generator shroud.

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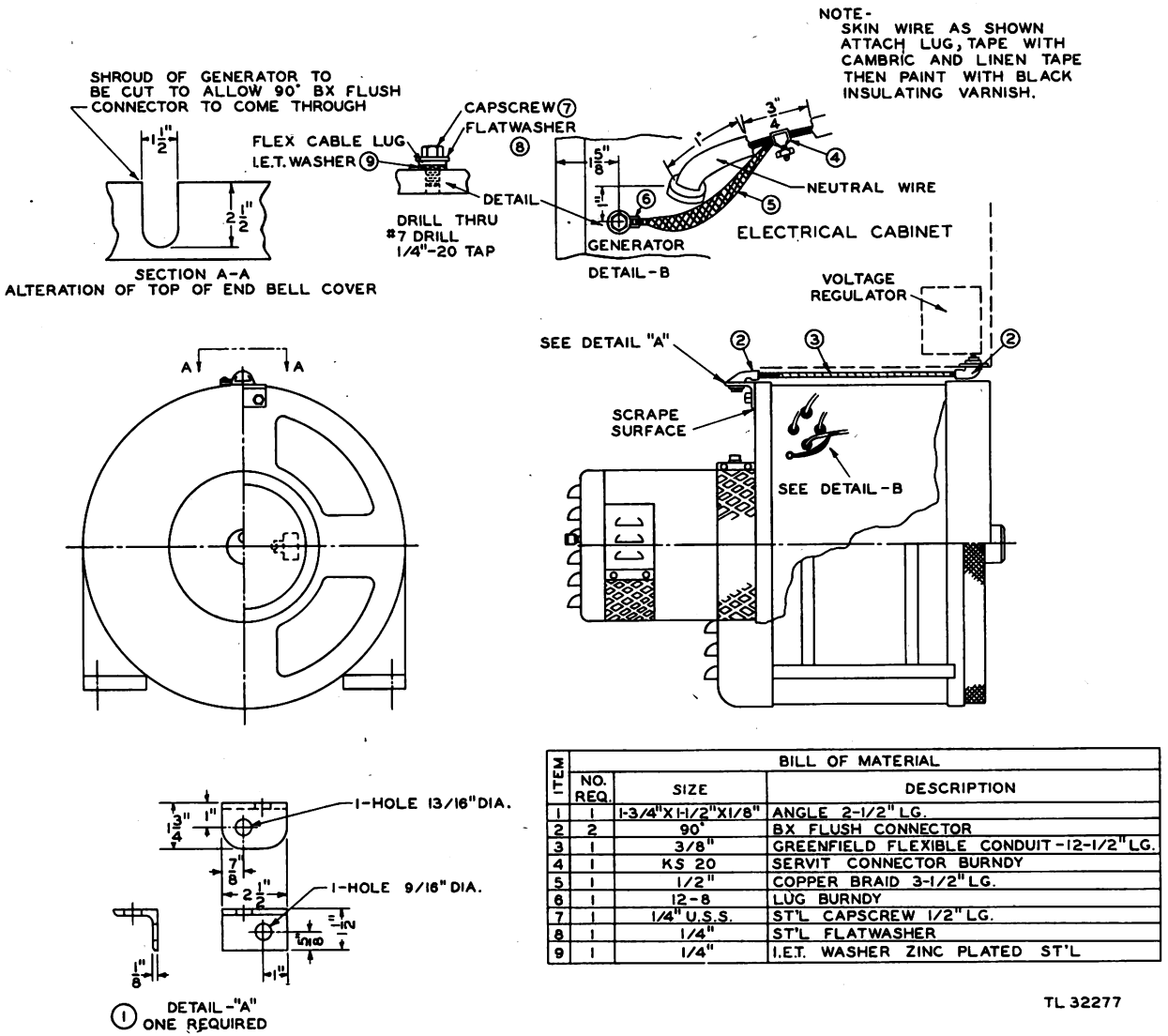

ITEM	BILL OF MATERIAL		
	NO. REQ.	SIZE	DESCRIPTION
1	1	1-3/4"X1-1/2"X1/8"	ANGLE 2-1/2" LG.
2	2	90°	BX FLUSH CONNECTOR
3	1	3/8"	GREENFIELD FLEXIBLE CONDUIT-12-1/2" LG.
4	1	KS 20	SERVIT CONNECTOR BURNDY
5	1	1/2"	COPPER BRAID 3-1/2" LG.
6	1	12-8	LUG BURNDY
7	1	1/4" U.S.S.	ST'L CAPSCREW 1/2" LG.
8	1	1/4"	ST'L FLATWASHER
9	1	1/4"	I.E.T. WASHER ZINC PLATED ST'L

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Figure 160. Exciter-alternator-voltage regulator radio-noise suppression.

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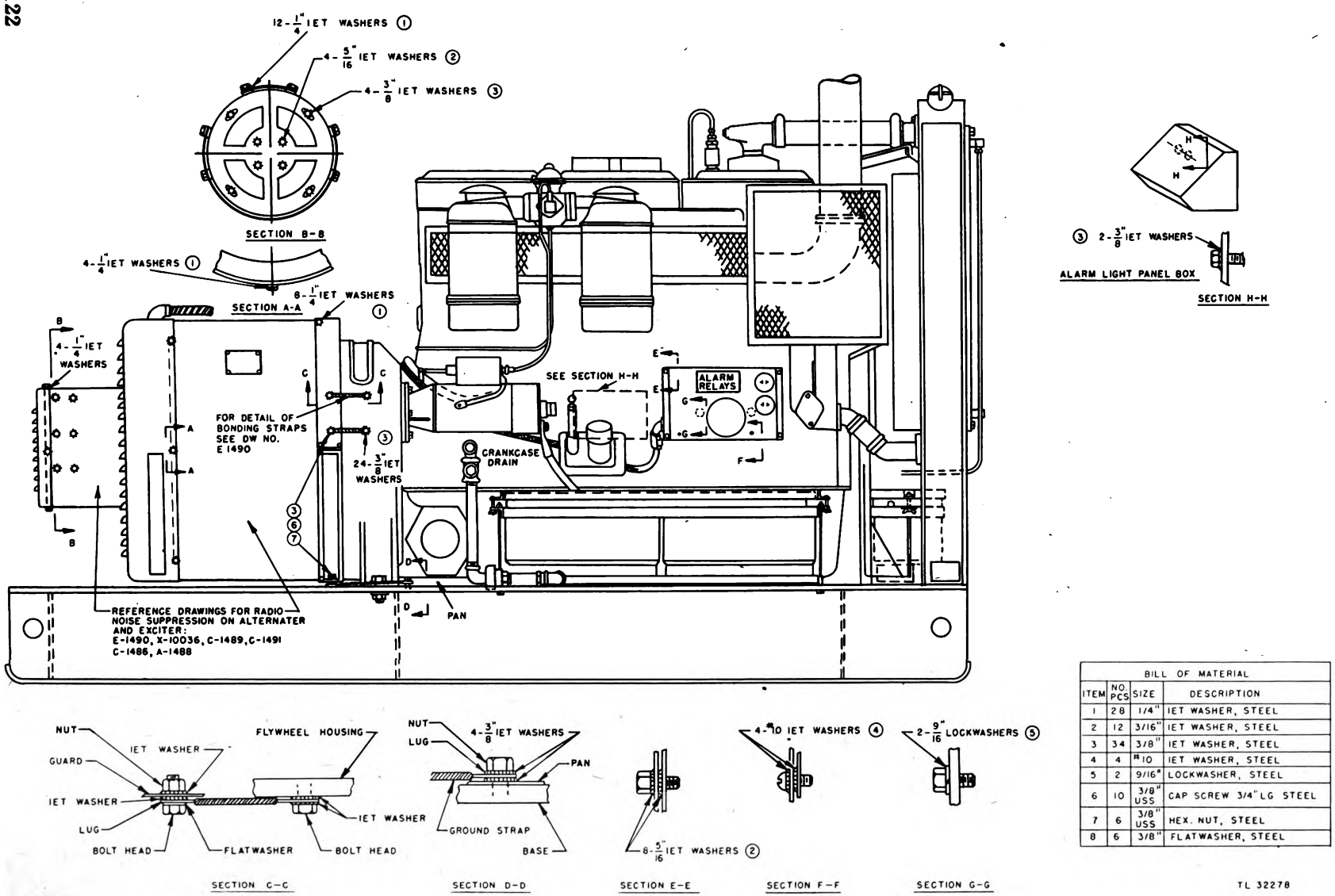

BILL OF MATERIAL			
ITEM	NO. PCS	SIZE	DESCRIPTION
1	28	1/4"	IET WASHER, STEEL
2	12	3/16"	IET WASHER, STEEL
3	34	3/8"	IET WASHER, STEEL
4	4	#10	IET WASHER, STEEL
5	2	9/16"	LOCKWASHER, STEEL
6	10	3/8" USS	CAP SCREW 3/4" LG STEEL
7	6	3/8" USS	HEX. NUT, STEEL
8	6	3/8"	FLATWASHER, STEEL

TL-32278

Figure 161. General external application of I. E. T. washers and bond for radio-noise suppression.

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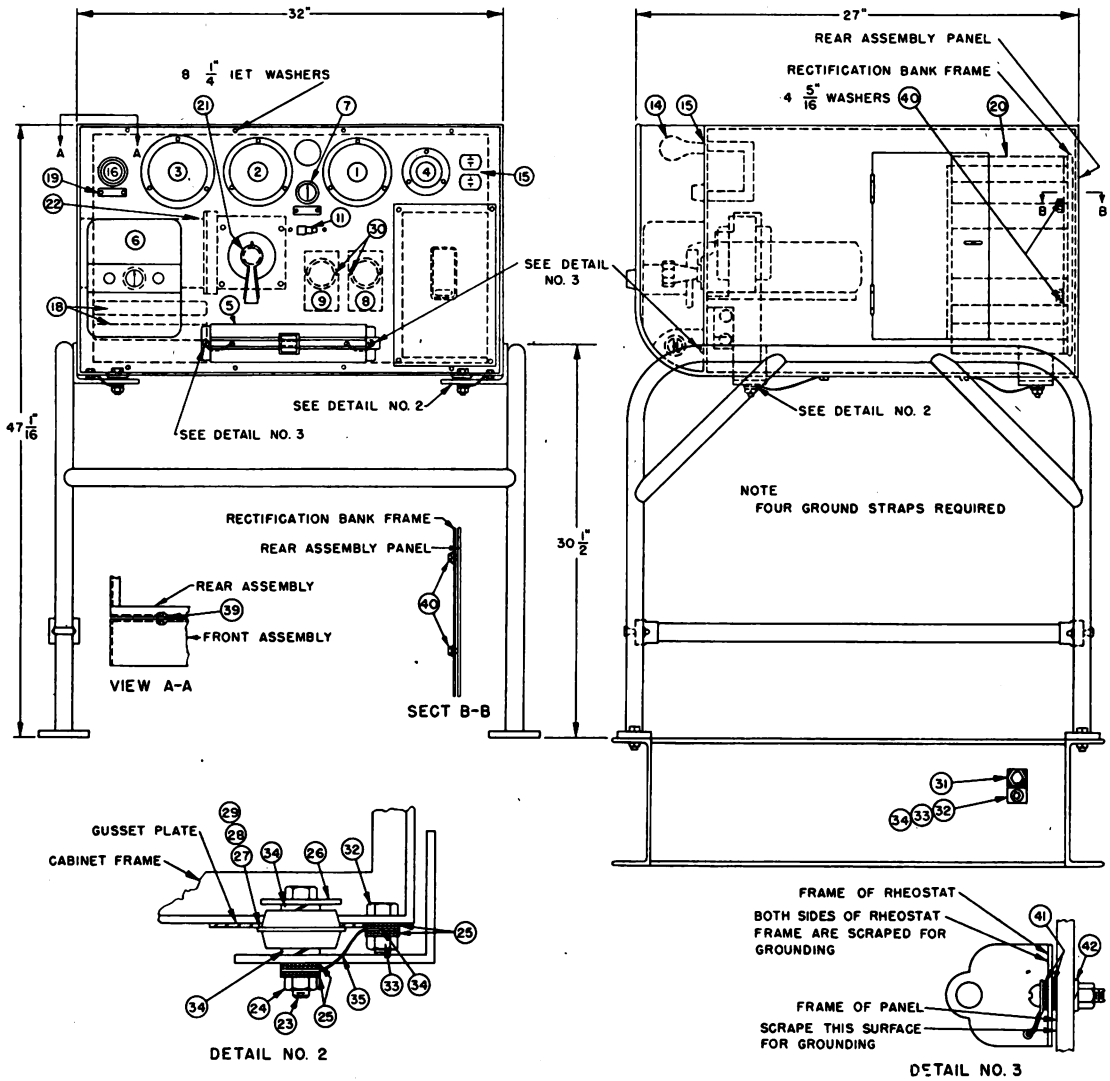

BILL OF MATERIAL

ITEM	QUAN	SIZE	DESCRIPTION
1	1	0/150	A-C AMMETER
2	1	0/150	A-C VOLTMETER w RESISTOR
3	1	58-629	FREQUENCY METER
4	1	120 V	ELAPSED TIME METER
5	1		RHEOSTAT - REX
6	1	GL-1	VOLTAGE REGULATOR
7	1	04A 300 Ω	RHEOSTAT - OHMITE NO. 0321
8	1	NO. 519110	W AMMETER TRANSF SW
9	1	NO 591454	W VOLTMETER TRANSF SW
10		100A	ITE DE ION CIR BREAKER CAT. #1638 - FRONT CONN
11	1		TOGGLE SW HUB NO 1815
12	3	300/5	CURRENT TRANSFORMERS
13	2		LAMP SOCKET GE NO. 49-866
14	1	40 W	LAMP - SILVER BOWL TYPE
15	1	NO. 9595	DUP CONV OUTLET
16	1		AMMETER (PART OF BATTERY CHARGER)
17	4	204 P 60	VIBRATION ELIMINATOR
18	2		RESISTORS (PART OF VOLTAGE REGULATOR)
19		1 SET	NAME PLATES
20	1		BATTERY CHARGER (COPPER OXIDE RECTIFIER)
21	1		SWITCH (RECTIFIER)

ITEM	QUAN	SIZE	DESCRIPTION
22			POT TRANF (PART OF RECTIFIER)
23	4	3/8"-16-2 1/4"	CAPSCREWS EVERDUR
24	4	3/8"-16	HEX NUTS EVERDUR
25	16	3/8"	IET WASHER
26	4	3/8"	R WASHER - 2" OD - 13/32" ID - 3/16" TH
27	16	NO. 10-32-3/4"	R H MACHINE SCREWS
28	16	NO 10-32	HEX NUTS
29	16	NO. 10	LOCKWASHERS EVERDUR
30	4	NO. 4-32-1/4"	RH MACHINE SCREWS EVERDUR
31	1		BURNDY QA QIKLUG FOR NO. 1 - NO. 4 WIRE
32	5	3/8"-USS	EVERDUR CAPSCREWS 3/4" LONG (HEX)
33	5	3/8"-USS	NUT EVERDUR
34	13	3/8"	LOCKWASHER EVERDUR
35	4		FLEXIBLE COPPER BRAID FOR 200 AMP 7" BETWEEN HOLES. DIA ONE HOLE 13/32", DIA OTHER HOLE 9/32"
39	8	1/4"	IET WASHER
40	4	5/16"	IET WASHER
41	4	NO 10 IET	STEEL (ZINC PLATED) WASHER
42	2	NO 10	STAR LOCKWASHER-EVERDUR

TL 32279

Figure 162. Assembly of switch cabinet with application of radio-noise suppression.

TL-32279

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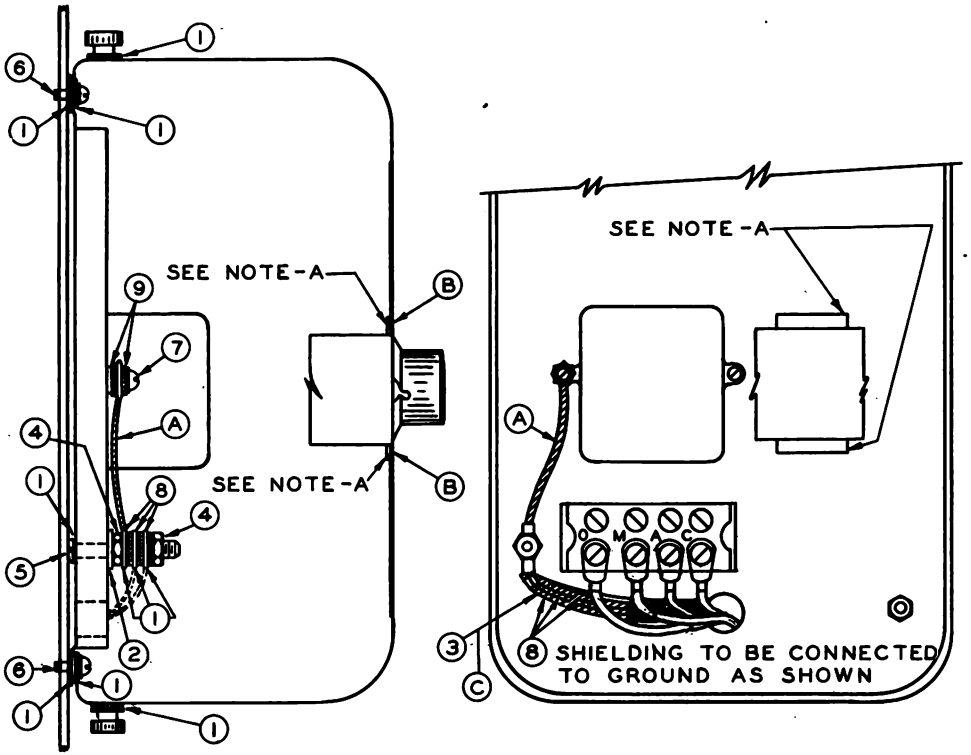
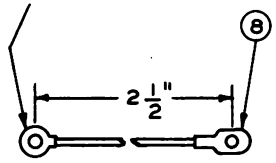


DETAIL-B

VOLTAGE REGULATOR COVER CLEAN AND TIN LIP COVER AREAS AS SHOWN ABOVE

TERMINAL AND WIRE SALVAGED FROM OTIS RELAY BOX



DETAIL-A
(1 REQ'D)

NOTE:
A- LIPS TO BE SCRAPED TINNED AND BENT IN ORDER TO INSURE PROPER GROUND TO COVERS.
B- VOLTAGE REGULATOR COVER TO BE CLEANED AND TINNED AS SHOWN IN DETAIL-B.
C- USE VERIFEX TO INSULATE SHIELDING FROM TERMINAL BLOCK.

ITEM	NO. REQ.	SIZE	DESCRIPTION
1	14	#10 I.E.T.	STEEL (ZINC PLATED) WASHER
2	1	3-16	COPPER WASHER
3	1	3/8"	VERIFLEX SLEEVE 2-1/2" LONG
4	2	10-32	HEX. NUT (COPPER OR BRASS)
5	1	10-32 X 1-1/2"	ROUND HEAD MACHINE SCREW ST.
6	4	10-32 X 3/4"	ROUND HEAD MACHINE SCREW ST.
7	1	#6-32X1/2"	ROUND HEAD MACHINE SCREW ST.
8	3	#12	10-32 BURNDY TOOLUG
9	2	#8 I.T.	STEEL COPPER PLATED WASHERS

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Figure 163. Grounding of voltage regulator for elimination of radio interference.

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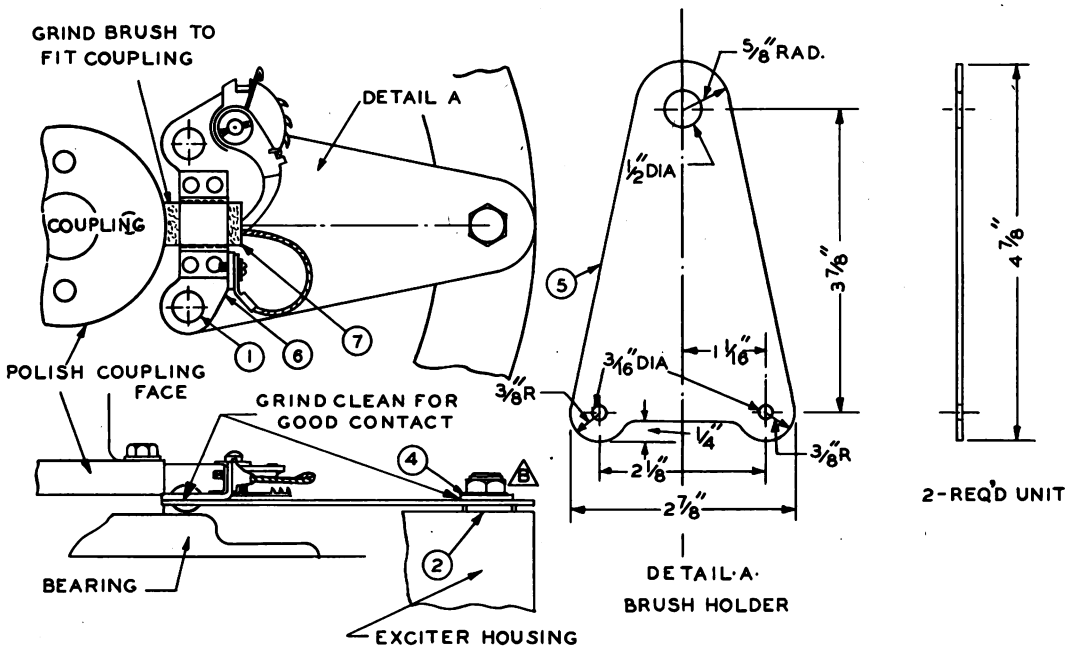

Figure 164. Assembly and detail of armature ground bracket.

NOTE:

MOUNT GROUNDING BRUSH ASSEMBLY BRACKET DIAGONALLY OPPOSITE ON TO THE EXCITER MOUNTING BOLTS ON HORIZONTAL ℄ OF GENERATOR

BILL OF MATERIAL			
ITEM	NO. PCS	SIZE	DESCRIPTION
1	2	R3-4	3/16" RIVET 1/4" LONG
2	2	1/2"	LOCKWASHER
3			
4	2	7/8" I.E.T.	STL.WASHER ZINC PLATE
5	2	2 7/8" 16GA	HR. STL 4 7/8" LONG
6	1	•	BR.HOLDER GEN. SHOP * 161
7	1	KEYSTONE 3C-15	COPPER BRUSH
8	2	ITEM 1-4 5-6&7	ASSY. PART * 2253

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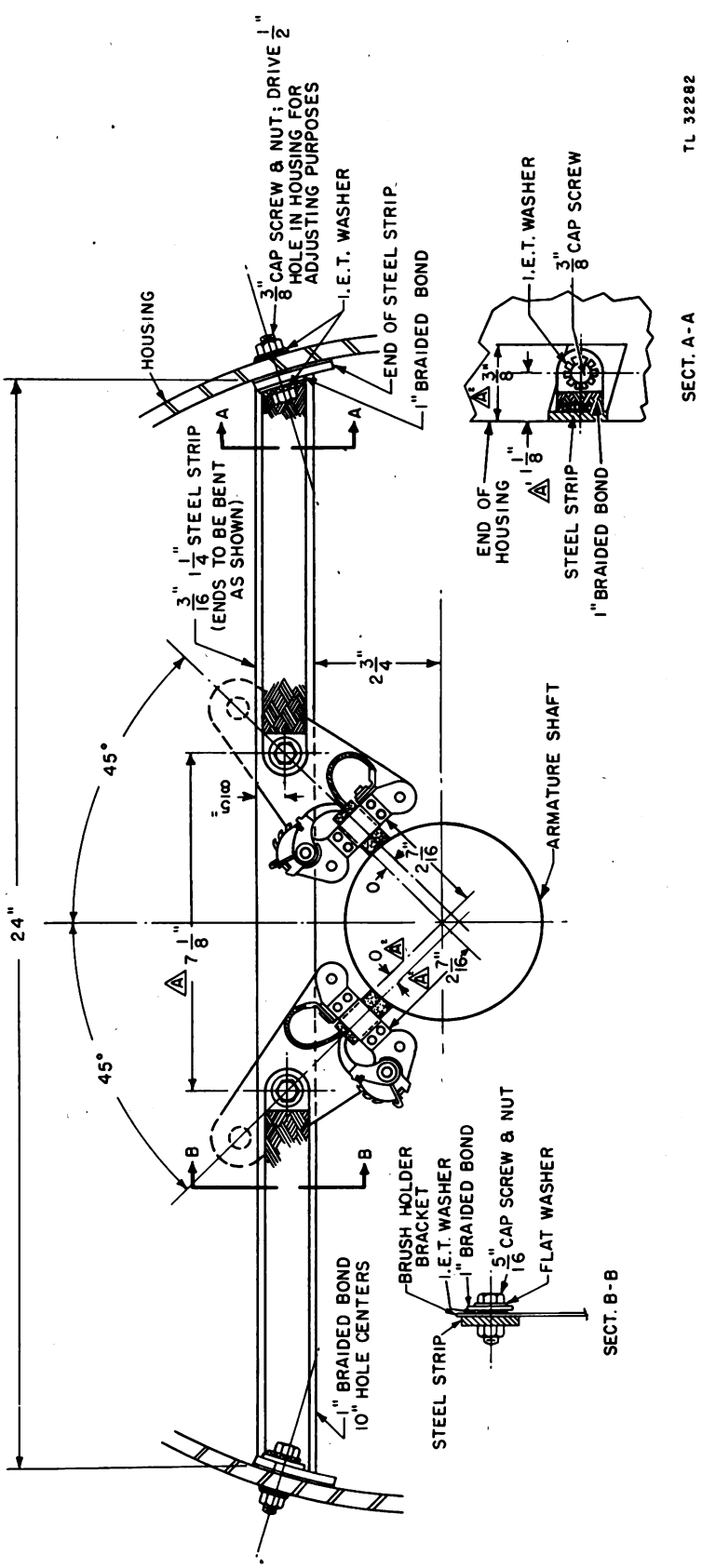

Figure 165. Assembly of generator-armature-grounding bracket.

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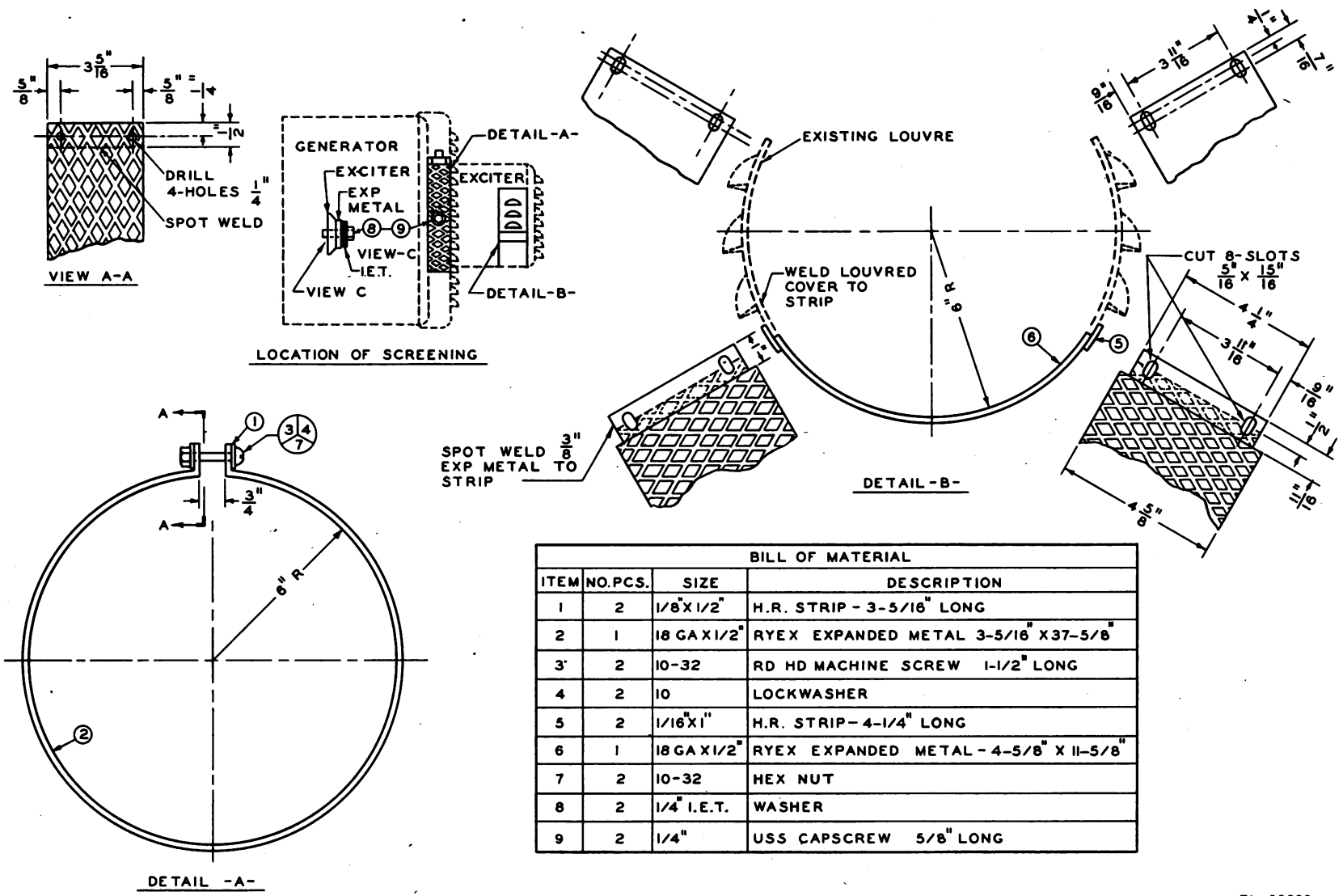

BILL OF MATERIAL			
ITEM	NO. PCS.	SIZE	DESCRIPTION
1	2	1/8" X 1/2"	H.R. STRIP - 3-5/16" LONG
2	1	18 GA X 1/2"	RYEX EXPANDED METAL 3-5/16" X 37-5/8"
3	2	10-32	RD HD MACHINE SCREW 1-1/2" LONG
4	2	10	LOCKWASHER
5	2	1/16" X 1"	H.R. STRIP - 4-1/4" LONG
6	1	18 GA X 1/2"	RYEX EXPANDED METAL - 4-5/8" X 11-5/8"
7	2	10-32	HEX NUT
8	2	1/4" I.E.T.	WASHER
9	2	1/4"	USS CAPSCREW 5/8" LONG

Figure 166. Screening details for exciter.

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Section V
SUPPLEMENTARY DATA

104. MATERIAL LIST FOR POWER UNIT PE-245-A. The following is a list of standard commercial assemblies incorporated in the power unit. This list also includes the names of the manufacturers of the parts.

Name of Part and Description	*Manufacturer*
Acid, battery, 2 carboys, packed separately.	Electric Storage Battery Co.
Battery, jumpers, and leads, 5 6-volt wet type XHM-25.	Electric Storage Battery Co.
Coupling, flexible, engine to generator, type 312SS.	Thomas Flexible Co.
Engine, model HI-600, spec H-26.	Cummins Engine Co.
Filter, air, oil bath type A-2107.	Donaldson Air Filter Corp.
Filter, fuel oil, primary, edge type D.	Cuno Engineering Co.
Filter, fuel oil, secondary, cartridge type F-10.	Briggs Clarifier Co.
Filter, lube oil, primary, nugent bag type S-1953.	Cummins Engine Co.
Filter, lube oil, secondary, cartridge type DF-2470.	Deluxe Products Corp.
Pump, fuel, distributor type H-90909-5.	Cummins Engine Co.
Generator, type S110, 25 kw A.C.	Rogers Diesel & Aircraft Co.
Governor, type B-SG, model C40305.	Woodward Governor Co.
Hose, auxiliary fuel, 20′ length, flex, with stand pipe.	Rogers Diesel & Aircraft Co.
Radiator, sectional core, type R-1983C.	Perfex Radiator Corp.
Silencer, exhaust, model MUC No. 7.	Maxim Silencer Corp.
Silencer, hose, flexible, 4′ length, 4″ diam.	Rogers Diesel & Aircraft Co.
Packing, silencer flange, ½″, asbestos.	Maxim Silencer Corp.
Motor, starting, model 711.	Delco-Remy Corp.
Switch, alarm, oil pressure, model 2500, type 260AP14X.	Penn Electric Switch Co.
Switch, alarm, water temperature, model 1400, type 262AT04X.	Penn Electric Switch Co.
Switchboard, generator control panel. See parts section for complete list.	Rogers Diesel & Aircraft Co.
Tank, fuel, 21-gallon capacity.	Rogers Diesel & Aircraft Co.

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105. ACCESSORIES.

Amount	*Name of Part and Description*
1	Extinguisher, fire, model 15, hand, carbon dioxide.
1	Lamp, extension, with bulb, Protex A-15'.
1	Can, oil, 2-gallon, portable, lube oil.
1	Can, oil, 5-gallon, portable, fuel oil.
2	Jumpers, battery, 00 cable with lugs, 7" long.
2	Jumpers, battery, 00 cable with lugs, 17" long.
1	Cable, starting, disconnected, negative lead –00 cable.
1	Tubing, copper, ¼", 25-ft roll.
1	Tubing, copper, 5/16", 10-ft roll.

106. TOOL KIT. This material is processed and packed in wooden tool box.

Amount	*Name of Part and Description*
1	Box, tool, 15" x 18" x 11¾" (RDA-3-1429).
2	Book, instruction, preliminary TM 11-930.
1	Hydrometer 51B.
1	Wrench, injector cup, spline (CECO H-5437).
1	Wrench, Allen, ¼" (CECO S-33).
1	Kit, cleaning, injector cup, wire brush-pin vise and drill wire ⅝" x 12" (S-17).
1	Pliers, No. 38, 8" slip joint.
1	Screwdriver, 10" blade.
1	Screwdriver, 6" blade.
1	Wrench, adjustable, 10".
1	Can, oil 8-oz, with carving clip.
1	Shellac, 1-pint can, and brush.
1	Pins, cotter, box, assorted sizes.
1	Depressor, spring, valve spring compressor.
1	Hammer, 1-lb, ball peen.
1	Wrench, open end, ⅜" x 7/16" (723).
1	Wrench, open end, ½" x 9/16" (725-B).
1	Wrench, open end, 19/32" x 11/16" (27).
1	Wrench, open end, ⅝" x ¾" (729).
1	Wrench, open end, 25/32" x ⅞" (31).
1	Wrench, open end, 13/16" x 1" (732).
1	Wrench, open end, 15/16" x 1-1/16" (34A).
2	Sandpaper, sheet No. 00.
1	Tape, roll, 1" asbestos tape, 100-ft.
1	Wire, 5-ft length, No. 10 gauge, soft iron.
1	Handle, barring, engine (CECO H-9544).
1	Gauge set, 4" feeler, 0.0015", 0.003", 0.004", 0.006", 0.008", 0.010", 0.013", 0.020".
1	Punch, ⅜" pin.
1	Wrench, box socket, 1-5/16" x 1".

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107. SUPPLEMENTARY TOOL KIT SUPPLIED FOR EACH STATION.

Amount	*Part No.*	*Name of Part and Description*
1	NY6077A	Puller and inserter, bushing, upper valve rocker.
1		Extension, 8" long, ¾" drive, snap-on.
1		Tool, tube flaring ¼" x ½", set with tube cutter.
1		Gear puller, snap-on.
1		Compressor, piston ring.
1		Tee handle, ¾" drive, snap-on sliding.
1		Socket, cylinder-head, 1-¼", ¾" drive.
1		Socket, main bearing, 1-½", ¾" drive.
1		Socket, connecting rod, 15/16", ¾" drive.
1		Chisel, snap-on.
1		Wrench, box, 1-7/16", and open end combination.
1	NY6085	Puller, cylinder liner.
1	NY6109	Pin vise and 24 drill wires.
1	711	Valve grinder, blue point.
1 can		Valve-grinder compound (clover brand).
1		Wrench, torque, 1000 lb.
1		Adapter, snap-on, ¾" male end, 1" female.
1		Feeler strip set 10" long, 0.014", 0.022", 0.006".
2		Bolts, full thread, water pump drive pulley puller.
2		Bolts, full thread flywheel puller bolts.

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109. APPARATUS PARTS LEGEND, ILLUSTRATED.

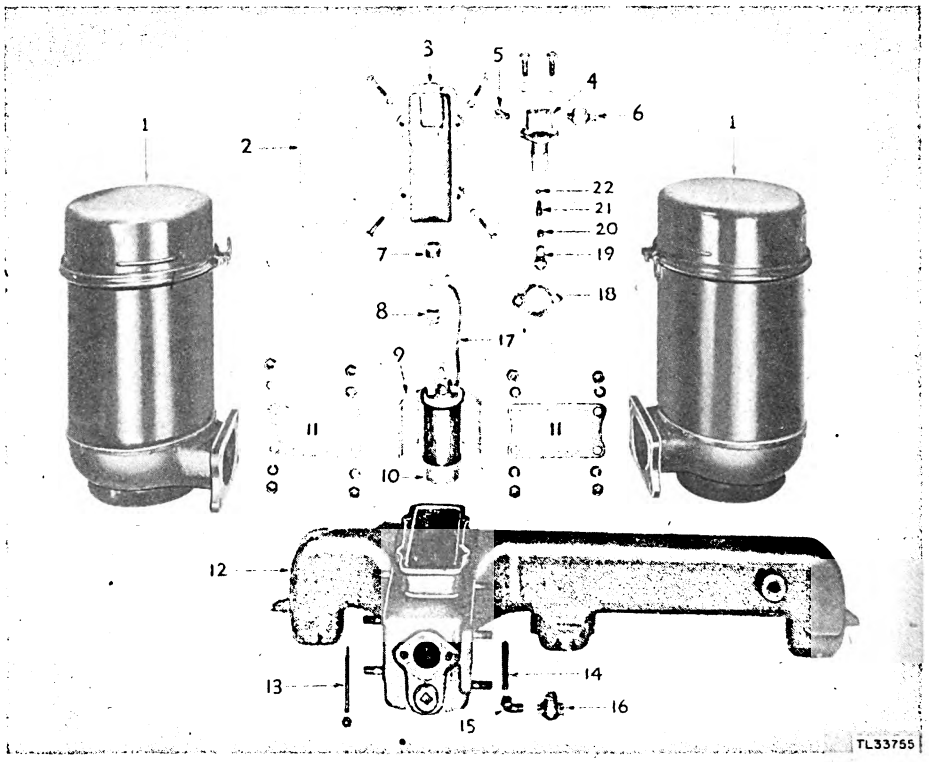

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Figure 167. Air intake manifold.

Item No.	*No. of units*	*Name of part and description*
		AIR INTAKE MANIFOLD (fig. 167)
	1	Cap screw, ⅜"—16 x ¾".
22	1	Ball, nozzle check valve.
17	1	Cable, preheater switch to ignition coil.
	4	Cap screw, ¼"—20 x 1¼", coil cover to manifold.
	2	Cap screw, retainer plate to manifold.
10	1	Coil, preheater ignition.
	1	Connection, coil to ground.
	1	Connection, terminal coil.
3	1	Cover, ignition coil.
5	1	Elbow, preheater.
	1	Elbow, preheater connection to fuel pump.
15	1	Elbow, street, priming pump to preheater tube.
13	1	Electrode, adjustable.
8	1	Electrode, stationary.
9	1	Felt, ignition coil packing.
18	1	Gasket, nozzle retainer plate.
2	1	Gasket, ignition coil cover.
	8	Lockwasher, ⅜" positive lock, air cleaner stud nut.
	1	Lockwasher, ⅝" positive lock, manifold plug.
	1	Lockwasher, No. 10, positive lock, coil ground screw.
	1	Lockwasher, ¼" positive lock, electrode retainer adjusting nut.
	4	Lockwasher, ¼" positive lock, ignition coil cover.
	2	Lockwasher, ⅜" positive lock, retainer plate to manifold.
12	1	Manifold, air intake.
14	1	Nipple, ½" x 2½", pipe.

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Item No.	No. of units	Name of part and description
		AIR INTAKE MANIFOLD (fig. 167) (Continued)
	1	Nipple, ⅛" x 2½", pipe, preheater drain.
19	1	Nozzle, preheater.
	8	Nut, ⅜"—24, air cleaner stud.
7	1	Nut, electrode retainer.
	1	Nut, ¼"—20, electrode retainer adjusting.
4	1	Plate, nozzle retainer.
	1	Plug, pipe, inspection.
	1	Screw, coil ground.
20	1	Screw, spring adjusting.
21	1	Spring, nozzle check valve.
	8	Stud, manifold, to air cleaner.
6	1	Switch, pressure.
16	1	Valve, ball check, priming pump to preheater.
	1	Strap, preheater cable.
11	2	Gasket, air cleaner.
1	2	Cleaner, air.
		CAM FOLLOWER HOUSING (fig. 168)
	3	Assembly, cam follower housing.
111	3	Housing, cam follower.
106	6	Plug, ⅞" expansion.
105	6	Screw, shaft lock.

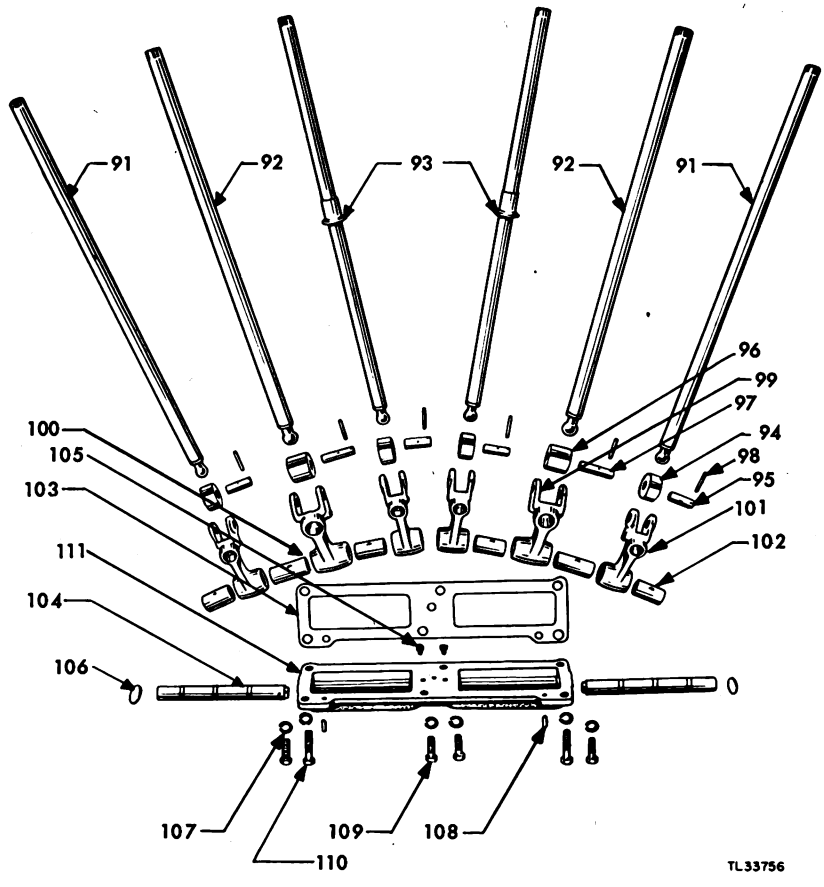

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Figure 168. Cam follower housing.

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Item No.	*No. of units*	*Name of part and description*
		CAM FOLLOWER HOUSING (fig. 168) (Continued)
104	6	Shaft, cam follower lever.
	6	Assembly, injector cam follower (includes items 96-100).
99	6	Lever and bushing, injector cam, H-9161-2 (includes item 100).
100	6	Bushing, injector cam lever.
97	6	Pin, injector cam roller.
98	6	Rivet, injector cam roller pin.
96	6	Roller, injector cam.
	12	Assembly, valve cam follower lever (includes items 94, 95, 98, 101, 102).
101	12	Lever and bushing, valve cam, H-9162-1 (includes item 102).
102	12	Bushing, valve cam lever.
95	12	Pin, valve cam roller.
98	12	Rivet, cam roller pin.
94	12	Roller, valve cam.
		Mounting parts:
109	12	Cap screw, ⅜"—24 x 1".
110	6	Cap screw, ⅜"—24 x 1½".
103	3	Gasket, cam rocker housing.
107	18	Lockwasher, ⅜" positive lock.
108	6	Pin, dowel housing.
		Push rods:
91	6	Rod, exhaust push.
92	6	Rod, injector push.
93	6	Rod, intake push.
		CAMSHAFT ASSEMBLY (fig. 169)
	1	Assembly, camshaft.
37	6	Bolt, camshaft gear.
35	1	Camshaft.
36	1	Gear, camshaft.
38	6	Nut, ⅜"—14, camshaft gear bolt.

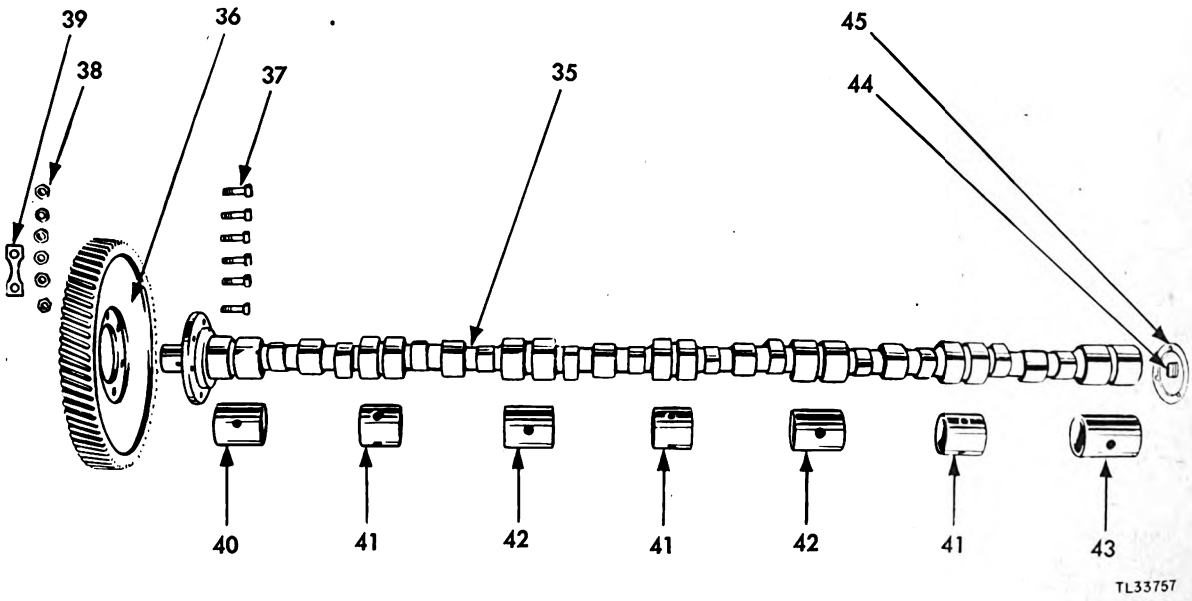

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Figure 169. Camshaft assembly.

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Item No.	No. of units	Name of part and description
		CAMSHAFT ASSEMBLY (fig. 169) (Continued)
44	1	Plug, ⅜" pipe.
39		Lockplate, camshaft gear.
45	1	Ring, camshaft thrust.
40	1	Bushing, camshaft, front.
42	2	Bushing, camshaft 3-5.
41	3	Bushing, camshaft 2-4-6.
43	1	Bushing, camshaft, rear.
		CRANKSHAFT (fig. 170)
	1	Assembly, crankshaft.
20	1	Crankshaft, bare view.
29	1	Key, crankshaft pinion.
32	1	Lock, crankshaft nut.
33	1	Nut, crankshaft.
30	1	Pin, hand cranking.
31	1	Pinion, crankshaft.
34	1	Slinger, oil.
35	3	Dowel, crankshaft flywheel.
		MAIN BEARING SHELLS (fig. 170)
26	7	Dowels, main bearing ring.
22	1	Shells, main bearing lower rear.
21	1	Shells, main bearing upper rear.
24	3	Shells, main bearing lower 2-4-6.
23	2	Shells, main bearing upper 2-6.
28	3	Shells, main bearing lower 1-3-5.
27	3	Shells, main bearing upper 1-3-5.
25	1	Shells, main bearing upper No. 4.

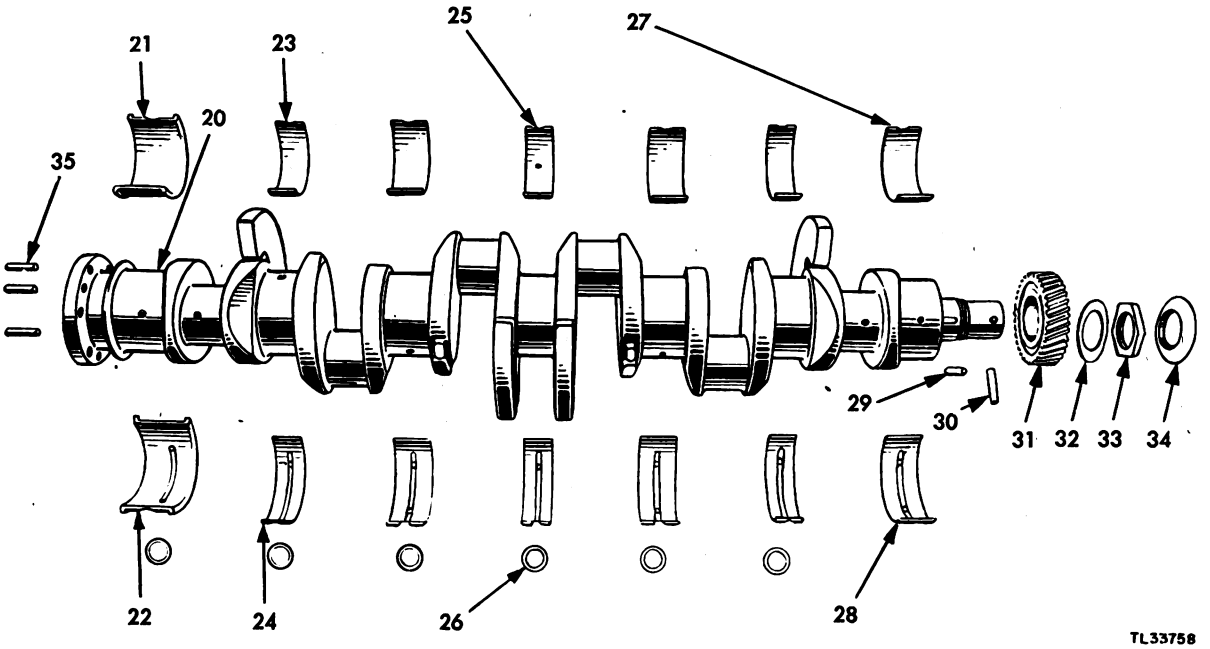

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Figure 170. Crankshaft assembly.

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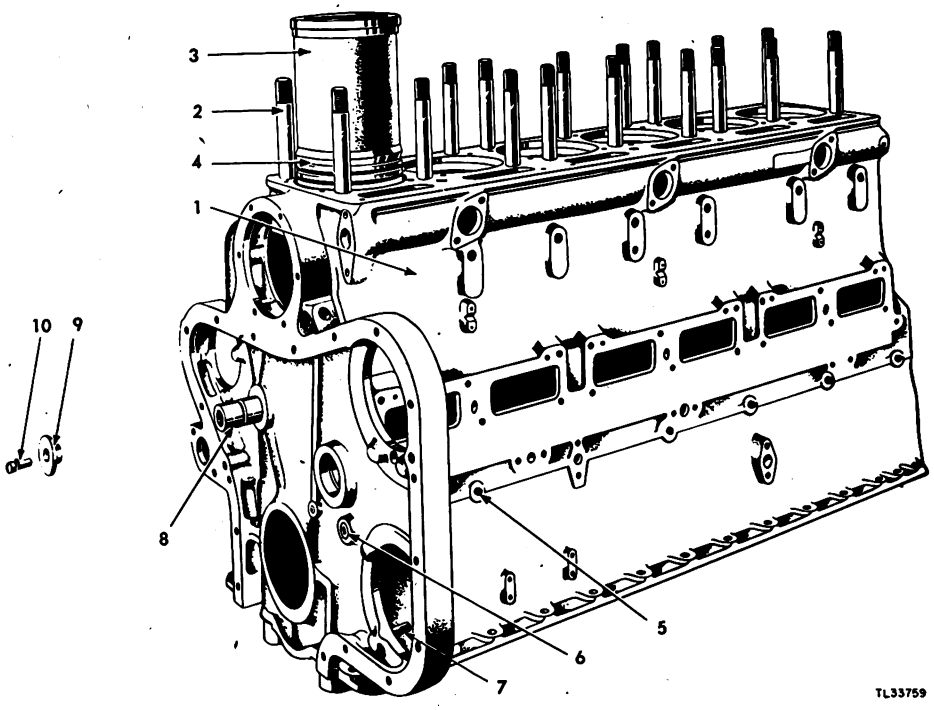

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Figure 171A. Cylinder block.

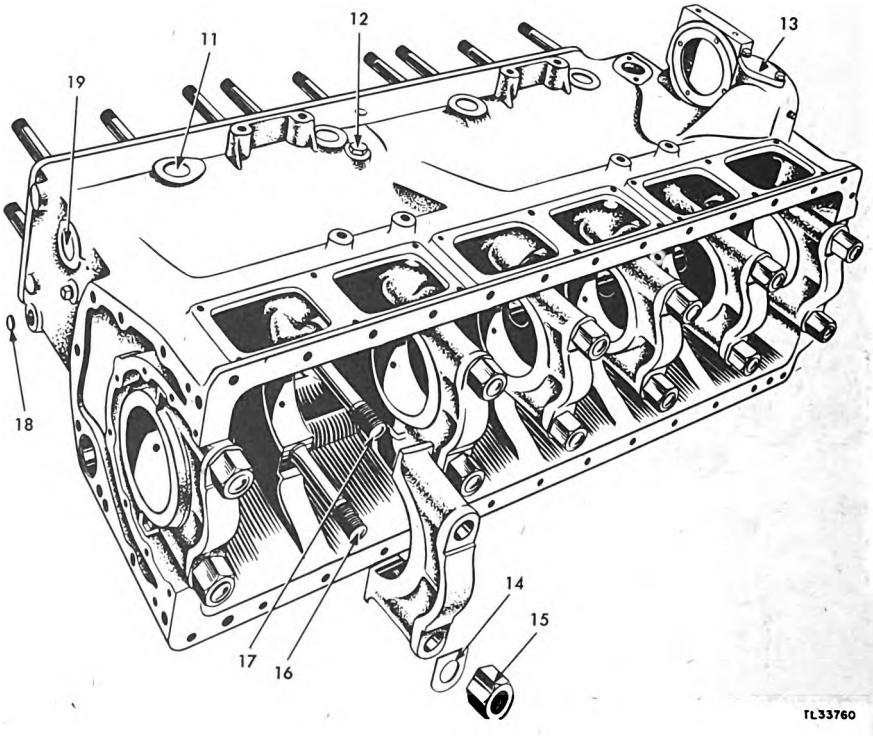

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Figure 171B. Engine block.

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Item No.	No. of units	Name of part and description
		CYLINDER BLOCK (fig. 171A) and ENGINE BLOCK (fig. 171B)
1	1	Cylinder, block studded (H-41492).
	2	Cap screw, ⅜"—16 x 1", water blind flange.
	6	Dowel, cylinder head.
	2	Dowel, flywheel housing.
	2	Dowel, gear case cover.
13	1	Flange, water blind, side.
	1	Gasket, water drain plug (for item 12, fig. 171B).
	1	Gasket, water blind flange.
	1	Gasket, generator drive hole.
27	14	Lock, main bearing stud nut.
14	2	Lockwasher, ⅜" positive lock, water blind flange.
15	14	Nut, main bearing stud.
8	1	Pin, idler gear.
18	1	Plug, 1" expansion, compression relief shaft hole.
	1	Plug, ¾" expansion, lubricating oil drain.
19	1	Plug, 1¾" expansion, water header.
11	4	Plug, 1½" expansion, water header.
	1	Plug, ¼" pipe, air discharge hole.
	1	Plug, ¼" pipe, lubricating oil drain.
5	7	Plug, ⅛" pipe, lubricating oil header.
6	2	Plug, ⅜" pipe, lubricating oil header.
	1	Plug, ¼" pipe, water drain.
	1	Plug, ½" pipe, water drain.
12	1	Plug, water header drain.
2	18	Stud, cylinder head.
7	4	Stud, lubricating pump.
17	7	Stud, main bearing.
16	7	Stud, main bearing, slotted.
3	6	Liner, cylinder.
	1	Lockwasher, ⅜" positive lock, idler lockscrew.
4	18	Packing, cylinder liner.
	1	Pin, washer lock.
10	1	Screw, washer.
	3	Tube, lubricating.
9	1	Washer, idler gear pin.
	1	Cover, generator drive hole.
	4	Cap screw, generator drive hole cover.
	4	Lockwasher, generator drive hole cover.
		CYLINDER HEAD ASSEMBLY (fig. 172)
	2	Assembly, cylinder head, valves and studs, (H-1196-5).
	1	Assembly, cylinder head, valves and studs, rear (H-1835).
77	24	Collett, valve.
78	12	Guide, valve spring.
79	12	Spring, valve.
88	6	Valve, exhaust.
89	6	Valve, intake.
84	2	Head, studded (H-1196-5).
84	1	Head, studded (H-1835) rear.
85	6	Dowel, exhaust manifold.
82	12	Guide, valve stem.
86	18	Plug, 1" expansion.
	6	Plug, ⅛" pipe.
	3	Plug, ⅜" pipe.

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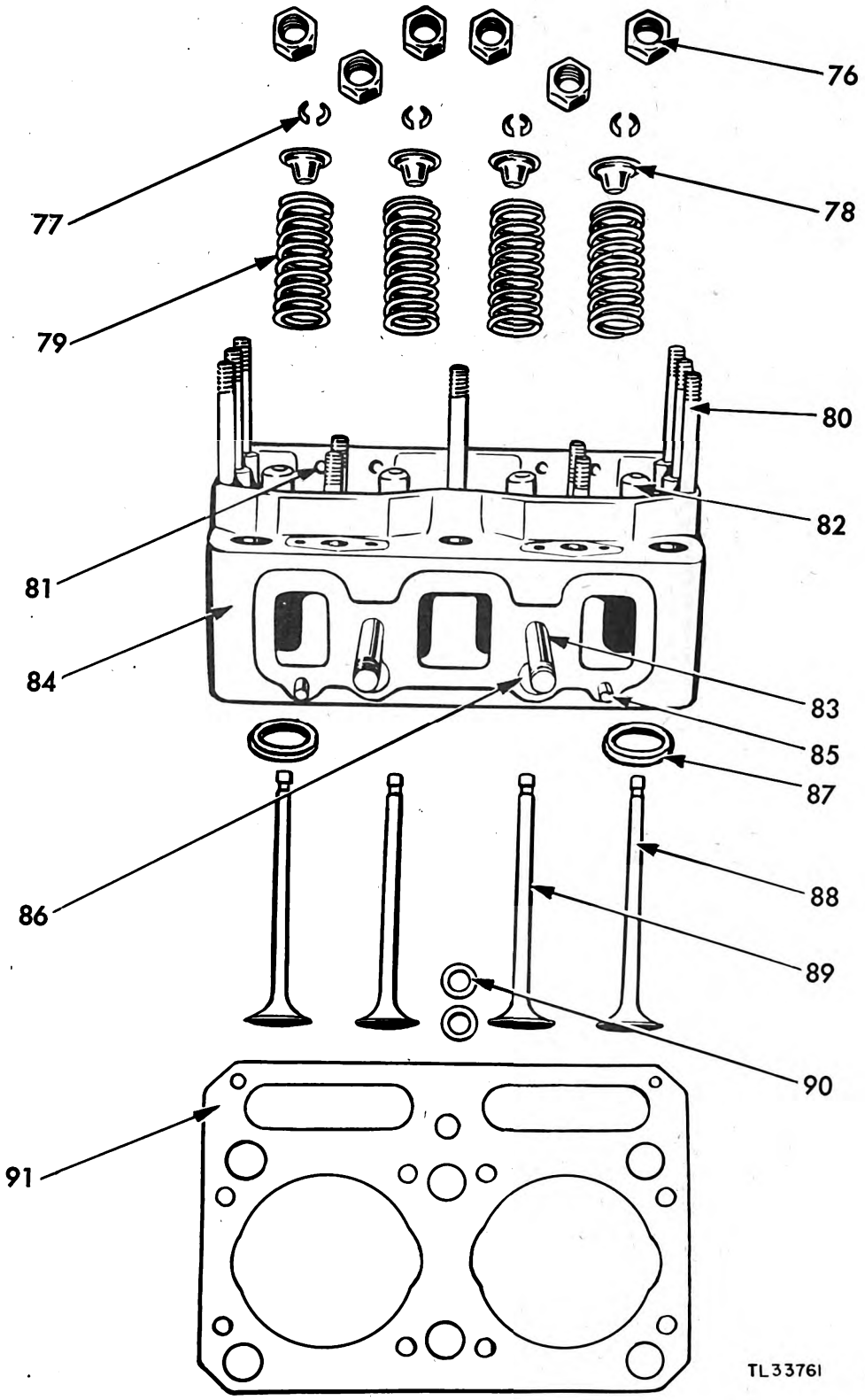

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Figure 172. Cylinder head assembly.

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Item No.	No. of units	Name of part and description
		CYLINDER HEAD ASSEMBLY (fig. 172) (Continued)
87	6	Seat, exhaust valve.
83	6	Stud, exhaust manifold.
81	12	Stud, injector.
80	21	Stud, rocker arm housing.
		Mounting parts:
91	3	Gasket, cylinder head.
76	18	Nut, 7/8"—24, cylinder head stud.
90	6	Packing, lubricating pipe.
		COMPRESSION RELEASE ASSEMBLY (fig. 173)
74	3	Bearing, compression release shaft.
71	6	Cap screw, 3/8"—24 x 1", compression release bearing.
65	1	Cap screw, 3/8"—24 x 2", compression release lever.
63	2	Cap screw, 3/8"—24 x 1 1/8", compression release packing gland.
66	1	Cap screw, 5/16"—24 x 5/8", compression release spring.
73	3	Gasket, compression release bearing.
62	1	Gland, compression release packing.
69	1	Lever, compression release.
72	10	Lockwasher, 3/8" positive lock.
67	1	Lockwasher, 5/16" positive lock.
64	1	Nut, 3/8"—24, compression release lever.
70	4	Packing, compression release lever shaft.
75	1	Screw, compression release shaft lock.
61	1	Shaft, compression release.
68	1	Spring, compression release leve

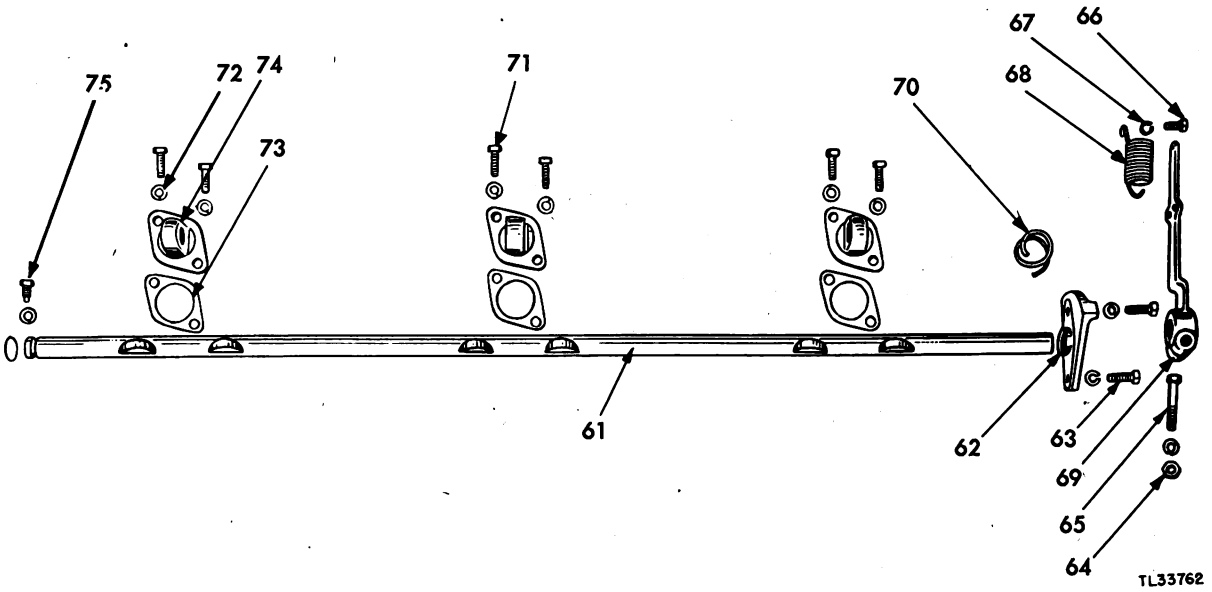

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Figure 173. Compression release assembly.

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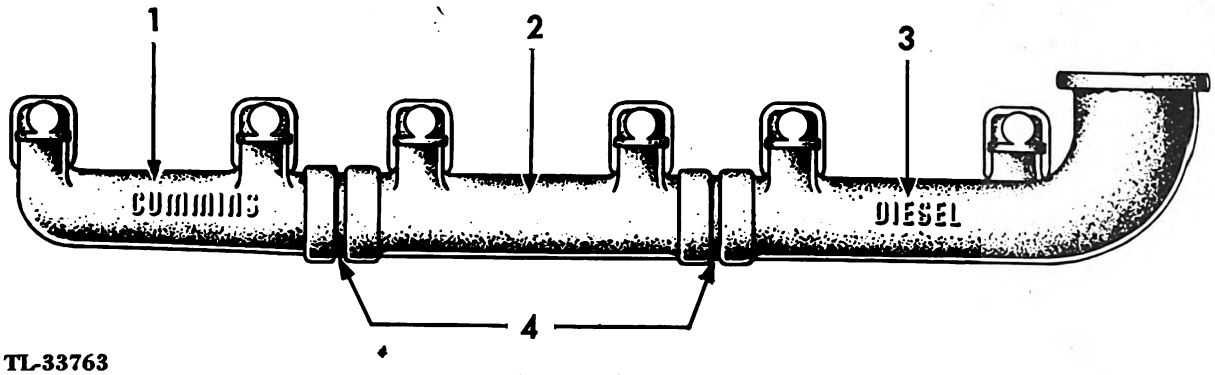
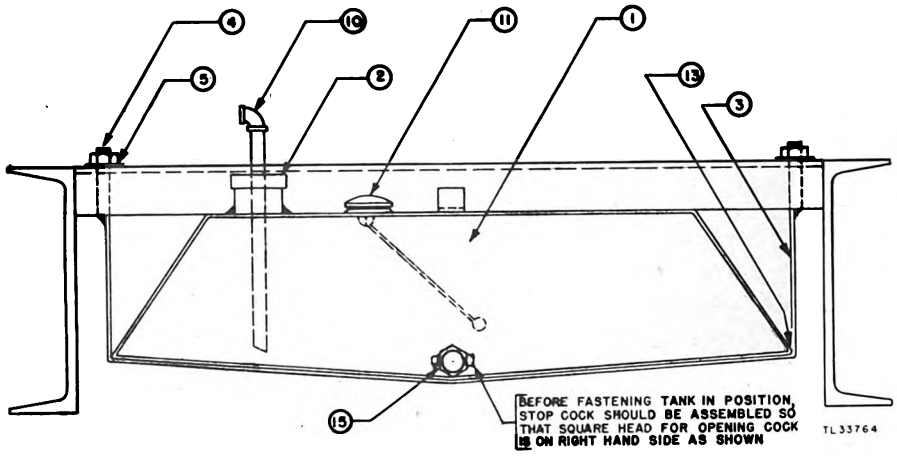


TL-33763

Figure 174. Exhaust manifold.

Item No.	*No. of units*	*Name of part and description*
		EXHAUST MANIFOLD (fig. 174)
	1	Assembly, exhaust manifold.
	3	Gasket, exhaust and intake manifold.
	6	Nut, exhaust manifold, brass.
2	1	Section, exhaust manifold, center.
3	1	Section, exhaust manifold, front.
1	1	Section, exhaust manifold, rear.
4	2	Sleeve, exhaust manifold.
	6	Lockwashers.



TL-33764

Figure 175. Fuel tank assembly.

Item No.	*No. of units*	*Name of part and description*
		FUEL TANK ASSEMBLY (fig. 175)
1	1	Assembly, fuel tank.
2	1	Cap, fuel tank.
15	1	Cock, fuel tank drain, ½" IPS.
11	1	Gauge, fuel tank level (C1362E-11).
3	2	Strap, fuel tank supporting.
10	1	Ell, tank suction pipe, ⅜" x 90°.
13	2	Strap, anti-squeak, tank supporting.
4	4	Nut, supporting strap, ⅝" USS.
5	4	Lockwasher, supporting strap, ⅝".

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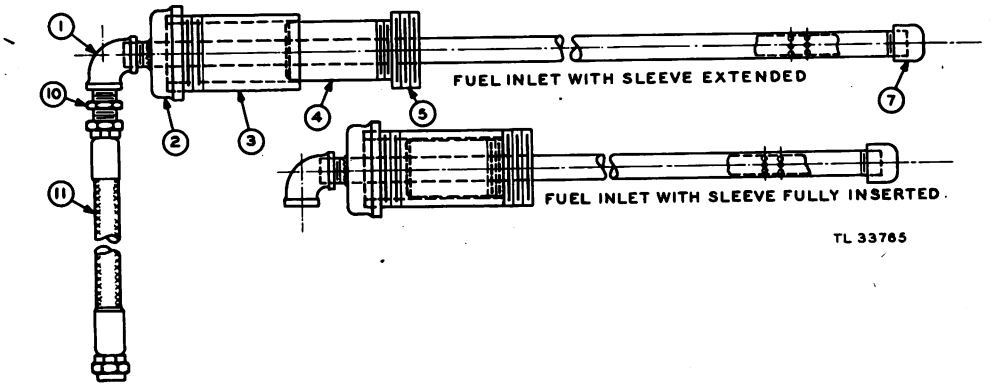
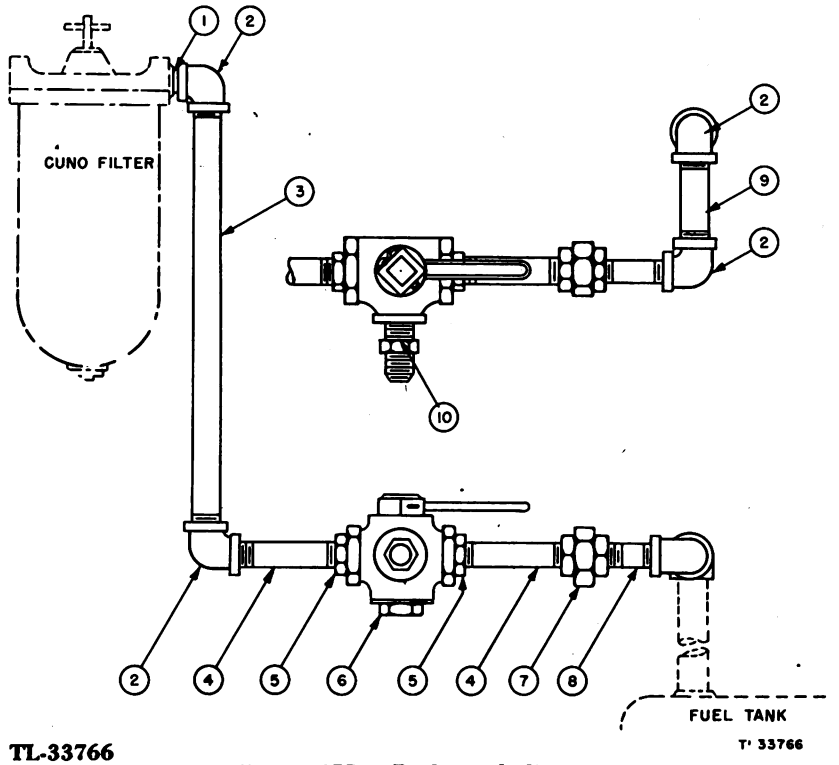


TL-33765

Figure 176. Fuel supply line, auxiliary.

Item No.	*No. of units*	*Name of part and description*
		FUEL SUPPLY LINE, AUXILIARY (fig. 176)
	1	Assembly, auxiliary fuel supply.
1	1	Ell, pipe, ½" x 90°.
2	1	Assembly, stand pipe and cap.
3	1	Sleeve, upper telescope.
4	1	Sleeve, lower telescope.
5	1	Bushing, lower telescope.
7	1	Cap, suction pipe ½" IPS.
10	1	Connector, SAE male, ½" x ⅜" (D1414A-10).
11	1	Hose, flexible, fuel suction (including fittings).



TL-33766

Figure 177. Fuel supply line.

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Item No.	*No. of units*	*Name of part and description*
		FUEL SUPPLY LINE (from tank to primary filter) (fig. 177)
	1	Assembly, tank to filter supply line.
1	1	Nipple pipe, ⅜" close.
2	4	Ell, pipe, ⅜" x 90°.
3	1	Nipple, pipe, ⅜" x 12".
4	2	Nipple, pipe, ⅜" x 3½".
5	3	Bushing, pipe, ½" x ⅜".
6	1	Valve, 3-way (C 1398B-6-11), ½" IPS.
	1	Bracket, valve stop.
	1	Cap screw, stop, bracket, ¼" x 1" USS.
	2	Nut, stop bracket, ¼" USS.
	2	Lockwasher, stop bracket, ¼".
	1	Cap screw, stop bracket, ¼" x 1½" USS.
7	1	Union, pipe, ⅜" IPS.
8	1	Nipple, pipe, ⅜" x 2".
9	1	Nipple, pipe, ⅜" x 2½".
10	1	Connector, SAE male, ½" x ⅜" (C 1398B-10).
	1	Bracket, CUNO filter.
	4	Cap screw, filter bracket, ¼" x ¾" USS.
	4	Nuts, filter bracket, ¼" USS.
	4	Lockwashers, filter bracket, ¼".
		FILTER, FUEL OIL, PRIMARY (fig. 178)
	1	Filter, fuel oil.
	1	Cartridge unit.
6	1	Follower, gland.
10	1	Gasket, head.
2	1	Gasket, vent screw.
	1	Handle.
1	1	Head.
8	2	Lockwasher, cartridge mounting screw.
5	1	Nut, gland.
7	1	Packing.
12	1	Plug, drain.
9	2	Screw, cartridge mounting.
	10	Screw, head.
3	1	Screw, vent.
11	1	Sump and drain plug.
		FILTER, FUEL OIL, ACCESSORIES, SECONDARY (fig. 179)
1	1	Assembly, secondary fuel filter bracket.
2	4	Cap screws, filter bracket, ⅜" x 1" USS.
3	4	Lockwashers, filter bracket, ⅜".
4	4	Nuts, filter bracket, ⅜" USS.
5	1	Tubing, secondary fuel filter, inlet.
6	1	Tubing, secondary fuel filter.
7	1	Clamp, secondary filter tubing.
8	1	Cap screw, tubing clamp, ¼" x ½" USS.
9	1	Nut, tubing clamp, ¼" USS.
10	1	Lockwashers, tubing clamp ¼".

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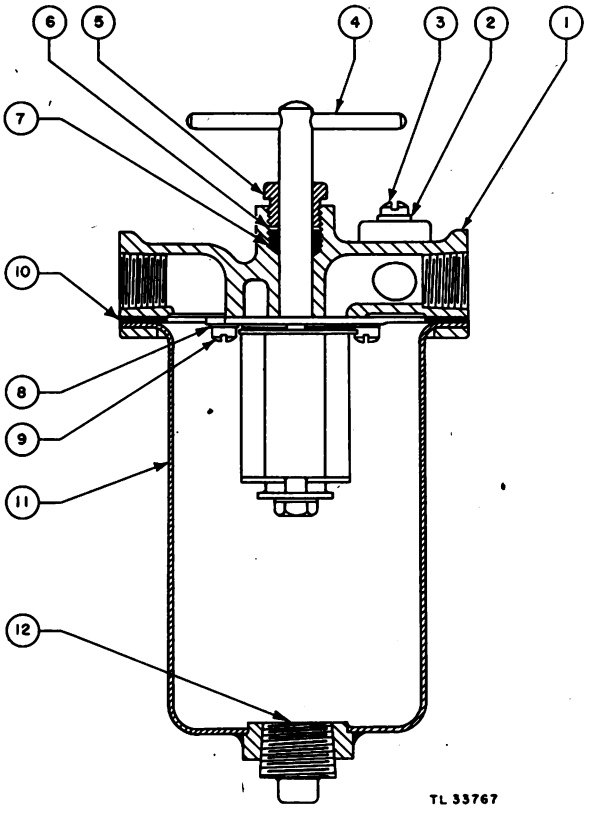
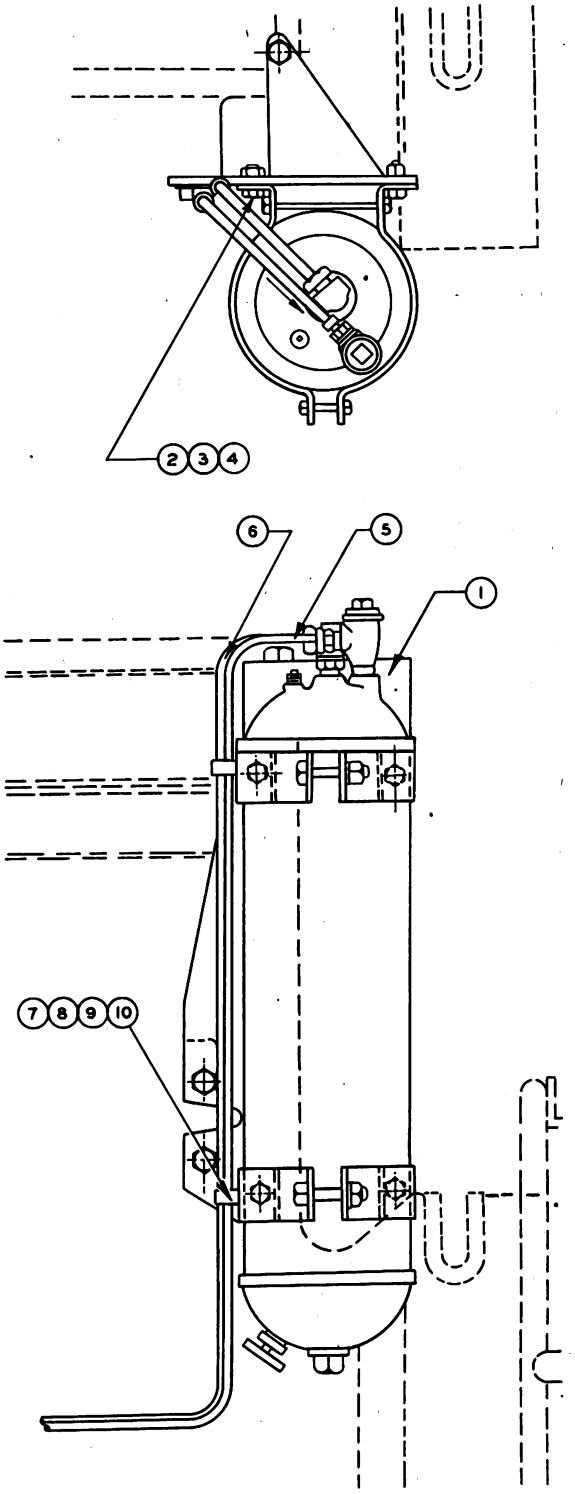


TL-33767

Figure 178. Filter, fuel oil primary.



TL-33768

Figure 179. Filter, fuel oil, accessories, secondary.

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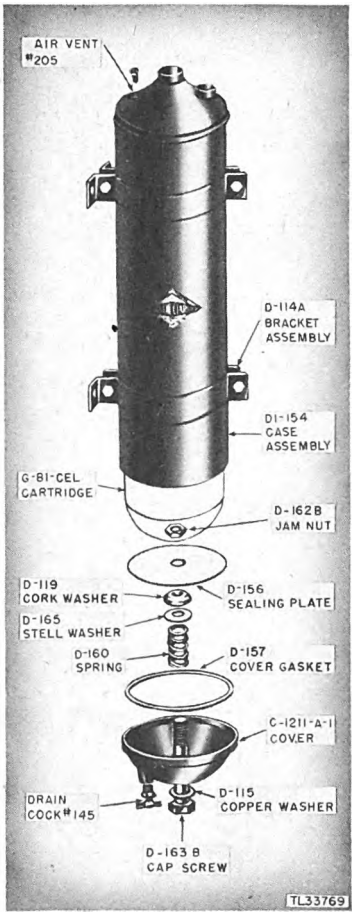
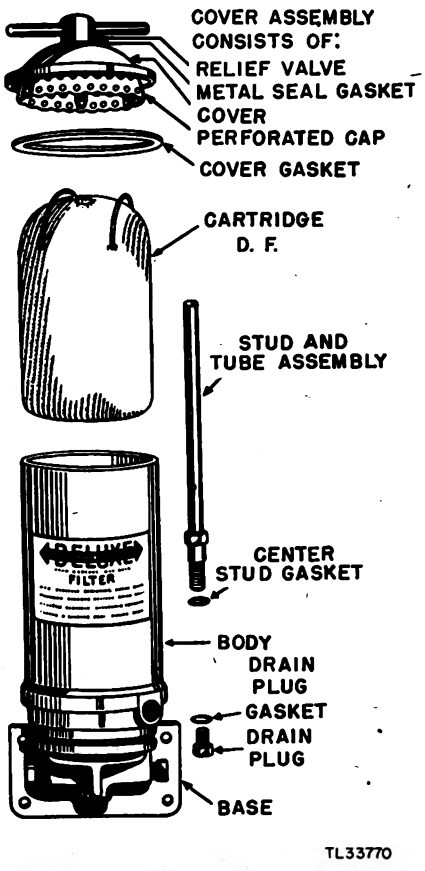


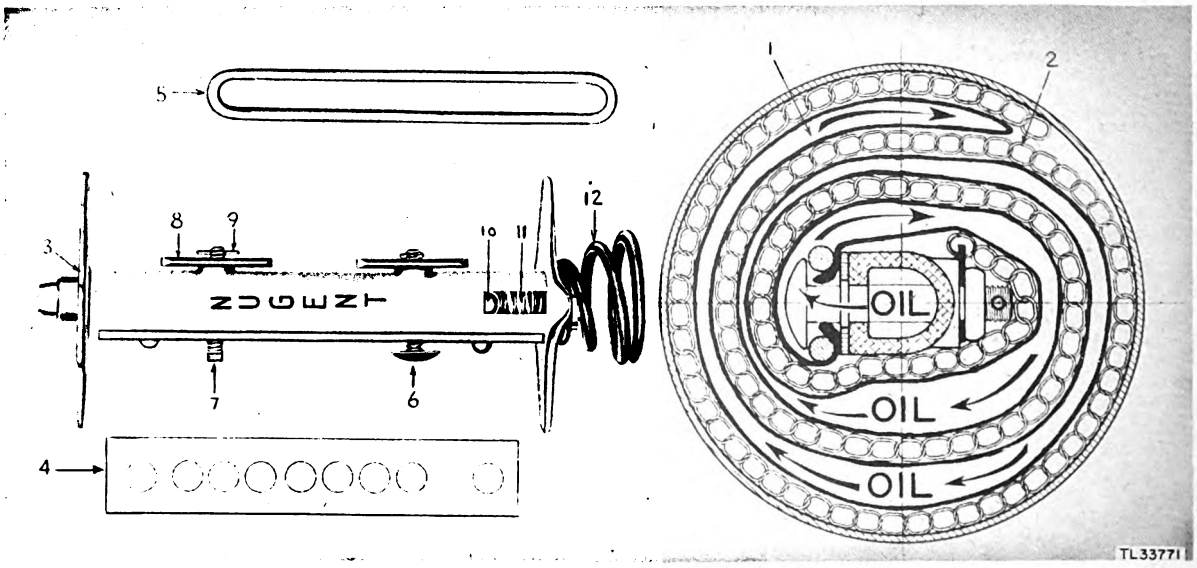
TL-33769

Figure 180. Filter, fuel oil, secondary.



TL-33770

Figure 181. Filter, lubricating oil, secondary.



TL-33771

Figure 182. Filter, lubricating oil, primary.

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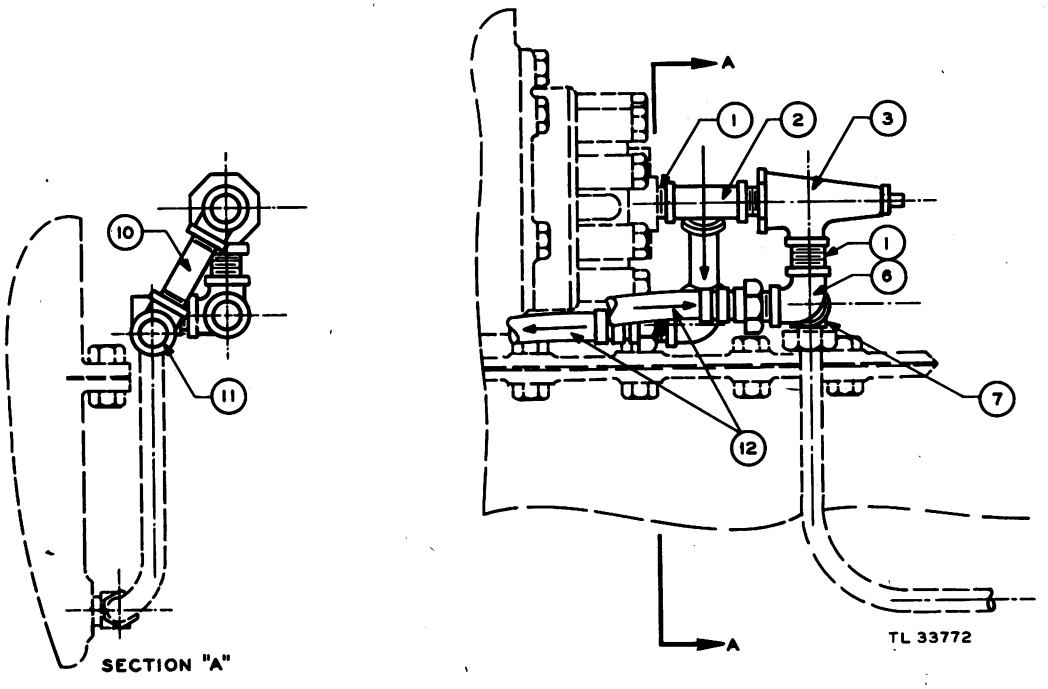
Item No.	No. of units	Name of part and description
		FILTER, LUBRICATING OIL, PRIMARY Bag Type in Pan (fig. 182)
	1	Cover, lubricating oil filter.
1	1	Bag, filter.
10	1	Ball, bypass relief.
6	2	Clamp, bag ring.
4	1	Gasket, bag.
	1	Nut, bypass adjusting.
8	1	Nut, elongated clamp.
	1	Pin, cotter.
9	2	Pin, cross.
5	1	Ring, bag.
2	1	Spacer, wire mat.
3	1	Spool, bag.
7	2	Spring, bag ring clamp.
11	1	Spring, bypass relief.
12	1	Spring, shock



TL-33772

Figure 183. Piping, lubricating oil cooling.

Item No.	No. of units	Name of part and description
		PIPING, LUBRICATING OIL COOLING (fig. 183)
1	2	Nipple, pipe, ½" close.
2	1	Tee, pipe, ½".
3	1	Valve, pressure relief, ½" (A1361A-3).
6	1	Ell, side outlet, ½".
7	2	Ell, inverted male (A1361A-7).
10	1	Nipple, pipe ½" x 2½".
11	1	Ell, pipe, ½" x 90°.
12	2	Tube, flexible (Resisto-Flex) including fittings.

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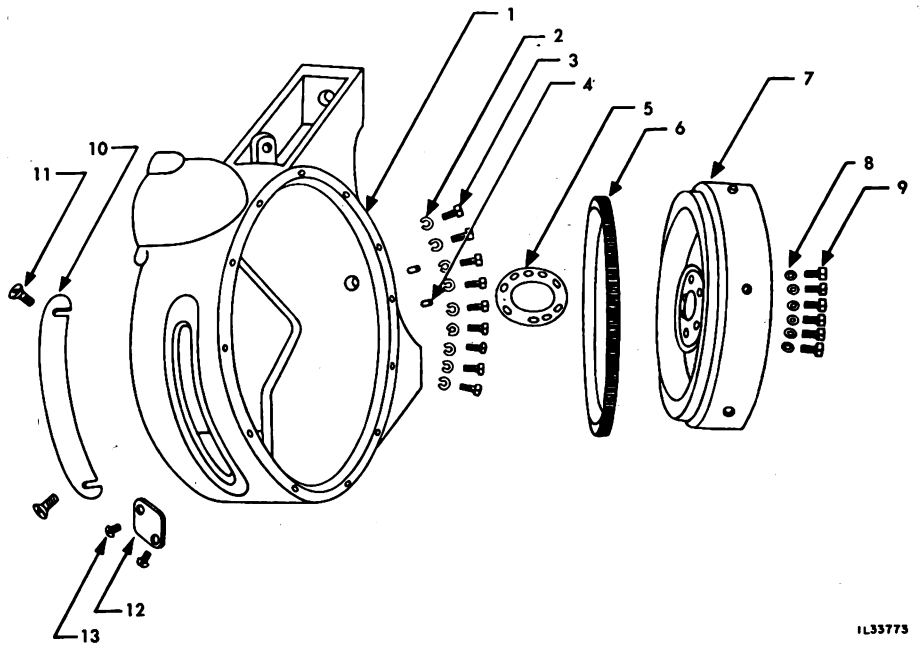

TL-33773

Figure 184. Flywheel and flywheel housing assembly.

Item No.	*No. of units*	*Name of part and description*
		FLYWHEEL AND FLYWHEEL HOUSING ASSEMBLY (fig. 184)
7	1	Flywheel.
6	1	Gear, flywheel ring.
		Mounting parts:
9	6	Cap screw, flywheel to crankshaft.
5	1	Gasket, flywheel to crankshaft.
8	6	Lockwasher, ⅝" everlock flywheel to crankshaft.
4	3	Lockwire, flywheel to crankshaft.
	2	Pins, dowel.
10	1	Cover, barring slot.
12	1	Cover, index hole.
1	1	Housing, flywheel (CECO H-10283).
	2	Lockwasher, ¼" positive lock, index hole cover.
11	2	Screw, barring slot cover.
13	2	Screw, index hole cover.
3	9	Cap screw, ⅝"—18 x 1½", housing to block.
	1	Gasket, housing to block.
2	9	Lockwasher, ⅝" positive lock, housing to block.
		FUEL PUMP
	1	Assembly, fuel pump.
	5	Cap screw, 7/16"—20 x 1", governor flange to block.
	2	Cap screw, ⅜"—24 x 3¼", pump to block, lower.
	2	Cap screw, 9/16"—18 x 1¼", pump to block, upper.
	1	Gasket, governor flange to block.
	1	Gasket, lubricating oil drain.
	5	Lockwasher, 9/16" positive lock, flange to block.
	2	Lockwasher, ⅜", positive lock, pump to block, lower.
	2	Lockwasher, 7/16", positive lock, pump to block, upper.

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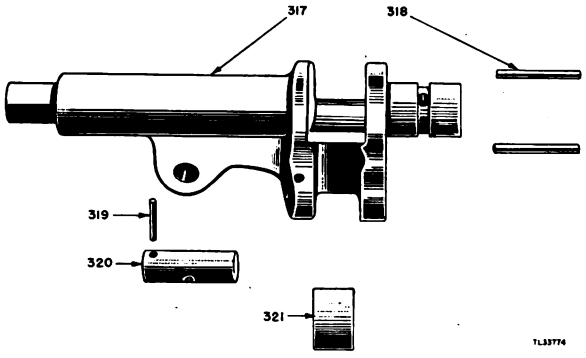
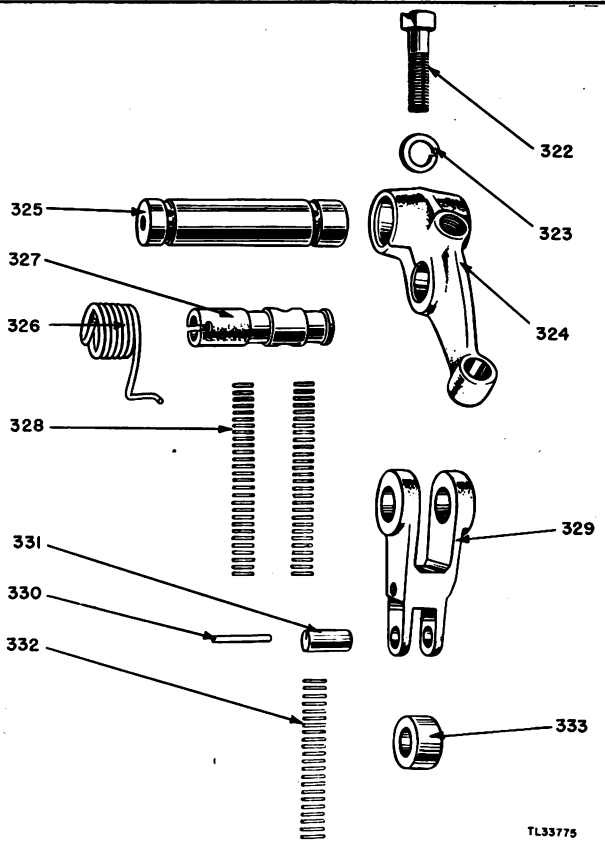


TL-33774

Figure 185. Lever assembly, cam rocker.



TL-33775

Figure 186. Vertical lever assembly.

Item No.	*No. of units*	*Name of part and description*
		FUEL PUMP (Continued)
		Cam Rocker Lever Assembly (fig. 185):
	1	Assembly, cam rocker lever.
317	1	Lever, cam rocker.
320	1	Pin, cam rocker lever roller.
	1	Plug, cam rocker lever.
319	1	Rivet, cam rocker lever roller pin
321	1	Roller, cam rocker lever.
	1	Sleeve, vertical lever stop.
318	2	Stop, vertical lever.
		Vertical Lever Assembly (fig. 186):
	1	Assembly, vertical lever.
328	56	Bearing, plunger lever pin.
332	22	Bearing, vertical lever roller.
322	1	Cap screw, ⅜"—24 x 1½", plunger lever.
324	1	Lever, plunger.
329	1	Lever, vertical.
323	1	Lockwasher, ⅜" positive lock, plunger lever cap screw.
327	1	Pin, plunger lever.
331	1	Pin, vertical lever, roller.
330	1	Rivet, vertical lever roller pin.
333	1	Roller, vertical lever.
325	1	Shaft, plunger lever.
		Mounting parts:
326	1	Spring, vertical lever.

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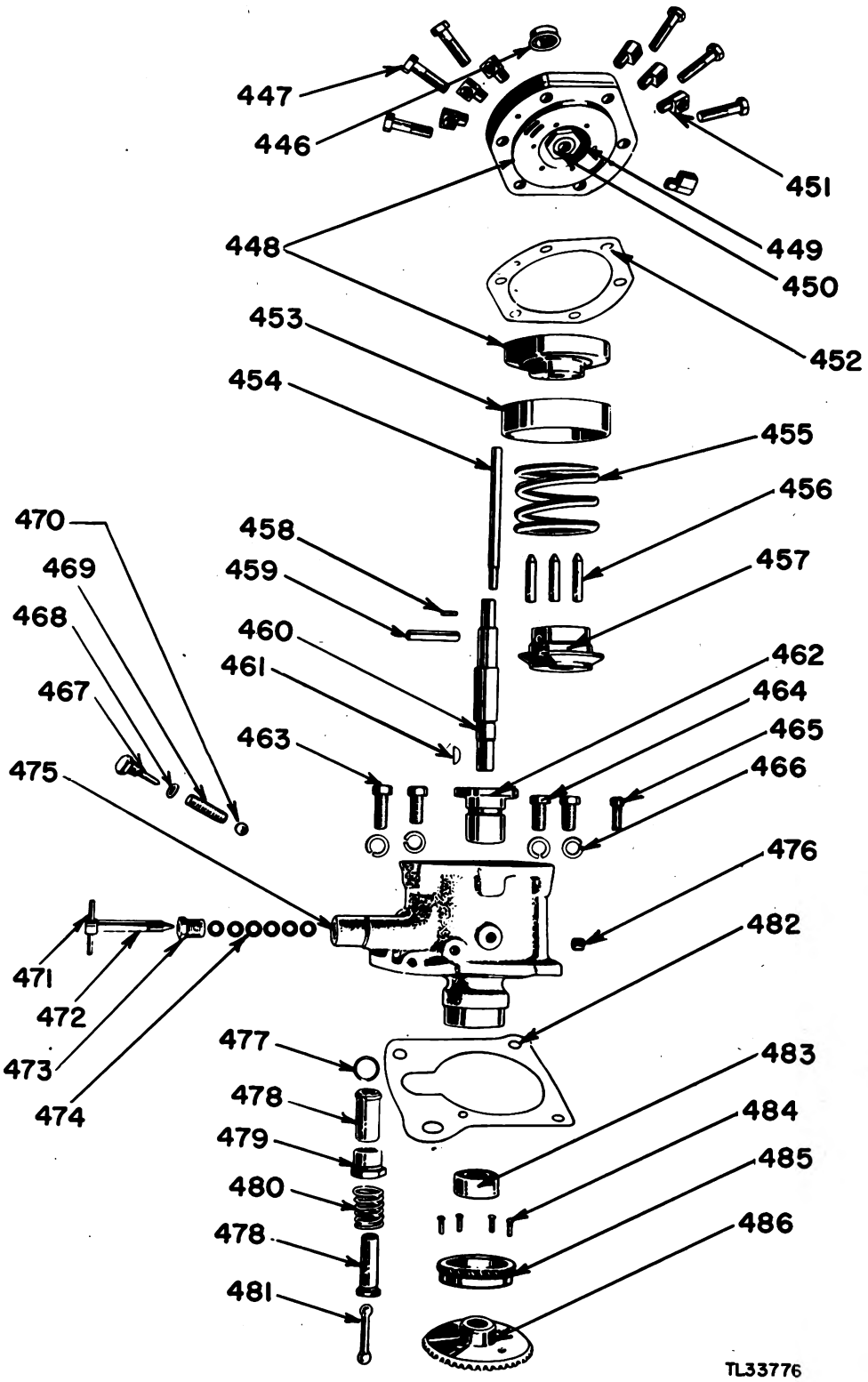

TL-33776

Figure 187. Distributor assembly.

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Item No.	No. of units	Name of part and description
		FUEL PUMP (Continued)
		Distributor Assembly (fig. 187):
	1	Assembly, distributor.
448	1	Assembly, disk and cover.
446	1	Cap, dust.
451	7	Elbow, tube.
	1	Gasket, tachometer shaft guide.
450	1	Guide, tachometer shaft.
449	1	Nut, tachometer shaft guide.
	1	Packing, tachometer shaft guide.
	1	Assembly, distributor shaft (includes items 454, 456, and 460).
457	1	Collar, distributor disk drive.
456	3	Pin, distributor disk drive.
459	1	Rivet, drive collar.
458	1	Rivet, tachometer shaft.
460	1	Shaft, distributor drive.
454	1	Shaft, tachometer drive.
475	1	Assembly, housing and bushing (includes items 453 and 462).
462	1	Bushing distributor shaft.
453	1	Bushing, distributor disk.
	1	Assembly, priming valve (includes items 471 and 472).
471	1	Pin, priming valve.
472	1	Valve, priming.
470	1	Ball, check.
483	1	Bearing, distributor shaft ball (N.D. 5203).
447	6	Cap screw, ⅜"—24 x 1½", distributor cover.
468	1	Gasket, distributor check valve.
452	1	Gasket, distributor housing cover.
477	1	Gasket, metering pump.
486	1	Gear, distributor drive.
485	1	Gear, overspeed stop drive.
461	1	Key, Woodruff distributor shaft.
479	1	Nut, plunger barrel clamp.
473	1	Nut, priming valve packing.
474	7	Packing, priming valve.
467	1	Plug, distributor check valve.
478	1	Pump, metering (plunger and barrel).
484	4	Rivet, overspeed stop drive gear.
469	1	Spring, distributor check valve.
455	1	Spring, distributor disk.
		Mounting parts:
463	1	Cap screw, 7/16"—14 x 1¼", distributor housing.
464	3	Cap screw, 7/16"—14 x 1", distributor housing.
482	1	Gasket, distributor housing.
481	1	Link, metering pump.
466	4	Lockwasher, 7/16" positive lock, distributor housing.
465	1	Screw, ⅛"—28 x 1", hollow head, distributor housing.
476	1	Plug, ⅛" pipe, timing hole.
480	1	Spring, metering pump.
	1	Tube, gear pump to overspeed stop.
	1	Nut, compression coupling.
	1	Nut, tube.
	1	Tube, overspeed stop to distributor.
	2	Nut, tube.

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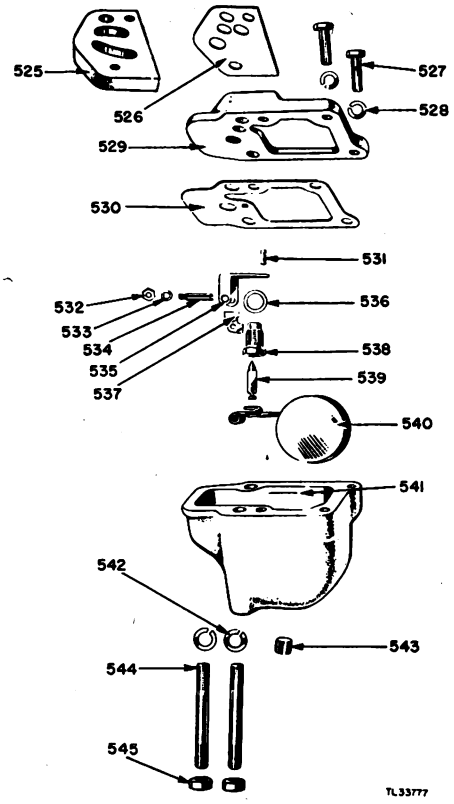
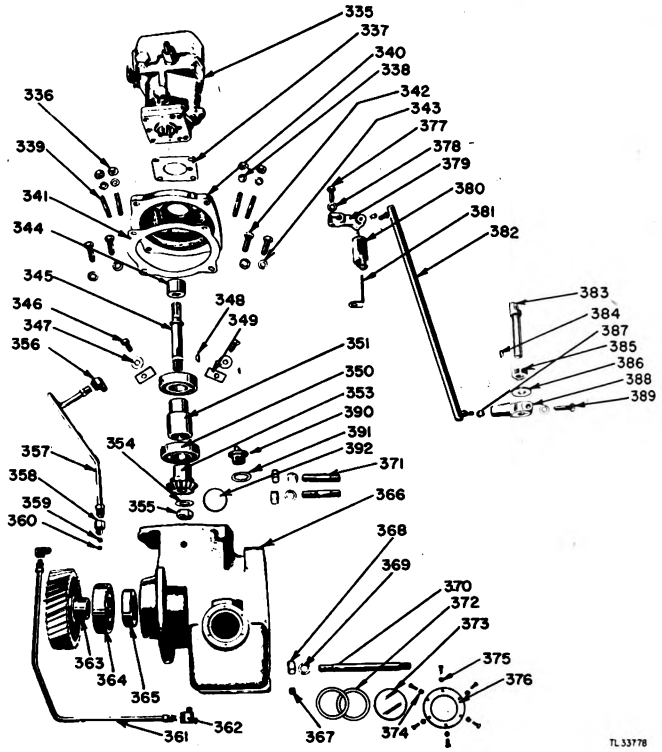


TL-33777

Figure 188. Float chamber assembly.



TL-33778

Figure 189. Governor housing assembly.

Item No.	*No. of units*	*Name of part and description*
		FUEL PUMP (Continued)
		Float Chamber Assembly (fig. 188):
	1	Assembly, float chamber.
535	1	Bracket, float bearing.
527	2	Cap screw, ¼"—28 x ⅞", float chamber top plate.
541	1	Chamber, float.
540	1	Float and lever.
530	2	Gasket, float chamber.
536	1	Gasket, float valve seat.
528	2	Lockwasher, ¼" positive lock, float chamber.
533	1	Lockwasher, float lever bearing pin.
532	1	Nut, float lever bearing pin.
534	1	Pin, float lever bearing.
531	1	Pin, float lever locating dowel.
529	1	Plate, float chamber top.
525	1	Plate, adapter to main housing and float chamber.
543	1	Plug, ⅛" pipe.
538	1	Seat, float valve.
537	1	Stop, float.
539	1	Valve, float.
		Mounting parts:
544	2	Stud, 5/16"—24 x 5¼".
545	2	Nut, 5/16"—24.
526	2	Gasket, float chamber top plate and adapter.
542	2	Lockwasher, 5/16" positive lock.

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Item No.	No. of units	Name of part and description
		FUEL PUMP (Continued)
		Governor Housing Assembly (fig. 189):
335	1	Governor, Woodward Hydraulic.
		Mounting parts:
340	1	Adapter, governor to governor housing.
360	1	Ball, check.
350	2	Bearing, governor spindle ball (N.D. 3206).
364	1	Bearing, drive gear ball (N.D. 1307).
342	4	Cap screw, ⅜"—16 x 1", adapter to governor housing.
346	2	Cap screw, 5/16"—18 x ⅝", ball bearing retainer.
389	1	Cap screw, 5/16"—24 x 1", governor lever, lower.
377	1	Cap screw, 5/16"—24 x ¾", governor lever, upper.
374	6	Cap screw, No. 6—40 x ⅜", oil level window cover.
344	1	Collar, governor drive.
376	1	Cover, oil level window.
358	1	Connection, lubricating oil tube.
356	1	Elbow, governor oil tube.
362	2	Elbow, governor vent tube.
341	1	Gasket, adapter to governor housing.
391	1	Gasket, governor housing filler plug.
337	1	Gasket, governor to adapter.
	1	Gasket, governor housing to fuel pump housing.
372	2	Gasket, oil level window.
363	1	Gear, fuel pump drive.
353	1	Gear, governor spindle.
366	1	Housing, governor.
384	1	Key, fuel control shaft.
348	1	Key, governor spindle pinion.
388	1	Lever, governor, lower.
379	1	Lever, governor, upper.
382	1	Link, governor control.
347	2	Lockplate, spindle bearing retainer.
354	1	Lock, spindle.
		Mounting parts (fig. 189):
343	4	Lockwasher, ⅜" positive lock, adapter to governor housing.
338	4	Lockwasher, 5/16" positive lock, governor to adapter.
369	3	Lockwasher, 7/16" positive lock, governor housing to fuel pump housing.
387	2	Lockwasher, ¼" positive lock, governor link.
378	2	Lockwasher, 5/16" positive lock, governor lever.
375	6	Lockwasher, oil level window cover.
336	4	Nut, 5/16"—18, governor adapter.
368	3	Nut, 7/16"—14, governor housing stud.
355	1	Nut, ⅝"—18, governor spindle.
392	1	Plug, governor housing expansion.
390	1	Plug, governor housing oil filler.
367	1	Plug, ⅛" pipe, housing drain.
349	2	Retainer, spindle bearing.
381	1	Retainer, tension spring.
385	1	Seal, control shaft oil.
365	1	Seal, main shaft.
383	1	Shaft, governor control.
351	1	Spacer, governor spindle bearing.
345	1	Spindle, governor.
359	1	Spring, governor check valve.
380	1	Spring, governor lever tension.
339	4	Stud, governor to adapter.

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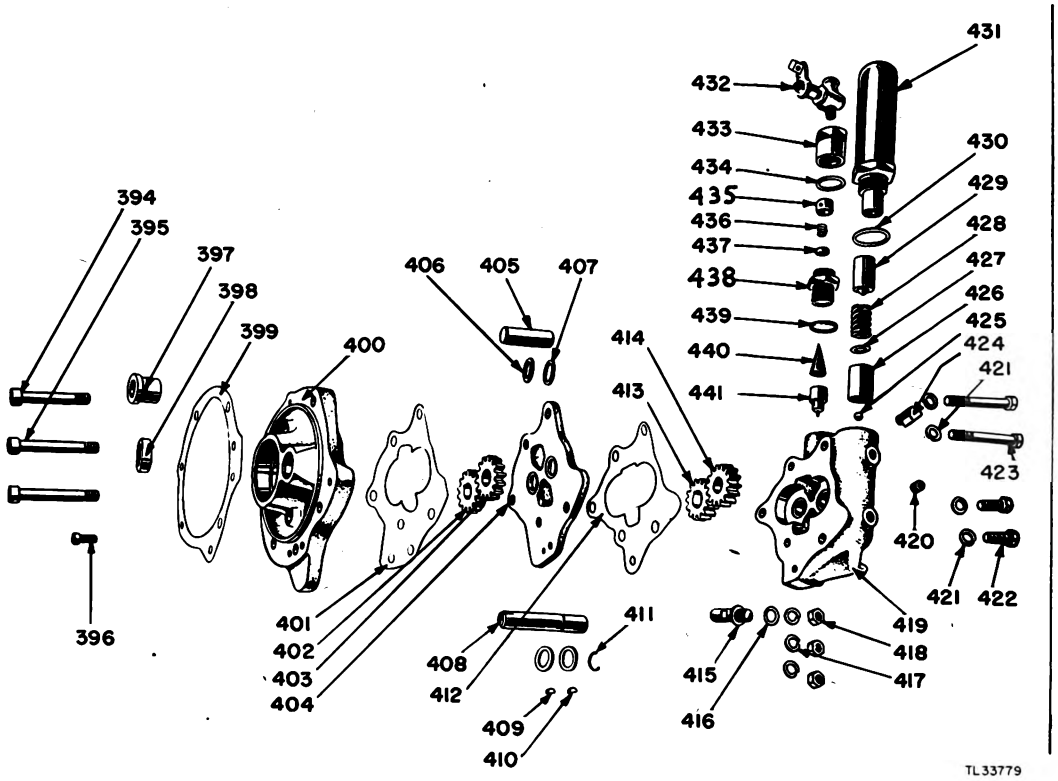
Item No.	*No. of units*	*Name of part and description*
		FUEL PUMP (Continued)
		Mounting parts (fig. 189) (Continued):
370	1	Stud, governor housing, long.
371	2	Stud, governor housing, short.
357	1	Tube, governor housing to governor.
	2	Nut, tube.
361	1	Tube, governor housing vent.
	2	Nut, tube.
386	1	Washer, governor lever spacer.
373	1	Window, oil level.



TL-33779

Figure 190. Gear pump assembly.

Item No.	*No. of units*	*Name of part and description*
		FUEL PUMP (Continued)
		Gear Pump Assembly (fig. 190):
	1	Assembly, gear pump.
438	1	Assembly, check valve seat and screen (includes item 440).
440	1	Screen, check valve seat.
425	1	Ball, check.
400	1	Body, No. 1 gear pump.
419	1	Body, No. 2 gear pump.
395	2	Bolt, gear pump body, long.
394	1	Bolt, gear pump body, short.
397	1	Bushing, cam rocker lever.

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Item No.	No. of units	Name of part and description
		FUEL PUMP (Continued)
		Gear Pump Assembly (fig. 190) (Continued):
431	1	Chamber, pressure.
432	1	Cock, shut-off.
424	1	Elbow, tube.
434	1	Gasket, check valve housing.
439	1	Gasket, fuel supply check valve.
401	1	Gasket, No. 1 gear pump spacer.
412	1	Gasket, No. 2 gear pump spacer.
416	1	Gasket, idling lever shaft.
430	1	Gasket, pressure chamber.
402	1	Gear, No. 1 drive.
413	1	Gear, No. 2 drive.
414	1	Gear, No. 2 idler.
403	1	Gear, No. 1 idler.
435	1	Guide, fuel supply check valve.
433	1	Housing, fuel supply check valve.
409	1	Key, No. 1, drive gear.
410	1	Key, No. 2, drive gear.
417	3	Lockwasher, ⅜", positive lock.
418	3	Nut, ⅜"—24, body bolt.
420	1	Plug, ⅛", pipe No. 2 body.
411	1	Ring, snap.
396	1	Screw, spacer plate.
406	2	Seal, spacer.
398	1	Seal, shaft oil.
408	1	Shaft, gear pump drive.
405	1	Shaft, gear pump idler.
415	1	Shaft, idling lever.
426	1	Sleeve, pressure regulating valve.
404	1	Spacer, gear pump.
436	1	Spring, fuel supply check valve.
428	1	Spring, pressure regulating valve.
441	1	Valve, fuel pump check.
437	1	Valve, fuel supply check.
429	1	Valve, pressure regulating.
407	2	Washer, for oil seals.
427	as req'd	Washer, pressure regulating.
		Mounting parts:
422	2	Cap screw, ⅜"—16 x 1", pump to housing, short.
423	2	Cap screw, ⅜"—16 x 2¾", pump to housing, long.
399	1	Gasket, gear pump to housing.
421	4	Lockwasher, ⅜" positive lock.
		Main Housing Assembly (fig. 191):
263	1	Assembly, fuel pump housing.
278	1	Bushing, cam rocker lever.
276	1	Bushing, control shaft.
279	1	Bushing, hand control eccentric.
261	1	Bushing, plunger lever shaft, short.
264	1	Bushing, plunger lever shaft, long.
	1	Dowel, gear pump housing.
	1	Plug, oil line.
277	1	Plug, ¼", pipe for drain.
	3	Plug, ⅛", pipe for housing.
274	1	Ball, fuel check.
269	1	Coupling, pipe, injector drain.
272	1	Gasket, bypass valve guide.

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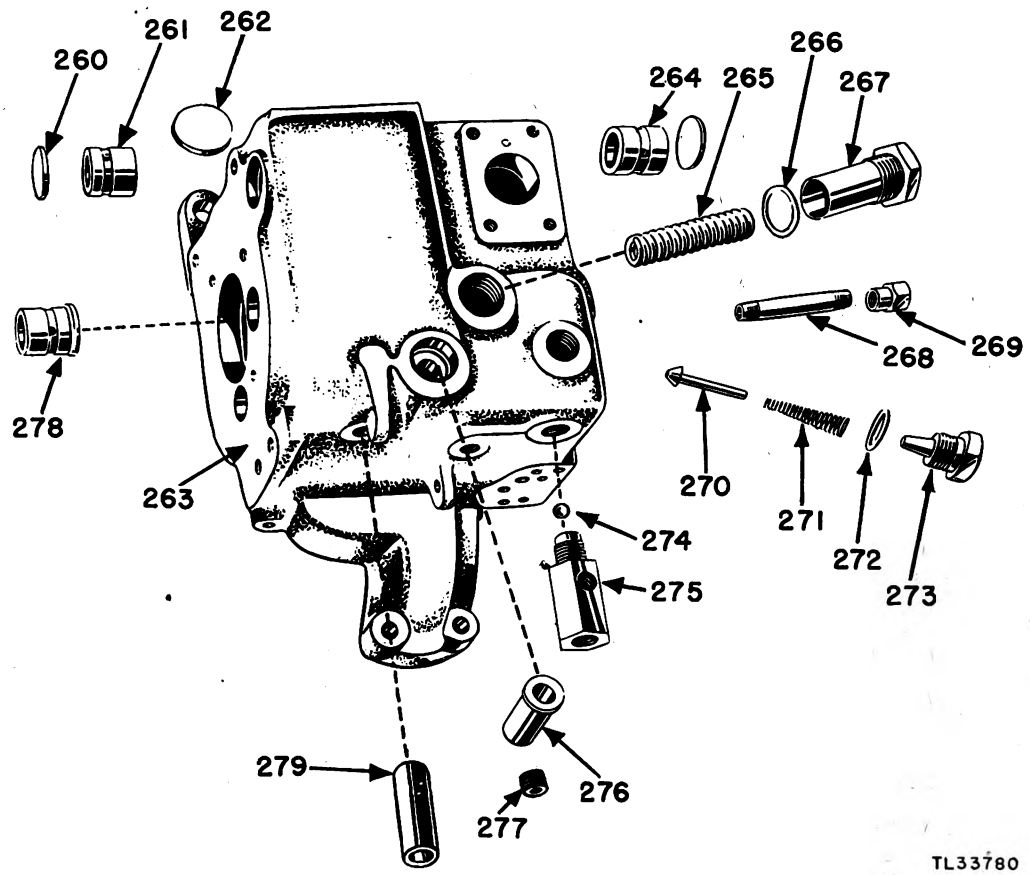

TL-33780

Figure 191. Main housing assembly.

Item No.	*No. of units*	*Name of part and description*
		FUEL PUMP (Continued)
		Main Housing Assembly (fig. 191) (Continued):
266	1	Gasket, cam rocker lever spring retainer.
273	1	Housing, bypass valve.
268	1	Nipple, ⅛" x 2¾" pipe, injector drain.
262	1	Plug, 1½", expansion, peep hole.
260	2	Plug, 1⅛", expansion, plunger lever shaft hole.
275	1	Plug, fuel inlet.
267	1	Retainer, cam rocker lever spring.
271	1	Spring, bypass valve.
265	1	Spring, cam rocker lever.
270	1	Valve, bypass.
		Hand Control Eccentric and Lever Assembly (fig. 192):
	1	Assembly, governor lever and bushing (includes items 281 and 282).
281	1	Bushing, governor lever.
282	1	Lever, governor.
290	1	Cap screw, 5/16"—24 x 1¼", control lever clamping.

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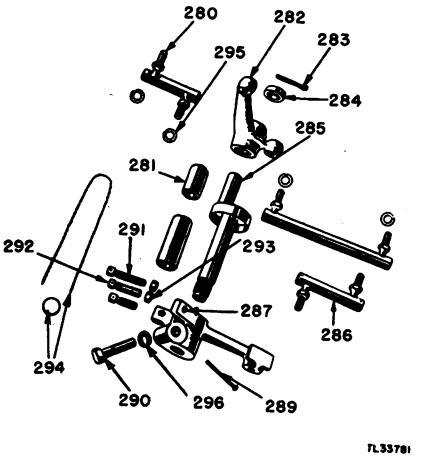
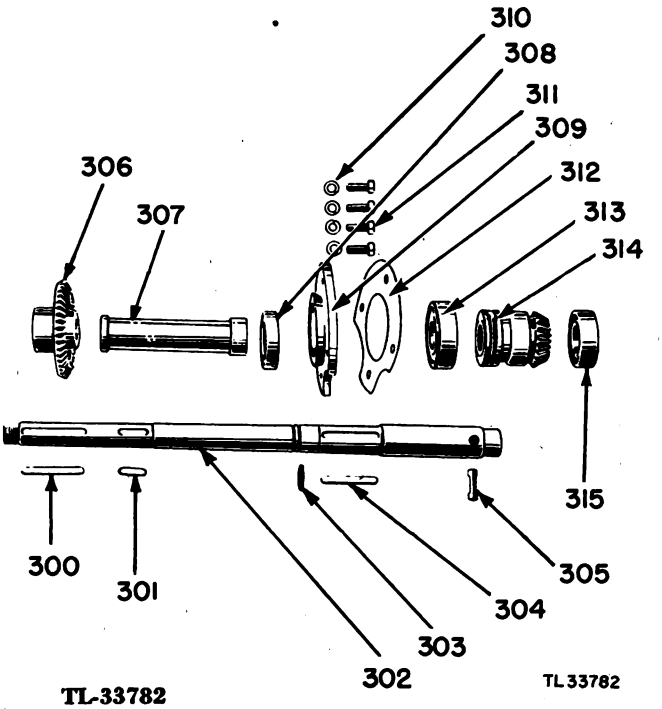


TL-33781

Figure 192. Hand control eccentric and lever assembly.



TL-33782

Figure 193. Main shaft assembly.

Item No.	*No. of units*	*Name of part and description*
		FUEL PUMP (Continued)
		Hand Control Eccentric and Lever Assembly (fig. 192) (Continued):
284	1	Collar, hand control eccentric.
285	1	Eccentric, hand control.
287	1	Lever, control.
286	1	Link, governor, control eccentric.
280	1	Link, vertical lever.
296	1	Lockwasher, 5/16", positive lock, control lever.
295	4	Lockwasher, ¼" positive lock.
293	2	Nut, ¼"—28, control lever adjusting screw.
283	1	Pin, 3/32" x 1" cotter.
289	1	Rivet, control lever.
292	1	Screw, control lever adjusting right side, long.
291	1	Screw, control lever adjusting left side, short.
294	1	Seal, lead, with wire.
		Main Shaft Assembly (fig. 193):
	1	Assembly, fuel pump main shaft.
313	1	Bearing, fuel pump cam ball (N.D. 7305).
315	1	Bearing, fuel pump ball (N.D. 3205).
314	1	Cam, fuel pump main shaft.
306	1	Gear, governor drive.
304	1	Key, main shaft, cam.
300	1	Key, fuel drive main shaft.
301	1	Key, governor drive.
305	1	Pin, gear pump drive.
303	as req'd	Ring, snap No. 0.059".
303	as req'd	Ring, snap No. 0.062".

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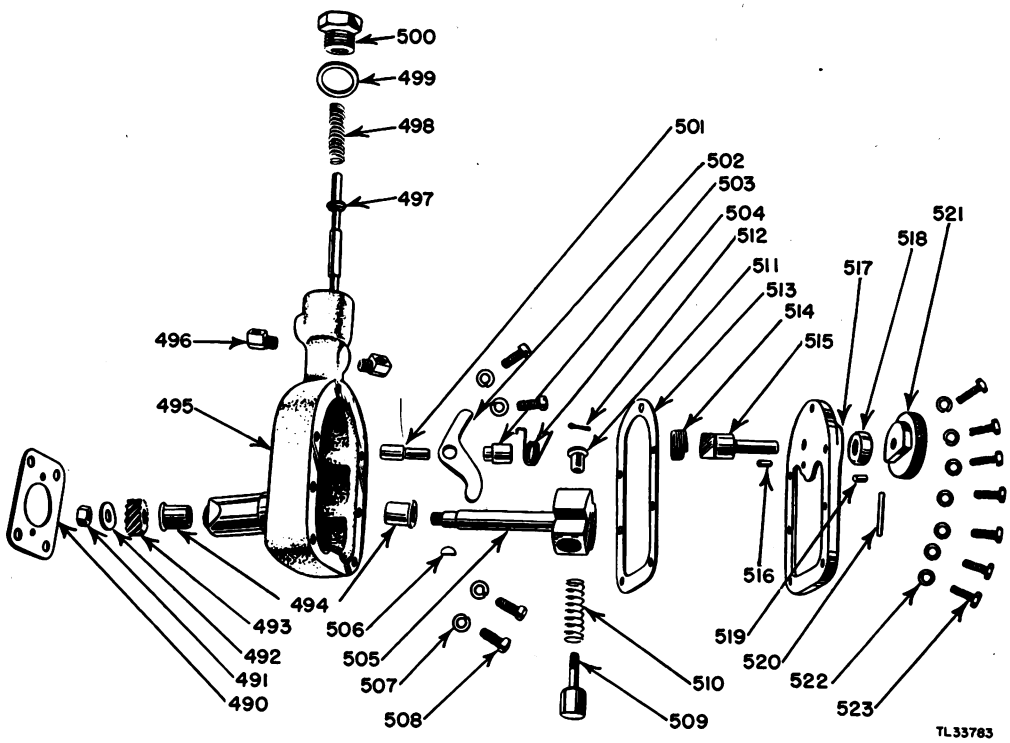
Item No.	*No. of units*	*Name of part and description*
		FUEL PUMP (Continued)
		Main Shaft Assembly (fig. 193) (Continued):
303	as req'd	Ring, snap No. 0.065".
308	1	Seal, ball-bearing oil.
302	1	Shaft, fuel pump main.
309	1	Shield, fuel pump ball bearing.
307	1	Spacer, governor drive gear.
		Mounting parts:
311	4	Cap screw, 5/16"—24 x 1¼", ball bearing shield.
312	1	Gasket, ball bearing shield.
310	4	Lockwasher, 5/16", positive lock ball bearing shield.



TL-33783

Figure 194. Overspeed stop assembly.

Item No.	*No. of units*	*Name of part and description*
		FUEL PUMP (Continued)
		Overspeed Stop Assembly (fig. 194):
	1	Assembly, valve and housing (H-2930) (includes items 495 and 497).
494	2	Bushing, overspeed stop shaft.
503	1	Bushing, overspeed stop pawl.
523	7	Cap screw, ¼"—20 x ¾", overspeed stop cover.
	1	Combination weight and spring, 1200 rpm (items 509-512).
510	1	Spring, overspeed stop.
509	1	Weight, overspeed stop.
511	1	Collett, overspeed stop weight.
517	1	Cover, overspeed stop.

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Item No.	No. of units	Name of part and description
		FUEL PUMP (Continued)
		Overspeed Stop Assembly (fig. 194) (Continued):
496	2	Elbow, tube.
499	1	Gasket, overspeed stop body plug.
513	1	Gasket, overspeed stop cover.
490	1	Gasket, overspeed stop housing.
493	1	Gear, overspeed stop.
495	1	Housing, overspeed body (not sold separate from item 497, see BM232).
506	1	Key, overspeed stop gear.
521	1	Knob, overspeed stop reset.
522	7	Lockwasher, ¼", cover screws.
507	4	Lockwasher, 5/16" positive lock, overspeed stop to main housing.
491	1	Nut, ⅜"—24, overspeed stop shaft.
502	1	Pawl, overspeed stop.
512	1	Pin, cotter.
520	1	Pin, overspeed stop knob.
501	1	Pin, overspeed stop pawl.
519	1	Pin, overspeed stop reset.
516	1	Pin, overspeed stop reset spring.
492	1	Plate, overspeed stop shaft nut lock.
500	1	Plug, overspeed stop body.
	1	Plug, ⅞" brass expansion, overspeed stop body.
508	4	Screw, overspeed stop housing to main housing.
518	1	Seal, reset shaft oil.
505	1	Shaft, overspeed stop drive.
515	1	Shaft, overspeed stop reset.
504	1	Spring, overspeed stop pawl.
514	1	Spring, overspeed stop reset.
498	1	Spring, overspeed stop valve.
497	1	Valve, overspeed stop.
		GEAR CASE COVER ASSEMBLY (fig. 195)
	1	Assembly gear case cover.
147	2	Cap screw, ⅜"—24 x ¾", cam shaft thrust plate.
136	1	Cover, gear case.
145	1	Gasket, camshaft thrust plate.
141	1	Gasket, gear case cover.
148	2	Lockwasher, ⅜" positive lock, thrust plate.
146	1	Plate, camshaft thrust.
144	2	Plunger, lubricating oil pressure regulator.
142	1	Seal, fan pulley oil.
140	1	Seal, crankshaft oil.
143	1	Spring, lubricating oil pressure regulator.
		Mounting parts:
137	17	Cap screw, 7/16"—20 x 2", gear cover to block.
139	2	Dowel, gear cover to block.
138	17	Lockwasher, 7/16" positive lock.

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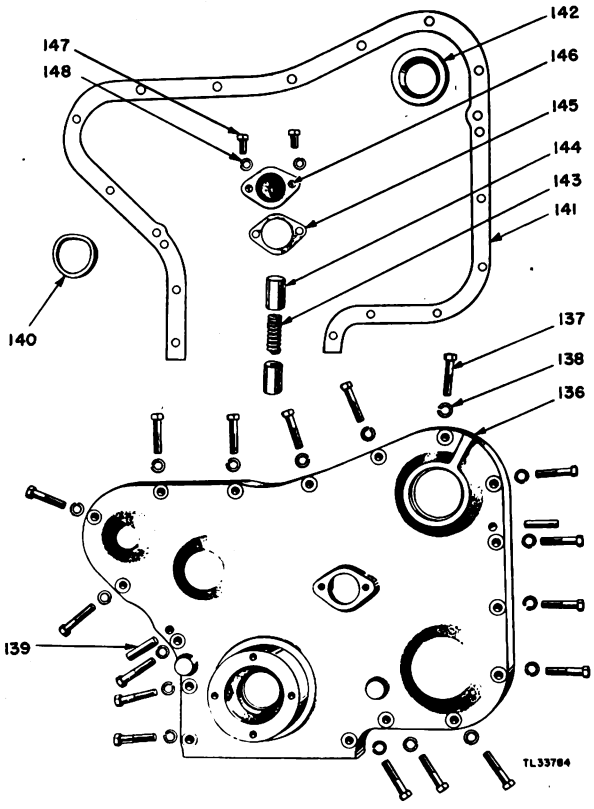
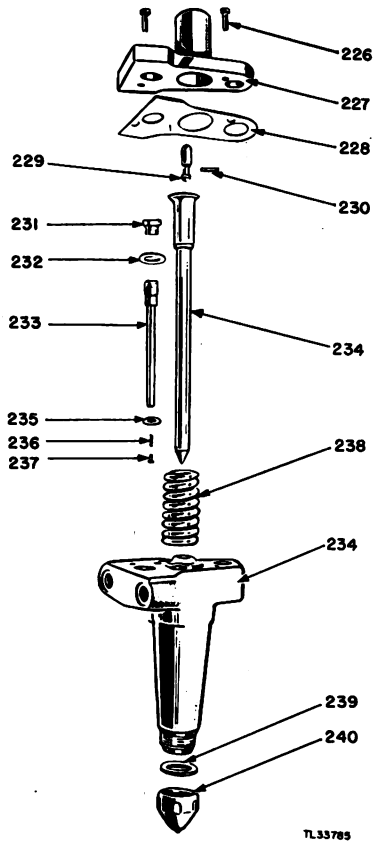


TL-33784

Figure 195. Gear case cover assembly.



TL-33785

Figure 196. Injector assembly.

Item No.	*No. of units*	*Name of part and description*
		INJECTOR ASSEMBLY (fig. 196)
	6	Assembly, injector.
234	6	Assembly, body and plunger.
229	6	Link, injector plunger.
230	6	Pin, injector plunger link.
233	6	Assembly, check valve and seat.
240	6	Assembly, injector cup (includes item 239).
239	6	Gasket, injector cup.
232	6	Gasket, check valve plug.
235	6	Gasket, check valve seat.
228	6	Gasket, top housing.
227	6	Housing, injector top.
231	6	Plug, injector check valve.
226	12	Screw, top housing.
236	6	Spring, injector check valve.
238	6	Spring, injector plunger.
237	6	Stop, injector check valve.
		Mounting parts:
	6	Guards, injector oil.
	12	Nut, ½"—13, injector stud.

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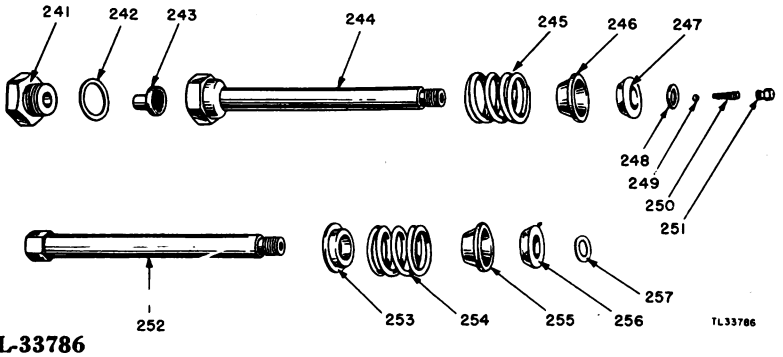

TL-33786

Figure 197. Injector fuel inlet and drain connector assemblies.

Item No.	No. of units	Name of part and description
		INJECTOR FUEL INLET AND DRAIN CONNECTOR ASSEMBLIES (fig. 197)
	6	Assembly, fuel inlet connection.
249	6	Ball, fuel connection check.
243	6	Cage and screen.
241	6	Cap, fuel connection.
244	6	Connection, fuel inlet.
242	6	Gasket, fuel cap.
248	6	Gasket, fuel connection, copper.
247	6	Gasket, fuel connection, leather.
246	6	Guide, fuel connection spring.
251	6	Plug, inlet connection.
245	6	Spring, fuel connection.
250	6	Spring, fuel check valve.
	6	Assembly, injector fuel drain.
252	6	Connection, injector fuel drain.
257	6	Gasket, injector drain connection, copper.
256	6	Gasket, injector drain connection, leather.
255	6	Guide, fuel connection spring.
253	6	Guide, fuel connection spring.
254	6	Spring, fuel connection.
		LUBRICATING PUMP ASSEMBLY (fig. 198)
	1	Assembly, lubricating pump.
178	1	Bracket and bushing.
177	1	Bushing, lubricating pump bracket.
171	1	Bearing, ball.
185	1	Body, lubricating pump.
170	1	Cage, lubricating pump bearing.
188	8	Cap screw, 5/16"—18 x 2¼", body to bracket.
186	2	Dowel, lubricating pump bracket.
181	1	Gasket, bracket to body.
176	1	Gasket, bracket to cage.
173	1	Gear, lubricating pump drive.
182	1	Gear, lubricating pump drive.
183	1	Gear, lubricating pump idler.

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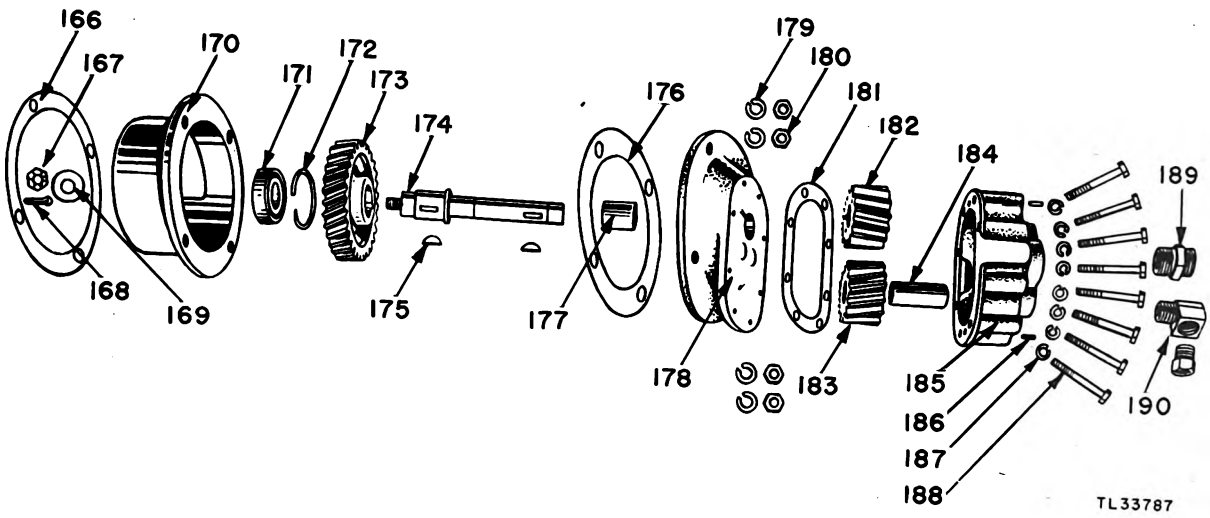

TL-33787

Figure 198. Lubricating oil pump assembly.

Item No.	*No. of units*	*Name of part and description*
		LUBRICATING PUMP ASSEMBLY (fig. 198) (Continued)
175	2	Key, lubricating pump drive gear.
187	8	Lockwasher, 5/16" positive lock.
167	1	Nut, retainer.
168	1	Pin, cotter for retainer nut.
172	1	Ring, bearing retainer snap.
174	1	Shaft, lubricating pump drive.
184	1	Shaft, lubricating pump idler.
169	1	Washer, retainer.
		Mounting parts:
189	1	Connection, suction tube.
190	1	Elbow, tube.
166	1	Gasket, lubricating pump.
179	4	Lockwasher, 7/16" positive lock.
180	4	Nut, 7/16"—20 lubricating pump studs.

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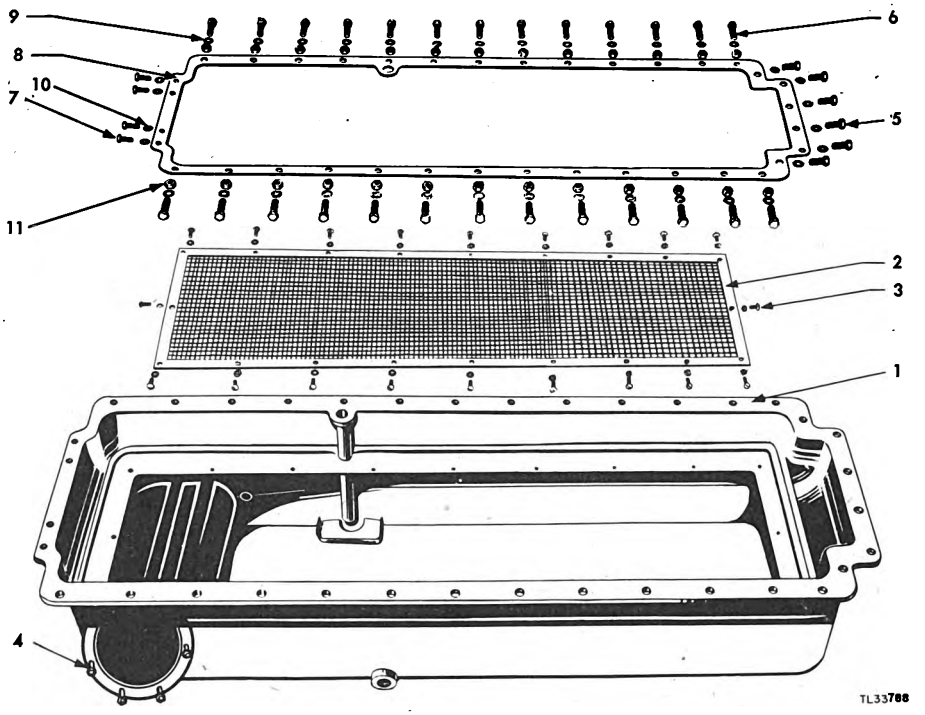

TL-33788

Figure 199. Oil pan.

Item No.	*No. of units*	*Name of part and description*
		OIL PAN (fig. 199)
	18	Lockwasher, ¼" everlock, oil pan screen.
1	1	Pan, oil bare.
2	1	Screen, oil pan.
3	18	Screw, oil pan (Parker Kalan).
4	6	Stud, filter cover.
		Mounting parts:
	1	Bushing, 1 x ½" pipe, lubricating oil temperature gauge.
5	4	Cap screw, 7/16"—14 x 1¼", pan to gear cover.
	3	Cap screw, 7/16"—14 x 1¼", pan to block.
6	27	Cap screw, 7/16"—20 x 1¾", pan to rear cover.
7	4	Cap screw, 5/16"—24 x 1", pan to rear cover.
	2	Elbow, oil tube (filter compartment).
8	1	Gasket, pan to block.
9	34	Lockwasher, 7/16" everlock, pan to block.
10	4	Lockwasher, 5/16" everlock, pan to rear cover.
11	27	Nut, 7/16"—20, oil pan cap screw.
	1	Plug, 1" pipe, oil drain.
	1	Plug, ⅜" pipe, oil drain.
	1	Plug, ½" pipe, oil pan, front.

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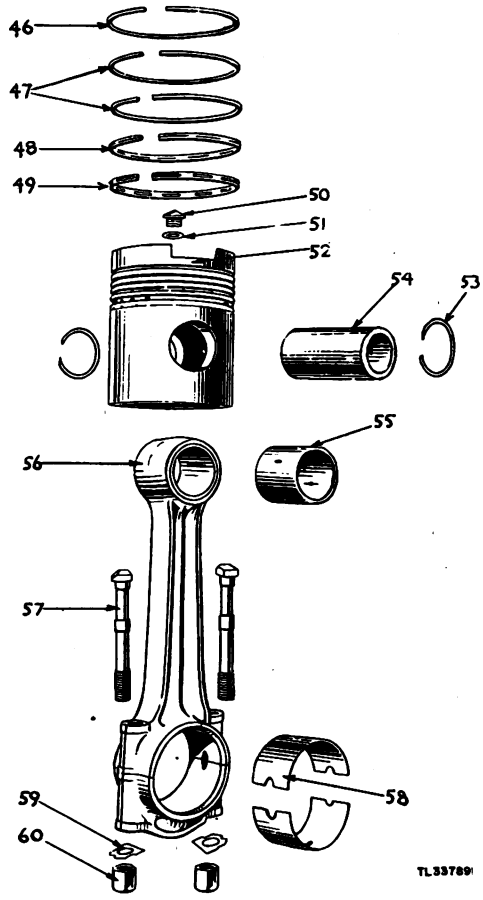

TL-33789

Figure 200. Piston and connecting rod assembly.

Item No.	*No. of units*	*Name of part and description*
		PISTON AND CONNECTING ROD ASSEMBLY (fig. 200)
	6	Assembly, piston (includes items 46-54 inclusive).
47	12	Ring, compression.
46	6	Ring, keystone.
48	6	Ring, oil regulator, narrow.
49	6	Ring, oil regulator, wide.
	6	Assembly, piston and pins (includes items 50-54 inclusive).
51	6	Lock, injector cup wiper (not sold separate with items 50 and 52).
54	6	Pin, piston.
52	6	Piston, bare.
53	12	Ring, piston pin snap.
50	6	Wiper, injector cup (not sold separate with items 51 and 52).
		Pistons and rings may be purchased in std 0.020", 0.030", and 0.040" oversize.
		Piston pins may be purchased in std 0.005" and 0.010" oversize.
56	6	Assembly, connecting rod less shell (including items 55-60).
57	12	Bolt, connecting rod.
55	6	Bushing, piston pin.
60	12	Nut, connecting rod bolt.
59	12	Plate, connecting rod lock.
58	12	Shell, connecting rod bearing.

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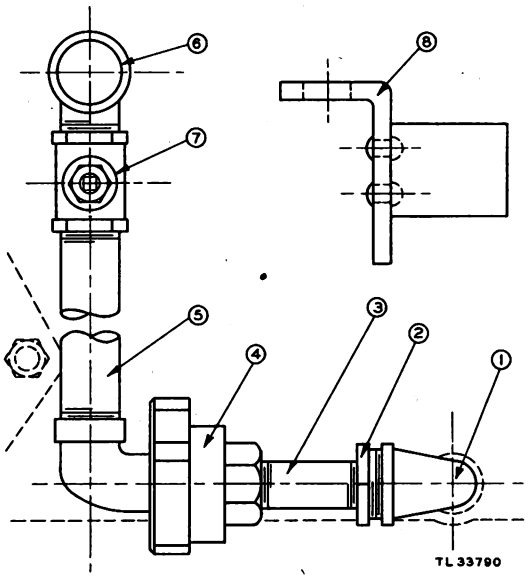
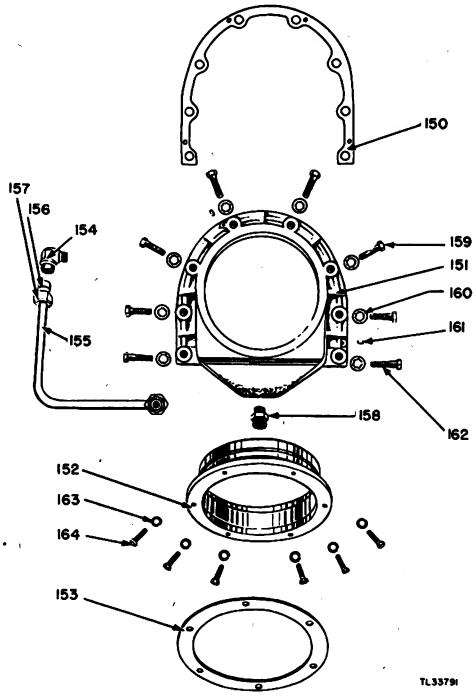


TL-33790

Figure 201. Oil pan drain assembly.



TL-33791

Figure 202. Rear cover and oil slinger assembly.

Item No.	*No. of units*	*Name of part and description*
		OIL PAN DRAIN ASSEMBLY (fig. 201)
	1	Assembly, lubricating oil drain.
1	1	Ell, street, 1" x 90°.
2	1	Bushing, reducer, 1" x ¾".
3	1	Nipple, pipe, ¾" x 2".
4	1	Joint, flexible (C1357D-4).
5	1	Nipple, pipe, ¾" x 9".
6	1	Ell, street, ¾" x 90°.
7	1	Cock, stop (C1357D-7).
8	1	Clamp, drain pipe.
		REAR COVER AND OIL SLINGER ASSEMBLY (fig. 202)
	1	Assembly, rear cover drain tube.
157	2	Nut, flexible tube.
156	2	Sleeve, rubber.
155	1	Tube, rear oil seal drain.
164	6	Cap screw, flywheel to slinger.
159	6	Cap screw, ⅜"—24 x 1¼", rear cover to block.
162	2	Cap screw, ⅜"—24 x 1½", rear cover to block.
151	1	Cover, rear.
150	As req'd	Gasket, rear cover to block 0.010".
150	As req'd	Gasket, rear to block 0.005".
153	1	Gasket, slinger to flywheel.
160	8	Lockwasher, ⅜" everlock, cover to block.
163	6	Lockwasher, 5/16" positive lock, slinger to flywheel.
152	1	Slinger, rear oil.
158	1	Union, rear oil seal tube.
161	2	Dowel, pin for cover.
154	1	Elbow, oil sling drain tube.

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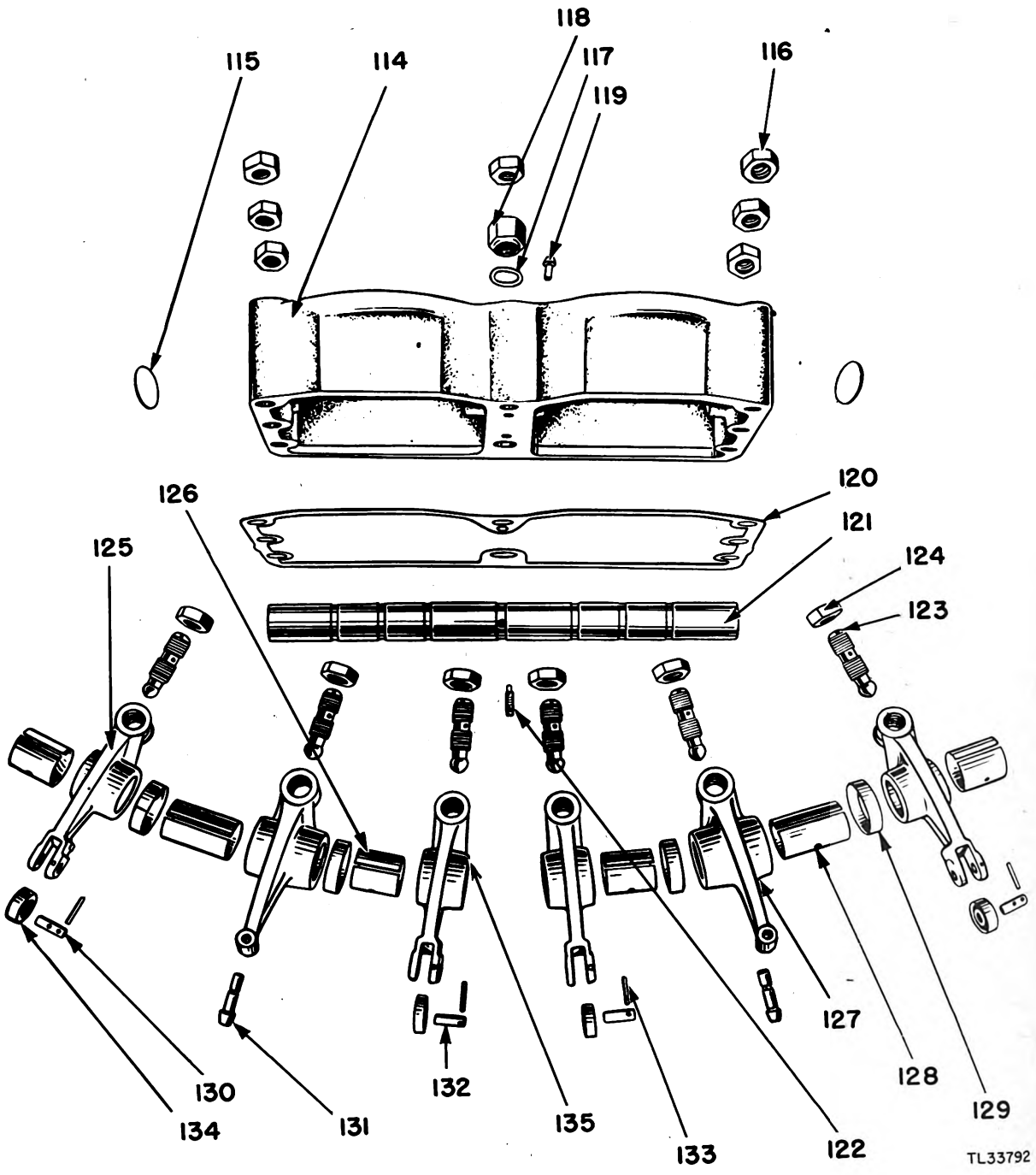

TL-33792

Figure 203. Rocker lever housing assembly.

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Item No.	No. of units	Name of part and description
		ROCKER LEVER HOUSING ASSEMBLY (fig. 203)
	3	Assembly, rocker lever housing.
129	12	Circlip, rocker lever.
114	3	Housing, rocker lever.
115	6	Plug, 1¼" expansion, rocker lever housing.
	3	Plug, ⅛" pipe, rocker housing.
119	3	Plug, rocker housing vent.
122	3	Screw, rocker shaft plug.
121	3	Shaft, rocker lever.
	6	Assembly, exhaust rocker lever (including items 123-126, 130, 133, 134).
125	6	Lever and bushing, exhaust.
126	6	Bushing, valve rocker lever.
124	6	Nut, ⅝"—18, rocker lever adjusting screw.
130	6	Pin, exhaust rocker lever roller.
133	6	Rivet, exhaust rocker lever roller pin.
134	6	Roller, rocker lever.
123	6	Screw, rocker lever adjusting.
	6	Assembly, injector rocker lever (including items 123, 124, 127, 128, 131).
127	6	Lever and bushing, injector.
128	6	Bushing, injector rocker lever.
124	6	Nut, ⅝"—18, rocker lever adjusting screw.
123	6	Screw, rocker lever adjusting.
131	6	Socket, injector rocker lever.
	6	Assembly, intake rocker lever (including items 123-126, 132-134).
135	6	Lever and bushing, intake.
126	6	Bushing, valve rocker lever.
124	6	Nut, ⅝"—18, rocker lever adjusting screw.
132	6	Pin, intake rocker lever roller.
133	6	Rivet, rocker lever roller pin.
134	6	Roller, rocker lever.
123	6	Screw, rocker lever adjusting.
		Mounting parts:
118	3	Cap, lubricating pipe.
117	3	Gasket, lubricating pipe cap.
120	3	Gasket, rocker housing to cylinder head.
116	21	Nut, ½"—13, rocker housing stud.
		ROCKER ARM HOUSING COVERS
	3	Cover, rocker housing.
	3	Gasket, rocker housing cover.
		Mounting parts:
	9	Cap screw, for rocker arm cover.
	9	Lockwasher, for rocker cover.

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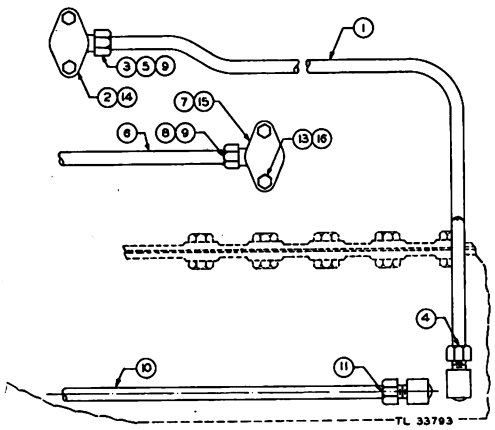
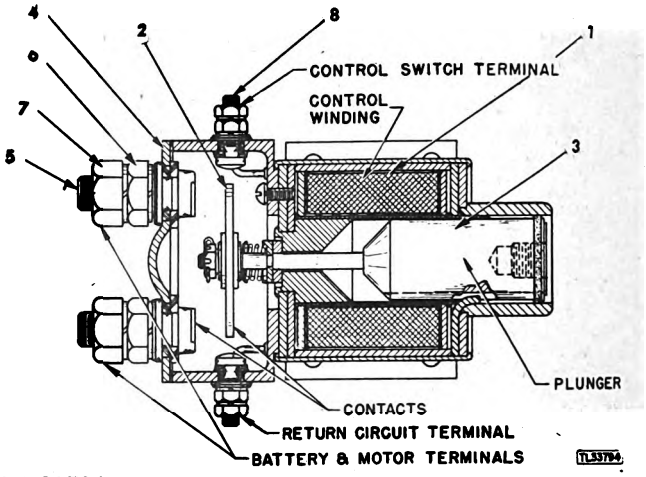


TL-33793

Figure 204. Lubricating oil tubing.



TL-33794

Figure 205. Starting motor solenoid.

Item No.	*No. of units*	*Name of part and description*
		TUBING, LUBRICATING OIL (fig. 204)
1	1	Tube, filter to engine block.
2	1	Flange, lubricating oil discharge tube.
3	1	Nut, packing.
4	1	Nut, tube.
5	1	Sleeve, tube packing.
6	1	Tube, lubricating oil suction.
7	1	Flange, lubricating oil suction tube.
8	2	Nut, packing.
9	2	Sleeve, tube packing.
10	1	Tube, pump to filter.
11	2	Nut, tube.
		Mounting parts:
13	4	Cap screw, ⅜"—24 x 2", lubricating tube flange.
14	1	Gasket, lubricating flange.
15	1	Gasket, suction tube flange.
16	4	Lockwasher, ⅜" positive lock, lubricating tube flange.
		SOLENOID, STARTING MOTOR (fig. 205)
	1	Solenoid switch (25-32 volt).
1	1	Case and coil assembly.
2	1	Contact disk on push rod.
3	1	Terminal and plate assembly.
4	2	Terminal stud, ½"—13.
5	1	Terminal stud insulated strip, inside.
6	2	Terminal stud nut, ½"—13 x 5/16" thick.
7	2	Terminal stud nut, ½"—13 x 7/16" thick.
8	2	Terminal stud, ¼"—20, square shoulder.
		STARTING MOTOR (fig. 206)
	1	Motor, starting.
1	1	Armature.
2	1	Coil, field, left-hand.
3	1	Coil, field, lower.

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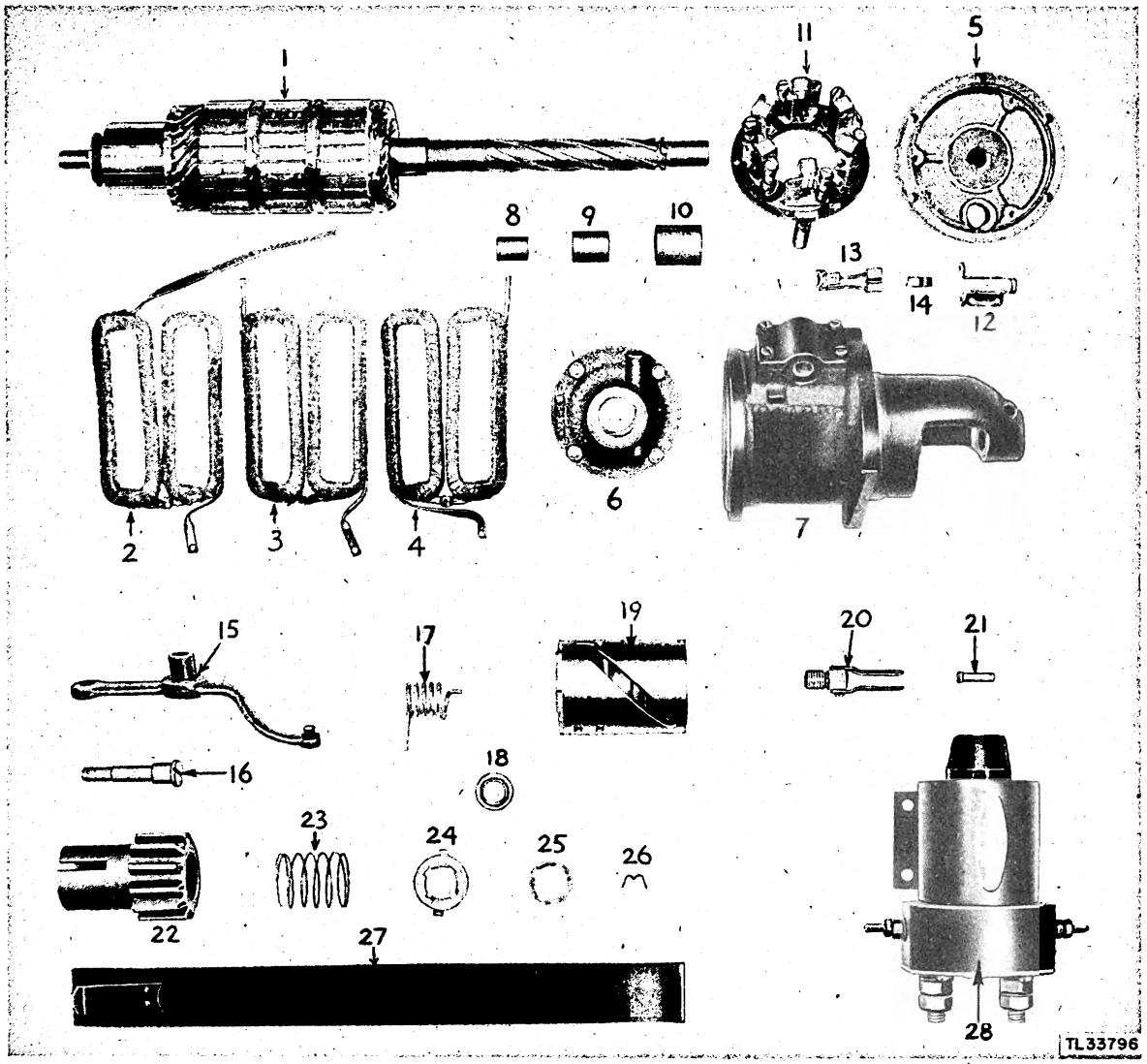

TL-33796

Figure 206. Starting motor.

Item No.	*No. of units*	*Name of part and description*
		STARTING MOTOR (fig. 206) (Continued)
4	1	Coil, field, right-hand.
5	1	End, commutator frame.
6	1	Bearing, center.
7	1	Housing, motor drive.
8	1	Bushing.
9	1	Bushing, drive housing.
10	1	Bushing, center bearing.
11	1	Assembly brush plate, less brushes.
12	1	Holder, brush.
13	12	Brush.
14	12	Spring, brush.
15	1	Lever, shift.

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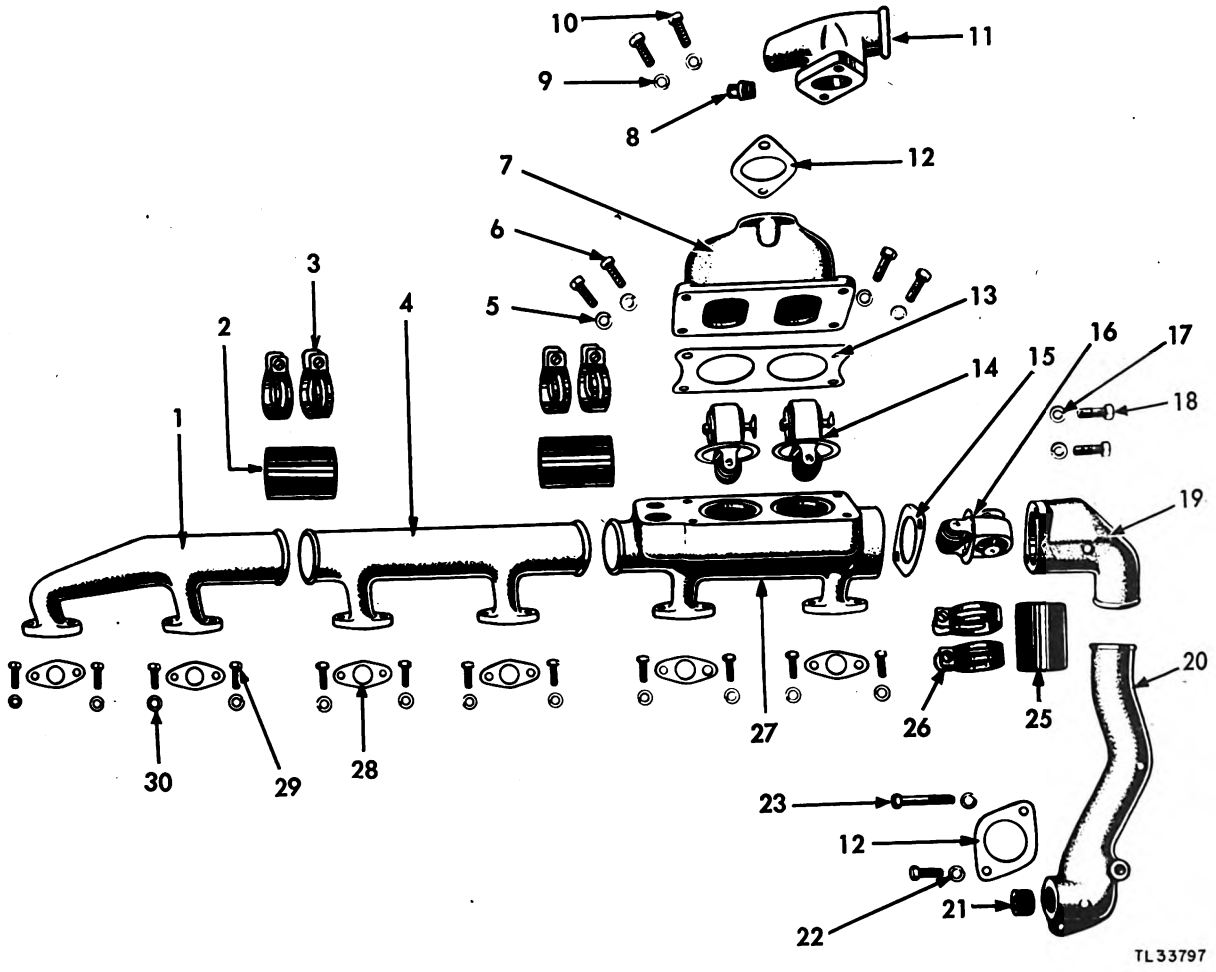
Item No.	*No. of units*	*Name of part and description*
		STARTING MOTOR (fig. 206) (Continued)
17	1	Spring, shift lever return.
19	1	Sleeve, shift.
20	1	Link, shift lever, and adjusting screw.
21	1	Pin, shift lever.
22	1	Pinion, drive.
23	1	Spring, pinion meshing.
24	1	Guide, pinion.
25	1	Collar, pinion stop.
26	1	Lockwire, pinion stop.
27	1	Band, commutator cover.
28	1	Solenoid.



TL-33797

Figure 207. Water manifold assembly.

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Item No.	No. of units	Name of part and description
		WATER MANIFOLD ASSEMBLY (fig. 207)
18	2	Cap screw, 3/8"—16 x 1", bypass connection.
23	1	Cap screw, 3/8"—16 x 2", bypass pipe.
22	1	Cap screw, 3/8"—16 x 1", bypass pipe.
6	4	Cap screw, 3/8"—16 x 1", thermostat housing.
10	2	Cap screw, 3/8"—16 x 1", water outlet connection.
26	2	Clamps, bypass hose.
3	4	Clamps, manifold hose.
19	1	Connection, water bypass.
11	1	Connection, water outlet.
15	1	Gasket, water bypass connection.
12	2	Gasket, water connection.
28	6	Gasket, water manifold to head.
13	1	Gasket, thermostat housing.
25	1	Hose, water bypass.
2	2	Hose, water manifold.
7	1	Housing, thermostat.
17	2	Lockwasher, 3/8" positive lock, bypass connection.
22	2	Lockwasher, 3/8" positive lock, bypass pipe.
9	2	Lockwasher, 3/8" positive lock, outlet connection.
5	4	Lockwasher, thermostat housing.
20	1	Pipe, bypass.
21	1	Plug, 3/4" pipe, bypass pipe.
8	1	Plug, 1/2" pipe, water outlet connection.
4	1	Section, water manifold center.
27	1	Section, water manifold front.
1	1	Section, water manifold rear.
16	1	Thermostat, bypass.
14	2	Thermostat, main.
		Mounting parts:
29	12	Cap screw, 5/16"—24 x 7/8", manifold to head.
28	6	Gasket, manifold to head.
30	12	Lockwasher, 5/16" positive lock, manifold to head.
		WATER PUMP ASSEMBLY (fig. 208)
	1	Pump, water.
201	1	Bearing, inner.
203	1	Bearing, outer.
198	1	Body.
204	1	Gasket, oil.
194	1	Guide, spring.
191	1	Impeller.
209	1	Key, impeller.
212	1	Key, pulley No. 8 Woodruff.
208	1	Lockwire.
214	1	Nut, slotted.
215	1	Pin, cotter.
199	3	Plug, oil, 1/8" std pipe, slotted head.
216	1	Pulley, water pump driven.
207	1	Retainer, cork.
200	1	Retainer, split ring.
193	1	Ring, seal clamp.
210	2	Ring, split.
195	1	Seal, flexible.

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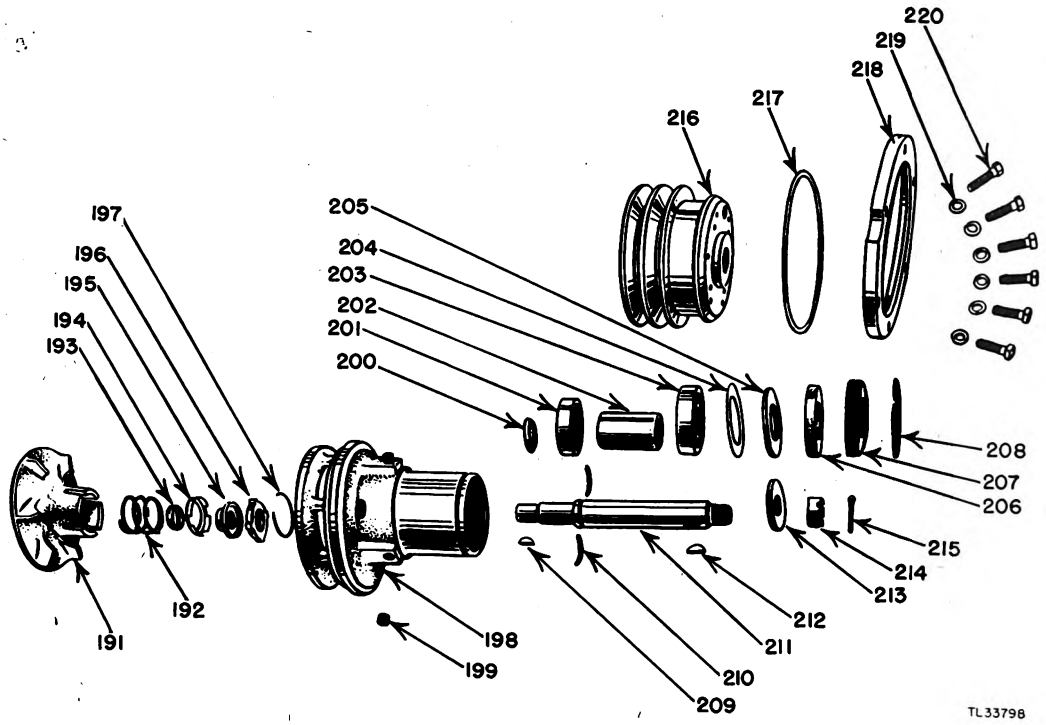

TL-33798

Figure 208. Water pump assembly.

Item No.	*No. of units*	*Name of part and description*
		WATER PUMP ASSEMBLY (fig. 208) (continued)
211	1	Shaft.
197	1	Snap wire.
202	1	Spacer, bearing.
192	1	Spring.
196	1	Washer, carbon.
213	1	Washer, clamp.
206	1	Washer, cork.
205	1	Washer cork retainer.
		Mounting parts:
220	6	Cap screw, ⅜"—24 x 1¼", water pump to block.
217	1	Gasket, water pump to block.
218	1	Ring water pump clamp.
219	6	Lockwasher, ⅜" positive lock pump to block.
		WATER PUMP DRIVE PULLEY AND BELTS
	1	Pulley, water pump drive.
	2	Belts, water pump and fan drive.
	1	Lockwasher, water pump drive pulley.
	1	Nut, ¾"—16, water pump drive pulley.
		FAN
	1	Fan.
	6	Cap screw, 5/16"—18 x ⅞", fan to water pump.
	6	Lockwasher, 5/16" positive lock, fan to water pump.

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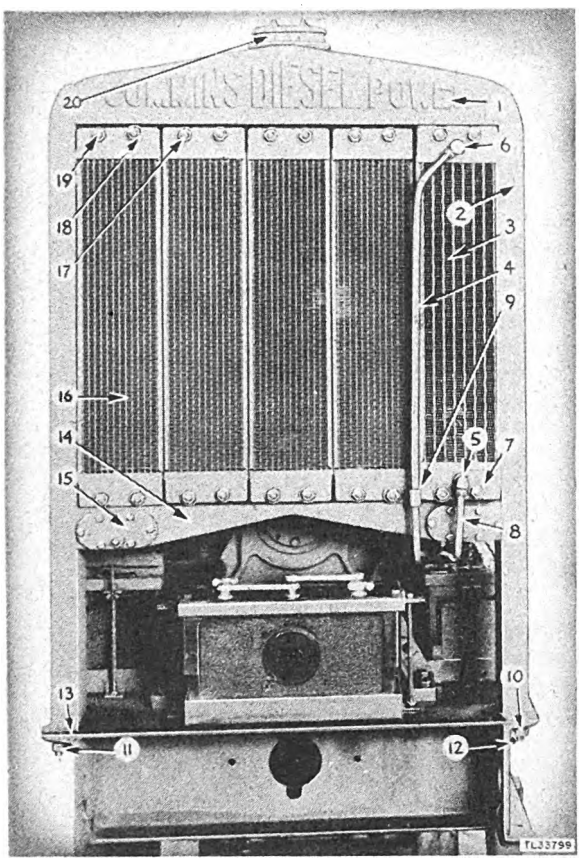
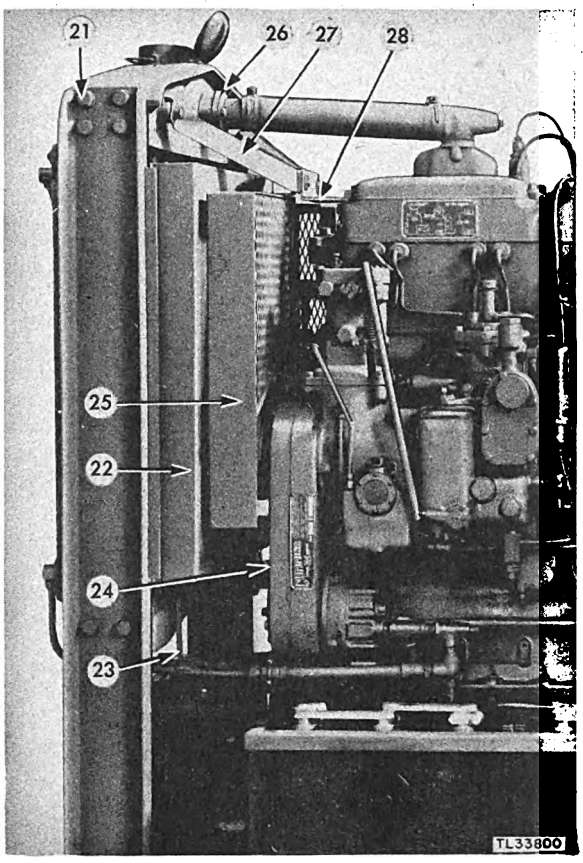


TL-33799

Figure 209. Radiator assembly.



TL-33800

Figure 210. Radiator accessories.

Item No.	*No. of units*	*Name of part and description*
		RADIATOR ASSEMBLY (fig. 209)
	1	Assembly, PERFEX R-1983-C modified.
1	1	Tank, top.
2	2	Support, radiator.
3	1	Section, oil cooler radiator.
4	1	Tubing, lubricating oil, to radiator.
5	2	Bushing, brass, ½" x ⅜".
6	2	Connection, tubing, inverted male ell.
7	4	Bolt, oil section square head.
8	1	Tubing, lubricating oil, from radiator.
9	1	Clamp, oil tube (includes clamp bolt and rubber grommet).
10	4	Washer, beveled, radiator support mounting.
11	4	Nut, radiator support mounting, ⅝" USS.
12	4	Cap screw, radiator support mounting ⅝" x 2½" USS.
	4	Lockwasher, radiator support mounting, ⅝".
13	2	Pad, radiator stand mounting.
14	1	Tank, bottom.
15	2	Plate, bottom cover.
	2	Gasket, bottom cover plate.
	12	Cap screws, bottom cover plate.

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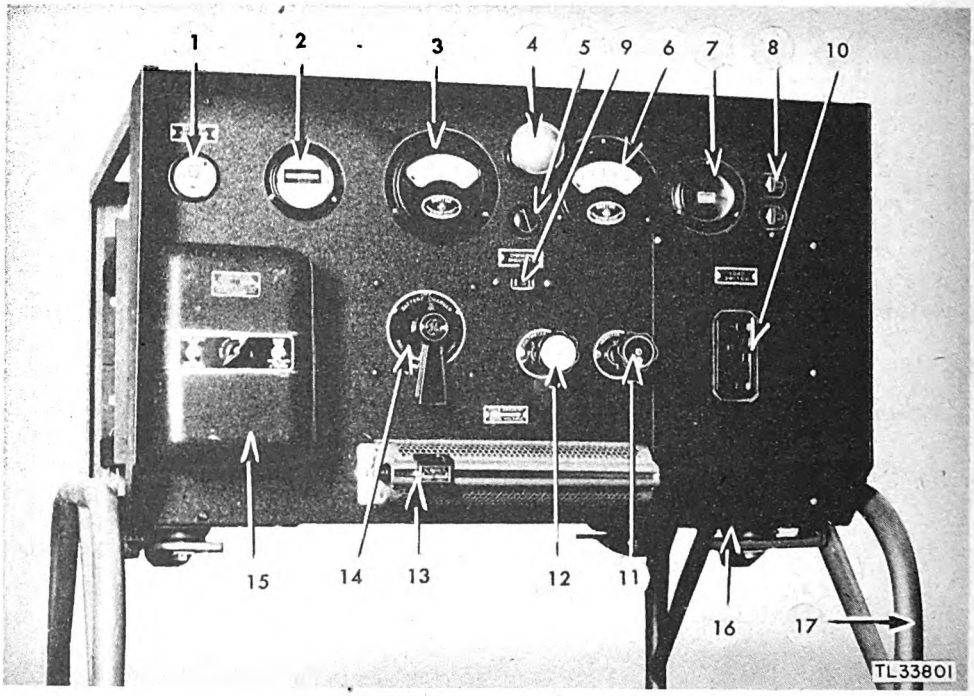
Item No.	*No. of units*	*Name of part and description*
		RADIATOR ASSEMBLY (fig. 209) (Continued)
16	4	Section, water cooler radiator.
17	20	Washer, core section.
18	20	Nut, core section.
19	16	Bolt, square head, water section.
20	1	Assembly, radiator cap.
21	12	Cap screw, support to tanks, ⅝" x 1", USS.
22	1	Shroud, fan (PERFEX FR-1983-C).
		RADIATOR ACCESSORIES (fig. 210)
23	1	Hanger, lubricating oil tube.
24	1	Connection, lower radiator water.
25	1	Guard, fan, right side.
26	1	Connection, upper radiator, water.
27	1	Brace, radiator.
28	1	Bracket, radiator brace.



TL-33801

Figure 211. Switch cabinet instruments.

Item No.	*No. of units*	*Name of part and description*
		SWITCH CABINET INSTRUMENTS (fig. 211)
1	1	Ammeter, battery-charging dc (0-6 amps).
2	1	Meter, reed type, flush mounted frequency (Frahm 58-62 cycles).
3	1	Voltmeter, flush mounted 4¼" diameter ac (0-150v with resistor).
	1	Socket, panel bulb.
4	1	Bulb, silver bowl panel (120-v).
5	1	Rheostat, bulb dimming.
6	1	Ammeter, flush mounted ac (0-150 amp).

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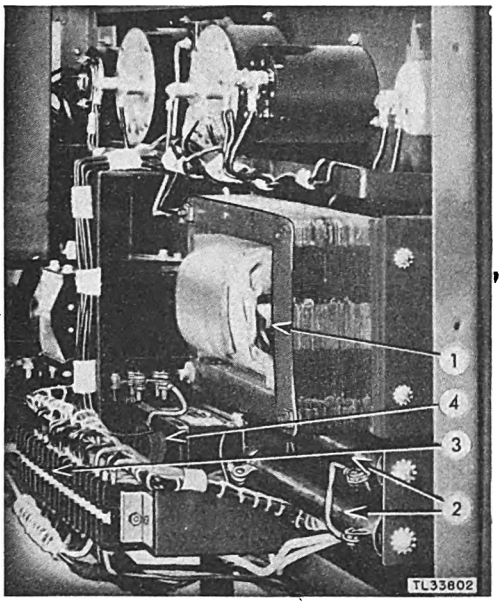
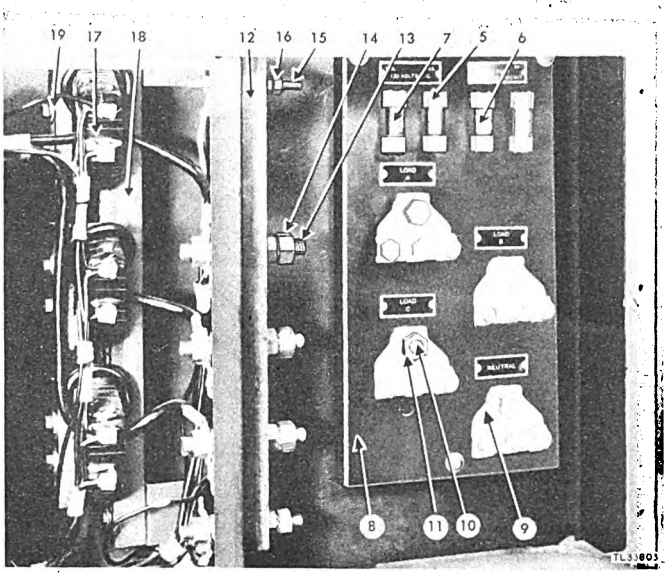
Item No.	No. of units	Name of part and description
		SWITCH CABINET INSTRUMENTS (fig. 211) (Continued)
7	1	Meter, elapsed time (120v 60 cycles).
8	1	Outlet, duplex.
9	1	Switch, toggle.
10	1	Breaker, air circuit (3 pole 100 amp, 250 v) front connected, thermal overload trip.
11	1	Switch, ammeter transfer.
12	1	Switch, voltmeter transfer.
13	1	Rheostat, slide type exciter field (750 ohms 2-9 amp).
14	1	Switch, rectifier, 14 point dial.
15	1	Regulator, voltage (see breakdown list).
16	4	Dampers, vibration.
	1	Plate, adapter.
17	1	Assembly, switch cabinet support.



TL-33802

Figure 212A. Switch cabinet parts.



TL-33803

Figure 212B. Switch cabinet parts.

Item No.	No. of units	Name of part and description
		SWITCH CABINET PARTS (figs. 212A and B)
1	1	Transformer, rectifier potential.
2	2	Resistor, voltage regulator (see breakdown parts list regulator).
3	1	Block, 17-point terminal.
4	1	Resistor, voltmeter (order with voltmeter).
5	8	Clip, fuse (30-amp).
6	2	Fuse, renewable link (6-amp, 250-volt).
7	2	Fuse, renewable link (8-amp, 250-volt).
8	2	Fuse, renewable link (10-amp, 250-volt).
9	1	Block, load terminal mounting.
10	4	Lug, load terminal.
11	4	Stud, load terminal, ½" x 4" USS brass.
12	16	Nut, load terminal, ½" USS brass.
13	1	Block, generator terminal.
14	4	Stud, generator terminal, ½" x 4" USS brass.
15	16	Nut, generator terminal, ½" USS brass.

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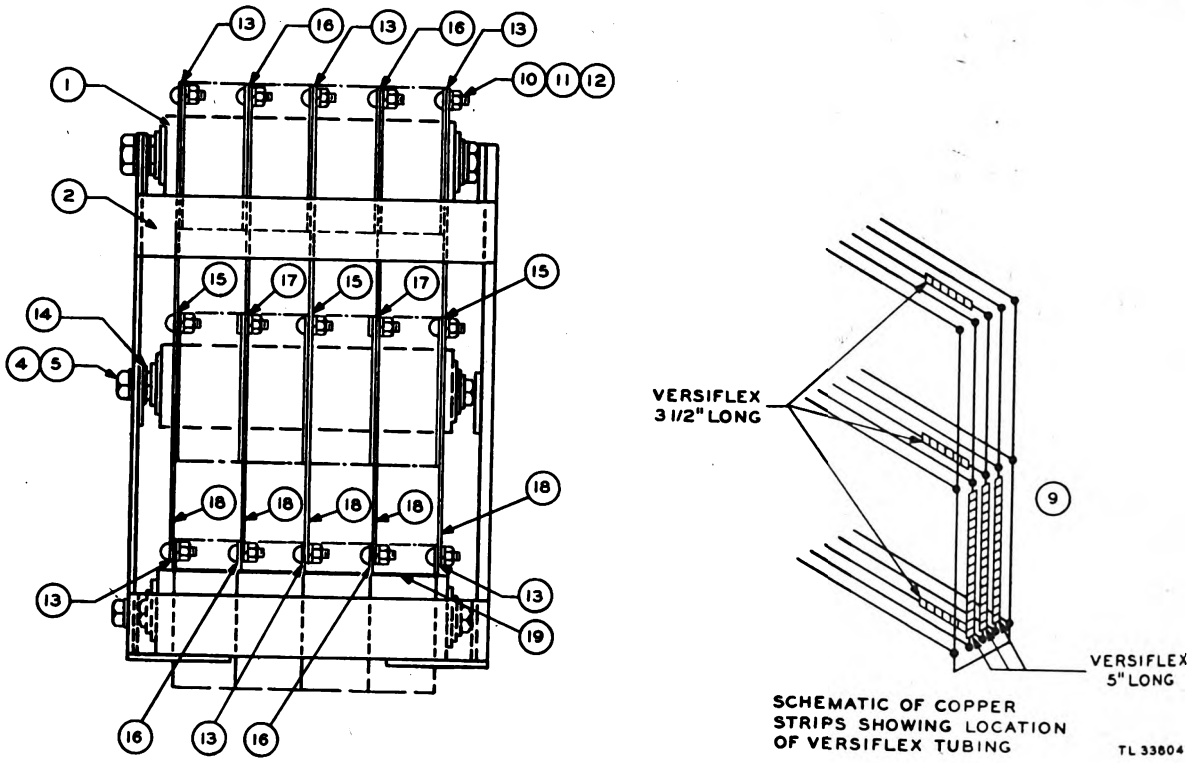

TL-33804

Figure 213. Rectifier, battery charging.

Item No.	*No. of units*	*Name of part and description*
		SWITCH CABINET PARTS (figs. 212A and B) (Continued)
16	4	Stud, generator terminal, ¼" x 3½" USS brass.
17	16	Nut, generator terminal, ¼" USS brass.
18	3	Transformer, current, 300/5 ratio.
19	1	Block, current, transformer mounting.
	3	Clamp, transformer mounting block.
		RECTIFIER, BATTERY CHARGING (fig. 213)
	1	Assembly, battery-charging rectifier.
2	1	Frame, rectifier-mounting.
	1	Frame, rectifier.
	1	Frame, rectifier-supporting.
1	12	Stack, rectifier (A-1232B-1).
4	24	Nuts, battery rectifier, ⅜" USS brass.
5	24	Lockwasher, battery rectifier (shakeproof ⅜").
14	24	Washers, battery rectifier spacer, ⅜" brass.
13	6	Strip, rectifier copper connecting (0.032" x ⅜" x 20-13/16").
15	3	Strip, rectifier copper connecting (0.032" x ⅜" x 19").
16	4	Strip, rectifier copper connecting (0.032" x ⅜" x 17⅝").
17	2	Strip, rectifier copper connecting (0.032" x ⅜" x 15-15/16").
18	5	Strip, rectifier copper connecting (0.032" x ⅜" x 11⅞").
19	1	Strip, rectifier copper connecting (0.032" x ⅜" x 8⅛").
10	13	Screws, rectifier connecting strip (No. 8-32 x ½").
13	13	Nuts, rectifier connecting strip (No. 8-32).
12	13	Lockwasher, rectifier connecting strip (No. 10).
	4	Cap screw, mounting frame, 5/16" x ⅝" USS.
	4	Lockwasher, mounting frame, 5/16".
9	6	Tubing, versiflex, ⅜" ID x 25½".

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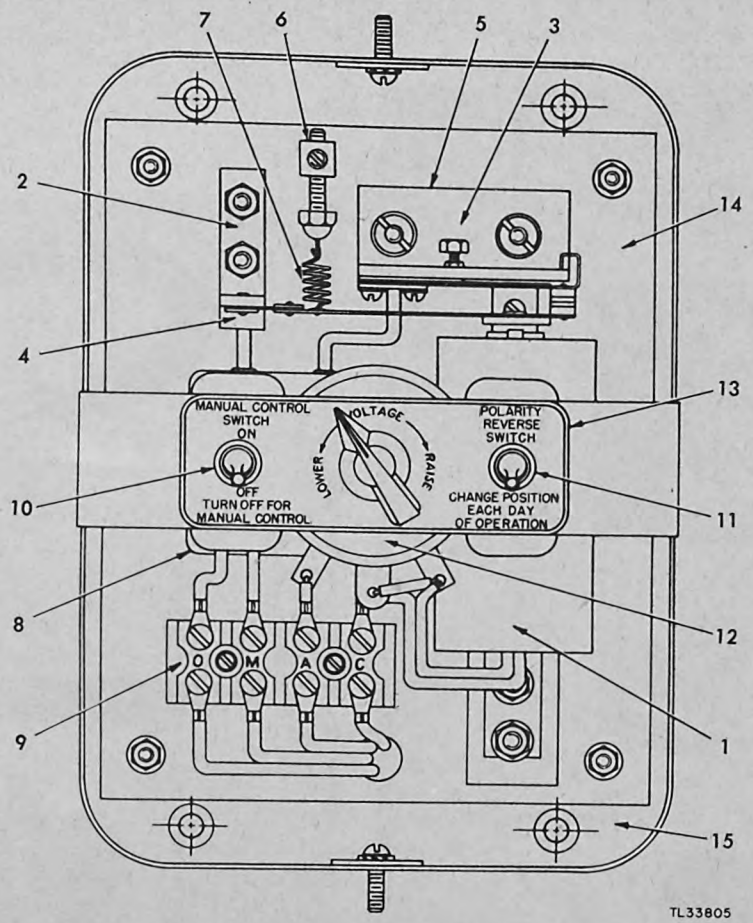

TL-33805

Figure 214. Voltage regulator.

Item No.	*No. of units*	*Name of part and description*
		VOLTAGE REGULATOR (fig. 214)
	1	Regulator, voltage.
1	1	Potential coil assembly, consisting of coil, lamination stack, bumper, coil bracket, coil spacer and screws, nuts, and washers required for mounting assembly.
2	1	Vibrator assembly, with lower contact.
3	1	Upper contact bracket assembly, consisting of upper leaf contact, spring back, contact washer, contact spacer, tension adjustment, angle bracket, and leaf contact screws.
4	1	Vibrator spacer, complete with mounting screws.
5	1	Angle bracket spacer, complete with mounting screws.
6	1	Voltage adjustment screw assembly, consisting of post, mounting screw, adjustment screw, setscrew, and slug.
7	1	Voltage adjustment spring.
8	1	Filter assembly, with leads and mounting screws.
9	1	Terminal block assembly, with mounting screws.
10	1	Regulator control switch assembly, with leads.
11	1	Polarity reverse switch assembly, with leads.
12	1	Voltage adjustment rheostat, with knob.
13	1	Control plate.
14	1	Ebony panel, with mounting screws.
15	1	Regulator case.

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Item No.	No. of units	Name of part and description
		EXCITER BALL BEARING (fig. 217)
61	1	Assembly complete (includes grease fitting).
73	1	Bearing housing.
74	2	Setscrew, 5/16" USS.
75	1	Closed end cap.
76	1	Grease fitting.
77	1	Ball bearing.
79	1	Clamp plate.
80	1	Cap screw, ⅜" x ¾" USS.
81	1	Lockwasher, ⅜".
137	1	Oil seal.
		EXCITER MAIN POLE (fig. 217)
54	2	Main pole assembly, complete.
51	2	Pole coil.
48	4	Pole piece cap screw.
49	4	Star washers, ⅜".
47	2	Pole shim.
136	2	Main pole.
		EXCITER BRACKET (fig. 217)
62	1	Exciter bracket.
139	4	Cap screw, ⅜" x 1¼" USS.
140	4	Flatwasher, ⅜".
141	4	Cap screw, ⅜" x 1" USS.
100	8	Star washer, ⅜".
		EXCITER INTERPOLE (fig. 217)
135	1	Assembly, complete.
		EXCITER BRUSH HOLDER STUD (fig. 217)
64	2	Insulator plug.
65	2	Insulator bushing.
66	4	Insulator washer.
67	2	Insulator bushing.
68	2	Stud washer, special.
69	2	Brush holder stud, special.
70	2	Expansion plug.
71	2	Jam nut, ¾" USS brass.
72	2	Star washer, ¾" brass.
		EXCITER HAND HOLE COVERS (fig. 217)
3	2	Cap screw, ¼" x ½" USS.
4	4	Star washer, ¼".
52	1	Hand hole cover, solid.
82	2	Hand hole cover, ventilated.
53	3	Gasket.
78	1	Radio interference suppression shield.
		EXCITER BRUSH HOLDER AND BRUSH (fig. 217)
56	2	Brush holder body.
57	2	Brush holder spring.
58	2	Brush holder arm.
59	2	Brush.
161	2	Condenser.
162	2	Machine screw No. 20—1¼" SAE.
165	4	Star washer No. 10.
158	2	Nut, No. 10.
163	6	Star washer No. 10.

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Item No.	*No. of units*	*Name of part and description*
		EXCITER ARMATURE ASSEMBLY (fig. 217)
55	1	Assembly, complete.
		EXCITER FRAME ASSEMBLY (fig. 217)
45	1	Assembly, complete.
46	1	Frame.
		ALTERNATOR BALL BEARING CARTRIDGE UNIT (fig. 217)
60	1	Assembly, complete.
30	1	Bearing housing.
31	2	Setscrew, 5/16" x 7/16" USS.
97	1	Locknut, special.
98	1	Lockwasher, special.
99	1	Ball bearing.
152	1	Oil seal.
153	1	Oil seal.
		ALTERNATOR COLLECTOR RING ASSEMBLY (fig. 217)
120	1	Assembly, complete.
106	2	Slip ring.
107	6	Insulator.
108	1	Sleeve.
109	1	Bushing.
110	1	Stud, special.
111	1	Stud, special.
112	1	Insulator sleeve.
113	4	Jam nut, ¼" USS.
114	2	Star washer, ¼".
		ALTERNATOR BRUSH HOLDER ASSEMBLY (fig. 217)
144	1	Assembly, complete.
115	1	Brush holder support.
116	2	Washer, bakelite.
117	3	Stud, special.
118	3	Nut, 5/16".
119	3	Star washer, 5/16".
42	6	Nut, ½".
121	3	Lockwasher, ½".
122	4	Brush holder.
134	4	Brush (110-4 superseded).
124	6	Round head machine screw No. 10-1½" USS.
125	6	Nut, ⅝".
126	6	Star washer, ⅝".
		ALTERNATOR BRACKET (fig. 217)
22	1	Alternator bracket.
23	6	Cap screw, ½" x 2".
24	8	Star washer, ½".
143	1	Cap screw, ½" x 1⅝".
25	2	Bushing.
40	4	End bell stud, special.

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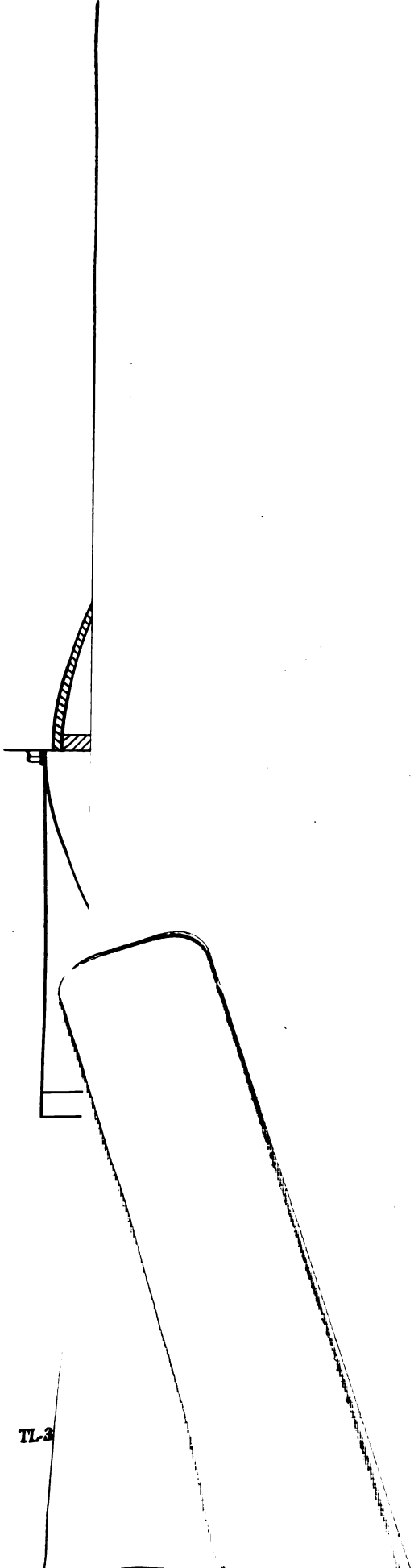

TL-3

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Item No.	*No. of units*	*Name of part and description*
		RADIO INTERFERENCE SUPPRESSION (fig. 217) (Exciter Shaft)
27	1	Brush holder assembly.
28	2	Grounding brush.
		RADIO INTERFERENCE SUPPRESSION SHIELD (fig. 217)
155	1	Shield.
157	2	Lockwasher, 5/8".
158	2	Nut No. 10 SAE.
160	2	Cap screw, 1/4" x 5/8" USS.
4	2	Star washer, 1/4".
		RADIO INTERFERENCE SUPPRESSION (fig. 217) (Alternator Shaft)
171	1	Bracket.
139	4	Cap screw, 3/8" x 1 1/4" USS.
173	2	Nut, 3/8" USS.
175	2	Braided strap.
100	2	Star washer, 3/8".
176	2	Cap screw, 5/16" x 1" USS.
177	2	Nut, 5/16" USS.
178	2	Flatwasher, 5/16".
179	2	Star washer, 5/16".
180	2	Grounding brush.
		ALTERNATOR BEARING GREASE FITTING (fig. 217)
32	1	Open end cap.
33	1	Pipe plug, 1/8" IPS.
34	1	Grease fitting.
35	1	Nipple, 1/8" x 4 1/2" IPS.
36	2	Elbow, 1/8" IPS.
37	1	Nipple, 1/8" x 1 1/2" IPS.
		ALTERNATOR STATOR (fig. 217)
44	1	Assembly, complete (including frame).
		ALTERNATOR ROTOR (fig. 217)
7	1	Assembly, complete.
6	1	Revolving field assembly.
		PARTS NOT LISTED IN ASSEMBLIES (fig. 217)
2	1	Fan guard, upper and lower (235).
8	2	Damper winding ring.
16	1	Support angle.
21	1	Eyelolt.
26	1	Greenfield connector.
38	5	Shaft coupling stud.
43	1	Alternator bracket cover.
63	1	Exciter bracket cover.
138	4	Bushing.
145	1	Fan.

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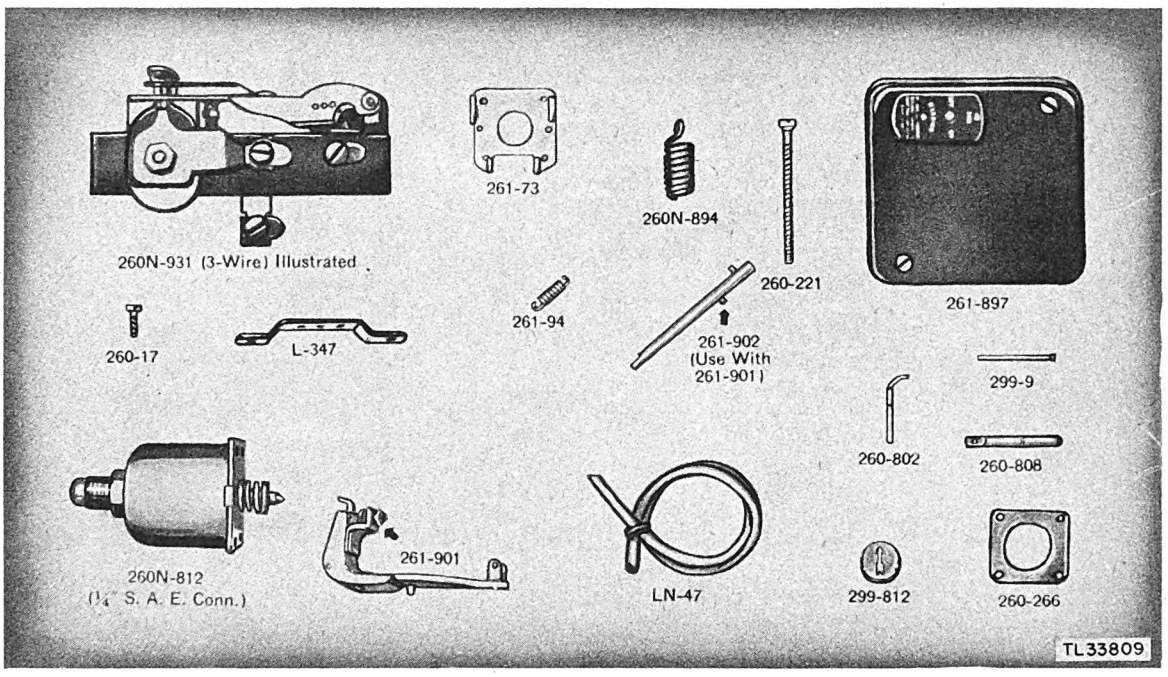

TL-33809

Figure 218. Switch, oil pressure alarm.

No. of units	*Name of part and description*
	SWITCH OIL PRESSURE ALARM (fig. 218)
	Assembly, switch.
1	Screw, connector rod pivot.
1	Screw, adjusting.
1	Gasket, bellows.
1	Hook, connector rod.
1	Ring, bakelite connector rod and sealing.
1	Bellows, pressure, ¼" SAE.
1	Spring, main.
1	Block, complete contact (3-wire).
1	Bracket, main arm.
1	Spring, manual knob return.
1	Assembly, cover and rubber molding.
1	Assembly, main arm.
1	Pins, manual knob and shaft.
1	Pin, main arm pivot.
1	Screw, manual knob and set.
2	Foot, mounting.
1	Molding, cover, rubber.

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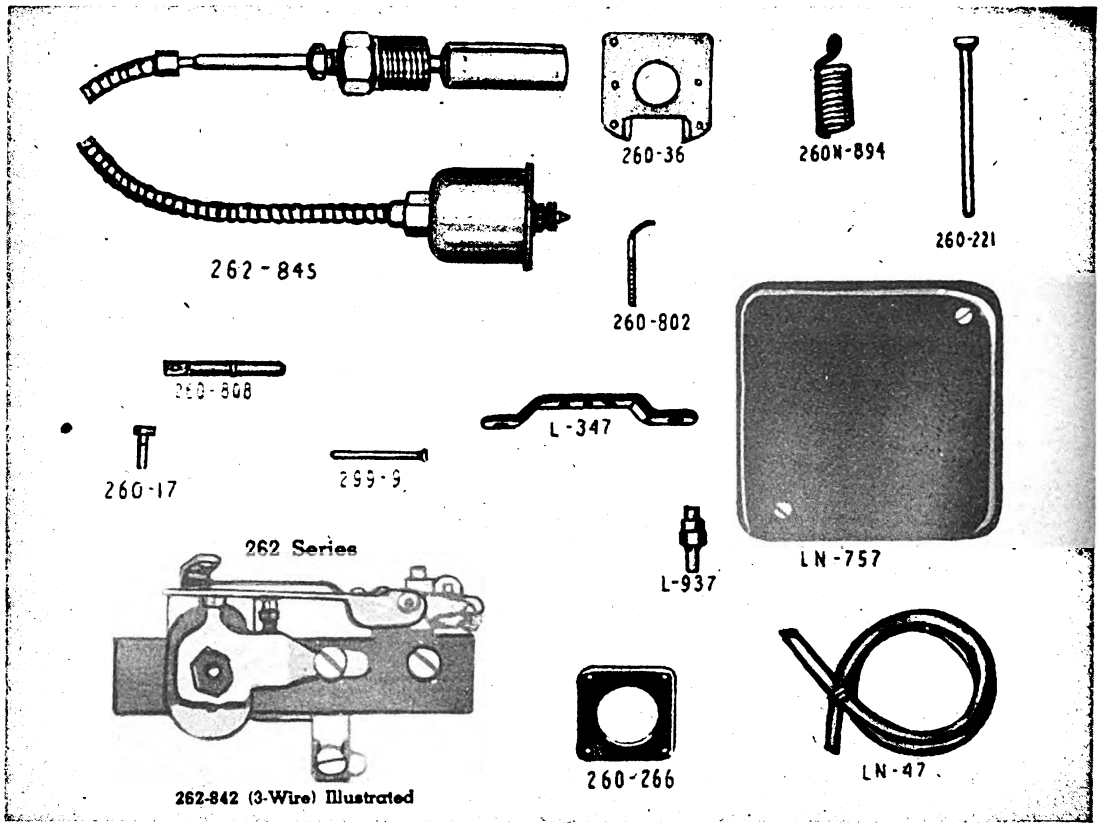

TL-33810

Figure 219. Switch, temperature alarm.

No. of units	*Name of part and description*
	SWITCH, TEMPERATURE ALARM (fig. 219)
	Assembly, switch.
1	Screw, connector rod pivot.
1	Bracket, main arm.
1	Hook, connector rod.
1	Screw, adjusting.
1	Gasket, bellows.
1	Ring, connector rod and sealing.
1	Assembly, main arm.
1	Spring, main.
1	Assembly, complete contact block (3-wire).
1	Element, temperature (4-ft tube).
1	Pin, main arm pivot.
2	Foot, mounting.
1	Assembly, manual reset pin.
1	Molding, cover, rubber.
1	Assembly, cover and rubber molding.

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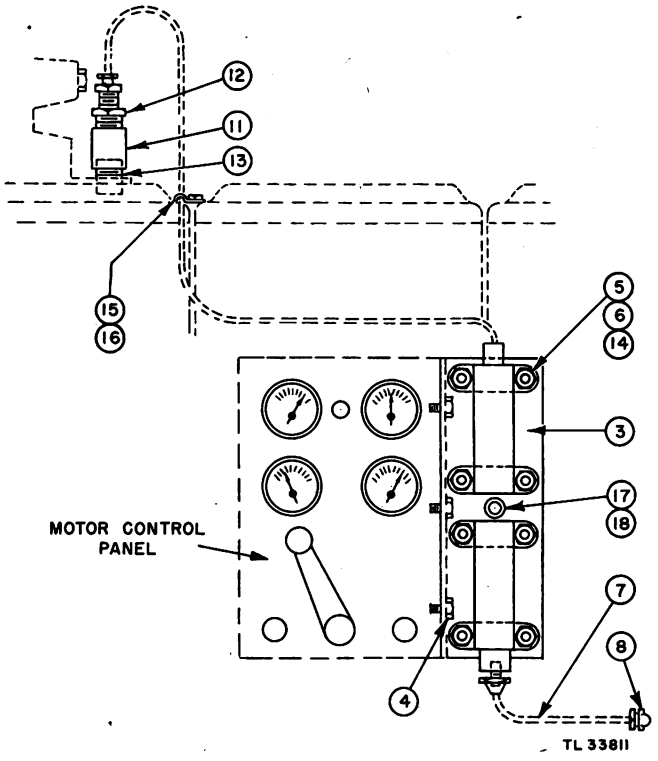
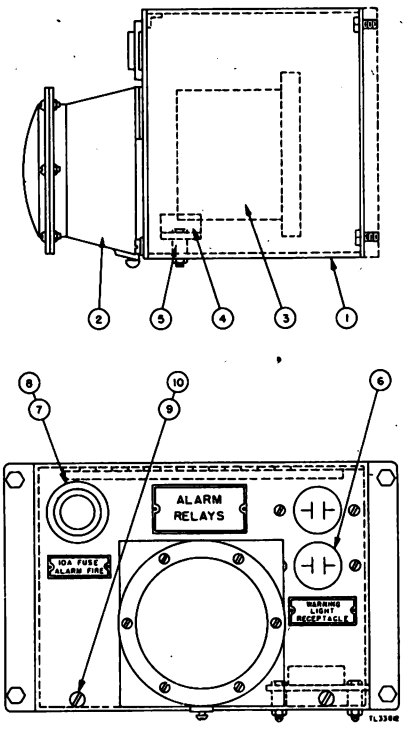


TL-33811

Figure 220. Alarm system accessories.



TL-33812

Figure 221. Alarm relay box.

Item No.	*No. of units*	*Name of part and description*
		ALARM SYSTEM ACCESSORIES (fig. 220)
3	1	Bracket, switch.
4	3	Cap screws, bracket holding, ¼" x ¾" USS.
5	8	Cap screws, switch holding, ¼" x ¾" USS.
6	11	Lockwashers, switch holding, ¼".
7	1	Tubing, oil pressure switch, ¼" OD.
8	1	Ell, inverted male (C1270M-9).
11	1	Coupling, pipe, ¾".
12	1	Bushing, pipe, ¾" x ½".
13	1	Nipple, pipe, ¾" close.
14	8	Nuts, switch holding, ¼" USS.
15	1	Clamp, temperature line.
16	1	Loom, temperature line.
17	1	Bushing, insulating.
18	1	Nut, insulating bushing.
		RELAY BOX, ALARM (fig. 221)
1	1	Box, alarm relay.
2	1	Horn, alarm 24-v, dc (X474-2).
3	1	Panel, alarm box relay.
	2	Machine screws, box panel, ¼" x ⅜" USS.
4	1	Flasher, thermostatic 50-w, 24-v, dc (X474-4).
5	2	Mounting, rubber (X474-5).
6	2	Receptacle, warning light (X474-6).
7	1	Socket, lamp (X474-7).
8	1	Fuse, plug, 10 amp.
12	2	Screws, face panel, No. 10—32 x ¼".
13	2	Washers, panel, No. 10—I.E.T.

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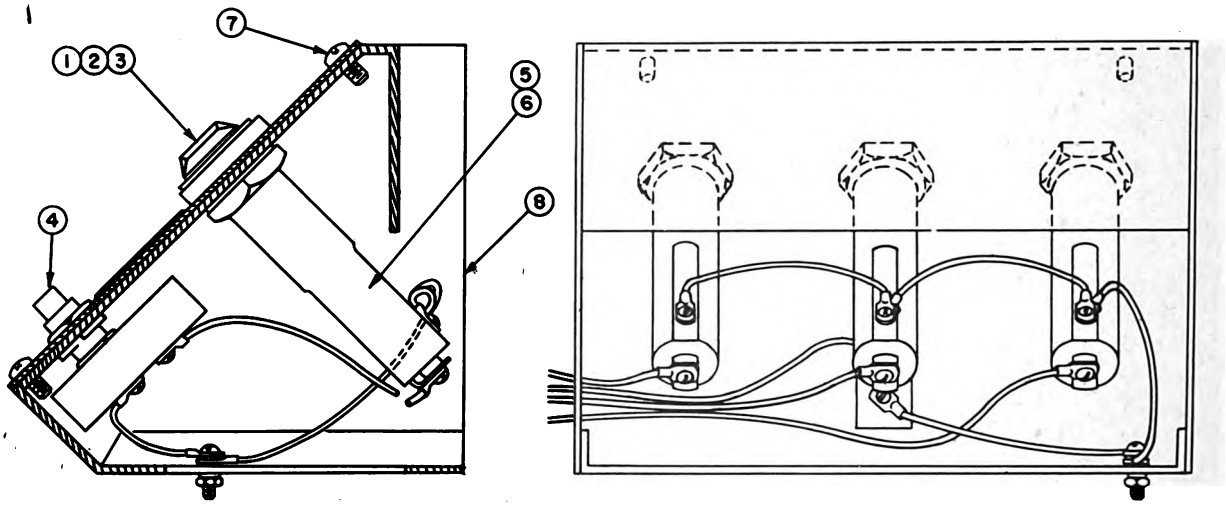
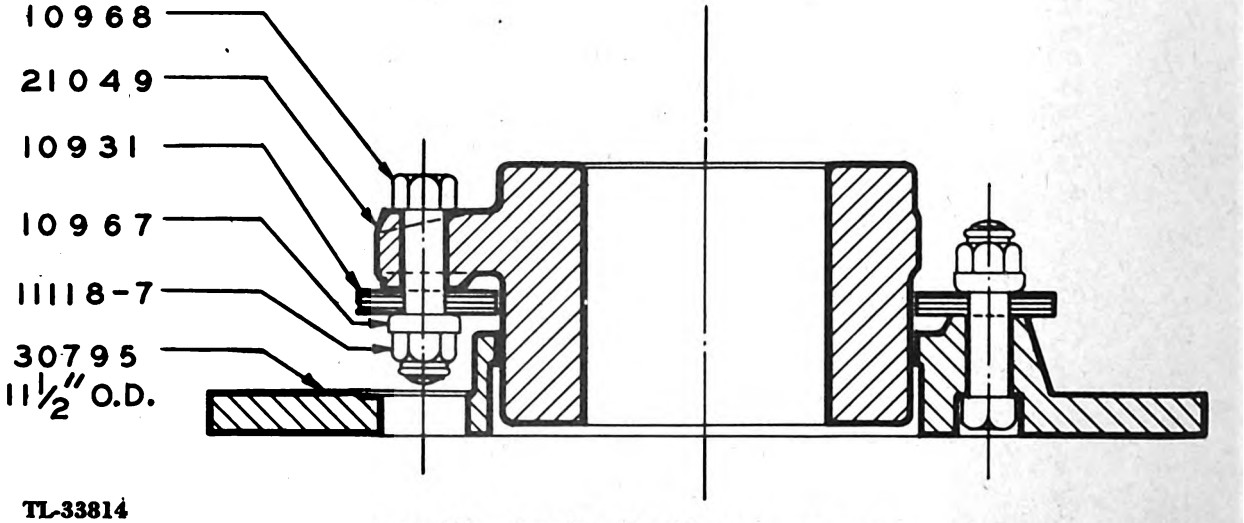


TL-33813

Figure 222. Signal light box.



TL-33814

Figure 223. Coupling, flexible, engine-generator.

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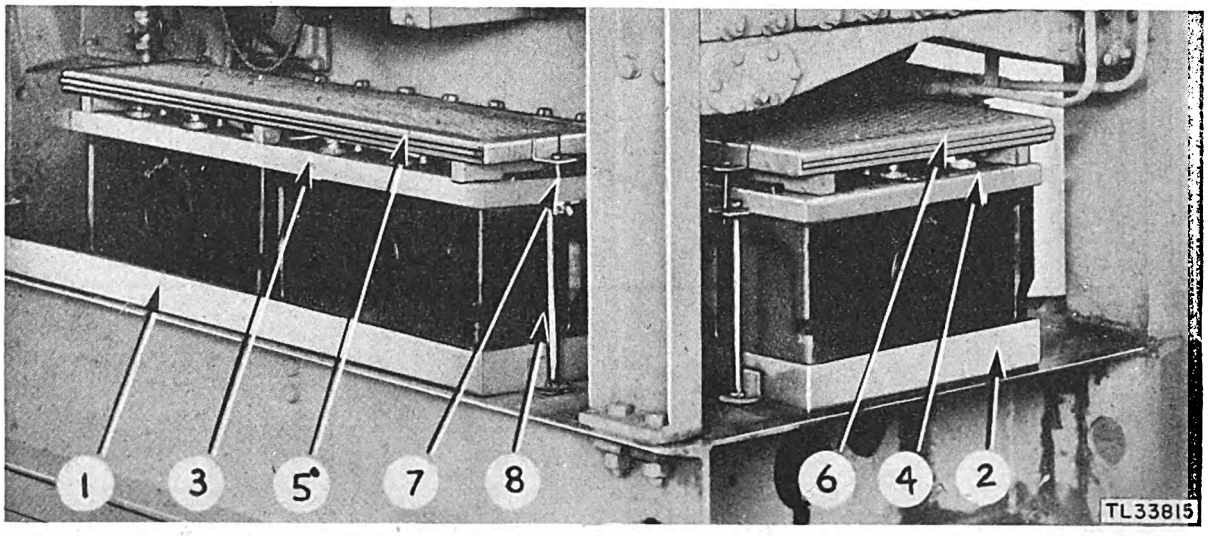
Item No.	No. of units	Name of part and description
		SIGNAL LIGHT BOX (fig. 222)
8	1	Assembly, signal light box.
7	4	Machine screw, box panel, No. 8—32 x ⅜".
5	3	Receptacles, bulb.
6	3	Bulb, signal light (30-v).
1	1	Lens, red signal light.
2	1	Lens, green signal light.
3	1	Lens, amber signal light.
	1	Switch, horn disconnector.
4	1	Switch, Acra snap.
		COUPLING, FLEXIBLE ENGINE-GENERATOR (fig. 223)
	1	Assembly, flexible coupling, stainless steel disks.
1	1	Adapter, flywheel.
2	1	Flange, pilot.
3	1 set	Disks, stainless steel.
4	8	Washers, bevel.
5	4	Bolts, flange.
6	4	Bolts, flywheel adapter special.
7	8	Nuts, lock ½".
		BATTERY, RETAINER, COVER AND PANS (fig. 224)
	5	Battery, 6-v, wet cell.
	1	Assembly, oil drip pan, fuel pump side.
1	1	Assembly, oil drip pan, manifold side.
2	1	Assembly, oil drip pan, front.
3	2	Retainer, battery, sides.
4	1	Retainer, battery, front.
	2	Frame, battery cover, side.
	1	Frame, battery cover, front.
5	2	Cover, battery, side.
6	1	Cover, battery, front.
7	6	Bolt, cover holdown, ¼" x 2½", USS.
	6	Lockwasher, cover holdown, ¼".
	6	Wingnut, cover holdown, ¼" USS.
8	6	Bolt, battery retainer, ⅜" x 9" USS.



TL-33815

Figure 224. Battery retainer, cover and pan.

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110. MAINTENANCE PARTS LIST FOR POWER UNIT PE-245-A.

NOTE: Order maintenance parts by stock number, name, and description. Only maintenance parts can be requisitioned.

Reference symbol	*Signal Corps stock No.*	*Name of part and description*	*Running spares*	*Quan per unit*	*Orgn stock*	*3d ech*	*4th ech*	*Depot stock*
	3H1907	ENGINE, Model HI-600 Cummins (Component).		1				*
		AIR INTAKE MANIFOLD GROUP						
10	3H1907/C35	COIL, preheater ignition.		1				*
22	3H4585A/7	BALL, nozzle-check valve.		1				*
13	3H1907/E15	ELECTRODE, adjustable.		1				*
8	3H1907/E16	ELECTRODE, stationary.		1				*
18	3H1907/G12	GASKET, nozzle retainer plate.		1				*
2	3H1907/G13	GASKET, ignition-coil cover.		1				*
12	3H1907/M11	MANIFOLD, air intake.		1				*
19	3H1907/N20	NOZZLE, preheater.		1				*
21	3H1907/S102	SPRING, nozzle-check valve.		1				*
6	3H1907/S142	SWITCH, pressure.		1				*
16	3H1907/V4	VALVE, ball-check, priming pump to preheater.		1				*
11	3H4585A/83	GASKET, air cleaner.		2			*	*
1	3H4600-245A/C18	CLEANER, air, DAFC-A-2107.		2				*
	3H4585A/110	GASKETS, manifold, intake and exhaust, copper, (also included in kit No. 7).		3		*	*	*
	3H4585A/406	NUTS, brass, 5/8-16 hex.		6			*	*
		CAM FOLLOWER HOUSING GROUP						
	3H4585A/45	ASSEMBLY, cam follower housing, steel.		3			*	*
	3H4585A/155	SHAFT, cam follower lever.		6			*	*
	3H4585A/156	ASSEMBLY, injector cam follower, steel.		6			*	*
	3H4585A/157	ASSEMBLY, valve cam follower lever, steel.		12			*	*
	3H4585F/P11	KIT, REPAIR, lower cam rocker assembly, CECO KIT No. 3.		1			*	*
91	3H4585A/61	ROD, exhaust, push.	3	6			*	*
92	3H4585A/77	ROD, injector, push.	3	6			*	*
93	3H4585A/150	ROD, intake, push.	3	6			*	*

*Indicates stock available.

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110. MAINTENANCE PARTS LIST FOR POWER UNIT PE-245-A (Continued).

NOTE: Order maintenance parts by stock number, name, and description. Only maintenance parts can be requisitioned.

Reference symbol	*Signal Corps stock No.*	*Name of part and description*	*Running spares*	*Quan per unit*	*Orgn stock*	*3d ech*	*4th ech*	*Depot stock*
		CAMSHAFT						
	3H1907/C15	ASSEMBLY, camshaft.		1			*	*
45	3H4585A/209	RING, camshaft thrust.		1			*	*
40	3H4585A/23	BUSHING, camshaft, front, cadmium silver.		1			*	*
42	3H4585A/26	BUSHING, camshaft, 3-5, cadmium silver.		2			*	*
41	3H4585A/25	BUSHING, camshaft, 2-4-6, cadmium silver.		3			*	*
43	3H4585A/646	BUSHING, camshaft, rear, cadmium silver.		1			*	*
		CRANKSHAFT						
	3H1907/C40	ASSEMBLY, crankshaft.		1				*
29	3H4585A/152	KEY, crankshaft pinion.	1	1				*
33	3H1907/N45	NUT, crankshaft.	1	1				*
		MAIN BEARING SHELLS						
26	3H4585A/514	DOWELS, main-bearing ring.	3	7			*	*
22	3H4585A/253	SHELLS, main-bearing, lower rear, alloy.		1		*	*	*
21	3H4585A/252	SHELLS, main-bearing, upper, rear, alloy.		1		*	*	*
24	3H4585A/251	SHELLS, main-bearing, lower, 2-4-6, alloy.		3		*	*	*
23	3H4585A/250	SHELLS, main-bearing, upper, alloy, 2-6.		2		*	*	*
28	3H4585A/249	SHELLS, main-bearing, lower, alloy, 1-3-5.		3		*	*	*
27	3H4585A/312	SHELLS, main-bearing, upper, alloy, 1-3-5.		3		*	*	*
25	3H1907/B10	SHELLS, main-bearing, upper, alloy, No. 4.		1		*	*	*
		CYLINDER BLOCK						
1	3H1907/830	CYLINDER BLOCK, studded, cast.		1				*
	3H1907/614	GASKET, water-drain plug.		1	*	*	*	*
	3H4585A/125	GASKET, water blind flange.		1	*	*	*	*
	3H4585A/193	LOCK, main-bearing stud nut.		14		*	*	*
15	3H4585A/173	NUT, main-bearing stud.	3	14			*	*
17	3H4585A/274	STUD, main-bearing.		7			*	*
16	3H4585A/275	STUD, main-bearing, slotted.		7			*	*
3	3H4585A/56	LINER, cylinder.	3	6			*	*
4	3H4585A/176	PACKING, cylinder liner (also included in gasket kit No. 7).	18	18			*	*

*Indicates stock available.

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110. MAINTENANCE PARTS LIST FOR POWER UNIT PE-245-A (Continued).

NOTE: Order maintenance parts by stock number, name, and description. Only maintenance parts can be requisitioned.

Reference symbol	*Signal Corps stock No.*	*Name of part and description*	*Running spares*	*Quan per unit*	*Orgn stock*	*3d ech*	*4th ech*	*Depot stock*
		CYLINDER HEAD						
	3H1907/H15	ASSEMBLY, cylinder head, valves, and studs.		2		*	*	*
	3H1907/H16	ASSEMBLY, cylinder head, valves, and studs, rear.	1	1			*	*
77	3H4585A/52	COLLET, valve, steel.	6	24			*	*
78	3H4585A/143	GUIDE, valve spring, cast.		12			*	*
79	3H4585A/262	SPRING, valve, steel.	1	12			*	*
88	3H4585A/336	VALVE, exhaust, steel.		6		*	*	*
89	3H4585A/293	VALVE, intake, steel.		6		*	*	*
82	3H4585A/144	GUIDE, valve stem, steel.		12			*	*
91	3H4585A/110	GASKET, cylinder head, copper (also included in gasket kit No. 7).	3	3		*	*	*
		EXHAUST MANIFOLD						
	3H1907/M10	ASSEMBLY, exhaust manifold, cast.		1				*
		FILTER—FUEL OIL—PRIMARY						
	3H4585A/480	FILTER, fuel oil, Cuno D-1400.		1				*
		FILTER—FUEL OIL—SECONDARY						
	3H1907/F17	FILTER, fuel oil, Briggs Model F-10, MODIFIED.		1				*
	3H1905-1/G107	GASKET, cover, vellumoid, Briggs No. D-157.	12	1	*	*	*	*
	3H1905-1/C15	CARTRIDGE, Briggs replacement, Briggs No. G-81-CEL.	12	1	*	*	*	*
		FILTER—LUBRICATING OIL—PRIMARY						
	3H1907/B1	BAG, filter.	12	1	*	*	*	*
	3H4585A/836	CARTRIDGE, De Luxe No. DF-35-48.	8	1	*	*	*	*
	3H4585A/772	GASKET, bag.		1	*	*	*	*
	3H4585A/112	GASKET, lubricating oil filter cover, cork (also included in gasket kit No. 7).		1	*	*	*	*

*Indicates stock available.

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110. MAINTENANCE PARTS LIST FOR POWER UNIT PE-245-A (Continued).

NOTE: Order maintenance parts by stock number, name, and description. Only maintenance parts can be requisitioned.

Reference symbol	*Signal Corps stock No.*	*Name of part and description*	*Running spares*	*Quan per unit*	*Orgn stock*	*3d ech*	*4th ech*	*Depot stock*
		FILTER—LUBRICATING—SECONDARY						
	3H1907/F16	FILTER, De Luxe lubricating oil, De Luxe No. S-2470.		1				*
	3H1907/G15	GASKET, cover, cork, De Luxe No. DF-29.	8	1	*	*	*	*
	3H1907/G16	GASKET, cover stud, De Luxe No. DF-32.		1	*	*	*	*
	3H1907/G17	GASKET, base, cork, De Luxe No. DF-31.		1	*	*	*	*
	3H1907/G18	GASKET, center stud, De Luxe No. DF-33.	2	1	*	*	*	*
	3H1907/G19	GASKET, drain plug, copper, De Luxe No. CS-52.	2	1	*	*	*	*
		FLYWHEEL AND FLYWHEEL HOUSING						
9	6L4910-31-1.18	SCREW, cap, flywheel to crankshaft.		6				*
		FUEL PUMP, LEVER, AND DISTRIBUTION GROUP						
	3H1907/P52	FUEL PUMP, complete.		1		*	*	*
	3H1907/L26	ASSEMBLY, cam rocker lever.		1				*
321	3H1907/R36	ROLLER, cam rocker lever.	1	1				*
	3H4585A/295	ASSEMBLY, vertical lever.	1	1				*
326	3H4585A/364	SPRING, vertical lever.		1			*	*
	3H4585A/932	ASSEMBLY, distributor.		1		*	*	*
448	3H1907-1/D10	ASSEMBLY, disc and cover.	1	1				*
	3H1907/S77	ASSEMBLY, distributor shaft.		1				*
462	3H1907/B43	BUSHING, distributor shaft.		1				*
	3H4585A/75	ASSEMBLY, priming valve.		1			*	*
	3H1907/B15	BALL, check.		1			*	*
452	3H4585A/319	GASKET, distributing housing cover.	3	1	*	*	*	*
477	3H4585A/210	GASKET, metering pump (also included in gasket kit No. 8).		1			*	*
461	3H4585A/330	KEY, Woodruff, distributor shaft.	3	1			*	*
478	3H1907/P51	PUMP, metering.	1	1			*	*
469	3H1907/S100	SPRING, distributor check valve.		1			*	*
	3H1907/L45	LINK, metering pump.		1			*	*
480	3H4585A/258	SPRING, metering pump.		1			*	*
	3H1907/C25	ASSEMBLY, float chamber, complete unit, 16 items.		1		*	*	*
536	3H4585A/318	GASKET, float valve seat, (also included in gasket kit No. 8).	1	1	*	*	*	*
	3H1907/T45	TUBE, injector supply No. 1.		1			*	*
	3H1907/T46	TUBE, injector supply No. 2.		1			*	*

*Indicates stock available.

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110. MAINTENANCE PARTS LIST FOR POWER UNIT PE-245-A (Continued).

NOTE: Order maintenance parts by stock number, name, and description. Only maintenance parts can be requisitioned.

Reference symbol	*Signal Corps stock No.*	*Name of part and description*	*Running spares*	*Quan per unit*	*Orgn stock*	*3d ech*	*4th ech*	*Depot stock*
		FUEL PUMP, LEVER, AND DISTRIBUTION GROUP (Contd.)						
	3H1907/T47	TUBE, injector supply No. 3.		1			*	*
	3H1907/T48	TUBE, injector supply No. 4.		1			*	*
	3H1907/T49	TUBE, injector supply No. 5.		1			*	*
	3H1907/T50	TUBE, injector supply No. 6.		1			*	*
	3H4585A/70	ASSEMBLY, gear pump.	1	1		*	*	*
406	3H4585A/235	SEAL, spacer.		2		*	*	*
		GOVERNOR GROUP						
335	3H4585A/371	GOVERNOR, Woodward Hydraulic WQ-040305.		1			*	*
337	3H4585A/323	GASKET, governor to adapter.		1		*	*	*
388	3H1907/L28	LEVER, governor, lower.		1			*	*
379	3H1907/L29	LEVER, governor, upper.		1			*	*
382	3H4585A/1072	LINK, governor control.		1			*	*
	3H1907/L30	ASSEMBLY, governor lever and bushing.		1			*	*
385	3H4585A/373	SEAL, control shaft, oil.		1			*	*
365	3H1907/S50	SEAL, main shaft.		1			*	*
376	3H1907/W15	COVER, window, oil level.		1			*	*
281	3H4585A/375	BUSHING, governor lever.		1			*	*
278	3H4585A/27	BUSHING, cam rocker lever.		1			*	*
286	3H4585A/372	LINK, governor, control eccentric.		1			*	*
280	3H4585A/159	LINK, vertical lever.		1			*	*
276	3H4585A/32	BUSHING, control shaft.	1	1			*	*
279	3H4585A/374	BUSHING, hand control eccentric.	1	1			*	*
261	3H1907/B42	BUSHING, plunger lever shaft, short, for part 40.	1	1			*	*
264	3H4585A/33	BUSHING, plunger lever shaft, long, for part 40.	1	1			*	*
	6Z3180	CONNECTION, 3/8" x 1/4", Weatherhead 200 x 6.	2	1			*	*
	3H1907/S76	ASSEMBLY, fuel oil main shaft.		1			*	*
	3H4585A/795	ASSEMBLY, injector cup.	6	6		*	*	*
239	3H4585A/325	GASKET, injector cup.	6	6		*	*	*
232	3H1907/G9	GASKET, check valve plug.		6			*	*
235	3H4585A/99	GASKET, check valve seat.		6			*	*
228	3H4585A/321	GASKET, top housing.		6			*	*
236	3H4585A/259	SPRING, injector check valve.	6	6			*	*
237	3H4585A/1395	STOP, injector check valve.	6	6			*	*

*Indicates stock available.

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110. MAINTENANCE PARTS LIST FOR POWER UNIT PE-245-A (Continued).

NOTE: Order maintenance parts by stock number, name, and description. Only maintenance parts can be requisitioned.

Reference symbol	*Signal Corps stock No.*	*Name of part and description*	*Running spares*	*Quan per unit*	*Orgn stock*	*3d ech*	*4th ech*	*Depot stock*
		INJECTOR FUEL INLET AND DRAIN GROUP						
	3H1907/C46	ASSEMBLY, fuel inlet connection.	2	6			*	*
	3H4585A/383	ASSEMBLY, injector fuel drain.	1	6			*	*
		INJECTOR ASSEMBLY						
	3H4585A/148	ASSEMBLY, injector	2	6		*	*	*
233	3H4585A/564	ASSEMBLY, check valve and seat.	6	6			*	*
	3H4585A/78	ASSEMBLY, injector rocker lever.		6				*
132	3H4585A/185	PIN, intake rocker lever roller.		6		*	*	*
133	3H4585A/220	RIVET, rocker lever roller pin.		6		*	*	*
123	3H1907/S30	SCREW, rocker lever adjusting.		18			*	*
	3H4585A/149	ASSEMBLY, intake-rocker lever.	1	6			*	*
117	3H1907/G27	GASKET, lubricating pipe cap.		3			*	*
	3H4585A/122	GASKET, rocker housing to cylinder head (also 3 in gasket kit No. 7).	3	3			*	*
	3H4585A/121	GASKET, rocker housing cover (also 3 in gasket kit No. 7).	3	3		*	*	*
5	3H1907/S90	SLEEVE, tube packing.		1			*	*
14	3H4585A/105	GASKET, lubricating flange (also in gasket kit No. 7).		2			*	*
15	3H1907/G22	GASKET, suction-tube flange (also in gasket kit No. 7).		1			*	*
		INSTRUMENT PANEL						
	3H4585A/129	GAUGE, fuel oil pressure.		1				*
	3H4585A/130	GAUGE, lubricating oil pressure.		1				*
	3H1907/G50	GAUGE, lubricating oil temperature.		1				*
	3H1907/G51	GAUGE, water temperature.		1				*
	3H4585A/203	PUMP, hand priming and preheater.		1		*	*	*
	3Z9829-1.2	SWITCH, push-button.		1			*	*
	3H1907/S32	SCREW, pressure gauge 6-32 x 3/4".	6	6		*	*	*
		LUBRICATING PUMP						
	3H4585A/161	ASSEMBLY, lubricating pump.		1		*	*	*
189	3H1907/C45	CONNECTION, suction tube.		1			*	*
	3H1907/G52	GAUGE, oil level.		1				*
	3H1907/C21	CAP, breather.		1		*	*	*
	3H1907/S15	ASSEMBLY, oil pan and screen.		1				*
	3H1907/G7	GASKET, oil pan to block (also in kit No. 7).		1		*	*	*

*Indicates stock available.

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110. MAINTENANCE PARTS LIST FOR POWER UNIT PE-245-A (Continued).

NOTE: Order maintenance parts by stock number, name, and description. Only maintenance parts can be requisitioned.

Reference symbol	*Signal Corps stock No.*	*Name of part and description*	*Running spares*	*Quan per unit*	*Orgn stock*	*3d ech*	*4th ech*	*Depot stock*
		PISTON AND CONNECTING ROD GROUP						
	3H4585A/1191	ASSEMBLY, piston, complete with pin.	2	6		*	*	*
47	3H4585A/211	RING, piston, compression.	24	12		*	*	*
46	3H4585A/216	RING, piston, keystone.	12	6		*	*	*
48	3H4585A/214	RING, piston, oil regulating, narrow.	12	6		*	*	*
49	3H4585A/213	RING, piston, oil regulating, wide.	12	6		*	*	*
	3H4585A/215	RING, piston, pin snap, H-61508.		12		*	*	*
56	3H1907/R55	ASSEMBLY, connecting rod, less shell.		6				*
57	3H4585A/21	BOLT, connecting rod, special.		12				*
55	3H4585A/42	BUSHING, piston pin.		6				*
60	3H4585A/166	NUT, connecting rod bolt.	6	12				*
59	3H4585A/192	PLATE, connecting rod lock.	12	12		*	*	*
58	3H4585A/64	SHELL, connecting rod bearing.	12	12		*	*	*
150	3H4585A/903	GASKET, rear cover to block, 0.005".		as req'd			*	*
	3H4585A/360	ASSEMBLY, rocker-lever housing.		3			*	*
115	3H4585A/1217	PLUG, 1-1/4", expansion rocker-lever housing.	6	6			*	*
	3H4585A/357	ASSEMBLY, exhaust rocker lever.	1	6			*	*
	3H1907/S120	ASSEMBLY, overspeed stop, complete.		1			*	*
	3H4585A/459	GASKET KIT, fuel pump gaskets, CECO gasket kit No. 8.		1	*	*	*	*
	3H4585A/208	SEAL, fan pulley, oil.	1	1			*	*
		STARTING MOTOR						
	3H3114-15	MOTOR, starting, Delco No. 711.		1		*	*	*
13	3H3114-B1	BRUSH, starting motor, Delco No. 38367.	12	12		*	*	*
22	3H3114-15/P15	PINION, drive, Delco No. 1856842.		1		*	*	*
	3H3114-15/S25	SPRING, pinion meshing, Delco No. 1869565.		1		*	*	*
24	3H3114-15/G35	GUIDE, pinion, Delco No. 1856840.		1		*	*	*
25	3H3114-15/C20	COLLAR, pinion stop, Delco No. 1860724.		1		*	*	*
28	3H3114-15/S20	SOLENOID, Delco No. 1118043.		1		*	*	*
		WATER CONNECTIONS AND HOSE						
3	3H4585A/313	CLAMP, hose, 2-1/2".	8	4	*	*	*	*
	3H4585A/329	GASKET, engine, water-inlet connection.	4	1	*	*	*	*
	3H4585A/326	GASKET, radiator water connection.		2	*	*	*	*
26	3H4585A/395	HOSE, radiator, 2" x 18" upper.	6	1	*	*	*	*
	3H1907-1/H16	HOSE, radiator, 2" x 6" lower.	2	1	*	*	*	*

*Indicates stock available.

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110. MAINTENANCE PARTS LIST FOR POWER UNIT PE-245-A (Continued).

NOTE: Order maintenance parts by stock number, name, and description. Only maintenance parts can be requisitioned.

Reference symbol	*Signal Corps stock No.*	*Name of part and description*	*Running spares*	*Quan per unit*	*Orgn stock*	*3d ech*	*4th ech*	*Depot stock*
		WATER MANIFOLD GROUP						
26	3H4585A/310	CLAMP, by-pass hose.	2	2	*	*	*	*
3	3H4585A/313	CLAMP, manifold hose.	8	4	*	*	*	*
15	3H1907/G20	GASKET, water by-pass connection.		1		*	*	*
12	3H4585A/125	GASKET, water connection.		2		*	*	*
28	3H4585A/126	GASKET, water manifold to head (also 6 in gasket kit No. 7).		6	*	*	*	*
13	3H1907/G21	GASKET, thermostat housing.		1		*	*	*
25	3H1907-1/H16	HOSE, water by-pass.	2	1	*	*	*	*
2	3H1907/H37	HOSE, water manifold.	4	2	*	*	*	*
4	3H1907/S65	SECTION, water manifold, center.		1				*
27	3H1907/S66	SECTION, water manifold front.		1				*
1	3H1907/S67	SECTION, water manifold rear.		1				*
16	3H1907/T15	THERMOSTAT, by-pass.		1		*	*	*
14	3H1907/T16	THERMOSTAT, main.		2		*	*	*
		WATER PUMP						
	3H1907/P50	PUMP, water.	1	1		*	*	*
201	3H320-34	BEARING, inner.	1	1			*	*
203	3H3404/3	BEARING, outer.	1	1				*
204	3H4585A/111	GASKET, oil.	1	1			*	*
194	3H4585A/394	GUIDE, spring.	1	1			*	*
	3H1907/J20	IMPELLER, water pump.		1			*	*
209	3H1907/J21	KEY, impeller.	3	1			*	*
212	6L995-8	KEY, pulley, Woodruff No. 8.	1	1			*	*
207	3H4585A/207	RETAINER, cork.		1			*	*
200	3H1907/R20	RETAINER, split ring.		1			*	*
210	3H1907/R26	RING, split.		2			*	*
193	3H1907/R25	RING, seal clamp.	1	1			*	*
195	3H4585A/234	SEAL, flexible.	3	1			*	*
211	3H1907/S75	SHAFT, water pump.		1				*
192	3H4585A/255	SPRING.	1	1			*	*
196	3H4585A/296	WASHER, carbon.	1	1			*	*
206	3H4585A/298	WASHER, cork.	1	1			*	*
217	3H4585A/128	GASKET, water pump to block.	3	1	*	*	*	*
	3H4585A/19	BELT, "V" water pump drive.	6	2	*	*	*	*

*Indicates stock available.

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110. MAINTENANCE PARTS LIST FOR POWER UNIT PE-245-A (Continued).

NOTE: Order maintenance parts by stock number, name, and description. Only maintenance parts can be requisitioned.

Reference symbol	*Signal Corps stock No.*	*Name of part and description*	*Running spares*	*Quan per unit*	*Orgn stock*	*3d ech*	*4th ech*	*Depot stock*
		MISCELLANEOUS GROUP						
	3H1907/R1	RADIATOR, sectional core, assembly (Perfex R-1983-C modified).		1				*
	3H1907/S85	SILENCER, exhaust, maxim		1				*
	3H1907/H35	HOSE, flexible, silencer, RDA E-1271.		1			*	*
	3H1907/S140	SWITCH, lube oil pressure alarm, Penn Electric Switch Co. 260-API 4X.		1				*
	3H1907/S141	SWITCH, water temperature alarm, Penn 262-ATO-4X.		1				*
	3H1907/H36	HOSE, tank, auxiliary fuel supply, RDA A-1361-A-12.		1		*	*	*
	3H1907/J10	JUMPER, battery, 7" length, Exide No. 27652-7.		2			*	*
	3H1907/J11	JUMPER, battery, 17" length, Exide No. 24497-17.		2			*	*
	3H1907/K15	GASKET KIT No. 7, complete set gaskets.		1 set		*	*	*
	3H4600-245A/C25	COUPLING, flexible, assembly, Thomas Flexible Coupling Co., C-10132.		1				*
	3H4600-245A/D20	DISCS, Coupling, flexible, Thomas Flexible Coupling Co., part 10931.		1 set			*	*
	3B200.1	BATTERY, storage, lead acid, 6 volt, Exide XHM-25.		5				*
		GENERATOR GROUP						
27	3H2418-1/H15	BRUSHHOLDER ASSEMBLY, grounding.		1				*
134	3H2418-1/B20	BRUSH ASSEMBLY, slip ring brush rigging.		1				*
	3H307	BEARING, BALL, alternator.		1				*
77	3H1901-A/B2	BEARING, BALL, exciter.		1				*
59	3H2418-1/B21	BRUSH, exciter.	2 sets	2	*	*	*	*
28	3H2418-1/B22	BRUSH, grounding, generator.		4	*	*	*	*
	3H2418-1/B23	BRUSH, alternator.	2 sets	4	*	*	*	*
56	3H2418-1/B15	BODY, brushholder.		2				*
6	3F1150-10	AMMETER, AC 0-150 A Westinghouse type H 4-1/4" diameter, flush mounting.		1				*
10	3H900-100-3	CIRCUIT BREAKER, 3-pole, 100 amperes, 250 volt, front connected with thermal overload trip, I.T.E. No. ET1638.		1				*
	3F2787	FREQUENCY METER, Frahm 58-62 cycles 3-1/2" diameter, reed type, flush mounted, Biddle Co.		1				*

*Indicates stock available.

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110. MAINTENANCE PARTS LIST FOR POWER UNIT PE-245-A (Continued).

NOTE: Order maintenance parts by stock number, name, and description. Only maintenance parts can be requisitioned.

Reference symbol	*Signal Corps stock No.*	*Name of part and description*	*Running spares*	*Quan per unit*	*Orgn stock*	*3d ech*	*4th ech*	*Depot stock*
		GENERATOR GROUP (Continued)						
	3H4960-1	VOLTAGE REGULATOR, Burlington type GL-1.		1			*	*
2	3H4960-1/V15	VIBRATOR ASSEMBLY, voltage regulator, with lower contact, Burlington part 218-VL.	1	1			*	*
3	3H4960-1/C10	UPPER CONTACT BRACKET ASSEMBLY, voltage regulator, includes upper leaf contact, spring back, contact washer, contact spacer, tension adjustment, angle bracket, and leaf contact screws, Burlington part 249-VL.	1	1			*	*
13	3Z7275-3	RHEOSTAT, field, exciter, 750 ohms, 0.29 amperes, Rex Rheostat Co. No. B2.		1			*	*
	3Z9825-74.23	SWITCH, battery-charging, 14-point dial, G.E. Co. No. 4865639.		1				*
9	3Z9858-8.72	SWITCH, toggle, H. Hubbell Co. No. 1815D.		1				*
12	3Z9825-71.4	SWITCH, voltmeter, Westinghouse style No. 591454.		1				*
18	2Z9900.7	TRANSFORMER, current 300/5 ratio, Westinghouse No. OC-133.		1				*
3	3F8150-92	VOLTMETER, AC, 0-150 volts, 4-1/4" diameter, flush mounted, Westinghouse type H; calibrated for No. 10-gauge sheet steel mounting.		1				*
6	3Z2606	FUSE, renewable link, 6 ampere, 250 volt.	6	2		*	*	*
7	3Z2608.2	FUSE, renewable link, 8 ampere, 250 volt.	6	2		*	*	*
8	3Z1931	FUSE, renewable link, 10 ampere, 250 volt.	6	2		*	*	*
	3Z3006	LINKS, renewable fuse, 6 ampere.	10	2	*	*	*	*
	3F3008-1	LINKS, renewable fuse, 8 ampere.	10	2	*	*	*	*
	3Z3010	LINKS, renewable fuse, 10 ampere.	10	2	*	*	*	*
	4C5424.7	LAMP, signal light, 30 volt, Westinghouse style 1124156.	6	3			*	*
	6Z6896-2	LAMP, Protex A, red, 25 watt, 30 volt.	2	1			*	*
	3Z2610.15	FUSE PLUG, 10 ampere, 125 volt.	6	1			*	*

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