DEPARTMENT OF THE ARMY TECHNICAL MANUAL

DEPARTMENT OF THE AIR FORCE TECHNICAL ORDER

TM 5-5161
TO 19-45-267

GENERATOR SET

PORTABLE, DIESEL-DRIVEN SKID-MOUNTED, 15-KW, 120–208- OR 240–416-VOLT, 3-PHASE, 60-CYCLE CONVERTIBLE TO 230–400-VOLT, 3-PHASE, 50-CYCLE

BUDA MODEL 4BDG–182

DEPARTMENTS OF THE ARMY AND THE AIR FORCE

DECEMBER 1953

TECHNICAL MANUAL
No. 5-5161
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AND THE AIR FORCE

WASHINGTON 25, D. C., *16 December 195*

GENERATOR SET, PORTABLE, DIESEL DRIVEN, SI MOUNTED, 15 KW, 120-208 OR 240-416 VOLT PHASE, 60 CYCLE, CONVERTIBLE TO 230-400 VO 3 PHASE, 50 CYCLE, BUDA MODEL 4BDG-182

SAFETY PRECAUTIONS

Main generator and exciter voltages are dangerous. Do not get any part of the body in direct contact with live parts of the machine.

Exhaust fumes are poisonous. Run engine exhaust to outside of building.

Battery acid is corrosive and will burn skin and clothing. Keep acid in tightly closed glass or rubber-lined containers marked "ACID POISON."

If the windings are damp or the generator has been immersed in water, make an insulation resistance test before operating.

Keep diesel fuel clean. Strain through 200 mesh screen. Drain fuel tank and filter sumps frequently.

Do not use emery cloth on commutators. Always use fine sandpaper.

Do not use carbon tetrachloride or alcohol on commutators, as either will destroy the operating surface and cause trouble. Use gasoline if sandpaper does not take off the dirt. Dry thoroughly before returning to service.

Never race a cold engine.

When operating this generator in parallel with others, follow the operating instructions carefully.

When reinstalling cylinder head, make certain nothing is lying on top of the piston.

Do not dip Bendix drive in cleaning solvent. This is a friction type drive and cannot be relubricated.

When removing and replacing instruments, follow the directions and wiring diagram carefully. Mark or tag any lines or terminals not marked or those with markings which have become unreadable.

When pressing water pump impeller on shaft, do not press too tightly as the seal washer will be cracked.

When using hydraulic nozzle tester, do not exceed 3,000 pounds pressure on the gage. Do not obstruct oil spray from nozzle. Keep hands and face away from spray at all times.

Never scrape injector parts with a metal tool or use any gritty material such as crocus or emery cloth for cleaning.

When using test probes, never touch polished contact surfaces of the commutator segments, sliprings, or bearing surfaces as an arc will mar the finish.

When inspecting, adjusting, or installing parts in the switchboard, shut down the generator. If necessary to run the generator while testing, wear rubber gloves and use a rubber floor mat.

CHAPTER 1
INTRODUCTION

Section I. GENERAL

1. Scope

a. This manual is published for the information and use of the personnel to whom this generator set is issued. It contains information on operation and organizational and field and depot maintenance of the generator set as well as a description of the major units and their functions in relation to other components of the generator set. It applies only to the Buda portable, skid mounted, diesel-driven, 4BDG–182 generator set.

b. Supply manuals, technical manuals, and other publications applicable to the equipment covered by this manual are listed in appendix I. Parts listings are correlated with illustration references under appendix II. Appendix III lists those items shipped with a new unit.

2. Record and Report Forms

Maintenance record and report forms listed and briefly described in *a* through *j* below will be used in the maintenance of this equipment.

a. DD Form 6, Report of Damaged or Improper Shipment. This form is used for reporting damages incurred in shipment.

b. Standard Form 91, Operator's Report of Motor Vehicle Accident. This form is to be filled out by the operator in case of accident resulting in injury or property damage.

c. DD Form 110, Vehicle and Equipment Operational Record. This form is used by equipment operators for reporting the accomplishment of daily preventive maintenance services, and for reporting any equipment deficiencies observed during operation.

d. DA Form 460, Preventive Maintenance Roster. This form is used for maintaining an operating time record on the item of equipment, and for scheduling lubrication and preventive maintenance services at proper intervals.

e. DA Form 464, Work Sheet for Preventive Maintenance and Technical Inspection of Engineer Equipment. This form is used by personnel of the using organization and higher echelons for reporting the results of preventive maintenance services and technical inspections.

f. DA Form 468, Unsatisfactory Equipment Report. This form is used for reporting manufacturing, design, or operational defects in the generator set, with a view to correcting such defects. It is also

used for recommending modifications of the generator set. Form 468 is not used for reporting failures, isolated materiel defects, or malfunctions of materiel resulting from fair wear and tear or accidental damage. Form 468 is not used to report issue of parts and equipment, or for reporting replacements and/or repairs.

g. DA Form 478, Organizational Equipment File. Major repairs or rebuilding, replacement of major unit assemblies, and accomplishment of equipment modifications are recorded on this form.

h. DA Form 811, Work Request and Job Order. This form is used when it is necessary for an organization to have work done by higher echelon organizations.

i. DA Form 867, Status of Modification Work Order. This form is used to maintain a record of all modification work performed on the equipment.

j. DA Form 9–81, Exchange Part or Unit Identification Tag. This form makes possible direct exchange of unserviceable for serviceable parts.

Section II. DESCRIPTION AND DATA

3. Description

a. General.

(1) The generator set described in this manual is the Buda 4BDG–182. It is a skid mounted, diesel-driven, alternating-current power plant, inclosed in a weatherproof housing with access doors on sides and rear. Refer to figures 1 and 2.

(2) A three-phase, alternating-current generator consists of a rotor with north and south magnetic poles rotating inside a stator. The stator has three separate windings spaced equally around the circle. As the magnetic poles sweep by the winding, alternating voltage is generated. Each winding is one phase. The three windings are connected together at one end of each to form a neutral point. The neutral and the free ends of the three windings are brought out to the wires which supply the electrical load. Brushes rubbing on two sliprings pass direct current through windings on the rotor, creating a magnetic field. Direct current is supplied by a small direct-current generator mounted on the end of the alternator shaft.

(3) A diesel engine gets its power by burning oil in cylinders. This is a four-cycle engine. Each cylinder fires once in every two revolutions. The complete cycle of one cylinder is shown in figure 3.

(*a*) First downstroke, intake valve open; air is drawn into the cylinder.

(*b*) First upstroke, both valves closed; the air is compressed and heats to about 1,000° F.

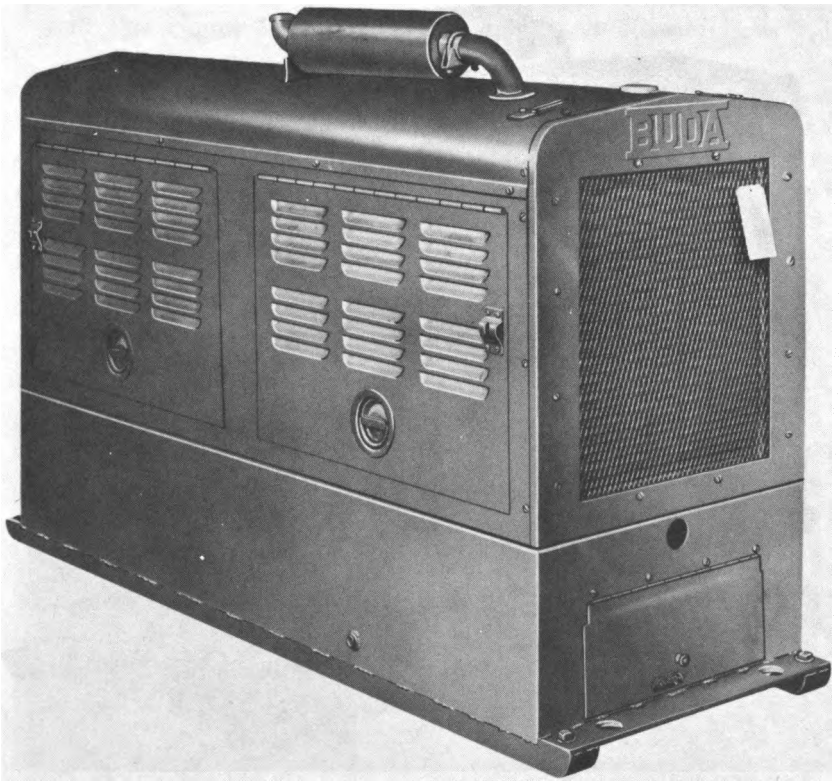


Figure 1. Front and right side of generator set with housing on.

(*c*) Second downstroke, both valves closed; oil is sprayed into the hot cylinder and burns, developing high pressure which drives the piston down in a power stroke.

(*d*) Second upstroke, exhaust valve open; burned gases are expelled from cylinder.

(4) The generated voltage is controlled by regulating the amount of direct current flowing in the rotor magnetizing winding. This control can be either automatic or manual. Meters are provided to show the current and voltage in each phase of the generator and to show the frequency, which depends upon the speed.

(5) The speed of the diesel engine is controlled automatically by a flyweight type governor. The speed which the governor will hold is controlled by the hand throttle.

(6) The generator set is capable of delivering 15 kw (kilowatts) of three-phase power and may be operated on any one of the following systems:

(*a*) 60 cycles, 208 volts line-to-line, 120 volts to neutral.

(*b*) 60 cycles, 416 volts line-to-line, 240 volts to neutral.

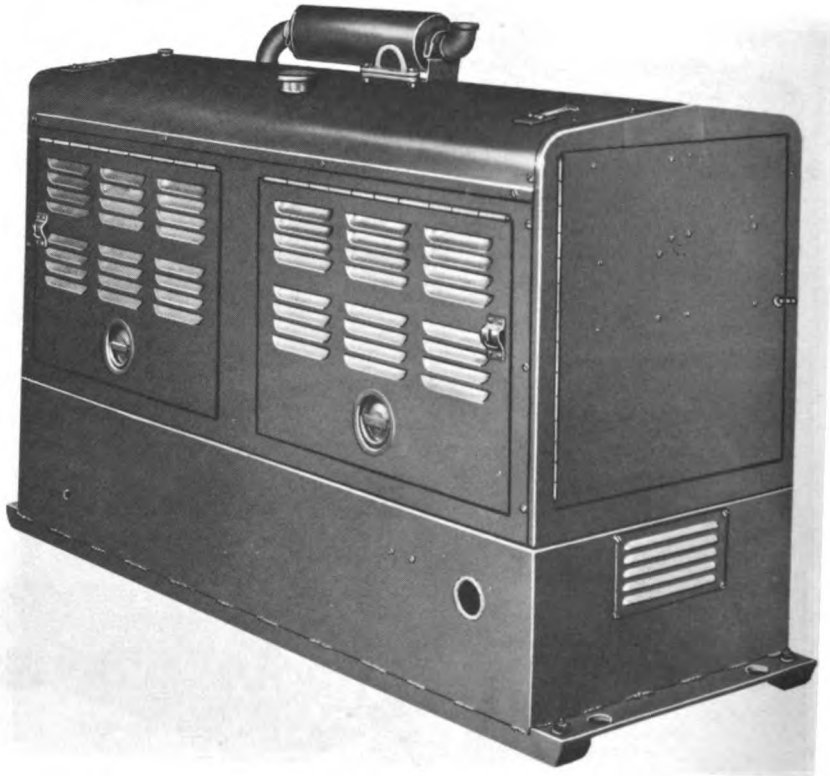


Figure 2. Rear and left side of generator set with housing on.

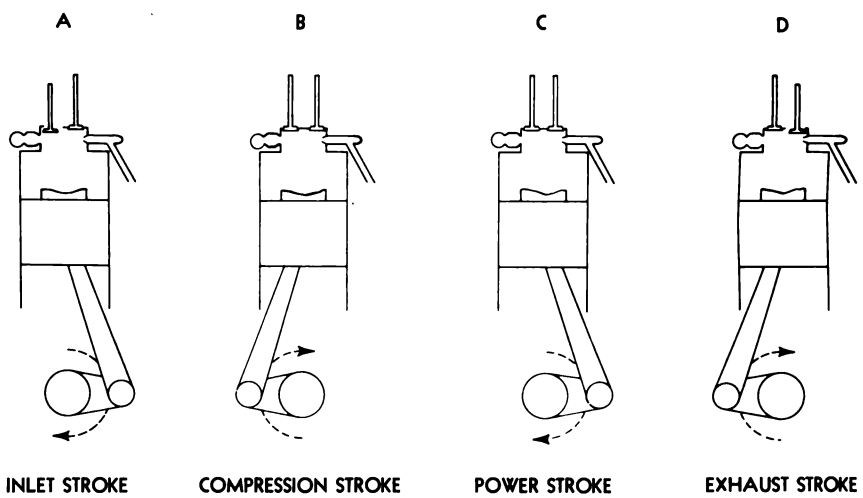


Figure 3. Illustrating principles of diesel operation.

(*c*) 50 cycles, 400 volts line-to-line, 230 volts to neutral.

(7) The engine is furnished with a 24-volt storage battery, a charging generator, and an electric starter.

b. Identification Information (fig. 4).

(1) The generator set has three identification plates. The Corps of Engineers identification plate (A), located on the inside of the control panel door, specifies the official nomenclature, the model number, and serial number of the equipment. The generator data plate (B), located on the left side of the generator housing, specifies the rating and serial number of this component. The engine identification plate (C), located on the left side of the engine flywheel housing, specifies the manufacturer, model, and serial number.

(2) When requisitioning spare parts for this equipment, specify the Department of the Army registration and serial numbers, the engine serial number, and the generator serial number.

Figure 4. Nameplates.

c. Major Components.

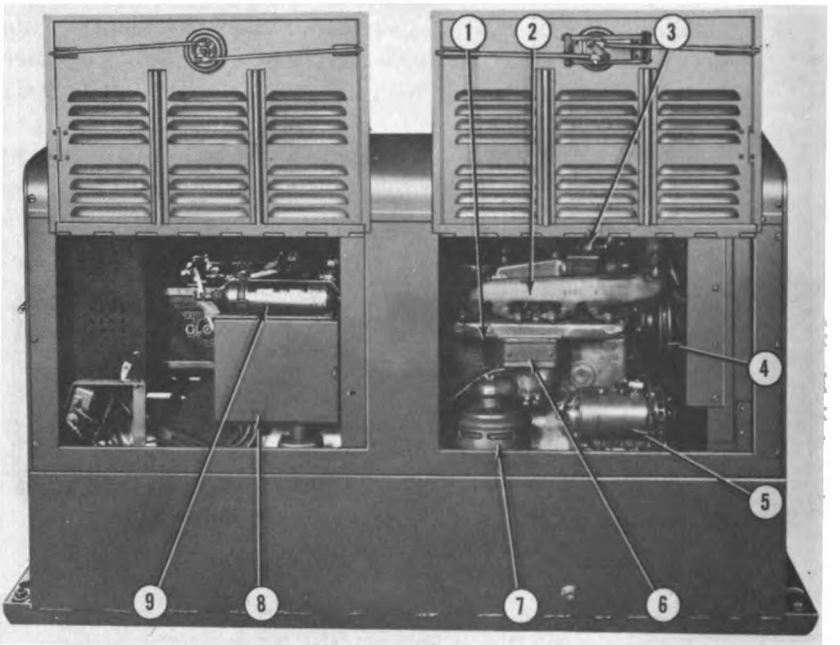
(1) The major components on the right side (fig. 5) include the voltage changeover switch, fire extinguisher, air cleaner, intake manifold, exhaust manifold, air heater, charging generator, thermostat, and water pump.

(*a*) The voltage changeover switch (8) is provided to change generator connections for the two voltages. It is in-

closed in a metal box with a hinged cover attached to the generator frame.

(*b*) The carbon tetrachloride type fire extinguisher (9) is held by a spring clip on top of the voltage changeover switch box.

(*c*) The automotive type air cleaner (7) has an oil cup and a wire screen filtering element. It is attached to a bracket on the right side of the engine, below and to the rear of the intake manifold (1).



1 Intake manifold
2 Exhaust manifold
3 Thermostat
4 Water pump
5 Charging generator
6 Air heater
7 Air cleaner
8 Voltage changeover switch
9 Fire extinguisher

Figure 5. Right side of generator set with doors open.

(*d*) The intake and exhaust manifolds (1) and (2) are attached to the right side of the engine cylinder head by clamps and studs.

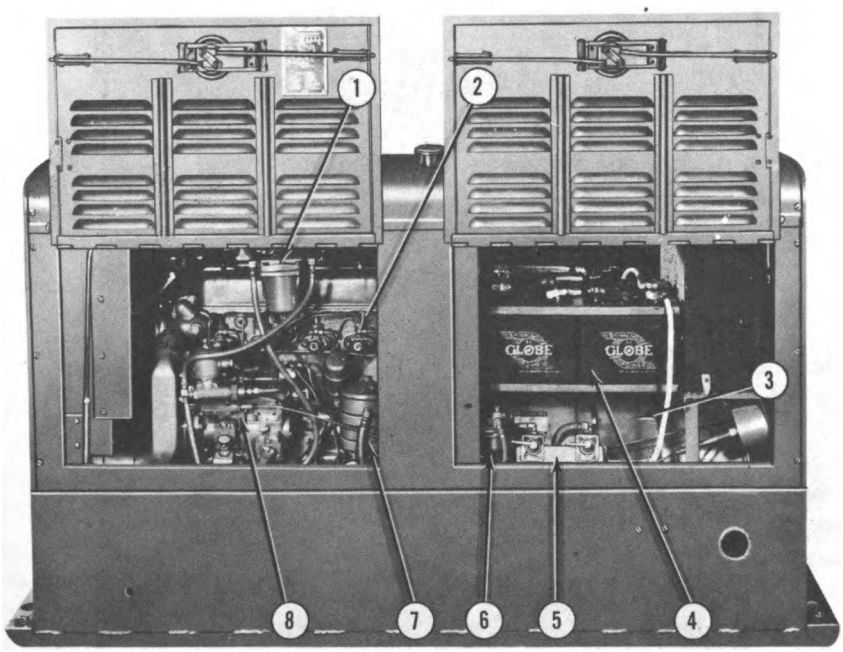
(*e*) The air heater (6) is a metal casting attached to the lower side of the intake manifold. It contains a grid of resistance wire through which battery current can be passed to heat the incoming air to the engine.

(*f*) The charging generator is an Auto-Lite model GFI-4805 A, 24-volt machine which is driven from the fan belt.

(2) The major components on the left side (fig. 6) include the fuel injection pump, secondary fuel filter, lubricating oil filter, starter (concealed behind case), storage batteries, primary fuel filter, fuel valves, main generator, and injector nozzles.

(*a*) The fuel injection pump (8) is an American Bosch type PSB, single-plunger pump. It is flange-mounted to the engine front cylinder plate and is driven by the timing gears.

(*b*) The secondary fuel filter (1) is a Fram cartridge type, bolted to a bracket on the cylinder head.



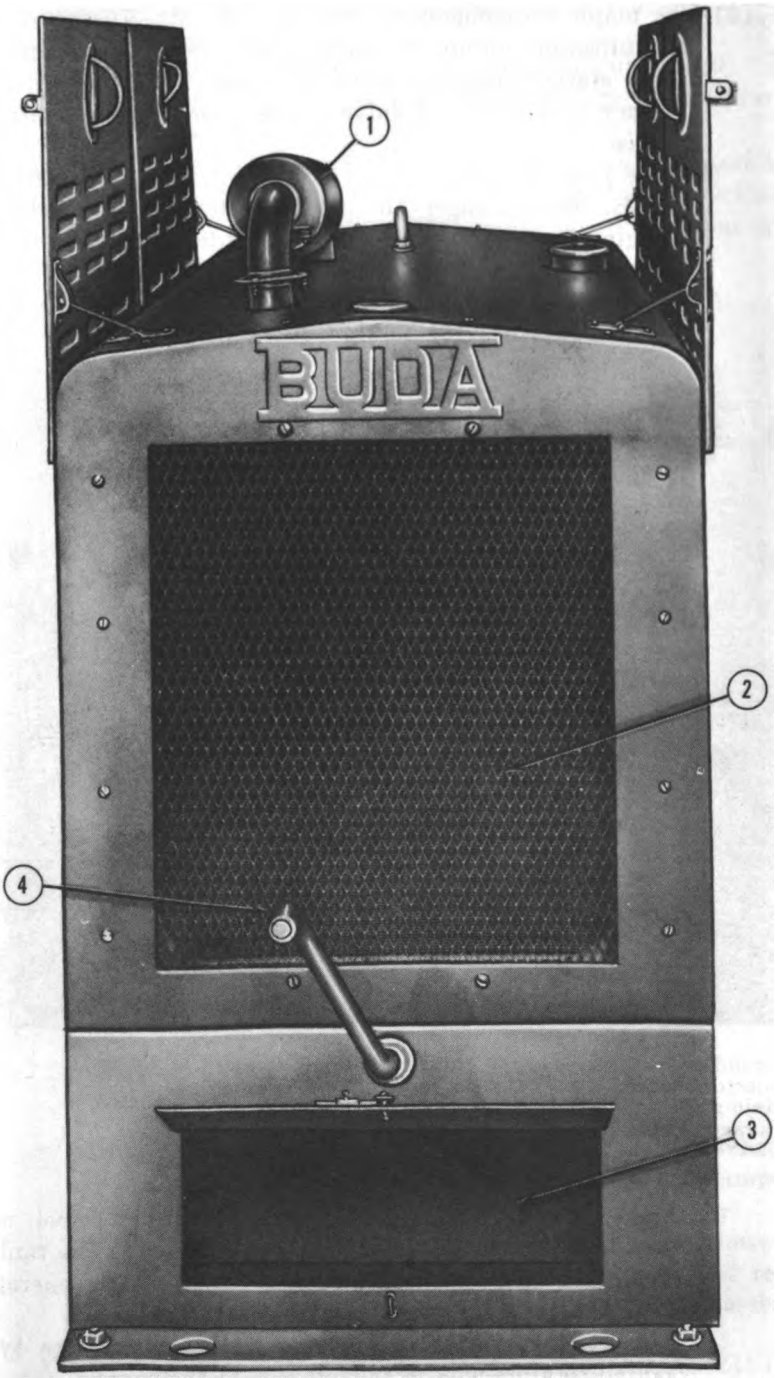
1 Secondary fuel filter
2 Injector nozzles
3 Main generator
4 Storage batteries
5 Fuel valves
6 Primary fuel filter
7 Lubricating oil filter
8 Fuel injection pump

Figure 6. Left side of generator set with doors open.

(*c*) The fuel tank is constructed of heavy welded steel, with feet bolted to the base of the generator set. The tank is located over the coupling between engine and generator. The lifting eye brackets are welded to the tank.

(*d*) The lubricating oil filter (7) is a Fram cartridge type, bolted to a bracket on the left side of the engine.

(*e*) The starting motor (not visible in fig. 6) is flange-mounted to the left side of the flywheel housing and lies along the side of the oil pan below the top of the base.



1 Muffler
2 Radiator
3 Tool compartment
4 Crank

Figure 7. Front end of generator set with doors open.

(*f*) Four six-volt, lead-type storage batteries (4) are held on a steel shelf just above the generator subassembly. They are connected in series to give 24 volts total.

(*g*) The primary fuel filter (6) is a Cuno type DS, held by a U-bolt to a bracket on the rear end of the fuel tank.

(*h*) The two fuel valves (5) are attached to a bracket on the base. They connect the fuel suction and return lines from the engine to either the tank on the generator set or to an external tank.

(*i*) The main generator (3) is a General Electric type AT 1326. It is fully described in paragraph 4*b*.

(*j*) The exciter is a General Electric type BY–176. It is fully described in paragraph 4*e*.

(*k*) The injector nozzles are inserted through holes in the cylinder head, one to each cylinder, and are held by two cap screws.

(3) The major components on the front end are the radiator (2, fig. 7), tool compartment (3), starting crank (4), and muffler (1).

(*a*) The radiator is of the tube and fin type. It is bolted to the base and the front end of the housing.

(*b*) The tool compartment is built into the front of the base and has a hinged door with a sliding bolt.

(4) The major components on the rear include the generator control panel (1, fig. 8), engine control panel (2), and access plate (3).

(*a*) The generator control panel contains the generator instruments and controls. The front of the panel is hinged at the bottom and secured at the top by two wing screws. It may be lowered to provide access to terminals, wiring, and instruments.

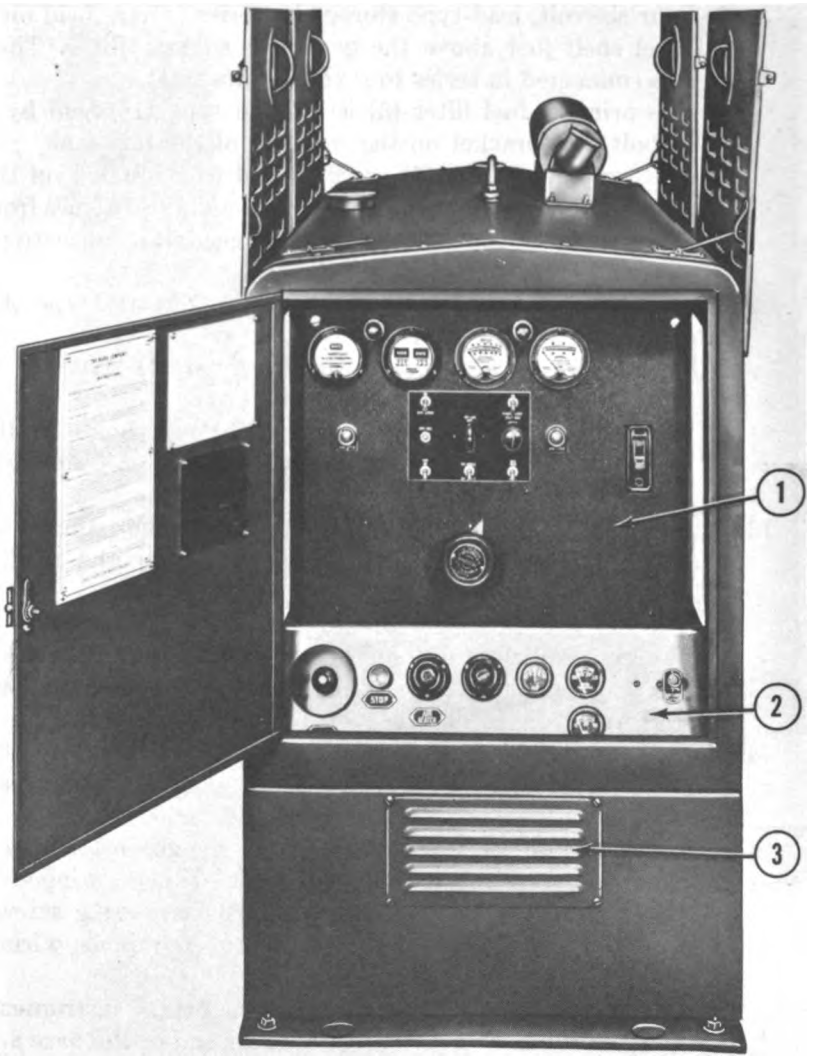
(*b*) The engine control panel contains the engine instruments and controls. It is bolted to the rear end of the base and it supports the generator control panel.

4. Tabulated Data

Information in this paragraph consists of overall dimensions, size, and weight of the complete 4BDG–182 generator set and its major components. Performance data and capacities for water, oil, and fuel are given as a reference for help in proper operation and handling.

a. Dimensions and Weight.

Weight (gross operating)	2338 lb.
Length (including base)	77 in.
Width (including base)	28⅝ in.
Height (including base and muffler)	49½ in.
Center of gravity	at lifting eye



1 Generator control panel 2 Engine control panel 3 Access plate

Figure 8. Rear end of generator set with doors open.

b. Generator Rating and Classification.

Type designation	AT 1326 (General Electric)
Rated kw	15
Voltage	120/208 and 240/416 at 60 cycles
	230/400 at 50 cycles, 3 phase
Frequency	50 and 60 cycles
Power factor	0.8
Number of phases	3
Rated speed	1,800 rpm at 60 cycles
	1,500 rpm at 50 cycles
Amperes full load	52.0 at 208 volts 60 cycles
	26.0 at 400 volts 50 cycles

Number of poles	4
Temperature rise	50° C.
Method of cooling	single-end ventilated
Type lubrication	pressure grease
Duty classification	continuous
Temperature, ambient range	120° to −65° F.
Degree of inclosure	dripproof
Insulation	armature class A, rotor class B
Mounting	bolts through feet of frame

c. Stator Winding Data.

Number of poles	4
Number of slots	36
Number of coils	36
Number of turns per coil	7
Number of coil groups (3 coils per group)	12
Wire size (2)	0.0605 QF in parallel
Coil span	1–9 slots
Resistance, ohms per phase @ 120/208	0.147 ohms @ 25° C.
Resistance, ohms per phase @ 240/416	0.588 ohms @ 25° C.

d. Rotor Winding Data.

Number of coils	4, 1 per pole
Turns per coil	425
Wire size and type	0.0453 HFTG

e. Exciter Rating and Classification.

Type designation	BY–176 (General Electric)
Rated kw	0.5
Voltage	125
Rated speed	1,800 rpm at 60 cycle 1,500 rpm at 50 cycle
Amperes full load	4.8
Number of main poles	4
Number of interpoles	none
Temperature rise	50° C.
Method of cooling	air, single-end ventilated
Duty classification	continuous
Temperature, ambient range	125° to −65° F.
Degree of inclosure	dripproof
Insulation	class A
Mounting	extension of alternator shaft

f. Armature Winding Data.

Number of coils	87
Turns per coil	8
Number of segments	87
Number of slots	29
Wire size and type	0.0305 QF
Coil pitch	1–8 slots
Coils per slot	3
Connection pitch	1–44 bars
Alinement	slot No. 1 alined with segment No. 12
Type of connections	wave
Slot insulation	press board 0.015 inch thick
Slot wedges	rawhide fiber 0.030 inch thick

g. Field Winding Data. Pole coils are stocked as replacement parts. Refer to parts list.

h. Engine Rating and Data.

BHP at 1,800 rpm for continuous service	31
BHP at 1,500 rpm for continuous service	27
Maximum torque at 1,800 rpm	90 ft-lb.
Maximum torque at 1,500 rpm	95 ft-lb.
Type engine	4-cycle diesel
Number of cylinders	4
Bore and stroke	3¾ x 4⅛ in.
Displacement	182 cu in.
Rotation	clockwise facing radiator end
Firing order	1-3-4-2
Compression ratio	12/1
Cetane rating limits	46 to 60
Engine speed, maximum recommended	2,000 rpm
Engine speed, governed	1,800 and 1,500 rpm

i. Capacities.

Fuel tank	15 gal
Radiator and engine	16 qt
Crankcase	5 qt
Air cleaner	½ qt

j. Batteries.

Number	4
Voltage per battery	6
Type	lead storage
Output	90 ampere hours at 20-hour rate

k. Fire Extinguisher.

Type	hand-operated pump
Chemical filler	carbon tetrachloride

CHAPTER 2
OPERATING INSTRUCTIONS

Section I. SERVICE UPON RECEIPT OF EQUIPMENT

5. New Generator Set (Boxed and Processed)

a. General. New generator sets which are boxed and processed to meet military requirements for domestic and oversea shipment make definite services necessary before the unit can be put into operation.

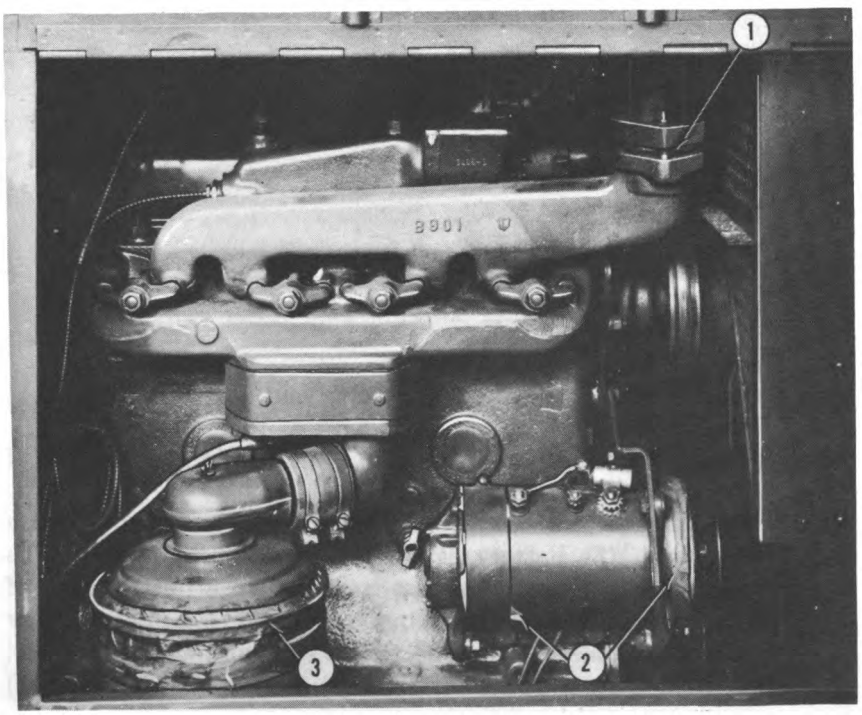
b. Unpack Generator Set. If the generator set has been in a very cold place, leave it in the box for several hours until it has warmed up to room temperature before opening. This will prevent sweating.

c. Remove Seals. Remove any tape that has been used to seal crankcase breather (fig. 9), exhaust, air cleaner intake, charging generator, meters (fig. 10), lamps, and fire extinguisher.

d. Remove Preservative Compounds, Lubricants, and Devices.

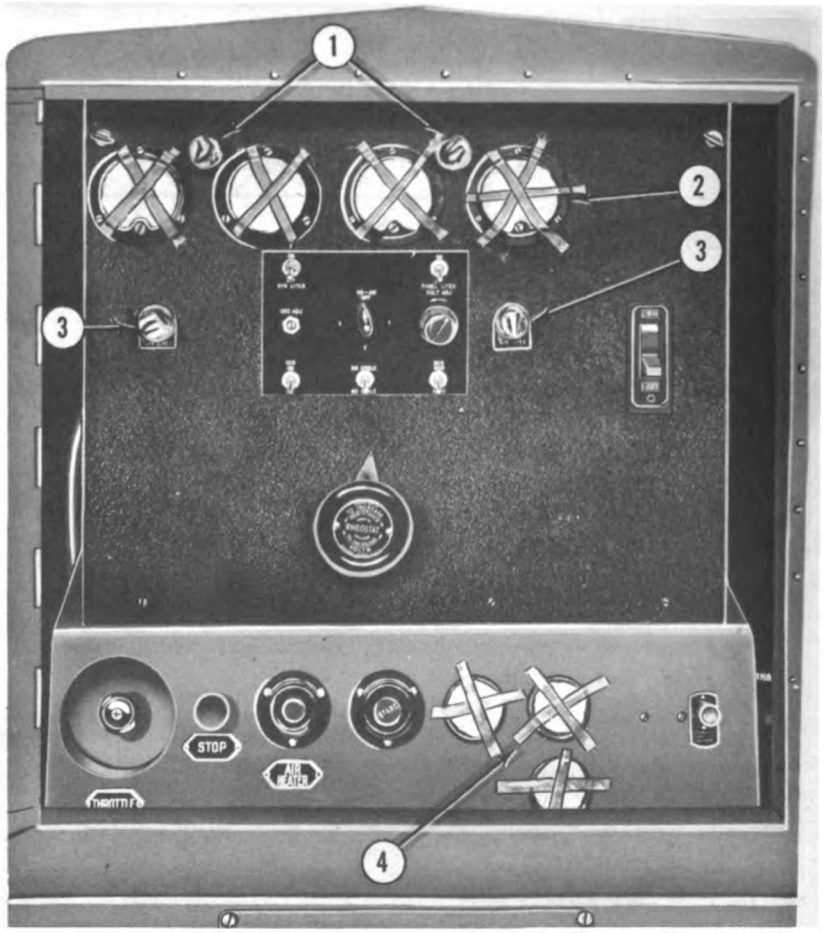
(1) Drain the engine crankcase. Replace all drain plugs.

(2) Drain radiator, pump, and water jackets.



1 Exhaust pipe. 2 Charging generator. 3 Air cleaner.

Figure 9. Location of seals on engine.



1 Panel lights
2 Generator instruments
3 Synchronizing lights
4 Engine instruments

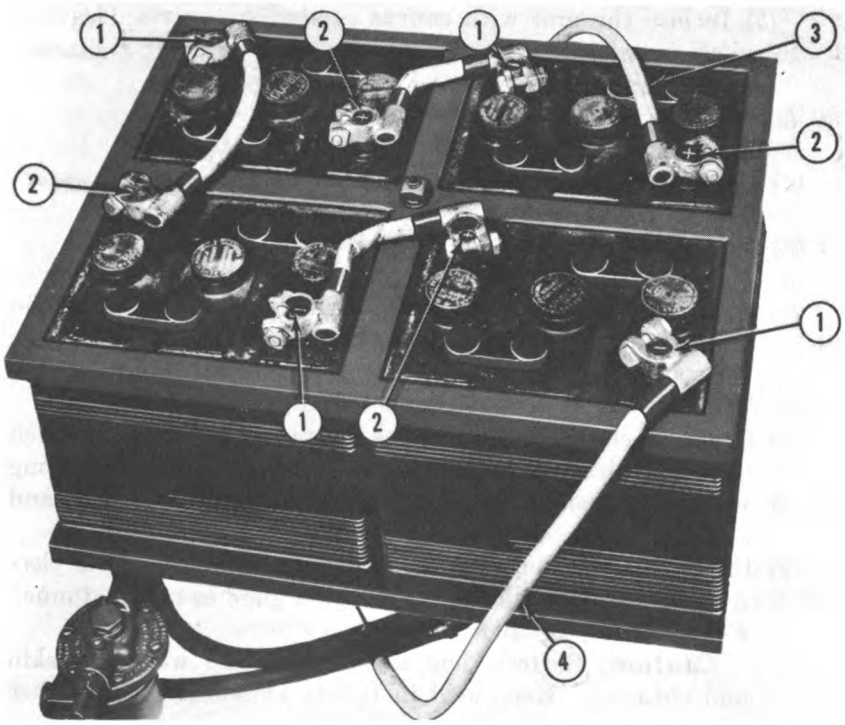
Figure 10. Location of seals on control panel.

e. Assemble Accessories.

(1) Run exhaust pipe through housing and attach it to exhaust manifold.

(2) Connect muffler to exhaust pipe and secure it to top of housing with two screws.

(3) Connect the four storage batteries in series as shown in figure 11, using the battery cables furnished with the set. The battery positive terminal is connected to a nut on back of voltage changeover switch box by ground lead (3). Battery negative cable (4) is connected to starting motor contactor. Intermediate negative terminal (1) and positive terminal (2) are connected by short jumpers.



1 Negative terminals
2 Positive terminals
3 Ground lead
4 Starter lead

Figure 11. Storage battery connections.

f. Check for Damages. Inspect the unit for damaged or missing parts.

(1) Look for broken or loose electrical and hose connections.
(2) Make sure all bolts, nuts, and cap screws are tight.
(3) Make sure all drain plugs and cocks are in place and tight.
(4) See that the engine air cleaner (7, fig. 5) is in place and its cap is tight.
(5) See that there is no dirt between radiator fins and on the generator air intakes.
(6) Look for sweating and moisture, particularly on main generator and exciter windings.

Note. If the windings are damp or if the set has been under water, make an insulation resistance test before operating.

(7) If the insulation-resistance meter indicates a value of less than 0.25 megohm, dry the moisture in the following ways:
(*a*) Bake the unit in an oven at temperatures not to exceed 90° C. until the insulation resistance becomes practically constant.

(*b*) Inclose the unit with canvas or similar covering, leaving an opening at the top for moisture to escape. Insert heating units or lamps.

g. Lubrication and Other Services.

(1) For lubrication, refer to paragraph 27.

(2) Close all drains in cooling system and fill radiator with water. For cold weather operation, see paragraph 21.

(3) Fill crankcase with recommended grade of oil (par. 27).

(4) Fill fuel tank (fig. 6) with diesel fuel. Turn both fuel valves to either UNIT TANK or EXTERNAL, depending on the supply used. Open the valve on the bowl filter under the fuel tank.

(5) Vent the fuel system as instructed in paragraph 63*d*.

(6) Check all electrical connections on engine for loose or broken wires. This includes ammeter, air heater, battery, starting motor, generator, voltage regulator, safety switch, and solenoid valve.

(7) Fill battery with electrolyte. Do not use water. Pour electrolyte into each filler hole through a glass or rubber funnel. Fill to bottom of filler tube.

Caution: Battery acid is corrosive and will burn skin and clothing. Keep acid in tightly closed glass or rubber container marked "ACID POISON".

(8) Remove fire extinguisher filler plug and check fluid level.

(9) Set up the equipment.

(*a*) The Buda 4BDG–182 generator set is designed as a complete unit for field use and no special foundation is required. If it is to be located on soft, muddy, or sandy ground, use a foundation of logs, timbers, or concrete at least 6 inches thick.

(*b*) Place the set so as to allow sufficient working space around it and so that cool air can reach the engine. The fan blows heated air out through the radiator and this air should not recirculate to the engine.

(*c*) If an external fuel tank is used, it should be as close as possible to the engine. Total lift from tank to engine should not exceed 6 feet.

Note. Keep diesel fuel clean. Strain through 200 mesh screen. Drain fuel tank and filter sumps frequently.

(*d*) If the generator is operated indoors or under a roof, run an exhaust pipe from the muffler to the outside. Use standard 1½-inch pipe. No exhaust stack is furnished with the generator set.

Caution: Exhaust fumes are poisonous. Run engine exhaust to outside of building.

(10) Make installation.
(*a*) Place the generator set on the foundation or in the location provided.
(*b*) Connect the service line to the generator set terminals for HIGH and LOW VOLTAGE (par. 85).
(*c*) See that the correct governor spring is installed for the frequency to be used (par. 9*h*).
(*d*) Check fan belt tension by depressing the fan belt midway between the generator and fan pulley. The slack should not be greater than one-half of an inch. Tension is adjusted by slightly changing the position of the generator.
(11) Test the operation.
(*a*) Turn the engine over by hand at least two turns to be sure everything is free.
(*b*) Start the set as described in paragraph 13. Watch all instruments. If operation is irregular at any step, stop the engine and correct the trouble.

Warning: Main generator and exciter voltages are dangerous. Keep clear of live parts of the machine. Shut the unit down before making repairs.

6. Used Equipment

a. Check for Damage. Inspect the entire set for damaged, loose, or missing parts (par. 5*f*).

b. Lubrication and Other Services. Proceed as in paragraph 5*g*.

Section II. CONTROLS AND INSTRUMENTS

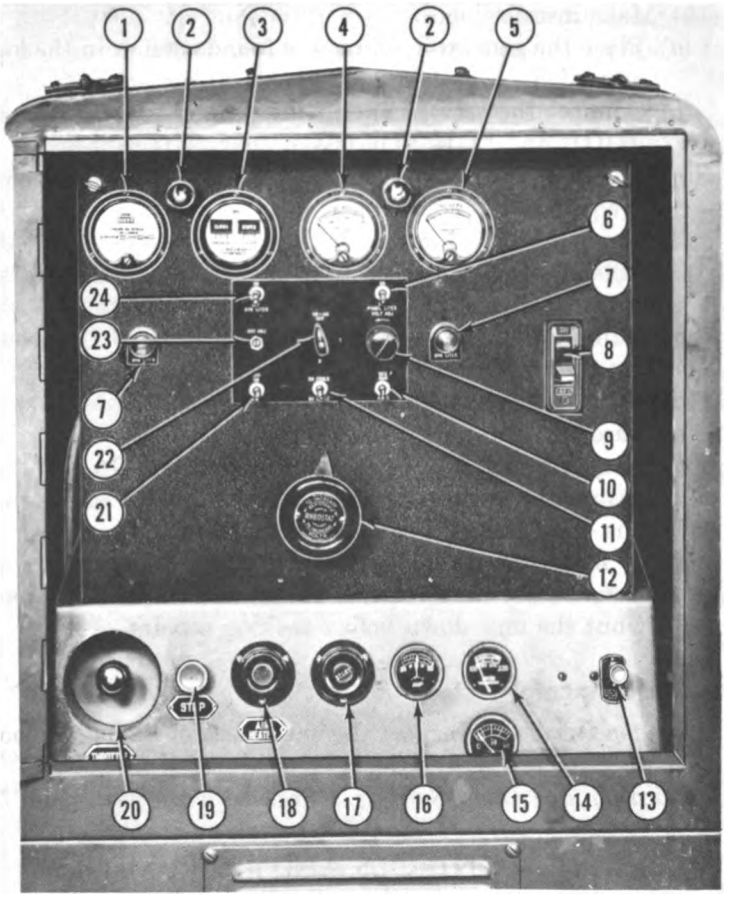
7. General

This section describes, locates, illustrates, and furnishes the operator sufficient information about various controls and instruments for proper operation of the generator set.

8. Controls, Generator

(fig. 12)

a. Voltmeter-Ammeter Phase Switch.
(1) The voltmeter-ammeter phase switch (22) makes necessary connections for the ammeter to read current in each phase and for the voltmeter to read voltage across each phase. It has four positions—OFF, 1, 2, and 3.
(2) Leave switch at OFF except when meters are to be read.
(*a*) Switch position 1 gives current in L 1 and voltage between L 1 and L 2 (par. 85).
(*b*) Switch position 2 gives current in L 2 and voltage between L 2 and L 3.



1 Time meter
2 Panel lights
3 Frequency meter
4 Voltmeter
5 Ammeter
6 Panel light switch
7 Synchronizing lights
8 Circuit breaker
9 Voltage regulator rheostat
10 Regulator switch
11 Frequency switch
12 Field rheostat
13 Safety switch
14 Temperature gage
15 Oil pressure gage
16 Battery charging ammeter
17 Starter switch
18 Air heater switch
19 Stop control
20 Throttle control
21 Crosscurrent compensation switch
22 Voltmeter-ammeter phase switch
23 Crosscurrent compensation rheostat
24 Synchronizing light switch

Figure 12. Instrument and control panel.

(*c*) Switch position 3 gives current in L 3 and voltage between L 1 and L 3.

b. Air Circuit Breaker.

(1) The air circuit breaker (8), on the right side of the control panel, is a three-pole breaker with an adjustable instantaneous trip on each pole. Each trip can be adjusted inde-

pendently over a range of 58 to 117 amperes. The breaker also serves as a hand-operated main switch to connect generator to service line terminals.

(2) For hand operation as a switch, throw the operating lever ON or OFF as desired.

(3) Tripping current values are adjusted by buttons on the front of the circuit breaker case.

c. Frequency Switch for 50 to 60 Cycle.

(1) The frequency switch (11) is on the regulator panel in the center of the control panel. It connects the voltage regulator for the required frequency.

(2) Throw to the required frequency.

d. Regulator Switch.

(1) The regulator switch (10) is on the regulator panel and has two positions, AUTOMATIC and MANUAL.

(2) Throw to AUTOMATIC for automatic operation of the voltage regulator. Throw to MANUAL for manual control of the voltage.

e. Field Rheostat.

(1) The field rheostat (12) is in the center of the control panel and is operated by a large knob. It does not operate when the regulator switch is on AUTOMATIC.

(2) With the regulator switch on MANUAL, turn the field rheostat knob to get the required voltmeter reading. If the load on the generator changes, the field rheostat will have to be repositioned to allow for change in load.

f. Voltage Regulator Rheostat.

(1) The voltage regulator rheostat (9) controls the value of voltage which the regulator holds constant. It does not operate when regulator switch is on MANUAL.

(2) With regulator switch on AUTOMATIC, turn voltage regu lator rheostat (9) to get the required voltmeter reading.

g. Crosscurrent Compensation (CCC) Switch.

(1) The crosscurrent compensation (CCC) switch (21) is an ON–OFF switch used only when the generator is operating in parallel with other generators.

(2) Throw this switch to ON for parallel operation. Throw it to OFF when the generator is operating alone.

h. Crosscurrent Compensating (CCC) Rheostat.

(1) The crosscurrent compensating (CCC) rheostat (23) is on the left center of the panel. It adjusts crosscurrent compensation when the generator is operating in parallel with the other generators.

(2) Turn the knob as required to eliminate circulating currents. Use it only when operating generators in parallel (par. 15).

i. Synchronizing Light Switch.

(1) The synchronizing light switch (24) is at the upper left center of the panel. It connects the two synchronizing lamps across two of the circuit breaker contacts when thrown to ON.

(2) Throw to ON when synchronizing for parallel operation (par. 15). Throw to OFF after the circuit breaker is closed.

j. Panel Light Switch.

(1) The panel light switch (6) is at the upper right center of the panel. It turns the two battery-fed panel lights off and on.

(2) Always turn lights off when set is stopped to avoid draining the storage battery.

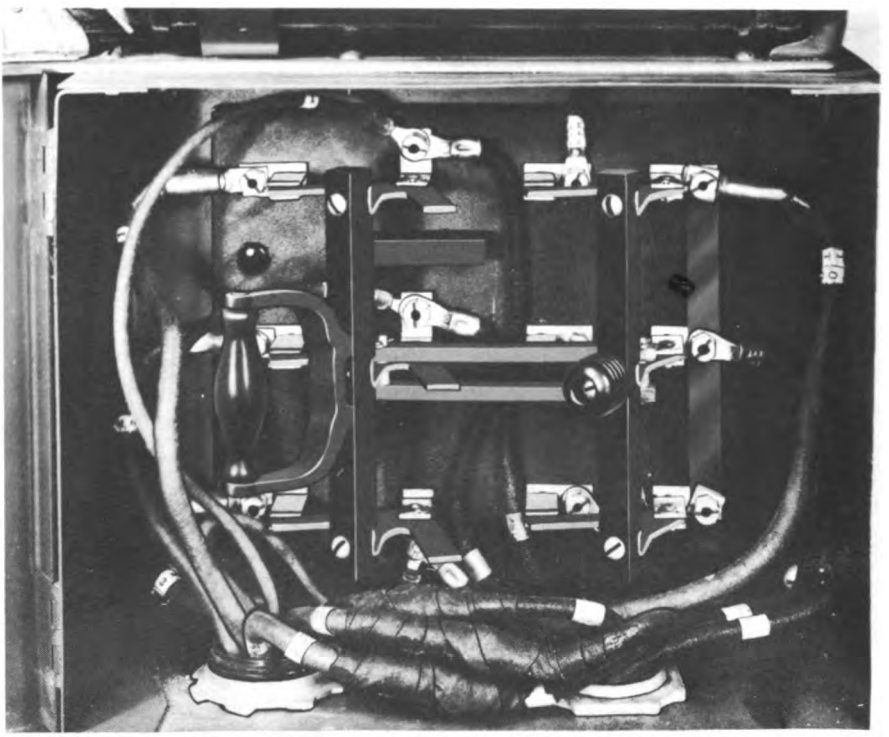


Figure 13. Voltage changeover switch.

k. Voltage Changeover Switch (fig. 13).

(1) The voltage changeover switch is a pair of three-blade knife switches ganged to a single handle. It is in a hinged-cover junction box on the right side of the generator under the housing cover.

(2) Throw switch to right for 230/400-volt, 50-cycle or 240/416-volt, 60-cycle operation. Throw switch to the left for 120/208-volt operation.

9. Controls, Engine

a. Starter Switch (fig. 12).

(1) The starter switch (17) is a pushbutton switch. When pressed in, it energizes a contactor which closes the circuit from battery to starting motor to crank the engine.

(2) Press in until engine starts, but not over 10 seconds at a time as the battery will run down rapidly.

b. Air Heater Switch

(1) The air heater switch (18) is a pushbutton switch. When pressed in, it connects the air heater to the battery.

(2) In cold weather, press in for about 30 seconds before pressing starter switch.

c. Throttle Control.

(1) The throttle control (20) is a knob which operates the governor operating lever through a wire running through a flexible tube.

(2) To operate, press button in center of knob. Pull out to increase speed and push in to decrease speed.

d. Stop Control.

(1) The stop control (19) is a knob which moves the control sleeve on the injection pump by means of a wire running through a flexible tube. This control shuts off fuel and stops the engine.

(2) To stop the engine, pull out knob and hold it until engine stops, then release.

e. Safety Switch.

(1) The safety switch (13) is in the lower right corner of the control panel. In the START position, it opens the solenoid fuel valve and permits fuel to enter the pump. When lubricating oil pressure rises to the proper value, this switch automatically turns to RUN. If oil pressure drops, the switch turns to OFF. It also turns to OFF if engine water temperature becomes too high. In the OFF position, the safety switch trips the solenoid valve and stops the engine, and also opens the air circuit breaker.

(2) Turn switch to START when starting engine.

f. Solenoid Valve.

(1) The solenoid valve is on top of the injection pump. It automatically shuts off fuel and stops the engine if temperature becomes too high orl ubricating oil pressure becomes too low.

(2) Operation of the solenoid valve is automatic.

g. Overspeed Switch.

(1) The overspeed switch is just back of the governor and is driven from the engine camshaft. It automatically trips the solenoid valve and stops the engine if the speed becomes too high. At the same time, it opens the air circuit breaker.

(2) Operation of the overspeed switch is automatic.

h. Governor Spring (fig. 14).

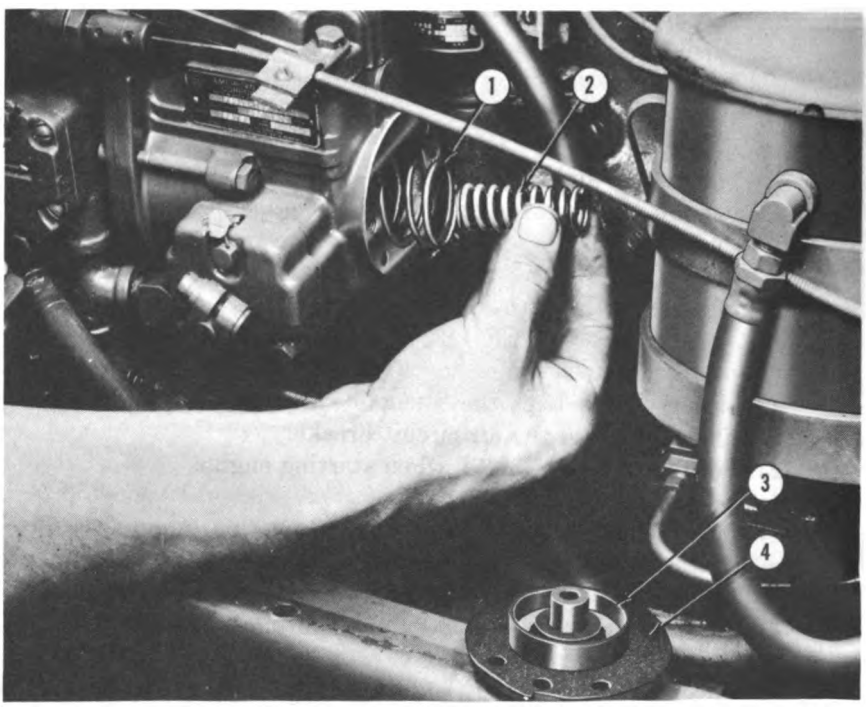
(1) The governor is factory-equipped with a spring marked 50/7 and is set for 60-cycle operation. For 50-cycle operation, another spring marked 50/14 is placed in the tool box. The number is stamped in extremely small figures on one end of the spring.

(2) The correct spring for the required frequency must be installed. Remove the end cap (4) on back end of governor and replace the inner spring (2). Do not remove or change the spacing washers (3) found in the end cap. Do not change the outer spring (1).

i. Fuel Valves (fig. 15).

(1) There are two valves on the left side just back of the fuel tank. The inlet valve (2) is in the transfer pump suction line. The return valve (1) is in the return line to the tank. Both are three-way valves marked OFF, EXTERNAL, and TANK.

(2) If an external tank is used, run lines from it to the plugged taps on both valves. Turn valves to either TANK or EXTERNAL, depending upon the supply used.



1 Outer spring
2 Inner spring
3 Spacing washers
4 End cap

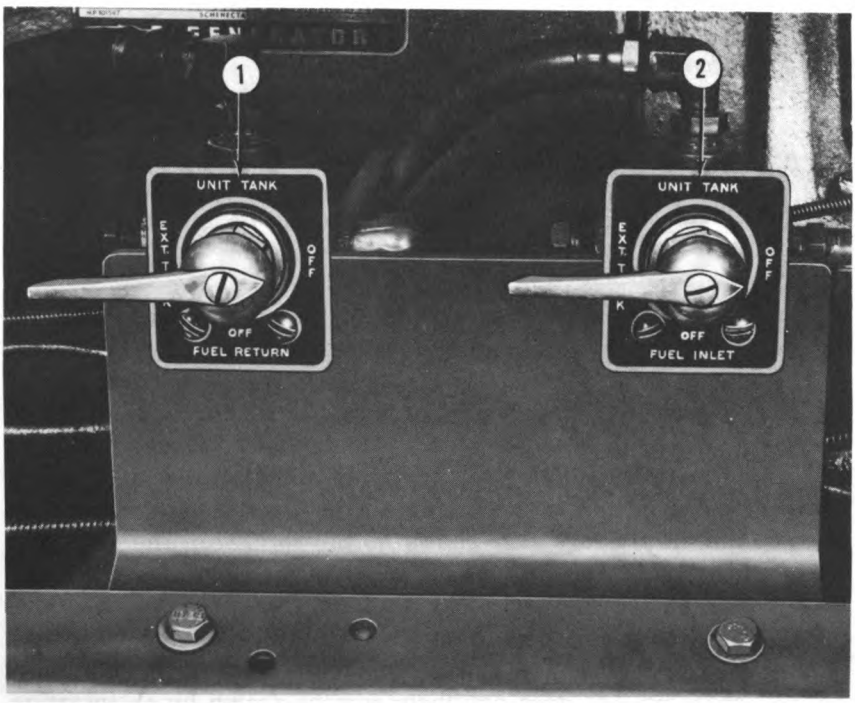
Figure 14. Changing governor spring.

10. Instruments, Generator
(fig. 12)

a. Time Meter.

(1) The time meter (1), at top left of the control panel, is operated by the main generator voltage. It records the cumulative hours of operation, in hours and tenths, on a direct reading indicator.

(2) Operation of the time meter is automatic.



1 Return valve 2 Inlet valve

Figure 15. Fuel valves.

b. Voltmeter (Dual Scale 0–300/600).

(1) The voltmeter (4), at top center of the control panel, indicates line voltage.

(2) The voltmeter is operated by the voltmeter-ammeter phase switch (par. 8*a*).

(3) Line voltage will be 208 or 416 at 60 cycles and 400 at 50 cycles.

c. Ammeter (Dual Scale 0–40/80).

(1) The ammeter (5), to the right of the voltmeter, indicates line current.

(2) The ammeter is operated by the voltmeter-ammeter phase switch (par. 8*a*).

(3) Line current will be a maximum of 52 amps at 208 volts, 60 cycle; 26 amps at 416 volts, 60 cycle; and 27 amps at 400 volts, 50 cycle.

d. Frequency Meter.

(1) The frequency meter (3) is between the time meter and voltmeter. There are two windows on the face of the frequency meter, each containing several reeds. One of these reeds vibrates at each particular frequency between 46 to 54 or 56 to 64 cycles.

(2) Operation of the frequency meter is automatic.

e. Synchronizing Lights.

(1) There are two lights (7), one on either side of the center part of the panel.

(2) Operation of these lights is described in paragraph 15*a*.

11. Instruments, Engine

(fig. 12)

a. Oil Pressure Gage (0 to 50 psi).

(1) The oil pressure gage (15) is on the lower portion of the control panel. It indicates engine lubricating oil pressure in psi.

(2) Operation of the oil pressure gage is automatic.

(3) Normal oil pressure is 15 to 25 pounds. Pressure will be above normal while the engine is cold and may drop below normal at idling speed after the engine has warmed up. If the oil pressure gage shows no pressure, stop the engine.

b. Battery Ammeter (−30 to +30 amps).

(1) The battery ammeter (16) is a zero-center ammeter to the left of the oil pressure gage. It indicates current in the battery and shows whether the battery is charging or discharging. It does not show current drawn by the starting motor when cranking.

(2) Operation of the battery ammeter is automatic.

(3) A low charging rate is normal; however, a high charging rate will be indicated after a long cranking period or with weak batteries.

c. Temperature Gage (100° to 220° F.)

(1) The temperature gage (14) is just above the oil pressure gage. It shows engine water temperature at top of cylinder head. Normal temperature is 165° to 190° F.

(2) Operation of the temperature gage is automatic.

Section III. OPERATION UNDER USUAL CONDITIONS

12. General

a. Instructions in this section are for the information of personnel responsible for operation of this generator set.

b. It is essential that the operator know how to perform every operation of which the machine is capable. This section gives instructions on starting and stopping the machine, instructions on the basic motions of the machine, and instructions on how to coordinate the basic motions to perform the specific tasks for which the machine is designed. Since nearly every job presents a different problem, the operator may have to vary the given procedure to fit the individual job.

13. Starting and Stopping

(fig. 12)

a. Preparation for Starting.

(1) Refer to paragraph 32 for before-operation services.
(2) Throw voltage changeover switch to correct position for voltage to be.generated.
(3) Open the air circuit breaker (8).
(4) Set the regulator switch (10) to MANUAL and the frequency switch (11) to the frequency required.
(5) Set the CCC switch (21) to OFF if generator is to operate alone. Set it to ON if generator is to operate in parallel with others.
(6) Turn the field rheostat handle (12) counterclockwise as far as it will go.
(7) Turn the safety switch (13) to ON.
(8) Pull the throttle (20) out to full speed position.

b. Starting Engine.

(1) If weather is cold, push air heater switch (18) and hold it for 45 seconds.
(2) Release air heater switch and press starter switch. This will avoid excessive drain on battery.
(3) If engine does not start in 10 seconds, release starter switch for 90 seconds and then try again.
(4) As soon as engine starts, release starter switch and push throttle in to idling speed.

c. Check Engine Operation.

(1) Read oil pressure gage (15). It should build up to at least 15 psi in a few seconds. Normal operating pressure is between 15 and 25 psi. When oil is cold, pressure may go as high as 50 psi or more, but will return to normal when operating temperature is reached.
(2) Read battery ammeter (16). It should read on the CHARGE side and be 10 amperes or less. If ammeter reads DISCHARGE, check the polarity of the battery circuit.
(3) Let engine run at idling speed until engine temperature gage begins to read. Normal operating temperature is 165° to 195° F.

(4) Gradually increase speed by pulling throttle out. Listen for unusual noises indicating trouble. Watch the engine instruments.

Caution: Never race a cold engine.

d. Starting Generator.

(1) When engine is up to full speed, throw the volt-meter-ammeter phase switch (22) to any one of its numbered positions.

(2) Turn field rheostat (12) clockwise until voltmeter reads the required voltage.

(3) Adjust throttle until frequency meter (3) reads the required frequency.

(4) Throw the regulator switch (10) to AUTOMATIC.

(5) Adjust the voltage regulator rheostat (9) until voltage is the required value.

(6) Throw the circuit breaker (8) to ON.

(7) Read voltage and current of each phase. The current should not be more than rated value for the voltage generated.

e. Stopping the Generating Set.

(1) Throw circuit breaker to OFF.

(2) Push throttle to idling position and let the engine run a few minutes to cool off gradually. Stopping directly from full speed may damage valves and manifold.

(3) Pull the stop control and hold it until the engine stops.

(4) Turn off the panel lights. They are supplied by the battery.

14. General Operating Details

a. Engine Temperature. Water temperature should not be over 195° F. Moderate overheating may result from overload on the generator or low water in the radiator. Overheating usually can be corrected by reducing load and adding water. Radiator boiling is an indication of serious trouble and the cause should be located and corrected at once.

b. Oil Pressure. Oil pressure gage should read between 15 and 25 pounds. Low oil pressure indicates seriously low oil level, clogged oil filter, or oil too light for the temperature.

c. Battery Charge. The battery charging ammeter will read about 10 amperes CHARGE until the battery is fully charged when it will drop to nearly zero. Ammeter reading on the DISCHARGE side when engine is running at full speed indicates serious trouble in the battery circuit—probably a short circuit or a burned-out generator or reversed battery polarity. Readings higher than 10 amperes CHARGE after the engine has been running for some time indicate either a bad battery or incorrect generator regulator adjustment.

d. Generator Load Balance. The electrical load on the generator should be kept fairly well balanced. This is shown by nearly equal readings of the ammeter in each of the three lines and by nearly zero current in the neutral. If one line current gets to be as much as twice the size of another, the fact should be reported to proper authority. Unbalance causes unequal heating in the generator and reduces available power output. The unbalanced condition can be corrected by changing the loads connected to the different phases.

e. Inspection During Operation. Refer to paragraph 32*d*.

15. Specific Operation

(fig. 12)

Caution: When operating this generator in parallel with others, follow operating instructions carefully.

a. Parallel Operation. This generator set can be operated in parallel with other generators running at the same voltage and frequency to furnish more power than one machine alone can give. See that the set is wired to a power circuit which is already being supplied by other generators. Open the main circuit breaker. Proceed as follows:

(1) Bring the set up to its rated voltage and frequency.

(2) Throw the crosscurrent compensation switches (21) on all the generators to PARALLEL position.

(3) Throw the synchronizing light switch (24) to ON. This will cause the two synchronizing lamps (7) to blink on and off. The lights should blink together. If they blink one after the other, the generator leads are connected with the wrong phase rotation. To correct this, shut off the power at the connection point and interchange any two of the wires to the generator set terminals.

(4) Adjust the throttle control (20) until the lamps blink, very slowly, four or five times a minute or less.

(5) Using the field rheostat (12) or the voltage regulator rheostat (9), adjust the voltage of the set until it is equal to the voltage of the circuit to which it is to be connected.

(6) Close the main circuit breaker (8) at the instant the lamps (7) are both dark.

(7) When several alternators are running in parallel, the amount of power each one supplies is fixed by the speed control of its engine. Moving the control toward high speed increases the power; moving it toward low speed decreases the power. The voltage controls will not affect the power output except for a small change in losses in the machines. Proceed to adjust the speed controls of all the generators in parallel to get the desired division of power between them. The best adjustment is to have the power from each machine

proportional to its rating. For example, if three generators rated 15, 30, and 60 kw are operating in parallel, they should be adjusted so that their currents are in the ratio of 1 to 2 to 4.

(8) The voltage controls do affect the currents of the individual generators by causing a so-called circulating current to flow between them. This current does not supply any power to the load. It merely causes a waste of power in each generator. Any change in the voltage control adjustment of one of the machines will make the currents in all the machines go either up or down. If increasing the voltage of one machine causes the currents of all the machines to go down, a point will presently be reached where the currents start to go up again. The point at which the currents are the smallest is the correct operating point.

(9) A change in the voltage control of any machine will affect the voltage of the whole system. When alternators run in parallel, they all have the same voltage and frequency and they all run at the same speed. The voltage controls of all the generators must be adjusted so that their currents are a minimum and so that the system voltage is the desired value. This adjustment sounds difficult, but a little practice will enable the operator to make it satisfactorily. It is important to make these adjustments to get the full power capacity of all the generators operating in parallel. Poor adjustment will cause the circuit breakers to trip before the machines are carrying their full rated loads.

(10) After the voltage controls have been set properly at one particular value of total load, the crosscurrent compensation automatically adjusts the field currents to keep circulating current at a minimum. Crosscurrent compensation is a compounding scheme by means of which the voltage regulator is affected by the line current as well as by the line voltage. The crosscurrent compensation rheostat adjusts the amount of feedback of line current into the regulator. After the voltage controls are properly set as in (8) above, watch the ammeter. When the ammeter reading has changed a few amperes as a result of a change in system load, turn the CCC rheostat until the ammeter reading is minimum. This adjustment may have to be changed occasionally, particularly if the generator set is supplying power to induction motors. This is because the power factor of induction motors changes as the load changes. Whenever the ammeter reads more than the rated value of current, try to reduce it by means of the CCC rheostat. It is impossible to give specific instructions for operating this

control. The operator must learn by experience how to get the best adjustment.

b. Operation at Different Voltages. Connect the service line to the proper terminals and throw the voltage changeover switch to the proper position.

c. Operation at 50 Cycles. Change the governor spring as instructed in paragraph 9*h* and set the voltage regulator frequency switch to 50-cycle operation.

16. Operating Precautions

a. Racing Cold Engine. Never race a cold engine. It shortens engine life and may do enough harm to require major repairs. Always run engine at idling speed until the water temperature gets up to about 140° F.

b. Running Without Load. Do not leave the engine running at governor speed without any load except for a few minutes at a time. Set it back to idling speed for short no-load periods. Stop it if the load is off for more than 15 minutes, except in unusually cold weather.

c. Keeping Set Clean. Keep the equipment clean. Watch particularly the spaces between radiator fins and air inlets on engine and generator. Take care to prevent dirt entering oil filling holes and other openings to bearings. When removing any parts for servicing, keep the parts clean.

d. Keeping Fuel Tanks Clean. Diesel engines are easily damaged by dirt in the fuel oil. Strain all oil. Clean oil filters and drain fuel filters frequently.

e. Service After First 8 Hours Operation.

(1) Inspect the equipment for loose connections, leaks, and loose nuts and screws. Tighten as required.

(2) Tighten cylinder-head nuts as instructed in paragraph 76*c*.

(3) Check fan belt tension and adjust if necessary as instructed in paragraph 56*a*.

(4) Change oil in generator and starting motor as directed in LO 5–5161.

(5) Drain water and sediment from bottom of primary and secondary fuel filters and from trap in bottom of fuel tank.

(6) Remove vent cocks from primary and secondary fuel filters and allow gravity pressure to force the air out. Operate the hand primer until no bubbles come out. Then replace vent cocks and screw in primer handle.

17. Moving to New Location

a. Service Lines. Disconnect service lines from terminals in back of control panel.

b. Fuel Valves. Turn both fuel valves to OFF.

c. Fuel Tank. If an external tank was used, disconnect the lines from it to the fuel valves.

d. Exhaust Pipe. If an exhaust pipe was used beyond the muffler, remove it.

e. Radiator. Be sure the radiator has enough antifreeze if cold weather is expected.

f. Reassembly. Follow paragraph 5 so far as it applies.

Section IV. RADIO INTERFERENCE SUPPRESSION

18. Purpose

Radio interference is caused by any electrical contacts which spark. Commutators in particular cause radio noise. Interference is suppressed by connecting electrical condensers from ground to all wires connected to sparking contacts and by shielding any long wires that lead to contacts. Ground is the set base, housing, engine block, generator frame, and all metal parts connected to them. All these parts must make a clean metallic contact with each other.

19. Description and Location

(fig. 16)

The location of the suppression condensers is shown in the wiring diagram. These condensers are placed on the charging generator

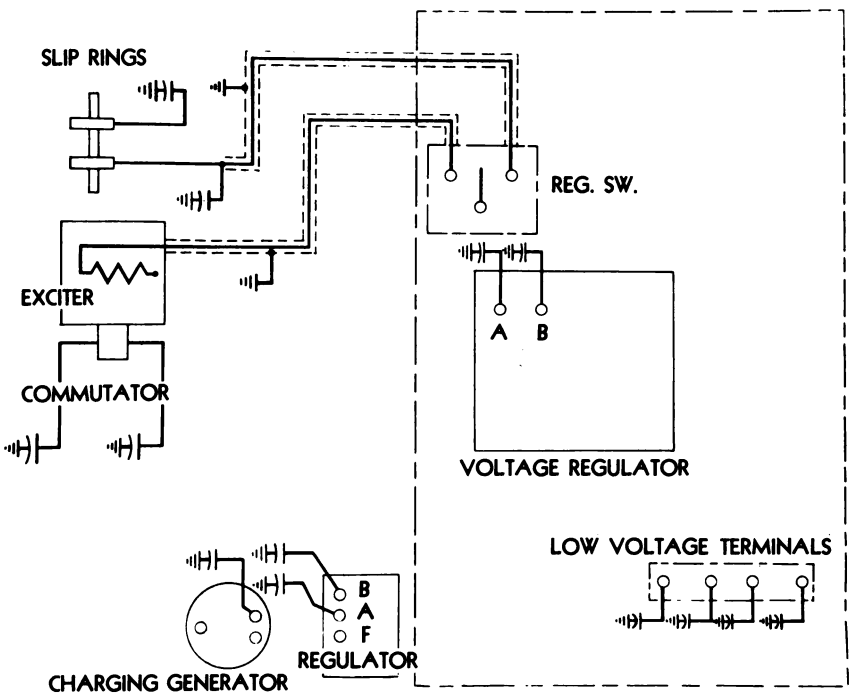


Figure 16. Wiring diagram of radio interference suppression system.

and regulator, on brushes of the alternator and exciter, and on the power terminals inside the control panel. Leads from the exciter to the voltage regulator on the panel are shielded with metal braid as a further step in suppressing interference.

20. Operation

Operation of the interference suppression condensers on the Buda generator is automatic.

Section V. OPERATION UNDER UNUSUAL CONDITIONS

21. Cold Weather Operation

a. General. Cold weather has serious effects on the generator set, making it hard to operate, and definite steps must be taken to make operation satisfactory. Freezing of water and battery acid must be prevented. All lubricants must be changed in accordance with instructions contained in LO 5–5161. Storage battery voltage drops with temperature.

b. Cooling System Protection (fig. 17).

(1) Drain radiator and clean and flush cooling system as instructed in paragraph 54. The radiator drain is at the bottom of the cold water pipe on left side of the generator set. There is also a drain on each side of the cylinder block and/or bottom of water pump.

(2) Locate and repair all leaks in radiator, hose, water pump, and cylinder block.

(3) Add antifreeze according to the table shown in figure 17.

(4) Test the antifreeze before every predicted period of extreme cold, and at least once a week.

c. Battery Protection.

(1) If the battery needs water, add it after starting the set. Do not add water when shutting down. Do not add water if the battery charge is low.

(2) Test the battery with a hydrometer at least once a week. If the reading is below 1.270, recharge the battery.

(3) Before cranking with the starter, turn the engine over by hand to be sure it is free to turn. This will save the battery and prevent damage to the water pump if it is frozen.

(4) In extreme cold it may be necessary to remove the batteries to a warm place to raise the voltage enough to turn the engine over.

d. Lubrication. All lubricants must be changed to the correct cold weather values given in LO 5–5161. For temperatures below −10° F., refer to Operation of Equipment in Protracted Cold Temperatures (Note 2) in LO 5–5161.

PROTECTION TO		PINTS PER	PERCENT
DEGREES FAHRENHEIT	DEGREES CENTIGRADE	GALLON	OF ANTIFREEZE BY VOLUME
+ 20	− 7	1.5	20
+ 10	−12	2	25
0	−18	2.5	32
− 10	−23	3	38
− 20	−29	3.5	44
− 30	−35	4	50
− 40	−40	4.5	57
− 50	−46	5	63
− 60	−51	5.5	70
− 70	−57	6	75

Figure 17. Table of antifreeze requirements from +20° to −70° F.

22. Operation in Extreme Heat

a. Cooling System. The cooling system must be kept in efficient condition.

(1) Clean and flush as instructed in paragraph 54.
(2) Add rust inhibitor as instructed in paragraph 55*b*.
(3) Keep all ventilating air openings clean.
(4) Keep radiator full of clean soft water.

b. Lubrication. Use proper lubricants as directed in LO 5–5161.

c. Battery. Keep level of electrolyte to proper point. It evaporates rapidly in hot weather.

d. Fungus and Termites. In tropical locations, watch battery, generator windings, wiring, and hose connections for signs of fungus and termite damage. Watch all electrical contacts for fungus and keep contacts cleaned.

23. Operation in Extreme Dust or Sand

a. Cooling System. Keep radiator fins clean. Inspect them every day and wipe or blow dirt out.

b. Lubrication. Be very careful to keep sand and grit out of lubricants and filling holes.

c. Air Cleaner. Clean air cleaner oil cup and refill with fresh oil every day. Refer to paragraph 71.

d. Generator Ventilation. Keep close watch on generator air passages. Blow out or clean by suction, if possible every 2 or 3 days.

e. Air Inlets. Shield the generator, engine, and radiator air inlets as much as possible from dust and sand.

24. Operation Near Salt Water

a. Lubrication. Salt water causes severe corrosion. Be particularly careful to follow the lubrication schedule.

b. Protection. Shield the entire set as much as possible from salt spray and fog.

c. Cleaning. Keep all parts of the set well wiped off. Clean off all rusty spots and protect with grease. Repaint rusty spots as soon as possible. Refer to paragraph 30.

Chapter 3
MAINTENANCE INSTRUCTIONS

Section I. SPECIAL ORGANIZATIONAL TOOLS AND EQUIPMENT

25. Special Service Tools

No special service tools are issued to organizational maintenance personnel for use with this generator set.

26. Tools Issued for Use With Generator Set

On-equipment tools and spare parts are listed in appendix III.

Section II. LUBRICATION AND PAINTING

27. General Lubrication Information

a. LO 5–5161 prescribes first and second echelon lubrication maintenance for the Buda generator set 4BDG–182.

b. A lubrication order is published for each item of equipment. The lubrication order shown in figure 18 is a reproduction of an approved lubrication order for this generator set. For current LO 5–5161, refer to SR 310–20–4.

c. Lubrication orders prescribe approved first and second echelon lubrication instructions for mechanical equipment issued by the technical services. Instruction contained therein are mandatory.

28. Detailed Lubrication Information

a. Care of Lubricants and Lubricating Equipment. It is important to prevent dirt, grit, and water from getting into lubricants and bearings. Keep lubricants in clean, tightly closed containers. Protect oil cans and grease guns from dirt. Clean all lubricating fittings before using.

b. Bearings of Electrical Equipment. Too much oil in the charging generator and starter bearings will get onto the commutator and prevent it from operating. Too much grease in the main generator bearing will have the same effect, and will also cause overheating of the bearing.

c. Proper Method of Checking Crankcase Oil.

(1) Check level after engine has been stopped long enough for oil to drain into crankcase.
(2) Remove oil level gage and wipe clean.
(3) Put oil level gage back in to full depth, then draw it out and read.

LUBRICATION ORDER

LO 5-5161

GENERATOR SET PORTABLE, DIESEL DRIVEN, 15 KW, 120/208 - 240/416 VOLTS, 3 PH, 60 CY, CONVERTIBLE TO 230/400 VOLTS, 3 PH, 50 CY, BUDA MODEL 4BDG-182.

Reference: TM 5-5161, TB 5-5161-1

Intervals given are maximums for normal 8-hour day operation. For abnormal conditions or activities, intervals should be shortened to compensate.

Clean fittings before lubricating.

Relubricate after washing.

Clean parts with SOLVENT, dry cleaning, or OIL, fuel, diesel. Dry before lubricating.

Lubricate dotted arrow points on both sides of the equipment.

Drain crank and gear cases only when hot after operation; check level and replenish when cool.

– KEY –

LUBRICANT	CAPACITY	EXPECTED TEMPERATURE			INTERVALS
		Above +32°F	+32°F to -10°F	Below -10°F	
OE—OIL, engine		OE 30 or NS 9250	OE 10 or NS 9110	See Note 1	D—Daily W—Weekly 2W—Two Weeks M—Monthly S—Semi-annually
Crankcase	5 qts.				
Air Cleaner	½ qt.	OE 30 or NS 9250	OE 10 or NS 9110	RL	
CG—GREASE, general purpose		CG 1 or NS 14L9	CG 0 or NS 14L9	OG 00	
RL—OIL, Recoil Light					
OG—GREASE, Low Temperature					
BR—GREASE, Ball and Roller Bearing					

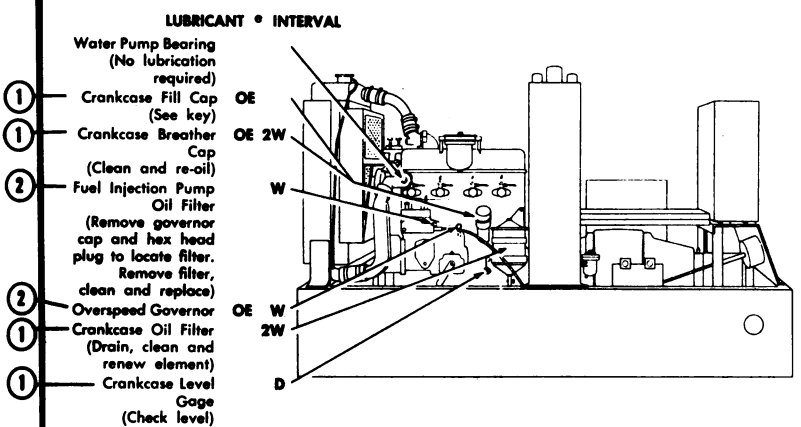


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Figure 18. Lubrication order.

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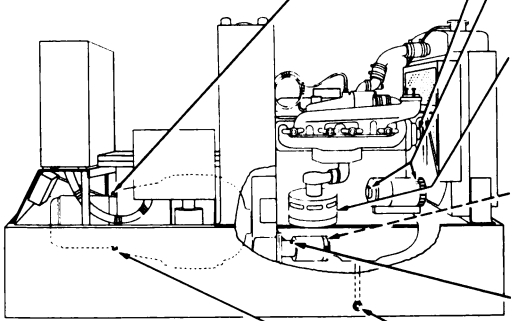


INTERVAL	LUBRICANT		
S	BR	Main Generator and Exciter Bearing (Remove Relief plug and with generator running, lubricate until fresh lubricant extrudes from relief opening) Fan Hub (No lubrication required)	3
W	OE	Engine Generator Bearings (Sparingly) (When equipped with life-seal type bearings, no lubrication required)	4
D	OE	Air Cleaner (See key) (Clean and refill oil reservoir to level mark) (Every week disassemble entire unit. Clean and reassemble)	5
W	OE	Starter Bearings (Sparingly) (When equipped with life-seal type bearings, no lubrication required)	6
S	CG	Starter Reduction Gears (Reduction type only) (Remove plug, fill ¾ full)	6
2W		Crankcase Drain Plug (Drain and refill)	
S		Main Generator and Exciter Bearing Relief Plug (Remove to lubricate bearings and replace)	3

NOTES:

1. COLD WEATHER—WHEN WINTERIZATION KIT IS NOT AVAILABLE. ENGINE CRANKCASE. Every 3 days drain crankcase; refill to "Full" mark with OE 10. Add 1½ qts of gasoline. Run engine 5 minutes to mix. Mark the new level on the gage for future reference. CAUTION: Every ½ day check level and fill to "Full" mark with OE 10. Then, if engine is to be shut down for ½ day or more, add 1½ qts of gasoline to reach new level mark. Operate engine for 5 minutes to mix. NOTE: OIL, fuel Diesel may be used as a temporary diluent, but ONLY when sufficient gasoline is not available.

WARNING: Diluent used is inflammable. Da not service equipment near heater or open flame.

2. FOR OPERATION OF EQUIPMENT IN PROTRACTED COLD TEMPERATURES BELOW −10°F. Remove the lubricants prescribed in the key for above −10°F. Clean part with Solvent, dry-cleaning, and drain gear cases. Relubricate with lubricants indicated in the key for below −10°F temperatures. If winterization kit is installed do not use diluent.

3. OIL CAN POINTS — Every week lubricate throttle, carburetor, and governor connections with OE.

Copy of this lubrication order will remain with the equipment at all times; instructions contoined herein are mandatory and supersede all conflicting lubrication instructions dated prior to the date of this lubrication order.

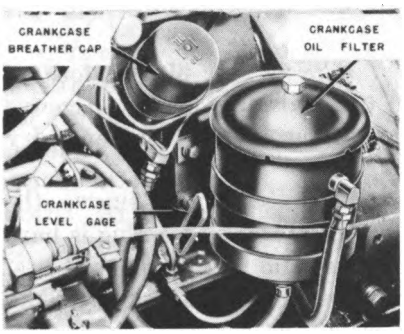
BY ORDER OF THE SECRETARY OF THE ARMY:

J. LAWTON COLLINS
Chief of Staff
United States Army

OFFICIAL:

WM. E. BERGIN
Major General, USA,
The Adjutant General

Figure 18—Continued.



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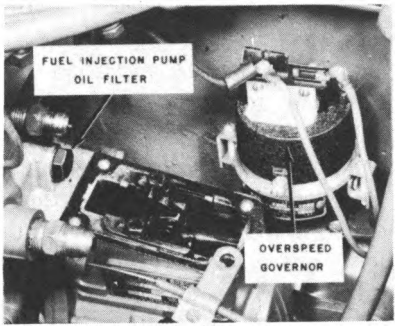

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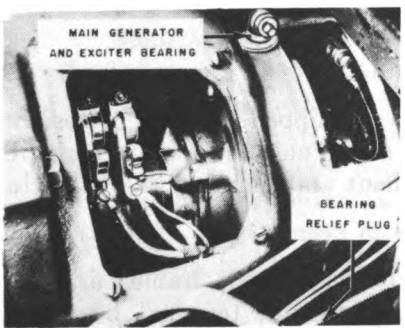

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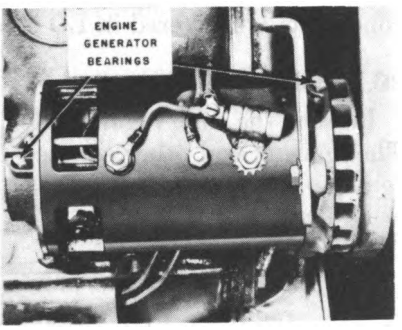

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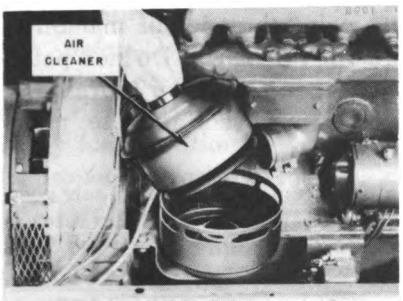

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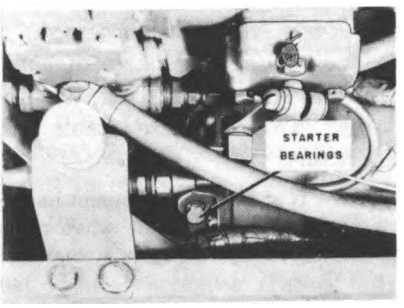

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Figure 18—Continued.

d. Draining Crankcase. Always drain the crankcase when the engine is hot.

e. Servicing Fuel Injection Pump Oil Filter. This filter is located under the governor cap in the side of the hydraulic head. Remove the cap and hex head plug. Clean the screw in a solvent and dry with compressed air before replacing.

f. Servicing Main Generator and Exciter Bearing. Remove the bearing relief plug at the bottom of the generator. This plug is hard to see but is directly opposite the filler plug and can be reached best under the right side of the generator. Turn relief plug out by hand and replace handtight. Remove the filler plug and, with generator running, lubricate until fresh lubricant extrudes from relief opening.

29. Special Lubrication

Lubrication requirements for unusual atmospheric and weather conditions are covered in LO 5–5161.

30. Painting

Inspect the unit regularly for signs of chipped paint or corrosion. The housing and other exposed parts of the unit will require periodic touchup or painting. Surface treatment and painting are to be in accordance with TM 9–2851.

a. Parts To Be Painted.

(1) When required, paint the housing, skid, frame, firewall, radiator, fuel tank, engine, generator, terminal box, and accessories.

Caution: Use only a heat-resistant paint when painting the engine, exhaust manifolds, pipes, or muffler.

(2) Information and data plates can be coated with a clear lacquer.

b. Parts Not To Be Painted. Do not paint threaded or machined surfaces, or sliding parts of control rods or linkages. Do not paint electrical contacts, wiring, terminal blocks, instruments, or lubrication fittings. Mask these items and inspection covers on the main generator.

Note. If accessory equipment has been removed from the unit, make sure good ground contacts are made when reinstalling the equipment. In some cases it may be necessary to scrape a small amount of paint.

Section III. PREVENTIVE MAINTENANCE SERVICES

31. General

The operator of this equipment and the organizational maintenance personnel must perform their preventive maintenance services regularly, to insure satisfactory operation of the equipment and to reduce the probabilities of mechanical failure.

32. Operator Maintenance

a. Inspections. Inspections must be made before operation, during operation, at halt, and after operation, as described in this section. All inspections of assemblies, subassemblies, or parts must include any supporting members or connections and must determine whether the unit is in good condition, correctly assembled, secure, or excessively worn. Any mechanical condition which may result in further damage to the unit must be corrected before the equipment is operated.

(1) Inspection for "good condition" is usually an external visual inspection to determine whether the unit is damaged beyond safe and serviceable limits, or to determine if it is in such a condition that damage will result from operation. The term "good condition" is further defined as not chafed or burned; not bent or twisted; not broken or cracked; not bare or frayed; not dented or collapsed; not torn or cut; adequately lubricated.

(2) Inspection of a unit to see that it is "correctly assembled" is usually an external visual inspection to determine whether it is in its normal assembled position in the equipment.

(3) Check of a unit to determine if it is "secure" is usually an external inspection, a hand-feel, or a pry-bar or wrench check for looseness in the unit. Such an inspection should include brackets, lockwashers, locknuts, locking wires, or cotter pins used in the assembly.

(4) "Excessively worn" means worn close to or beyond serviceable limits, a condition likely to result in a failure if replacement of the affected parts is not made before the next scheduled inspection.

b. Reporting Deficiencies. The operator will report all deficiencies on DD Form 110.

c. Before-Operation Services. The following services will be performed to determine if the condition of the equipment has changed since it was last operated and to make sure that the equipment is ready for operation. Any deficiencies must be corrected or reported to proper authority before the unit is put in operation.

(1) *Equipment setting.* The generator should be set on a solid level foundation and where there is the least danger of being damaged by moisture, dust, and corrosive fumes. It should be located where the shortest possible transmission lines can be used. Make sure that the transmission lines are properly connected and are large enough to carry the current. If the location is indoors, be sure there is adequate ventilation. Avoid unnecessary bends in the exhaust line. If the exhaust pipe loops to form a trap or rises in a vertical direction, a drain should be provided at the lowest point to

expel the water from the exhaust. Open the drain when the engine is stopped and leave it open until the engine is started again. An inclined exhaust pipe should slope away from the engine for drainage.

(2) *Fuel.* Check the fuel supply. See that tank is full. Check reserve supply of fuel and replenish if necessary.

(3) *Oil.* Check oil level in crankcase and add oil if necessary. Check reserve supply of lubricants and replenish if necessary.

(4) *Water.* See that coolant is up to proper level in radiator. When filling cold radiator containing antifreeze, allow room for expansion.

(5) *Instruments.* Check all instruments to see that they are securely mounted and not damaged. Check all gage readings. At normal operating temperatures the oil pressure indicator should read between 15 and 25 pounds. Pressure will be above normal while engine is cold, and may drop below normal at idling speed after the engine has warmed up. If oil pressure indicator shows an unusual drop or no pressure, stop the engine immediately and report the condition to the proper authority. The coolant temperature gage should show a gradual rise during warmup period until it reaches the maximum of 165° to 190° F. Ammeter should be in the charge range.

(6) *Leaks, general.* Check for leaks, paying particular attention to the cooling system and oil and fuel lines and connections. Check for signs of leaks under the engine. Correct or report any leaks noticed.

(7) *Visual inspection.* Make a visual inspection of the entire unit, checking for insecurely mounted, damaged, or missing parts. Inspect all wires and terminals for damage and loose connections.

(8) *Starting precautions.* Before starting engine, see that air circuit breaker is in OFF position. Allow the engine to warm up at fast idling speed. *Do not race a cold engine.*

d. During-Operation Services. The operator is responsible for correcting or reporting unusual sounds or odors, deficiencies in performance, or other signs of abnormal operation.

(1) *Instruments (gages, meters).* Check all gage readings frequently. If oil pressure indicator shows an unusual drop or no pressure, or if coolant temperature gage shows engine overheating, stop the engine immediately and report the irregularity to proper authority. Do not operate again until the failure is corrected.

(2) *Unusual operation and noises.* Check for anything unusual in the operation, such as engine failing to respond to controls or excessive sparking at the generator brushes. Spark-

ing must be corrected to prevent damage to the generator. It is usually caused by short brushes, wrong brush pressure, or rough commutator or sliprings. Check for odor of burnt insulation or smoke. This will indicate a shorted stator coil. The generator should then be shut down immediately. Also stop the engine if unusual noises or vibration are noticed. If generator appears excessively hot, compare temperature rise with that indicated on nameplate. Report all deficiencies to the proper authority.

e. At-Halt Services. During halts, even if only for short periods, the operator should make a general check of the equipment and correct or report any deficiencies noticed, in addition to performing the following specific duties.

(1) *Fuel.* Check fuel supply. Add fuel if necessary.

(2) *Oil.* Check oil level in crankcase. Add oil if necessary.

(3) *Water.* Check coolant in radiator and see that it is up to proper level. Add coolant if necessary. If engine overheats because of a lack of coolant, allow it to cool before filling radiator; otherwise, there is danger of cracking the cylinder head. If it is necessary to fill the radiator before the engine has cooled, fill it *very* slowly while the engine runs at idling speed.

(4) *Leaks, general.* Check for fuel, oil, and coolant leaks.

(5) *Visual inspection.* Make a visual inspection of the entire unit, checking for bent, cracked, or broken parts, and for loose or missing bolts and nuts. Check condition of fan belt. If operating under extremely dusty conditions, inspect air cleaner and service as indicated in LO 5–5161.

f. After-Operation Services. To make sure that the generator set is ready to operate at any time, the operator must perform the following services immediately after any operating period of 8 hours or less. All deficiencies must be corrected or reported.

(1) *Shutdown precautions.* Place the generator circuit breaker in the OFF position and allow the engine to run at fast idling speed for a few minutes before stopping.

(2) *Fuel, oil, and water.* Fill fuel tank with clean fuel. Check oil level in crankcase and add oil if necessary. Check coolant in radiator; proper level is at or near overflow when engine is hot. Add coolant if necessary. Change coolant if it is contaminated with rust and dirt. If antifreeze is used, check its freezing point. If antifreeze is added, mix the solution thoroughly by running engine.

(3) *Clean equipment.* Clean all dirt and excess oil and grease from exterior of unit. See that radiator core and guard are clean.

(4) *Tools and equipment.* See that all tools and equipment assigned to the generator are clean and properly stowed or mounted and that the tool compartment lid will close and fasten. Report any unserviceable tools to the proper authority.

(5) *Fuel filters.* Remove the drain plugs and drain out any water and sediment from the bottom of both the primary and secondary fuel filters. Replace the plugs. Remove the bleed cock (air vent) on the primary filter and allow the gravity pressure to force out the air. Also remove the bleed cock at the top of the secondary fuel filter and operate the hand primer pump until the fuel flows with no air bubbles. Replace the bleed cock and be sure to lock the pump handle in closed position.

(6) *Lubrication.* Lubricate as specified in LO 5–5161. See that all grease fittings are in place and in good condition.

(7) *Visual inspection.* Make a visual inspection of the unit. Check for loose or missing bolts, nuts, and pins; and for bent, cracked, or broken parts. Check the fan belt tension. See that belt slack is one-half inch midway between pulleys.

(8) *Protection.* See that generator control panel doors and hood side panels are closed and fastened. If the generator is not under a shelter, cover it with a suitable covering. If there is any danger of water freezing in the radiator, and anti-freeze has not been added, drain the cooling system and leave the drains open.

33. Maintenance and Safety Precautions

a. Always correct or report any mechanical deficiencies that may result in further damage to the unit if operation is continued.

b. Do not run starting motor for more than 10 seconds at any one time.

c. Make all electrical connections before starting operation.

d. Be sure ventilation is adequate if operating within an inclosed space.

e. Use sandpaper only for cleaning exciter commutator and sliprings or for seating brushes. Never use emery cloth.

f. Keep the generator clean and dry.

34. Organizational Maintenance

a. Organizational preventive maintenance is performed by organizational maintenance personnel, with the aid of the operator, at weekly and monthly intervals. The "W" or weekly interval will cover about 60 hours of use and the "M" or monthly interval will be equivalent to 250 hours of use.

b. The preventive maintenance services to be performed at these regular intervals are listed and described below. The numbers appear-

ing in the columns opposite each service refer to a corresponding number appearing on DA Form 464, and indicate that a report of the service should be made at that particular number on Form 464. These numbers appear in either second, third, or both columns as an indication of the interval at which the service is to be performed. The column headed Technical Inspection is provided for the information and guidance of personnel performing technical inspections, and constitutes the minimum inspection requirements for the equipment.

Technical inspection	Service		
	Monthly	Weekly	
			GENERAL
1	1	1	*Before-operation services.* Check and perform services listed in paragraph 32c(2) to (8), inclusive.
2	2	2	*Lubrication.* Inspect the entire unit for missing or damaged lubrication fittings, lines, and grease cups, and for indications of insufficient lubrication.
	2	2	Lubricate as necessary. Refer to lubrication order. Replace missing or damaged fittings.
3	3	3	*Tools and equipment.* Inspect condition of all tools and equipment assigned to the unit. Check condition and mounting of the tool boxes or compartments.
	3	3	See that all tools and equipment assigned to the generator are clean, serviceable, and properly stowed or mounted. See that tool boxes or compartments are in good condition and that they close and fasten properly.
4	4	4	*Fire extinguisher.* Check carbon tetrachloride type for. full charge, proper working order, and secure mounting. The amount of charge can usually be determined by shaking the extinguisher and judging by sound and weight whether it is full. Inspect carbon-dioxide (CO_2) type for insecure mounting, kinked or damaged hose, and missing or broken seal. If the seal is missing or broken, the extinguisher should be weighed to determine the amount of charge. The empty and full weights are stamped on the valve body.
	4	4	See that any extinguisher deficiencies are corrected or reported to the proper authority.
5	5	5	*Publications.* See that TM 5–5161, TB 5–5161–1, and LO 5–5161 are on the equipment and in serviceable condition.
6	6	6	*Appearance.* Inspect the general appearance of the equipment, paying special attention to cleanness, legibility of identification markings, and condition of paint.
	6	6	See that any deficiencies noticed are corrected or reported to proper authority.
7	7	7	*Modifications.* See if all available modification work orders applying to this machine have been completed and recorded on DA Form 478, Organizational Equipment File.

Technical inspection	Service		
	Monthly	Weekly	
			ENGINE AND ACCESSORIES
11	11	11	*Cylinder head, manifolds, and gaskets.* Inspect cylinder head, manifolds, and exhaust pipe for leaks, loose bolts, and defective gaskets.
	11	11	Tighten loose manifolds and exhaust pipe mounting bolts and nuts. Replace defective gaskets. On new or reconditioned engines, check all cylinder-head bolts for tightness at the first weekly service. Correct torque-wrench pull is 95 to 105 foot-pounds (par. 76). Valve clearance adjustment must be made after tightening head bolts (par. 76).
12	12	------	*Valve mechanism.* Check condition of valve mechanism. Check the tappet adjustment while engine is hot. The correct adjustment for both intake and exhaust valves is 0.009 inch.
	12	------	Adjust the valve clearance if necessary (par. 76).
14	14	14	*Crankcase, breather.* Inspect the crankcase for leaks. Check condition, cleanness, and mounting of the crankcase breather and oil fillercap.
	14	14	Correct or report any leaks noticed. If breather and fillercap are dirty, remove and clean (par. 74*c*).
15	15	15	*Oil filter.* With the engine running, inspect the filter assembly and connections for leaks.
	15	15	Repair any leaks noticed. Service the filter as specified in LO 5–5161 (par. 74). Replace filter cartridge or element if necessary.
16	16	16	*Radiator.* Inspect the radiator for leaks, insecure mounting, and obstructions in the core air passages. Inspect all lines and connections for leaks. Check hoses for excessive deterioration and loose connections. Check engine operating temperature and condition of coolant. If antifreeze is used, check its freezing point.
	16	16	Drain, flush, and refill cooling system if coolant is contaminated with rust or dirt (par. 54). See that core air passages and guard are clean. Renew any damaged or defective cooling system hoses, lines, and gaskets. See that all mounting bolts and connections are tight. Be sure the thermostat works properly. Protect coolant from freezing and record its freezing point on DA Form 464.
17	17	17	*Water pump, fan, and shroud.* Inspect the pump for leaks and for loose mounting bolts. Check the condition and mounting of the fan and shroud.
	17	17	Tighten or replace loose or missing bolts and cap screws. Correct misalinement. If the pump leaks, replace it with a new or reconditioned one.
18	18	18	*Belt and pulleys.* Inspect for excessively worn, cracked, or frayed fan belt. Check the belt tension and the condition and alinement of the pulleys. The belt is properly adjusted when it can be deflected one-half inch from normal position, without undue pressure, at a point midway between the pulleys.

Technical inspection	Service: Monthly	Service: Weekly	
			ENGINE AND ACCESSORIES—Continued
	18	18	Adjust tension of belt if necessary and correct any misalinement. Replace belt if it is frayed or badly worn (par. 56).
20	20	20	*Governor and linkage.* Check governor for correct operation and adjustment.
	20	20	Adjust governor if necessary (par. 67).
			FUEL SYSTEM
40	40	40	*Filters.* Check fuel filters for cleanness and tightness of connections.
	40	40	Remove all sediment from the bottom of both fuel filters (par. 65). Tighten all loose connections.
41	41	41	*Air cleaner.* Inspect all joints between air cleaner and intake manifold to see if they are tight.
	41	41	See that air cleaner is securely mounted and that all connections are tight. Service air cleaner as specified in the lubrication order.
42	42	42	*Nozzles, injection pump, and housing.* Inspect injection pump housing for proper oil level. Inspect all lines and connections for leaks. Note if engine runs irregularly or if exhaust shows an excessive amount of smoke.
	42	42	Service injection pump housing as specified in the lubrication order. If engine runs irregularly or if exhaust shows an excessive amount of smoke, injector nozzles should be checked for proper operation and replaced if necessary (par. 66).
43	43	43	*Tank, cap, and gaskets.* Inspect the fuel tank for loose mounting bolts. Check for leaks in the tank and for dirty fillercap.
	43	43	See that tank is securely mounted. Report any leaks in tank to proper authority. Open the draincock in bottom of fuel tank and drain out any water that may have accumulated. See that the fillercap and strainer are in place and clean.
44	44	44	*Fuel lines.* Check all fuel lines for leaks and damage.
	44	44	Repair or replace leaky or damaged fuel lines.
			ELECTRIC SYSTEM
47	47	47	*Battery.* Inspect the battery for cracks, leaks, and loose holddown bolts or clamps, and for dirt and corrosion on top of the case. Check for loose cable connections and corroded and damaged terminals and cables. Check the level of the electrolyte; it should be about one-half of an inch above the plates. Check the electrolyte and record its specific gravity on DA Form 464.

Technical inspection	Service		
	Monthly	Weekly	
			ELECTRIC SYSTEM—Continued
	47	47	Clean all dirt and corrosion off the top of the battery, posts, cables, and cable terminals. Renew damaged cables. Apply a thin film of chassis grease over terminals after they are clamped tight. Add distilled water if needed but do not overfill (par. 80). If freezing temperatures prevail, battery must be charged long enough to mix solution thoroughly. See that battery is securely mounted and that caps are tight and ventholes are open.
48	48	48	*Generator, starter motor.* Inspect for loose mounting bolts and external wiring connections.
48	48	------	Inspect commutators and brushes for excessive wear, dirt, and oil deposits. Check for loose brush wire connections. See if brushes are free in holders and if they make good contact with the commutators.
	48	48	See that mounting bolts and wiring connections are tight. Clean commutator and replace brushes if necessary (par. 81).
50	50	50	*Wiring, switches.* Inspect wiring for loose and corroded connections, broken wires, and oil-soaked, cracked, or frayed insulation. Check operation of switches.
	50	50	Replace defective switches and wires. See that all wiring is clean and that connections are clean and tight.
			CONTROL SYSTEM
57	57	57	*Gages (engine).* Check condition and mounting of all gages.
	57	57	Tighten any loose mounting screws and connections. Replace damaged or defective gages.
			FRAMES AND MOUNTINGS
80	80	80	*Frame (hood, covers).* Inspect for cracks, breaks, damaged sheet metal, defective door or side panel latches, and loose or missing mounting and assembly bolts and screws.
	80	80	Tighten or replace all loose or missing bolts, nuts, and screws. Repair or replace defective door and side panel latches. See that any cracks, breaks, or other damages are repaired.
			GENERATOR
172	172	172	*Armature, commutator, sliprings.* Inspect all visible parts in the exciter and alternator brush compartments for an accumulation of dust, dirt, oil, and grease. Inspect the brushes for wear and loose wire connections. Brushes should be replaced when they are worn to an overall length of three-fourths inch. See that the brushes move freely in the holders and make firm contact with the sliprings and commutator, and that the brush springs have about equal pressure.

Technical inspection	Service		GENERATOR—Continued
	Monthly	Weekly	
	172	------	Inspect the sliprings for excessive wear or pitting. Inspect the exciter commutator for excessive wear, pitting, and high mica between the commutator segments. The mica should be below the surface of the segments. If thin edges of mica are at or above the surface, excessive sparking results during operation.
	172	172	Blow dust and dirt from the inside of the generator if necessary, using not more than 25 pounds of compressed air pressure. Air must be free of oil and water. See that brushes, commutator, and sliprings are clean. Replace excessively worn or damaged brushes. See that brushes are free in the holders, that brush wires are in good condition, and that connections are tight. Adjust or replace brush springs if necessary. If sliprings or commutator are pitted or rough, or if mica is high between commutator segments, report the condition to the proper authority.
173	173	173	*Controls, instruments, wiring.* Inspect all controls and instruments on the front of the control panel to see if some of them are damaged or inoperative. Check for an accumulation of dirt and dust, loose connections, cracked or frayed wiring insulation, corroded terminals, and loose or missing nuts and screws on the controls, instruments, and other units that are visible from back of control panel. *Do not remove cover from any of the instruments or controls.* ***Caution:*** Be sure that circuit breaker is on OFF position and, if possible, the switchboard should be deenergized before inspecting, installing, adjusting, or replacing parts. If the switchboard cannot be deenergized, use tools with insulated handles, wear rubber gloves, and use a rubber floor mat.
	173	173	Blow accumulated dust and dirt from the inside and rear of the control cabinet. See that all visible wiring connections, nuts, and screws are tight. Replace or report damaged or defective controls, instruments, and wires.
174	174	------	*Drive coupling.* Inspect the driving disk for any signs of insecure mounting and damage.
	174	------	See that driving disk is securely mounted. If any damage to the disk is noticed, report the deficiency to the proper authority.

Section IV. TROUBLESHOOTING

35. Use of Troubleshooting Section

This section provides information useful in diagnosing and correcting unsatisfactory operation or failure of the generator set or any of its components. Each trouble symptom stated is followed by a list of probable causes of the trouble. The possible remedy recommended is described opposite the probable cause.

Note. All references in this section to paragraphs in chapter 4 (pars. 108 to 155), pertain to operations that are the responsibility of field and depot maintenance personnel. Organizational maintenance personnel should not proceed without proper authority.

36. Engine Is Hard To Start or Fails To Start

	Probable cause	*Possible remedy*
a.	Insufficient fuel	Fill fuel tank. Vent fuel lines (par. 63).
b.	Air traps	Vent fuel lines (par. 63).
c.	Incorrect timing	Check timing (par. 68).
d.	Worn rings	Replace rings (par. 139). See note in paragraph 35.
e.	Pitted or warped valves	Grind or replace (par. 130). See note in paragraph 35.
f.	Dirty injectors	Test and replace injectors (par. 66).
g.	Battery charge low	Replace with fully charged batteries (par. 80).
h.	Valve clearance not correct	Check valve clearance (par. 76).
i.	Transfer pump faulty	Replace fuel injection pump (par. 63).
j.	Safety switch not in START position.	Turn to START position.

37. Engine Misses or Fires Irregularly

	Probable cause	*Possible remedy*
a.	Governor springs broken or weak	Replace springs (par. 9*h*).
b.	Fuel delivery valve not seating properly.	Replace fuel injection pump (par. 63).
c.	Water in fuel	Drain and vent fuel system (par. 63).
d.	Air traps	Check for leaks and vent fuel lines (par. 63).
e.	Incorrect valve clearance	Check rocker arm and tappet clearance (par. 76).
f.	Sticking fuel injection pump plunger.	Replace fuel injection pump (par. 63).
g.	Dirty injection nozzles	Replace with serviceable nozzles (par. 66).
h.	Control rod binding	Remove governor cover, inspect rod and oil. Replace injection pump (par. 63).
i.	Overflow valve spring worn or broken.	Replace overflow valve. Temporary repair may be made by stretching spring with fingers.
j.	Broken or weak fuel pump plunger return spring.	Replace fuel injection pump (par. 63).
k.	Governor motion sticking	Replace governor springs (par. 9*h*).

38. Engine Stops Suddenly

Probable cause	*Possible remedy*
a. Insufficient fuel	Refill fuel tank and bleed or vent fuel injection system (par. 63).
b. Air traps	Vent the fuel injection system (par. 63).
c. Dirt in fuel	Replace fuel filters (par. 65). Clean tank.
d. Water in fuel	Drain filters (par. 65), tank and fuel injection pump. Vent the system (par. 63).
e. Plugged fuel line	Clean fuel lines. Examine for kinks, wear or breaks (par. 69).
f. Engine overheated	Check water and oil. See paragraph 39.
g. Low oil pressure (shown by safety switch snapping to OFF).	Check for dirt under oil pressure relief valve (par. 74) or loose oil lines.
h. High engine temperature (shown by safety switch snapping to OFF).	Let engine cool off. See paragraph 39. Reduce load.

39. Engine Overheats

Probable cause	*Possible remedy*
a. Lack of water	Allow engine to cool and add water.
b. Fuel transfer pump defective	Replace fuel injection pump assembly (par. 63).
c. Frozen radiator	Stop engine for 5 minutes. Run engine for 3 minutes with radiator covered. Stop for 5 minutes. Continue this treatment until radiator is thawed. Check for leaks. ***Caution:*** Do not run continuously to thaw, as water will overheat and boil away, thus seriously endangering the engine.
d. Faulty thermostat	Replace with thermostat at proper opening temperature (par. 58).
e. Leaky radiator	Repair radiator (par. 54).
f. Faulty hose connection	Tighten or replace hose (par. 54).
g. Internal collapse of suction hose at the pump.	Renew with wire reinforced hose.
h. Leaky water pump	Replace (par. 57).
i. Dirt, rust, scales, and sediment in the water jacket.	Use a solvent to remove; flush and drain entire system (par. 54).
j. Pieces of broken hose in system	Remove by draining and flushing out the system (par. 54).
k. Back pressure in exhaust line caused by obstructed pipe of muffler.	Replace pipe section or muffler (par. 61).

40. Engine Knocks

Probable cause	*Possible remedy*
a. Fuel injection too early for speed and load on engine.	Check timing (par. 68).
b. Bearing worn	Replace bearings (pars. 139 and 148). See note in paragraph 35.
c. Piston rings worn or stuck	Replace rings (par. 139). See note in paragraph 35.
d. Dirty air cleaner	Clean air cleaner (par. 71).

41. Engine Lacks Power

Probable cause	*Possible remedy*
a. Insufficient fuel	Check fuel tank.
b. Air in fuel lines	Vent or bleed fuel injection system and check for air leaks (par. 63).
c. Clogged fuel lines	Clean fuel lines (par. 69) and filters (par. 65).
d. Fuel too heavy	Drain fuel filter and tank; refill with fuel of proper specifications. Vent fuel system (par. 63).
e. Loose fuel pump coupling results in late injection	Check fuel pump couplings. Retime (par. 68).
f. Weak or missing cylinders	Check valve clearance (par. 76). Check injectors for atomization (par. 66).
	Note. To discover which cylinder or cylinders are missing, loosen nipple nut slightly at the injector so that fuel leaks along the nut. If engine performance does not drop appreciably, the cylinder being tested is not operating.
g. Sticking fuel injection pump plunger.	Replace fuel injection pump (par. 63).
h. Sticking valves	Free valves by applying a 50 percent mixture of lubricating oil and kerosene between valve stem and guide. A penetrating oil similar to Casite may also be used. Manually work the valve up and down, using a piece of wood if necessary.
	Caution: If a quantity of oil is allowed to flow between the valve stem and guide, turn the engine over by hand several revolutions to blow the excess oil out of the combustion chamber.
i. Loss of compression	Check for pitted, burned, or warped valves, insufficient valve clearance, worn piston rings, leaking cylinder head gasket. Grind or replace valves (par. 130). Replace rings (par. 139). See note in paragraph 35.
j. Clogged air cleaner	Clean air cleaner (par. 71).
k. Valve clearance out of adjustment.	Check tappet clearance (par. 76).
l. Faulty nozzle	Replace with serviceable nozzle (par. 66).
m. Fuel injection pump out of time	Retime fuel injection pump (par. 68).

42. Oil Consumption High

	Probable cause	*Possible remedy*
a.	Leaks in lubricating system	Check oil lines to rocker arm and injection pump, and oil pan gasket.
b.	Worn piston rings	Replace rings (par. 139). See note in paragraph 35.
c.	Worn or scored cylinders	Check and rebore (par. 140). See note in paragraph 35.
d.	Oil too light for the temperature	Replace with heavier grade of oil.
e.	Worn bearings or seals	Replace bearings and seals (pars. 139 and 148). See note in paragraph 35.

43. Exhaust Smoky

	Probable cause	*Possible remedy*
a.	Valves not seating properly	Check and adjust tappet clearance (par. 76). Grind or replace valves (par. 130). See note in paragraph 35.
b.	Injection timing not correct	Check timing (par. 68).
c.	Piston rings worn	Replace rings (par. 139). See note in paragraph 35.
d.	Dirty air cleaner	Clean air cleaner (par. 71).
e.	Worn or stuck injection nozzles	Replace with serviceable nozzle (par. 66).

44. Compression Poor

	Probable cause	*Possible remedy*
a.	Worn piston rings	Replace rings (par. 139). See note in paragraph 35.
b.	Worn or scored cylinders	Check and rebore (par. 140). See note in paragraph 35.
c.	Burned or warped valves	Grind or replace (par. 130). See note in paragraph 35.
d.	Sticking valves	Free the valves. See paragraph 41*h*.
e.	Broken valve springs	Replace valve spring (par. 130). See note in paragraph 35.
f.	Leaky injector nozzles	Replace nozzles (par. 66).
g.	Insufficient valve clearance	Check rocker arm and tappet clearance (par. 76).

45. Low or No Oil Pressure

	Probable cause	*Possible remedy*
a.	Low oil in crankcase	Fill crankcase.
b.	Plugged line to oil gage	Clean or replace line.
c.	Defective gage	Replace gage (par. 101).
d.	Defective oil pump	Replace oil pump (par. 127). See note in paragraph 35.

46. Generator Fails to Build Up Rated A-C Voltage

Probable cause	*Possible remedy*
a. Voltmeter not indicating	Check for loose connections. Replace (par. 100).
b. Open circuit in exciter external wiring.	Check wiring from exciter brushes through control panel to sliprings for open or loose connections.
c. Open circuit in exciter field rheostat.	Check connections. Replace (par. 97).
d. Open or short circuit in field or armature windings of exciter or alternator.	Inspect, test, and repair exciter (par. 150), and alternator (par. 151). See note in paragraph 35.
e. Loss of residual magnetism in exciter.	Connect a 6- or 12-volt storage battery across exciter field terminals for an instant. This should restore the residual magnetism.
f. Dirty commutator or sliprings	Clean rings (par. 106).
g. Improper connections	Check load and terminal box connections.

47. Generator Voltage Too High

Probable cause	*Possible remedy*
a. Excessive speed	Reduce speed. Adjust governor or replace springs (par. 9*h*).
b. Voltage regulator switch in OFF position and low resistance in field circuit.	Turn field rheostat counterclockwise.
c. Voltage regulator switch ON but regulator not operating.	Use hand control in emergency. Check or replace regulator (par. 160). See note in paragraph 35.

48. Erratic Voltage

Probable cause	*Possible remedy*
a. Loose switchboard wiring connections.	Shut down set and check all wiring connections. Tighten as required.
b. Voltage regulator not operating	See paragraph 47*c* above.
c. Regulator resistor open	Replace regulator assembly (par. 160). See note in paragraph 35.
d. Brushes not seated on commutator.	Refit brushes (par. 107).
e. Imprcper grade of brushes	Replace with proper brushes (par. 107).
f. High mica on exciter commutator.	Undercut mica (par. 150). See note in paragraph 35.
g. Rough commutator or slipring surfaces.	Clean commutator or sliprings (par. 106).
h. Loose brush holder	Tighten brush holder (par. 105).

49. Overheating of Generator

Probable cause	*Possible remedy*
a. Generator overloaded	Reduce load.
b. Shorted stator windings in generator.	Inspect, test, and repair (par. 151). See note in paragraph 35.
c. Air passages obstructed	Clean generator and vents.
d. Poor ventilation in operating area.	Make necessary changes so that cool air can reach generator air intakes freely.
e. Delivering too high voltage or current.	Reduce voltage (par. 47) above. If current is still above rated value, disconnect part of the load.

50. Generator Noisy

Probable cause	*Possible remedy*
a. Dry bearing	Lubricate bearing (par. 28).
b. Defective bearing	Replace bearing (par. 151). See note in paragraph 35.
c. Rotor fan hitting stator	Check for bent blades. Check for loose coupling (par. 109). See note in paragraph 35.

51. Flickering Lights in Service Line

Probable cause	*Possible remedy*
a. Loose connection	Tighten connection.
b. Low speed	Increase speed to get correct frequency.

52. Circuit Breaker Continues to Trip

Probable cause	*Possible remedy*
a. Short in service line	Inspect line and clear the short circuit.
b. Defective trip unit	Replace circuit breaker (par. 103).
c. Load too high	Reduce load unitl current is rated value Improve load balance (par. 14*d*).

Section V. COOLING SYSTEM

53. Description

(fig. 19)

The cooling system consists of the following major units: water pump, cylinder head water outlet manifold, thermostat and housing, water inlet elbow, water bypass line, radiator, and fan.

54. Radiator

(fig. 20)

a. Cleaning. It is recommended that the cooling system be cleaned at least twice a year, before antifreeze is put in and when it is removed.

(1) Warm up engine to operating temperature. Stop engine, remove radiator cap, open drain cocks in inlet pipe, pump, and both sides of engine block.

(2) Allow engine to cool. Close draincocks. Pour water into radiator until system is about half full (8 quarts). Add cleaner (one container). Then fill up with water.

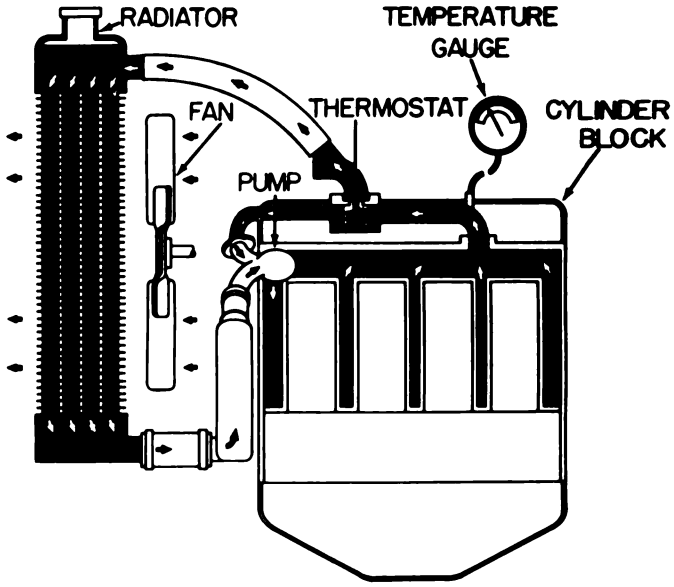
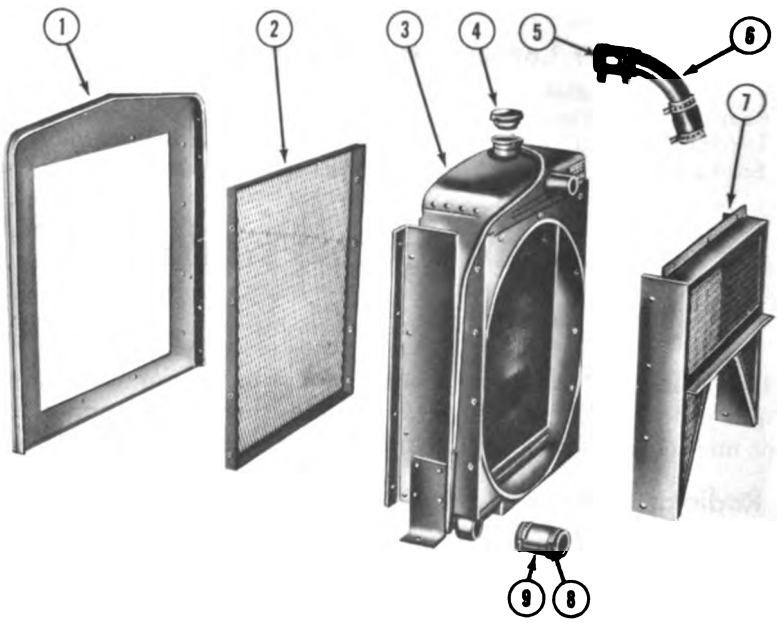


Figure 19. Cooling system schematic.



1 Front guard
2 Front guard screen
3 Core
4 Fillercap
5 Hose clamp
6 Pipe
7 Fan guard
8 Hose clamp
9 Hose

Figure 20. Exploded view, radiator assembly.

(3) Place a clean drain pan to collect the overflow and pour overflow back into radiator if level drops.

(4) Replace radiator cap and run engine at fast idling speed for at least 30 minutes after cleaning solution is heated to 180° F. or above. Remove radiator cap and drain system completely.

b. Neutralizing.

(1) Allow engine to cool. Close drains. Pour water slowly into radiator until system is half full (about 8 quarts). Start engine and set at idling speed. Add neutralizing compound (one container). Then fill up with water.

(2) Cover radiator and let engine idle for at least 5 minutes at normal temperature. Then stop engine.

(3) Drain system completely.

c. Flushing.

(1) Allow engine to cool. Close all drains. Pour water slowly into radiator until half full (8 quarts). With engine at idling speed, fill radiator with water.

(2) Idle engine with radiator covered if necessary until it gets to about 180° F.

(3) Drain system completely and repeat flushing until drain water is clear.

(4) Allow engine to cool and then clean all sediment from radiator cap, drains, and overflow pipe. Blow insects and dirt from radiator fins with compressed air, blowing from rear. Use water to soften up deposits if necessary.

d. Locating Leaks. When finished flushing, make certain that engine has cooled off again. Close all drains. Pour water slowly into radiator (8 quarts). With engine at idling speed, fill up with water. Stop engine when radiator is full. Inspect the entire cooling system for leaks. This is important because the cleaning solution opens up leaks which have been plugged with rust and dirt.

e. Correcting Leaks. All leaks that can be corrected by the using organization should be taken care of immediately. If beyond the facilities of the using organization, report to higher authority.

f. Hose Replacement. Replace frayed or leaking hose connections.

g. Radiator Assembly Removal. This assembly can be removed without removing the housing.

(1) Drain radiator.

(2) Remove the upper radiator pipe (6) and lower hose (9).

(3) Remove the screws holding the fan guard (7) to the radiator core (3). Let the fan guard rest on the fan blade.

(4) Remove the screws and nuts holding the front guard (1) to the housing and the radiator, and lift out.

(5) Remove the two bolts holding the radiator to the base. Remove radiator cap and slide radiator forward out of housing.
(6) Remove front guard screen (2) from core.
(7) The fan guard (7) can be lifted out over the top of the fan.

h. Inspection and Testing.
(1) Examine the radiator core for deposits of scale. The deposit indicates a leak at the location of the scale.
(2) Examine front guard screen assembly and fan guard for damage.
(3) See that the overflow tube is open and not mashed, broken, or clogged.
(4) Check radiator core for leaks by plugging all openings, immersing radiator in a tank of water, and blowing low-pressure air into the filler pipe. Leaks will be shown by air bubbling up through the water.
(5) Solder leaks in the core or replace with new core.
(6) Clean, neutralize, and flush radiator following instructions in *a*, *b*, and *c* above.

i. Radiator Assembly Reinstallation.
(1) Reassemble in reverse order of *g* above. Be sure to drop fan guard in first.
(2) Replace worn, cracked, or scaled hoses or rusted hose clamps.
(3) Fill radiator and examine all connections for leaks.

55. Coolant Service

a. Winter. When servicing the generator set for winter, refer to the antifreeze requirement table (fig. 17) for proper proportions of antifreeze and water. Refer to paragraph 21 for cooling system protection.

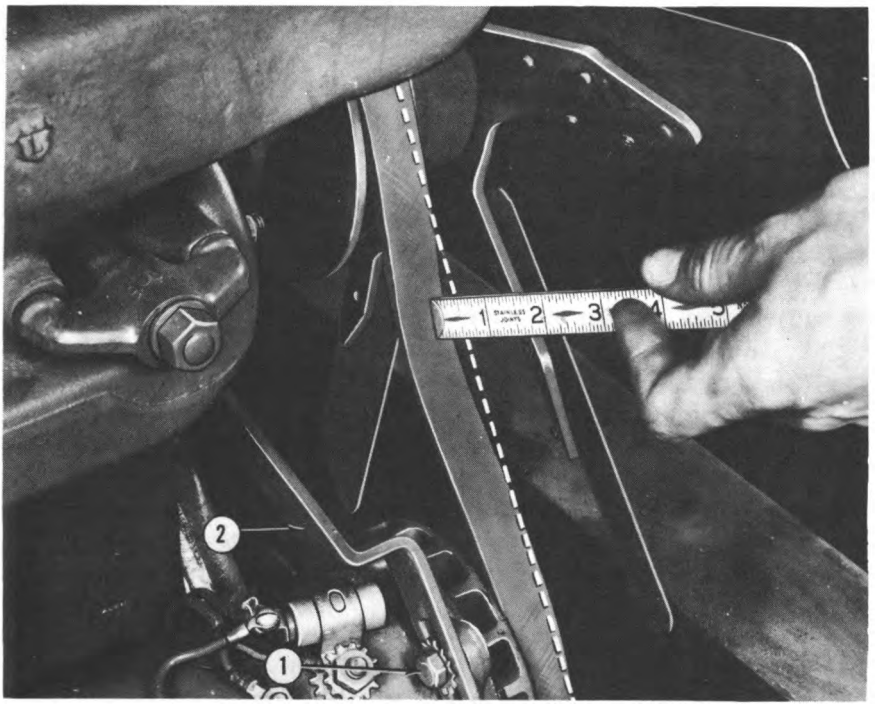
b. Summer and Extreme Heat. When servicing for hot weather, fill the cooling system nearly full with clean soft water. Add corrosion inhibitor compound (one container). Then fill up with water. Refer to paragraph 22 for hot weather precautions.

56. Fan Belt

(fig. 21)

a. Adjusting Fan Belt. Fan belt tension is adjusted by loosening the bolt (1) on the generator adjusting brace (2) and swinging the generator on its bracket. Adjustment should be made so the belt can be pushed in about one-half of an inch.

b. Removing Fan Belt.
(1) Loosen bolt (1) on generator adjusting brace (2) and swing generator to slacken belt.
(2) Slip belt off pulleys.
(3) Work belt up over fan blades and out between blade and guard.



1 Bolt 2 Generator adjusting brace

Figure 21. Adjusting fan belt.

c. Replacing Fan Belt.

(1) Work belt over one fan blade at a time between fan and guard, turning fan as necessary.

(2) Locate belt on the three pulleys.

(3) Adjust belt tension as instructed in *a* above.

57. Fan and Water Pump Assembly

a. Removal.

(1) Remove radiator assembly as instructed in paragraph 54*g*.

(2) Remove the four cap screws holding the fan and pulley to the pump.

(3) Remove cap screw holding pump to pump support link.

(4) Remove the water pump attaching screw while supporting the pump with one hand. If the entire assembly is to be replaced, (2) above is not necessary.

b. Inspection.

(1) Inspect the fan for bent blades. Replace if necessary.

(2) Inspect the water pump for cracks or other damage. If not operating properly, replace pump.

c. Replacement.

(1) Make sure gasket is in place. Apply shellac.

(2) Install pump and fan in the reverse of *a* above.

58. Thermostat and Thermostat Housing
(fig. 22)

a. General. The thermostat is in a housing bolted to the cylinder head water outlet pipe. The coil or bellows is in the outlet pipe and, therefore, is at engine water temperature. When water is cold, the thermostat seals the pipe to the radiator and bypasses the water. When hot, it opens and permits water to flow to the radiator.

b. Removal.

(1) Drain cooling system.

(2) Loosen hose from water outlet pipe to radiator at water outlet elbow.

(3) Loosen hose from bypass line assembly to thermostat housing (1).

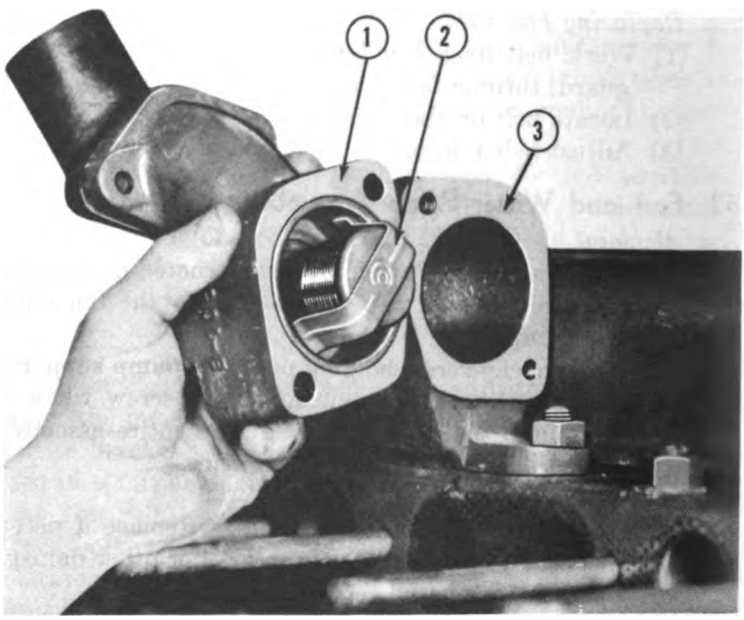
(4) Remove cap screws holding thermostat housing to cylinder head outlet pipe (3).

(5) Remove thermostat (2).

c. Testing. Test by putting thermostat into a pail of water heated to between 175° and 180° F. If the thermostat opens, it is satisfactory.

d. Reassembly and Installation.

(1) Replace thermostat (2) in housing (1) with coil part toward cylinder head outlet pipe (3). Be sure the neoprene ring on the thermostat valve is in place and in good condition.



1 Thermostat housing
2 Thermostat
3 Cylinder head outlet pipe

Figure 22. Removing thermostat housing.

(2) Shellac all gaskets. Tighten hose clamps before tightening cap screws.
(3) Fill cooling system and check for leaks.

59. External Jackets, Pipes, and Connections
(fig. 23)

a. General. The external parts of the cooling system conduct the coolant from the engine block to the radiator, and from the radiator back to the water pump and engine block. When the thermostat is closed, the water bypasses the radiator and returns to the water pump and block directly.

b. Removal. Since the system is joined by flanges and hoses, the outlet fittings (1) through (12), the bypass line (26), or the inlet fittings (16) through (25) can be removed independently to facilitate repair or replacement. For complete disassembly, proceed as follows.

(1) Remove the water outlet pipe (3), water outlet elbow (4), thermostat housing (6), and thermostat (8) as directed in paragraph 58.
(2) Disconnect the temperature gage at bushing (12) and remove the stud nuts holding flange gasket (13) to remove the outlet pipe (10).
(3) Remove the bypass line (26) by removing the two cap screws and nuts holding it to the upper inlet pipe (17).
(4) To remove the lower inlet pipe (20), loosen the hose connection, and remove the nut and cap screw holding the pipe to the front gear cover.
(5) To remove the upper inlet pipe (17), remove the cap screw (19).

c. Inspection and Repair.

(1) Inspect and replace all worn, cracked, or scaled hoses and rusted hose clamps.
(2) Inspect all ports for plugged passages, warped flanges, or cracks. Clean as required. Except for the bypass line (26), the parts are cast iron. Cracked or damaged components must be replaced. Temporary repairs of the cast pieces may be made by brazing cracks or breaks.

d. Reassembly.

(1) Reverse the order of *b* above.
(2) Shellac and replace each gasket carefully.
(3) Fill cooling system.
(4) When engine is back in operation, check each flange and hose connection for leaks.

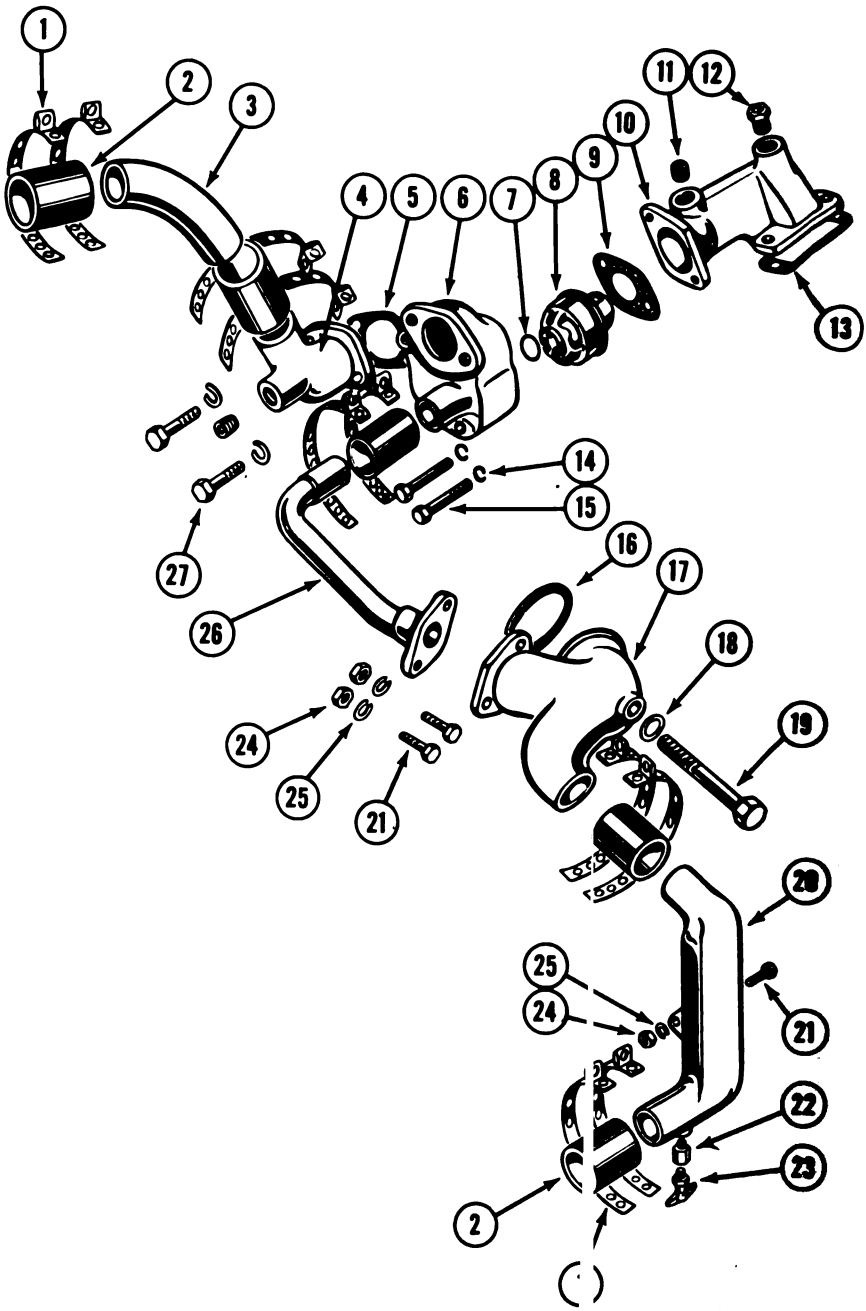


Figure 23. Exploded view of cooling system, jacke , and connections.

1 Hose clamp
2 Hose
3 Water outlet pipe
4 Elbow
5 Gasket
6 Thermostat housing
7 Neoprene ring
8 Thermostat
9 Gasket
10 Outlet pipe
11 Pipe plug
12 Temperature gage bushing
13 Gasket
14 Lockwasher
15 Cap screw
16 Gasket
17 Inlet pipe
18 Plain washer
19 Cap screw
20 Inlet pipe
21 Cap screw
22 Draincock adapter
23 Draincock
24 Nut
25 Lockwasher
26 Bypass line
27 Cap screw

Figure 23—Continued.

Section VI. FUEL SYSTEM

60. Description

(fig. 24)

a. General. The fuel system is made up of two parts, the supply or low-pressure system and the injection or high-pressure system. Before removing any of the component parts, shut off fuel tank at filter bowl.

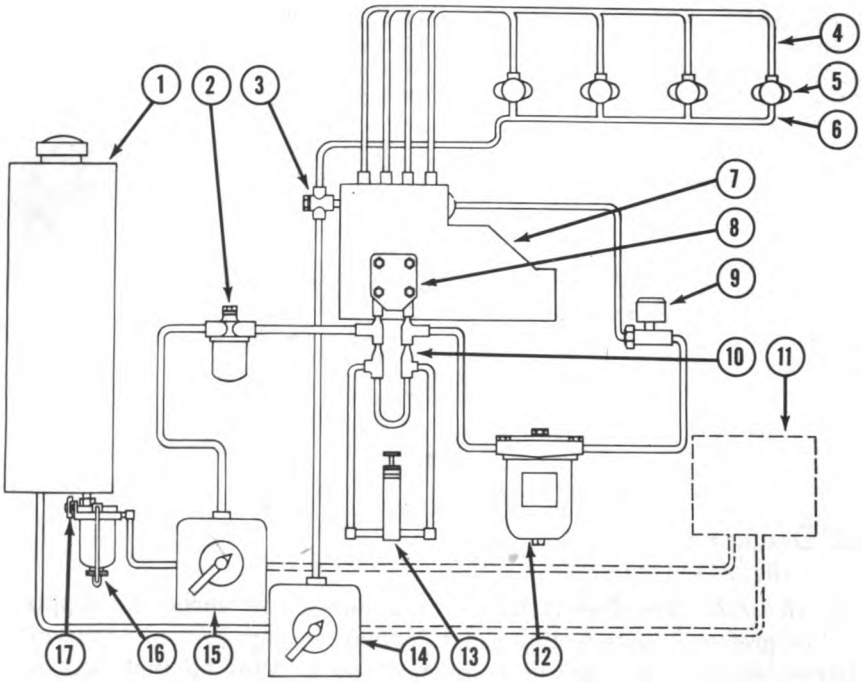
b. Supply. The low-pressure system consists of the fuel tank (1), bowl type filter (16), transfer valve (15), primary filter (2), transfer pump (8), hand pump (13), and secondary filter (12) which discharges into the fuel injection pump (7). An overflow line from the injectors to the injection pump and a return line through the outlet transfer valve (14) to the tank form a second part of the low-pressure system.

c. Injection. The high-pressure system consists of a fuel injection pump (7) with a built-in distributor to supply fuel through injection nozzles (5) to the engine cylinders. The pump forces a metered amount of fuel through an injector nozzle at high pressure into each cylinder. Metering is controlled by the governor which is built into the injection pump.

61. Housing

a. Removal.

(1) Remove screws and nuts holding housing to radiator front guard (1, fig. 20).
(2) Remove the eight screws and nuts holding the housing to the base.
(3) Remove screw holding hood (1, fig. 25) to bracket on top of control panel.
(4) Loosen three screws holding engine control panel to base. These screws clamp the lip of the housing.
(5) Remove the lifting ring.



1 Fuel oil tank
2 Primary filter
3 Overflow valve
4 Fuel injection lines
5 Nozzles
6 Nozzle drip line manifold
7 Injection pump
8 Fuel transfer pump
9 Fuel cut off valve
10 Overflow valve
11 Outside tank
12 Secondary filter
13 Hand pump
14 Outlet transfer valve
15 Inlet transfer valve
16 Bowl filter
17 Bowl filter shutoff valve

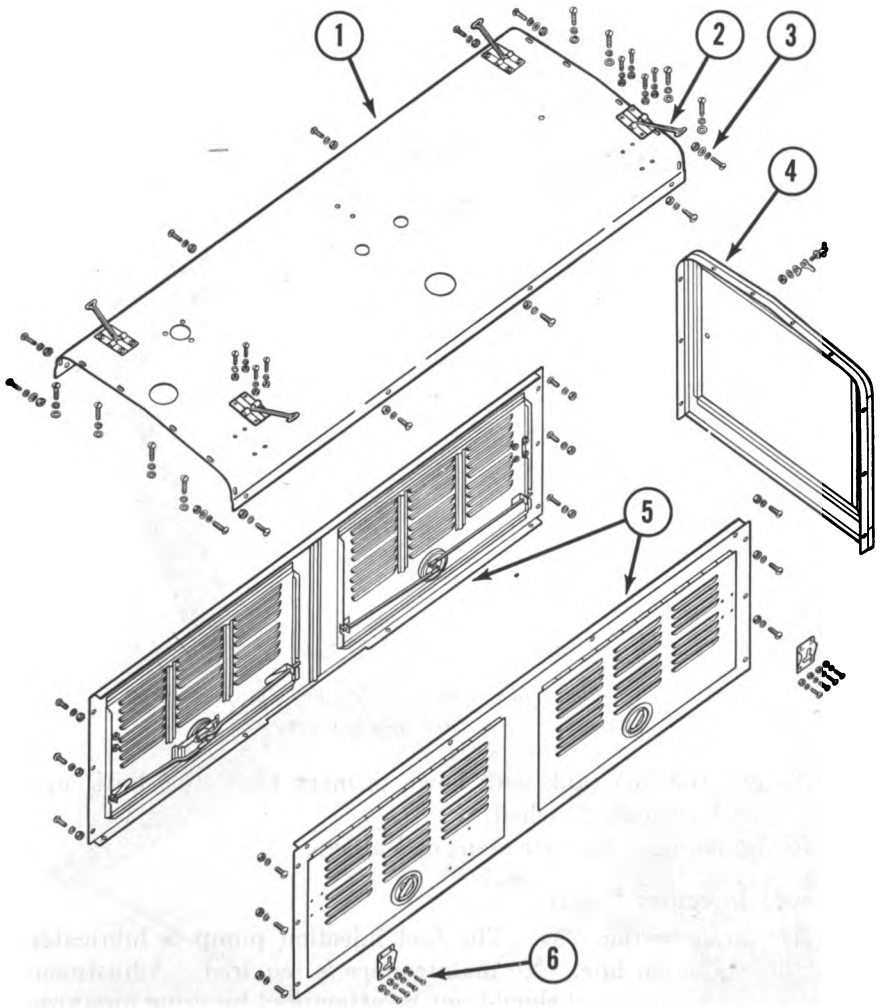
Figure 24. Diagram of fuel system.

(6) Remove muffler clamps (3, fig. 26), exhaust pipe (2) and muffler (1).
(7) Remove radiator cap and gas tank fillercap.
(8) Lift housing slightly and move in the direction of the control panel until clear of the unit.
(9) The housing can be broken down into hood (1, fig. 25), side panels (5), rear panel (4), and door latches (6) by removing the remaining screws and nuts.

b. Reinstallation. Reverse procedure of *a* above.

62. Fuel Tank

a. Maintenance (fig. 27). Drain water and sediment out of the bowl filter (5) in bottom of fuel tank and clean the fillercap (2) once a week. A shutoff valve at the top of the bowl filter should be closed before removing the bowl. Fill the fuel tank each evening to prevent condensation in the tank when the temperature drops.

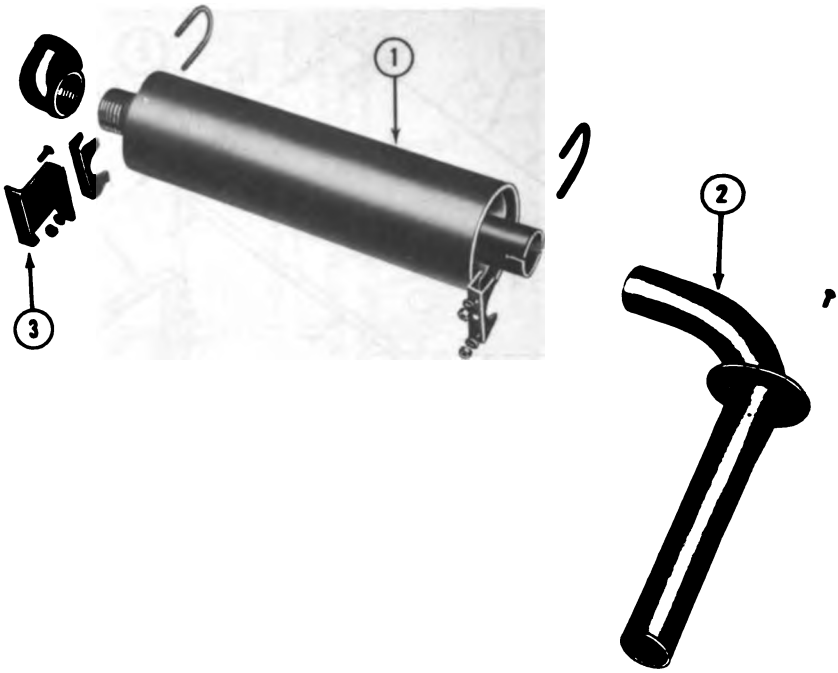


1 Hood top
2 Door catch
3 Fastening screw
4 Rear panel assembly
5 Side panel assembly
6 Door latch

Figure 25. Exploded view of housing.

b. Removal (fig. 28).

(1) Shut off tank at sediment bowl.
(2) Disconnect fuel lines at fuel valves.
(3) Remove the two cap screws (16) on each side of the gas tank holding the tank to the base.
(4) Remove the battery holddown bolt (8) and frame (9).
(5) Disconnect and remove batteries.
(6) Remove two cap screws (13) holding battery shelf (10) to control panel base (14).



1 Muffler 2 Exhaust pipe 3 Muffler clamp assembly

Figure 26. Exploded view of muffler.

(7) Lift the fuel tank with bowl, primary filter, fuel lines, and battery shelf attached.

c. Reinstallation. Reverse steps of *b* above.

63. Fuel Injection Pump

a. Maintenance (fig. 29). The fuel injection pump is lubricated from the engine oil line. No maintenance is required. Adjustment requires special tools and should not be attempted by using organization personnel. Replace the whole pump unit if it is defective. The injection pump includes the governor, transfer pump, distributor, and overflow valve, as an assembly.

b. Removal.

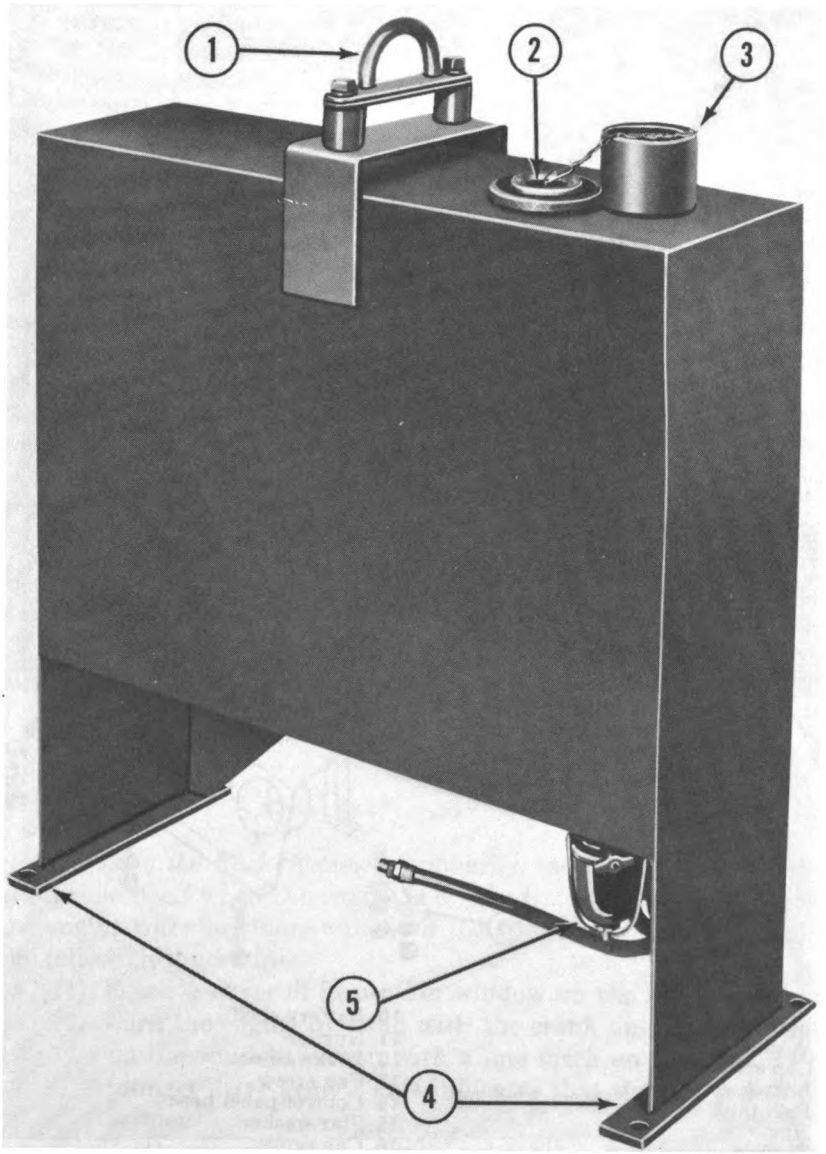
(1) Close valve at bowl filter (14, fig. 30), return valve (12), and fuel valve (13).

(2) Disconnect lines to solenoid valve (10) and remove solenoid from injection pump (16).

(3) Disconnect lines from hand primer (15) to pump (16).

(4) Disconnect cylinder fuel lines (18), (19), (20), and (21) and oil line from engine to bottom of pump.

(5) Remove inspection cover plate on front of timing gear cover (fig. 31).



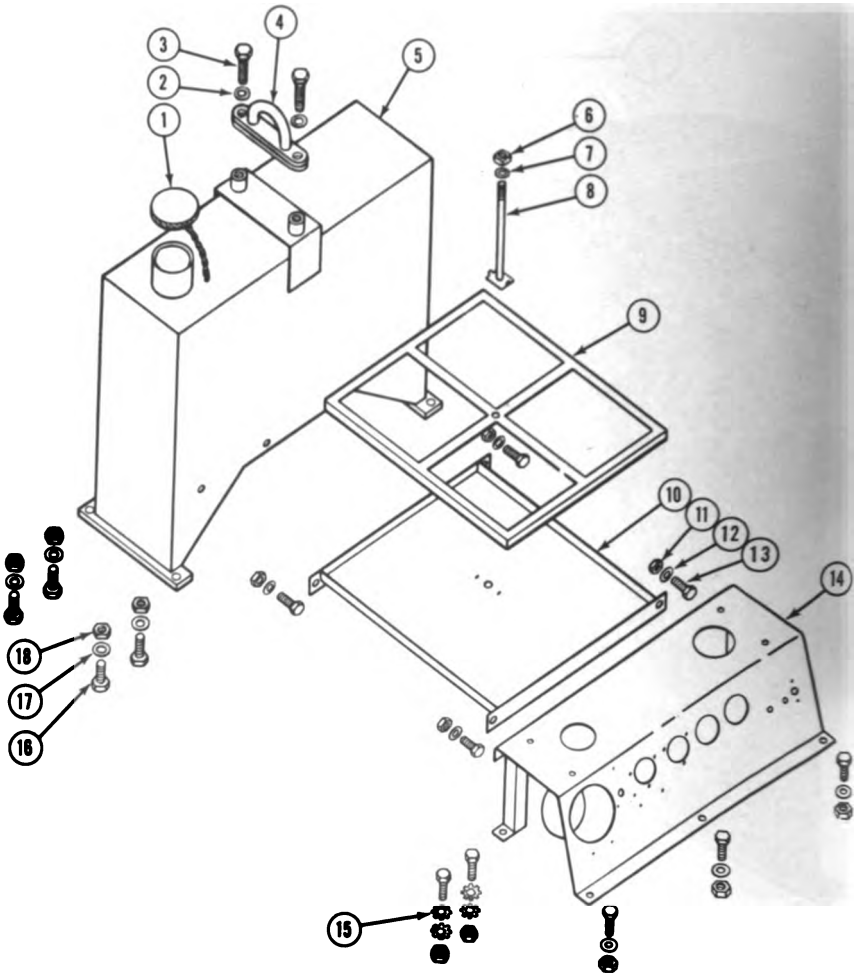
1 Lifting ring
2 Fillercap
3 Filler pipe
4 Mounting feet
5 Bowl filter

Figure 27. Fuel tank and mounting.

(6) Remove lock wire (5) and cap screws (3) holding pump drive gear (2).

(7) Disconnect throttle control (4, fig. 29) and stop control wire (3).

(8) Remove three cap screws holding fuel injection pump at mounting flange and remove pump with care.



1 Fillercap
2 Washer
3 Cap screw
4 Lifting eye
5 Fuel tank
6 Nut
7 Washer
8 Battery holddown bolt
9 Battery holddown frame
10 Battery shelf
11 Nut
12 Lockwasher
13 Cap screw
14 Control panel base
15 Star washer
16 Cap screw
17 Lockwasher
18 Nut

Figure 28. Exploded view of fuel tank, battery support, and engine control panel.

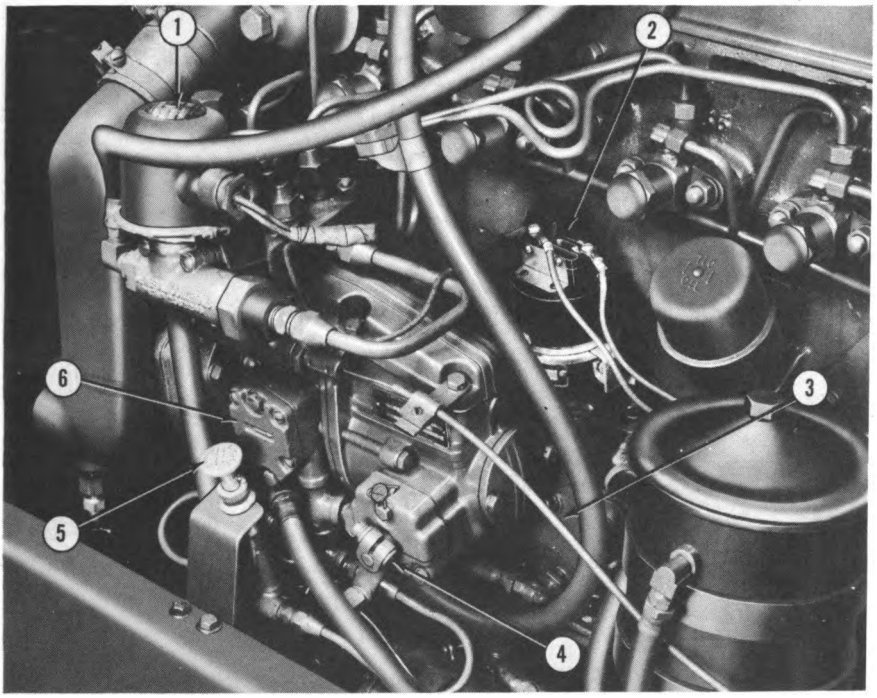
c. Installation.

(1) Put fuel injection pump in place with its pilot through the hole in the front plate and secure with three cap screws.

(2) See that the fuel pump drive gear timing marks line up with mark on the camshaft gear as shown in figure 31.

(3) Time the fuel injection pump (par. 68).

(4) Replace all lines to the pump in the reverse of *b* above.



1 Solenoid valve
2 Overspeed trip
3 Stop control wire
4 Throttle control
5 Hand primer
6 Fuel transfer pump

Figure 29. Fuel injection pump.

d. Venting the Fuel System. Ordinarily the fuel system will vent and prime itself when the engine is cranked. After long idle periods, the engine will start more quickly if the system is vented by hand by the following procedure.

(1) Remove cover of inspection window on the fuel pump.
(2) Turn the engine by hand with the crank until the "O" mark on the window is even with a line mark on the tooth of the plunger drive gear. This indicates that the fuel pump port is open.
(3) Partly unscrew the delivery valve retaining screw on top of pump.
(4) Unscrew locknut on hand primer (5, fig. 29) and pump the primer handle until fuel flows freely from the loose screw on the delivery valve. This shows that all air is forced out and the pump chambers are full of fuel.
(5) Tighten the valve retaining screw and hand primer locknut.

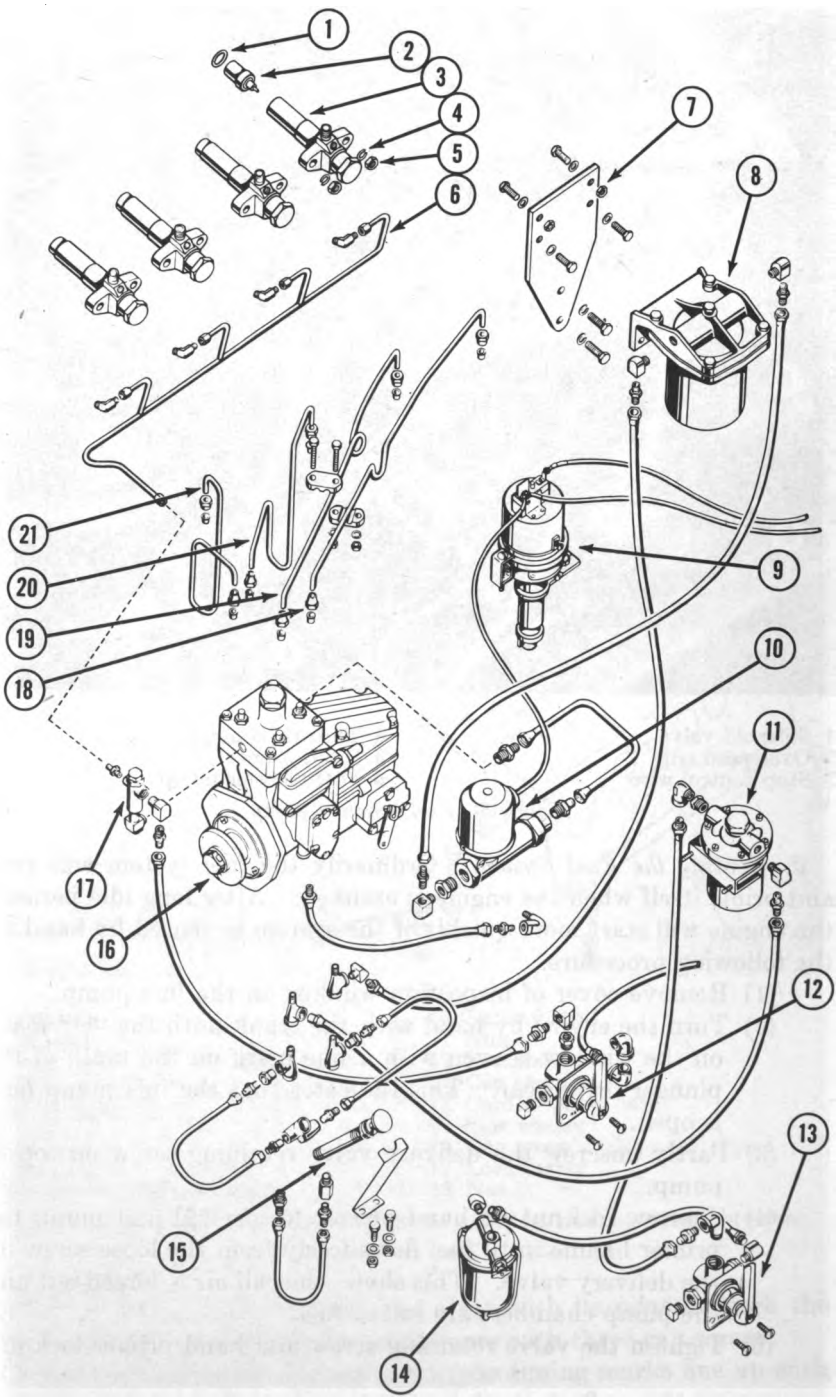
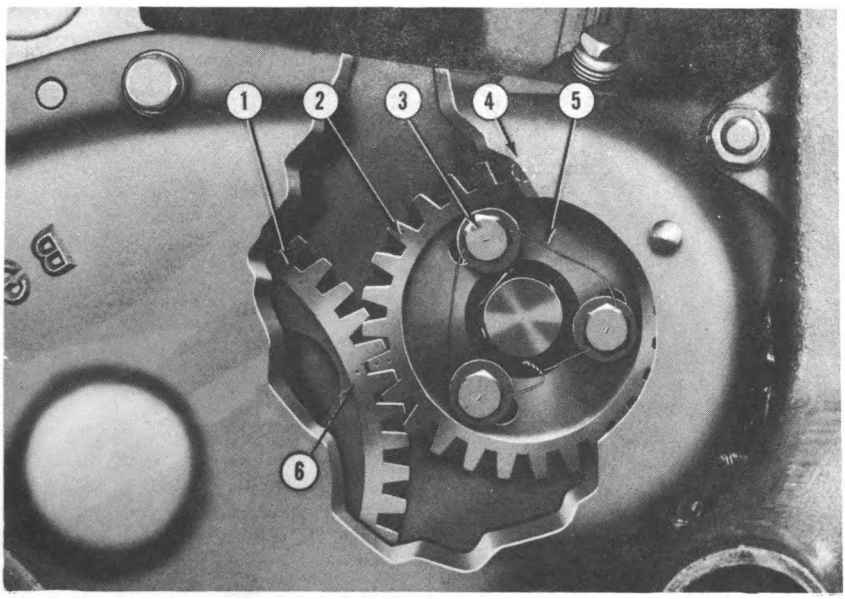


Figure 30. Exploded view of fuel injection system.

1 Nozzle gasket
2 Nozzle
3 Nozzle holder assembly
4 Lockwasher
5 Nut
6 Nozzle drip line
7 Secondary filter bracket
8 Secondary filter
9 Overspeed trip
10 Solenoid valve
11 Primary filter
12 Return valve
13 Fuel valve
14 Bowl filter
15 Hand primer
16 Fuel injection pump
17 Overflow valve
18 No. 4 cylinder fuel line
19 No. 3 cylinder fuel line
20 No. 2 cylinder fuel line
21 No. 1 cylinder fuel line

Figure 30—Continued.



1 Camshaft gear
2 Pump drive gear
3 Cap screws
4 Pointer
5 Lock wire
6 Timing marks

Figure 31. Injection pump drive gears.

64. Fuel Transfer Pump

The fuel transfer pump is treated as an integral part of the fuel injection pump. No maintenance is necessary. If it is found defective, replace the entire fuel injection pump.

65. Fuel Filters

a. General (fig. 32). Remove drain plugs in bottom of primary and secondary filters once a week and allow the water and sediment to drain out. Remove the glass bowl from the bowl filter under the tank and pour out water and sediment.

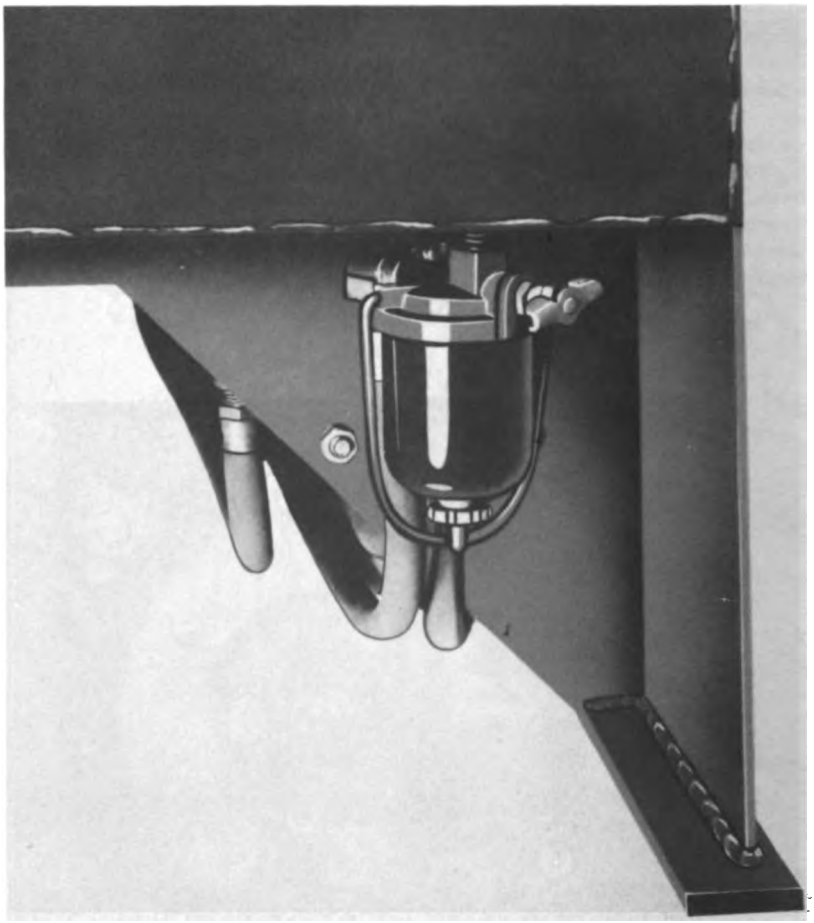


Figure 32. Bowl filter.

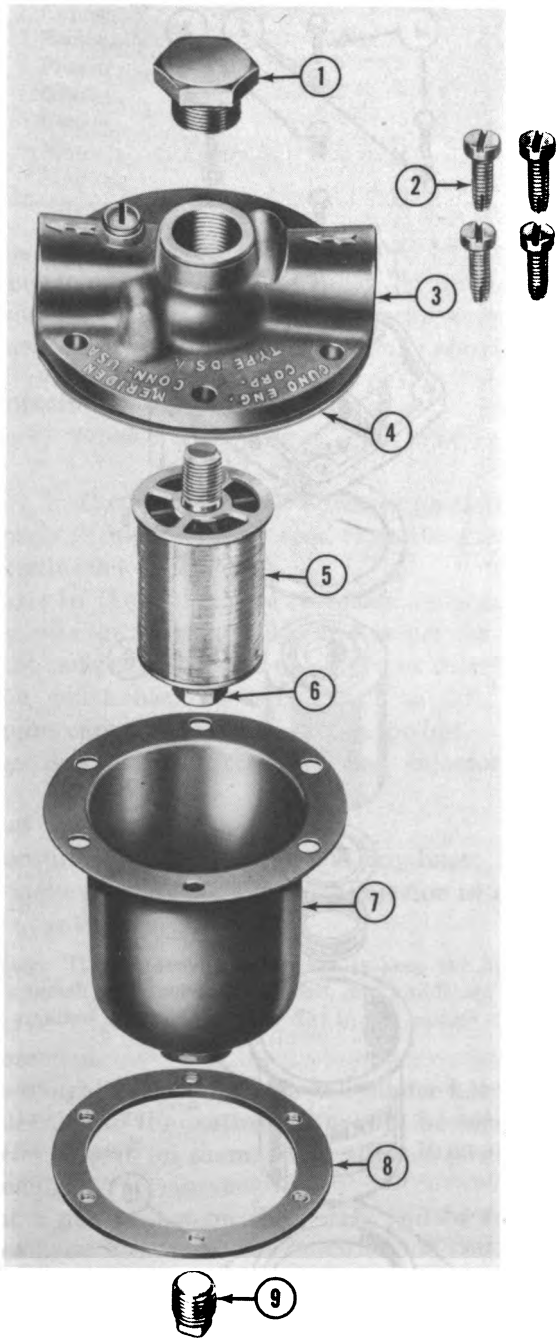
b. Maintenance. Every 2 months remove the filter element, clean the inside of the filter body, and replace element.

(1) *Primary fuel filter.* Shut off fuel at tank. Remove U-bolt holding filter to tank. Remove the six screws (2, fig. 33) holding the head (3) to the body (7). Remove the cartridge (5) by removing nut (6). When assembling, replace gasket (4) if it is worn.

(2) *Secondary fuel filter.* Remove the four cap screws (1, fig. 34) holding the head (4) to the body (9). Remove the cartridge (6). When assembling, replace the gasket (5) if it is worn.

c. Removal.

(1) The primary filter (11, fig. 30) is held by a U-bolt to a bracket on the fuel tank. To remove, disconnect the two fuel lines, loosen both U-bolt nuts, and lift the filter out.



1 Capnut
2 Screws
3 Head
4 Gasket
5 Cartridge
6 Nut
7 Body
8 Ring
9 Plug

Figure 33. Exploded view of primary fuel filter.

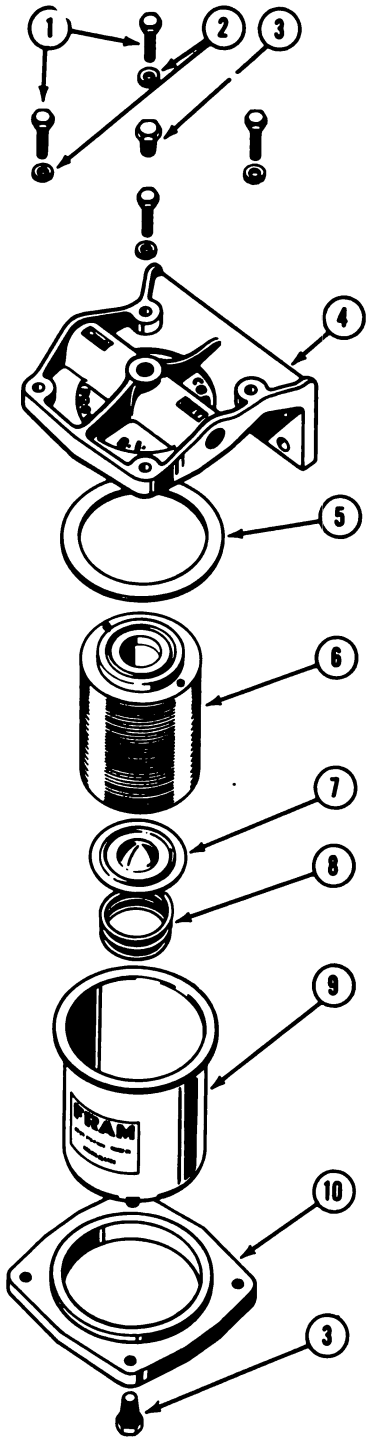


Figure 34. Exploded view of secondary fuel filter.

1 Cap screw
2 Lockwasher
3 Plug
4 Head
5 Gasket
6 Cartridge
7 Lube spoke
8 Spring
9 Body
10 Clamp ring

Figure 34—Continued.

(2) The secondary filter (8) is fastened by two cap screws to a bracket on the cylinder head. To remove, disconnect the two fuel lines and remove the two cap screws.

d. Replacement. Reverse the procedure of *c* above.

66. Fuel Injector Nozzles

a. Causes of Trouble. Dirt, water, and heat cause most injector troubles.

(1) Dirt, in the form of small abrasive particles, wears away the closely fitting valve surfaces, clogs the nozzle, and makes the spindle stick in its guide.

(2) Water in the fuel causes corrosion, enlarges the nozzle opening, pits the valve surfaces, and causes the spindle to stick.

(3) Heat causes cracking of the fuel and results in carbon formal tion which has the same effect as dirt. Overloading the engine causes the injector to run too hot.

b. Testing. Remove and test the fuel injector nozzles every 2 months.

c. Removal (fig. 35).

(1) Disconnect the fuel supply and drip lines.

(2) Remove the two nuts holding injector to cylinder block and remove injector.

Note. It is extremely important to keep the injectors clean. Clean work bench, fluid containers, tools, and hands are absolutely necessary. The smallest speck of water or dirt in the nozzles will cause trouble.

d. Replacement.

(1) Thoroughly clean the hole in cylinder head. Pay particular attention to the seating surfaces to be sure there are no particles of grit on them. Use a small piece of wood for this cleaning.

(2) Put a new gasket on the nozzle and be sure both faces are clean.

(3) Insert the nozzle carefully so that the tip does not strike the seating surface and raise a bur.

(4) Tighten the two nuts evenly so that the injector will go in straight without cramping.

(5) Connect the fuel supply and drip lines and tighten the fittings securely.

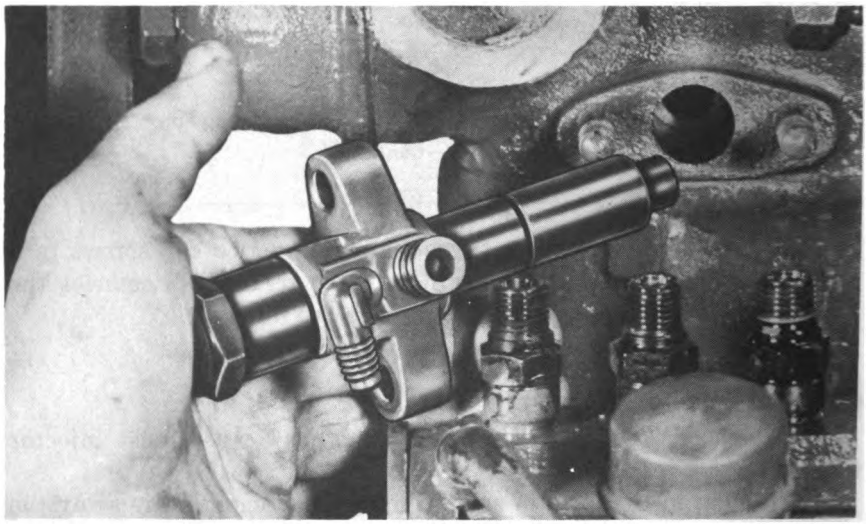


Figure 35. Removing fuel injector nozzles.

e. Testing for Leakage.

(1) Remove nozzle from cylinder.

(2) Connect the high-pressure fuel supply line to the nozzle.

(3) Either turn the engine by hand or run it on three cylinders and watch the spray that comes from the nozzle. The spray should be fine and make a circular pattern on a sheet of paper a few inches away from the nozzle. The spray should cut off sharply without any leakage or dripping at the end of the injection stroke.

f. Cleaning. If test indicates a defective nozzle, put on a new nozzle. Using organization personnel should not attempt to clean or repair nozzles.

67. Governor

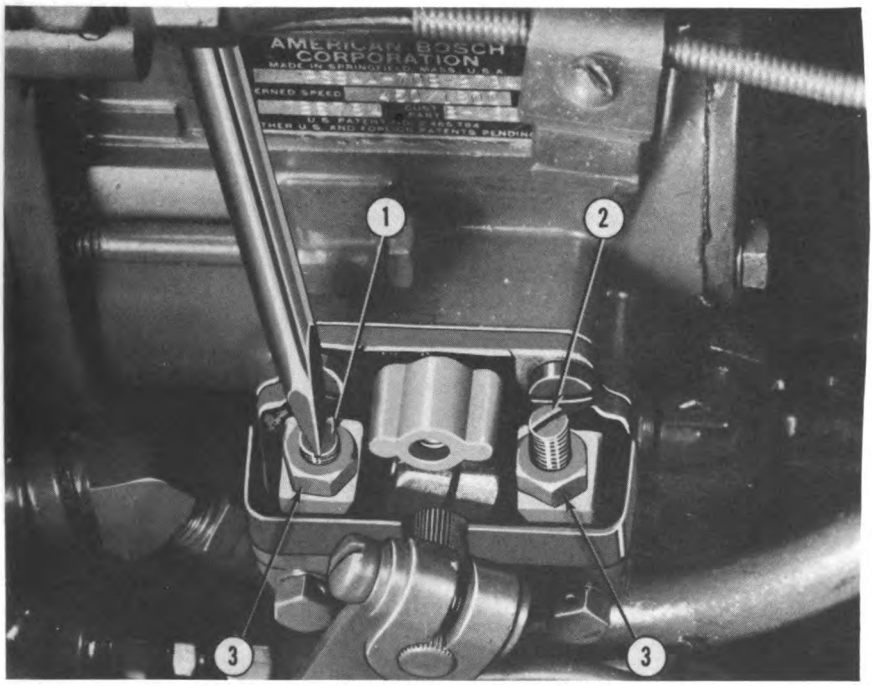
a. General. The governor is an integral part of the fuel injection pump. Defective units will be replaced. Repairs will be performed by field and depot maintenance personnel.

b. Operating Lever Stops (fig. 36).

(1) The operating lever is provided with two adjustable stops to limit its motion toward idle and high speed settings. These stops are under a factory-sealed cover just behind the throttle operating lever.

(2) The idle adjustment (1) should be set for sufficient idle speed to prevent stalling, or about 400 rpm. Tighten the locknut (3).

(3) The full-load adjustment (2) should be set to permit carrying the full electrical load at 60-cycle frequency, or 1,800 rpm. Adjust the unit under load and tighten the locknut. If



1 Idle adjustment 2 Full load adjustment 3 Locknuts

Figure 36. Governor operating lever stops.

necessary, due to a tactical situation, this adjustment can be increased for short periods of time (not over one-half hour) to permit more load to be carried.

(4) Tighten the locknuts (3) securely after adjusting the screws.

68. Timing Fuel Injection Pump

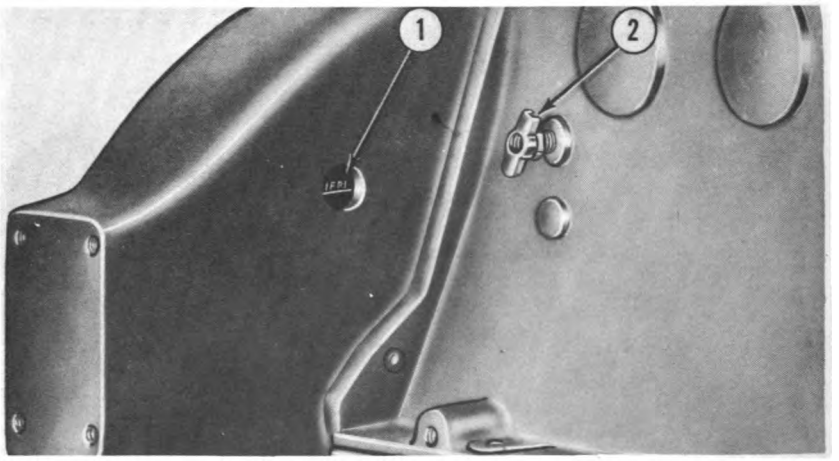
a. Timing Mark on Flywheel (fig. 37). Turn engine with crank until timing mark No. 1 FPI (No. 1 fuel pump injects) on flywheel is in center of timing hole (1) in flywheel housing. No. 1 cylinder must be on the compression stroke when the timing mark is centered in the timing hole. To check, remove the valve cover and make sure that if the intake and exhaust valves of No. 1 and No. 2 cylinders are closed, No. 1 is on compression.

b. Time Pump.

(1) Remove cover (3, fig. 38) of timing window on pump.

(2) Remove inspection plate on timing gear cover (fig. 31). Timing marks on pump gear teeth should line up with timing mark on camshaft gear.

(3) Remove lock wires (5) from cap screws (3) on pump drive gear (2) and slightly loosen cap screws.



1 Timing hole 2 Cylinder block drain

Figure 37. Timing hole in flywheel housing.

(4) Turn pump camshaft until the line mark (2, fig. 38), machined at the tip of one of the teeth on the plunger drive gear, is lined up with the "PC" mark (1) on the timing window.

(5) The pump has a timing pointer at the front, lining up with a mark on the gear hub. These marks give a more accurate setting but they cannot be seen unless the radiator and gear case are removed.

c. Reassembly.

(1) Tighten cap screws (3, fig. 31) on pump drive gear (2).

(2) Replace wire lock (5).

(3) Replace the inspection plate.

(4) Replace timing window cover (3, fig. 38).

69. Fuel Lines

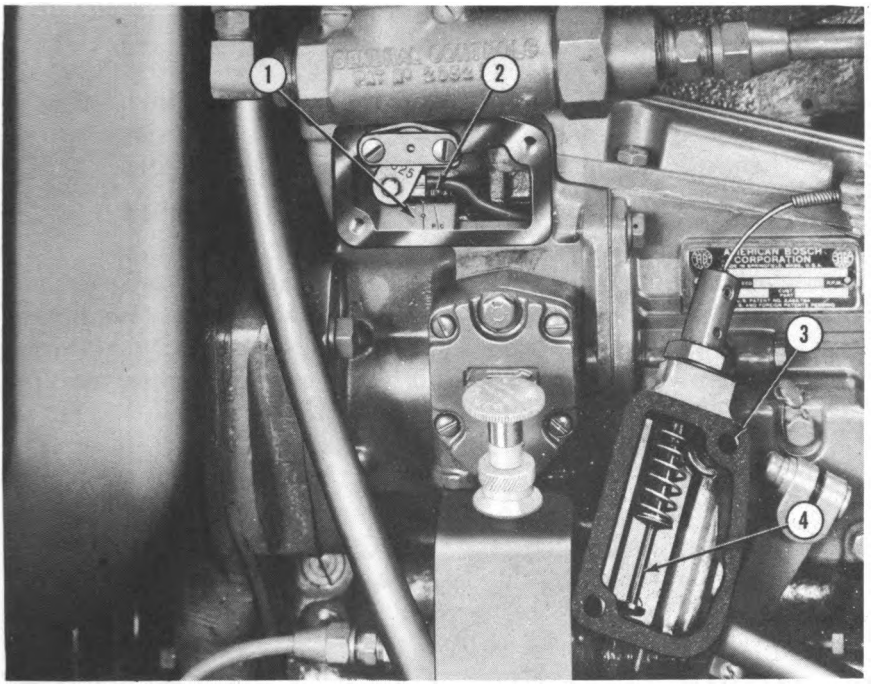
a. Description. Copper tubing is used for the high-pressure lines and the return lines connected to the nozzle. Low-pressure lines from the tank to primary and secondary filters and pump are flexible hose. Two sets of hose for suction and return lines to an external tank are supplied with the generator set.

b. Inspection and Cleaning.

(1) When disconnecting and reconnecting line fittings, be careful of the threads. Always line up nipple nuts so the thread will engage properly to prevent stripping.

(2) If troubleshooting indicates water or dirt in the fuel lines, remove lines and blow them out with dry compressed air.

(3) Inspect lines for signs of wear, cracks, chafing, collapse, and pinching. Wipe off grease and oil. Replace damaged or pinched lines.



1 Timing mark on window
2 Timing mark on gear
3 Timing window cover
4 Stop control rod

Figure 38. Timing marks on fuel injection pump.

Section VII. AIR INTAKE SYSTEM

70. General

The air intake system consists of an air cleaner and an intake manifold mounted on the right side of the engine. The manifold contains an electric heating element to heat the air when necessary.

71. Air Cleaner

(fig. 39)

a. Description. The air cleaner is an automotive type cleaner with a wire gauze element dipping into a cup filled with oil.

b. Removal.

(1) Loosen clamps on hose leading to intake manifold and remove air cleaner.

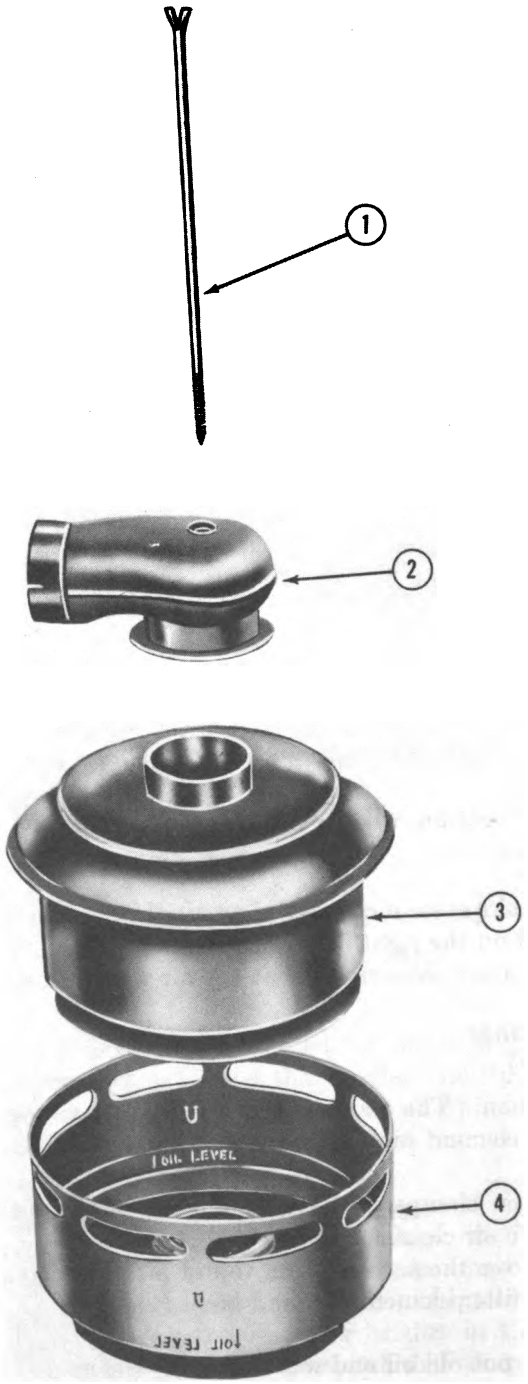
(2) Remove the screw (1) on top of air cleaner and remove cap (2), filter element (3), and bowl (4).

c. Cleaning.

(1) Pour out old oil and wipe bowl (4) clean.

(2) Wash and rinse the filter element (3) in cleaning fluid. Allow it to dry thoroughly.

(3) Wipe cap (2) clean.



1 Screw
2 Cap
3 Filter element
4 Bowl

Figure 39. Air cleaner disassembled.

d. Installation.

(1) Fill bowl (4) to the level mark with clean oil. See LO 5–5161.

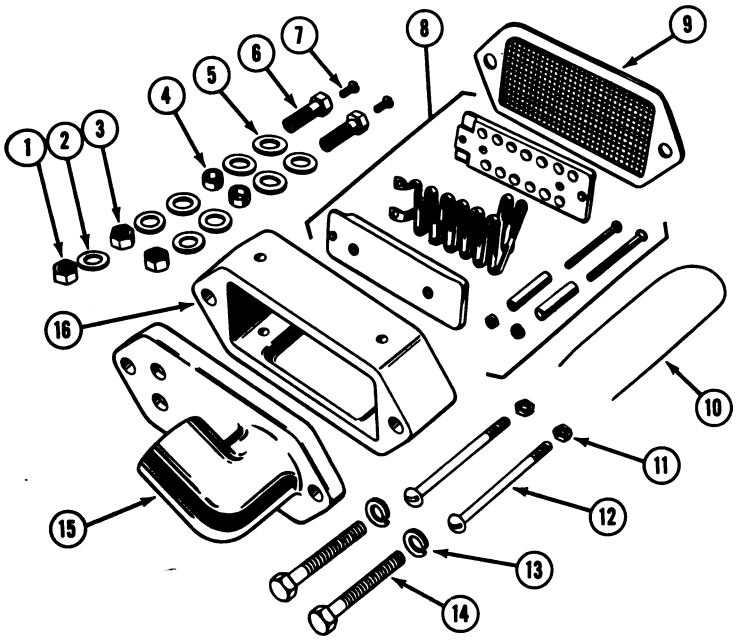
(2) Reassemble bowl (4), filter element (3), and cap (2) with screw (1).

(3) Attach to hose. Tighten screw (1) and hose clamps.

72. Air Heater

(fig. 40)

a. General. The air heater is a strip of nichrome resistance wire wound on an asbestos form. It is installed in the air heater box assembly which is held to intake manifold by two cap screws. It requires no maintenance except for inspection of the wires leading to it. If the air heater fails, it must be replaced.



1 Locknut
2 Insulating washer
3 Binding post nut
4 Insulating bushing
5 Brass washer
6 Binding post
7 Brass screw
8 Heater element assembly
9 Screen
10 Binding wire
11 Brass nut
12 Screw
13 Lockwasher
14 Cap screw
15 Air cleaner adapter
16 Air heater body

Figure 40. Exploded view of air heater.

b. Testing. The air heater may be tested by pressing the heater switch and watching the battery ammeter. No reading indicates a burned-out heating element.

c. Removal.

(1) Disconnect wire from heater binding post (6).
(2) Remove hose from air cleaner to adapter (15).
(3) Remove two cap screws (14) holding air heater to under side of intake manifold.

d. Replacing Heater Element.

(1) Take out two long screws (12) holding element (8) to heater body (16).
(2) Remove two terminal screws (7) and screws holding the element to the asbestos covers.
(3) Reassemble with new element.

e. Replacement. Reassemble heater to manifold and attach the wire and air cleaner.

Section VIII. LUBRICATION SYSTEM

73. Description

a. Engine Lubrication (fig. 41). A gear type oil pump inside the crankcase forces oil under pressure through oil filter into the crankcase gallery line. From this line, oil goes to main bearings and through the drilled connecting rods to the wrist pins. A tube from gallery

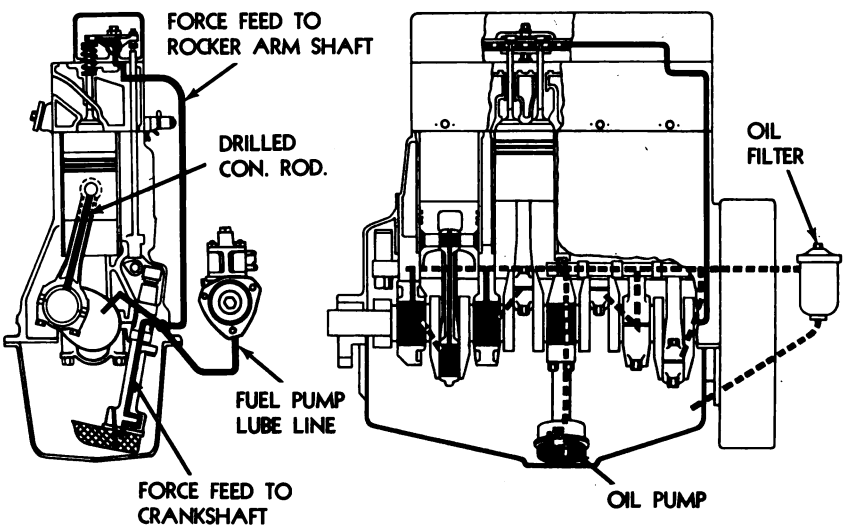


Figure 41. Diagram of engine lubrication system.

line to the drilled rocker arm shaft carries oil to valve rocker arms. Pressure is regulated by a valve at end of gallery line and excess oil drops on camshaft drive gears and drains back into oil sump. Cylinder walls and camshaft bushings are lubricated by splash. Valve cams are lubricated by oil draining from rocker shaft. The fuel injection pump is lubricated by an external tube from the gallery line.

b. Generator Lubrication. The generator has one ball bearing between main generator and exciter. This bearing is grease lubricated.

74. Lubrication System Components

a. Oil Filter (fig. 42). The oil filter element (6) should be replaced whenever the engine crankcase is drained and refilled with new oil.

(1) Remove filter cover (3) and spring (4) under the cap.
(2) Pull out the filter element (6).
(3) Remove drain plug (17) in bottom of filter body (7). Drain and clean inside of filter body.
(4) Replace drain plug.
(5) Insert new filter element.
(6) Replace cover with new gasket (5). Be sure to place the spring under the cover. Start engine and test for leakage.

b. Adjusting Oil Pressure Relief Valve (fig. 43). This adjustment should be made after filling the crankcase with clean oil, in accordance with LO 5–5161, and allowing the engine to warm up to operating temperature. With the engine at full governed speed, loosen the locknut (1) and turn the adjusting screw (2) until the oil pressure reads 25 psi. Tighten the locknut (1).

c. Breather and Filler. Before refilling the crankcase with fresh oil, wipe off the breather. Check inside of filler tube for dirt and wipe it clean with a cloth. Dip the fillercap in cleaning solvent to remove dirt from the wire screen inside it.

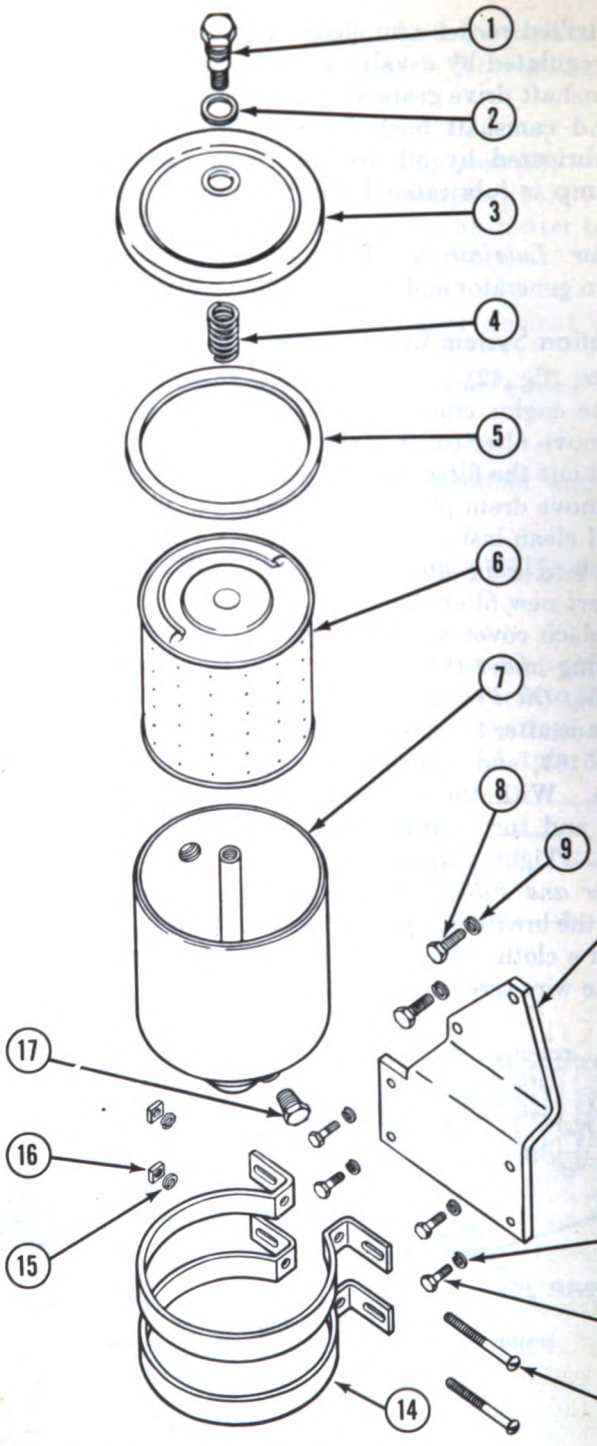
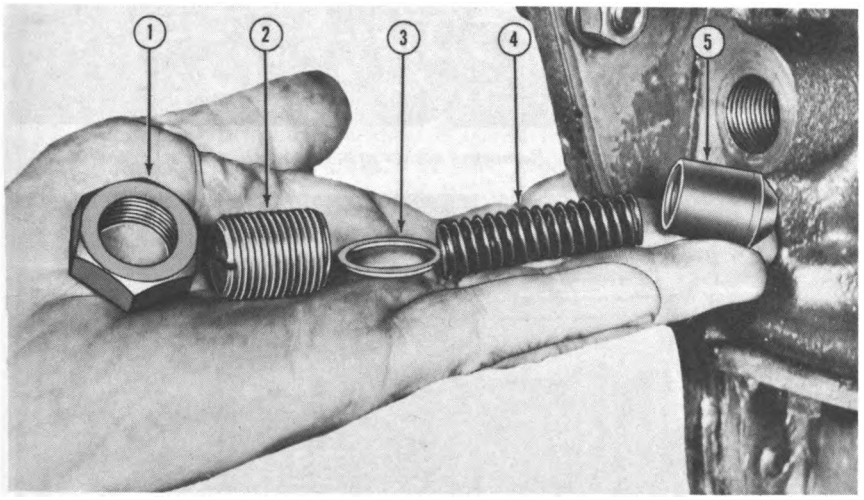


Figure 42. Exploded view of lube oil filter.

1 Cover screw
2 Washer
3 Cover
4 Spring
5 Gasket
6 Element
7 Body
8 Cap screw
9 Lockwasher
10 Bracket
11 Lockwasher
12 Cap screw
13 Bolt
14 Strap
15 Lockwasher
16 Nut
17 Plug

Figure 42—Continued.



1 Locknut
2 Screw
3 Gasket
4 Spring
5 Piston

Figure 43. Oil pressure relief valve.

Section IX. CYLINDER HEAD AND VALVE MECHANISM

75. General

a. Cylinder Head. Cylinder head stud nuts must be tightened on new generator sets after the first 8 hours of operation. See paragraph 76*b*.

b. Valve Tappets. Valve tappet clearance must be checked and adjusted if necessary. See paragraph 76*d*.

76. Rocker Arm Assembly

a. Removal (fig. 44). Remove two acorn nuts holding cover and lift cover and gasket off. Remove the two stud nuts and two cap screws holding the rocker arm assembly and lift straight up. Remove push rods.

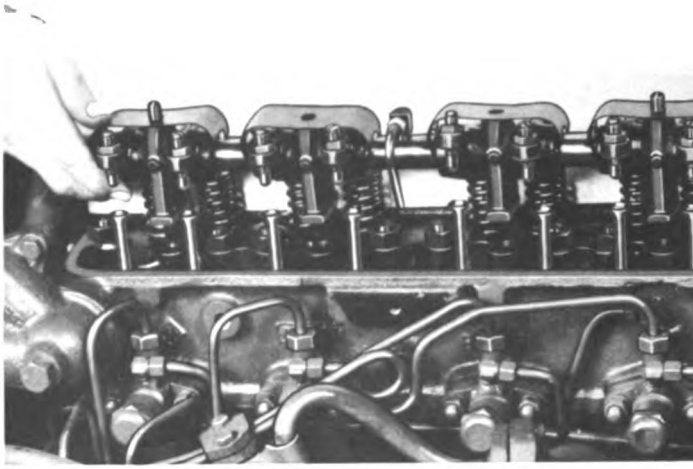


Figure 44. Removing rocker arm assembly.

Figure 45. Tightening cylinder head stud nuts.

b. Tightening Cylinder Head Stud Nuts.

(1) Using a torque wrench, tighten the stud nuts (

(2) Start in the center and work alternately towar
The sequence of tightening is shown in figure

(3) Tighten to a torque value of 95 to 105 foot-po

c. Installation.

(1) Check for bent push rods. Replace if required.

(2) Lower rocker arm assembly over the two guidi
tighten down.

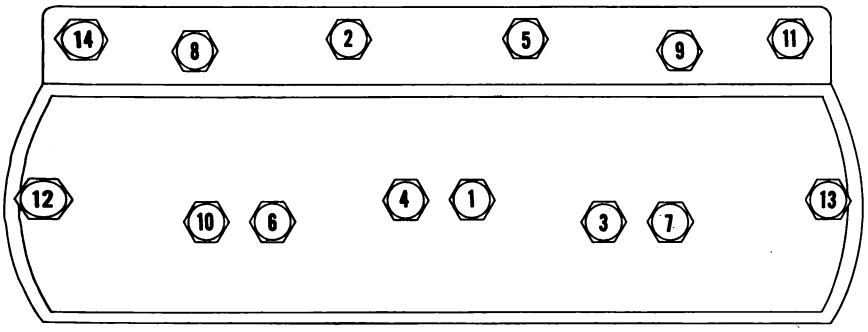


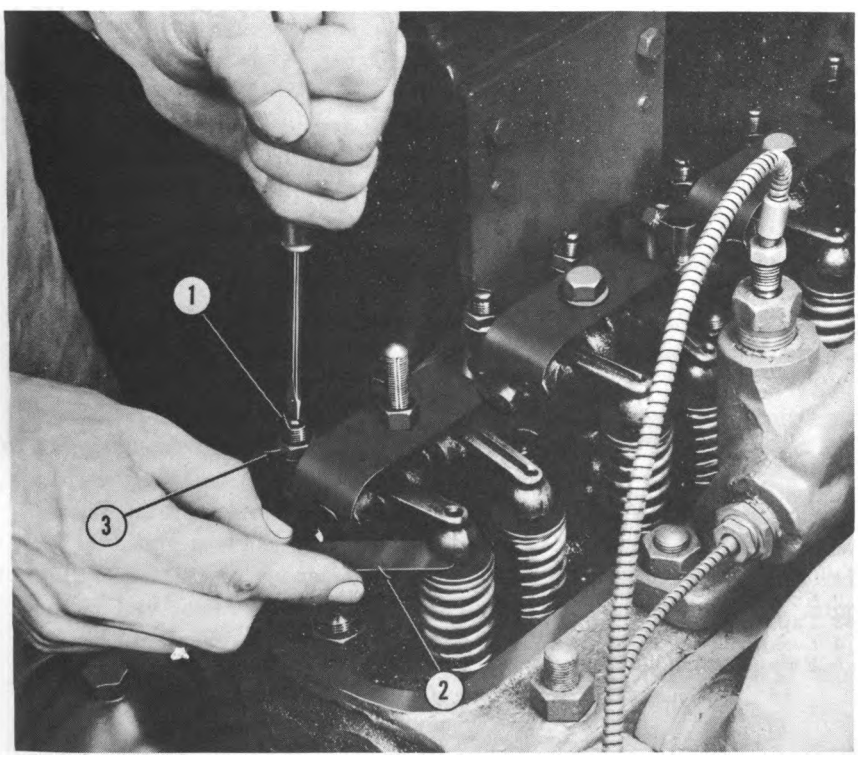
Figure 46. Cylinder head stud nut tightening sequence.

d. Adjusting Valve Tappets (fig. 47).

(1) Turn engine over by hand and check tappet clearance.

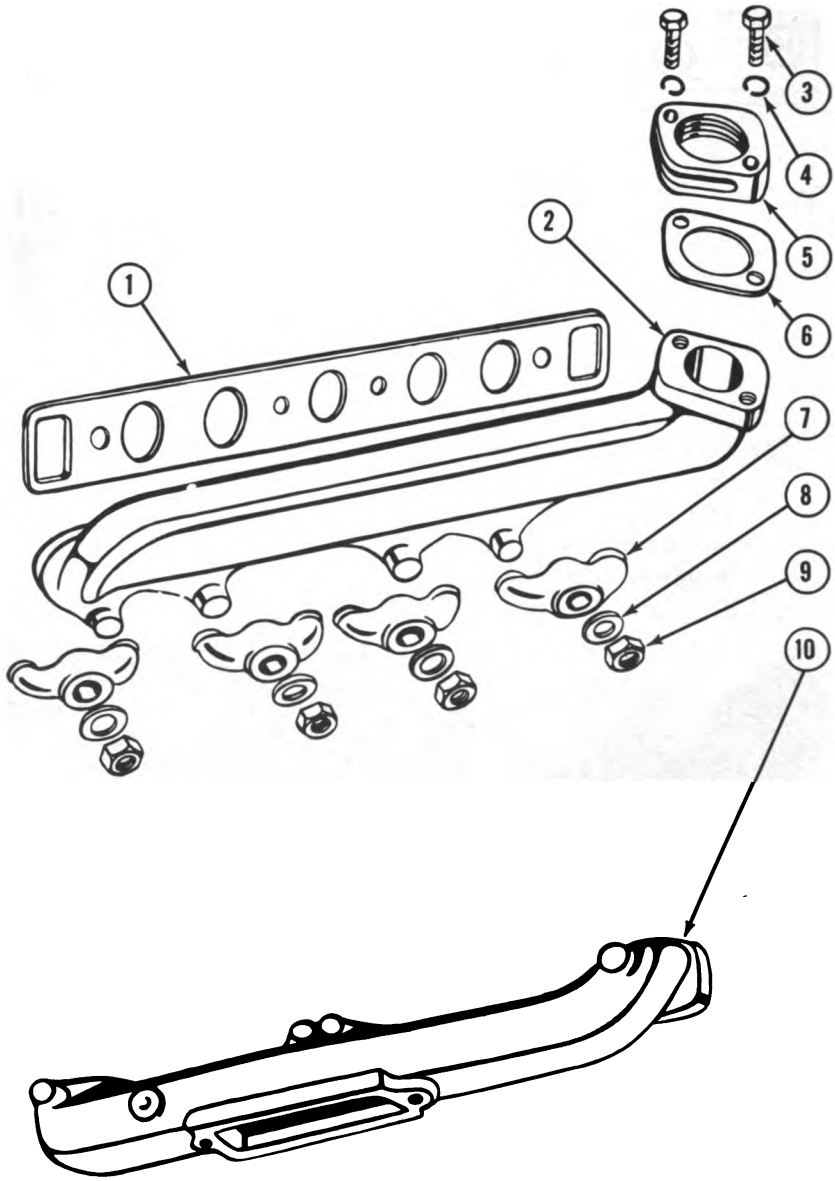
(2) Proper tappet clearance is 0.009 inch (hot) for both intake and exhaust valves. If the clearance on any valve is excessively large or small, make approximate adjustment before starting engine.

(3) Start engine and allow it to reach operating temperature.



1. Adjusting screw 2 Feeler gage 3 Locknut

Figure 47. Adjusting valve tappet clearance.



1 Gasket
2 Exhaust manifold
3 Cap screw
4 Lockwasher
5 Exhaust manifold outlet flange
6 Gasket
7 Clamp
8 Washer
9 Nut
10 Intake manifold

Figure 48. Exploded view of exhaust and intake manifolds.

(4) To adjust clearance, insert a 0.009-inch feeler gage (2) between the valve stem and contact button.
(5) Loosen the adjusting screw locknut (3) and turn the adjusting screw (1) until a clearance of 0.009 inch is reached.
(6) Hold adjusting screw (1) and tighten locknut (3).
(7) Always check adjustment after tightening locknut.

77. Exhaust and Intake Manifolds

a. Removal (fig. 48).
(1) Loosen clamps and hose between air cleaner and air heater. Disconnect wire to heater.
(2) Disconnect exhaust pipe at flange.
(3) Remove nuts (9), washers (8), and manifold clamps (7).
(4) Remove exhaust manifold (2) and intake manifold (10).

b. Inspection.
(1) Inspect the manifolds for cracks. Replace if necessary. The manifolds can be brazed to make emergency repairs.
(2) Check for warpage by placing manifolds on a flat, smooth surface. If warped, replace.

c. Reinstallation. Reverse procedure of *a* above.

78. Cylinder Head

a. Removal.
(1) Remove rocker arm assembly (par. 76).
(2) Drain the cooling system.
(3) Remove manifolds (par. 77).
(4) Remove fan and water pump (par. 57).
(5) Remove water jackets and pipes (par. 59).
(6) Remove primary fuel filter (par. 65).
(7) Disconnect or remove injector nozzles (pars 66).
(8) Remove the nuts from the cyclinder head studs and, using a chain hoist, lift the head. Discard gasket.

b. Gasket Replacement. Thoroughly clean the machined surfaces of the cylinder head and block and place the gasket over studs.

c. Reinstallation.

Caution: Make certain nothing is lying on top of the pistons.
(1) Using a chain hoist, carefully lower the head over the studs.
(2) Install the stud nuts (par. 76*c*), except that when the head has been removed, the nuts are to be turned down to a snug fit in sequence before full torque is applied.
(3) Reverse the order of *a* above. Make sure to refill the cooling system and check for leaks.

79. Description

(fig. 49)

The engine electrical system consists of a 24-volt generato by the engine fan belt, a starting motor with Bendix d 6-volt storage batteries, an air heater with necessary w switches, and an ammeter. A combination circuit bre voltage regulator is mounted on the engine crankcase in b generator. The circuit breaker protects the generator agai loading and prevents the battery from discharging into the at low engine speeds.

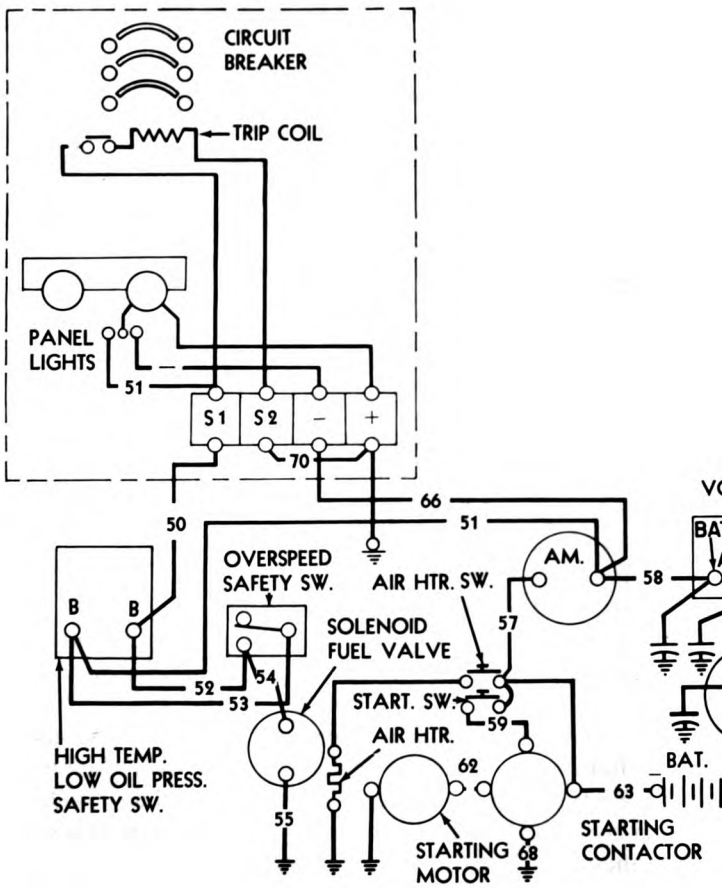


Figure 49. Engine wiring diagram.

80. Battery

a. Maintenance. The battery should be kept fully charged at all times.

(1) Check water level in each fillercap every week. Add water if necessary to just below bottom of filling tube. Use distilled water, if available, or clean soft water. Refer to paragraphs 21 and 22 for maintenance in hot and cold weather.

(2) Keep terminals tight and clean. If sulfate forms on terminals, clean them thoroughly and apply a thin coating of vaseline or cup grease.

(3) If battery acid spills over metal parts, wash parts with ammonia, washing soda, or baking soda solution, and dry carefully.

(4) Every week check each cell with a hydrometer. A reading of 1.270 to 1.285 indicates fully charged; 1.200 to 1.215, half discharged; 1.125 to 1.140 discharged. Always let a battery charge at least 30 minutes after water has been added before taking a hydrometer reading. Readings taken sooner will not be accurate.

(5) If battery charge is low, remove battery and have it charged. This is particularly important in cold weather.

(6) In cold weather, add water to battery after the set is started up; not when it is being shut down. Battery acid freezes at temperatures of +20° to −50° F., depending on its state of charge. A weak battery will freeze.

b. Charging. In normal operations of the generator set, the batteries will be kept fully charged. If necessary, they must be removed and charged separately.

81. Starting Motor

a. General (fig. 50).

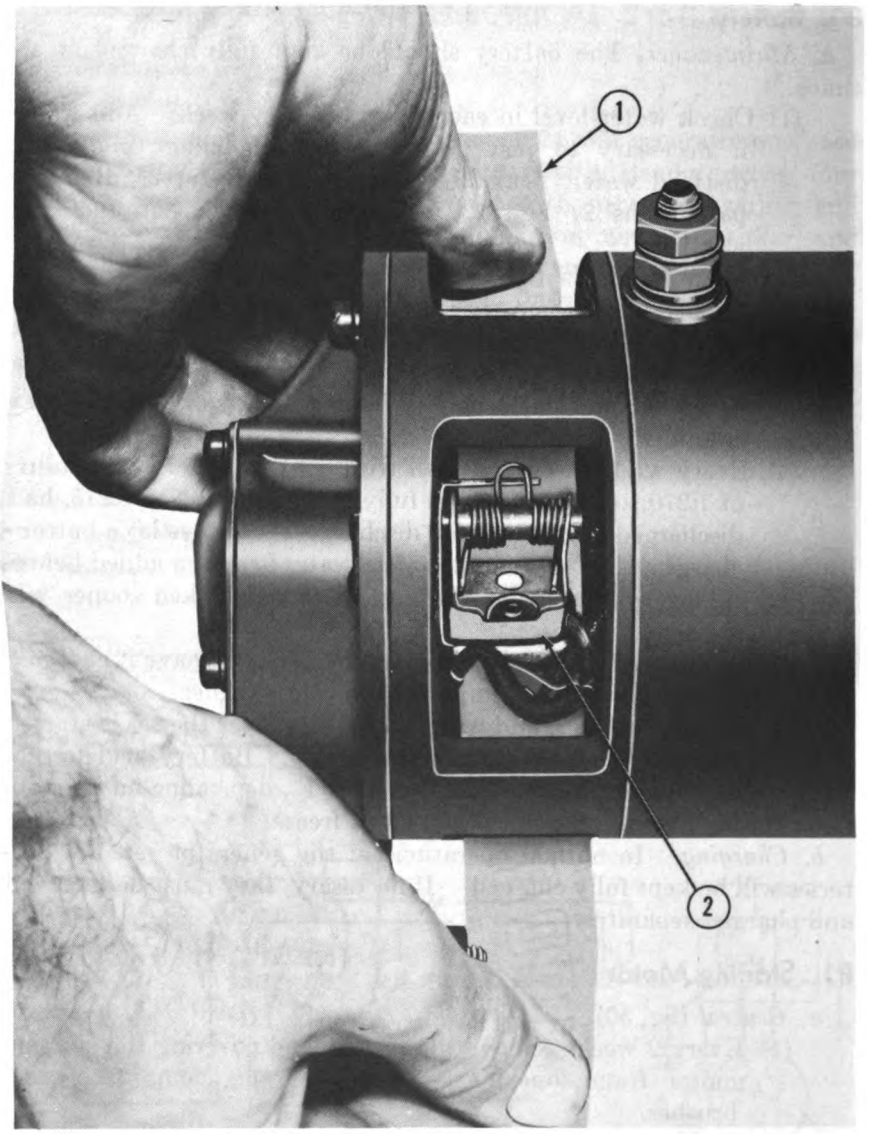
(1) Every 2 weeks remove the metal band covering the starting motor frame openings and inspect the commutator and brushes.

(2) The commutator should be smooth and should have a polished surface. If dirty, run a strip of No. 00 sandpaper under the brushes and hold against the commutator while turning the starter over.

(3) See that the brushes slide freely in their holders.

(4) Look for high ridges of mica between the commutator bars. If the commutator is rough or worn, it should be replaced.

(5) New brushes are three-fourths of an inch long. They should be replaced when worn down to one-half of an inch. Refer to paragraph 107.



1 Sandpaper 2 Brush

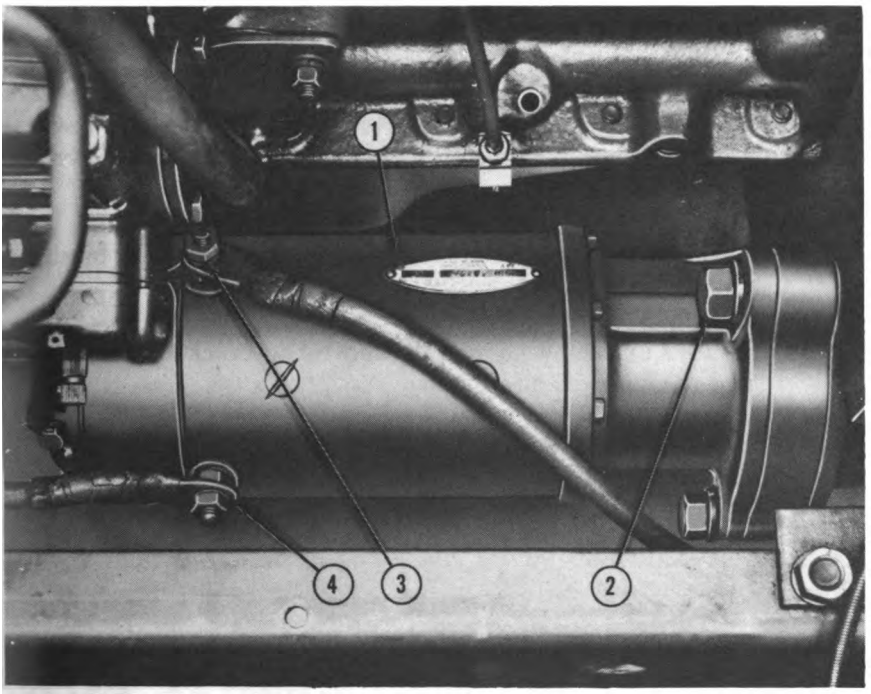
Figure 50. Cleaning commutator with sandpaper.

b. Remove Starting Motor (fig. 51).

(1) Remove lubricating oil filter.

(2) Disconnect fuel lines and throttle control wire, which may interfere with removal of the starter.

(3) Disconnect battery cable (3) from starter (1) and tape the end to prevent accidental electric contact.



1 Starter
2 Cap screws
3 Battery cable
4 Ground cable

Figure 51. Starting motor.

(4) Disconnect the ground cable (4).
(5) Remove three cap screws (2) holding starter (1) to flywheel housing. Two of these screws are difficult to reach. Use a socket wrench with universal joints in driver.

c. Remove Bendix Drive. Loosen the shaft spring screw, which can be reached through hole in pinion housing. Then take out housing screws and slide Bendix drive off shaft. Replace worn or broken parts.

Note. Do not dip the Bendix drive in cleaning solvent. This is a friction type drive and cannot be relubricated.

d. Replace motor (fig. 51).
(1) Give the shaft a thin coat of light oil and reassemble Bendix drive to shaft.
(2) Place starter in position and secure with three cap screws (2). Connect battery cable (3) and ground cable (4).
(3) Reconnect fuel lines and throttle control wire.
(4) Install oil filter.

82. Battery Charging Generator
(fig. 52)

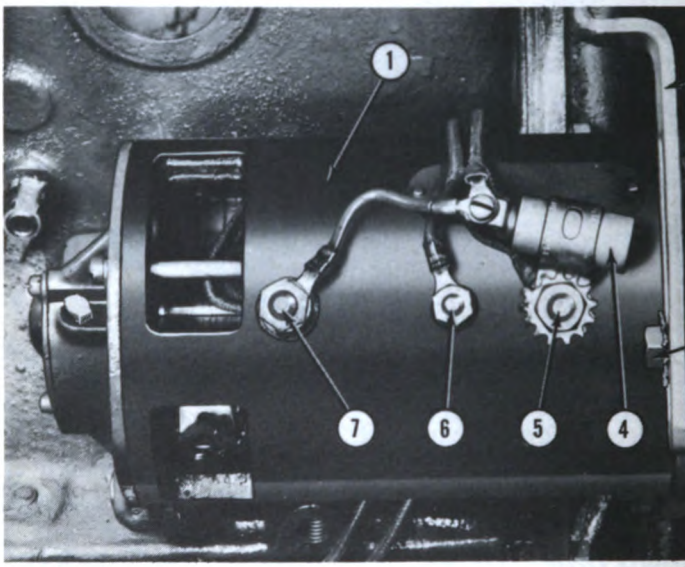
a. General. Maintenance of the battery charging ge same as for the starting motor (par. 81*a*). New brush eighths of an inch long. Replace them when they are v three-eighths of an inch.

b. Removal.

(1) Disconnect wire from ground binding post (5), post (6), and armature binding post (7).

(2) Remove adjusting screw (3) from brace (2).

(3) Remove two screws holding generator to bracke and remove generator.



1 Generator
2 Generator adjusting brace
3 Adjusting screw
4 Condenser
5 Ground binding pos
6 Field binding post
7 Armature binding p

Figure 52. Battery charging generator.

c. Installation.

(1) Reverse the steps of *b* above.

(2) Adjust fan belt as directed in paragraph 56.

83. Voltage Regulator
(fig. 53)

a. Description. The combination voltage regulato breaker is attached to a bracket on the engine crankcas the charging generator. The regulator element auton trols battery charging current to the proper value.

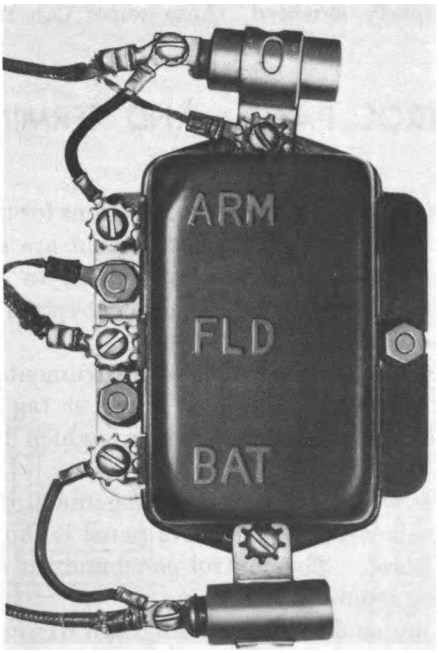


Figure 53. Voltage regulator.

breaker element opens the battery circuit at low speeds to prevent discharging. The regulator cover is sealed by a lead pin peened over. No maintenance is required. Do not remove the cover or tamper with the regulator. If it is defective, replace it.

b. Regulator Defects. The regulator will give long service before becoming defective. Eventually the vibrating contacts will become burned and they may freeze together. Two indications of trouble are—

(1) Charging current high (10 to 20 amperes) when battery tests fully charged and panel lights are out.
(2) Battery discharges at low speeds and charges at high speeds.

84. Radio Interference Suppression System

a. Description. The system for suppression of radio interference is described in paragraphs 18 and 19.

b. Inspection and Repair. Operate any amplitude-modulated (AM) radio receiver near the generating set while it is running. If you get interference, remove each condenser in turn and test on a suitable impedance bridge. Replace defective condensers. Make sure that all condensers are well grounded. Clean rust and dirt from the points at which they are attached to the frame. See that the wires from the exciter to the voltage regulator on the control panel are a metal shielded type and that the shielding braid is grounded satis-

factorily. If not properly shielded, these wires can radia
ference.

Section XI. CONTROL PANEL AND TERMINA

85. Wiring

a. Wiring Diagram (fig. 54). Complete connections for the g
exciter, control panel and engine electrical system are show
wire numbers shown on this diagram correspond to the
marked on each wire. Marks on terminals correspond to
the instruments and equipment.

Caution: When removing and replacing instruments, fo
directions and wiring diagram carefully. Mark or tag any
terminals not marked or those with markings which have
unreadable.

b. Control Panel Interior (fig. 55). The arrangement of inst
and service line terminals within the control panel is shown.

c. Control Panel Removal. The control panel and the cont
base (14, fig. 28) can be removed as a unit.

(1) Remove housing as directed in paragraph 61.
(2) Disconnect engine controls, gage lines, and all
wiring to control panel as directed in paragraphs 86
103.
(3) Disconnect and remove batteries.
(4) Remove two screws (13) holding battery shelf (10) t
panel base (14).
(5) Remove five screws holding control panel base to
base and remove control panel.

d. Control Panel Installation.

(1) Install the control panel and panel base on the
base and secure with five cap screws and nuts.
(2) Install the battery shelf batteries.
(3) Connect the engine controls and gage lines. Make
throttle and stop controls operate freely and do n
(4) Connect all the electrical wiring to the control pan
low the wiring diagram (fig. 54) carefully.
(5) After the unit is placed in operation, check all inst
and controls for proper operation at no load and
full load.

86. Throttle Control

(fig. 29)

a. Maintenance. Oil the throttle operating wire cable as d
in the lubrication order. Make sure the wire is fastened sec
the governor throttle control lever.

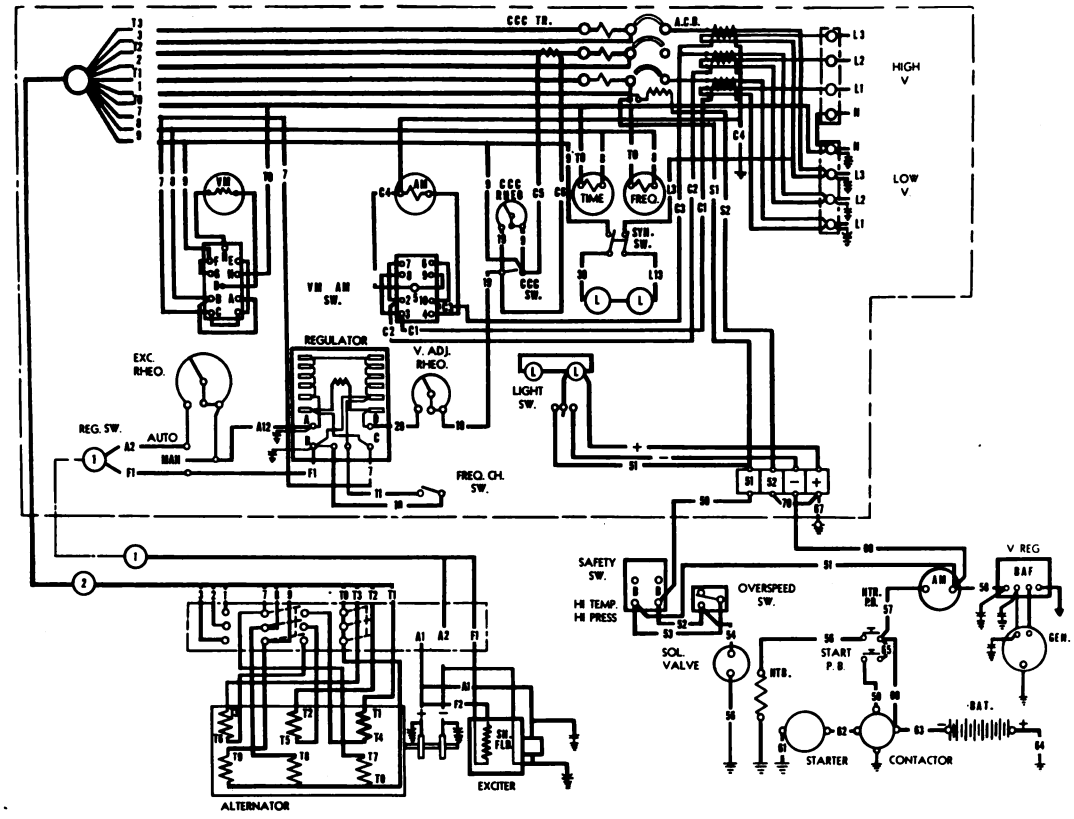
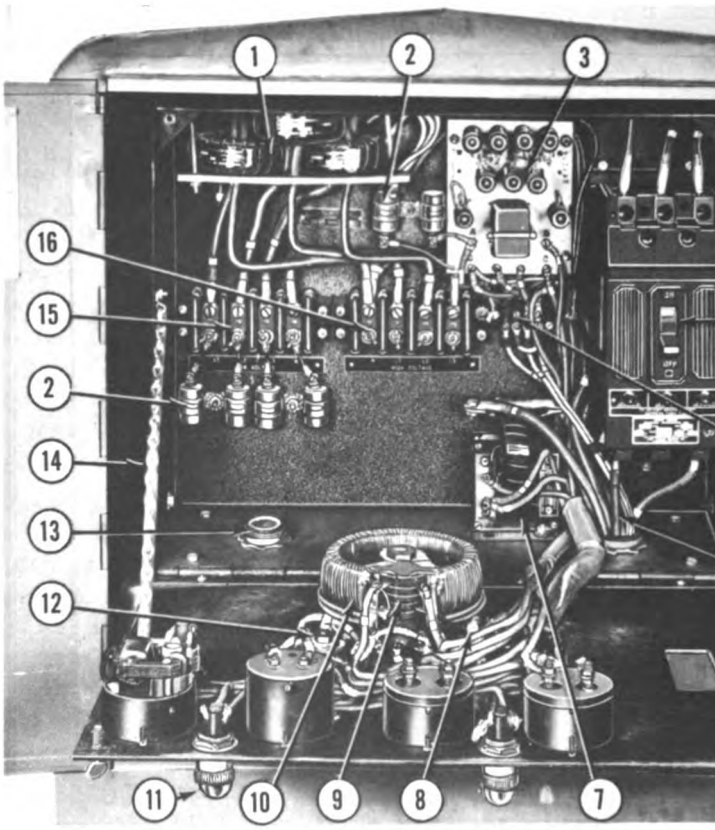


Figure 54. Wiring diagram of generator set.



1 Current transformers
2 Suppression condensers
3 Voltage regulator
4 Circuit breaker
5 Terminal block for engine controls
6 Generator lead bushing
7 Crosscurrent compensation transformer
8 Voltage regulator rheostat
9 Voltmeter-ammeter p
10 Field rheostat
11 Panel light
12 Crosscurrent compen stat
13 Bushing for load lead
14 Panel support chain
15 Low-voltage terminal
16 High-voltage termina

Figure 55. Interior view of control panel.

b. Removal.

(1) Unfasten operating wire from governor throttle co
It is held by a setscrew.

(2) Remove large nut on throttle control which be
the back of the cup on the engine control panel.

(3) Pull assembly of throttle control and operating wi
front of control panel.

c. Replacement.

(1) Push assembly through the panel from front.

(2) Thread the operating wire cable through the
guides it on the flywheel housing and fasten the

governor throttle control lever. Make sure the throttle control is at a setting which corresponds to the position of the governor throttle control lever. The throttle control should be all the way in when the throttle control lever is against the idling stop screw.

87. Stop Control

Construction and operation of the stop control is similar to that of the throttle control. Refer to paragraph 86 for maintenance, removal, and replacement.

88. Starter Switch

(fig. 12)

a. Maintenance. The starter switch (17) is in a sealed case. No maintenance is required.

b. Removal.

(1) Disconnect all wires from starter switch terminals in back of panel.

(2) Remove three screws from front of panel. These screws have nuts on the back.

(3) Remove switch from front and case from back.

c. Replacement. Reverse the procedure of *b* above.

89. Air Heater Switch

(fig. 12)

Maintenance, removal, and replacement are the same for the air heater switch (18) as for the starter switch. Refer to paragraph 88.

90. Voltmeter-Ammeter Phase Switch

a. Maintenance (fig. 55). The voltmeter-ammeter phase switch (9) is in a sealed case. No maintenance is required.

b. Removal (fig. 12).

(1) Disconnect all wires from switch (22).

(2) Loosen screws on phase switch knob and knob for the regulator rheostat (9). Remove the two knobs.

(3) Remove the hex bushing nuts from the switches for synchronizing light switch (24), panel light switch (6), voltage regulator frequency switch (11), voltage control switch (10), and remove the hex nut from the adjusting screw on the crosscurrent compensation rheostat (23).

(4) Remove the large nameplate from the front of the panel. This uncovers the screws which hold the switch.

(5) Remove the four screws and nuts holding switch to panel.

c. Replacement (fig. 12). Reverse the procedure of *b* above. Follow the wiring diagram (fig. 54) to make correct connections to the switch.

91. Synchronizing Light Switch

a. Maintenance (fig. 12). The synchronizing light swit
toggle switch sealed in its case. No maintenance is requi

b. Removal.

(1) Disconnect all wires to the switch.

(2) Remove the hex bushing nut from the front and
from the back of the panel.

c. Replacement. Reverse procedure of *b* above. Follow
diagram (fig. 54) to make correct connections.

92. Panel Light Switch

(fig. 12)

For maintenance, removal, and replacement of the
switch (6), follow the procedure in paragraph 91.

93. Voltage Regulator Frequency Switch

(fig. 12)

For maintenance, removal, and replacement of the volta
frequency switch (11), follow the procedure in paragraph 9

94. Voltage Control Switch

(fig. 12)

For maintenance, removal, and replacement of the vol
switch (10), follow the procedure in paragraph 91.

95. Crosscurrent Compensation Switch

(fig. 12)

For maintenance, removal, and replacement of the cr
compensation switch (21), follow the procedure in paragrap

96. Regulator Voltage Adjusting Rheostat

a. Removal (fig. 12).

(1) Disconnect all wires to rheostat (9).

(2) Loosen setscrew and remove knob.

(3) Remove hex bushing nut from front and rheostat
of panel.

b. Replacement (fig. 54). Reverse procedure of *a* abo
sure the setscrew in the knob is tight. Follow the wiri
(fig. 54) to make correct connections.

97. Exciter Field Rheostat

a. Maintenance (fig. 12). Follow the procedure in pa
for maintenance of the exciter field rheostat (12).

b. Removal (fig. 55). Follow the same procedure as in
96, except that the exciter field rheostat (10) is held to th
two flat head screws.

c. Replacement. Reverse procedure for removal.

98. Panel Lights
(fig. 55)

a. General. Panel lights (11) have screw-on metal hoods. To replace bulbs, unscrew and remove the hoods.

b. Removal. Panel light sockets are held to the panel by a hex nut in back and a knurled nut in front. Unscrew the hex nut and pull out the socket.

c. Replacement. Reverse procedure for removal.

99. Synchronizing Lights
(fig. 12)

a. Maintenance. The synchronizing lights (7) have screw-on clear glass bull's-eyes. To replace bulbs, unscrew the bull's-eyes.

b. Removal and Replacement. Follow the procedure in paragraph 98.

100. Meters (Time, Ammeter, Voltmeter, Frequency)
(fig. 12)

a. Maintenance. No maintenance is required. Do not attempt to service or repair meters. Replace them when they are defective.

b. Removal. Each of these meters is held to the panel by three screws and nuts. Disconnect all wires before removing the meter.

c. Emergency Procedure. If operation of the generator set is necessary with a meter removed from the panel, proceed as follows:

(1) *Ammeter.* Connect together with a screw and nut all wires which were fastened to the meter. Wrap the joint with friction tape.

(2) *Voltmeter, time meter, frequency meter.* Wrap separately each loose wire with friction tape. Do not twist any wires together.

101. Meters (Battery Charge, Oil Pressure, Temperature)
(fig. 12)

a. Maintenance. No maintenance is required. Refer to paragraph 100.

b. Removal. Each of these meters has two screws attached which pass through straps on back of panel and are held by nuts. Disconnect all wires or tubes, remove nuts, and pull meter through from front of panel.

c. Emergency Procedure. To run generating set without any of these meters proceed as follows:

(1) *Battery charge ammeter.* Connect the wires together and tape the joint.

(2) *Oil pressure gage.* Plug end of oil line.

(3) *Temperature meter.* Leave cable disconnected.

102. Safety Switch

a. Maintenance (fig. 12). Every 2 weeks remove t
of the safety switch (13) and carefully blow out any di
may be inside. No other maintenance is required
entire unit if one is found to be defective.

b. Removal.

(1) Disconnect oil pressure line and all wires from
(2) Loosen set screw and remove switch knob.
(3) Remove two screws from front of panel an
out from back.

c. Replacement. Reverse procedure of *b* above.
diagram (fig. 54) to make correct connections.

103. Circuit Breaker

a. General (fig. 55). No maintenance of the circuit
required. Replace the entire unit if defective.

b. Removal.

(1) Disconnect three wires from top and three
terminals.
(2) Remove four screws holding circuit breaker to
screws have nuts on the back.
(3) Pull circuit breaker forward and disconnec
from back terminals.

c. Replacement. Reverse procedure of *a* above.
diagram (fig. 54) to make correct connections.

104. Voltage Changeover Switch Box

a. Maintenance (fig. 5). Monthly, apply CG very
hinges of the voltage changeover switch (8) and wor
and forth a few times. Check for loose connections.

b. Removal.

(1) Remove two cap screws holding box to ge
These go through a bracket under the box.
(2) Open the box and unscrew the nut on the c
to the generator.
(3) Disconnect all wires from the switches.
(4) Lift box and pull wires out through the condu

c. Replacement. Thread wires through conduit ho
box in place. Reconnect all wires according to w
(fig. 54).

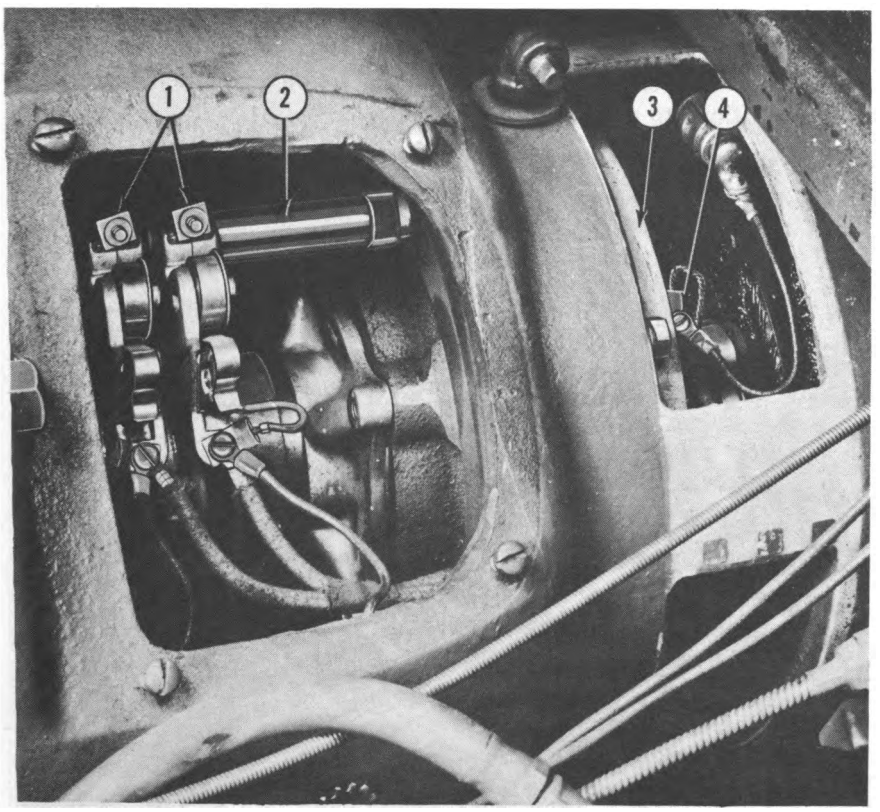
Section XII. CLEANING AND BRUSH REPLACEMENT

105. Inspecting Generators and Starter (fig. 56).

a. Remove Inspection Covers. The covers on the charging generator, starting motor, and exciter are flexible steel bands drawn tight by long screws. Loosen the screw and slide the cover back to expose the brushes. The inspection covers on the main generator are flat metal plates on each side of the generator end shield, each held by four cap screws.

b. Sliprings. Sliprings are made of stainless steel. See that they are well polished.

c. Commutators. Inspect all commutators for dirt, rough and pitted appearance, and high mica between the segments. A good commutator has a polished look and a light chocolate color. If the commutator appears to be in good condition but sparks badly when



1 Brush springs
2 Brush holder stud
3 Exciter brush yoke
4 Exciter brush spring

Figure 56. Generator with inspection covers removed.

running, the condition should be reported so that an electrical technician can check the trouble. Sparking ruins a commutator rapidly.

d. Brushes. Check each brush to see that it moves freely in its holder. Make sure the brush rigging is fastened securely. See that insulation of brush studs is not cracked or broken.

e. Windings. Inspect generator and exciter windings for dust, dirt, or moisture. Look for signs of melting varnish on windings as this indicates overheating.

f. Brush Leads. Make sure that wires on brushes are in good condition and tightly fastened

106. Cleaning Generator

a. Removal. Remove inspection covers.

b. Sliprings (fig. 57). Polish sliprings with a piece of canvas or clean cloth on the end of a dry piece of wood while set is running.

c. Commutator (fig. 58). Clean the commutator on the charging generator, starter, and exciter with fine sandpaper. Do not use emery cloth. If high mica is found, the machine must be disassembled and the commutator undercut. If commutator cannot be cleaned up with sandpaper, it will have to be machined. Report these conditions to proper authority.

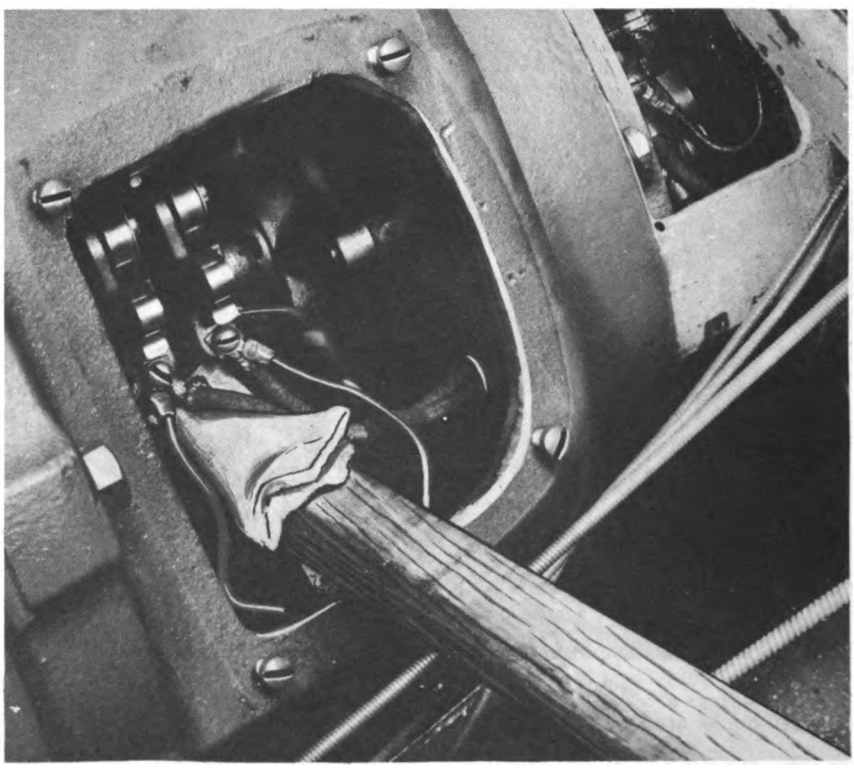


Figure 57. Cleaning sliprings.

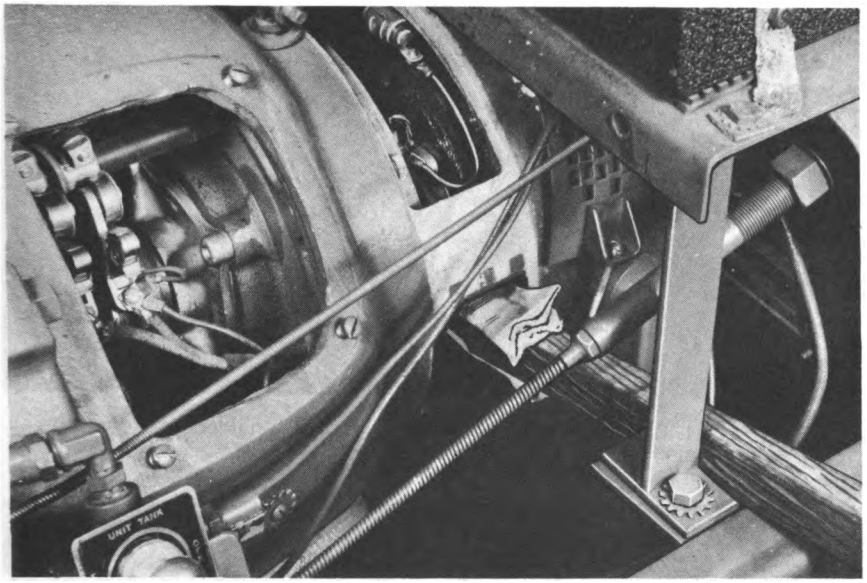


Figure 58. Cleaning commutator.

d. Brushes and Brush Holder. Wipe clean while set is stopped.

e. Windings. Blow windings with dry compressed air of not more than 10 psi. If possible, use suction cleaning. If grease or sticky dirt is present, the unit will have to be disassembled for cleaning. Report this condition to proper authority.

f. Fan. Wipe fan blades clean. Use dry-cleaning solvent if necessary.

107. Replacing Brushes

a. Remove Brushes (fig. 59).

(1) Remove screw holding brush wire (pigtail) to holder.

(2) Lift brush spring (1) and slide brush (2) out of holder (3).

Note. The alternator has two brushes easily reached through the inspection covers. The exciter has four brushes, two of which are on the under side and difficult to reach unless the generator is removed from the base. Brushes on the charging generator are easily reached. Brushes on starter are hard to reach unless starter is removed.

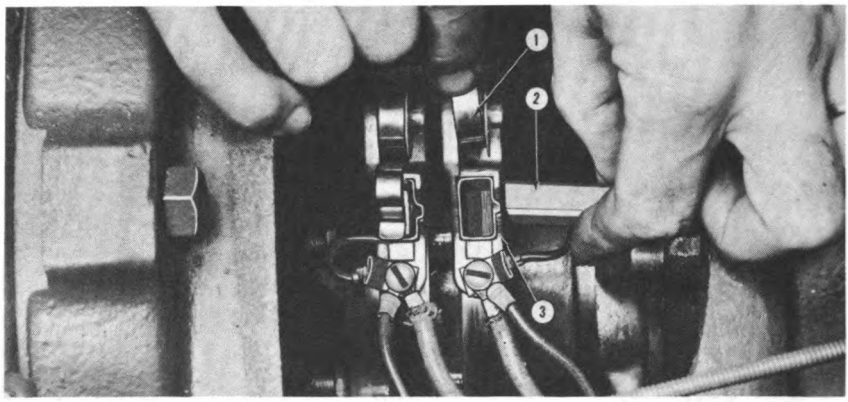
b. Fitting Brushes (fig. 60).

(1) Place a strip of coarse sandpaper (1), sand side up, over commutator or slipring.

(2) Insert brush and pull sandpaper back and forth to shape end of brush to curve of surface.

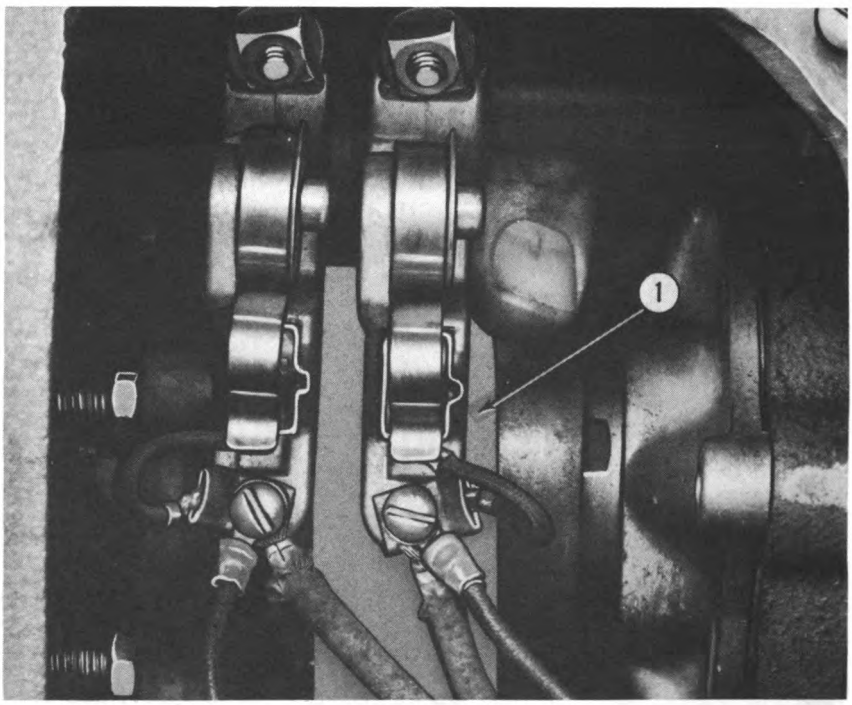
(3) When roughly shaped, finish to a good fit with fine sandpaper.

(4) Blow out all sand and carbon dust.



1 Brush spring 2 Brush 3 Brush holder

Figure 59. Removing brushes.



1 Sandpaper

Figure 60. Fitting brushes.

c. Adjusting Brush Springs.

(1) Accurate setting requires a small spring scale. Hook scale on brush spring and pull directly in line with brush holder. Correct tensions are as follows:

(*a*) Charging generator, 35 to 53 ounces.

(*b*) Starter, 34 to 43 ounces.

(*c*) Alternator, 10 to 16 ounces.

(*d*) Exciter, 8 to 12 ounces.

(2) Adjust to required value by setting the spring holder to the correct notch on main generator and exciter and bending the spring on starter and charging generator.

(3) If correct tension cannot be obtained, brushes are too short and must be replaced.

CHAPTER 4

FIELD AND DEPOT MAINTENANC

Section I. INTRODUCTION

108. General

a. Scope. Instructions in this chapter are published for th tion and guidance of maintenance personnel responsible for higher echelons of maintenance of this generator set. Th information on maintenance of this generator set which is l scope of the tools, equipment, and supplies normally availab organizations.

b. Sequence of Disassembly and Assembly. It is recomm disassembly of the generator set proceed by systems as d the following sections of this chapter.

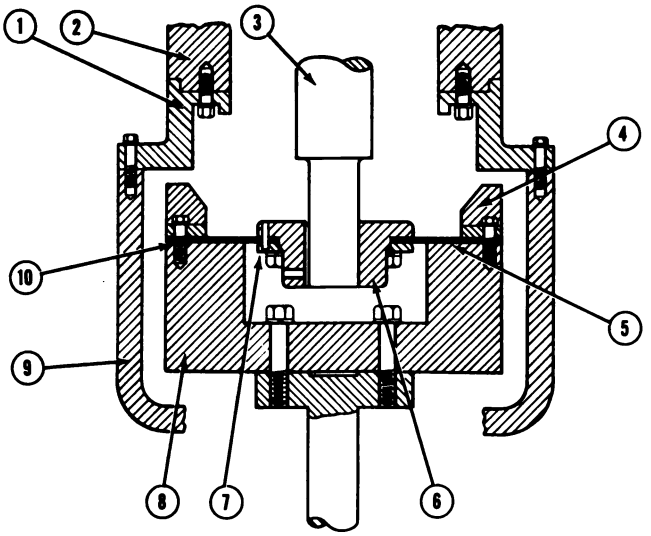
(1) Remove housing (par. 61).
(2) Disconnect storage batteries and remove.
(3) Remove fuel tank (par. 62).
(4) Remove radiator assembly (par. 54).
(5) Remove control panel (par. 85).
(6) Drain crankcase and disconnect drainpipe from eng
(7) Remove engine and generator assembly.
   (*a*) Remove holddown bolts, two in front engi bracket and four in feet of generator frame.
   (*b*) Place slings around engine front support br generator frame and lift the assembly off the b assembly weighs about 1,500 pounds. Do slings under the oil pan.
   (*c*) Block up the engine and generator assembly in working space.
(8) Disassembly can now proceed according to the sections on the different systems.
(9) Reassembly in general follows the opposite orc assembly.

c. Replaceable Parts. Appendix II is a list of replaceabl this generator set.

109. Removing Engine from Generator

(fig. 61)

a. Blocking. Block up under flywheel housing to suppor of engine. It is convenient to rest the generator on a fo truck so it can be pulled back from the engine.



1 Adapter ring
2 Generator frame
3 Generator shaft
4 Fan
5 Driving disk
6 Generator coupling hub
7 Screw plate
8 Flywheel
9 Flywheel housing
10 Flywheel coupling cap screws

Figure 61. Coupling assembly.

b. Cover Plate. Remove cover plate over generator fan just back of flywheel housing.

c. Frame Connection. Remove 12 cap screws holding adapter ring (1) to flywheel housing (9).

d. Shaft Coupling. Remove six cap screws (10) holding outer fan (aluminum casting) (4) to flywheel (8). These screws go through driving disk (5). Generator is now free from engine and can be pulled back out of way. Support engine end of generator shaft to prevent straining bearing.

Section II. COOLING SYSTEM

110. Removing Lime Deposits

a. General. Some types of water leave lime deposits in radiator, water jackets, and pump. These deposits must be removed, as they prevent proper water circulation.

b. Checking for Lime. Remove thermostat as described in paragraph 58. Lime deposits appear as a hard, white scale in water passages.

c. Cleaning Cooling System.

(1) Fill system with a mixture consisting of 3 pints of commercial hydrochloric (muriatic) acid, ½ pint of formaldehyde, and 14½ quarts of water. Mix formaldehyde and water first and then add acid.

Caution: This mixture will burn skin and eyes.

(2) Operate engine for 3 hours and then drain out t solution.

(3) Neutralize and flush thoroughly, following d paragraph 54.

111. Radiator

(fig. 20)

a. General. Removal, disassembly, inspection, and test tor is covered in paragraph 54.

b. Repair.

(1) Solder all leaks in the core.

(2) Straighten bends in fan guard, brush guard, and

(3) Repair cracks in guard frame and fan guard by v

(4) Repair or replace overflow tube.

c. Reassembly. Refer to paragraph 54.

d. Installation. After engine and generator assembly ar in the base, replace radiator assembly (par. 54).

112. Fan

(fig. 62)

a. General. The fan has six blades and is driven by a b crankshaft. This belt also drives the charging generato pulls air from around the engine and blows it out through

b. Fan Belt Replacement. Refer to paragraph 56.

c. Adjustment. Refer to paragraph 56.

d. Fan and Pulley Removal. Refer to paragraph 57.

e. Fan Repair. If fan blade (4) is bent slightly, it may ened. If badly bent or broken, it should be replaced.

f. Reassembly and Installation. Place pulley (5) and position over pump hub (22) and secure with four cap

113. Water Pump

(fig. 62)

a. Seal. The centrifugal water pump is equipped wi seal assembly and does not have a packing gland.

b. Removal. Refer to paragraph 57.

c. Disassembly and Repair.

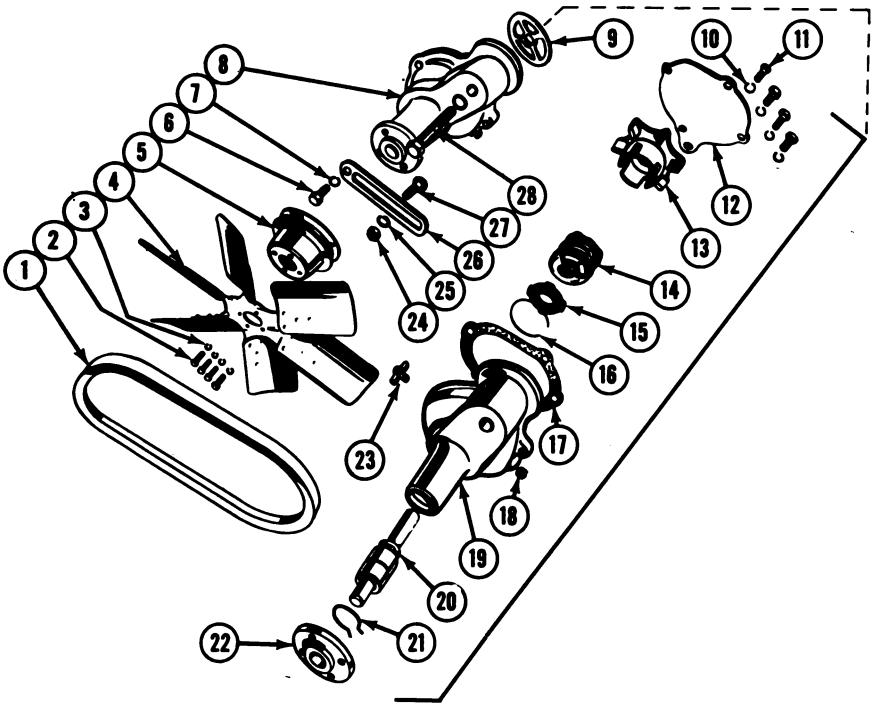
(1) Remove pump pulley hub (22) by pressing pum through it. If an arbor press is not available, rod and hammer.

(2) Use pliers and remove bearing wire (21) in en

(3) Remove pump cover (12) and gasket (17).

(4) Press or drive shaft and bearing (20) out of i and pump body (19).

(5) Remove seal retaining wire (16) from impeller seal washer (15) and seal assembly (14).



1 Fan belt
2 Fan blade cap screw
3 Lockwasher
4 Fan
5 Pulley
6 Cap screw
7 Lockwasher
8 Water pump
9 Pump gasket
10 Lockwasher
11 Cap screw
12 Pump cover
13 Impeller
14 Seal assembly
15 Seal washer
16 Seal retaining wire
17 Pump cover gasket
18 Drain plug
19 Pump body
20 Shaft and bearing
21 Bearing retaining wire
22 Pulley hub
23 Draincock
24 Nut
25 Lockwasher
26 Water pump support link
27 Carriage bolt
28 Cap screw

Figure 62. Exploded view of water pump and fan.

(6) Check pump body (19) for cracks.

(7) See if bearing is a good fit in body, shaft runs smoothly in bearing, and shaft is straight.

(8) Examine seal contact surfaces. They must be smooth and in good condition. If they are worn or rough, replace them.

d. Reassembly and Installation.

(1) Replace any worn or defective parts.

(2) Replace seal assembly (14) and seal washer (15) in impeller (13) and lock in place with retaining wire (16).

(3) Place shaft and bearing (20) in pump body (19). Make sure it enters straight. Press in until bearing is seated against shoulder. Use an arbor press or a vise.

(4) Start impeller (13) on shaft, put a block of w
impeller, and press until shaft is flush with back
Caution: Never press too tightly. This w
seal washer.
(5) Replace bearing wire (21).
(6) Press on pump pulley hub (22), using block of w
impeller.
(7) Shellac gasket (17) and replace gasket and pump
(8) Replace pump on engine and secure it with cap
Be sure gasket (9) is in place.

114. Thermostat

Refer to paragraph 58 for removal, testing, and rep
thermostat.

Section III. FUEL SYSTEM

115. Fuel Pump Description

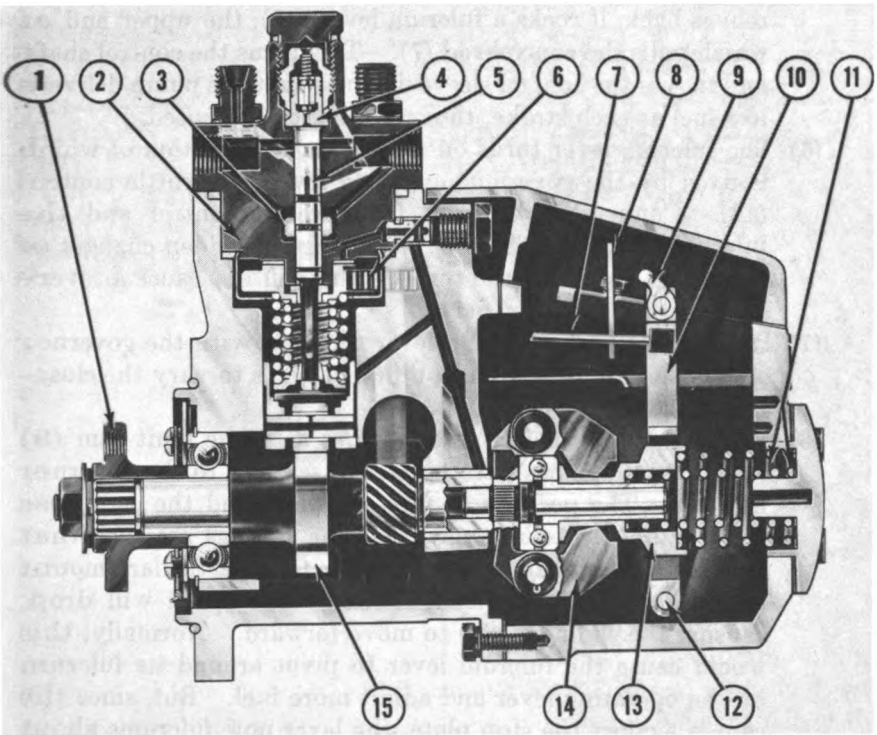
(fig. 63)

a. Fuel System. The fuel system is described in pa
b. Fuel Injection Pump. The injection pump is a sin
multi-outlet unit. The hydraulic head contains the pum
mechanism. The camshaft mounts a two-lobed cam (1
drive flange (1), and governor weights (14). A positive d
gear type fuel transfer pump is mounted to the outside of
and is driven by the pump camshaft.

(1) The plunger (5) is driven by a two-lobed cam (
at engine speed. Each one-half engine revolutio
causes the plunger to make one stroke, pumping
to fire one cylinder. The amount of fuel pum
stroke is fixed by the control sleeve (3) which i
by the governor. When the control sleeve is in
position, maximum delivery is obtained. When
sleeve is in the lowest position, no fuel is deliver

Note. The no-delivery point is controlled by the stop

(2) A spring-loaded delivery valve (4) is located
plunger. When the plunger builds up enough p
valve opens, permitting fuel to flow. It snaps
as the pressure drops. This rapid closing giv
metering because it stops fuel from flowing to t
soon as the correct amount determined by the g
been forced through by the plunger.
(3) The plunger has a parallel groove which serves
for high-pressure fuel. The plunger is rotated in
by the drive gear (6) in such a way that this groo
opposite each hole, in turn, leading to the fitting



1 Driving flange
2 Hydraulic head
3 Control sleeve
4 Delivery valve
5 Plunger
6 Plunger drive gear
7 Control rod
8 Stop plate
9 Torque limit cam
10 Fulcrum lever
11 Governor springs
12 Throttle control
13 Sliding sleeve
14 Governor weights
15 Cam

Figure 63. Cross section of fuel injection pump.

fuel to one cylinder. One complete turn of the pump drive gear delivers fuel first to No. 1, then to No. 3 cylinder. The next complete turn delivers fuel first to No. 4 and then to No. 2 cylinder, completing one firing cycle, or two complete revolutions, of the engine.

(4) The position of the control sleeve is controlled by an eccentric pin on the control shaft which is positioned by the control rod (7) from the governor.

(5) The flyweight governor is on the pump drive shaft. As speed increases, the two weights (14) fly outward. Cams on the weights push the sliding sleeve (13) toward the back of the pump against the pressure of two springs (11). The outer spring is for low speed control only. Both springs act together for high speed control. The inner spring is calibrated for the desired full load speed and must be changed for different speeds. Refer to paragraph 9*h*. As the sleeve

moves back, it rocks a fulcrum lever (10), the u
which pulls the control rod (7). This turns the
and moves the control sleeve down so that the pu
less fuel at each stroke, thus reducing engine spe

(6) The fulcrum lever turns on a fulcrum, the positi
is fixed by the governor operating lever or thr
(12). Connection between the throttle contr
fulcrum lever is made by spiral springs. Sudde
speed will not move the throttle and will not ca
shock to the governor parts.

(7) Pins by which the fulcrum lever connects with t
sliding sleeve may be set in different holes to va
ness of governor regulation.

(8) The top of the fulcrum lever carries a torque li
which bears against a stop plate (8) screwed to t
housing. The position of the stop plate and th
is adjustable. Assume now that the settings a
the cam nose is against the stop plate for a partic
of load. If now the load increases, the speed
causing the sliding sleeve to move forward. No
would cause the fulcrum lever to pivot around
on the operating lever and admit more fuel. Bu
cam is against the stop plate, the lever now fulc
the nose of the cam. Since the control lever is att
this point, the motion is such as to reduce fu
Since a drop in speed of an alternator causes a dr
output, this action causes a reduction in load.
cam and stop plate, therefore, act as a means
the maximum power which the generating set

116. Fuel Pump Removal and Disassembly

a. Removal. Refer to paragraph 63.

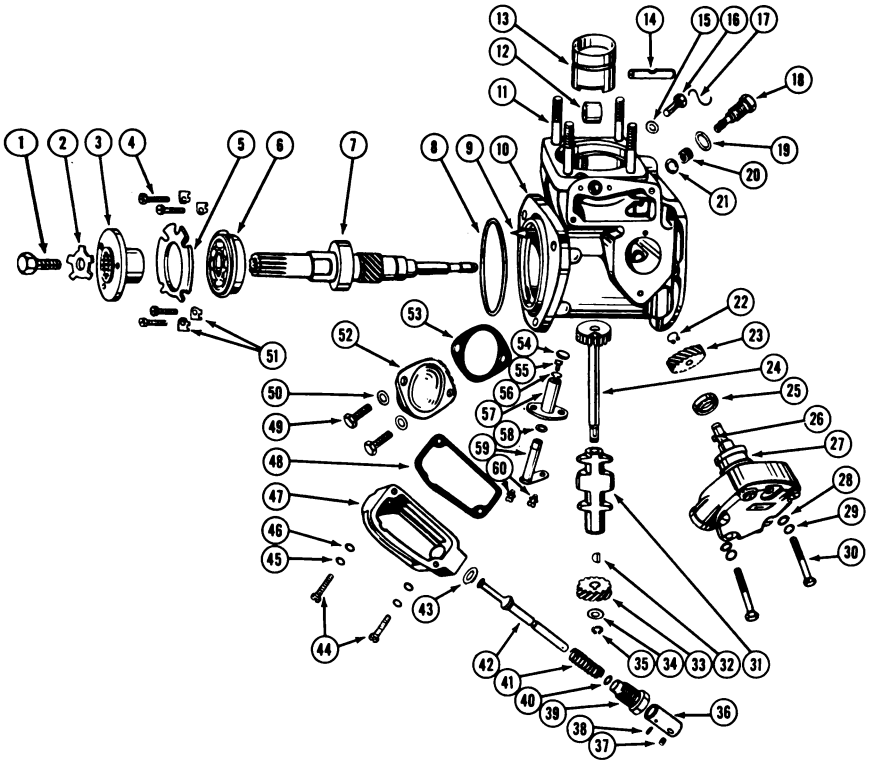
b. Disassembly.

Note. Parts numbers of special tools and test equipment are An
parts numbers. All work on the injection pump (fig. 64) must b
cleanest possible place. Do not permit any filing, scraping, or s
bench. Work in a dust-free room.

(1) Clean all dirt and grease from the outside of
Mount the pump on a special flange mounting t
See paragraph 119*a*.

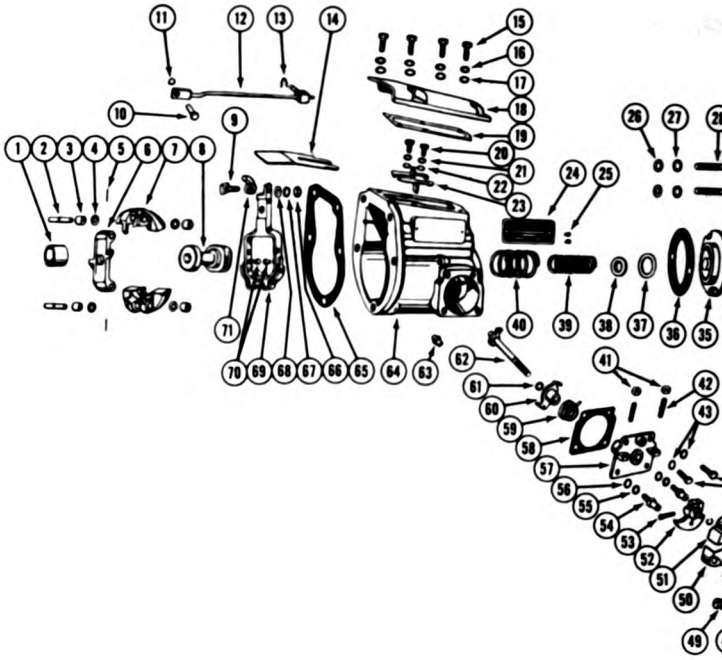
(2) Remove two cap screws (44, fig. 64) holding tim
cover (47) and remove the cover and gasket (4
rod assembly (36) to (43) will be removed a
time.

(3) Remove the two screws (30) and the fuel transfer



1 Camshaft hub screw
2 Lockwasher
3 Drive hub
4 Bearing retainer plate screw
5 Bearing retainer plate
6 Camshaft ball bearing
7 Camshaft
8 Gasket
9 Timing pointer
10 Pump housing
11 Stud
12 Tappet roller assembly
13 Tappet guide assembly
14 Tappet assembly pin
15 Gasket
16 Quill shaft locating screw
17 Locking wire
18 Filter screw
19 Filter screw gasket
20 Screen filter
21 Gasket
22 Spring ring
23 Gear
24 Quill shaft
25 Oil seal
26 Key
27 Transfer pump assembly
28 Plain washer
29 Lockwasher
30 Fastening screw
31 Bushing
32 Key
33 Gear
34 Spacing washer
35 Spring ring
36 Shutoff fitting
37 Setscrew
38 Pin
39 Bearing screw
40 Gasket
41 Shutoff spring
42 Shutoff rod
43 Gasket
44 Screw
45 Lockwasher
46 Plain washer
47 Timing window cover
48 Timing window cover gasket
49 Quill shaft pad screw
50 Gasket
51 Lockwasher
52 Quill shaft pad
53 Pad gasket
54 Control unit gasket
55 Plunger sleeve pin
56 Spring ring
57 Bushing
58 Gasket
59 Control shaft
60 Screw

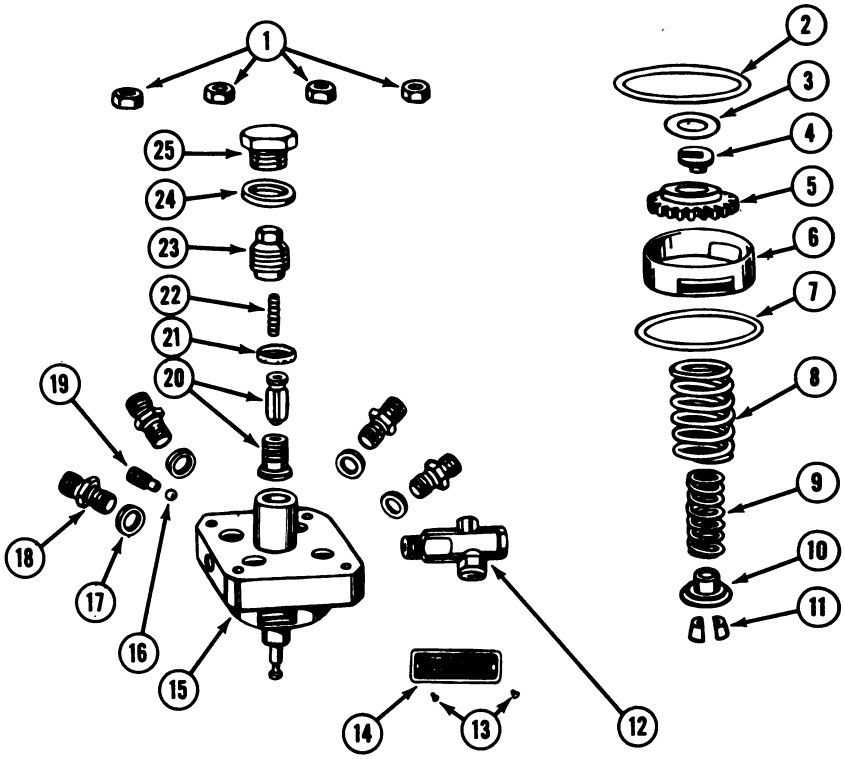
Figure 64. Exploded view of fuel injection pump.



1 Camshaft bushing
2 Weight pin
3 Weight bushing
4 Washer
5 Locking pin
6 Weight spider
7 Weight
8 Sleeve assembly
9 Cam screw
10 Control rod pin
11 Spring ring
12 Control rod
13 Control rod hairpin
14 Oil baffle plate
15 Top cover screw
16 Lockwasher
17 Plain washer
18 Governor cover
19 Cover gasket
20 Stop plate fastening screw
21 Lockwasher
22 Plain washer
23 Stop plate
24 Nameplate
25 Nameplate screw
26 Plain washer
27 Lockwasher
28 Long housing screw
29 Plain washer
30 Lockwasher
31 Short housing screw
32 Plain washer
33 Lockwasher
34 End cap screw
35 End cap
36 Gasket
37 Outer spring spacer
38 Inner spring spacer
39 Inner spring
40 Outer spring
41 Stop screw nut
42 Stop screw
43 Gasket
44 Screw
45 Lockwasher
46 Screw
47 Operating lever
48 Nut
49 Screw
50 Lower cover
51 Upper cover
52 Stop lever
53 Clamping screw
54 Stud
55 Lockwasher
56 Plain washer
57 Shaft bearing plate
58 Gasket
59 Operating lever spring
60 Spring plate assembly
61 Gasket
62 Operating shaft assem
63 Pivot pin
64 Governor housing
65 Gasket
66 Cam screw nut
67 Lockwasher
68 Plain washer
69 Fulcrum lever assemb
70 Pivot pin
71 Torque cam

Figure 65. Exploded view of governor.

(4) Remove the governor top cover (18, fig. 65) by removing cover screws (15).
(5) Remove the oil filter assembly (18) to (21) (fig. 64). This is important as the pump will be damaged if the filter assembly is not removed.
(6) Disconnect control rod (12, fig. 65) by removing pin (10) and spring (11) from control shaft (59, fig. 64).
(7) Remove the five screws (28 and 31, fig. 65) holding the governor to the pump body and carefully remove the governor, guiding the control rod (12) through the pump housing and releasing the sleeve assembly (8) from the weights (7).
(8) Loosen two screws (60, fig. 64) and draw out the control assembly (54) to (59) from the head.
(9) Remove the quill shaft pad (52) and gasket (53).
(10) Rotate pump camshaft (7) until the line mark on a tooth of the plunger drive gear (5, fig. 66) lines up with the 0 mark on the timing window.
(11) Remove four nuts (1) and raise the head assembly from the pump housing, keeping the camshaft in place.
(12) Lift out the tappet assembly (12, 13, and 14, fig. 64).
(13) Unscrew the quill shaft locating screw (16) and slide quill shaft assembly (24), (31) to (35) down through the pump housing.
(14) Straighten tabs on lockwasher (2). Remove hub screw (1) and drive hub (3).
(15) Remove screws (4) and ball bearing retainer plate (5).
(16) Use a service tool (TSE 76192) (1, fig. 67) to pull the camshaft (2) with its ball bearing (3) free of the weight assembly and bushing. Do not remove the ball bearing from the camshaft unless bearing needs to be replaced.
(17) Press out the camshaft bushing (1, fig. 65) with special service tool, using small end of tool in the hole in the bushing. The large end of the tool is used for pressing in a new bushing.
(18) Put the hydraulic head assembly in an arbor press (1, fig. 68) with the top down. Using service tool (TSE 76189) (2) on the spring seat (3), compress the spring (4) until plunger lock (11, fig. 66) can be removed.
(19) Remove spring seat (10) and plunger springs (8) and (9). Also remove rubber gasket rings (2) and (7).
(20) Pry off retainer cover (6) carefully with two screwdrivers put into slots between head and plate.
(21) Lift off plunger drive gear (5), thrust washer (3), and plunger guide (4).
(22) The plunger and control sleeve (15) can now be lifted out. These parts and the head are lapped to each other and must be kept together. They are not interchangeable.



1 Fastening nut
2 Gasket
3 Thrust washer
4 Plunger guide
5 Plunger drive gear
6 Gear retainer cover
7 Gasket
8 Outer plunger spring
9 Inner plunger spring
10 Spring seat
11 Plunger lock
12 Overflow valve
13 Screw
14 Part number plate
15 Plunger and control sleeve
16 Sealing ball
17 Gasket
18 Discharge fitting
19 Setscrew
20 Delivery valve assembly
21 Gasket
22 Delivery valve spring
23 Delivery valve holder
24 Gasket
25 Cap screw

Figure 66. Exploded view of hydraulic head.

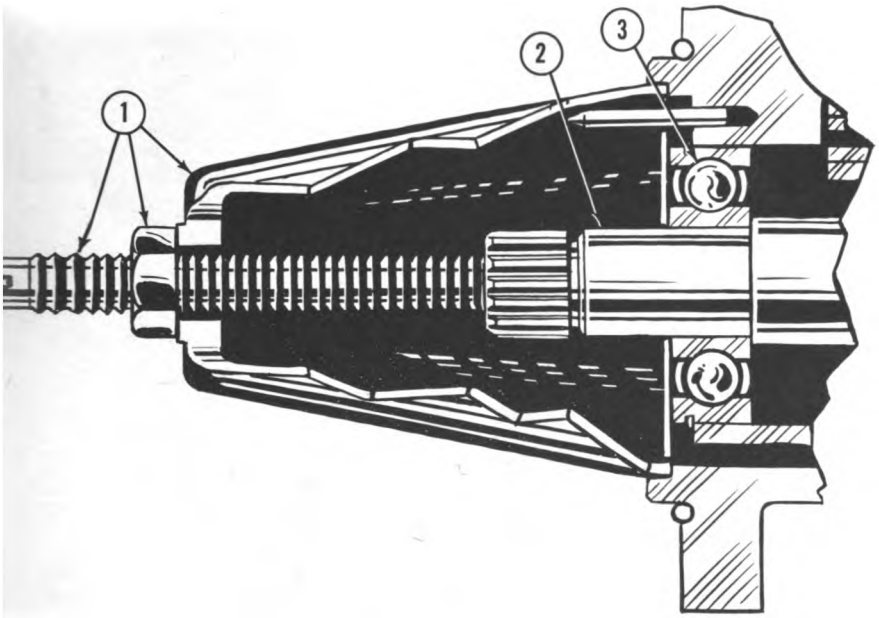
(23) Hold the hydraulic head right side up in a vise, gripping the square part. Remove delivery valve cap screw (25) and copper gasket (24).

(24) Remove delivery valve holder (23) and spring (22), using a $\frac{7}{16}$-inch socket wrench.

(25) Remove delivery valve assembly (20) and gasket (21), using service tool (TSE 7682) (fig. 69). The delivery valve and body are fitted to each other and must be kept together. They are not interchangeable.

(26) Remove four discharge fittings (18, fig. 66) and gaskets (17) only if they are leaking or damaged.

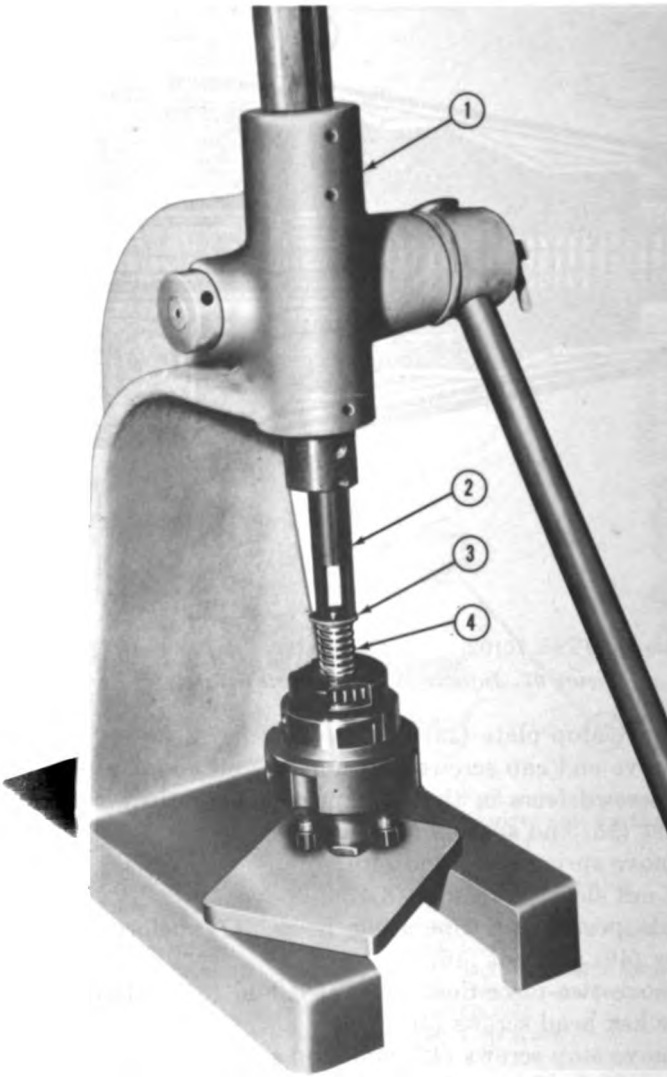
(27) Pull out oil baffle plate (14, fig. 65).



1 Service tool (TSE 76192) 2 Camshaft 3 Ball bearing

Figure 67. Injector pump camshaft puller.

(28) Remove stop plate (23).
(29) Remove end cap screws (34) and pry off end cap (35) with two screwdrivers in the slots provided for them. Remove gasket (36) and spacers (37) and (38).
(30) Remove springs (39) and (40).
(31) Lift out sleeve assembly (8).
(32) Mark position of operating lever (47) before removing screw (49) and nut (48).
(33) Remove two-piece dust cover (50) and (51). It is held by three hex head screws (46).
(34) Remove stop screws (42) and stop screw nuts (41).
(35) Note the position of stop lever (52) on shaft. Remove clamping screw (53) before removing the stop plate.
(36) Remove two screws (44), two studs (54) and plate (57).
(37) Lift out fulcrum lever assembly (69) and remove control rod (12). Remove cam screw (9) and torque cam (71).
(38) Pull out operating shaft assembly (62).
(39) Take off spring plate assembly (60), gasket (61), and operating lever spring (59).
(40) If pivot pin (63) shows signs of wear, press it out of the governor housing aud replace.
(41) Disassemble weight assembly by removing locking pins (5) and pressing out weight pins (2) from weight spider (6).
(42) Use service tool (TSE 7937) to press out weight bushings (3).



1 Arbor press
2 Service tool (TSE 76189)
3 Spring seat
4 Spring

Figure 68. Plunger spring compressor.

117. Fuel Pump Inspection and Repair

a. Hydraulic Head Assembly.

(1) Examine plunger and control sleeve (15, fig. 66) nifying glass. Fine scratches, scuff marks, and ance of the lapped surfaces indicate wear. If replace both with mated parts (par. 116*b*(22)).

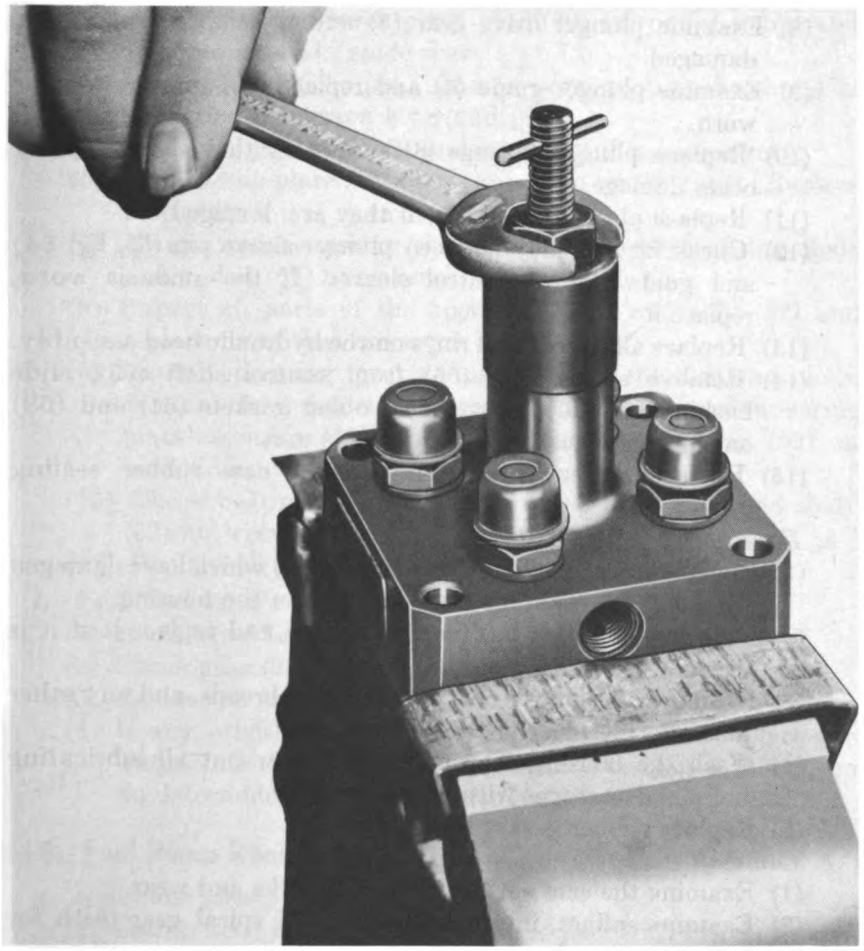


Figure 69. Delivery valve extractor.

(2) Examine delivery valve assembly (20) for scratches and scuff marks. Lap valve seat to body, if necessary, with fine lapping compound. If the valve sticks because of gummy deposits, use diesel fuel oil or carbon solvent and rotate valve back and forth until it is free. If badly worn, replace valve and body with mated parts.

(3) Check delivery valve holder (23) and cap screw (25) for finger-tight movement to their seat.

(4) Examine delivery valve spring (22) for nicks and scratches. Replace if it is damaged in any way.

(5) Always replace all copper gaskets.

(6) Replace gear retainer cover (6) if it was damaged in disassembly.

(7) Install new thrust washer (3).

(8) Examine plunger drive gear (5) and replace it
damaged.
(9) Examine plunger guide (4) and replace it if it
worn.
(10) Replace plunger springs (8) and (9) if they s
other damage.
(11) Replace plunger locks (11) if they are damage
(12) Check for end play between plunger sleeve pi
and guide slot of control sleeve. If the gu
replace it.
(13) Replace all rubber seal rings on the hydraulic h
(14) Remove spring ring (56) from control shaf
bushing (57) off, and replace rubber gaskets
on shaft and bushing. Reassemble unit.
(15) Replace screen filter (20). Install new ru
gasket (21).

b. Housing.

(1) Replace any of the four studs (11, fig. 64) which h
threads. These studs must be tight in the hou
(2) Examine camshaft bushing (1, fig. 65) and rep
worn.
(3) Examine housing for cracks, damaged threads, a
damage. Replace or repair as required.
(4) Wash the housing thoroughly and blow out a
holes and passages with compressed air.
(5) Replace rubber gasket (8, fig. 64).

c. Camshaft.

(1) Examine the cam surface for score marks and w
(2) Examine splines, internal threads, and spiral g
wear.
(3) Replace any parts which are worn or scored.

d. Quill Shaft Assembly (fig. 64). Clean oilhole in h
Check quill shaft (24) and gear (33) for wear. Clear
bushing (31) and gear (33) should be 0.001 to 0.006 in
either if worn.

e. Tappet Assembly (fig. 64). Inspect assembly for e
in pin (14) between roller (12) and tappet guide (13).
passage in pin.

f. Camshaft Ball Bearing (fig. 64). Inspect this be
roughness and excessive play. Replace if worn.

g. Governor Assembly (fig. 65).

(1) See that governor weights (7) are free in th
Replace pins and bushings (3) if there is ex
which would result in binding of the governor
(2) Inspect sliding sleeve (8) for roughness and free
the shaft.

(3) Inspect fulcrum lever pivot pins (70) for out-of-round and free movement in guide slots.
(4) Inspect lower yoke pin. If it is worn, replace the complete assembly of fulcrum lever and pins.
(5) Inspect control rod (12) and replace it if it is binding.
(6) Inspect stop plate (23) for wear caused by the cam. Replace stop plate if it is worn.
(7) Always replace rubber ring gasket (61) on operating shaft and gasket (65) on governor housing (64).
(8) Inspect all parts of the operating shaft assembly (62) and replace parts that are worn.
(9) Inspect operating lever spring (59) for scratches and nicks. See that the spring ends bear against the tongues of the spring plate assembly (60) and operating shaft assembly (62) on both sides.
(10) Check bearing plate (57) with spring plate (60) and shaft (62) for wear.
(11) Replace all gaskets.

h. Fuel Transfer Pump (fig. 64).
(1) Replace rubber ring gasket.
(2) Check gear (23) for wear and replace it if necessary.
(3) Replace oil seal (25) if worn.
(4) If any other parts of this pump are defective, replace the entire fuel transfer pump as a unit. For test of this pump to determine if it is defective, refer to paragraph 119*c*.

118. Fuel Pump Reassembly

a. Hydraulic Head. Dip each part in oil.
(1) Clamp head in a vise by the square part with delivery valve up.
(2) Insert delivery valve (20, fig. 66), gasket (21), and spring (22).
(3) Thread in delivery valve holder (23) and tighten with a torque wrench to 32 to 34 foot-pounds.
(4) Screw in cap screw (25) with gasket (24) and torque to 32 to 34 foot-pounds.
(5) If discharge fittings (18) were removed, put them back with new gaskets (17) and torque to 32 to 34 foot-pounds.
(6) Place protection caps over discharge fittings to prevent entrance of dirt.
(7) Turn hydraulic head over in the vise so that delivery valve is down.
(8) Install control sleeve with slots on the side that has the widest opening in the gear retainer cover (6). The surface marked by a drill point must be facing in the direction opposite to the delivery valve cap screw.

(9) Aline the bore of the control sleeve with the bo with a suitable tapered brass driftpin.

(10) Carefully insert plunger through head into b sleeve and then into upper bore of head. It essary to change the location of the control sl Do not force the plunger through.

(11) Put bronze thrust washer (3) in place.

(12) Install plunger guide (4) so that flat side of g flat of plunger.

(13) Place plunger gear (5) over plunger guide (4 should now have the number facing upward an gear should make the plunger turn.

(14) Install gear retainer cover (6) with the lug on i with a notch in the hydraulic head. Crimp plate securely in the groove in the head with a punch.

(15) Install plunger springs (8) and (9).

(16) Place lower spring seat (10) over springs.

(17) Press spring down in an arbor press (1, fig. service tool (TSE 76189) (2) and install plung fig. 66) into lower spring seat (10).

(18) Install new gaskets (2) and (7) on hydraulic he

b. Pump Housing.

(1) When installing new bushing (1, fig. 65), make su is near the top end of the main oil feed passage. press to press in the bushing.

(2) When installing a new ball bearing on the camsha place bearing, with the identification side down press. Be sure to press on the inner race, ne race.

(3) Put the camshaft with assembled ball bearing i housing (10). Aline the camshaft with the and press in an arbor press to seat the ball be

(4) Mount the housing pump on a flange mounting vise.

(5) Install bearing retainer plate (5) with cutaway p with slots in housing and secure with four bea place screws (4). Put two lock wires through t in vertical pairs.

(6) Install tappet assembly (12) to (14) so that s shell engages in pump housing bore.

(7) Reassemble quill shaft (24) with removable gear ing end. Fasten the gear with the number ou spacing washer (34) to take up clearance.

(8) Turn camshaft so that center of wide groove on splined end lines up with CLW assembly mark on bearing retainer plate (5).

(9) Take a pump driving hub (3) and screw a 5/16 x 24 pointed setscrew 1 inch long through one of the tapped holes. Place this hub on the camshaft temporarily with the setscrew point against the wide splined groove. This provides a pointer for setting the line mark and camshaft. Turn the bracket to a horizontal position in the vise, with the opening for the supply pump downward

(10) Put the quill shaft assembly (24) through bottom of pump housing so that helical gear (33) on quill shaft mesheswith helical gear on camshaft. The open tooth of the spur gear must line up with the drill mark on the counterbore of the pump housing. Secure the quill shaft in position with quill shaft locating screw (16) and gasket (15).

(11) Install quill shaft pad (52) with gasket (53) and fasten with two screws (49). Reassemble control shaft (59) and gasket (58) to bushing (57). Install spring ring (56), pin (55), and gasket (54). Install the assembly in the housing.

(12) Turn pump vertically in vise.

(13) Position plunger drive gear (5, fig. 66) with line mark on tooth in center of widest opening in gear retainer cover (6).

(14) Insert hydraulic head assembly so that line mark on plunger drive gear lines up with 0 mark on timing window. Do not use force to put in the head.

(15) Secure head to housing with four fastening nuts (1).

(16) Turn housing horizontally in vise, with timing window upward, and move control sleeve to midposition. Swing control shaft (59, fig. 64) to lower vertical position and plunger sleeve pin (55) to horizontal position. Carefully engage plunger sleeve pin in slot of control sleeve and fasten bushing (57) with two screws (60). Do not use force.

(17) Screw lube oil filter assembly (18) to (21) into housing.

(18) Install fuel transfer pump, using care to engage the gears.

(19) Remove the pointed cap screw from the hub.

c. Governor Assembly.

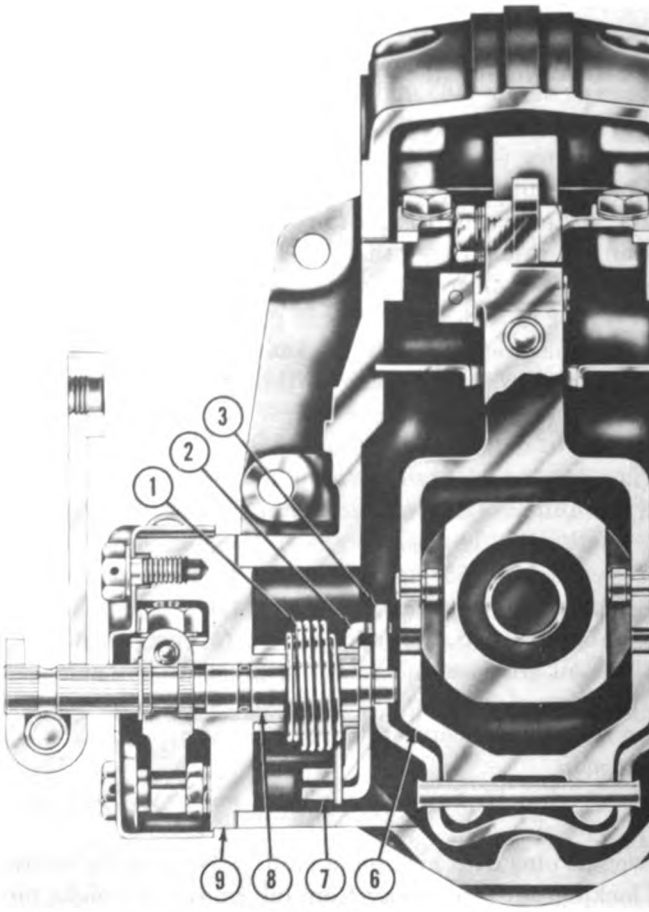
(1) Assemble weights (7, fig. 65) to weight spider (6) and press in the weight pins (2).

(2) Secure weight pins with locking pins (5). Be sure the slotted side of locking pin faces away from oil groove in weight pin.

(3) Using an arbor press (1, fig. 68) and service tool (TSE 76189) (2), press spider, with weights assembled, onto camshaft. Spider must be tight on shaft.

(4) Assemble control rod (12, fig. 65) to fulcrum lever (69) on side that has the yoke tongue extension.

(5) Press bracket pivot pin (63) into governor ho
been removed.
(6) Place fulcrum lever assembly (6, fig. 70) int
engage yoke (5) with bracket pivot pin (4).
(3) faces opening for the operating lever.
(7) Insert oil baffle plate (14, fig. 65) below co
the rolled edge downward.
(8) Assemble operating lever spring (1, fig. 70) t
assembly (2).
(9) Place spring plate assembly (2) over operating
plate (9).



1 Operating lever spring
2 Spring plate assembly
3 Yoke tongue
4 Bracket pivot pin
5 Yoke
6 Fulcrum lever asse
7 Bearing plate tong
8 Operating shaft as
9 Shaft bearing plat

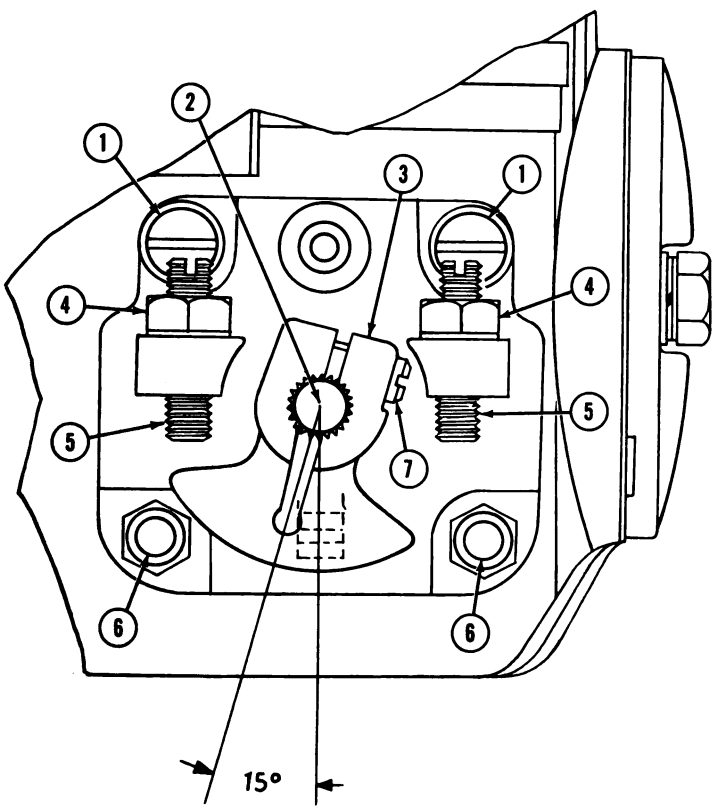
Figure 70. Cross section of governor assembly.

(10) Insert operating shaft assembly (8) through spring plate (2) and shaft bearing plate (9) with bearing plate tongue (7) sliding over spring plate tongue and between spring ends.

(11) Install stop lever (3, fig. 71) on operating shaft (2) with notch in spring plate upward and lever in position noted at time of disassembly, or approximately 15° left of vertical center line. Before tightening screw (7), adjust lever (3) so that clearance between stop lever and shaft bearing plate is 0.002 to 0.004 inch.

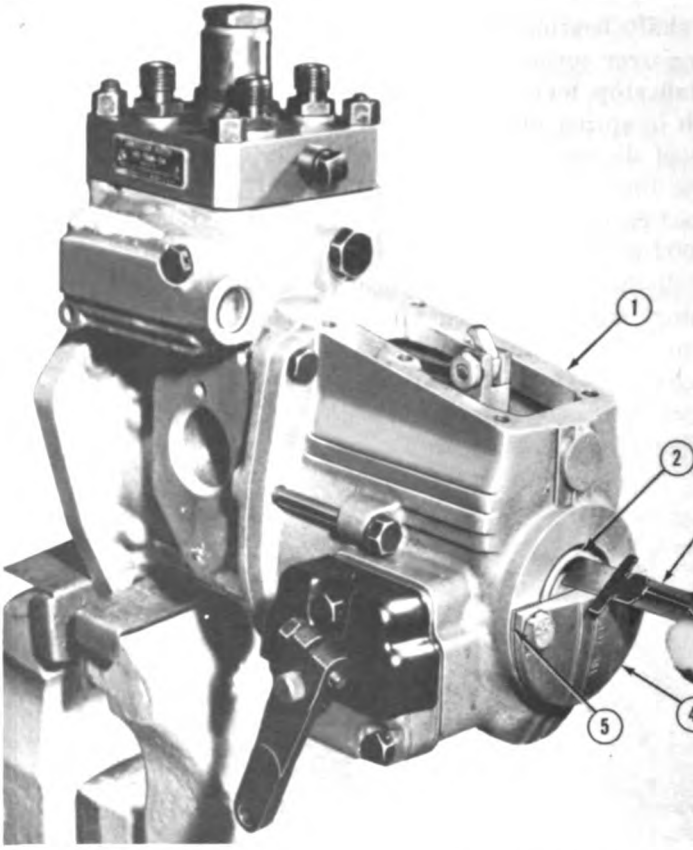
(12) Install the operating lever bearing assembly into governor housing, engaging notch of spring plate (2, fig. 70) with tongue (3) of fulcrum lever yoke which automatically engages yoke (5) with pivot pin.

(13) Fasten assembly to housing with two fillister head screws (1, fig. 71) and two studs (6).



1 Fillister head screws
2 Operating shaft
3 Stop lever
4 Locknuts
5 Adjusting screws
6 Studs
7 Screw

Figure 71. Assembly of governor stop lever.



1 Governor housing
2 Spring
3 Steel rule
4 Spring gap gage (TSE
5 Gasket

Figure 72. Governor spring gage.

(14) Install high speed and idling adjusting scre locknuts (4).
(15) Fasten operating lever (47, fig. 65) to shaft noted at time of disassembly.
(16) Check all pivot points carefully to be sure they
(17) Install stop plate (23) and secure with two scr
(18) Engage sleeve (8) in fulcrum lever pivot pins.
(19) Install governor housing assembly to pump hou sleeve to permit it to slide on weight shaft and guiding control rod through pump housing. Sec housing with five hex-head cap screws.
(20) Press control rod pin (10, fig. 65) through (59, fig. 64) into control rod (12, fig. 65) and with spring ring (11).

(21) Insert inner and outer springs (39) and (40, fig. 65) and adjust for proper spring gap with spring gap gage (TSE 76190) (4, fig. 72). Clearance is measured between inside edge of gage and end of spring (2) or spacer. Always use a gasket (5) under the gage. The correct spring spacing is 0.079 inch for the inner spring and 0.059 inch for the outer spring. Add gasket thickness until the proper spacing is obtained.

(22) Replace spring cover and secure with two hex screws.

(23) Replace timing window cover assembly. Governor top cover and dust covers over throttle adjusting screws will be replaced after testing and timing.

119. Fuel Pump Timing and Testing

a. Mounting (fig. 73).

(1) Mount the pump on flange mounting bracket (6) on test stand (7).

(2) Connect oil line from gravity supply tank on test stand to inlet side of hydraulic head on pump.

(3) Remove overflow valve and replace it with a quarter-inch pipe plug (11).

b. Timing. Timing of this pump is accomplished by controlled dimensions of its internal parts. However, when a new hydraulic head has been installed, it is sometimes necessary to make a new mark on the drive hub. The flow method is used to determine the time when the port closes for cylinder No. 1.

(1) Bleed the pump of all air by loosening the plug (11) and turning the drive hub (8) by hand until solid fuel flows out of the loosened plug. It is important to get out all the air and to tighten the plug.

(2) Place operating lever (4) in full load position.

(3) Remove delivery valve cap screw (2).

(4) Remove delivery valve holder (23, fig. 66) and spring (22).

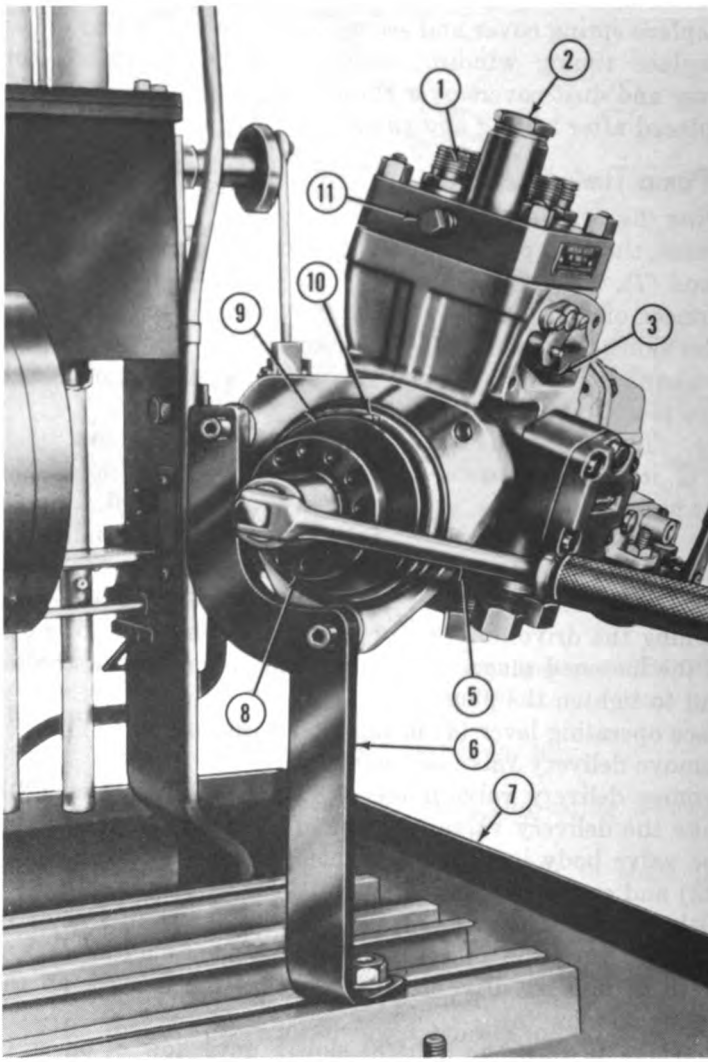
(5) Take the delivery valve (20) out of the holder (23), leaving the valve body in position. Then replace the valve holder (23) and cap screw (25).

(6) With a wrench (5, fig. 73) on the cap screw in the drive hub (8), turn the pump camshaft clockwise until marked tooth of plunger drive gear approaches the 0 mark on the timing window (3).

(7) Continue to turn the hub (8) slowly until flow of oil stops at outlet No. 1 (1). At the point where flow of oil stops, the scribed mark on the coupling rim (9) must be exactly in line with the timing pointer (10). This test also indicates if the internal parts of the pump have been properly put together. If the timing marks are considerably out of line,

check the position of the timing marks on the ge
if they are properly assembled. If a new hydr
has been installed and the marks are slightly o
file off the scribed mark on the coupling rim (9) an
the rim correctly.

(8) Replace the delivery valve, spring, holder, cap s
overflow valve.



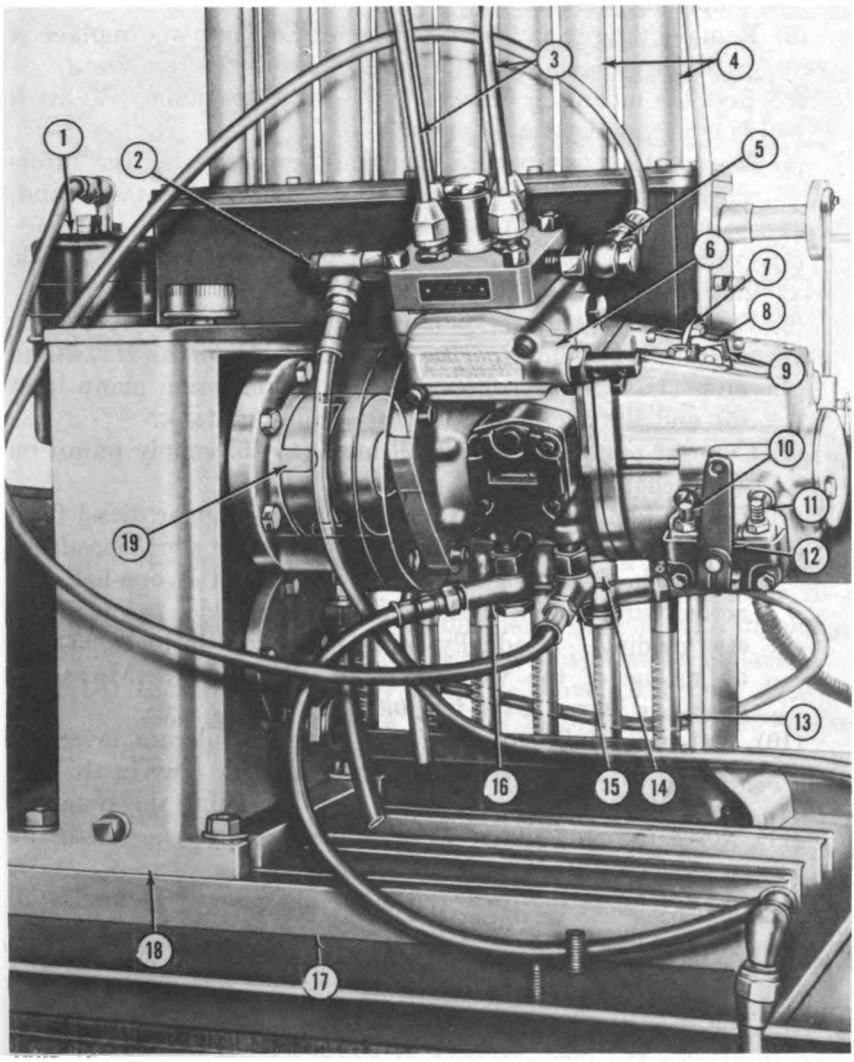
1 Outlet No. 1
2 Delivery valve cap screw
3 Timing window
4 Operating lever
5 Wrench
6 Flange mounting bracket
7 Test stand
8 Drive hub
9 Coupling rim
10 Timing pointer
11 Plug

Figure 73. Timing pump by flow method.

c. Testing.

(1) The following equipment is required for accurately testing the fuel injection pump:

(*a*) Test stand (17, fig. 74).



1 Filter
2 Overflow valve
3 High-pressure tubing
4 Nozzle holders
5 Inlet
6 Timing window cover
7 Stop plate
8 Torque cam
9 Fulcrum lever
10 Idle stop screw
11 Full load stop screw
12 Operating lever
13 Graduated cylinder
14 Lubricating oil inlet
15 Fuel transfer pump discharge
16 Fuel transfer pump suction
17 Test stand
18 Mounting bracket
19 Intermediate mounting disk

Figure 74. Fuel injection pump on test stand.

(*b*) Mounting bracket (18) with 2/1 gear ratio provi
speeds up to 4000 rpm.
(*c*) High pressure tubing (3), four pieces.
(*d*) Four nozzle holders (4) with nozzles adjusted t
opening pressure.

(2) Remove the regular drive hub from the pump and
with the special drive hub furnished with the test

(3) Bolt the mounting bracket (18) to the test stand
four nuts and plain washers.

(4) Mount the pump on the mounting bracket, using
mediate mounting disk (19) furnished with the t
between pump and bracket.

(5) Connect high-pressure tubing (3) between pump
holders (4).

(6) Connect fuel transfer pump suction (16) to the
on the test stand, and the discharge (15) to the
filter (1). Connect filter outlet to the injection p
(5) and the overflow valve (2) to the fuel tank.

(7) Connect pump lubricating oil inlet (14) to supply
speed changer.

(8) Fill the fuel tank on the test stand with regular

(9) Start the test stand in the lowest variable speed
The tachometer reading on the test stand is or
actual pump speed, or the pump speed is twice th
eter reading. Gradually bring the pump up to
by means of the variable speed adjustment.
operating lever (12) to full load position.

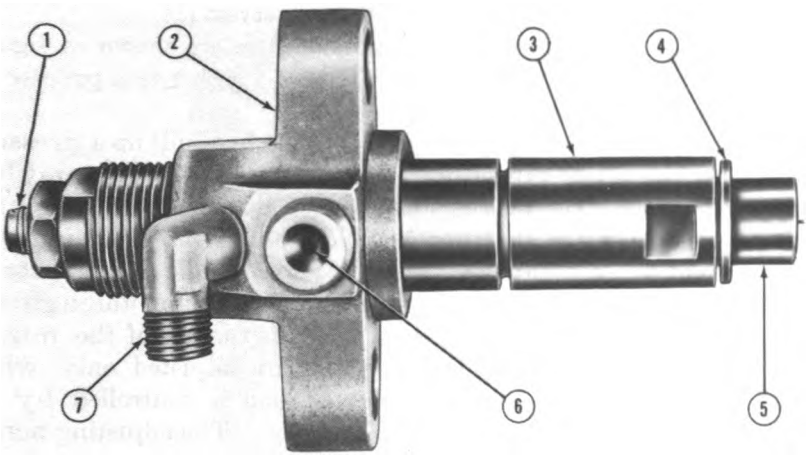
(10) Watch carefully to see if the governor fulcrum
oscillates. Large oscillations are caused by play
stand and must be corrected before adjusting th

(11) Move the stop plate (7) to prevent interference
torque cam (8).

(12) Adjust operating lever full load stop screw (11)
delivery averaging, per nozzle, 28 to 30 cubic c
(cc) per 500 strokes. The test stand catches the oi
by each nozzle in a separate graduated cylinder (
the quantity can be read. All nozzles will n
exactly the same amount of oil, so an average
readings is taken.

(13) Adjust the stop plate (7) to just touch the torqu
on the fulcrum lever (9) after oil delivery adjus
been made.

(14) Reduce the speed to about 1,200 rpm with oper
(12) still in full load position. The average deliv
increase 5 to 8 percent or to about 30 to 32 cc per 5



1 Adjusting screw
2 Holder body
3 Capnut
4 Gasket
5 Nozzle body
6 Fuel inlet
7 Return line

Figure 75. Fuel injector.

(15) Reduce the speed to 450 rpm with operating lever (12) still in full load position. If delivery drops below 18 or 20 cc per 500 strokes, the hydraulic head (fig. 66) with its plunger and control sleeve (15) is worn and must be replaced.

(16) Increase speed slowly until it is above 1,800 rpm. Delivery of oil should stop at a speed of 2,070 to 2,160 rpm. Adjust the stop plate (7, fig. 74) if necessary.

(17) Set the operating lever (12) to idle position. Slow down the pump to 450 rpm. Adjust the idle stop screw (10) to get an average delivery of between 6 and 7 cc per 500 strokes.

(18) Increase speed to 500 or 550 rpm and see if the governor operates properly. When speed is increased, the governor tends to reduce oil delivery. When speed is decreased, the governor tends to increase oil delivery.

(19) Install the timing window cover (6) with the shutoff assembly. Pull the shutoff rod (42, fig. 64) and see that the delivery stops entirely. This completes the test and adjustment of the pump.

120. Fuel Injector

a. Description.

(1) There is one fuel injector to each engine cylinder. The injector assembly members are a holder body (2, fig. 75), capnut (3), gasket (4), and nozzle body (5). The fuel inlet (6) is connected to the fuel pump high-pressure line and the

return line (7) returns excess fuel to the fuel pu
Adjustment is made with adjusting screw (1).

(2) The pressure adjusting spring and valve are show
76. The valve and body are lapped together to a
and must be kept together.

b. Operation. When the fuel injection pump has built up
of 2,000 psi, the nozzle valve is forced back against the sprin
is sprayed through the nozzle. As soon as the pressure
spring snaps the valve shut and completely prevents dri
small amount of fuel seeps back along the valve spindle to lu
This seepage drains back to the injection pump sump th
nozzle return line. Figure 77 shows the construction of t

c. Adjustments (fig. 76). The injectors are adjusted o
tested with a suitable device. Spring tension is control
adjusting screw and locknut in rear of injector. The adjus
is covered and protected by a cap screwed onto the nozzle

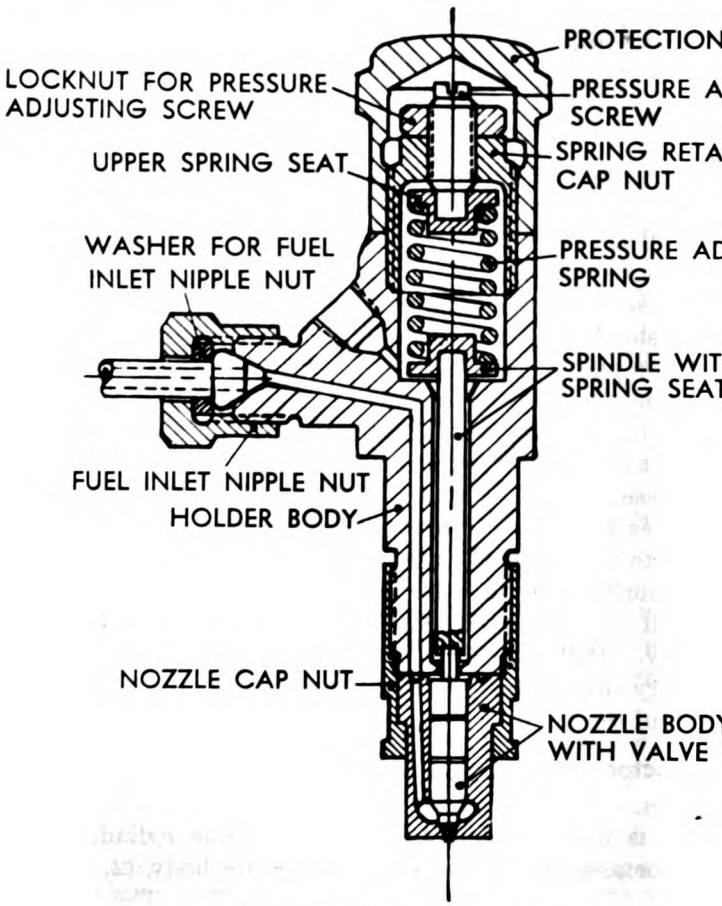
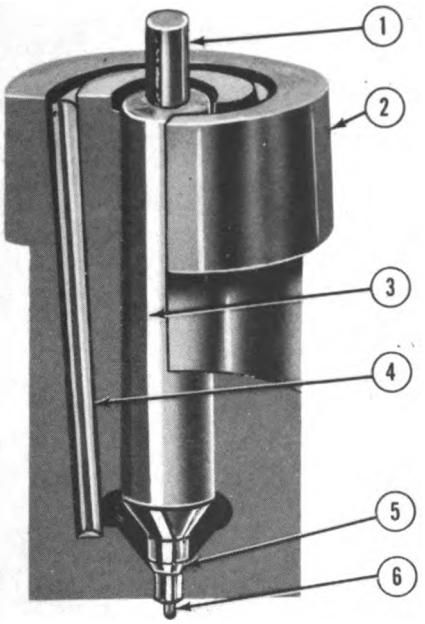


Figure 76. Cross section of injector.



1 Stem
2 Body
3 Valve
4 Fuel duct
5 Valve seat
6 Pintle

Figure 77. Cutaway view of nozzle assembly.

121. Using Hydraulic Nozzle Tester

a. Description (fig. 78). The nozzle tester is a hand-operated precision instrument which can produce and accurately measure oil pressures up to several thousand psi. It has a test fitting (3) for attaching an injector nozzle (1). A handle inserted in socket (7) operates pump (8). Pressure is read on gage (4) when valve (5) is open.

Caution: Do not exceed 3,000 pounds pressure on the gage. Do not obstruct oil spray from nozzle. Keep hands and face away from spray at all times.

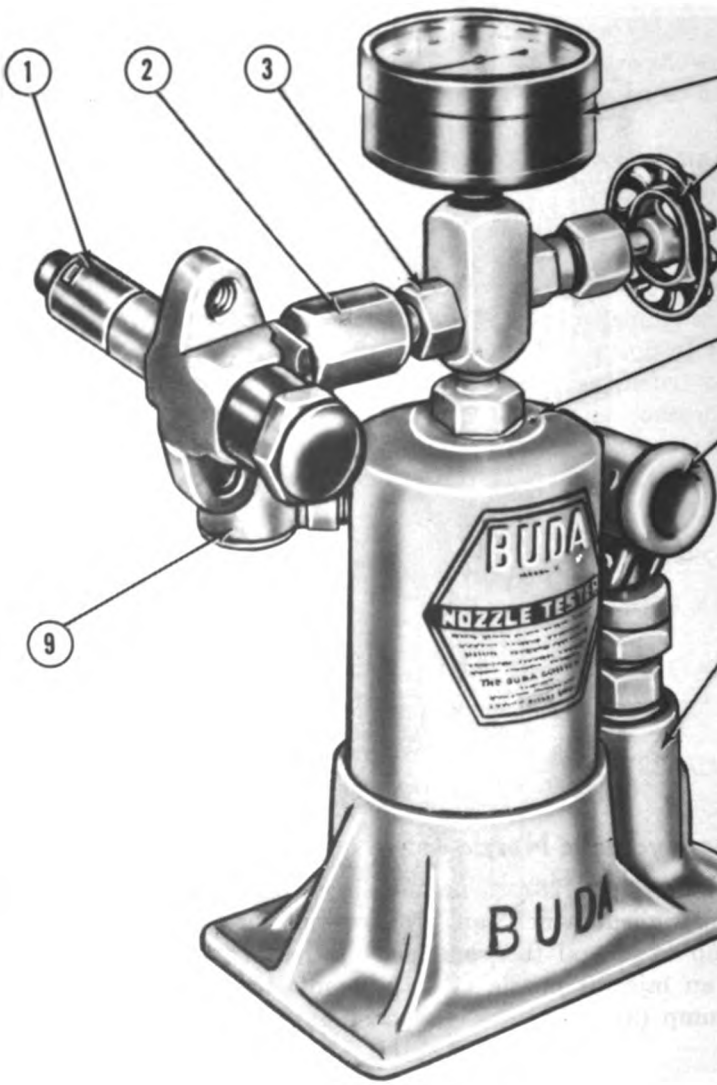
b. Operating the Tester (fig. 79).

(1) Fill tester (6) with clean diesel fuel oil.

(2) Remove cover on adapter fitting (10) and pump the lever (5) until oil runs out the fitting.

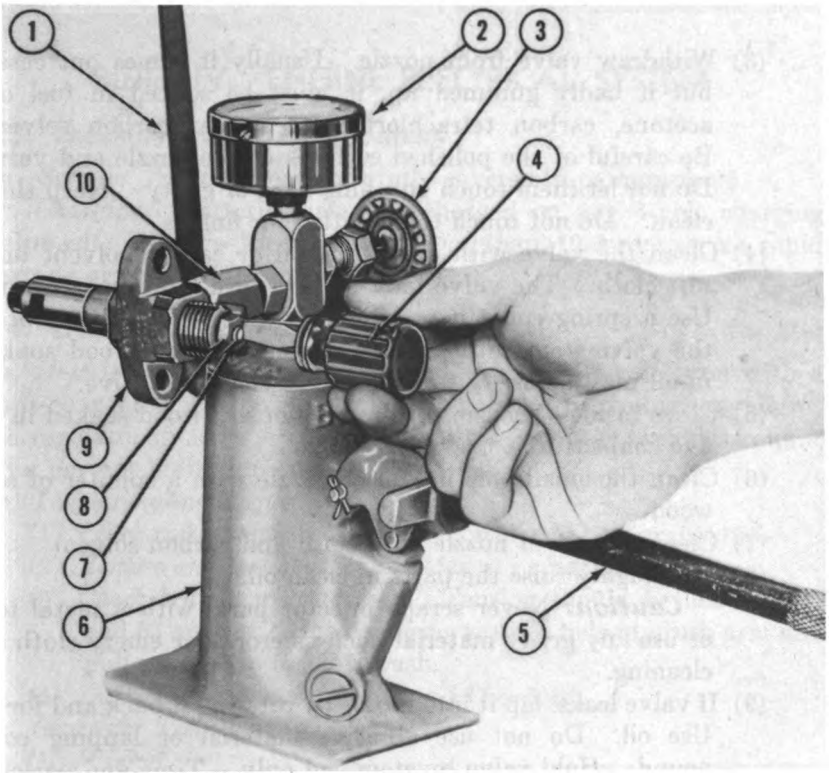
(3) Secure injector (9) under test to the adapter (10).

(4) Close the gage valve (3) and make a few quick strokes of the lever (5). If the lever operates extremely hard, it indicates a plugged nozzle. In that case, proceed to clean the nozzle according to *d* below.



1 Nozzle under test
2 Adapter fitting
3 Test fitting
4 Pressure gage
5 Gage valve
6 Tester body
7 Handle socket
8 Pump
9 Filler

Figure 78. Hydraulic nozzle tester.



1 Oil supply line
2 Gage
3 Gage valve
4 Screwdriver
5 Operating lever
6 Nozzle tester
7 Adjusting screw
8 Locknut
9 Injector
10 Adapter fitting

Figure 79. Adjusting injection pressure.

c. Testing and Adjustment (fig. 79). Stroke the tester lever (5) not less than 100 strokes per minute and watch the nozzle for leakage or dribble. If no leakage is seen at pressures up to 1,700 psi on gage (2), consider the nozzle tight. If stroking speed is too low, the nozzle may drip even if it is in good condition.

(1) Look at the spray pattern. It should be a fine spray and form a round mark on a paper held a few inches in front of the nozzle. If the pattern is one-sided, irregular, or shows "flags," disassemble and clean the injector.

(2) The correct injection pressure is 2,000 psi. To adjust to that value, loosen locknut (8) and bring injection pressure up to 2,000 psi by turning adjusting screw (7). Tighten locknut (8).

d. Cleaning Nozzle and Nozzle Holder (fig. 76).

(1) Wipe all dirt and loose carbon from injector with a clean, lint-free cloth.

(2) Clamp nozzle holder in a vise. Unscrew nozzle cap nut and remove nozzle.

(3) Withdraw valve from nozzle. Usually it comes
but if badly gummed up, it must be soaked
acetone, carbon tetrachloride, or similar carb
Be careful of the polished surfaces of the nozzle
Do not let them touch anything hard or gritty.
clean. Do not touch them with your fingers.

(4) Clean the valve with diesel fuel oil or carbon s
soft cloth. The valve may be held in a lathe f
Use a spring collet if possible. If a chuck is us
the valve stem with copper. A piece of soft w
in oil may be used, if necessary, to clean the val

(5) Clean inside of nozzle with a piece of soft wood s
and shaped to fit the valve seat.

(6) Clean the small hole in end of nozzle with a spli
wood.

(7) Clean outside of nozzle with cloth and carbon so

(8) Thoroughly rinse the parts in clean oil.

Caution: Never scrape injector parts with a
or use any gritty material such as crocus or eme
cleaning.

(9) If valve leaks, lap it into nozzle by rotating it bac
Use oil. Do not use abrasive material or la
pound. Hold valve by stem end only. Time a
are required in this operation.

(10) Disassemble nozzle holder by removing capnut
loosening the spring tension adjusting screw, an
the spring retaining nut.

(11) Wash the parts thoroughly in fuel oil. Examin
end of the spindle for a rough surface where it
nozzle stem. If rough or pitted, replace. Cl
seat for tightness to spindle and for cracks or wo

(12) Reassemble spindle, spring, and retainer in hol
the spring adjusting nut loose.

(13) Reassemble valve and nozzle in holder. It is
tant to center the nozzle perfectly in the ca
centering sleeve should be used for this purpose.

(14) Test the injector and adjust spring to inject
then tighten locknut and replace cap.

122. Fuel Transfer Pump

The transfer pump is a part of the fuel injection pu
covered in paragraph 117*h*.

Section IV. ENGINE ELECTRICAL SYSTEM

123. Checking and Servicing Battery

a. Service. Battery service is fully covered in paragraph 80.

b. Charging. Batteries can be recharged on any 6-volt charging equipment. Charge them at not more than 10 amperes, as rapid charging greatly reduces battery life.

124. Generator and Voltage Regulator

a. Description. The generator is a standard 24-volt type with a shunt-connected field winding and vibrating type voltage regulator. The regulator includes a cutout relay unit, a voltage regulator unit, and a current limiting regulator unit.

b. Inspection and Adjustment.

(1) *Check commutator and brushes.* Refer to paragraph 105.

(2) *Remove and seat brushes.* Refer to paragraph 107.

(3) *Check brush spring tension.* Tension should be between 35 and 53 ounces. Hook a spring scale in hole in brush arm and pull parallel to face of brush.

(4) *Lubricate generator.* Refer to LO 5–5161.

c. Generator Testing and Overhaul.

(1) *Wiring.*

(*a*) Inspect all wiring between the generator, voltage control regulator, and battery to make sure that all connections are clean and tight before proceeding with any electrical tests.

(*b*) To check, connect an ammeter between the battery terminal of the regulator and the lead removed from this terminal (fig. 53). Run the engine at governed speed and turn on panel lights or d-c accessories to obtain a generator output of 3 amperes. At this charging rate, measure the voltage between the points listed below with an accurate voltmeter. Maximum allowable voltage is shown.

	Volt
1. Generator A to regulator ARM	0. 1
2. Generator F to regulator FLD	0. 05
3. Battery negative to regulator BAT	0. 1
4. Regulator ground screw to generator frame	0. 03
5. Regulator ground screw to battery positive	0. 03
6. Generator frame to battery positive	0. 03

(*c*) Voltmeter readings higher than those shown above indicate high resistance connections. Connections should be cleaned and tightened or replaced if worn or rusted.

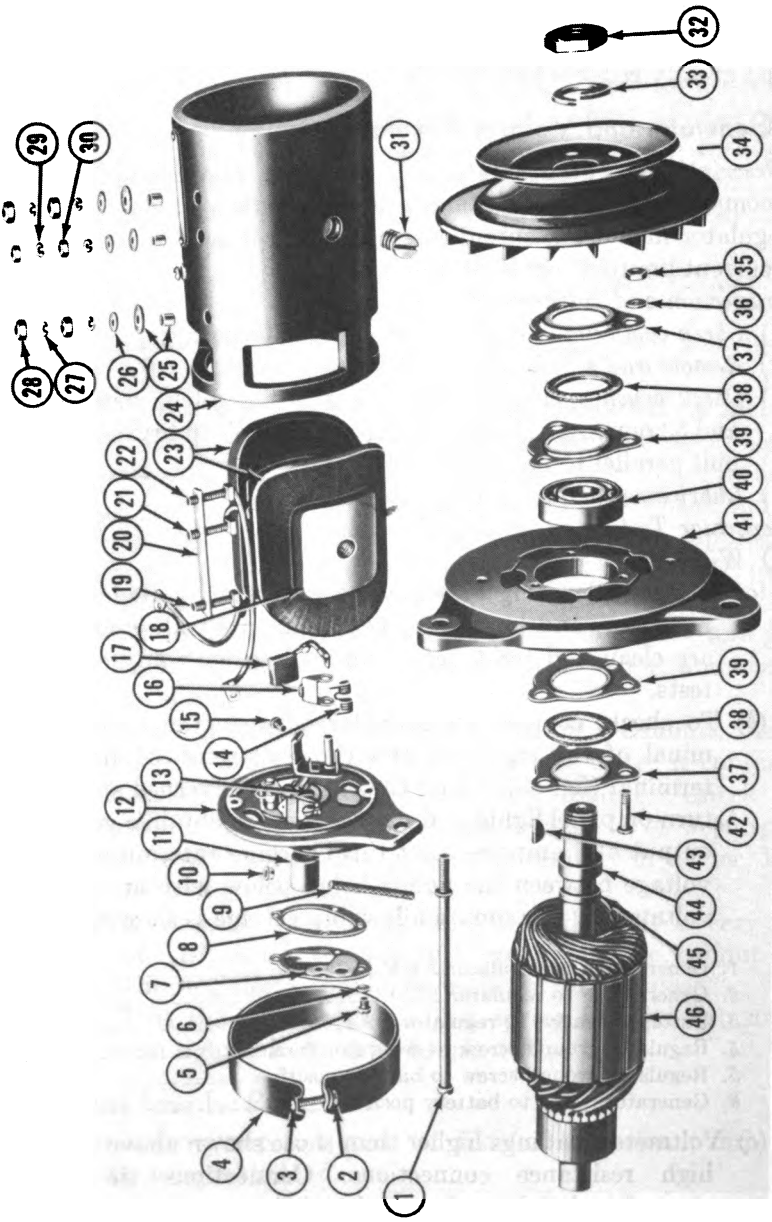


Figure 80. Exploded view of battery charging generator.

1 Through bolt
2 Nut, #10 NF (1 req'd)
3 Screw, #10 x 1–1/2 NF (1 req'd)
4 Cover band
5 Screw, #8 x 5/16 NC (4 req'd)
6 Lockwasher, #8 (2 req'd)
7 Cover
8 Gasket
9 Felt wick
10 Wick cover
11 Bronze bearing
12 Commutator end head
13 Oil guard
13 Gasket
14 Brush spring
15 Screw, #8 x 1/4 NC (2 req'd)
16 Brush arm
17 Brush set
18 Pole shoe
19 Armature terminal stud
20 Insulation
21 Field terminal stud
22 Return terminal stud
23 Field coils
24 Frame
25 Insulation
26 Plain washer
27 Lockwasher, 5/16 (4 req'd)
28 Hex nut, 5/16 NF (4 req'd)
29 Lockwasher, 1/4 (3 req'd)
30 Hex nut 1/4 NF (1 req'd)
31 Pole shoe screw
32 Shaft nut
33 Shaft lockwasher
34 Pulley
35 Hex nut, #10 NF (3 req'd)
36 Lockwasher, #10 (3 req'd)
37 Bearing retainer
38 Felt washer
39 Felt washer retainer
40 Ball bearing
41 Drive end head
42 Screw, #10–7/8 NF (3 req'd)
43 Woodruff key, 5
44 Felt washer retainer
45 Snap ring
46 Armature assembly

Figure 80—Continued.

(2) *Disassembly* (fig. 80).

(*a*) Remove the generator from the engine (par. 82).

(*b*) Remove the cover band (4) and disconnect the leads from the terminal studs (19), (21), and (22).

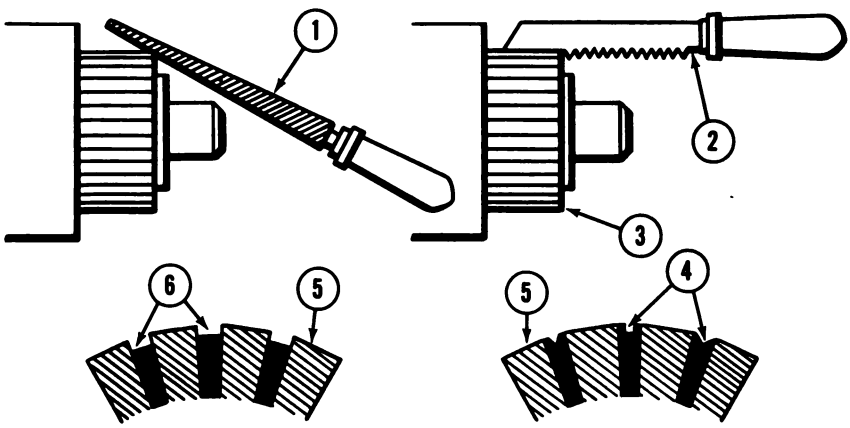
(*c*) Remove the through bolts (1) and the commutator end head (12). The pulley (34), drive end head (41), and armature (46) are removed from the opposite end.

(*d*) Remove the nut (32), washer (33), and pulley (34) which is held to the armature shaft by key (43).

(*e*) To remove ball bearing (40), remove the screws (42), nuts (35), lockwashers (36), bearing retainers (37), felt washers (38), and felt washer retainers (39).

(*f*) To remove bronze bearing (11), remove the screws (5), lockwashers (6), cover (7), and gasket (8).

(*g*) Remove field coils (23) from frame (24) by removing the pole shoe screws (31).



1 Three-cornered file
2 Undercutting saw
3 Commutator
4 Incorrect undercut
5 Commutator segments
6 Correct undercut

Figure 81. Undercutting mica.

(3) *Armature.*

(*a*) Inspect the armature for mechanical defects.

(*b*) If the commutator is worn or rough, turn the commutator on a lathe. Maximum eccentricity is not to exceed 0.001 inch.

(*c*) If the mica between the commutator segments is high or if the commutator has been turned, undercut the mica (fig. 81).

1. Start groove in mica using a three-cornered file (1).

2. Using an undercutting saw (2), undercut mica. A hacksaw blade, ground down, can be used. Cut to a depth of one-thirty second of an inch over the full width of the mica.

3. The finished cut should appear as shown in (6) and not any of the variations (4). Sand off all burs with No. 00 sandpaper and make sure that no copper dust remains between the segments.

(*d*) To test armature circuits, use a set of test probes (fig. 82) consisting of a lamp in series with two test points and connected to a 110-volt supply. A complete circuit between the test probes will cause the lamp to light.

Note. When using test probes, never touch polished contact surfaces of the commutator segments, sliprings, or bearing surfaces as an arc will mar the finish.

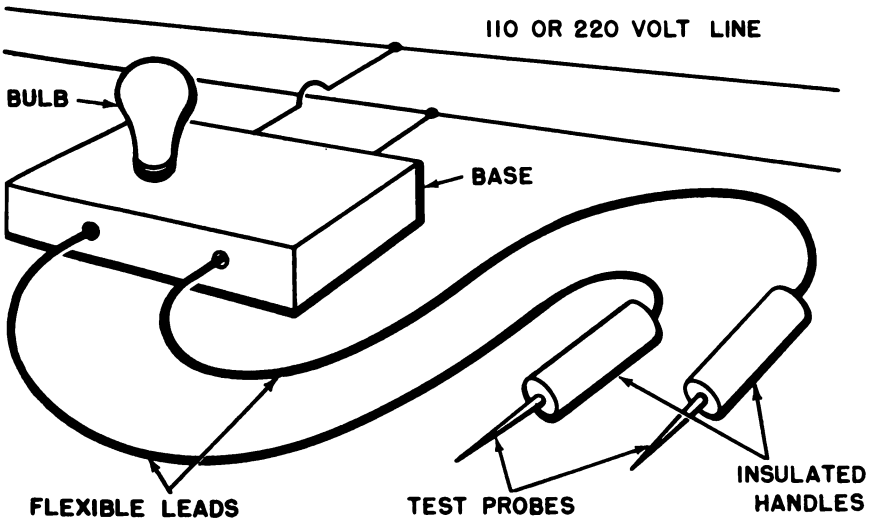


Figure 82. Test probes.

(*e*) To test for grounds, touch one point to the core or shaft and touch a commutator segment with the other. If the lamp lights, the armature winding is gounded. Replace the armature.

(*f*) To test for shorted armature coils, use a growler. The field windings of the growler, by changing polarity 120 times per second, duplicate the same condition as the armature would create when running in the generator at a speed of 3600 rpm.

(*g*) Place the armature on the growler and hold a thin steel strip over the armature core. Rotate the armature slowly by hand. Current will flow through a shorted coil and cause the steel strip to vibrate. If shorted, replace the armature.

(4) *Field coils.*

(*a*) To test for an open coil, connect the test pro to the two leads of each field coil (23, fig. 80). does not light, the coil is open and is to be re

(*b*) To test for grounds, place one probe on the gen and the other to a field coil terminal. If the the coil is grounded and is to be replaced.

Note. If materials for fungicidal treatment ((6) b available, replace the complete frame and field ass coils are required.

(5) *Brush holders.*

(*a*) Place one of the test probes (fig. 82) on the ins holder and the other to the commutator en fig. 80). If the lamp lights, the brush holder Replace the commutator end head.

(*b*) After assembly, inspect the brush holders for improper alinement. The brushes (17) shoul in the brush arm (16) and be in line with the segments.

(6) *Fungicidal treatment* (fig. 80).

(*a*) Before assembling generator, paint terminal tion (20) and brush holder insulation with Paint frame (24) and field coils (23) inside a air-drying fungicidal varnish. Let varnish so coils but do not paint studs (19), (21), and holder leads.

(*b*) Paint drive end head (41) with fungicidal varni paint the mounting face, bearing (40), was retainer (39).

(*c*) Paint commutator end head (12) with fungici Do not paint brushes (17), brush arms (16), b or generator mounting face.

(*d*) Paint the armature core, windings, commutato front face of commutator with fungicidal v not paint commutator or bearing surfaces.

(7) *Reassembly* (fig. 80). Reverse the procedure o Pack the ball bearing (40) with a high-temper and soak the felts (38) and (39) in medium o sembly. Seat brushes (par. 107).

(8) *Lubrication.* After assembly, lubricate the gen ings as directed by LO 5–5161.

(9) *Bench test.* After assembly, test the generator b ing on engine.

(*a*) Place the battery and ammeter in series wi coils and a voltmeter across the field coi Adjust the voltage to 20 volts and read th

It should read 0.6 to 0.8 amps. Any other reading indicates defective field coils or connections.

(*b*) Check the motorizing draw. Connect a battery and ammeter in series with the armature terminal and frame. With the voltage adjusted to 20, the live current should be 1.2 to 1.4 amps. If the reading is higher, check bearings and armature for binding and correct alinement.

(*c*) With the generator connected as in (*b*) above, drive the generator on the test bench or on the engine with the regulator disconnected. At 1,350 rpm, the current should be 5 amps with a terminal voltage of 30.

(*d*) Polarize the generator with the battery before running. Use a jumper from the starting switch battery terminal to the armature terminal of the generator with the field circuit connected as in (*b*) above.

d. Voltage Regulator Testing and Overhaul.

(1) *Removal* (fig. 53).

(*a*) Disconnect wires from regulator terminals.

(*b*) Remove screws holding regulator to bracket.

(*c*) Break seal and remove regulator cover.

(2) *Wiring.*

(*a*) Check all wiring connections with figure 49.

(*b*) Before testing regulator, test the generator as directed in *c*(1) above.

(*c*) Remove the cover to expose the cutout relay (1, fig. 83), current regulator unit (2), and the voltage regulator unit (3).

(3) *Testing cutout relay.* The cutout relay unit (1, fig. 83) is the end unit with the heavy wire winding.

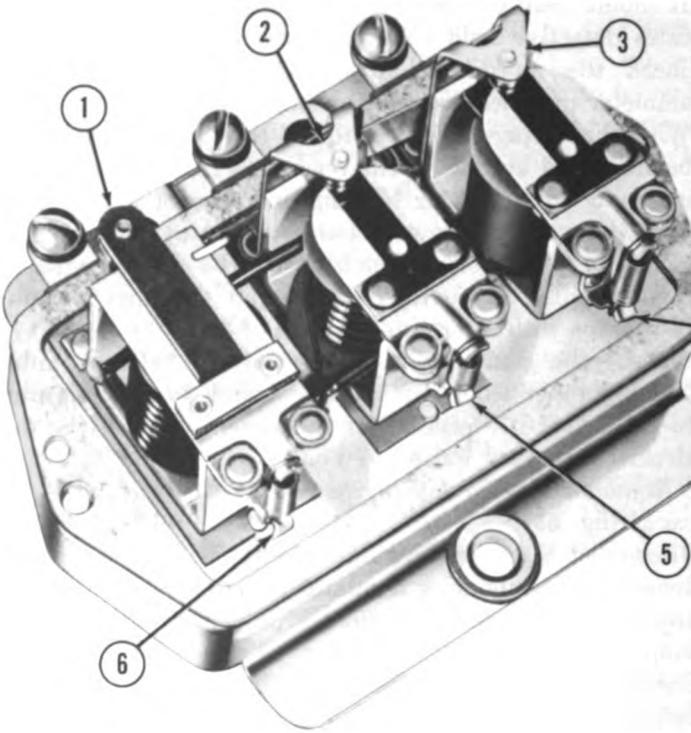
(*a*) Connect an ammeter between BAT terminal and battery wire (fig. 84).

(*b*) Connect a voltmeter from ARM terminal to regulator base.

(*c*) Place a thermometer about 2 inches from the regulator, not touching the regulator or the engine. The thermometer readings will be needed for adjustment ((4) below).

(*d*) Between the generator field lead and the FLD terminal, connect a variable resistance of 50 ohms maximum value and a current rating of at least 3 amperes.

(*e*) Run the generator at about 1,000 rpm. Set the resistance to its maximum value. Then slowly reduce the resistance and note the voltmeter reading just before it changes when the relay closes. The contact should close at between 25.0 and 26.5 volts. The closing point of the contacts can be found accurately by connecting a 2,000-ohm headphone between the BAT and ARM terminals. A click will be heard when the contacts open or close.



1 Cutout relay unit
2 Current regulator unit
3 Voltage regulator unit
4 Lower spring hanger
5 Lower spring hanger
6 Lower spring hanger

Figure 83. Voltage regulator, cover removed.

(*f*) Continue to reduce resistance until the amme amperes. Then increase the resistance slowl the ammeter reading just before it drops to zer contact opens. This current should be betwe 3.0 amperes.

(*g*) To adjust closing voltage, bend the lower spr (6, fig. 83). Increase spring tension to raise voltage. Decrease tension to lower voltage.

(*h*) To adjust the opening current, raise or lower the contact under the point opening by bending t making sure that both contacts are lined up. the gap lowers the opening current. Do not gap to less than 0.015 inch.

(4) *Adjustment of voltage regulator.* The voltage reg (3, fig. 83) is the end unit with a fine wire windi

(*a*) Connect ammeter between battery wire and BA (fig. 84).

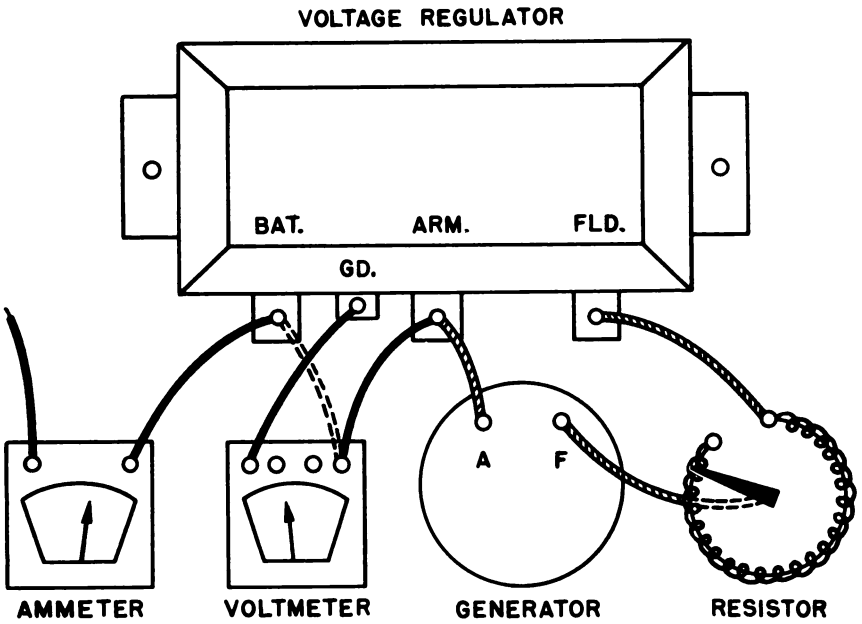


Figure 84. Voltage regulator test diagram.

(*b*) Connect voltmeter from BAT terminal to regulator base as shown by dotted line in figure 84.

(*c*) Remove the variable resistor.

(*d*) With the cover on the regulator, run the generator for 15 minutes to bring the regulator up to normal operating temperature.

(*e*) Stop the generator. Then bring the speed up until the ammeter reads 2.5 amperes. Turn on panel lights or d-c accessories to bring the current output up.

(*f*) Read the voltmeter and check against the following values at the ambient temperature indicated by the thermometer placed near the regulator.

Temperature	70°	80°	90°	100°	110°	120°
Voltage, low	28.00	27.82	27.65	27.48	27.31	27.14
Voltage, high	29.00	28.82	28.65	28.48	28.31	28.14

(*g*) If the voltage is outside the high and low limits given, make adjustment by bending the lower spring hanger (4, fig. 83). After each adjustment, stop the engine and restart it.

(*h*) To get an accurate indication of voltage regulator operation, connect a headphone from FLD terminal to ground. The clicks should be regular and clear without any missing. If not, inspect and clean the contacts, ((6) below).

(5) *Adjustment of current regulator.* The current r
(2, fig. 83) is the center unit.
(*a*) Connect instruments as described in (4) abov
(*b*) Bring engine up to full speed at 1,800 rpm
panel lights and d-c accessories. The operati
of the regulator is between 4.8 and 5.2 amp
by bending the lower spring hanger (5) to
between these limits. Have cover on the re
reading meters.
(6) *Contacts.* Inspect contacts for pits and roughn
contact is smooth and dull gray. Smooth co
fine file just enough to make them flat and pa
other. After filing, clean with linen or lintles
with carbon tetrachloride, and then dry conta
linen.
(7) *Voltage regulator replacement.* If any of the re
are defective or if the adjustments cannot b
entire regulator is to be replaced.

125. Starting Motor

a. Description (fig. 51). The starting motor is a
wound type. The right-hand Bendix drive engages the
the flywheel.

b. Inspection.
(1) Inspect the wiring. See that all connections
tight. Replace leads having worn insulation.
(2) Check commutator and brushes (par. 81).
spring tension should be 34 to 43 ounces wit
quarter inch brushes.

c. Testing and Overhaul.
(1) *Disassembly* (fig. 85).
(*a*) Remove the starting motor from engine (par.
(*b*) Remove the eight screws (36) and lockwasher
the pinion housing (35) to the frame and fi
(29). Remove the Bendix drive (39) and
bearing assembly (41).
(*c*) Remove the cover band (3) and lift the
(18), (27), and (28) and remove the ar
Remove the thrust washers (14), (15), and
armature shaft. Thrust washers (15) are used
(*d*) Remove the eight screws (43) and lockwash
remove the head assembly from the fra
assembly (29).
(*e*) To separate the brush plate (10) from the hea
the remaining four screws (43) and lock

The brush springs (11) and spacer (12) are held to the brush plate by clip (13).

(*f*) Using an arbor press, remove bronze bearings (6), (34), and (40) if they are loose or worn.

(*g*) Remove terminal studs (19) and (32) and hardware (20) to (26). Brushes (17), (18), (27), and (28) are soldered to their leads.

(*h*) To remove field coils from the frame (29), remove pole shoe screws (30).

(2) *Cleaning.* Wash all parts, except armature, field and frame assembly, brushes, and Bendix drive in dry-cleaning solvent. Gummy deposits on the Bendix drive shaft can be removed using solvent but do not dip the clutch body in the solvent.

(3) *Inspection and testing* (fig. 85).

(*a*) Inspect and test the armature, field coils, and brush holders as directed in paragraph 124.

(*b*) Inspect the head (9), frame (29), and pinion housing (35) for cracks. Replace if defective.

(*c*) Inspect the pinion of the Bendix drive (39) for worn or broken teeth. See that the pinion is free to turn for the length of the screw shaft.

(*d*) Inspect bronze bearings (6), (34), and (40) and replace if worn or loose. Bearings are of the absorbent bronze type and will absorb 25 percent of their own volume of oil. Soak new bearings in oil and wipe down the bearing seats with oil.

(4) *Fungicidal treatment.* The fungicidal treatment is the same as for the generator (par. 124*c*(6)), except that the pinion housing (35) is to be painted with the fungicidal varnish.

(5) *Reassembly.* Assemble the generator in the reverse of (1) above. Soak new bearings in oil, and wipe down bearing seats, armature shaft, and Bendix drive screw shaft with oil. Place thrust washers (14), (15), and (42) on the armature shaft and adjust end play to 0.005 to 0.030 inch by adding or deleting washers (15).

(6) *Bench test.*

(*a*) At no load with 20 volts supplied, the starting motor should draw 65 amperes maximum and run at 5300 rpm minimum. If the current is too high or speed to low, check bearing alinement.

(*b*) Using a spring scale and torque arm, check the stall torque, which should be a minimum of 35 pound-feet at 6.0 volts and a maximum current of 590 amperes. The stall torque in pound-feet is equal to the spring scale reading in pounds multiplied by the length of the torque arm in feet.

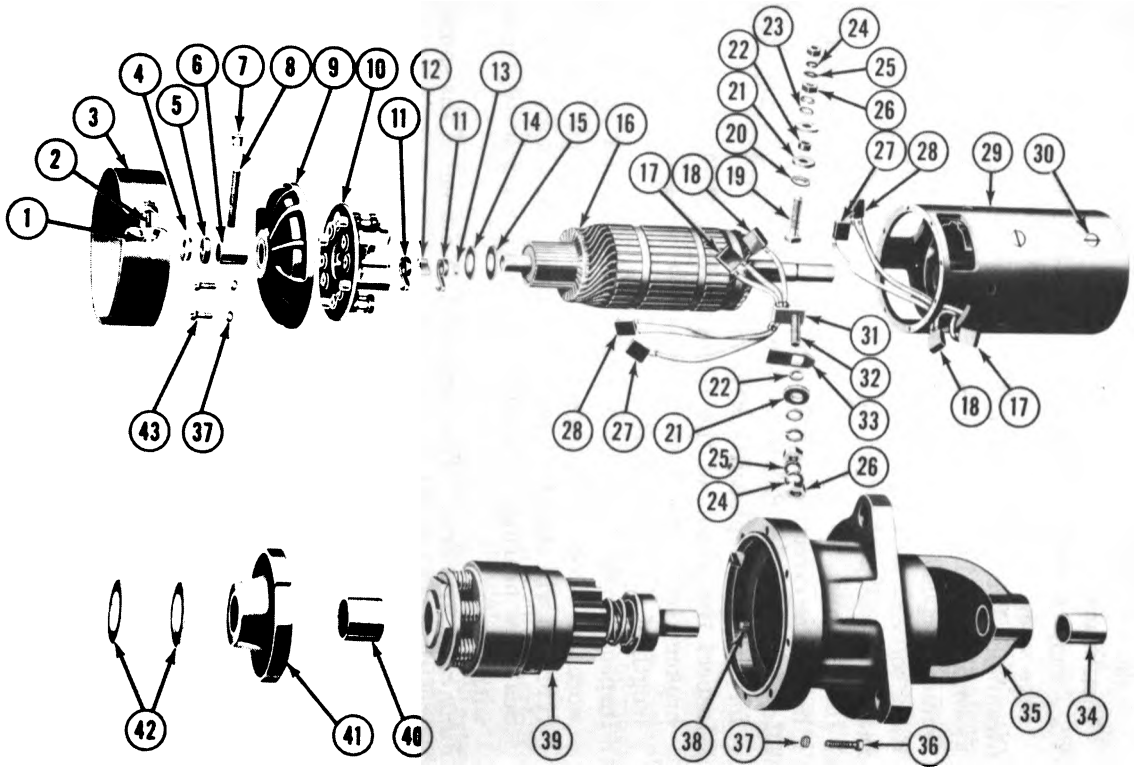


Figure 85. Exploding view of starting motor.

1 Nut, #10 NF (1 req'd)
2 Screw, rd-hd #10 x 1-1/2" NF (1 req'd)
3 Cover band
4 Bearing cover
5 Felt
6 Absorbent bronze bearing
7 Oiler, 3/8"
8 Felt wick
9 Commutator end head assembly
10 Brush plate assembly
11 Brush spring
12 Spring spacer
13 Brush holder clip
14 Thrust washer
15 Thrust washer,*
16 Armature
17 Brush
18 Brush
19 Terminal stud
20 Plain washer, 3/8" (1 req'd)
21 Insulating washer
22 Insulating bushing
23 Plain washer, 3/8" (2 req'd)
24 Lockwasher, 3/8" (4 req'd)
25 Plain washer, 3/8" (2 req'd)
26 Hex nut, 3/8" NC (4 req'd)
27 Brush
28 Brush
29 Frame and field assembly
30 Pole shoe screw
31 Terminal
32 Terminal stud
33 Insulation
34 Absorbent bronze bearing
35 Pinion housing assembly
36 Hex-hd screw, #10 x 7/8" NF (8 req'd)
37 Lockwasher, #10 (8 req'd)
38 Dowel pin
39 Bendix drive
40 Absorbent bronze bearing
41 Intermediate bearing assembly
42 Thrust washer
43 Fil-hd screw, #10 x 5/8" NF (12 req'd)

*Thickness as required, 1/64", 1/32" and 3/64"

Figure 85.—Continued

Section V. LUBRICATING SYSTEM

126. General

a. Description. Refer to paragraph 73.

b. Servicing. Refer to the lubrication order.

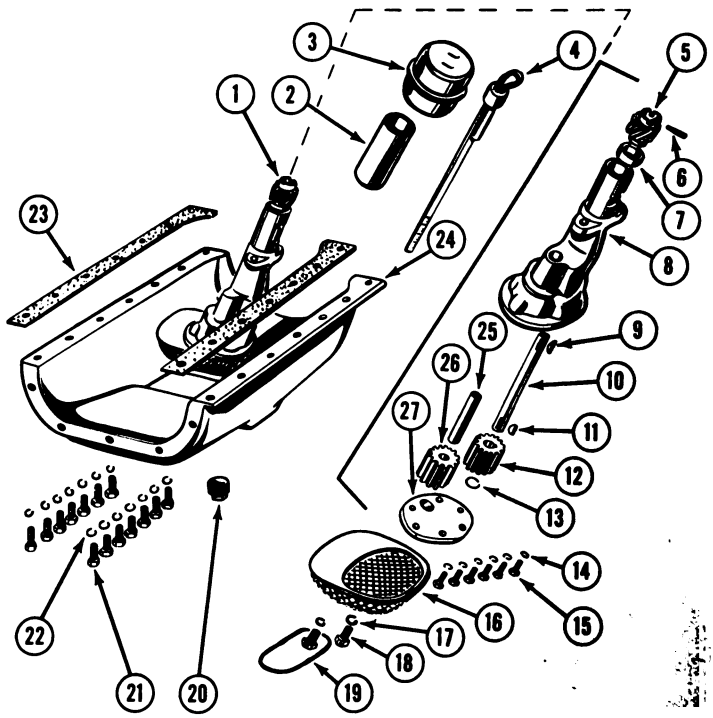
127. Oil Pan and Oil Pump

a. Removal.

(1) Drain oil before proceeding with other operations.

(2) Carefully lay engine on its side with timbers underneath to hold it level.

(3) Remove all cap screws (21, fig. 86) holding oil pan to engine.



1 Oil pump assembly
2 Breather pipe
3 Breather cap
4 Crankcase oil level gage
5 Oil pump drive gear
6 Driving gear pin
7 Oil pump seal
8 Oil pump body
9 Key
10 Oil pump drive shaft
11 Key
12 Oil pump driver gear
13 Retaining ring
14 Lockwasher
15 Cap screw
16 Strainer
17 Lockwasher
18 Cap screw
19 Strainer bale wire
20 Pipe plug
21 Cap screw
22 Lockwasher
23 Oil pan gasket
24 Oil pan
25 Idler gear shaft
26 Oil pump idler gear
27 Oil pump cover

Figure 86. Exploded view of oil pump, strainer, crankcase oil level gage, and oil pan.

(4) Carefully remove oil pan (24). Discard old gaskets (23).
(5) Remove two cap screws holding oil pump to crankcase (fig. 87).
(6) Remove oil pump. It is driven by helical gears. Turn the pump as you withdraw it to unmesh the gears.

b. Disassembly.

(1) Remove strainer (16, fig. 86) from bottom of pump. It is held on by strainer bale wire (19).
(2) File off head of drive gear pin (6, fig. 86) and drive the pin out (fig. 88). Be careful not to crack the gear hub.
(3) Remove drive gear (5, fig. 86).
(4) Remove pump cover (4, fig. 89) to expose the driver gear (5) and the idler gear (6).
(5) Pull out idler gear (26, fig. 86), idler shaft (25), and drive shaft (10) with driver gear (12) attached, from bottom of pump.

c. Inspection and Repair (fig. 86).

(1) Examine the pump gears (12) and (26). If they are badly worn, replace them. Press them further on the shaft until the retaining ring (13) is uncovered. Remove the retaining ring and press gears off shafts.

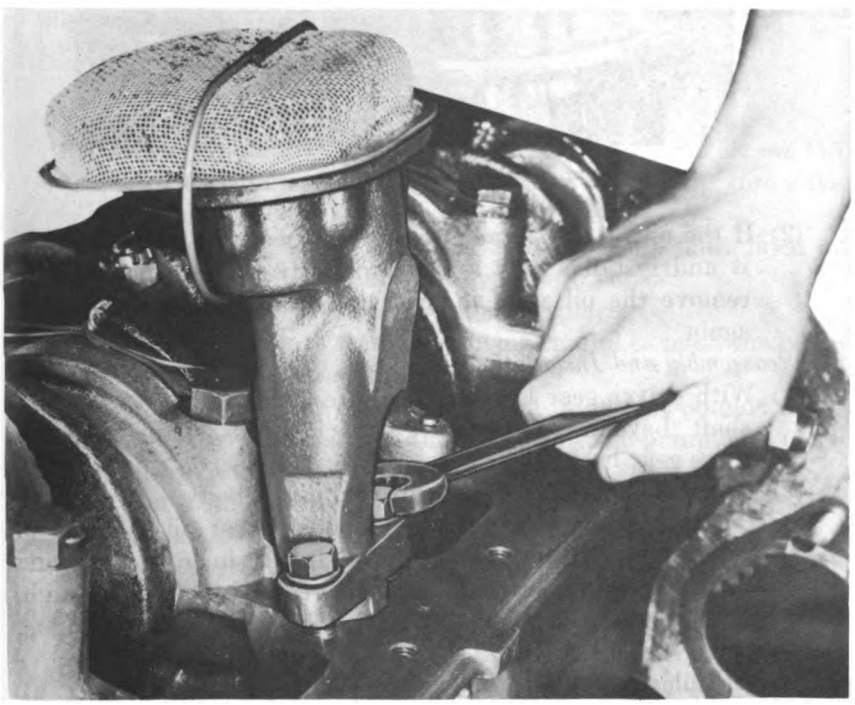


Figure 87. Removing oil pump.

Figure 88. Removing drive gear pin from oil pump.

(2) If the oil seal (7) is removed from the pump b it and install a new seal. Ordinarily there is remove the oil seal, and it can be left in pla again.

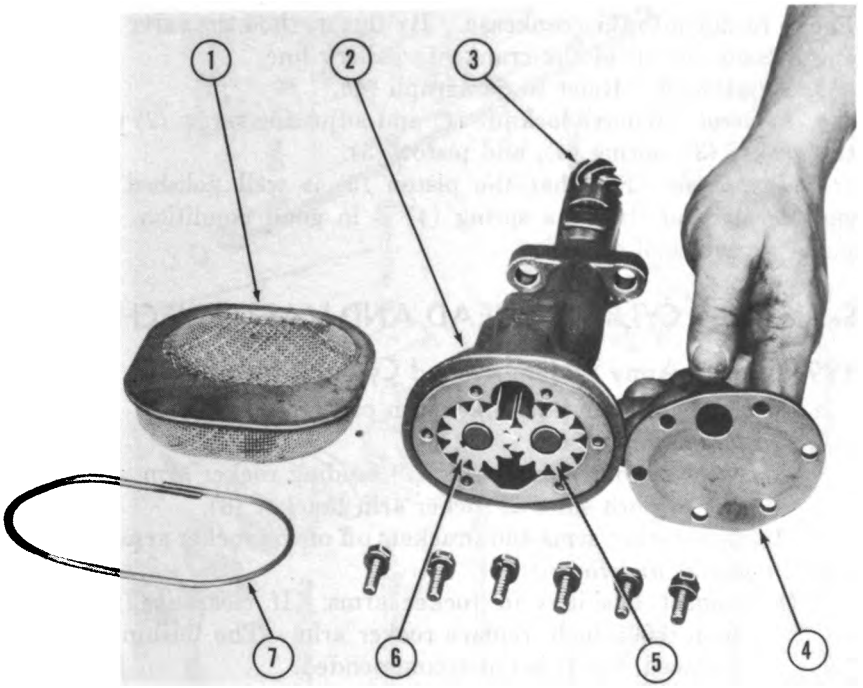
d. Reassembly and Installation (fig. 86).

(1) With driver gear key in place, press the pump shaft beyond snap ring groove. Install sna press gear back against it.

(2) If new oil seal is used, press it into pump body.

(3) Put idler shaft (25) into pump body (8) at oil pump temporarily. Put drive shaft (10) in fro until it meets idler shaft. Then press drive sh forcing idler shaft out. This method prevent the oil seal.

(4) Put idler shaft (25) in place.



1 Strainer
2 Oil pump body
3 Driving gear
4 Pump cover
5 Driver gear
6 Idler gear
7 Strainer bale wire

Figure 89. Removing oil pump cover.

(5) Replace pump cover (27) and secure with six cap screws (15) and lockwashers (14). No gasket is used. Be sure cover and pump body faces are clean.
(6) Press drive gear with key on shaft, with pin holes lined up.
(7) Put in new pin (6) and peen over both ends.
(8) Clean strainer (16) in solvent and replace.
(9) Put oil pump into crankcase, being careful to mesh the helical gears without damaging them.
(10) Tighten the two cap screws to 60 to 70 foot-pounds with a torque wrench. When they are tight, the pump does not fit flush with bottom of crankcase.
(11) Put new gaskets (23) on bottom of crankcase with gasket cement.
(12) Replace oil pan (24) and tighten all the cap screws.

128. Oil Pressure Relief Valve

(fig. 43)

a. Description. The oil pressure relief valve is a spring-loaded relief valve which permits excess oil from the crankcase gallery oil

line to escape into the crankcase. By this method the
the pressure of oil in the crankcase gallery line.

b. Adjustment. Refer to paragraph 74*b*.

c. Removal. Remove locknut (1) and adjusting screw
the gasket (3), spring (4), and piston (5).

d. Inspection. See that the piston (5) is well pol
slide freely and that the spring (4) is in good condi
parts in reverse of *c* above.

Section VI. CYLINDER HEAD AND VALVE M

129. Rocker Army Assembly and Cylinder Head

a. Removal. Remove as directed in paragraph 76.

b. Disassembly (fig. 90).

(1) Remove four spring clips (7) holding rocker
(1) to both sides of rocker arm bracket (8).

(2) Slide rocker arms and brackets off of the rocke

c. Inspection and Repair.

(1) Inspect bushings in rocker arms. If cleara
than 0.005 inch, replace rocker arm. The b
replaced, but it is not recommended.

(2) Inspect rocker arm valve contact buttons (1
they are loose in socket end or damaged whe
valve stems, replace contact buttons.

(*a*) Remove snap retainer ring (4) and contact

(*b*) Replace felt oil wick.

(*c*) Insert new contact buttons and replace sna
The button may have to be lapped to fit
socket. Use a fine lapping compound and l
to seat button in the socket.

(3) Inspect rocker arm shaft for wear. If it h
grooved, replace the shaft.

(4) Clean out the holes in the shaft and rocker a

(5) One of the long studs holding cylinder head c
to supply oil to rocker arms. Clean this slot

(*a*) Remove oil fittings on side of cylinder head

(*b*) Clean fitting hole and slot in stud.

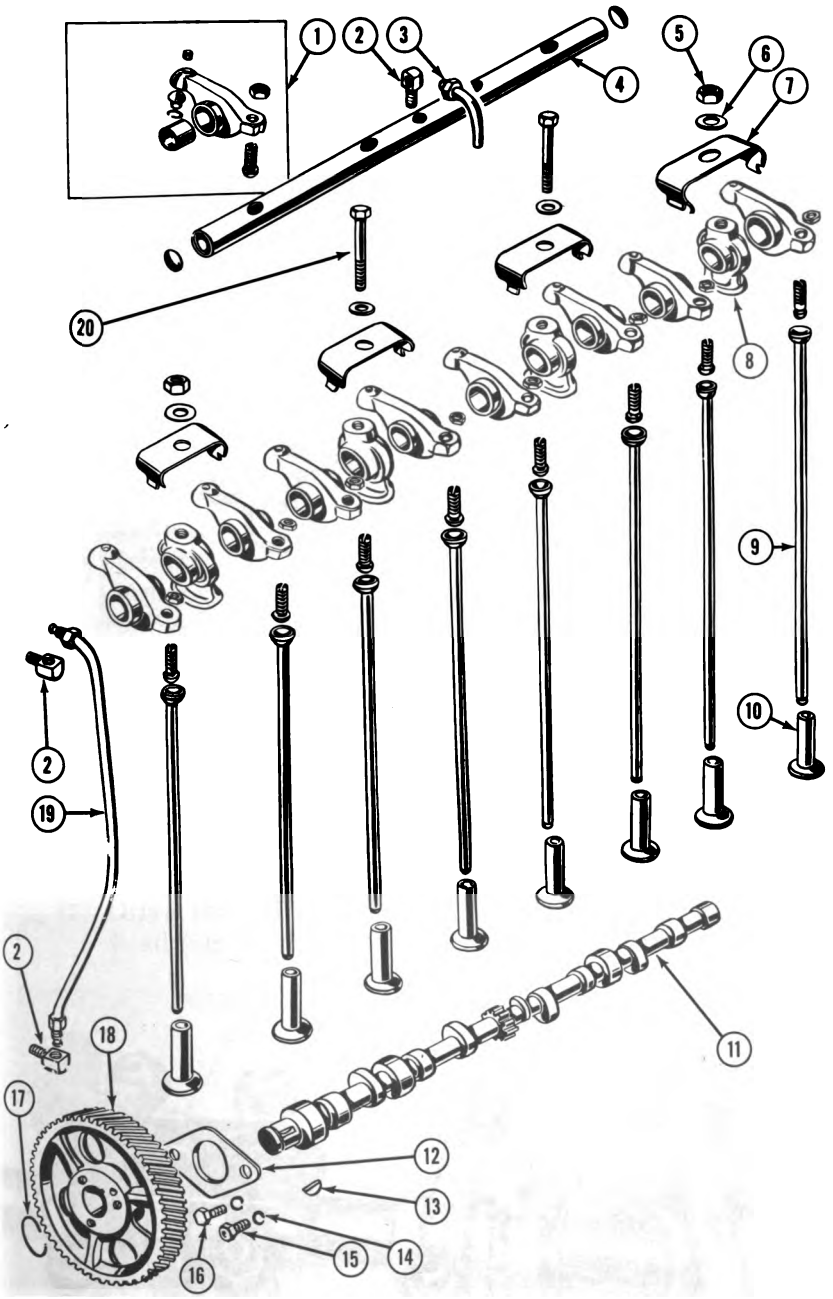
(*c*) Replace fitting.

d. Reassembly and Installation.

(1) Reassemble rocker arms and brackets to shaft

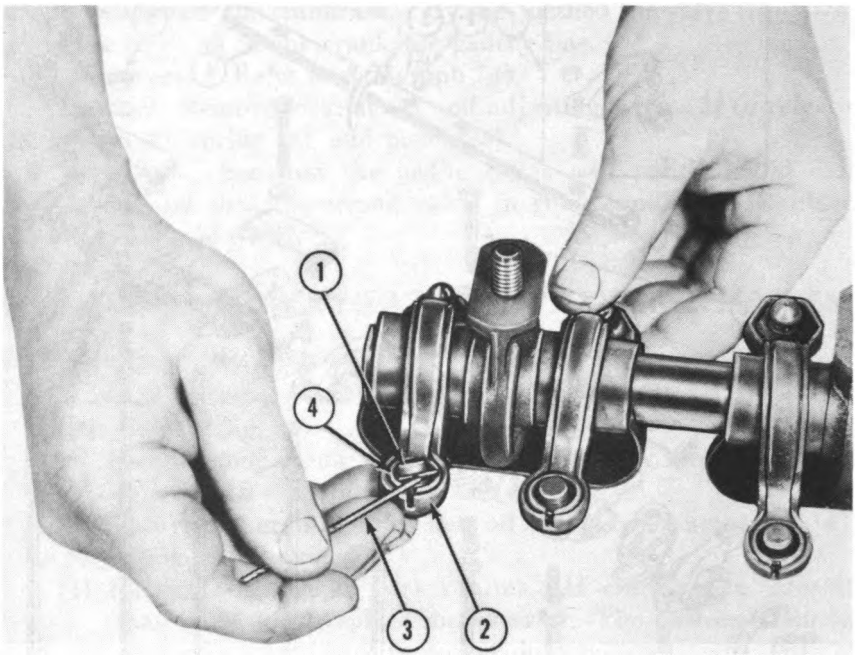
(2) Replace spring clips.

(3) Replace head and assembly (par. 76).



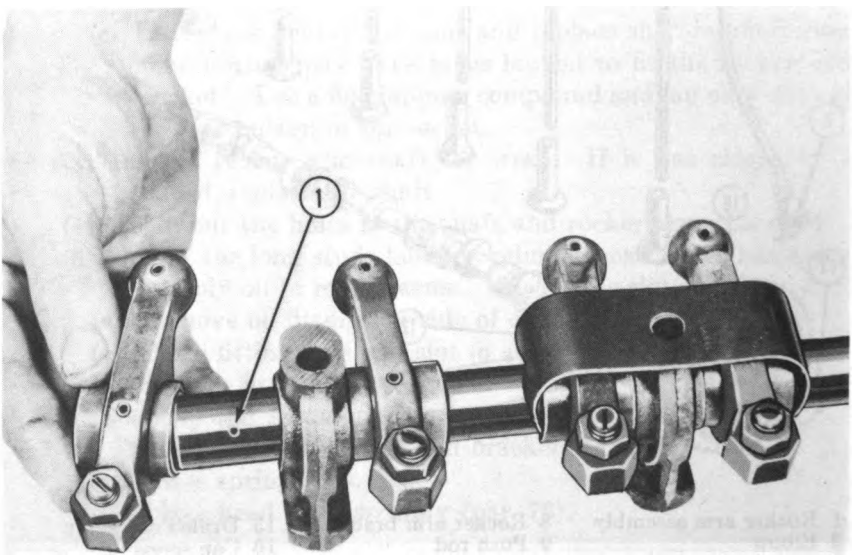
1 Rocker arm assembly
2 Elbow
3 Overflow line
4 Rocker arm shaft
5 Nut
6 Washer
7 Spring clip
8 Rocker arm bracket
9 Push rod
10 Valve lifter
11 Camshaft
12 Thrust plate
13 Key
14 Lockwasher
15 Drilled cap screw
16 Cap screw
17 Gear retainer
18 Gear
19 Oil line
20 Cap screw

Figure 90. Exploded view of valve operating mechanism, camshaft, and gear.



1 Contact button
2 Socket end of rocker arm
3 Pick
4 Retainer ring

Figure 91. Removing contact button.



1 Oilhole

Figure 92. Rocker arm shaft showing oilhole.

130. Valves

a. Checking for Leakage (fig. 93). Make a leakage test whenever cylinder head is removed and after a valve grinding job. This test will indicate a burned or warped valve (1), a broken valve spring (3), or poorly ground valves.

(1) Block up the head upside down with valves assembled. In this position the valves are held closed by their springs.

(2) Pour fuel oil into each combustion chamber to cover the valve heads.

(3) Wrap cloth around an air hose and blow into each port in side of cylinder head. If valve leaks, bubbles will come up through the oil.

b. Removing Valves.

(1) Compress valve spring with a valve spring compressor (2, fig. 94) and remove the locking ring and the two retainer halves (1).

(2) Release compressor. Remove valve spring (8, fig. 95), spring retainer (7), and valve (9).

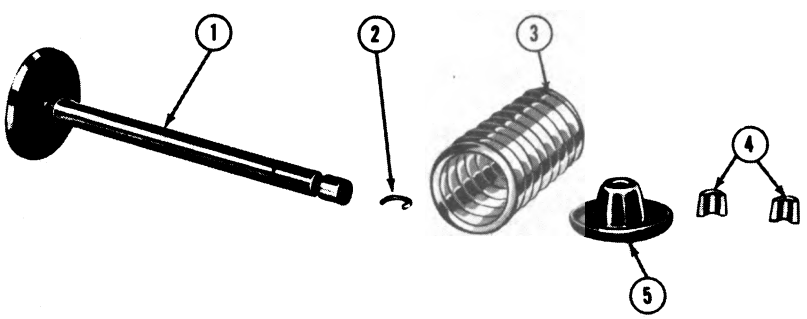
c. Inspecting Valve Seats and Guides.

(1) Inspect all valve seats (17, fig. 95) for burns, cracks, and pits. Reface if necessary with a 45° grinding wheel. Valve seats should be one-eighth inch wide. Narrow them, if necessary, with a 20° and 70° wheel (fig. 96).

(2) Check clearance of valve stem in guide (13, fig. 95). If it is over 0.006 inch, replace valve guide. If valve stem is worn, replace valve and guide.

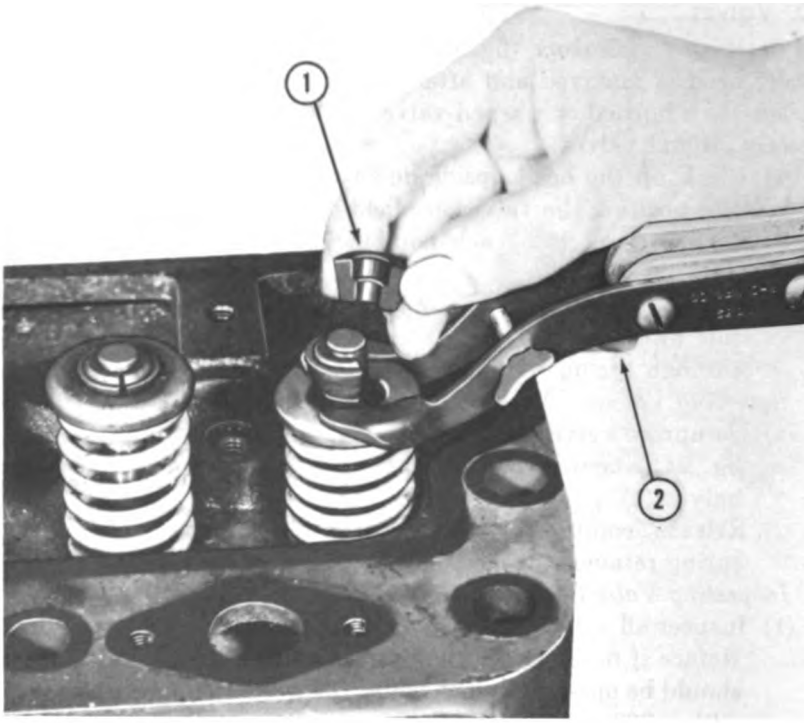
d. Replacing Valves Guides.

(1) Drive the valve guide (13, fig. 95) out from underside of head (fig. 97).



1 Valve
2 Locking ring
3 Valve spring
4 Retainer halves
5 Retainer

Figure 93. Valve assembly.



1 Retainer halves 2 Valve spring compressor

Figure 94. Removing valve retainers.

(2) Install new guide in from top of head. Use an arbor pr if possible.

(3) Clearance between new guide and valve stem should 0.0015 to 0.0030 inch. Ream guide if necessary.

e. Grinding Valves.

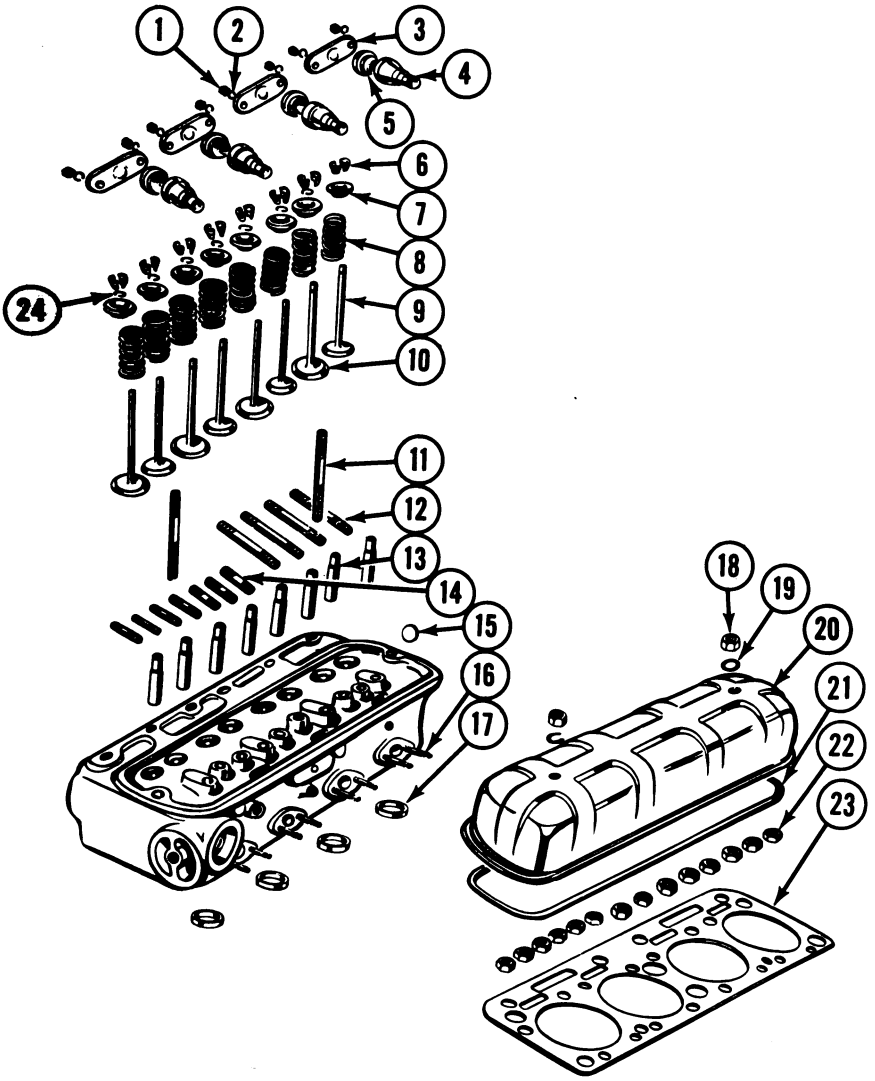
(1) Valves must be replaced if warped, burned, or badly pitt or if stems are worn.

(2) Clean valves thoroughly with carbon solvent. Do not emery cloth or wire brush on stems. Abrasives destroy wearing surfaces.

(3) If valves are slightly pitted and stems are in good condit reface the valves at 45° before grinding.

(4) Use a good quality, water-soluble valve-grinding compou

(5) Grind lightly. Use compound sparingly. The finished va seat should be between one-sixteenth and one-eighth of inch wide. Narrow the seat if it is wider than one-eig of an inch, as you will not be able to get a good grinding (fig. 98).



1 Nut
2 Lockwasher
3 Air cell retainer flange
4 Air cell assembly
5 Air cell plug
6 Retainer halves
7 Spring retainer
8 Valve spring
9 Intake valve
10 Exhaust valve
11 Rocker arm bracket stud
12 Manifold stud
13 Valve guide
14 Air cell stud
15 Expansion plug
16 Nozzle stud
17 Exhaust valve seat
18 Nut
19 Washer
20 Cylinder head cover
21 Gasket
22 Nut
23 Gasket
24 Lock

Figure 95. Exploded view of cylinder head and valve assembly.

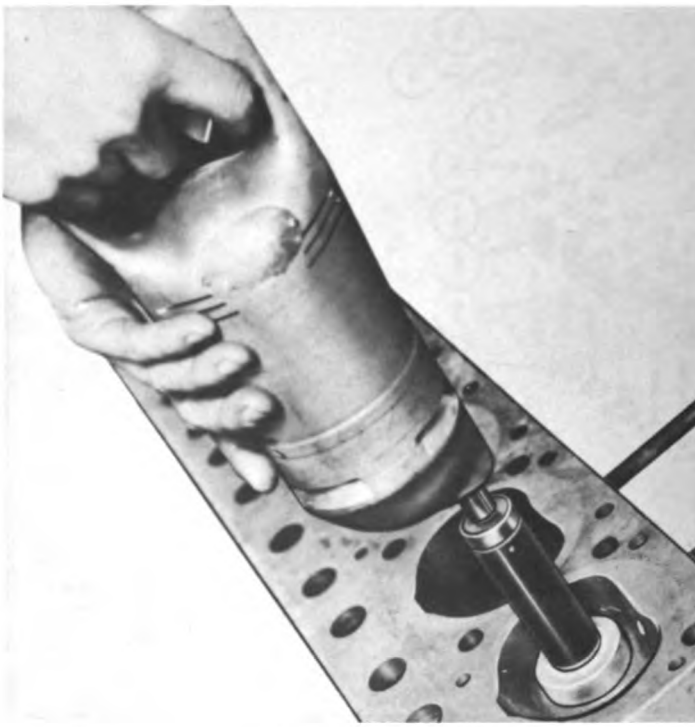


Figure 96. Refacing valve seats.

(6) When valve and seat look like gray emery pape put a small amount of prussian blue on the Turn valve in seat one complete turn. Prussian show completely around the seat.

(7) Check valve for leakage. Refer to *a* above.

131. Valve Springs

a. Spring Tension.

(1) Test the valve springs. Force to compress to 1⅜ should be between 40 and 50 pounds. Force to $1\frac{13}{32}$-inch length should be between 105 and Free length (uncompressed) is about $2\frac{1}{32}$ inches.

(2) All springs in one engine should have the same s

b. Replacement. Replace all weak, cracked, or broken

132. Push Rods

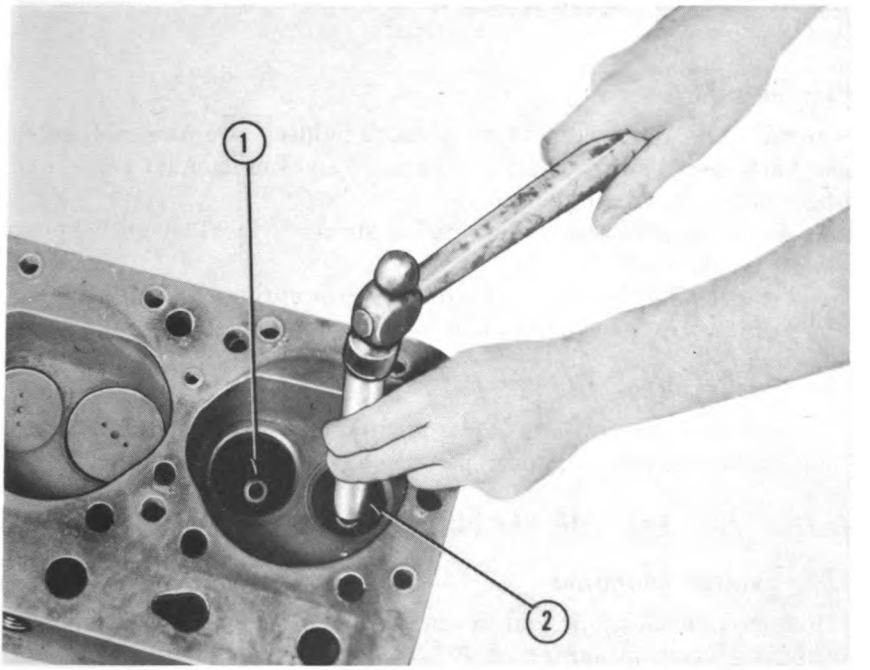
a. Removal. Remove push rods before removing head

b. Servicing.

(1) Replace bent or twisted rods.

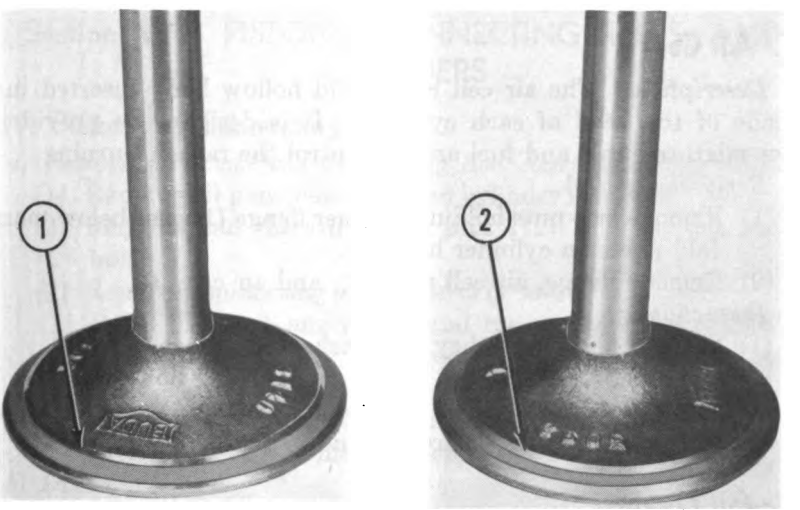
(2) Check the ball and cup ends for wear.

(3) Polish out any nicks or scores with a hand stone



1 Valve guide 2 Tool

Figure 97. Removing valve guides.



1 Good grinding 2 Poor grinding

Figure 98. Good and poor valve grinding.

c. Replacement. Replace rods after cylinder hea
block.

133. Installing Valves

a. Placing. Slide valve stems through guides. E
goes back into its own position; exhaust valves in e
intake valves in intake ports.

b. Assembling Spring. Place valve spring over
seat on top.

c. Compressing Spring. Compress with spring
insert the two retainer halves and lock.

134. Rocker Arm

Rocker arm removal and replacement is covered
Disassembly, inspection, and repair are covered in p

Section VII. ENGINE MANIFOLDS AND A

135. Exhaust Manifold

Removal, inspection, and reinstallation of the
are fully covered in paragraph 77.

136. Intake Manifold

Intake manifold is removed at same time as e
Refer to paragraph 77 for removal, inspection, and

137. Air Cells

a. Description. The air cell is a round hollow b
the side of the head of each cylinder. It is desig
better mixture of air and fuel and to control the ra

b. Removal (fig. 99).

(1) Remove two nuts holding retainer flange (1
fold ports on cylinder head.

(2) Remove flange, air cell plug (2), and air ce

c. Inspection.

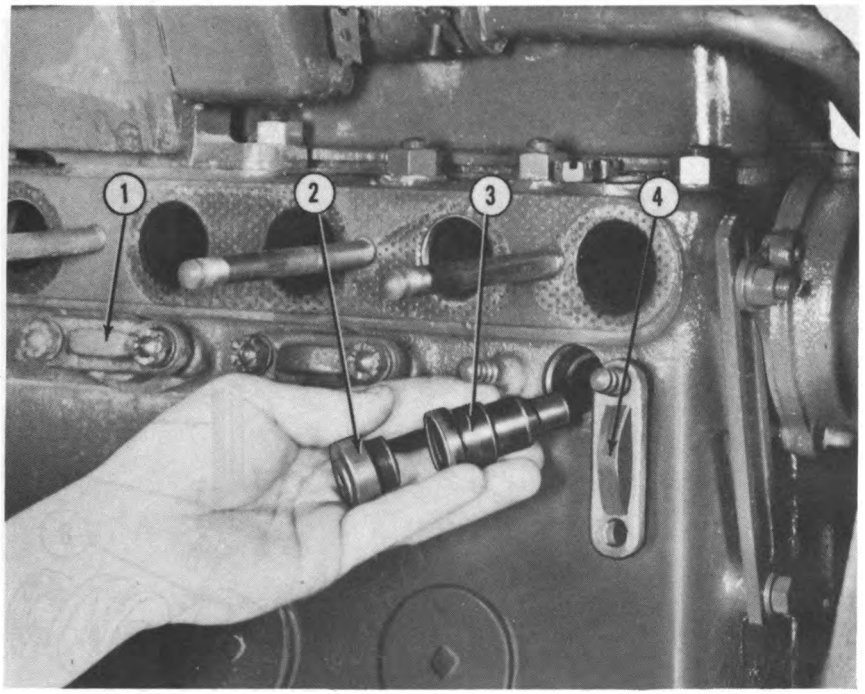
(1) Replace air cells if they are cracked or bro

(2) Clean cells and recesses thoroughly with ca

d. Reassembly and Installation. Replace air cell a
head. Replace flange and secure with nuts on stud

138. Air Heater

The air heater is removed with the intake ma
paragraph 72 for air heater maintenance, testing,
placement.



1 Retainer flange
2 Air cell plug
3 Air cell
4 Flange removed

Figure 99. Removing air cells.

Section VIII. PISTONS, CONNECTING RODS, AND CYLINDERS

139. Piston and Connecting Rod

a. Removing Pistons and Connecting Rod Assemblies (fig. 100).

(1) Remove oil pan (par. 127) and cylinder head (par. 78).

(2) Remove and discard cotter pins (12) from connecting rod bolts (7).

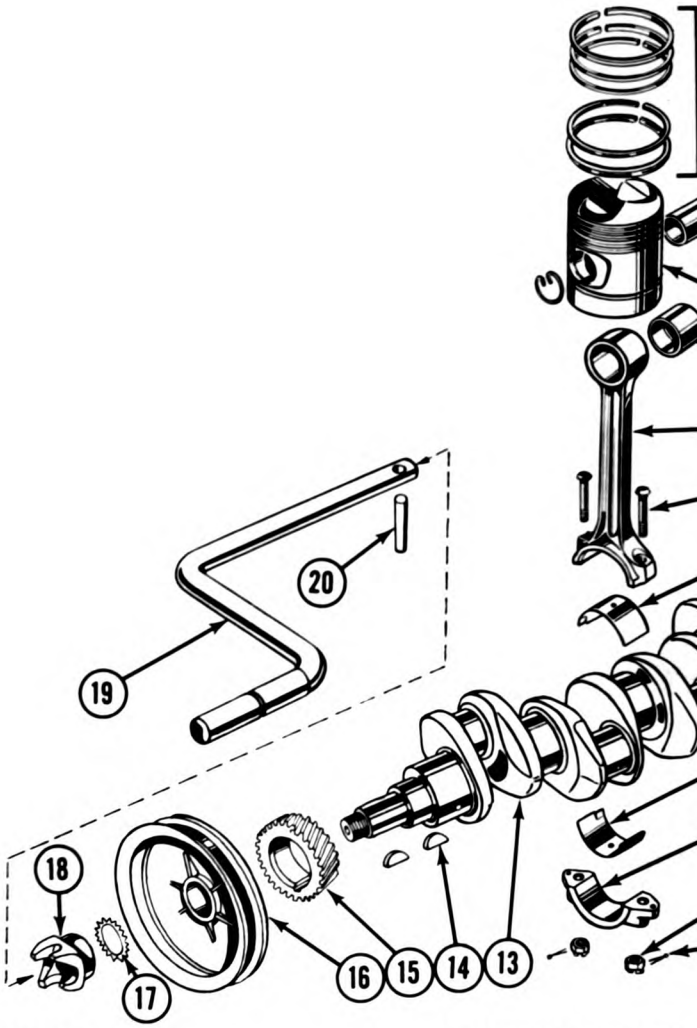
(3) Remove connecting rod nuts (11) and connecting rod caps (10). Remove one piston and rod assembly at a time and reassemble each cap to its rod after removing from the cylinder. Mark each piston with the cylinder number. The connecting rod caps and connecting rods are marked so that each may be assembled correctly with its matching part.

b. Disassembly.

(1) *Remove rings* (fig. 101).

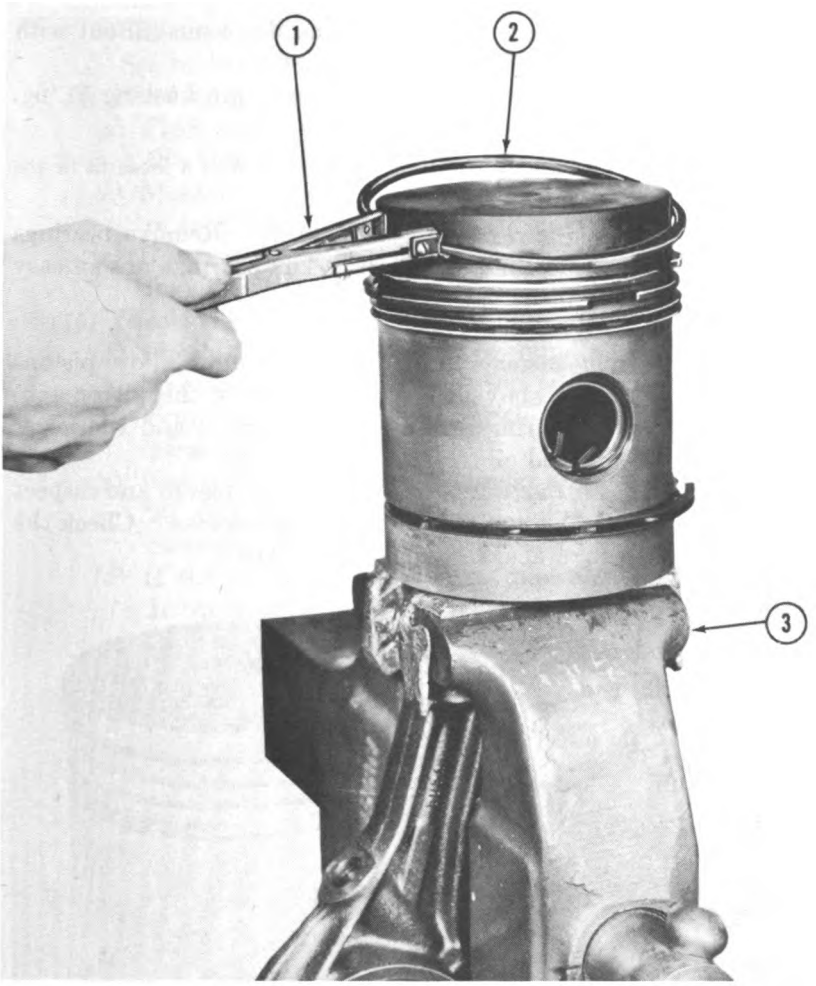
(*a*) Place assembly upright in a vise with lead jaws, gripping upper I-section of connecting rod.

(*b*) With a ring expander (1), remove the piston rings (2). Be careful as the rings break easily.



1 Piston ring
2 Piston pin retainer
3 Piston pin
4 Piston
5 Bushing
6 Connecting rod
7 Connecting rod bolt
8 Upper half bearing
9 Lower half bearing
10 Connecting rod cap
11 Connecting rod nut
12 Cotter pin
13 Crankshaft
14 Key
15 Gear
16 Pulley
17 Star washer
18 Cranking jaw
19 Crank
20 Crank pin

Figure 100. Exploded view of crankshaft, piston, and connect



1 Ring expander 2 Ring 3 Vise

Figure 101. Removing rings.

(*c*) Clean each ring groove thoroughly with cloth and carbon solvent.

(*d*) Scrape out all carbon from ring grooves and piston head. Take care not to nick the edges of ring grooves.

Note. When to replace rings: Always replace rings during an engine overhaul. Do not install new rings until piston is about to be installed in the engine.

(2) *Remove pins and bushings.*

(*a*) Remove snap ring (1, fig. 102) and drive pin (2) out with a hammer and a block of wood.

(*b*) Using an arbor press, press the piston pin bushing (5, fig. 100) out of the connecting rod (6).

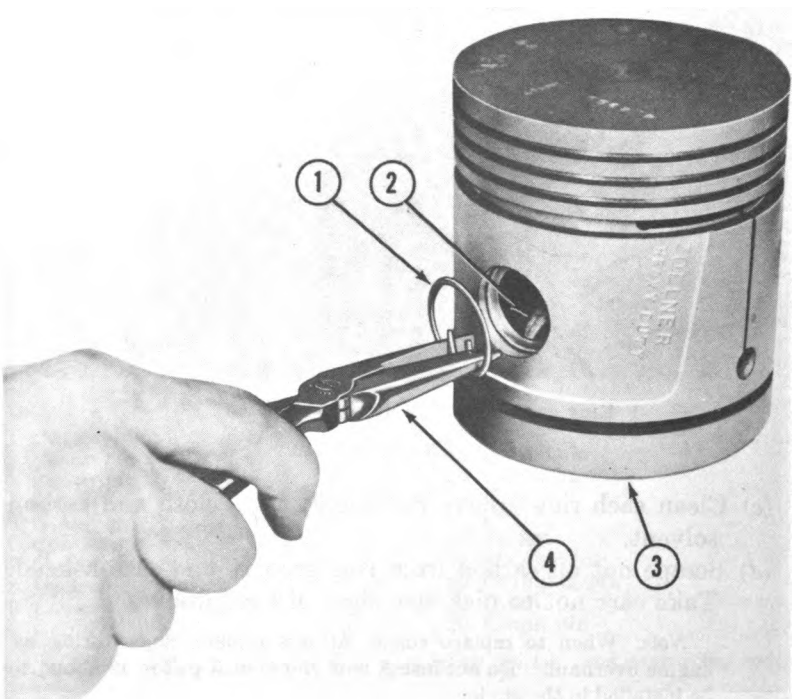
Note. This bushing can be replaced, but if it is a loose fit in the rod, install a new rod.

(2) *Remove connecting rod bearings* (fig. 100). Remove bearings (8) and (9) from the crankshaft. The bearings are an easy fit and can be lifted out.

c. Inspection and Repair.

(1) *Description of piston rings.* The aluminum alloy pistons have four rings above and one ring below the piston pin. The upper three rings are compression rings and the lower two are ventilated oil rings.

(2) *Cleaning and inspecting piston.* Clean the piston and inspect the grooves and ring lands for burns and cracks. Check the piston skirt for cracks. Replace if cracked.



1 Snap ring
2 Pin
3 Piston
4 Pliers

Figure 102. Removing piston pin retainer rings.

(3) *Checking ring groove* (fig. 103). With a feeler gage, check clearance of the new rings between ring and side of groove. See table of tolerances (par. 156) for correct clearances.

(4) *Checking ring gap* (fig. 104).

(*a*) Place each new ring in the cylinder about halfway down the bore. Square it up with a piston.

(*b*) Measure ring gap with feeler gage and check against table of tolerances (par. 164).

(*c*) If gap is too small, remove ring and dress the ends with a fine cut file to get the correct gap.

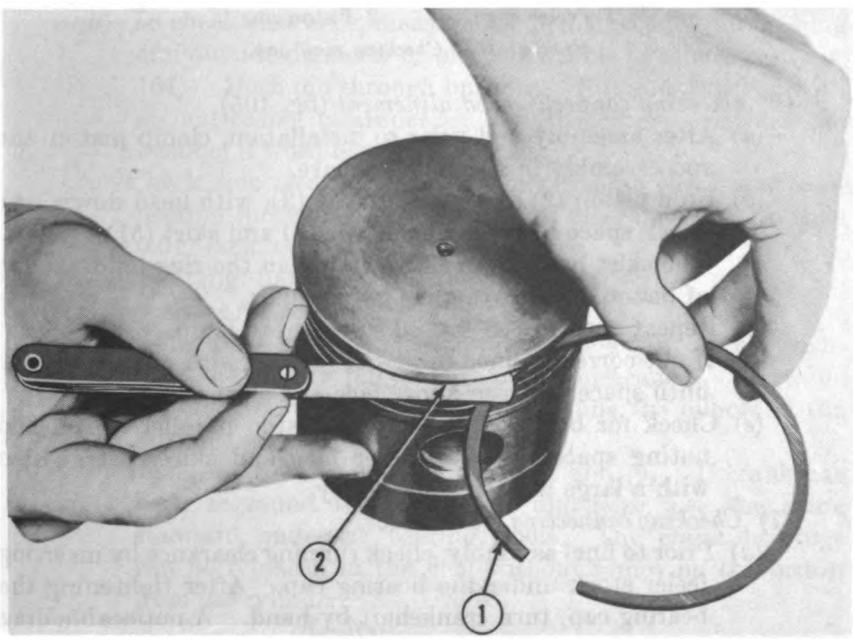
(5) *Checking piston fit.*

(*a*) Check the cylinder for out-of-round and taper (par. 140*a*).

(*b*) Measure the size of the piston with a micrometer at the ring lands and compare with the list of tolerances in paragraph 164.

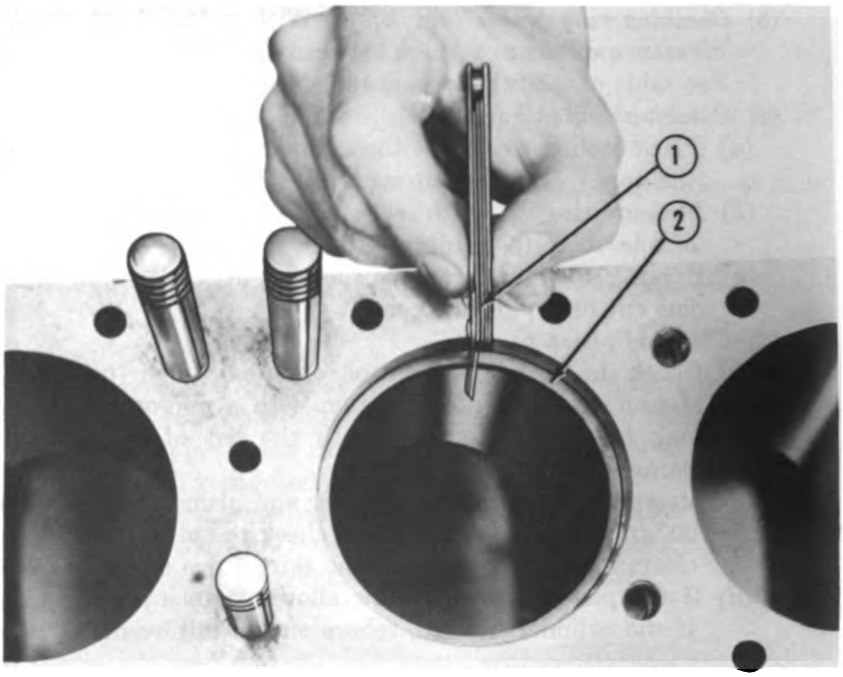
(*c*) Insert the piston in the cylinder and, using feeler stock at 90° from the piston pin holes, check the piston to cylinder clearance at the bottom of the skirt. See paragraph 164.

(*d*) If the piston is worn below allowable tolerance, replace. If the cylinder is worn, rebore and install oversize piston (par. 140).



1 Ring 2 Feeler gage

Figure 103. Checking ring clearance to groove.



1 Feeler gage 2 Piston ring

Figure 104. Checking ring gap.

(6) *Checking connecting rod alinement* (fig. 105).

(*a*) After assembly and prior to installation, clamp piston and rod assembly in an alining fixture.

(*b*) Hold piston (2) diagonally to rod (3), with head down, and check space between aliner face (1) and skirt (5) of piston. The skirt has a larger diameter than the ring lands at top of piston, so always aline by the skirt.

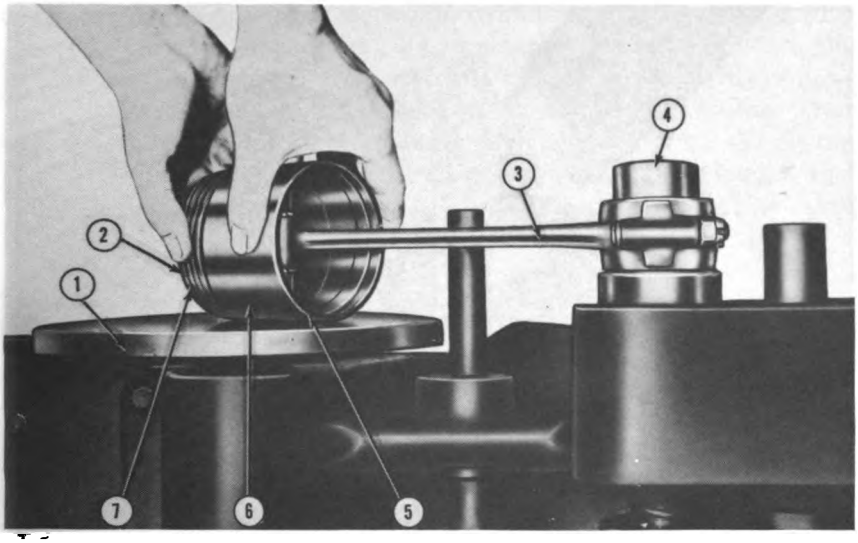
(*c*) Repeat with piston turned so the head is up.

(*d*) If not correctly lined up, twist the rod with a large wrench until space between aliner face and skirt is even.

(*e*) Check for bent rod by holding piston parallel to rod and noting space between aliner face and skirt. Straighten with a large wrench if necessary.

(7) *Checking connecting rod bearings.*

(*a*) Prior to final assembly, check running clearance by inserting feeler stock under the bearing cap. After tightening the bearing cap, turn crankshaft by hand. A noticeable drag indicates that the clearance is less than the thickness of the feeler stock. No drag indicates that another piece of feeler stock must be inserted. Check clearance against table of tolerances (par. 164). Replace rod bearing if it is worn beyond limit.



1 Aliner face
2 Piston
3 Connecting rod
4 Mandrel
5 Lower skirt
6 Upper skirt
7 Piston head

Figure 105. Checking connecting rod alinement.

(*b*) To check clearance, measure inside diameter of pin bushing and outside diameter of pin. See table of tolerances (par. 164). Push pin through bushing. If it goes through with no noticeable clearance, it is satisfactory. Replace pin bushing if worn beyond the limit.

(*c*) Check side clearance between crankshaft cheek and connecting rod with a feeler gage. If clearance is more than 0.011 inch, replace the connecting rod.

d. Reassembly (fig. 100).

(1) *Connecting rod bearings.*

(*a*) Using a brass block, press in pin bushing (5). Ream bushing to fit the new pin (3) with proper clearances. See table of tolerances (par. 164). Always aline the oilhole in the bushing with the oilhole in the rod.

(*b*) Install new crank bearing shells (8) and (9). If crank has been reground to a standard undersize, use the same standard undersize bearing shells. The crank bearings can be replaced in the field without removing the piston from the cylinder.

(2) *Piston assembly* (fig. 100).

(*a*) Replace parts under the following conditions:

1. Replace pin if diameter is under low limit, and if surface is scratched or marred.

2. Replace piston if retainer ring groove is worn so that rings do not fit tight.

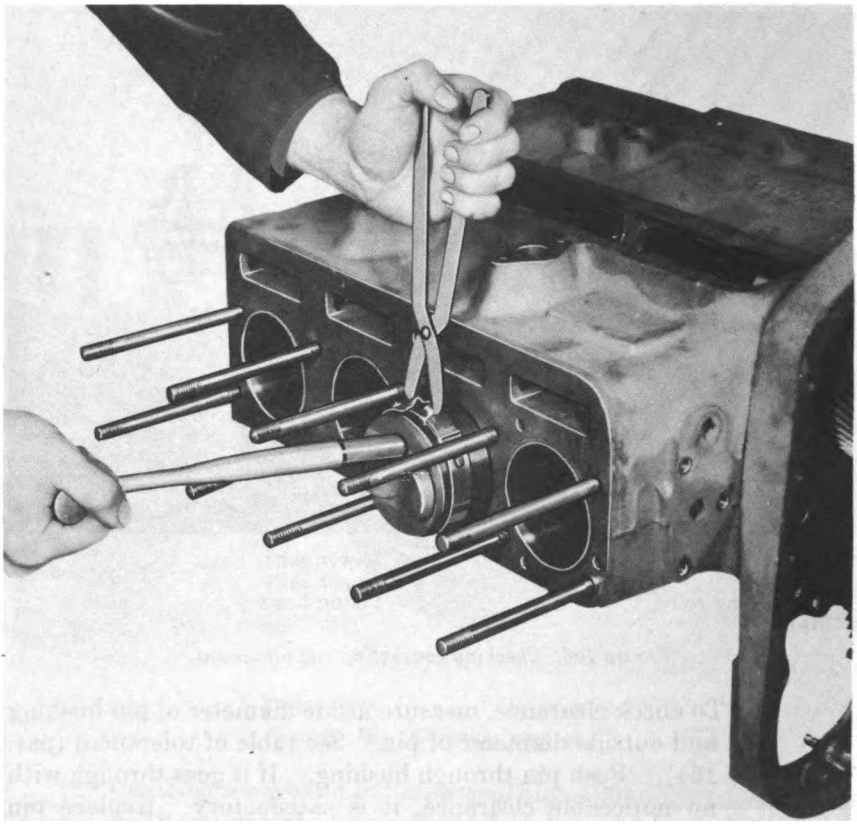


Figure 106. Installing pistons.

3. Replace connecting rod if pin bushing is oversize.

4. Replace pin retainers (2) if they show any signs of wear.

(*b*) Replace piston pin as follows:

1. Let piston stand in boiling hot water for 5 minutes. This expands the hole in the boss so pin can enter.

2. Push pin through piston and connecting rod. It should be a light push-fit.

3. Place pin retainers (2) into their grooves in each side of piston.

(3) *Rings* (fig. 106).

(*a*) Do not assemble new rings to piston until ready to replace piston in cylinder. The upper three rings are the compression rings and the lower two are the ventilated oil rings.

(*b*) Open rings with a spreader and seat them in grooves. Use care as rings break easily. Stagger the ring gaps 180° (halfway around piston). Keep gaps in line with piston pin hole on each side.

(c) When putting pistons into cylinder, protect the rings with a ring compressor. Be sure each piston goes back in the same cylinder from which it was removed. Always have crank at bottom of throw when installing piston. Put the piston in the cylinder with the arrow on the piston top, of the low or shallow side of the lobe, toward fuel injector. Tighten ring compressor just enough so that the piston slides easily into the cylinder.

140. Cylinders

a. Checking for Out-of-Round and Taper.

(1) With an inside micrometer, measure cylinder diameter at upper end of ring travel. Measure first parallel to crankshaft, and then at right angles to shaft.

(2) Repeat (1) above at bottom of cylinder. It is a good idea to write all these measurements on a piece of paper in tabular form, four readings for each cylinder.

b. Reboring or Honing. If cylinders are out-of-round or taper more than 0.009 inch, or if they are scored, the block must be either honed or rebored to a standard oversize. Standard oversizes for which pistons are available are 0.010, 0.020, 0.030, 0.040 inch. If there is a ring travel ridge at the top of the cylinder, remove with a ridge reamer.

Section IX. TIMING GEAR AND CAMSHAFT

141. Gear Case Cover and Front Cylinder Plate

a. Removal.

(1) Unscrew cranking jaw (18, fig. 100) from crankshaft (13). It has a right-hand thread.

(2) Remove the fan pulley by prying off with two screwdrivers as shown in figure 107 or, if necessary, use a puller.

(3) Loosen nut (17, fig. 108) and cap screw (19), permitting the front engine support (16) to slide off the shoulder on the gear case cover (1).

(4) Remove the nuts (11) and lockwashers (5) and remove the inspection cover (9) and gasket (8).

(5) Remove the cap screws (14), lockwashers (13), nuts (20), and lockwashers (21) holding the gear cover (1) to the block and pan.

(6) Carefully remove the cover (1) and gasket (2). The oil seal (24) and felt washer (23) are a light press-fit in the cover.

(7) If the crankshaft is to be removed, remove the camshaft (par. 142) and lift the front cylinder plate (3) and gasket (4) off the studs (10) and (22).

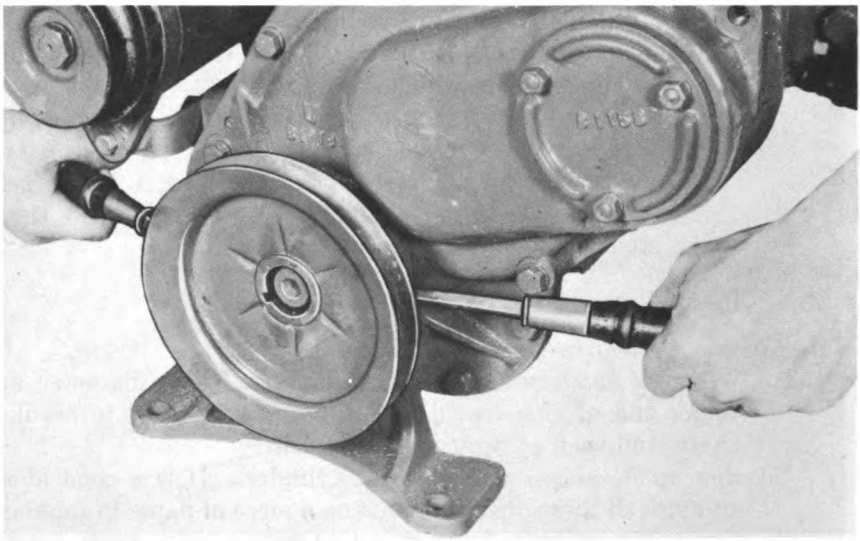


Figure 107. Removing crankshaft pulley.

b. Inspection. Check the timing gear backlash with a dial indicator as shown in figure 109. If the backlash measures more than 0.007 inch, replace the gears.

c. Installation (fig. 108).

(1) If the front cylinder plate (3) has been removed, apply gasket cement to a new gasket (4) and install the cylinder plate.

(2) Apply gasket cement to a new gasket (2) and install cover (1) with felt washer (23) and oil seal (24) in place.

(3) Replace the lockwashers (13), cap screws (14), lockwashers (21), and nuts (20). Tighten equally.

(4) Install the inspection cover (9) and gasket (8), and secure with lockwashers (5) and nuts (11).

(5) Slip the front engine support (16) over the shoulder on gear cover (1). This should be a free fit with not more than 0.004-inch clearance. Tighten cap screw (19) and nut (17).

(6) Replace the fan pulley and cranking jaw.

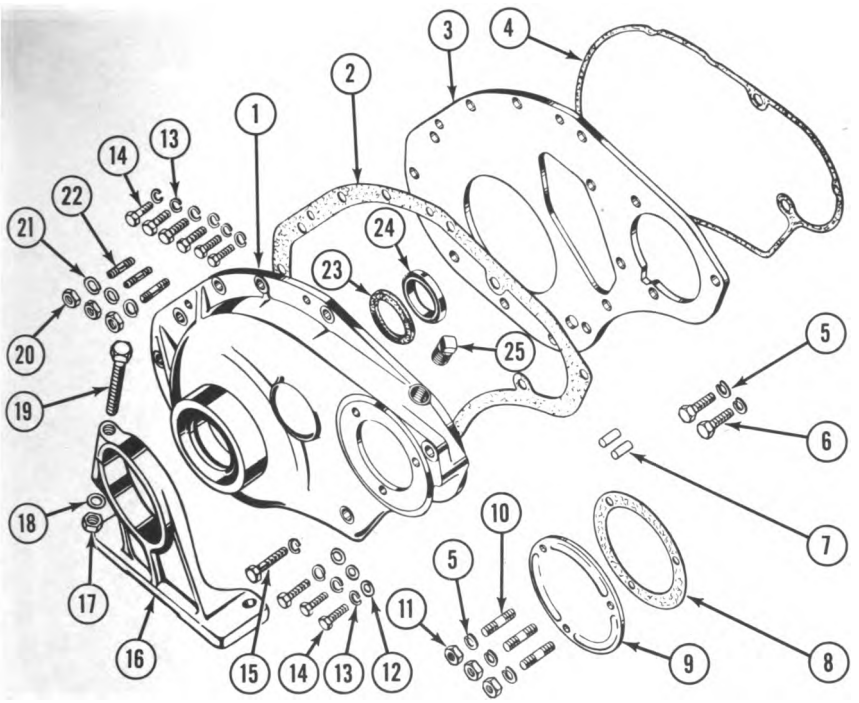
142. Camshaft

a. Removal (fig. 110).

(1) Remove the valve cover, rocker arm assembly, and push rods (par. 76). Keep the push rods in order by placing them in a numbered rack.

(2) Remove the gear case cover (par. 141).

(3) Remove the oil pan and oil pump (par. 127)



1 Gear cover
2 Cover gasket
3 Front cylinder plate
4 Gasket
5 Lockwasher
6 Cap screw
7 Dowel
8 Inspection plate gasket
9 Inspection plate cover
10 Inspection cover stud
11 Stud nut
12 Flat washers
13 Lockwasher
14 Cap screw
15 Cap screw
16 Front engine support
17 Hex nut
18 Washer
19 Cap screw
20 Hex nut
21 Lockwasher
22 Stud
23 Felt washer
24 Oil seal
25 Plug

Figure 108. Exploded view of gear cover and front cylinder plate:

(4) Remove two camshaft thrust plate cap screws which can be reached with a socket wrench through holes in the gear.

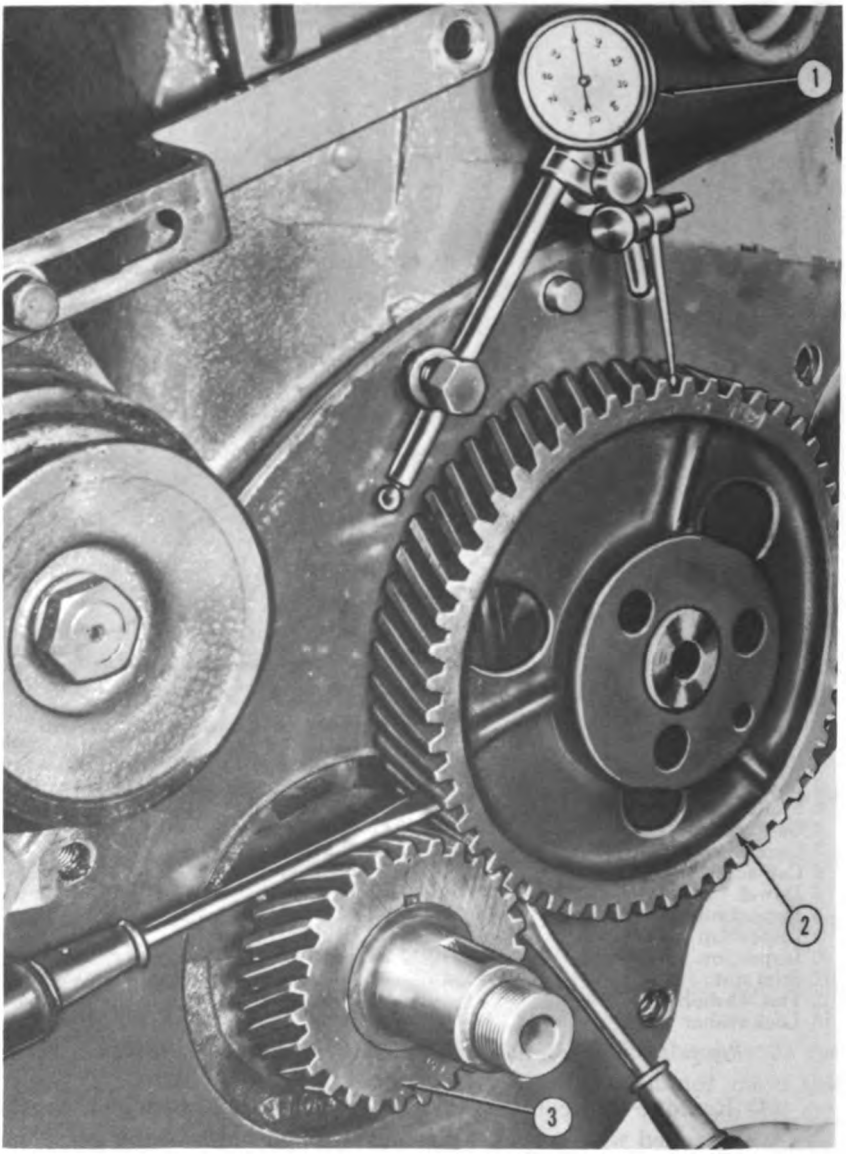
(5) Invert the engine so the tappets will not interfere with the removal of the camshaft.

(6) Carefully pull out the camshaft with its gear and thrust plate.

b. Inspection and Repair.

(1) Check thrust clearance as shown in figure 111. This clearance should be from 0.003 to 0.008 inch.

(2) If clearance is more than 0.014 inch, press gear off shaft and file back end of gear hub as shown in figure 112. Then press gear on shaft to shoulder, being sure the key is in place.



1 Indicator dial 2 Camshaft gear 3 Crankshaft gear

Figure 109. Checking camshaft gear backlash.

c. Reassembly and Installation.

(1) Oil camshaft bushings in crankcase.

(2) Assemble thrust plate and gear to camshaft. If a new gear is to be used, refer to paragraph 143.

(3) Slide the camshaft through the bushings carefully.

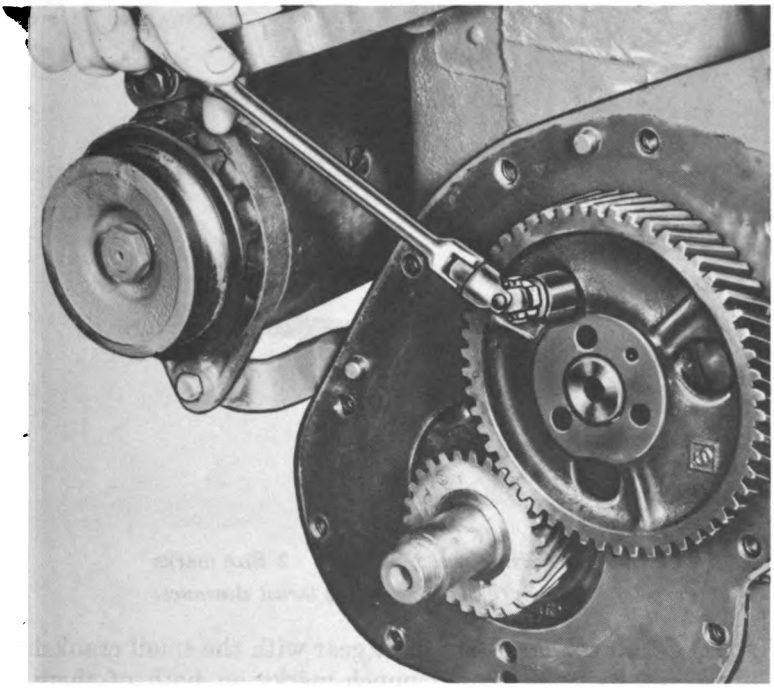


Figure 110. Removing camshaft thrust plate cap screw.

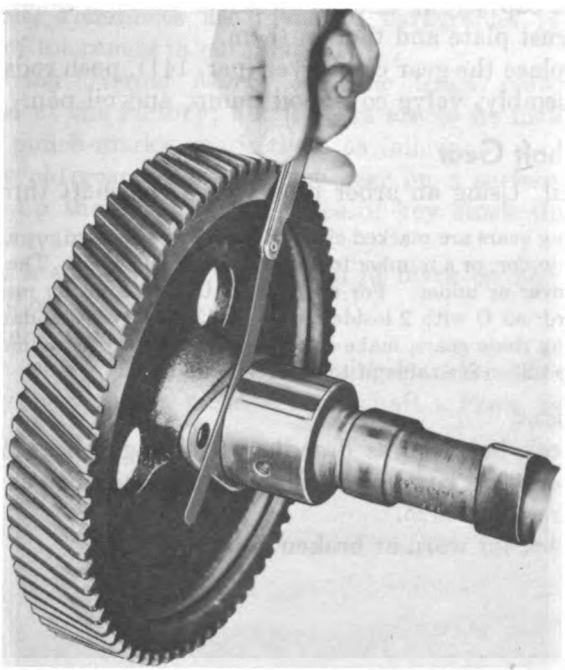


Figure 111. Checking Camshaft thrust clearance.

1 Prick punch marks 2 Size marks

Figure 112. Correcting thrust clearance.

(4) Mesh the large camshaft gear with the small crankshaft gear so that the timing punch-marks on both of them line up (fig. 113).

(5) Put cap screws and lockwashers through holes in gear and thrust plate and tighten them.

(6) Replace the gear case cover (par. 141), push rods, rocker arm assembly, valve cover, oil pump, and oil pan.

143. Camshaft Gear

a. Removal. Using an arbor press, press camshaft through gear.

Note. Timing gears are marked either S, meaning standard; or a number inside a U, meaning under; or a number inside an O, meaning over. The number shows thousandths over or under. For example, a U with 2 inside means 0.002 inch under standard; an O with 2 inside means 0.002 inch over standard (2, fig. 113). When replacing these gears, make selection according to these marks in order to obtain required fit. See table of tolerances (par. 164).

b. Inspection.

(1) Check backlash as described in paragraph 141*b*.

(2) Check and correct camshaft thrust clearance as described in paragraph 142*b*.

(3) Check for worn or broken teeth.

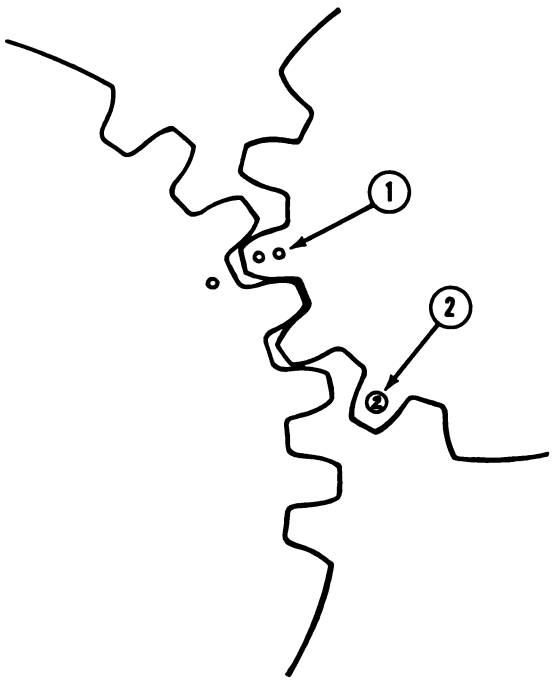


Figure 113. Marks on timing gears.

c. Tolerances. Tolerances are given in paragraphs 141 and 142 and in table of tolerances in paragraph 164.

d. Transferring Timing Marks on New Gears. New gears are punch-marked at the factory; but if gears are to be installed which do not have punch-marks, mark them as follows:

(1) Place old gear on top of new gear on a surface plate.
(2) Line up the gears with a piece of key stock through both keyways.
(3) With a square, lay out position of mark on new gear from mark on old gear.
(4) Center-punch the mark.

e. Installation (fig. 114). Be sure timing punch-mark is on gear and that key and thrust plate are on shaft. Press gear against shoulder of shaft.

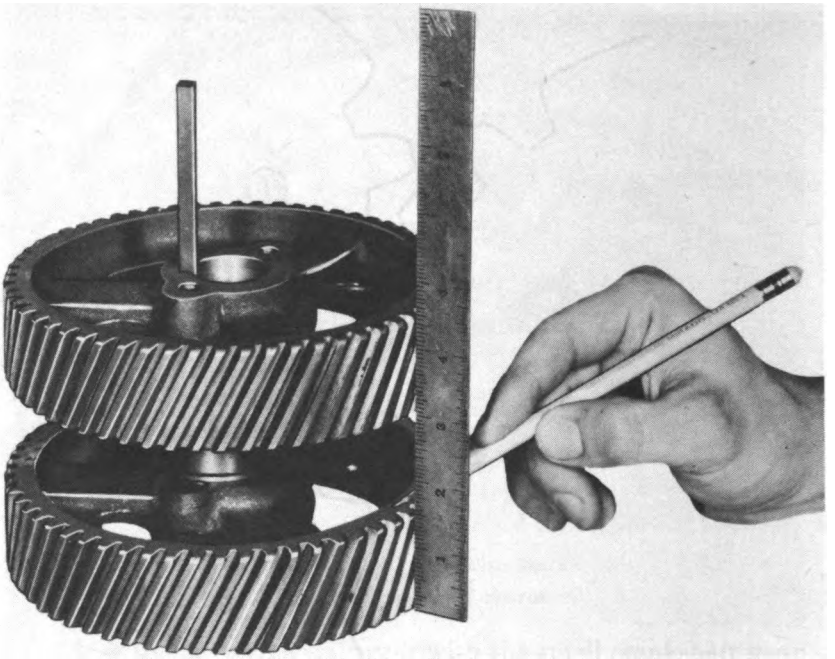


Figure 114. Transferring timing marks on new gears.

144. Camshaft Bushings

(fig. 115)

a. Inspection.

(1) The bushing should not be loose in place.

(2) See if bushings are scored or marred.

(3) Measure camshaft and bushing diameters with feeler stock to determine clearance. See table of tolerances (par. 164).

b. Removal.

(1) Cut through each camshaft bearing (7), (8), and (9) with a hacksaw blade. Be careful not to saw into the crankshaft.

(2) Break the bushing and knock it out with a cold chisel.

(3) An expansion plug (6) is driven into a hole in back end of crankcase opposite the end of camshaft. This plug must be knocked out before the last bushing can be removed.

c. Installation.

(1) Use a bushing guide tool to prevent damage and insure alinement when installing bushing. This tool consists of a short leader plug about 0.001 inch smaller than the bushing, held to the bushing by a cap screw and washer. The leader plug should be at least half the length of the bushing.

(2) Carefully line oilholes in bushings with mating holes in crankcase.

(3) Press bushing into place or, if necessary, drive bushing into place with a driving bar.

(4) Remove bushing guide tool.

(5) After all the bushings have been replaced, install a new expansion plug (6). The plug must be tapped in with a hammer.

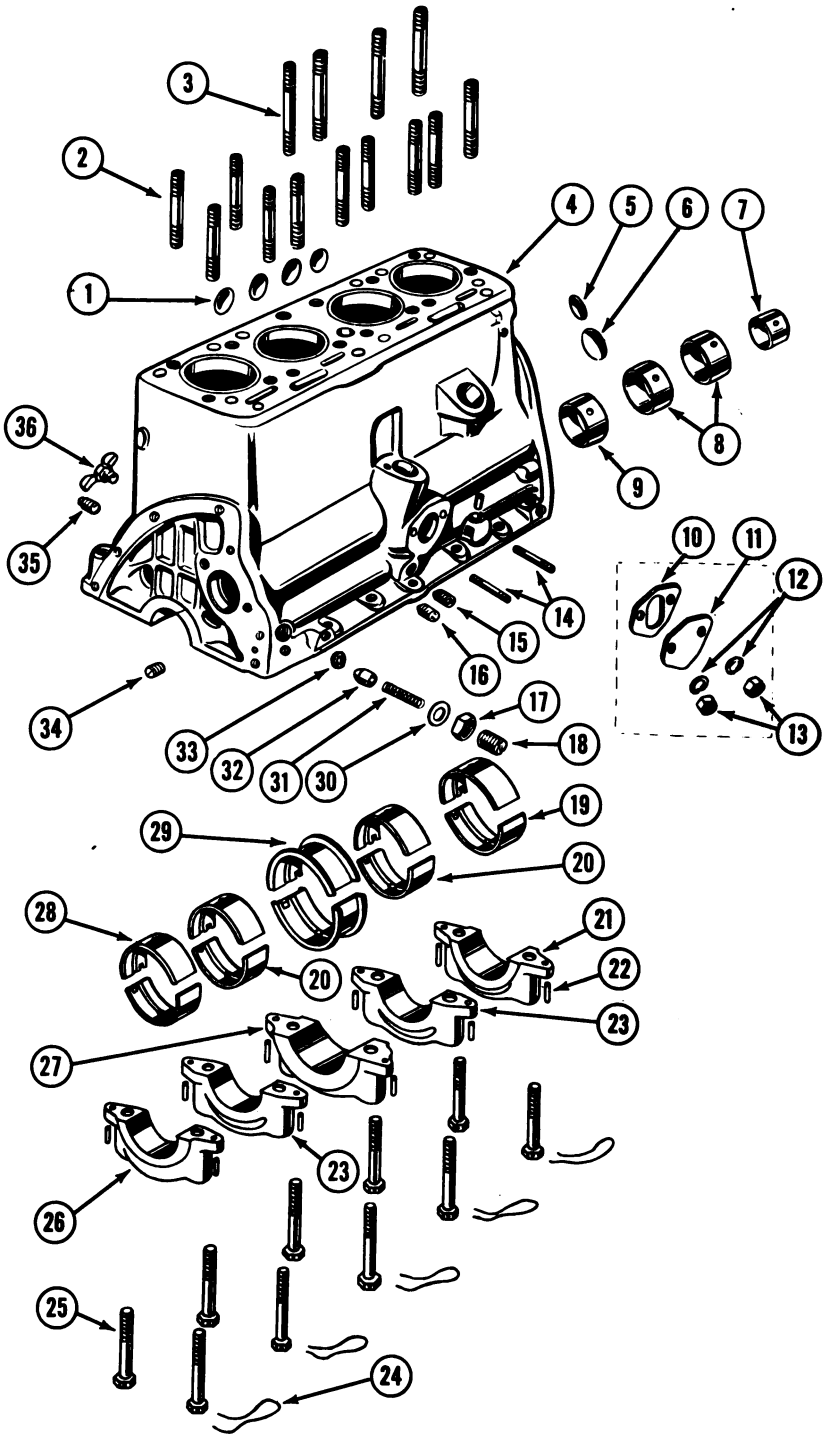


Figure 115. Exploded view of cylinder block and crankcase.

1 Expansion plug
2 Short cylinder head stud
3 Long cylinder head stud
4 Cylinder block
5 Expansion plug
6 Expansion plug
7 Rear camshaft bearing
8 Intermediate camshaft bearing
9 Front camshaft bearing
10 Gasket
11 Fuel pump pad cover
12 Lockwasher
13 Nut
14 Fuel pump stud
15 Pipe plug
16 Pipe plug
17 Oil pressure regulator nut
18 Oil pressure regulator screw
19 Rear main bearing
20 Intermediate main bearing
21 Rear bearing cap
22 Dowel
23 Intermediate bearing cap
24 Lock wire
25 Cap screw
26 Front bearing cap
27 Center bearing cap
28 Front main bearing
29 Center main bearing
30 Gasket
31 Oil pressure regulator spring
32 Oil pressure regulator piston
33 Gasket
34 Pipe plug
35 Pipe plug
36 Water draincock

Figure 115—Continued.

Section X. CRANKSHAFT, MAIN BEARINGS, AND FLYWHEEL

145. Fan Drive Pulley, Cranking Jaw, and Front Support

Removal of fan drive pulley, cranking jaw, and front support is described in paragraph 141.

146. Flywheel

a. Removal of Flywheel (fig. 116). Remove four cap screws (4) holding flywheel (5) to crankshaft flange and pull off of the crankshaft.

b. Removal of Bell Housing (fig. 116).

(1) Remove cap screws (2) holding housing (11) to cylinder block.

Caution: Use hoist to remove housing. This housing is very heavy.

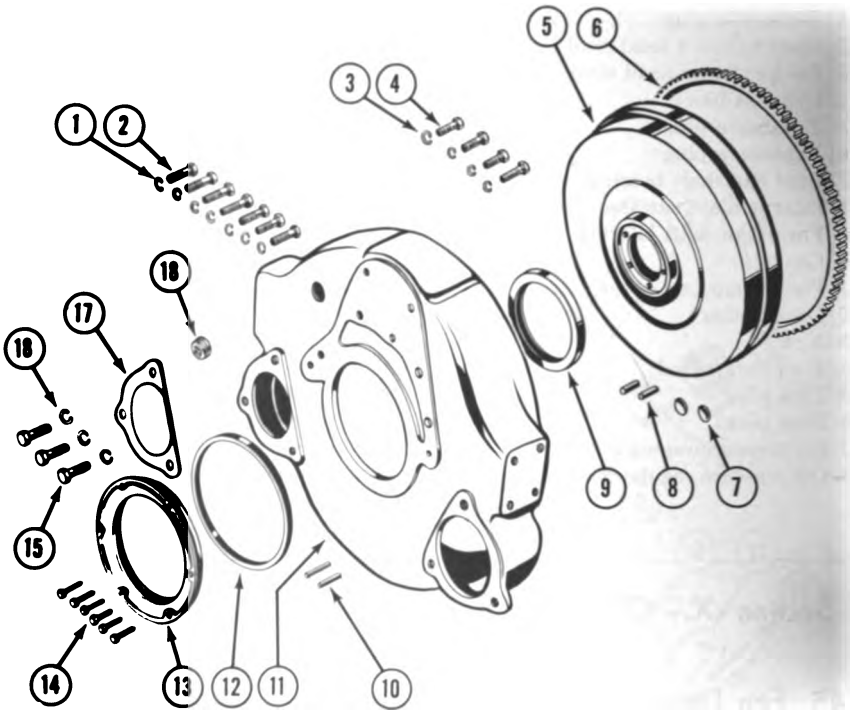
(2) Pull off housing and oil seals (9) and (12).

c. Inspection and Checking.

(1) Examine ring gear (6, fig. 116) for worn or broken teeth. Replace ring gear if it is damaged. Refer to *e* below.

(2) Check flywheel runout (fig. 117). Clamp a dial indicator (1) to the housing with its point on face of flywheel. Rotate flywheel slowly and check runout. The maximum runout should not be more than 0.011 inch.

(3) If flywheel runout is more than 0.011 inch, remove flywheel and check runout of crankshaft flange in the same way. If crankshaft flange runout is more than 0.002 inch, replace or regrind the crankshaft.



1 Lockwasher
2 Cap screw
3 Lockwasher
4 Cap screw
5 Flywheel
6 Ring gear
7 Expansion plug
8 Housing dowel
9 Oil seal
10 Flywheel dowel
11 Housing
12 Oil seal
13 Oil seal retainer
14 Retainer screw
15 Cap screw
16 Lockwasher
17 Cover plate
18 Pipe plug

Figure 116. Exploded view of flywheel and housing.

(4) Check bell housing by attaching dial indicator to flywheel as shown in figure 118. If housing runout is more than 0.010 inch, remove it and look for burs or dirt between housing and crankcase. Check dowel pins. The mating surface between housing and crankcase must be perfectly clean and smooth.

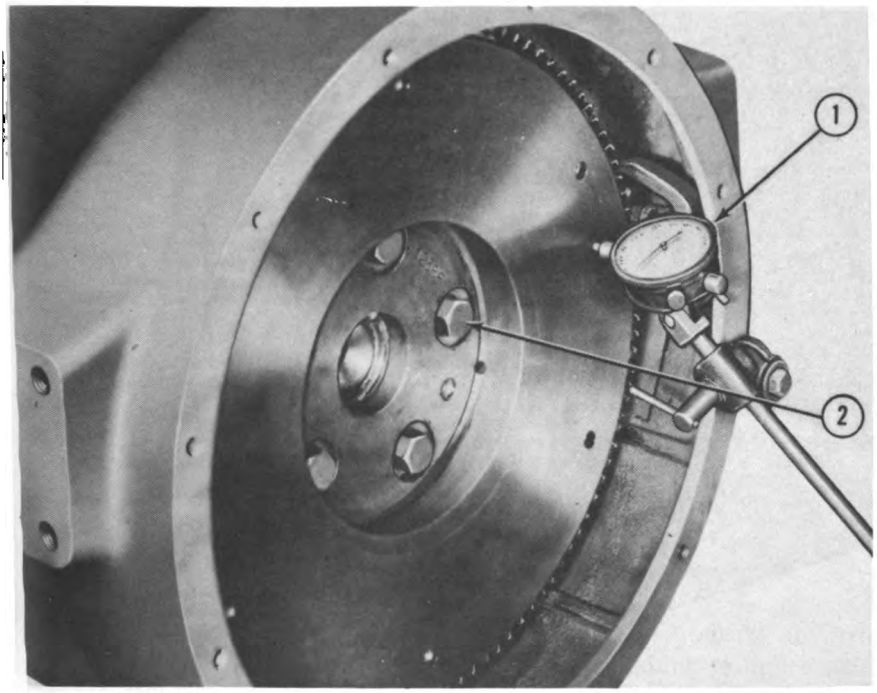
d. Reassembly and Installation (fig. 116).

(1) Check the oil seal (12) that goes in back of crankcase. Replace it if it is not straight and in good condition.

(2) Oil the seal and place it carefully in position.

(3) Lift flywheel housing (11) with a hoist. Line up dowels (10) with their holes and put in the two cap screws next to the pins, one on each side.

(4) Tighten these two cap screws a little at a time to draw the housing up straight. When housing is drawn up against crankcase, put in the other cap screws and tighten.



1 Dial indicator 2 Flywheel cap screws

Figure 117. Checking flywheel runout.

(5) Make sure the mating surfaces of crankshaft flange and flywheel are clean, smooth, and free of burs.

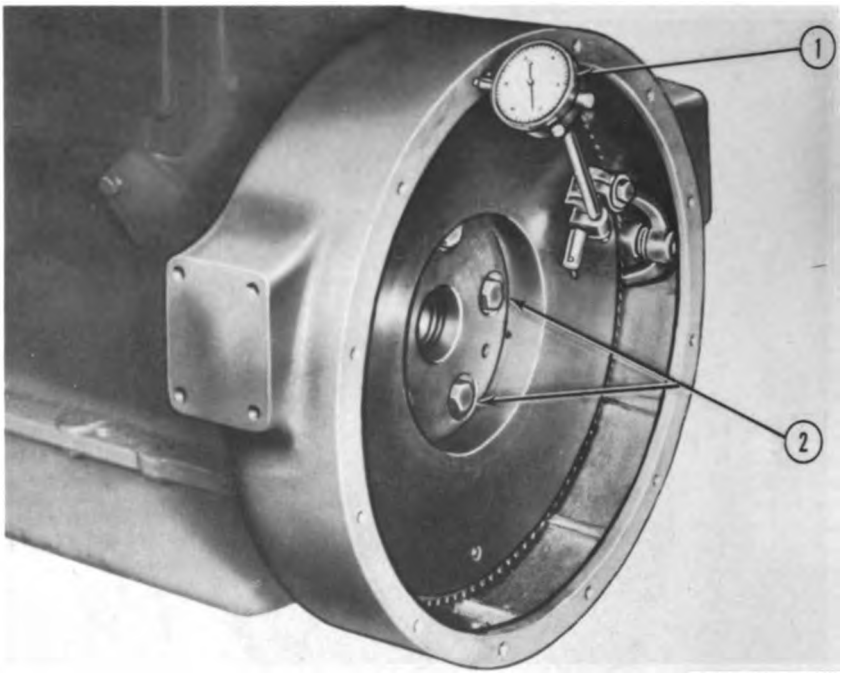
(6) Make sure oil seal seat is smooth and clean and install a new oil seal (9).

(7) The flywheel goes on in only one position because of the offset dowel pins. Take a bar with a sharp point and put it through the flywheel pilot bearing and into the hole in the end of the crankshaft. This allows the flywheel to be turned to where it lines up the dowel pins with the right holes. Put in the four cap screws and tighten alternate screws until wheel is drawn up tightly. Then go over the cap screws with a torque wrench and tighten them to 95 to 105 foot-pounds.

e. Removing and Installing Ring Gear (fig. 116).

(1) The ring gear (6) is shrunk onto the wheel (5). To remove the gear, drill $\frac{3}{16}$-inch holes through the face parallel with the teeth. Cut along these holes with a cold chisel to split the gear in two.

(2) To install a new ring gear, boil it in oil for 15 minutes or heat it evenly all around with a ring burner or several torches used at once. Lay flywheel flat with crankshaft side up.



1 Dial indicator 2 Flywheel cap screws

Figure 118. Checking bell housing runout.

Using tongs, lift the gear with bevel end of teeth up. Place the gear on the flywheel, making sure it is seated against the shoulder. Let heated gear cool.

147. Crankshaft

a. Description. The crankshaft is a balanced special open-hearth steel forging with five main bearings. Bearing journals are hardened by high-frequency heating.

b. Removal (fig. 115).

(1) The engine must be stripped down to a point where cylinder front plate (par. 141) and flywheel housing (par. 146) are removed. Camshaft, pistons, and connecting rods will be out. Place the engine upside down.

(2) Remove and discard lock wires (24) on main bearing cap screws (25).

(3) Remove cap screws (25) and bearing caps (21), (23), (26), and (27). Caps are numbered and have dowel pins so that they can always be replaced just as they were originally.

(4) Remove the lower main bearing shells. Lift crankshaft out of bearings carefully as shown in figure 119.

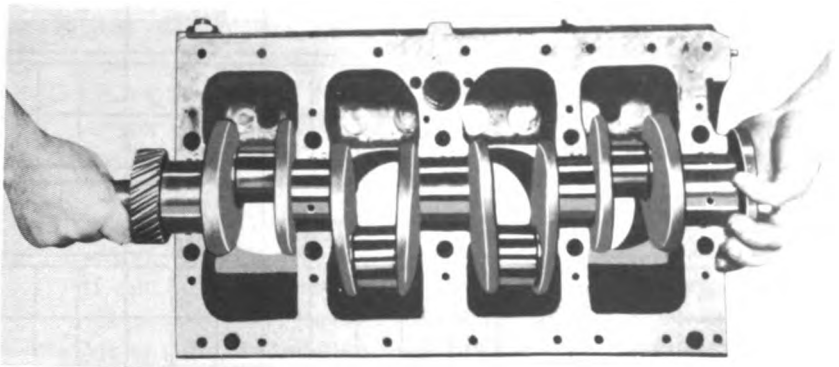


Figure 119. Removing crankshaft.

(5) Lift out upper bearing shells. If bearing shells are to be reused, they should now be assembled with their own bearing caps, wrapped in oiled paper, and put in a safe place.

c. Checking Crankshaft Wear.

(1) Measure each main and connecting rod journal in two directions. Record readings on chart similar to figure 120.

(2) Before writing down any measurements, take micrometer readings all around each journal to find the smallest diameter.

(3) Take three readings on each journal at the middle and at each end. This will give the taper. Then repeat at right angles to the first three.

(4) Main journal diameter should be 2.498/2.497 inches. Connecting rod journal should be 1.9985/1.9975 inches. If the wear or the out-of-round is more than 0.002 inch, the crankshaft should be reground to a standard undersize of 0.020 or 0.040 inch or replaced with a new shaft.

(5) Remove any nicks or burs on flanges. Clean the oilholes in the shaft and blow dry with compressed air.

d. Checking Crankshaft Alinement.

(1) Place crankshaft with front and rear main journals on knife-edge rollers.

(2) Set a dial indicator to center journal. Rotate crankshaft slowly and check to see that runout is not more than 0.002 inch.

e. Checking Crankshaft Gear.

(1) Examine crankshaft gear for worn and broken teeth. If teeth are badly worn, replace with a new gear having the same size mark as the old gear.

(2) If new gear does not have a timing mark, transfer this mark to new gear. Refer to paragraph 143.

	MAIN BEARING NO. 1			MAIN BEARING NO. 2			MAIN BEARING NO. 3			MAIN BEARING NO. 4			MAIN BEARING NO. 5		
HORIZONTAL															
VERTICAL															
	CONNECTING ROD BEARING NO. 1			CONNECTING ROD BEARING NO. 2			CONNECTING ROD BEARING NO. 3			CONNECTING ROD BEARING NO. 4					
HORIZONTAL															
VERTICAL															

Figure 120. Chart for recording crankshaft measurements.

(3) Press old gear off crankshaft with an arbor press.
(4) Boil new gear in oil for 15 minutes to expand it as much as possible. Lift gear with tongs and slip it on crankshaft with key in place.

f. Reassembly and Installation (fig. 115).
(1) Place the five upper bearing shells (19), (20), (28), (29) in their seats.
(2) Lubricate the shells with OE when reassembling.
(3) Lay crankshaft carefully in bearings.
(4) Replace bearing caps (21), (23), (26), and (27) with lower bearing shells (19), (20), (28), and (29). Be sure the caps go in their numbered places.
(5) Tighten bearing nuts to 125 to 135 foot-pounds with a torque wrench.
(6) Install new lock wires (24).

148. Main Bearings

a. Description. The main bearings are of the steel-backed precision type, and no scraping or fitting is required. Standard size is 2½ inches. Standard undersizes of 0.020 and 0.040 inch are available.

b. Inspection.
(1) Remove bearings as directed in paragraph 147*b*.
(2) Look for holes and cracks in bearing surfaces.
(3) Assemble bearing caps, tighten the cap screws, and measure bearing diameter with a micrometer. If it is worn not more than 0.002 inch and the crankshaft journal shows practically no wear, replace with standard size bearings. If crankshaft journals have been reground to a standard undersize, use undersize bearings. Correct main bearing clearance is from 0.0023 to 0.0045 inch. The crankshaft should turn freely by hand. To check clearance, place feeler stock under bear-

ing and turn crankshaft by hand. A drag should be noticeable within the clearance limits specified. See table of tolerances in paragraph 164 for wear limits.

(4) Check crankshaft end play with a feeler gage between the center main bearing and the crankshaft cheek. The center main bearing is the thrust bearing. This clearance should be between 0.002 and 0.006 inch. If it is more than 0.011 inch, replace the center main bearing.

c. Installing New Bearings (fig. 121).

(1) If one bearing needs to be replaced, it is recommended that all of them be replaced at the same time.

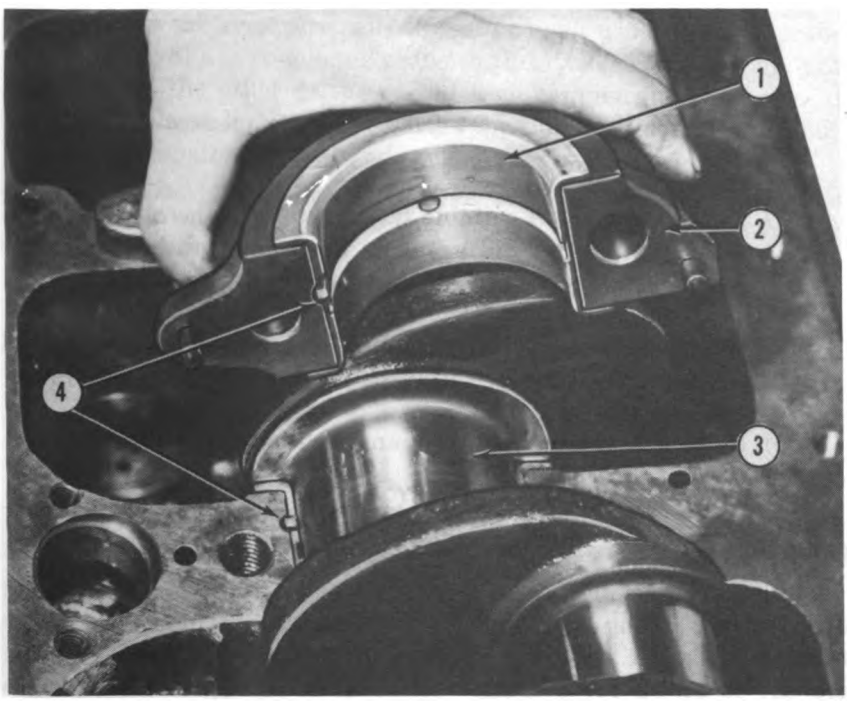
(2) Make sure the caps go back on the corresponding bearings by number.

(3) Make sure the locating ears are together.

(4) Install crankshaft and tighten bearing caps as described in paragraph 147*f*.

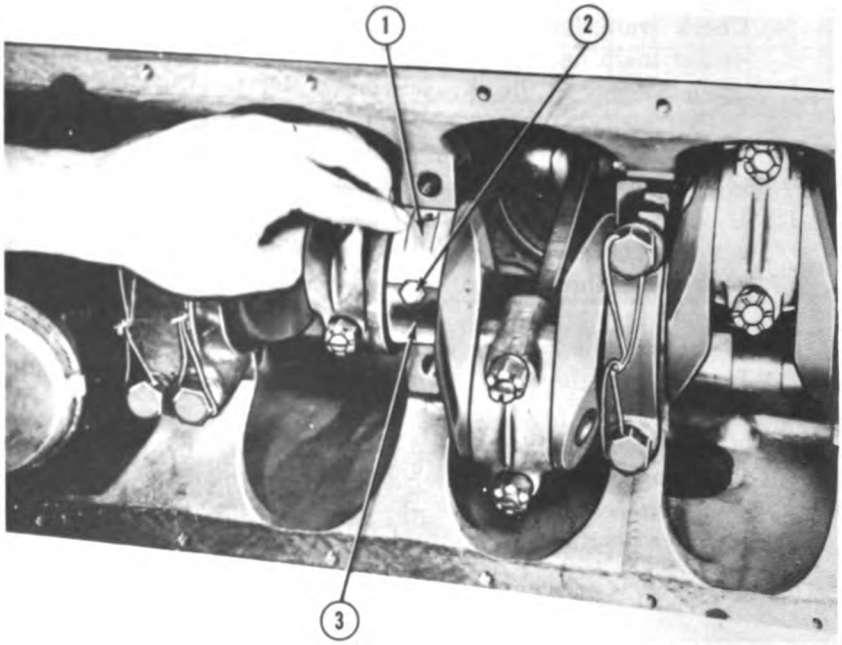
d. Field Replacement (fig. 122). Main bearings can be replaced without removing connecting rods. Replace bearings one at a time, leaving the others assembled.

(1) Remove bearings, caps, and lower shells.



1 Main bearing shell
2 Bearing cap
3 Main journal
4 Locating ear

Figure 121. Locating ear on main bearing.



1 Bearing shell 2 Bolt 3 Main journal

Figure 122. Installing main bearings.

(2) Take a bolt (2) of suitable size to slip into the oilhole in the main journal (3) and grind its head down to less than the shell thickness. Put bolt in oilhole and turn crankshaft to push out upper shell (1).

(3) Use the same bolt to push in new upper shell. When nearly in place, use a bolt with full-size head to push the shell flush with its seat.

(4) Replace lower shell and cap and tighten cap screws.

Section XI. GENERATOR SUBASSEMBLY

149. General

The generator subassembly consists of the alternator and exciter with voltage changeover switch box attached. This subassembly stands on its feet with the engine end of the shaft blocked up to prevent strain on the bearing. Removal of the generator from the engine is covered in paragraphs 108 and 109.

150. Exciter

a. Removal (fig. 123).

(1) Remove exciter inspection cover (5).

(2) Lift all four exciter brushes clear of commutator.

(3) Remove exciter fan cover (8).

(4) Remove bolt (9) and washer from end of exciter shaft.

(5) Take any 3/4–10 bolt 3½ inches or more long and screw into the tapped hole in the end of the exciter shaft until it butts against the end of the generator shaft. Then turn bolt with a wrench to loosen armature from shaft.

(6) Pull exciter armature (7) out by hand.

(7) Unfasten all wires to exciter brush rigging.

(8) Remove four magnet frame bolts (12).

(9) Tap frame (6) with a soft mallet and remove it from collector end shield (4).

(10) Pull out the two shielded wires to the stator through the changeover switch box. The stator is now free.

b. Testing.

(1) Inspect the exciter armature (33, fig. 124) for worn or rough commutator (32), worn or broken coils (3), worn insulation, and loose soldered connections.

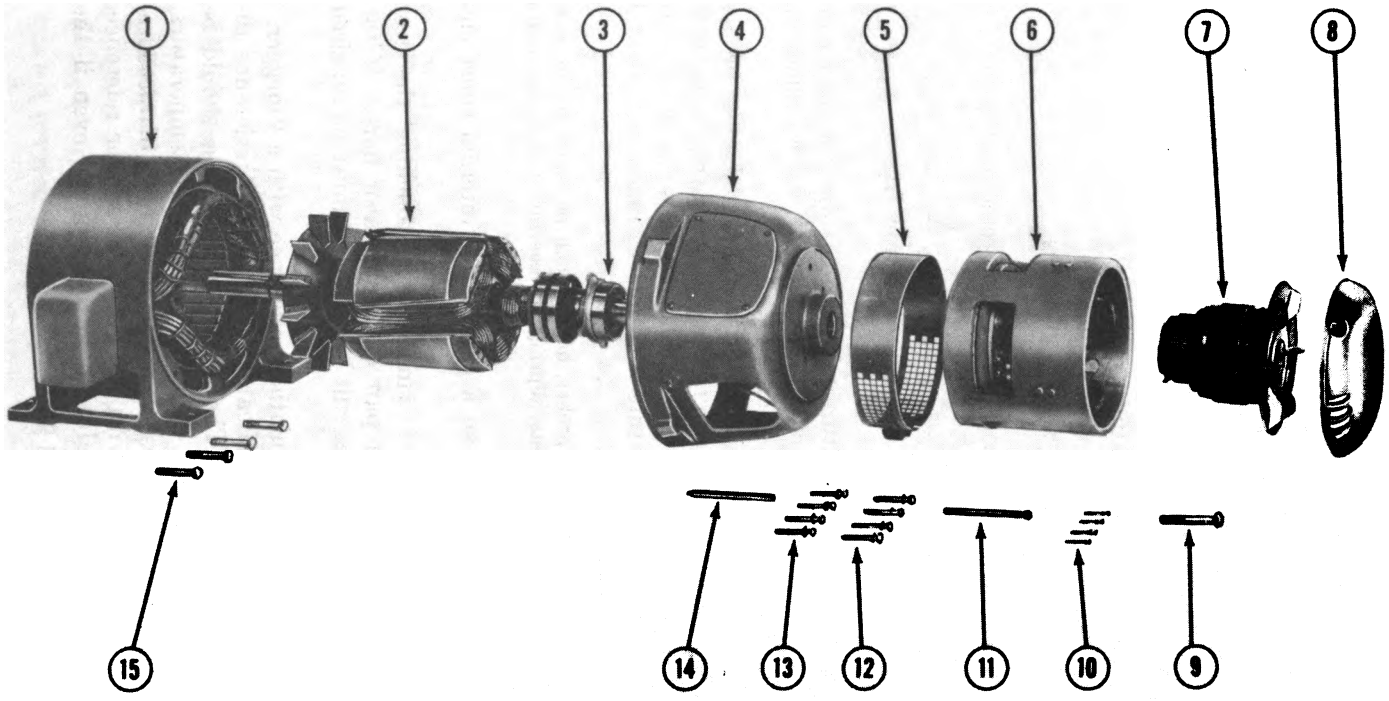
(2) Test the armature coils (3) for ground, using the test probes (fig. 82). Touch one probe to the exciter shaft (35, fig. 124) and the other to the end of each commutator segment. If the lamp lights, the armature winding is grounded and should be repaired or replaced.

Note. When using test probes, never touch polished contact surfaces of commutator segments, sliprings, or bearing surfaces as an arc will mar the surface.

(3) Test the armature (33) on a growler for internal short circuits (par. 124*c*(3)).

(4) Check for open-circuited windings by touching the test probes to each adjacent pair of commutator bars. If the lamp fails to light, the circuit is open and must be repaired or replaced.

(5) If available, test the insulation resistance with a "megger." This instrument will indicate the insulation resistance directly on a dial scale. The insulation resistance should be at least 0.25 megohm and will vary with temperature, humidity, and cleanliness of parts. A record of measurements should be kept with the generator set for reference. A drop in resistance values indicates trouble, even if the measured value is above minimum.



1 Stator assembly
2 Shaft and rotor assembly
3 Bearing and retainer assembly
4 Collector end shield
5 Exciter inspection cover
6 Magnet frame
7 Exciter armature
8 Exciter fan cover
9 Armature holdon bolt
10 Fan cover screw
11 Relief plug
12 Magnet frame bolt
13 End shield bolt
14 Brush holder stud
15 Stator holddown bolt

Figure 123. Exploded view of generator subassembly.

(*a*) To test, measure from any one commutator segment to ground. The armature windings of the d-c exciter are closed. Lift brushes if machine has not been disassembled.

(*b*) Disconnect the leads to the field coils (4) and check from either field lead to ground. Resistance should be at least 0.25 megohm.

c. Disassembly (fig. 124).

(1) Remove all pole screws (5) and withdraw the pole pieces with the coils from magnet frame (6).

(2) Press poles out of the field coils (4). For reference when reassembling, make a diagram of the coil terminal markings and connections before disconnecting the coils.

(3) Remove two bolts holding brush holder yoke (9) and remove yoke. Do this only if the brush holders or yoke need replacing. Otherwise, do not disturb the yoke position. Before removing the yoke, make chisel marks on yoke and frame to show the yoke position, if no such marks can be seen.

d. Inspection and Repairs.

(1) Check for broken or damaged brush holders (5, fig. 125), yoke (6), or springs (3). See that the insulation on the cross connector leads (2) and brush leads (4) is not frayed and that screws (9) are tight. Lead ties (1) are painted with red glyptol cement.

(2) Check commutator (32, fig. 124) for burns, pits, or high mica.

(3) Clean all parts with dry-cleaning solvent. Do not use carbon tetrachloride or alcohol near the commutator.

e. Undercutting Commutator (fig. 81). Undercut mica to depth equal to thickness of mica. Use a regular undercutting saw if possible. In an emergency, grind a hacksaw blade to proper thickness for this purpose. Follow the directions in paragraph 124*c*(3).

f. Rewinding.

(1) The exciter field pole windings may be replaced as units. When connecting the four coils, follow the connection diagram (fig. 126).

(2) The exciter armature is machine-wound and should be replaced as a unit if the winding is defective. In an emergency, if no replacement is available, a skilled workman can remove the old winding and rewind the armature. Wire size and winding pitches are given in paragraph 4. Figure 127 illustrates schematically the coil pitch of 1 to 8 slots, connection pitch of 1 to 44 bars, and alinement of slot No. 1 with segment No. 12. Rewinding is not recommended as the result may be unsatisfactory. After rewinding, the armature must be thoroughly dried, then given several coats

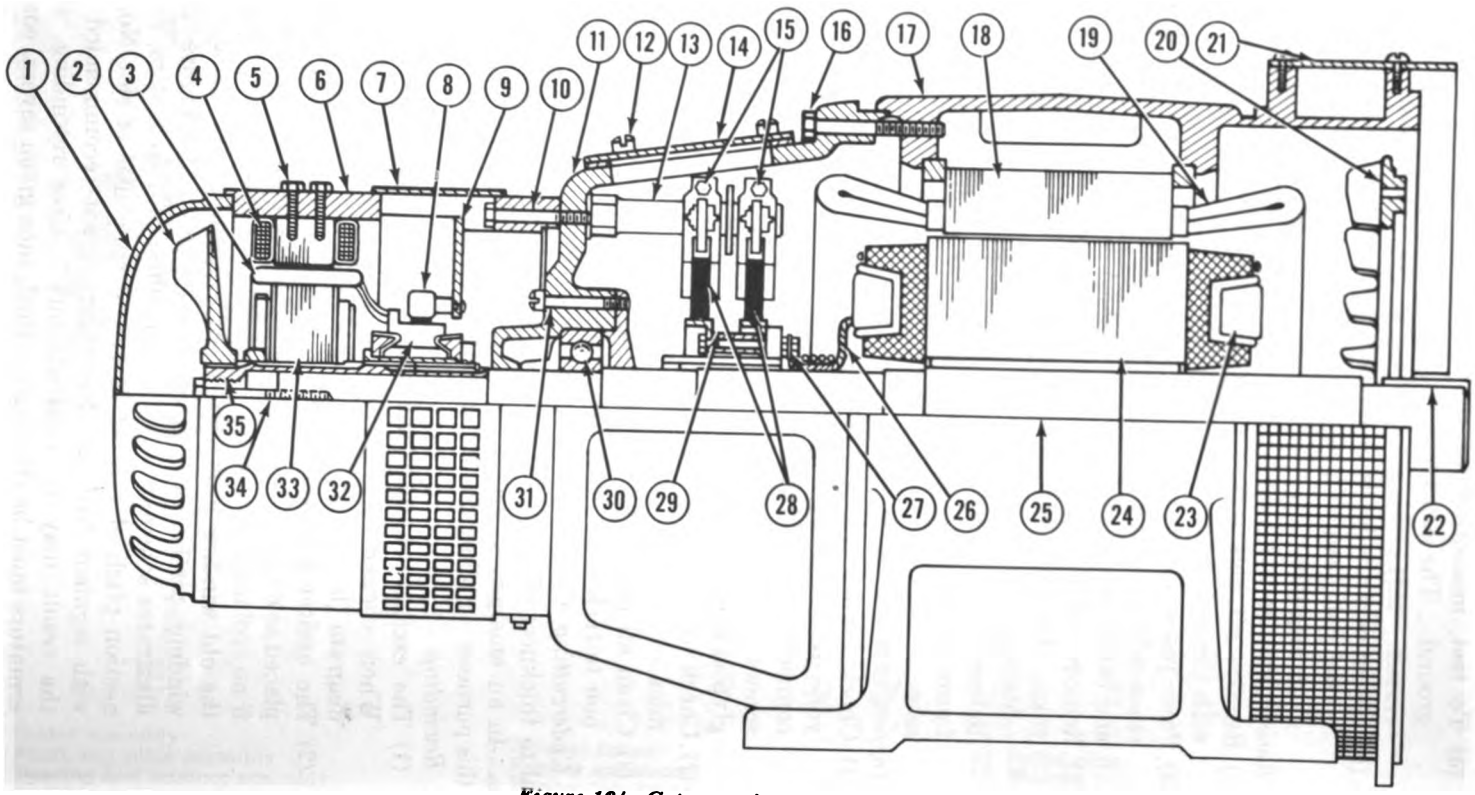
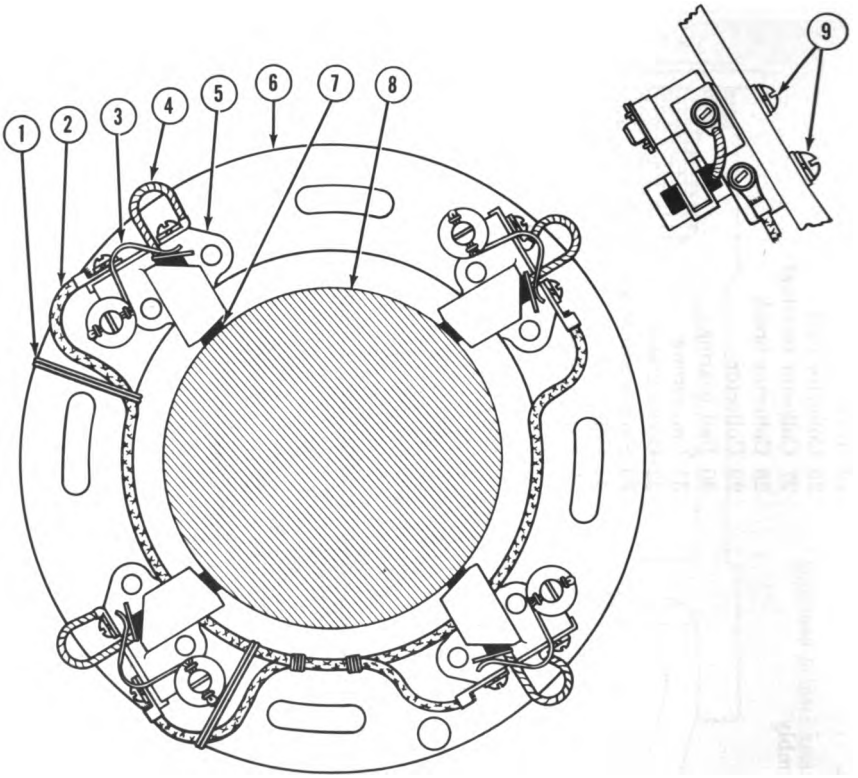


Figure 124. Cutaway view of generator.

1 Exciter fan cover
2 Exciter fan
3 Armature coils
4 Field coils
5 Pole screws
6 Magnet frame
7 Exciter inspection cover
8 Brush holder assemblies
9 Brush holder yoke
10 Bolt
11 Collector end shield
12 Cover screws
13 Brush holder stud
14 Cover
15 Brush holder assembly
16 Bolt
17 Stator assembly
18 Stator
19 Stator winding
20 Fan
21 Coupling inspection cover
22 Key
23 Rotor winding
24 Rotor assembly
25 Alternator shaft
26 Collector lead
27 Collector terminal
28 Collector brush
29 Collector
30 Ball bearing
31 Cap screws
32 Commutator
33 Exciter armature
34 Bolt
35 Exciter shaft



1 Lead tie
2 Cross connector lead
3 Brush spring
4 Brush lead
5 Brush holder
6 Brush holder yoke
7 Brush
8 Commutator
9 Screws

Figure 125. Exciter brush rigging.

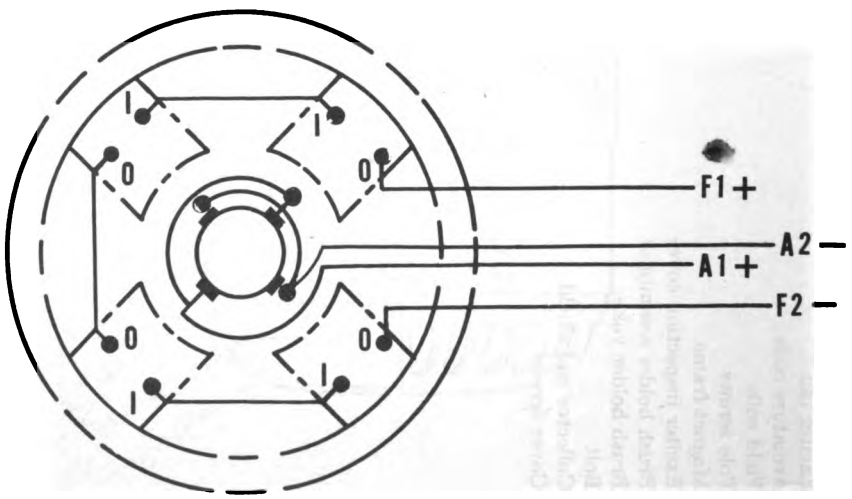


Figure 126. Exciter field winding connections.

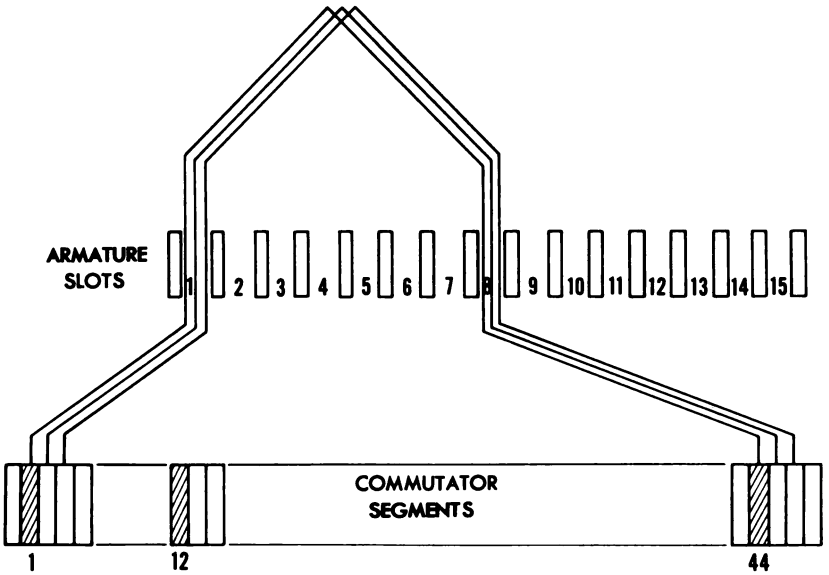


Figure 127. Exciter armature winding diagram.

of phenolic insulating varnish, and baked. This varnish treatment will not be satisfactory unless proper dipping and baking equipment is used.

g. Reassembly and Installation (fig. 124).

(1) Replace brush holder yoke (9) if it has been removed. Set it to the marks on the frame and yoke.

(2) Replace field coils (4) and secure with pole screws (5).

(3) Replace magnet frame (6) on alternator end shield and secure with bolts (10).

(4) Reconnect wires to brush rigging.

(5) Slide armature (33) into magnet frame (6) and onto shaft. Insert bolt (34) and washer. Start bolt into tapped hole in alternator shaft (25) and draw up tight.

(6) Seat exciter brushes on commutator.

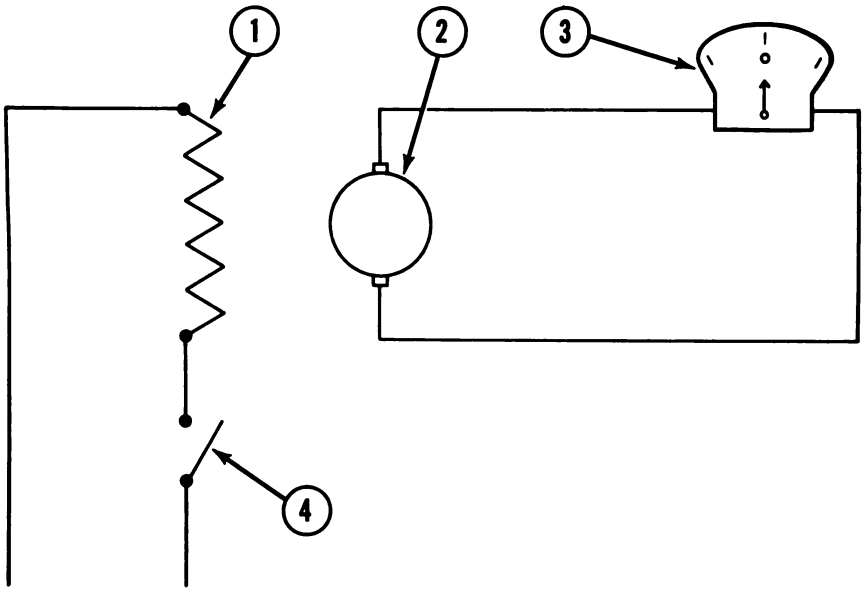
h. Setting Brushes on Neutral.

(1) If the armature has been rewound or the brush yoke has been moved, the neutral setting should be checked.

(2) If the exciter commutator sparks when commutator and brushes are in good condition, a check of neutral setting should be made.

(3) There are several methods of setting on neutral. The induced voltage, or "kick" method, is described here as being the most convenient and reliable method.

(4) Connect as shown in figure 128. Disconnect exciter field leads and alternator brush leads from exciter brushes. Connect a low-reading, zero-center voltmeter to the exciter



1 Field winding
2 Armature
3 Voltmeter
4 Switch

Figure 128. Circuit for setting brushes on neutral.

brushes. Connect a 6- or 12-volt d-c source through a switch to the exciter field leads. Close the switch for a few seconds. Open the switch and note accurately the deflection or "kick" of the voltmeter needle. Loosen the brush yoke bolts and turn the yoke one commutator bar and repeat the test. Repeat above procedure, moving yoke in direction to give least "kick". The brushes are on "no-load neutral" when the voltmeter "kick" is at the smallest value. Always have the yoke bolts tight as tightening them shifts the brushes slightly. The above setting will insure best performance at no-load. To get best position for operation under load, turn yoke slightly in direction of rotation. Disconnect test leads and reconnect exciter field leads and alternator brush leads to exciter brushes. Operate exciter generator under rated conditions. If brushes do not spark, brushes are in proper commutating plane.

151. Alternator

a. Testing.

(1) Check the rotor assembly (24, fig. 124) for worn or rough sliprings, worn insulation, or broken soldered connections.

(2) Test the rotor winding (23, fig. 124) for grounds, using the test probes (fig. 82). Touch one probe to the collector (29, fig. 124) and the other to the shaft (25). See note

(par. 150*b*(2)). If the lamp lights, either the collector or rotor winding is grounded.

(3) Check the rotor winding for open circuits by touching one probe to each of the collector terminals (27). If the lamp fails to light, the rotor requires overhaul or replacement.

(4) Repair any exposed winding by reinsulating with tape and varnish. Repair or replace frayed or worn leads.

(5) In the stator assembly (17), check the winding (19) for ground by using test probes. Place one probe to the outlet lead of each coil and the other to ground on the housing. If the lamp lights, the stator must be rewound.

(6) Check the stator coils for open circuits by placing the test probes in series with each winding. If the lamp fails to light, the coil circuit is open and the stator must be rewound.

(7) If available, use a "megger" to check the insulation resistance (par. 150*b*). Take measurements from the collector (29) to ground and from stator coil leads to ground. Minimum insulation resistance should be 0.25 megohm with a dry machine. If less, repair or rewind.

b. Dissassembly (fig. 124).

(1) Remove brush holders (15) from stud (13).

(2) Remove four cap screws (31) holding bearing (30) and retainer to the collector end shield.

(3) Remove four bolts (16) holding the collector end shield (11) to stator assembly (17).

(4) Slide assembly of shaft (25), rotor (24), collector (29), and bearing (30) out of stator assembly (17).

c. Inspection and Repair.

(1) Check for broken or damaged brush holders (3, fig. 129) and brush springs (1). See that the insulation on the brush leads (4) and the leads to the alternator are not frayed.

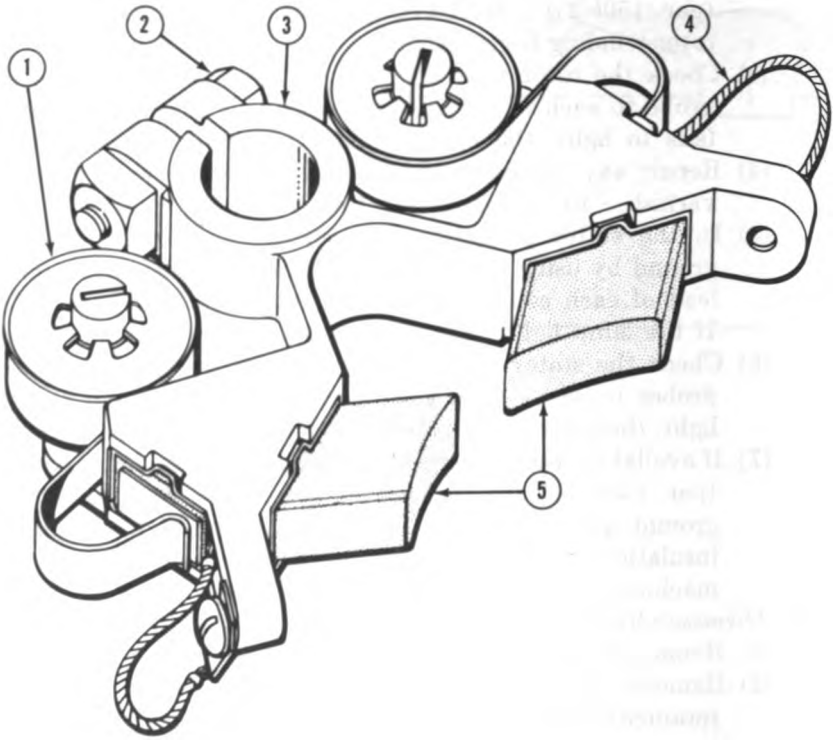
(2) Rotate the bearing (30, fig. 124) by hand. If it is noisy or if there is any evidence of metal chips in the bearing races, replace the bearing. To remove the bearing, use a bearing puller and apply pressure on the inner race.

(3) Check collector (29) for burns or pits. Polish with cloth or No. 00 sandpaper if necessary. Use a puller, applying pressure near the shaft, to remove.

(4) See that the collector terminals (27) are tight and that the leads (26) are securely tied down.

d. Rewinding Stator (fig. 130).

(1) Coils in the alternator stator are not replaceable. Complete rewinding data are given in paragraph 4. Figure 130 is a stator winding diagram showing coil group connections and terminal wires of the three phases. The terminal wires are led to the voltage changeover box where voltage is selected.



1 Brush spring
2 Adjusting screw
3 Brush holder
4 Brush lead
5 Brushes

Figure 129. Alternator brush rigging.

(2) Each coil group is made up of three coils with seven turns per coil. It is possible for an experienced winder to cut out a bad coil group and jump its coil connections. This is not recommended and should only be done in an emergency. The result will be lower voltage in that phase and overheating of the alternator.

(3) After rewinding stator, preheat for 2 hours at 125° F., dip in phenolic insulating varnish, and bake for 3 hours at 280° F. Allow stator to cool and repeat. For third bake, allow 8 hours, then spray the unit with red glyptol and bake 2 hours at 280° F. Spray with fungicide.

e. Rewinding Rotor. The alternator rotor is wound by hand. Number of turns and correct wire size are given in paragraph 4. Use the same size wire and the same number of turns as were on the rotor originally, and always wind around the pole in the same direction. After rewinding, apply phenolic varnish and bake as directed for the exciter armature.

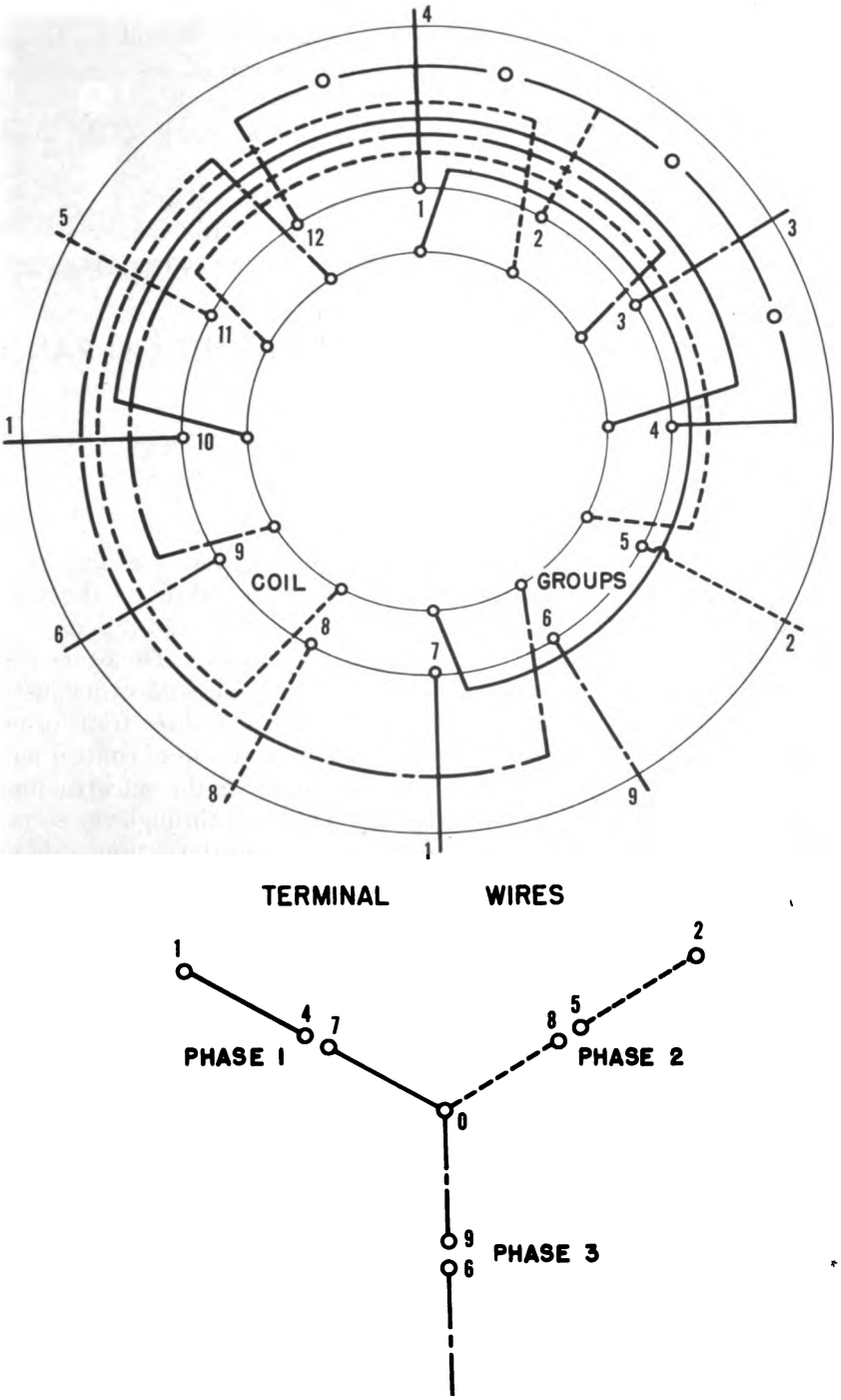


Figure 130. Stator winding diagram.

f. Reassembly and Installation (fig. 124).

(1) Press bearing (30) on shaft (25) against the shoulder. Grease bearing moderately. Too much grease causes the bearing to overheat.

(2) Slide rotor assembly through stator assembly (17). Block up both ends.

(3) Install brush holder assemblies (15) on stud (13).

(4) Install end shield and secure with bolts (16).

(5) Secure bearing (30) and retainer with cap screws (31).

(6) Reassemble exciter (par. 150*g*).

Section XII. CONTROLS AND INSTRUMENTS ON PANEL

152. Control Panel

Remove control panel. Follow instructions in paragraph 85*c*.

153. Current Transformers

(fig. 131)

a. Current transformers (1) on this equipment are doughnut-type transformers. The main wires (7) are threaded through the transformers twice to form the primary. One secondary lead (2) from each transformer is grounded to a stud (4) on the panel. The other three secondary leads (3) go through a plastic envelope with other instrument wires to the hinged front of the panel. The three transformers are held between two micarta plates (8) bolted to top of control panel cabinet. To remove, unscrew two nuts holding the micarta plate, unfasten the main (primary) wires, and pull them through the secondary windings. Disconnect the secondary leads at the ground stud and at the instrument panel.

b. The current transformers (1) are rated 80/5 amperes with a two-turn primary. To check the transformer ratio, proceed as follows:

(1) Connect ammeter (0 to 100 amp) in the load line L1, L2, or L3 on the low-voltage block (6).

(2) Connect ammeter (0 to 10 amp) in the corresponding secondary lead (3) C1, C2, or C3.

(3) Vary the load on the generator and record ammeter readings simultaneously for several load values.

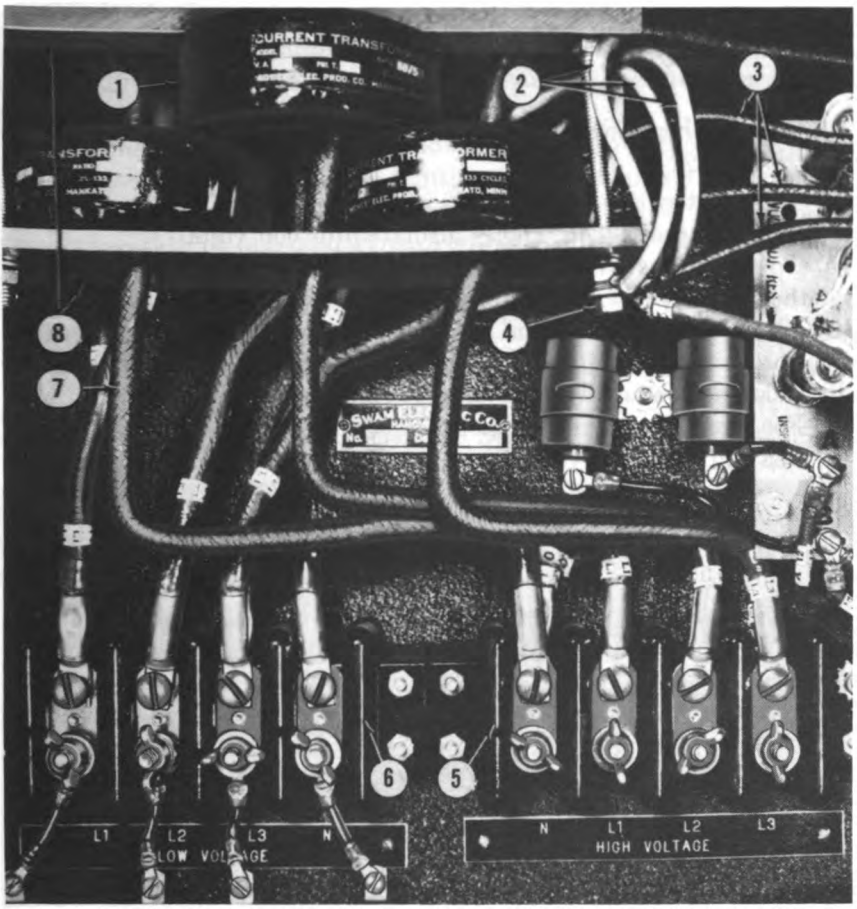
(4) The ratio of the readings of the load ammeter to the secondary lead ammeter should be about 80/5 or 16/1.

(5) If the transformer is defective, it should be replaced.

Caution: When inspecting, adjusting, or installing new parts in the switchboard, shut down the generator. If necessary to run generator while testing, wear rubber gloves and use a rubber floor mat.

c. When replacing current transformers, follow figure 54 carefully.

(1) Pass the main wires (7, fig. 131) through the current transformer (1) and fasten to the micarta plates (8).



1 Current transformers
2 Secondary ground lead
3 Secondary instrument panel lead
4 Ground terminal stud
5 High-voltage terminal block
6 Low-voltage terminal block
7 Main wires
8 Micarta plates

Figure 131. Current transformers and terminal blocks.

(2) Connect the secondary ground lead (2) to stud (4).
(3) Connect the secondary instrument panel lead (3) to the voltmeter-ammeter phase switch (9, fig. 55).

154. Crosscurrent Transformer

a. The crosscurrent transformer consists of a ring-type primary in series with line T2 (fig. 54). The primary is wound through the secondary which is held to the base of the panel cabinet by two bolts and nuts. The secondary leads C5, C6, and C9 are led through the plastic envelope to the instrument panel.

b. This transformer is rated at 40/5 amperes. Check the ratio as in paragraph 153, placing the 0 to 100 amp ammeter in line T2 and the 0 to 10 amp ammeter in line C5 or C6.

c. To remove, disconnect the lines to the primary and secondary and remove the two nuts holding the transformer to the cabinet base. When reconnecting this transformer, follow figure 54.

155. Exciter Field Rheostat

(fig. 12)

a. The exciter field rheostat (12) is rated 250 ohms, maximum amps 1.6, minimum amps 0.46, and is insulated for 600 volts.

b. To test, place an ohmmeter in the line between the field rheostat and the regulator switch (10). Place the regulator switch in MANUAL position and move the field rheostat in a clockwise direction from the point of maximum resistance to the point of least resistance. The resistance should vary smoothly from high to low values.

c. For removal and replacement, refer to paragraph 97.

d. See caution (par. 153*b*(5)).

156. Crosscurrent Compensation Rheostat

(fig. 12)

The crosscurrent compensation rheostat (23, fig. 12) is rated 10 ohms, 25 watts, and 1.6 amperes. Place the ohmmeter in line between the crosscurrent compensation rheostat and the crosscurrent compensation switch. Move the field rheostat in a clockwise direction from the point of maximum resistance to the point of least resistance. The resistance should vary smoothly from high to low values. Remove and replace as directed in paragraph 90.

157. Voltage Regulator Rheostat

(fig. 12)

The voltage regulator rheostat (9) is rated 500 ohms, 50 watts. Place the ohmmeter in the line between the regulator rheostat and the regulator. Place the regulator switch in "AUTOMATIC" position. Move the rheostat in a clockwise direction from the point of maximum resistance to the point of least resistance. The resistance should vary smoothly from high to low values. Remove and replace as directed in paragraph 96.

158. Indicating Instruments

All defective indicating instruments are to be replaced. These instruments will be discarded or reconditioned by a special instrument repair section, according to prevailing shop practice. See paragraphs 100 and 101.

159. Terminal Blocks and Insulators

(fig. 131)

Replace cracked or chipped terminal blocks. Terminal blocks (5) and (6) are held to the back of the panel by four screws and nuts.

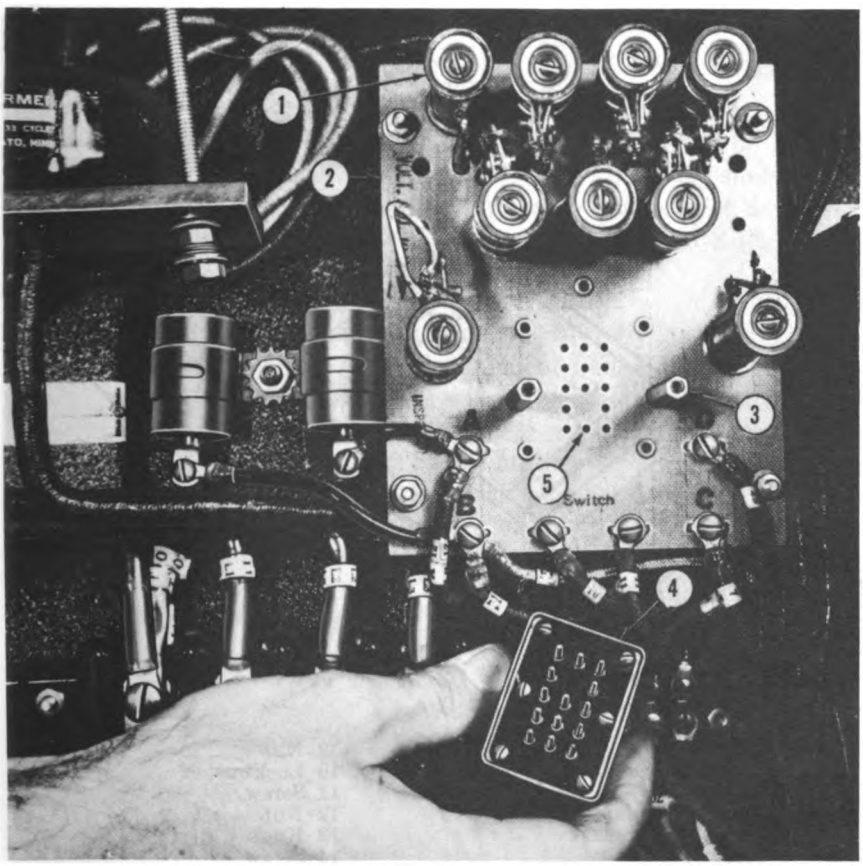
160. Voltage Regulator

a. The voltage regulator assembly (fig. 132) consists of several resistors (1) and a plug-in type regulator (4) mounted on an insulated subpanel (2).

b. The only adjustment is a dashpot adjusting screw under the cover of the plug-in regulator (4). If hunting occurs, or if the regulator is sluggish in response, the dashpot should be adjusted by turning the screw one-eighth or one-quarter turn in either direction to obtain the best response.

c. The plug-in regulator (4) is kept from vibrating out of its receptacle (5) by a bar across the spacers (3).

d. To test the regulator, load the generator and measure the terminal voltage at terminal blocks (5) or (6) (fig. 131). If the voltage regulation varies more than 5 percent from no load to full load, re-



1 Resistors
2 Insulated subpanel
3 Spacer
4 Regulator
5 Regulator receptacle

Figure 132. Generator voltage control regulator assembly.

place the regulator (4, fig. 132). The regulating resistors (1) are wires to the receptacle (5). Check for loose or broken connections. If regulation is still not correct, replace the regulator assembly.

e. To remove the assembly, disconnect all wiring from the subpanel (2). Remove four screws and nuts holding the regulator to the control cabinet. Spacers are used to provide the necessary clearance in back of subpanel.

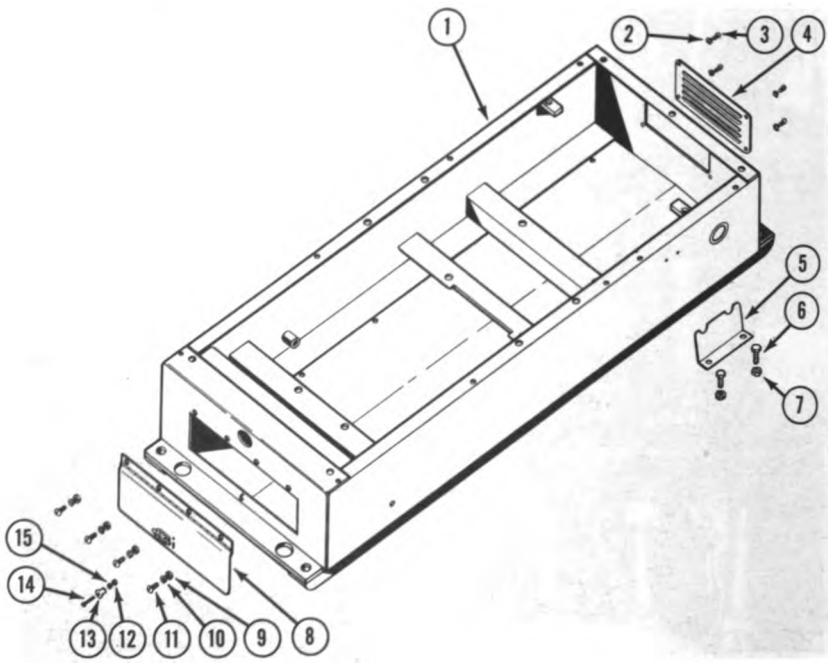
f. To install the regulator assembly, reverse the procedure of *e* above. Connect wiring as shown on wiring diagram (fig. 54).

Section XIII. BASE AND HOUSING

161. Base

(fig. 133)

a. Description. The base is of welded steel construction. The only removable parts are the toolbox door on the front and the inspection plate held to the back by four screws.



1 Subbase
2 Truss head screw
3 Lockwasher
4 Rear cover plate
5 Fuel valve bracket
6 Screw
7 Nut
8 Toolbox door
9 Nut
10 Lockwasher
11 Screw
12 Nut
13 Knob
14 Screw
15 Lockwasher

Figure 133. Exploded view of base and skid.

b. Inspection and Repair.

(1) Clean off all rust and repaint if necessary. Refer to paragraph 30.

(2) See that the toolbox door latch and hinges are free and work easily.

(3) See that the drain holes along the edges of the bottom pan are clear.

162. Housing

(fig. 25)

a. Inspection. Check hinges and latches on access doors. Check for bends and dents which prevent a good fit of doors and housing to base.

b. Repair. Clean off all rust and dirt. Straighten bends and dents. Repair cracks and breaks by welding. Touch up or repaint as required. Lubricate hinges and latches with OE.

163. Shaft Alinement

a. Description. The engine drives the generator through a flexible coupling consisting of a stack of thin steel disks attached by bolts to the engine flywheel and the driving hub on the alternator shaft. The alternator frame has a short pilot fitting the counterbore of the engine flywheel housing. Alinement of the generator shaft with the engine shaft depends upon the fit of this pilot.

b. Method of Alining.

(1) Check the flywheel and housing carefully as instructed in paragraph 146. Any misalinement of the flywheel housing or runout of the flywheel will throw the shafts out of alinement. To get accurate alinement, it is important to remove all dirt, nicks, and burs on the mating surfaces of the housing and crankcase and on the flywheel and crankshaft flange.

(2) Inspect the machined surface of the pilot on the generator frame and the mating counterbored surface of the flywheel housing for dirt, nicks, and burs. Clean and scrape these surfaces if necessary.

Section XIV. ENGINEERING INFORMATION

164. Tolerances and Wear Limits

	Desired Tolerance	Max. Wear Limit
a. Main bearing oil clearance	0.0023 –0.0045	0.0065
b. Crankshaft end play	.002 – .006	.011
c. Connecting rod bearing oil clearance	.0015 – .0035	.006
d. Connecting rod side clearance	.003 – .009	.013
e. Piston pin to rod bushing clearance	.00015– .00085	.002
f. Piston pin to piston fit	.00025 tight	.00045 loose
g. Piston to cylinder clearance at bottom of skirt (90° to pin)	.0037 – .0065	.010
h. Ring to piston groove clearance:		
top groove	.003 – .005	.007
2d groove	.002 – .004	.0055
3d groove	.002 – .004	.0055
4th groove	.0015 – .0035	.005
bottom groove	.0015 – .0035	.005
i. Ring gap	.012 min.	.017
j. Camshaft bushing oil clearance	.002 – .0046	.0065
k. Camshaft end play	.003 – .008	.014
l. Valve clearance adjustment set hot (water temp 180° F.)	.009	
m. Oil pump shaft to bushing clearance	.001 – .0025	.005
n. Oil pump gear to housing clearance	.001 – .0025	.005
o. Oil pump gear to housing cover clearance	.001 – .003	.006
p. Oil pump drive gear end play	.001 – .003	.006
q. Backlash:		
timing gears	.001 – .003	.007
injection pump drive	.001 – .003	.007
oil pump drive	.001 – .003	.012

165. Torque Wrench Settings

Torque-wrench settings listed below should be followed in tightening bolts and studs of the diameters shown.

Diameter	*Foot-Pounds*	*Diameter*	*Foot-Pounds*
3/8"	60–70	3/4"	210–230
7/16"	75–85	13/16"	230–250
1/2"	95–105	7/8"	245–275
9/16"	125–135	1"	285–315
5/8"	150–160	1 1/8"	325–350
11/16"	195–200		

Chapter 5

SHIPMENT AND LIMITED STORAGE AND DEMOLITION TO PREVENT ENEMY USE

Section I. LIMITED STORAGE AND SHIPMENT

166. Limited Storage

a. Inspection. Refer to paragraph 34. Make a complete inspection in accordance with the "W" or weekly schedule.

b. Cleaning and Painting.

(1) Wipe off and clean the housing and all parts of the generator set that can be reached without disassembly.

(2) Remove any water, oil, or grease which has accumulated inside the base of the set.

(3) Thoroughly clean off any rust and corrosion.

(4) Paint bare and rusted places after cleaning. Refer to paragraph 30.

c. Draining Fuel and Lubricants.

(1) Drain radiator and refill with equal parts of ethylene glycol and water.

(2) Drain crankcase and refill with 5 quarts of clean engine oil as directed by LO 5–5161.

(3) Drain the fuel tank.

d. Rust Prevention.

(1) Disconnect the fuel and return lines from fuel pump to tank and pump the hand primer until all fuel is forced out of the system. Then dip the fuel line into a small, clean container of rust preventive oil and pump the primer until the fuel system is filled. Start the engine and let it run at half speed for about 10 minutes.

(2) Remove exhaust manifold (par. 77) and air cells (par. 137). Spray 1 ounce of rust preventive into each cylinder. Turn engine at least 25 revolutions. Then replace air cells and manifold.

(3) Remove cylinder-head cover and paint rocker arm assembly and valve springs with rust preventive. Replace cover.

(4) Put tape over air cleaner inlet, exhaust manifold outlet, and crankcase breather.

e. Batteries. Disconnect and remove batteries. Pack or store them separately. In storage, the batteries should be recharged once each month.

167. Domestic Shipment

a. Preparation of Equipment.

(1) For transportation and immediate reuse, refer to paragraph 17.

(2) For transportation involving long idle time, refer to paragraph 166.

b. Loading and Blocking (fig. 134).

(1) Place the generator set on wooden skids at least 2 by 6 inches.

(2) Spike 2 x 4 bolsters across the skids at each end and along both sides.

(3) Cover the housing with heavy paper to prevent damage to paint.

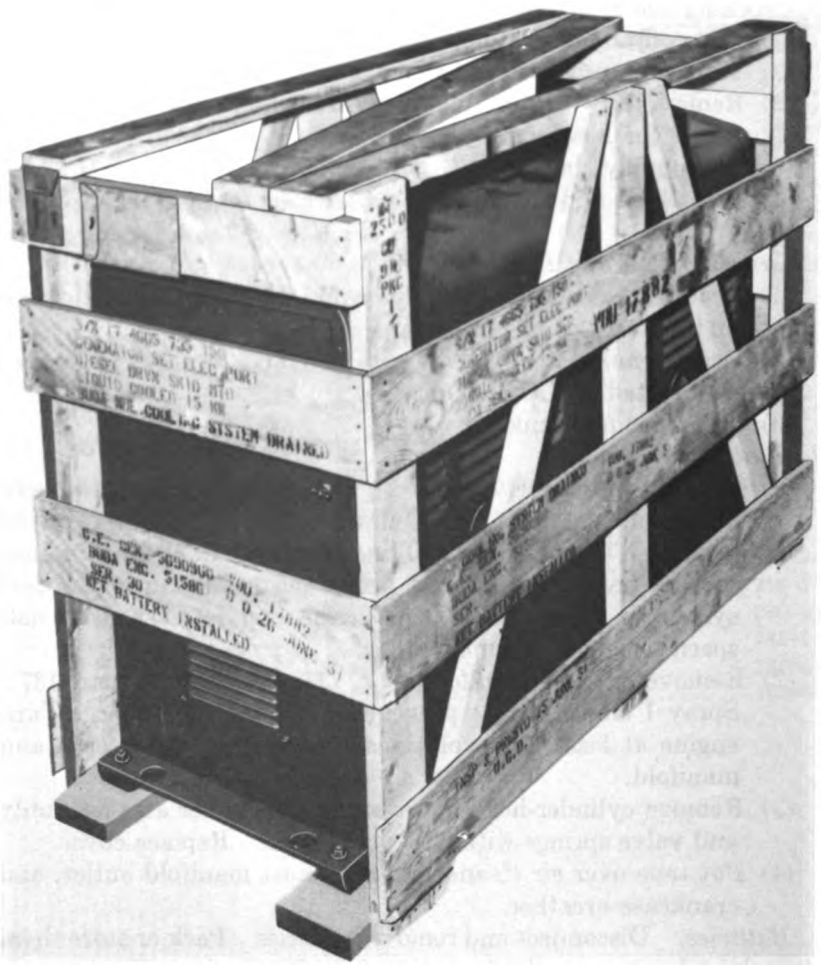


Figure 134. Blocking and crating for domestic shipment.

(4) Construct a substantial crate on the skids with strong diagonal bracing. Be sure the lifting eye can be reached by a crane hook.

c. Lifting Eye. The lifting eye is at top center over the fuel tank. It will stand the weight of the complete generator set crated.

Section II. DEMOLITION OF GENERATOR SET TO PREVENT ENEMY USE

168. General

When capture or the abandonment of the generator set to an enemy is imminent, the responsible unit commander makes the decision either to destroy the unit or to render it inoperative. Orders based on this decision are issued covering the desired extent of destruction. Whatever method of demolition is employed, it is essential to destroy corresponding vital parts of all the generator sets and all corresponding repair parts.

169. Preferred Demolition Methods

Explosives or mechanical means, either singly or in combination, are the most effective methods to employ. Listed below are the vital parts in order of priority of demolition for each preferred method. In each case, completion of the first *two* steps will render the unit inoperative. Completion of the additional steps listed will further destroy the unit.

a. By Explosives (fig. 135). Place as many of the following charges as the situation permits and detonate them simultaneously with detonating cord and a suitable detonator:

(1) A 2-pound charge between the fuel injection pump and the engine block, and a ½-pound charge at each fuel injection nozzle.

(2) A 4-pound charge on the armature shaft next to the rear bearing carrier. (Remove the cover plate from the rear of the generator.)

Note. The above steps are the minimum requirement for this method.

(3) A 2-pound charge on the right side of the engine block.

(4) A 1-pound charge behind the electrical control panel.

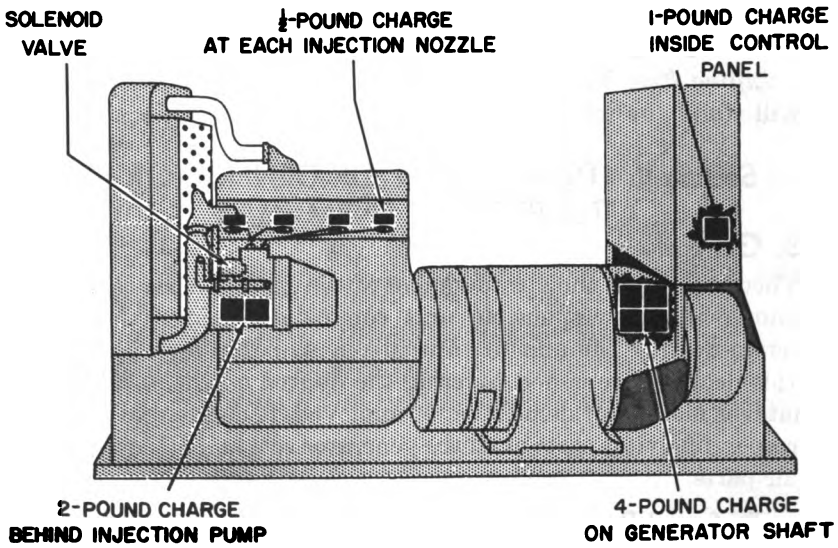
(5) A 1-pound charge on both the starting motor and charging generator.

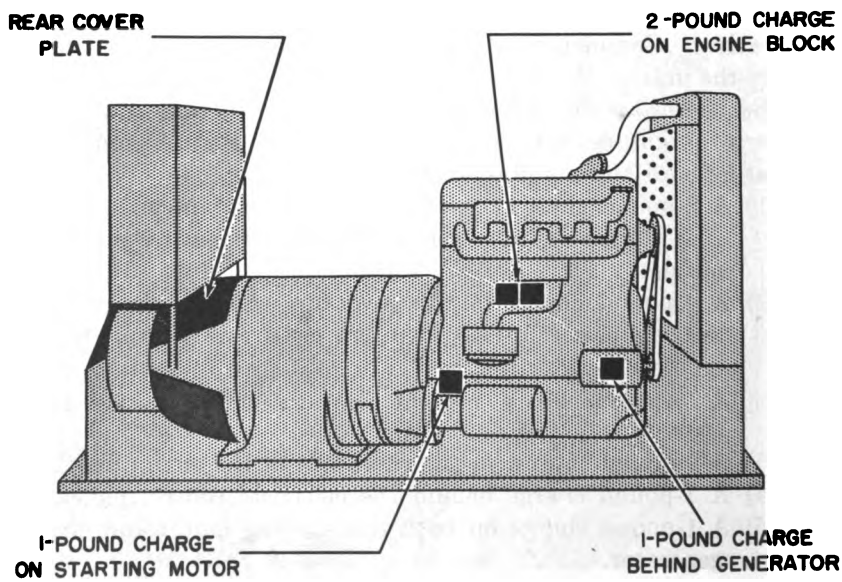
b. By Mechanical Means. Use sledge hammers, crowbars, picks, axes, or any other heavy tools which may be available, together with the tools normally included with the generator set, to destroy the following:

(1) The fuel injection pump and nozzles and injection lines.

(2) The sliprings, brush holders, and armature windings. (Remove the cover plate from the rear of the generator.)

Note. The above steps are the minimum requirements for this method.





LEGEND:

■ 1-POUND CHARGE ▮ HALF-POUND CHARGE

Figure 135. Placement of charges.

(3) All switches and instruments on the electrical-control panel and all wiring.
(4) The radiator core, batteries, and engine block.

170. Other Demolition Methods

When the situation prohibits employing either of the preferred methods, use the following, either singly or in combination.

a. By Weapons Fire. Fire on the generator set with the heaviest weapons available. Direct firing at both engine and generator.

b. By Scattering and Concealment. Remove all easily accessible vital parts such as the injection pump, injection nozzles, generator and exciter brushes, and batteries, and scatter them through dense foliage, bury them in dirt or sand, or throw them in a lake, stream, well, or other body of water.

c. By Burning. Pack rags, clothing, or canvas under and around the unit and inside the generator and exciter housings. Saturate this packing with gasoline, oil, or diesel fuel, and ignite. Because of the type of insulating material used on windings and wiring, this method will not seriously damage the generator unless high temperatures are sustained for some time.

d. By Submersion. Totally submerge the unit in a body of water to provide some water damage and concealment. Salt water will do the greatest damage to metal parts.

e. By Misuse. Protective devices built into the engine ignition system are designed to prevent its operation at overspeed, or without oil or water. Perform the first step listed below to put these devices out of action and the remaining steps to make the engine inoperative.

(1) Cut the wires leading into the solenoid valve.
(2) Drain the radiator and oil pan.
(3) Remove the cover plate from the rear of the generator.
(4) Start the engine.
(5) Drop small tools, bolts, nuts, or metal scraps into the rear of the generator and abandon the unit.
(6) Set the throttle so that the engine will run at maximum speed until failure occurs.

171. Training

All operators should receive thorough training in the destruction of the generator set. Simulated destruction, using all the methods listed above, should be included in the operator-training program. It must be emphasized in training that demolition operations are usually necessitated by critical situations in which the time available for destruction is limited. For this reason it is necessary that operators be thoroughly familiar with all methods of destruction and be able to carry out demolition instructions without reference to this or any other manual.

APPENDIX I

REFERENCES

1. Dictionaries of Terms and Abbreviations

SR 320-5-1	Dictionary of United States Army Terms.
SR 320-50-1	Authorized Abbreviations.

2. Lubrication and Painting

TM 9-2851	Painting Instructions for Field Use.
LO 5-5161	Generator Set, Portable, Diesel Driven, 15 KW, 120/208-240/416 Volts, 3 Ph, 60 Cy, Convertible to 230/400 Volts, 3 Ph, 50 Cy, Buda Model 4BDG-182.

3. Preparation for Export

TB 5-9711-1	Preparation of Corps of Engineers Equipment for Overseas Shipment.
TB 5-9713-1	Preparation for Export, Spare Parts for Corps of Engineers Equipment.

4. Preventive Maintenance

TB 5-5161-1	Preventive Maintenance Services, Generator Set, Portable, Diesel-Driven, Skid-Mounted, 15 KW, 120-208, 240-416 Volts, 3 Phase, 60 Cycle, Convertible to 230-249 Volts, 3 Phase, 50 Cycle, With Buda Model 4BDG-182 Engine.
TM 5-505	Maintenance of Engineer Equipment.

5. Publication Indexes

SR 110-1-1	Index of Army Motion Pictures, Kinescope Recordings, and Film Strips.
SR 310-20-3	Index of Training Publications.
SR-310-20-4	Index of Technical Manuals, Technical Regulations, Technical Bulletins, Supply Bulletins, Lubrication Orders, and Modification Work Orders.
SR 310-20-5	Index of Administrative Publications.
SR 310-20-6	Index of Blank Forms and Army Personnel Classification Lists.
ENG 1	Introduction and Index (Department of the Army Supply Manual).

6. Training Aids

FM 21-8	Military Training Aids.

APPENDIX II

IDENTIFICATION OF REPLACEABLE PARTS

The data in this appendix are not to be used as a basis for requisitions for spare parts. Refer to the appropriate published Department of the Army Supply Manual for requisitioning data.

Fig. No.	Index No.	Engineer stock No.		Manufacturer's part No.		Federal supply class and item identification No.	Description	Quantity per unit
		Code No.	Part No.	Code No.	Part No.			
12	1	640	8KT8F2				METER, time	1
	2	640	47901				LIGHT, panel	2
	3	640	33–FX				METER, frequency	1
	4	640	AO–22 VDF–19				VOLTMETER	1
	5	640	AC–22 ABS–205				AMMETER	1
	6	621	8801–K–9				SWITCH, TOGGLE: spst, switching data, 2 position.	1
	7	621	8801–53				LIGHT, synchronizing	2
	8	017	F Frame TYPE ETA.				BREAKER, air circuit	1
	9	017	50W3000HM				RHEOSTAT, voltage regulator	1
	10	621	8810–K–8				SWITCH, regulator	1
	11	621	8801–K–9				SWITCH, frequency	1
	12	670	N–24349				RHEOSTAT, exciter field	1
	13	670	261 Series				SWITCH, safety	1
	14	887	442228				GAGE, temperature	1
	15	887	44201				GAGE, oil pressure	1
	16	887	440074				AMMETER, battery charge	1
	17	887	185–0				SWITCH, starting	1
	18	887	71151				SWITCH, air heater	1
	19	024	DL–70051				CONTROL, stop	1
	20	024	DE–61302				CONTROL, assembly, manual, governor	1
	21	621	8801–K–9				SWITCH, cross current compensating	1
	22	098	8367C				SWITCH, voltmeter-ammeter	1
	23	670	MODEL H				RHEOSTAT, cross current compensating	1

	24	621	8822-K-7				SWITCH, synchronizing light	1
20	1						GUARD, front	1
	2						SCREEN, front guard	1
	3						CORE	1
	4		6455A				CAP, filler	1
	5	910	33-2340-100-300				CLAMP, hose	4
	6						PIPE	1
	7						GUARD, fan	1
	8						CLAMP, hose	2
	9						HOSE	1
23	1	910	33-2340-100-300				CLAMP, hose	10
	2	ORD	4007-0100220				HOSE	5
	3		B-4342				PIPE, water outlet	1
	4		DL-7953				ELBOW, water outlet pipe	1
	5		1645				GASKET	1
	6		B-3872				HOUSING, thermostat	1
	7		252855				RING, thermostat, neoprene	1
	8		B-4061				THERMOSTAT	1
	9		DE-145				GASKET	1
	10		B-1190				PIPE, cylinder head outlet	1
	11	914	45-6042-500-005				PLUG, pipe ½ in	2
	12		DL-7859				BUSHING, temperature gage	1
	13		B-1161				GASKET, water outlet pipe and manifold	1
	14	913	43-9538-500-040				WASHER, lock ⅜ in	4
	15	913	43-6792-040-300				SCREW, CAP NC: HEX HD: ⅜ in. dia, 3 in. long, 16 threads per in.	2
	16		B-291				GASKET, water inlet pipe	1
	17						PIPE, water, inlet	1
	18		251369				WASHER, ½ in	1
	19	913	43-6792-050-330				SCREW, cap	1
	20		DE-5465				PIPE, water outlet	1
	21	913	43-6777-035-110				SCREW, cap	3

Fig. No.	Index No.	Engineer stock No.		Manufacturer's part No.		Federal supply class and item identification No.	Description	Quantity per unit
		Code No.	Part No.	Code No.	Part No.			
	22						ADAPTER, drain cock	1
	23	896	145				COCK, drain	1
	24	913	43-4445-035-180				NUT	3
	25	913	43-9533-500-033				WASHER, lock 5/16 in	3
	26		B1104				ASSEMBLY, bypass line	1
	27	913	43-6777-040-100				SCREW, cap 5/8 inch—16 x 1 in	2
25	1		DL-7864				TOP, hood	1
	2						CATCH, door	4
	3						SCREW	20
	4		DL-7910				ASSEMBLY, rear panel	1
	5		DL-7889				ASSEMBLY, side panel	2
	6						LATCH, door	4
26	1		DL-8194				MUFFLER	1
	2		DL-7862				PIPE, exhaust	1
	3		DL-8200				MUFFLER CLAMP ASSEMBLY	2
28	1		DL-4444				CAP, filler assembly	1
	2	913	43-9533-500-050				WASHER, lock 1/2 in	2
	3	913	43-6792-050-200				SCREW, cap	2
	4	024	DL-7913				EYE, lifting	1
	5		DL-7898				TANK ASSEMBLY	1
	6						NUT	1
	7						WASHER	1
	8		DL-7982				BOLT, battery hold-down	1
	9		DL-7869				FRAME, battery hold-down	1
	10		DL-7865				SHELF, battery	1

	11	913	43-4445-030-200				NUT	4
	12	913	43-9533-500-060				WASHER, lock	4
	13	913	43-6777-060				SCREW, cap	4
	14		DL-7971				BASE, control panel	1
	15	913	43-9351-500-030				WASHER, lock, ¼ in	4
	16	913	43-6777-050-150				SCREW, cap	4
	17	913	43-9533-500-050				WASHER, lock	4
	18	913	43-4445-050-130				NUT	4
30	1		DE-31198				GASKET	1
	2	604	ADN4S504				NOZZLE	1
	3		B-584				HOLDER	1
	4	913	43-9533-500-040				WASHER, lock	2
	5	913	43-4489-040-240				NUT, ⅜"—24	2
	6	024	B-3080				NOZZLE DRIP LINE, assembly	1
	7		B-4934				BRACKET, secondary filter	1
	8		B-4916				FILTER, secondary	1
	9		AP-6651				TRIP, overspeed	1
	10		DE-41934				VALVE, solenoid	1
	11		11970-1				FILTER, primary	1
	12		253092				VALVE, return	1
	13		253092				VALVE, fuel	1
	14	855	159J				FILTER, bowl	1
	15	024	DE-64679				PRIMER, hand, ⅛-inch	1
	16		B-4300-B				PUMP, fuel injection	1
	17		B-4972				VALVE, pressure relief	1
	18		B-4408				LINE, fuel, No. 4 cylinder	1
	19		B-4407				LINE, fuel, No. 3 cylinder	1
	20		B-4406				LINE, fuel, No. 2 cylinder	1
	21		B-4405				LINE, fuel, No. 1 cylinder	1
34	1	913	43-6792-030-170				SCREW, cap	4
	2		10124				WASHER, lock	4
	3		11979				PLUG	2

Fig. No.	Index No.	Engineer stock No.		Manufacturer's part No.		Federal supply class and item identification No.	Description	Quantity per unit
		Code No.	Part No.	Code No.	Part No.			
	4		13734				HEAD	1
	5		101378				GASKET	1
	6		5864				CARTRIDGE ASSEMBLY	1
	7		100118				SPOKE, lube	1
	8		13129				SPRING	1
	9		5776				BODY, assembly	1
	10		13125				RING, clamp	1
39			DL-8151				CLEANER, air	1
40	1		140631				NUT, lock 3/8-24—thin	1
	2	024	DE-40236				WASHER, air heater bolt	3
	3	913	43-4420-040-248				NUT, binding post	2
	4		DL-70035				BUSHING, insulating	2
	5		116093				WASHER, 5/8 in	8
	6		DE-4171				POST, binding	2
	7		43-7710-100-040				SCREW, 10-24 x 5/8 in	2
	8	024	B-1508				HEATER element assembly	1
	9		DE40939				SCREEN, air heater	1
	10						WIRE binding	1
	11		113104				NUT, 10-24	2
	12		DE-5472				SCREW, 10-24	2
	13	913	43-9533-500-040				WASHER, lock	2
	14	913	43-6777-040-100				SCREW	2
	15	024	DL-7876				ADAPTER, air cleaner	1
	16		DL-7858				ADAPTER, air heater box	1
42	1-7		F21P2		B4723		FILTER, lube oil (parts 1 to 7)	1

	1	913	43–6777–035–070				SCREW, cover	1
	2	913	43–9582–500–033				WASHER	1
	3	097	5241		5241		COVER	1
	4						SPRING	1
	5	097	11582		11582		GASKET	1
	6	097	7631		7631		ELEMENT	1
	7	097	5310		5310		BODY	1
	8	913	43–6777–035–070		100121		SCREW, cap	2
	9	913	43–9533–500–033		103320		WASHER, lock	2
	10		B–4724		B–4724		BRACKET	1
	11	913	43–9533–500–033		103320		WASHER, lock	4
	12	913	43–6777–035–070		100121		SCREW, cap	4
	13		12420		12420		BOLT	2
	14		11563		11563		STRAP	2
	15		10113		10113		WASHER, lock	2
	16		12384		12384		NUT	2
	17						PLUG	
48	1		B832				GASKET, exhaust and intake manifold	1
	2		B–901				MANIFOLD, exhaust	1
	3	913	43–6792–045–200				SCREW, cap: NC hex hd, 7/16 in. dia., 2 in	2
	4	913	43–9533–500–044				WASHER, lock: 7/16 in	2
	5	024	B–801				FLANGE, exhaust manifold	1
	6		B–802				GASKET, flange	1
	7		DE–60146				CLAMP, manifold	4
	8		JE84				WASHER, plain	4
	9	913	43–4489–045–200				NUT, 7/16"–20	4
	10	024	B–673				MANIFOLD, intake	1
55	1		80/5 AMP				TRANSFORMER, current	3
	2	308	CA482				CONDENSER, capacitor	6
	3		C230				REGULATOR, voltage	1
	4	017	TYPE ETA				BREAKER, air circuit	1
	5		152–4				BLOCK, terminal	1

Fig. No.	Index No.	Engineer stock No.		Manufacturer's part No.		Federal supply class and item identification No.	Description	Quantity per unit
		Code No.	Part No.	Code No.	Part No.			
	6		B–112–LN				BUSHING, generator	1
	7		5CT44				TRANSFORMER, cross current compensating.	1
	8		50W 500 OHM				RHEOSTAT, voltage regulator	1
	9	098	8367C				SWITCH, voltmeter-ammeter	1
	10	670	N–24349				RHEOSTAT, exciter field	1
	11		4790EXP10				LIGHT, panel	2
	12	670	Model H				RHEOSTAT, cross current compensating	1
	13		B–114–LN				BUSHING, load	1
	14						CHAIN, panel support	1
	15						STRIP, terminal	1
	16						STRIP, terminal	1
61	1						RING, adapter	1
	2						FRAME, generator	1
	3						SHAFT, generator	1
	4						FAN	1
	5		DL–7004				DISK, driving	5
	6		DL–7003				HUB, generator coupling	1
			141203				PIN, dowel	2
	7		DL–7005				PLATE, screw	1
	8		B–1760				FLYWHEEL	1
	9		B–742				HOUSING, flywheel	1
	10						SCREW, cap	6
62	1		DE–51295				BELT, fan	1
	2	913	43–6777–035–070				SCREW, cap, 5/16″–18 x 3/4″	4

	3	913	43-9533-500-033				WASHER, lock, 5/16"	4
	4		B-2078				BLADE, fan assembly	1
	5	024	B-664				PULLEY, water pump	1
	6	913	43-6792-040-070				SCREW, cap, NC; hex hd; 3/8 in. dia. 3/4 in. long; 16 threads per in.	1
	7	913	43-9533-500-040				WASHER, lock	1
	8	024	B-590				PUMP ASSEMBLY, water	1
	9		B-244				GASKET, mounting	1
	10	913	43-9533-500-033				WASHER, lock, 5/16"	4
	11		B-351				SCREW, cap, 5/16" thin head	4
	12		B-242				COVER, water pump	1
	13		B-245				IMPELLER, water pump	1
	14		B-3375				SEAL ASSEMBLY, water pump	1
	15		B-248				WASHER, seal	1
	16		H-11602				RING, retaining, seal	1
	17		B-243				GASKET, cover, water pump	1
	18	914	3150X2				PLUG, PIPE: 1/8 in	1
	19	024	B-241				BODY, water pump	1
	20		B-266				SHAFT, water pump, with bearing	1
	21		B-254				WIRE, bearing retainer	1
	22		B-663				HUB, water pump pulley	1
	23		896/135				COCK, drain, 1/8"	1
	24	913	43-4445-040-160				NUT, hex; NC; 3/8 in; 16 threads per in	1
	25	913	43-9533-500-040				WASHER, lock, 3/8"	1
	26	024	B-257				LINK, water pump support	1
	27		B-2721				BOLT, carriage, 3/8"-16 x 1"	1
	28						SCREW, cap, 1/2"-13 x 3"	1
64	1		SC-908				SCREW, camshaft hub 7/16"-20	1
	2		WA-7623				WASHER, lock	1
	3		HB-907				HUB, drive	1
	4		SC-1555				SCREW, bearing retaining plate	4
	5		PL-907				PLATE, bearing retainer	1

Fig. No.	Index No.	Engineer stock No.		Manufacturer's part No.		Federal supply class and item identification No.	Description	Quantity per unit
		Code No.	Part No.	Code No.	Part No.			
	6		BB–1023				BEARING, ball, camshaft	1
	7		SH–904A				CAMSHAFT	1
	8		GA–76200				GASKET, rubber ring	1
	9		PO–763				POINTER, timing	1
	10		HG–903A				HOUSING, pump	1
	11		SD–901				STUD	4
	12		RL–902A				ASSEMBLY, tappet roller	1
	13		GU–901A				ASSEMBLY, tappet guide	1
	14		PN–904				PIN, tappet assembly	1
	15	604	GA–7616				GASKET	1
	16	913	43–6792.030.070				SCREW, cap: NC; hex hd; ¼″ dia., $1\frac{1}{16}$″ long; 20 threads per in.	1
	17		WI–1073				WIRE, locking	1
	18		SC–903				SCREW, filter	1
	19		GA–7965				GASKET, filter screw	1
	20		FE–901				FILTER, screen	1
	21		GA–1012				GASKET, ring filter screw	1
	22		RG–1014				RING, spring	1
	23		GE–908				GEAR	1
	24		SH–909A				SHAFT, quill	1
	25		PK–7910				SEAL, oil	1
	26		KY–901				KEY	1
	27		SGB–15–B2				PUMP, assembly, transfer	1
	28		WA–1143				WASHER, plain	2
	29		WA–22–8BL				WASHER, lock	2

30	------	SC–1516	----------	----------	----------	SCREW, fastening, supply pump	2
31	------	BG–905	----------	----------	----------	BUSHING	1
32	912	42–5416–500–150	----------	----------	----------	KEY	1
33	------	GE–908	----------	----------	----------	GEAR	1
34	------	WMS2157/400X	----------	----------	----------	WASHER, 0.002" thick	(*)
34	------	WMS2157/IX	----------	----------	----------	WASHER, 0.004" thick	(*)
34	604	WMS2157/2X	----------	----------	----------	WASHER, pressure adjusting, 0.2 MM thick	(*)
34	------	WMS2157/3X	----------	----------	----------	WASHER, pressure adjusting: 0.5 MM thick	(*)
34	------	WMS2157	----------	----------	----------	WASHER	(*)
35	------	RG–1014	----------	----------	----------	RING, spring	1
36	------	FI–902	----------	----------	----------	FITTING, shut-off	1
37	------	SC–325–4BI	----------	----------	----------	SCREW, set	1
38	------	PN–1026	----------	----------	----------	PIN	1
39	------	SC–904	----------	----------	----------	SCREW, bearing	1
40	------	GA–1019	----------	----------	----------	GASKET	1
41	------	SP–904	----------	----------	----------	SPRING, shut-off	1
42	------	RD–903	----------	----------	----------	ROD, shut-off	1
43	------	GA–1036	----------	----------	----------	GASKET, shut-off rod	1
44	------	SC27–18BL	----------	----------	----------	SCREW, timing window cover	2
45	------	WA22–8BL	----------	----------	----------	WASHER, lock	2
46	------	WA–1143	----------	----------	----------	WASHER, plain	2
47	------	CV–905	----------	----------	----------	COVER, timing window	1
48	------	GA–909	----------	----------	----------	GASKET, timing window cover	1
49	913	43–6792–030–070	----------	----------	----------	SCREW, quill shaft pad	2
50	------	GA–7616	----------	----------	----------	GASKET, fastening screw	2
51	------	WA–901	----------	----------	----------	WASHER, lock	4
52	------	CV–903C	----------	----------	----------	PAD, quill shaft	1
53	------	GA–904	----------	----------	----------	GASKET, quill shaft pad	1
54	------	GA–1014	----------	----------	----------	GASKET, control unit assembly	1
55	------	PN–906	----------	----------	----------	PIN, plunger sleeve	1
56	------	RG–1015	----------	----------	----------	RING, spring, control shaft	1

*As required.

Fig. No.	Index No.	Engineer stock No.		Manufacturer's part No.		Federal supply class and item identification No.	Description	Quantity per unit
		Code No.	Part No.	Code No.	Part No.			
	57		BG–901A				BUSHING, control shaft	1
	58		GA–76195				GASKET, control shaft	1
	59		LE–9013A				SHAFT, control	1
	60		SC–1148				SCREW, fastening	2
65	1		BG–7649				BUSHING, camshaft	1
	2		PN–915A				PIN, weight	2
	3		BG–903				BUSHING, weight	4
	4		WA1134				WASHER, flat, governor weight	4
	5		PN–1104				PIN, locking	2
	6		HP–901				SPIDER, weight	1
	7		WT–901A				WEIGHT	2
	8		SV–901A				SLEEVE, assembly	1
	9		SC–1136				SCREW, cam	1
	10		PN–9010				PIN, control rod	1
	11		RG–901				RING, spring	1
	12		RG–9011–14				ROD, control	1
	13		PN–1100				PIN, hair, control rod	1
	14		BA–901				PLATE, oil baffle	1
	15		SC–1110				SCREW, top cover	4
	16		WA–22–8BL				WASHER, lock	4
	17		WA–1143				WASHER, flat, governor weight	4
	18		CV–902C				COVER, top governor	1
	19		GA–908				GASKET, top cover	1
	20		43–6792–030–070				SCREW, cap: NC; hex hd; ¼ in. dia., $1\frac{1}{16}$'' long; 20 threads per in.	2

						WASHER, lock	2
21		WA–22–8BL				WASHER, plain	2
22		PL–1143				PLATE, stop	1
23		PL–904				PLATE, name	1
24		NP–901				SCREW, name plate	2
25		SC–150				WASHER, plain	2
26		WA–1143				WASHER, lock	2
27		WA–22–8BL				SCREW, governor housing, long	2
28		SC–1351				WASHER, plain	3
29		WA–1143				WASHER, lock	3
30		WA–22–8BL				SCREW, cap: NC; hex hd; ¼″ dia., 1 1/16″ long 20 threads per inch.	3
31		43–6792–030–070				WASHER, plain	2
32		WA–1143				WASHER, lock	2
33		WA–22–8BL				SCREW, end cap	2
34	913	44–6792–030–070				CAP, governor end	1
35		CP–901C				GASKET, end cap	1
36		GA–902				SPACER, outer, spring, 0.020″ thick	(*)
37		SR–7914/1				SPACER, outer, spring, 0.042″ thick	(*)
37		SR–7914/2				SPACER, outer, spring, 0.058″ thick	(*)
37		SR–7914/3				SPACER, outer, spring, 0.083″ thick	(*)
37		SR–7914/4				SPACER, governor, inner, 0.020″ thick	(*)
38		SR–799/1				SPACER, governor, inner, 0.042″ thick	(*)
38		SR–799/2				SPACER, governor, inner, 0.058″ thick	(*)
38		SR–799/3				SPACER, governor, inner, 0.083″ thick	(*)
38		SR–799/4				SPRING, governor, inner, 60 cycle	1
39		SR–7950/7				SPRING, governor, inner, 50 cycle	1
39		SP–7950/14				SPRING, governor, outer	1
40		SP–7951/11				NUT, hex, stop screw	2
41		NT6–8BL				SCREW, stop	2
42		SC 350–16 BI				GASKET, fastening screw	2
43		GA–7616					

* As required.

Fig. No.	Index No.	Engineer stock No.		Manufacturer's part No.		Federal supply class and item identification No.	Description	Quantity per unit
		Code No.	Part No.	Code No.	Part No.			
	44		SC–1356				SCREW	2
	45		WA–22–6BL				WASHER, lock	3
	46		SC–1354				SCREW	1
	47		LE–79116				LEVER, operating	1
	48		NT–7919				NUT	1
	49		SC–7961				SCREW, operating lever	1
	50		CV–7946				COVER, stop lever, lower	1
	51		CV–7945				COVER, stop lever, upper	1
	52		BL–901				LEVER, stop	1
	53		SC–901				SCREW, clamping, stop lever	1
	54		SC–902				STUD, fastening	2
	55		WA22–8BL				WASHER, lock	2
	56		WA–1143				WASHER, flat, end cover screw	2
	57		BG–904				PLATE, shaft bearing	1
	58		GA–901				GASKET, shaft bearing plate	1
	59		SP–902				SPRING, operating lever	1
	60		PL–902A				SPRING PLATE, assembly	1
	61		GA–76195				GASKET, shaft assembly	1
	62		SH–901A				ASSEMBLY, operating shaft	1
	63		PN–901A				PIN, pivot, fulcrum lever	1
	64		HG–901				HOUSING, governor	1
	65		GA–907				GASKET, governor housing	1
	66		NT8–8BL				NUT, cam screw	1
	67		WA–228BL				WASHER, lock, cam screw	1
	68		WA–1143				WASHER, plain	1

							ASSEMBLY, fulcrum lever	1
	69		LE9025A				PIN, pivot, fulcrum lever	2
	70		PN-901A				CAM, torque	1
	71		CA-793				NUT, fastening	4
66	1		NT-1127				GASKET, ring	1
	2		GA-1010				WASHER, thrust	1
	3		WA-1362				GUIDE, plunger	1
	4		GU-903				GEAR, plunger drive	1
	5		GE-903				COVER, gear retainer	1
	6		RN-902				GASKET, ring	1
	7		GA-1009				SPRING, plunger, outer	1
	8		SP-903				SPRING, plunger, inner	1
	9		SP-901				SEAT, lower plunger spring	1
	10		GU-904				LOCK, plunger, two piece	1
	11		HP-902				VALVE, overflow	1
	12		VA-7928R				SCREW, part number plate	2
	13		SC-150-2				PLATE, part number	1
	14		NP-902				HEAD, hydraulic	1
	15		HD-901-1A				BALL, sealing	1
	16		BB-1024				GASKET, discharge fitting	4
	17		GA-9010				FITTING, discharge	4
	18		FI-901				SCREW, set	1
	19		SC-1352				VALVE, assembly, delivery	1
	20		VA-901A				GASKET, delivery valve holder	1
	21		GA-905				SPRING, delivery valve	1
	22		SP-7655				HOLDER, delivery valve	1
	23		HP-903				GASKET, cap screw	1
	24		GA-906				SCREW, delivery valve cap	1
	25		SC-902				BOLT, through	2
80	1		GY20B		GY-20B		NUT, cover band, square, #10 NF	1
	2		X-2875		X-2875		SCREW, cover band, rd-hd, #10 1½ NF	1
	3		X-2882		X-2882		BAND, cover	1
	4		GBW-24X		GBW-24X			

Fig. No.	Index No.	Engineer stock No.		Manufacturer's part No.		Federal supply class and item identification No.	Description	Quantity per unit
		Code No.	Part No.	Code No.	Part No.			
	5–17						COMPONENT PARTS OF HEAD ASSEMBLY COMMUTATOR END GFL–2056-AS.	1
	5		X1754		X–1754		SCREW, cover, fill-hd #8–5/16 NC	4
	6		12X–195		12X–195		LOCK WASHER, lead screw #8	2
	7		GBW–1068C		GBW–1068C		COVER, commutator end	1
	8		GBW–69		GBW–69		GASKET, commutator end cover	1
	9		GAR–73		GAR–73		WICK, felt	1
	10		GBF–79		BGF–79		COVER, wick	1
	11		GAR–98C		GAR–98C		BEARING, absorbent	1
	12		GDZ–10566		GDZ–1056C		HEAD, partial, commutator end assembly	1
	13				GBW–72A		GUARD, oil	1
	13		GBW–12A		GBW–73		GASKET, oil guard	1
	14		GBW–45A		GBW–45A		SPRING, brush	2
	15		X–10		X–10		SCREW, brush lead, rd-hd #8–¼ NC	2
	16		CGJ–26B		GCJ–26B		ARM, brush	2
	17		GFL–2012AS		GFL–2012AS		BRUSH SET, service	1
	18–31						COMPONENT PARTS OF FRAME AND FIELD ASSEMBLY GFL–2053BS.	1
	18						POLE SHOE	1
	19						STUD, armature terminal	1
	20						INSULATION	1
	21						STUD, field, terminal	1
	22						STUD, return terminal	1
	23						COIL, field	2

	24	------	----------	----------	----------	FRAME	1
	25	------	----------	----------	----------	INSULATION (2 types)	3 ea
	26	------	----------	----------	----------	WASHER, plain	3
	27	606	12X–1014	----------	12X–1014	LOCK WASHER, armature terminal, 5/16 *J*	4
	28	------	X–180	----------	X–180	NUT, armature terminal, hex, 5/16 NF	4
	29	------	12X–199	----------	12X–199	LOCK WASHER, field terminal and through bolt 1/4″.	3
	30	------	X–2903	----------	X–2903	NUT, field terminal, hex 1/4–NF	1
	31	------	----------	----------	----------	SCREW, pole shoe	1
	32	------	GBM–21C	----------	GBM–21C	NUT, armature shaft, drive end	1
	33	------	12X–864	----------	12X–864	LOCK WASHER, shaft, drive end	1
	34	------	SP–465C	----------	SP–465C	PULLEY	1
	35–42	------	----------	----------	----------	COMPONENT PARTS OF HEAD ASSEMBLY DRIVE END GDZ–1003D.	1
	35	------	X–2853	----------	X–2853	NUT, retainer screw, hex #10 NF	3
	36	606	12X–196	----------	12X–196	LOCK WASHER, retainer screw #10	3
	37	------	GAR–64B	----------	GAR–64B	RETAINER, bearing	2
	38	------	GG–164A	----------	GG–164A	WASHER, felt	2
	39	------	GAR–63B	----------	GAR–63B	RETAINER, felt washer	2
	40	------	X–295	----------	X–295	BEARING, ball, SAE 203	1
	41	------	GDZ–3D	----------	GDZ–3D	HEAD, drive end	1
	42	------	X–25	----------	X–25	SCREW, bearing retaining, rd-hd 10⅞ NF	3
	43	------	X–260	----------	X–260	KEY, woodruff, No. 5	1
	44	------	GR–32B	----------	GR–32B	RETAINER, felt washer	1
	45	------	GAR–171A	----------	GAR–171A	SNAP RING	1
	46	------	GFL–2006FT	----------	GFL–2006FT	ARMATURE, assembly	1
	------	------	606GFL480SAT	----------	----------	GENERATOR, battery charging	1
	------	024	B–462	----------	----------	BRACE, generator adjusting	1
	------	------	B–484	----------	----------	BRACKET, generator	1
	------	------	B–4663	----------	----------	REGULATOR, voltage: generator	1
85	1	606	8X–794	----------	8X–794	NUT, cover band, square, 10 NF	1
	2	------	8X–714	----------	8X–714	SCREW, cover band, rd-hd, 10–1½″ NF	1

Fig. No.	Index No.	Engineer stock No.		Manufacturer's part No.		Federal supply class and item identification No.	Description	Quantity per unit
		Code No.	Part No.	Code No.	Part No.			
	3		MBD–24		MBD–24		BAND, cover	1
	4	606	GAL–40A		GAL–40A		COVER, bearing, commutator end	1
	5		MAD–110		MAD–110		FELT	1
	6		GBF–79		GBF–79		BEARING, absorbent bronze	1
	7		X–1573		X–1573		OILER, press in type, ⅜″	1
	8		MBD–150		MBD–150		WICK, felt	1
	9		MBD–1236		MBD–1236		HEAD, partial, commutator end, assembly	1
	10		MBD–2079		MBD–2079		PLATE, brush, assembly	1
	11		MBD–19		MBD–19		SPRING, brush	8
	12		MBD–47		MBD–47		SPACER, spring	4
	13		GG–81		GG–81		CLIP, brush holder	4
	14		MAK–61		MAK–61		WASHER, armature thrust, commutator end	1
	15		MU–54		MU–54		WASHER, thrust, 1/32″ thk	(*)
	15		MU–54A		MU–54A		WASHER, thrust, 1/64″ thk	(*)
	15		MU–54B		MU–54B		WASHER, thrust, 3/64″ thk	(*)
	16		MBD–2212		MBD–2212		ARMATURE	1
	17		MBD–13A		MBD–13A		BRUSH	2
	18		MBD–12A		MBD–12A		BRUSH	2
	19		MBD–233A		MBD–233A		STUD, terminal	1
	20		MC–51A		MC–51A		WASHER, plain, terminal stud, inner, ⅜″	1
	21		MBD–119		MBD–119		WASHER, insulating, terminal stud	3
	22		MAW–37		MAW–37		BUSHING, insulating, terminal stud	2
	23		MAX–44		MAX–44		WASHER, plain, terminal stud, outer, ⅜″	2
	24		12X–201		12X–201		WASHER, lock, terminal stud, ⅜″	4
	25		MN–47A		MN–47A		WASHER, plain, terminal stud, ⅜″	2

	26		8X–830		8X–830		NUT, hex, terminal stud, ⅜″ NC	4
	27		MBD–12		MBD–12		BRUSH	2
	28		MBD–13		MBD–13		BRUSH	2
	29		MBD–2239		MBD–2239		FRAME AND FIELD, assembly	1
	30		GK–38		GK–38		SCREW, pole shoe	8
	31		MBD–34		MBD–34		TERMINAL	1
	32		SS–119		SS–119		STUD, terminal	1
	33		MBD–15		MBD–15		INSULATION, terminal stud, inner	1
	34		MBD–257		MBD–257		BEARING, absorbent bronze	1
	35		PS–1228		PS–1228		HOUSING, pinion, assembly	1
	36		MBD–254		MBD–254		SCREW, hex-hd, pinion housing, 10 x ⅞″ NF	8
	37		X–196		X–196		WASHER, lock, housing screw, 10	8
	38		MAB–88		MAB–88		PIN, dowel	1
	39		EBA–75		EBA–75		DRIVE, Bendix	1
	40		MBD–285		MBD–285		BEARING, absorbent bronze	1
	41		MBD–1118		MBD–1118		BEARING, intermediate, assembly	1
	42		MBD–76		MBD–76		WASHER, armature thrust, intermediate	2
	43		8X–120		8X–120		SCREW, fill-hd, commutator end head 10 x ⅝″ NF.	12
	5–13, 43						COMPONENT PARTS OF HEAD, assembly, commutator, end MBD–2236C.	
	17–33						COMPONENT PARTS OF FRAME AND FIELD ASSEMBLY MBD–2239.	
		913	43–9533–500–060				WASHER, lock, ⅝ in	3
			106353				SCREW, cap	3
			B–4664				STARTER	1
			B–4665				CONTACTOR	1
			B–1304				ADAPTER, starter	1
86	1		B–260				PUMP, assembly, oil	1
	2		B–2702				PIPE, breather	1
	3		B–319				CAP, breather	1

*As required.

Fig. No.	Index No.	Engineer stock No.		Manufacturer's part No.		Federal supply class and item identification No.	Description	Quantity per unit
		Code No.	Part No.	Code No.	Part No.			
	4		B–2242				GAGE, crankcase level	1
	5		B–265				GEAR, drive, oil pump	1
	6		111991				PIN, driving gear	1
	7	226	10016				SEAL, oil pump	1
	8	024	B–261				BODY, oil pump	1
	9	912	42–5416–500–180				KEY, ⅛″ x ½″	1
	10	024	B–267				SHAFT, drive, oil pump	1
	11	912	42–5416–500–180				KEY, ⅛″ x ½″	1
	12		B–263				GEAR, oil pump drive	1
	13		B–310				RING, retaining, driving gear, oil pump	1
	14	913	43–953–500–030				WASHER, lock, ¼″	6
	15	913	43–6777–030–060				SCREW, cap: NC, hex hd, ¼ in. x ⅝″ long; 20 threads per in.	6
	16		B–270				STRAINER, oil pump	1
	17	913	43–9533–500–040				WASHER, lock, ⅜ in	2
	18	913	43–6792–040–130				SCREW, cap, ⅜″—16 x 1¼″	2
	19	024	B–271				BAIL, oil strainer	1
	20	914	45–6040–500–004				PLUG, pipe, ⅜ in	1
	21	913	43–6777–040–080				SCREW, cap	14
	22	913	43–9533–500–040				WASHER, lock, ⅜ in	14
	23	024	B–1057				GASKET, oil pan	2
	24		B–1055				PAN, oil, crankcase	1
	25		B–268				SHAFT, idler gear, oil pump	1
	26		B–263				GEAR, idler, oil pump	1
	27		B–262				COVER, oil pump	1

90	1	024	B–4065				ARM ASSEMBLY, rocker, intake valve: offset to front.	2
	4		B–1011				SHAFT, rocker arm, with expansion plug	1
	5	913	43–4489–040–240				NUT, ⅜ in., NF, hex, 24 threads per in	2
	6	913	43–9215–500–040				WASHER, ⅜ in	4
	7		B–176				CLIP, spring, rocker arm bracket	4
	8		B–4051				BRACKET, rocker arm	4
	9		B–4052				ASSEMBLY, push rod	8
	10		B–1113				LIFTER, valve	8
	11		B–1014				CAMSHAFT	1
	12		B–2467				PLATE, thrust, camshaft	1
	13	912	42–5416–500–300				KEY, Woodruff: ¼ x ⅜ in	1
	14		110405				WASHER, lock, 7/16"	2
	15		B–2468				SCREW, cap, drilled	1
	16		122213				SCREW, cap 7/16"–14 x 9/16"	1
	17		B–313				RETAINER, camshaft gear	1
	18		B–2070				GEAR, helical, camshaft	1
	19		B–1252				LINE ASSEMBLY, oil, crankcase to head	2
	20	913	43–6792–040–330				SCREW, cap: NC hex hd, ⅜ in. dia, 3¼ in. long, 16 threads per in.	2
91	1	024	B–4066				ARM ASSEMBLY, rocker, intake valve: offset to rear.	2
	1		B–4143				ARM, assembly, rocker, exhaust, offset to front.	2
	1		B–4142				ARM, assembly, rocker, exhaust, offset to rear.	2
	2		251877				ELBOW, ¼"–90	3
	3		B–2408				LINE ASSEMBLY, overflow, rocker arm shaft.	1
95	1	913	43–4459–040–240				NUT, ⅜ in. NF	8
	2	913	43–4489–040–240				WASHER, lock, ⅜ in	8
	3	024	B–2009				FLANGE, retainer, air cell	4

Fig. No.	Index No.	Engineer stock No.		Manufacturer's part No.		Federal supply class and item identification No.	Description	Quantity per unit
		Code No.	Part No.	Code No.	Part No.			
	4	024	B–2935				CELL AIR ASSEMBLY	4
	5	024	B–967				PLUG, air cell	4
	6		56080				RETAINER, valve spring	8
	7		DE–53139				RETAINER, valve spring	8
	8	024	B–4082				SPRING, compression, valve	8
	9	024	B–282				VALVE, intake	4
	10	024	B–2003				VALVE, exhaust	4
	11		B–3875				STUD, rocker arm bracket	2
	12	024	B–1050				STUD, mounting, manifold	4
	13		B–166				GUIDE, valve	8
95	14		B–2010				STUD, air cell	8
	15	910	18–4700–700–130				PLUG, expansion, 1/14 in	2
	16	024	1656				STUD NOZZLE	8
	17	024	B–2004				SEAT, exhaust valve	4
	18	915	43–4489–040–240				NUT, 3/8 in	2
	19		105451				WASHER, 3/8 in	2
	20	024	B–4080				COVER, cylinder head	1
	21	024	B–1034				GASKET, cover, cylinder head	1
	22		B–1707				NUT, cylinder head stud	14
	23	024	B–1426				GASKET, cylinder head	1
	24		DE–56080		DE–56080		LOCK, valve spring retainer	8
100	1	024	MQC–311				PISTON RING SET, regular	4
	1		MQC–3110				PISTON RING SET, expander type	4
	2	024	2204				RETAINER, piston pin	8
	3		B–2860				PIN, piston	4
	4	024	B–3457P				PISTON, with piston pin retainers	4

	5	024	B–145				BUSHING, connecting rod	4
	6	024	B–2582				ROD ASSEMBLY CONNECTING	4
	7	024	B–143				BOLT, connecting rod	8
	8 & 9		B–2741				BEARING, plain	4
	8 & 9		B–2741A				BEARING 0.010 undersize	4
	8 & 9		B–2741B				BEARING 0.020 undersize	4
	8 & 9		B–2741D				BEARING 0.040 undersize	4
	10		B–2582		B–2582		CAP, bearing, connecting rod	4
	11		2255				NUT, castle, connecting rod bolt	8
	12		103373				PIN, cotter	8
	13		B–3800				CRANKSHAFT	1
	14	912	42–5416–500–300				KEY, ¼ in. x ⅞ in	2
	15		B–101				GEAR, helical, crankshaft	1
	16	024	B–639				PULLEY, fan drive	1
	17		B–306				WASHER, star	1
	18	024	B–586				JAW, starting crank	1
	19		B–1231				ASSEMBLY, hand crank	1
	20		1112				PIN, crank	1
108	1		B–3253				ASSEMBLY, gear cover	1
	2		B–531				GASKET, gear cover	1
	3		B–3157				PLATE, cylinder, front	1
	4	024	B–127				GASKET, front plate	1
	5	913	43–9533–500–040				WASHER, lock	3
	6	913	43–6777–040–060				SCREW, cap	2
	7		141244				DOWEL	2
	8						GASKET, inspection plate	1
	9						COVER, inspection plate	1
	10	913	43–6777–040–100				SCREW, cap, ⅜ in	
	11	913	43–4445–040–160				NUT, ⅜ in	3
	12		106333				SCREW, cap, ⅜ in	1
	13		B–3052				SUPPORT, front	1
115	1		103897				PLUG, expansion, 1¾ in	4

Fig. No.	Index No.	Engineer stock No.		Manufacturer's part No.		Federal supply class and item identification No.	Description	Quantity per unit
		Code No.	Part No.	Code No.	Part No.			
	2		B–315				STUD, cylinder head, short	10
	3		B–316				STUD, cylinder head, long	4
	4		B–4097				BLOCK, cylinder	1
	5	910	08–4700–700–100				PLUG, expansion 1 in	1
	6	910	08–4700–700–150				PLUG, expansion 1½ in	1
	7	024	B–157				BEARING, camshaft, rear	1
	8	024	B–156				BEARING, camshaft, intermediate	2
	9	024	B–155				BEARING, camshaft, front	1
	10		3813				GASKET, head pad cover	1
	11		B–332				COVER, fuel pump pad	1
	12	913	43–9533–500–033				WASHER, lock 5/16 in	2
	13	913	43–4489–035–240				NUT	2
	14		B–1415				STUD, mounting, fuel pump	2
	15						PLUG, pipe, ⅜ in. CTSK HD	2
	16	914	45–6068–500–004				PLUG, pipe, ⅜ in. ctsk hd	1
	17	913	43–4162–070–160				NUT, jam, ¾ in	1
	18		B–3810				SCREW, adjusting, oil pressure regulator	1
	19	024	B–2740				BEARING, crankshaft, rear	1
	20	024	B–2738				BEARING, crankshaft, intermediate	2
	21		B–1865				CAP, bearing, rear	1
	22		B–2098				DOWEL, bearing cap	10
	23		B–630				CAP, bearing, intermediate	2
	24		DE–5476				LOCK WIRE	5
	25		B–327				CAP SCREW, 9/16–12 x 3½	10
	26		B–1999				CAP, bearing, front	1
	27		B–1998				CAP, bearing, center	1

	28		B–2737				BEARING, crankshaft, front	1
	29	024	B–2689				BEARING, crankshaft, center	1
	30	024	113897				GASKET, oil pressure relief valve cap	1
	31	024	B–231				SPRING, compression, oil pressure regulator	1
	32	024	B–230				PISTON, oil pressure relief valve	1
	33		B–3798				INSERT, Oil Pressure Regulator	1
	34	914	45–6074–500–001				PLUG, Pipe, ⅛ In. Slotted	1
	35	914	45–6050–500–003				PLUG, Pipe, ¼ In. Sq. HD	1
	36	896	140				VALVE, Drain Cock	2
116	1	913	43–9533–500–050				WASHER, Lock, ½ In	7
	2		4054				SCREW, Cap, Flywheel Housing ⅝–11 x ¾	7
	3	913	43–9533–500–050				WASHER, Lock, ½ In	4
	4	024	B–318				SCREW, Cap, Flywheel	4
	5		B–1760				FLYWHEEL	1
	6	024	DE–50235				GEAR, Ring, Flywheel	1
	7	910	08–4700–700–050				PLUG, Expansion, ½ In	2
	8	024	141238				DOWEL, Housing	2
	9	024	B–504				SEAL, Oil, Flywheel Housing	1
	10		B–300				DOWEL, Flywheel	2
	11	024	B–742				HOUSING Assembly, Flywheel	1
	12	024	B–2930				SEAL, OIL, Flywheel Housing, outer	1
	13	024	B–582				RETAINER, Oil, Seal, Flywheel Housing	1
	14		172332				SCREW, retainer	6
	15		100181				SCREW, cap ⅝–11 x ¾	3
	16	913	43–9533–500–061				WASHER, lock, ⅝ in	3
	17	024	DE–3737				COVER, starter pad	1
	18	914	45–6068–500–007				PLUG, pipe ¾ in	1
123	1		GE				ASSEMBLY, stator	
	2		GE				ASSEMBLY, shaft and rotor	1
	3		GE				ASSEMBLY, bearing and retainer	1
	4		GE				SHIELD, collector end	1
	5		GE				COVER, inspection, exciter	1

Fig. No.	Index No.	Engineer stock No.		Manufacturer's part No.		Federal supply class and item identification No.	Description	Quantity per unit
		Code No.	Part No.	Code No.	Part No.			
	6	------	GE				FRAME, magnet	1
	7	------	GE				ARMATURE	1
	8	------	GE				COVER, exciter fan	1
	9	------	GE				BOLT, armature hold-on	1
	10	------	GE				SCREW, exciter fan cover	4
	11	------	GE				PLUG, relief	1
	12	------	GE				BOLT, magnet frame	4
	13	------	GE				BOLT, end shield	4
	14	------	GE				STUD, brush holder	1
	15	------	GE				BOLT, stator hold-down	4
133	1	------	DL-7877				BASE, sub-	1
	2	------	120572				SCREW, truss head	4
	3	913	43-9533-500-030				WASHER, lock	4
	4	024	DL-7955				PLATE, rear cover	1
	5	------	DL-70018				BRACKET, fuel valve	1
	6	913	43-6777-030-200				SCREW	2
	7	913	43-4445-030-200				NUT	2
	8	024	DL-7957				DOOR ASSEMBLY, tool box	1
	9	913	43-4445-030-200				NUT	4
	10	913	43-9533-500-030				WASHER, lock	4
	11	------	120572				SCREW	4
	12	913	43-4445-030-200				NUT	1
	13	024	DL-7966				KNOB	1
	14	------	113959				SCREW	1
	15	913	43-9533-500-050				WASHER, lock	1

APPENDIX III

ON-EQUIPMENT TOOLS AND SPARE PARTS

1. General

The tools and spare parts normally supplied with this generator set for the use of the operator are listed in paragraph 2. This list may be supplemented or modified by the proper authority.

2. Tool and Spare Parts List

(fig. 136)

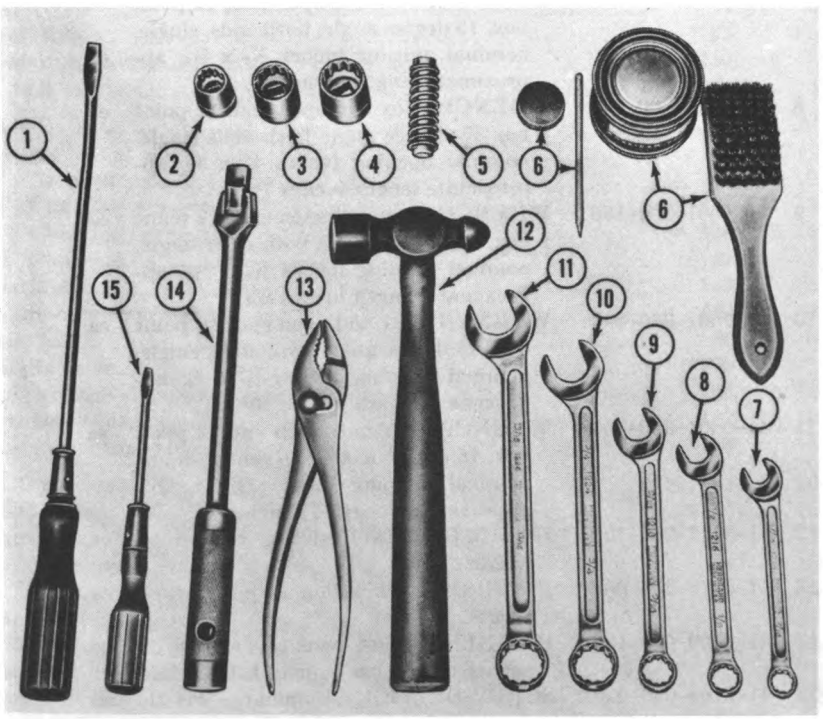


Figure 136. On-equipment tools and spare parts.

Index No.	GE/SN	Nomenclature	Unit	Quantity
1	41–7165–100–040	SCREWDRIVER, Common, Plastic handle 10 inches long x 3/8 inch wide blade.	ea	1
2	41–9892–057–180	WRENCH, Socket, socket only, 1/2 inch square drive, 12 point opening, regular single 9/16 inch.	ea	1
3	41–9892–057–240	WRENCH, Socket, socket only, 1/2 inch square drive, 12 point opening, regular single 3/4 inch.	ea	1
4	41–9892–057–260	WRENCH, Socket, socket only, 1/2 inch square drive, 12 point opening, regular length single 13/16 inch.	ea	1
5		SPRING, Governor, inner, for Bosch PSB fuel injection pump 50 cycle operation.	ea	1
6		KIT, Service, injector nozzle	ea	1
7	41–9601–300–140	WRENCH, Box and open end, 12 point box, 15 degree angle, both ends, single, nominal opening inches 7/16 x 7/16, approximate length inches 7.	ea ea	1 1
8	41–9601–300–160	WRENCH, Box and open end, 12 point box 15 degree angle both ends single, nominal opening inches 1/2 x 1/2, approximate length inches 7 5/8.	ea	1
9	41–9601–300–180	WRENCH, Box and open end, 12 point box, 15 degree angle both ends single, nominal opening inches 9/16 x 9/16, approximate length inches 8 1/4.	ea	1
10	41–9601–300–240	WRENCH, Box and open end, 12 point box, 15 degree angle both ends, single, nominal opening inches 3/4 x 3/4, approximate length inches 10 5/8.	ea	1
11	41–9601–300–250	WRENCH, Box and open end 12 point box, 15 degree angle both ends, single, nominal opening inches 13/16 x 13/16, approximate length 10 inches.	ea	1
12	41–4277–200–100	HAMMER Machinist's, ball peen handled 1 lb.	ea	1
13	41–5976–300–080	PLIERS, Combination slip joint, 8 inches.	ea	1
14	41–4569–050–120	HANDLE Socket wrench, sliding T square drive inch 1/2, length 12 inches.	ea	1
15	41–7165–030–020	SCREWDRIVER, Common, Plastic handled, 3 inches long x 3/16 inch wide blade.	ea	1
Not Illustrated				
	13–5496–005–095	OILER, steel round force feed, 1 pt capacity, 10 inch flexible spout.	ea	1
	41–4141–009–785	GUN, lubricating pressure type, hand operated alemite 9 oz No. 7585.	ea	1
	99–1999–000–010	MODIFICATION KIT, MWO ENG 1999–1, for lubrication guides, check cards and manuals.	ea	1

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[AG 412.41 (1 Dec 53)

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