TM 5-5002

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

GENERATOR SET

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

CONSOLIDATED DIESEL ELECTRIC MODEL 1664

DEPARTMENT OF THE ARMY • AUGUST 1955

SAFETY PRECAUTIONS

Before making any connections, make sure the electrical contactor has been tripped and the generator set is not operating.

Do not have a load greater than 15 kw on the service lines when removing one of two units operating in parallel. If the load is too great for one generator to handle and the second unit is removed from the line, overloading will result.

If fuel is still dripping from the overflow tube by the time the heater is ready for ignition, do not start the heater. Shut off the fuel supply and refer to the troubleshooting section.

Never operate the heater with the manual ignition port open.

Incorrect timing will shorten engine life and reduce power.

When using the fire extinguisher, put out the flames quickly and avoid exposure to smoke and fumes.

Do not use gasoline to clean the diesel fuel tank. Gasoline fumes are dangerous even after flushing. Keep tanks clear of spark or flame.

Always neutralize the cooling system after a cleaning solvent has been used.

When removing or installing wiring, follow instructions and the wiring diagram carefully. Mark or tag any wires or terminals not marked or whose markings have become illegible.

Do not use emery cloth to clean the commutators or to seat the brushes. The abrasive material will cause short circuits and seriously damage the electrical equipment.

After a charging generator has been installed or when the leads to it have been disconnected, the generator must be in correct polarity with the battery before starting the engine. Severe damage to electrical equipment may result from reversed generator polarity which causes the relay contact points in the regulator to vibrate arc, and burn.

Clean all grinding compound from the valve seats and stems before reinstalling.

Before doing any work on the switchboard, make sure the generator set is not operating.

When using test prods or contact fingers, never touch brush contact surfaces or bearing surfaces, since an arc will mar the finish.

When hoisting the generator or engine do not let them swing and damage equipment or injure personnel.

Keep all dirt or foreign material out of the cylinders or recesses in the block.

Do not run the engine at high speeds or under full load when cold.

Do not operate the generator set within a closed building or vehicle unless the exhaust gases are piped to the outside. Exhaust gases contain carbon monoxide which is a deadly poison.

Before starting the engine heater, make sure the valves in the coolant lines to the heater are open.

TECHNICAL MANUAL No. 5-5002 } DEPARTMENT OF THE ARMY
WASHINGTON 25, D. C., 11 August 1955

GENERATOR SET, PORTABLE, DIESEL DRIVEN, SKID MOUNTED, 15 KW, 120-208 OR 240-416 VOLT, 3 PHASE, 60 CYCLE CONVERTIBLE TO 120-208 OR 240-416 VOLT, 3 PHASE, 50 CYCLE, CONSOLIDATED DIESEL ELECTRIC MODEL 1664

CHAPTER 1

INTRODUCTION

Section I. GENERAL

1. Scope

a. These instructions are published for the use of the personnel to whom the generator set is issued. They contain information on the operation and organizational maintenance of the generator set as well as a description of the major units and their functions in relation to other components of the materiel. They apply only to the Consolidated Diesel Electric Model 1664.

b. Supply manuals, technical manuals, and other publications applicable to the equipment covered by this manual are listed in appendix I. Appendix II tabulates the replaceable parts available for the equipment. Appendix III lists the tools issued with and carried on or with the equiment.

2. Record and Report Forms

a. DA Form 5–13, Spotcheck Inspection Report of Organizational Maintenance of Engineer Equipment. Organizations having engineer field maintenance responsibility use DA Form 5–13 for reporting the results of semiannual spotcheck inspections.

b. DA Form 5–14, Annual Technical Inspection Report of Engineer Equipment. Organizations having engineer field maintenance responsibility use DA Form 5–14 for reporting the results of annual technical inspection.

c. DA Form 9–71, Locator and Inventory Control Card. DA Form 9–71 is used by highly mobile engineer units for controlling stock levels, and locating parts and supplies.

d. DA Form 9–77, Job Order Register. A record of all work requests and job orders within the using organization is maintained on DA Form 9–77.

e. DA Form 9–79, Parts Requisition. DA Form 9–79 is used in engineer units to issue repair parts and common supplies from the parts supply room to the operators and mechanics.

f. DA Form 9–81, Exchange Part of Unit Identification Tag. DA Form 9–81 is used to accomplish the direct exchange of unserviceable for serviceable parts.

g. DA Form 285, Accident. DA Form 285 is used by supervisors for reporting all accidents causing serious injury or death to personnel or damage to property and equipment, including Army aircraft accidents, non-Army motor vehicle accidents, and Army fires.

h. DA Form 446, Issue Slip. DA Form 446 is used for requisitioning repair parts from sources outside the using organization.

i. DA Form 447, Turn-in-Slip. DA Form 447 is used by units for turning in unserviceable and excess serviceable parts and equipment to supply officers.

j. DA Form 460, Preventive Maintenance Roster. DA Form 460 is used for scheduling preventive maintenance services at proper intervals.

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

l. DA Form 468, Unsatisfactory Equipment Report. DA Form 468 is used for reporting manufacturing, design, or operational defects in the equipment, with a view of correcting such defects; it also is used for recommending modifications of the equipment. Form 468 is not used for reporting equipment failures, isolated defects, or malfunctions resulting from ordinary wear and tear or accidental damage. Form 468 is not used to report issue of parts and equipment, or for reporting replacements or repairs.

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

n. DD Form 518, Accident-Identification Card. DD Form 518 is carried on all items of equipment at all times. In case of an accident, the operator completes the form and gives a copy to his supervisor and to each person involved.

o. DA Form 811, Work Request and Job Order. DA Form 811 is used to request work to be done by higher echelon organizations.

p. DA Form 867, Status of Modification Work Order. DA Form 867 is used to maintain records of all modification work performed on equipment.

q. DD Form 6, Report of Damaged or Improper Shipment. DD Form 6 is used for reporting damage incurred in shipment.

r. DD Form 110, Vehicle and Equipment Operational Record. Operators use DD Form 110 to maintain a vehicle or equipment operational record. It also is used by operators for reporting accomplishment of daily preventive maintenance services, and for reporting any deficiencies observed in the vehicle or equipment during operation.

Section II. DESCRIPTION AND DATA

3. Description

a. General Information. The Consolidated generator set, Model 1664 (fig. 1), is a portable, skid-mounted, canopy-covered, winterized unit. It is powered by a four-cylinder, full diesel engine (11, fig. 2), direct coupled to a 15-kw (kilowatt) a-c (alternating-current) generator (13). The unit is complete with all controls and instruments necessary for operation. Components of the unit are accessible through hinged side and rear panels.

b. Engine. The engine (11, fig. 2) is a Continental Model HD 260, four-cylinder, four-stroke-cycle, cold-starting, full diesel.

(1) The engine is rated at 32.5 continuous brake horsepower at 1,200 rpm (revolutions per minute) and 29.25 continuous brake horsepower at 1,000 rpm. The single plunger fuel injector pump (17, fig. 3), with its governor, regulates engine operation from idle to full load.

(2) The engine heater (12, fig. 2) and the heavy-duty batteries, located in the battery box (1), enable starting at a temperature as low as –65° F. (Fahrenheit).

(3) A gear type oil pump, located in the crankcase, furnishes full pressure lubrication to all parts of the engine. Oil pressure is automatically regulated by the pump.

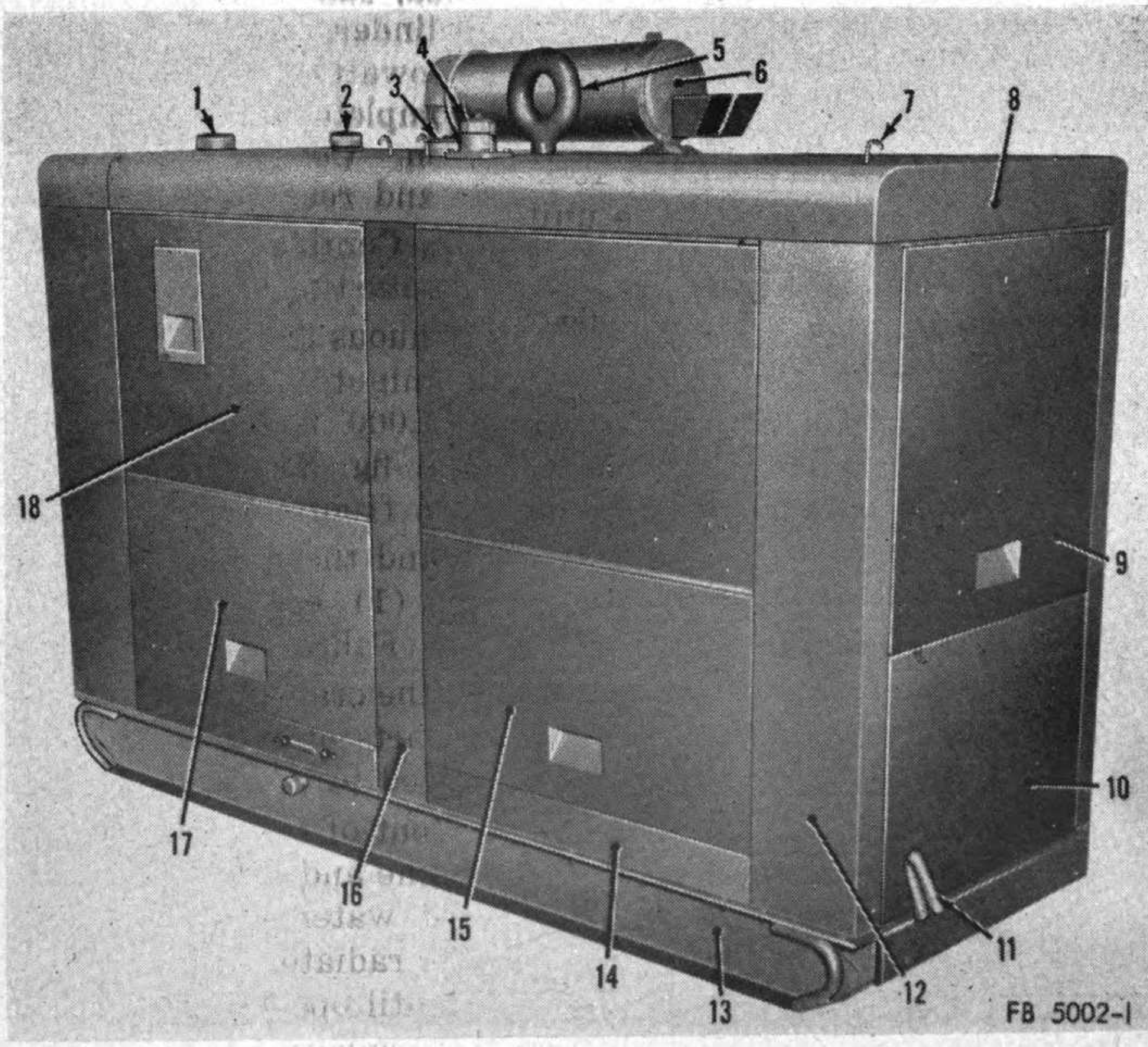
(4) A water pump, located in the front of the engine block, circulates water through the engine and radiator (1, fig. 3). A thermostatically operated water bypass system shuts off the flow of water to the radiator and directs it to the pump to be recirculated until operating temperature is reached. When operating temperature is reached, a second thermostat (1, fig. 4) opens the radiator shutters.

(5) Safety devices are provided to shut down the engine in the event of high water temperature, low oil pressure, or overspeed.

c. General. The generator (18, fig. 4) is a Kato Model 52MSSS, wye-connected, rotating field alternator with a d-c (direct-current), stationary field exciter (15) mounted on the same shaft. The unit is designed to supply power to either a 50- or 60-cycle system.

(1) When operating as a 60-cycle machine, the generator is rated at 15 kw and will provide terminal voltages of either 120–208 or 240–416 volts. As a 50-cycle machine, the generator is rated at 12.5 kw and 240–416 volts.

(2) The revolving field windings are energized by a d-c excitation current to produce the required magnetic field. This excitation current is supplied through sliprings by the d-c exciter (15). The exciter is a conventional four-pole, self-excited, d-c generator directly coupled to the main generator shaft.



1	Radiator cap	8	Top housing	14	Skirt
2	Heater fuel tank cap	9	Switchboard door housing	15	Left rear lower door housing
3	Diesel fuel tank cap	10	Rear access panel assembly	16	Center post housing
4	Battery-charging receptacle	11	Cable sleeve	17	Left front lower door housing
5	Lifting eyebolt	12	Corner post	18	Left front top door housing
6	Muffler	13	Skid base		
7	Door fastener				

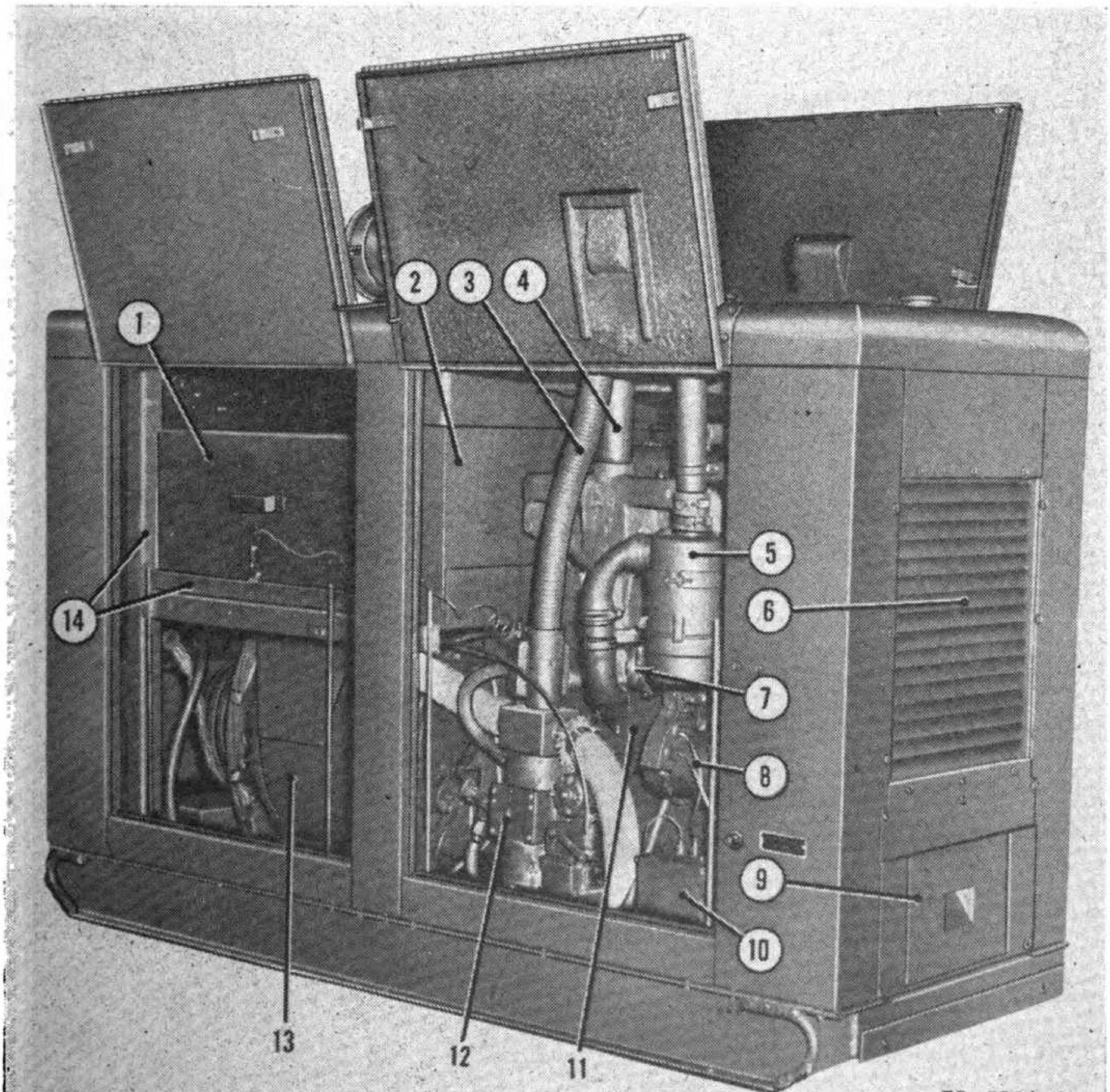
Figure 1. Generator set, housing in place.

(3) Alternating current is generated in the stator windings which are directly connected to the changeover panel (13). Connections for the desired voltage are made at the changeover panel and tapped at the load terminal block (16).

(4) Generator voltage output can be either automatically controlled by a regulator in the control cabinet or manually controlled by a rheostat mounted on the door section switchboard panel (10).

(5) Cooling air is forced through the generator by a shaft-mounted fan.

(6) Safety devices are provided which effect the opening of the main breaker switch when the machine overspeeds or is overloaded.

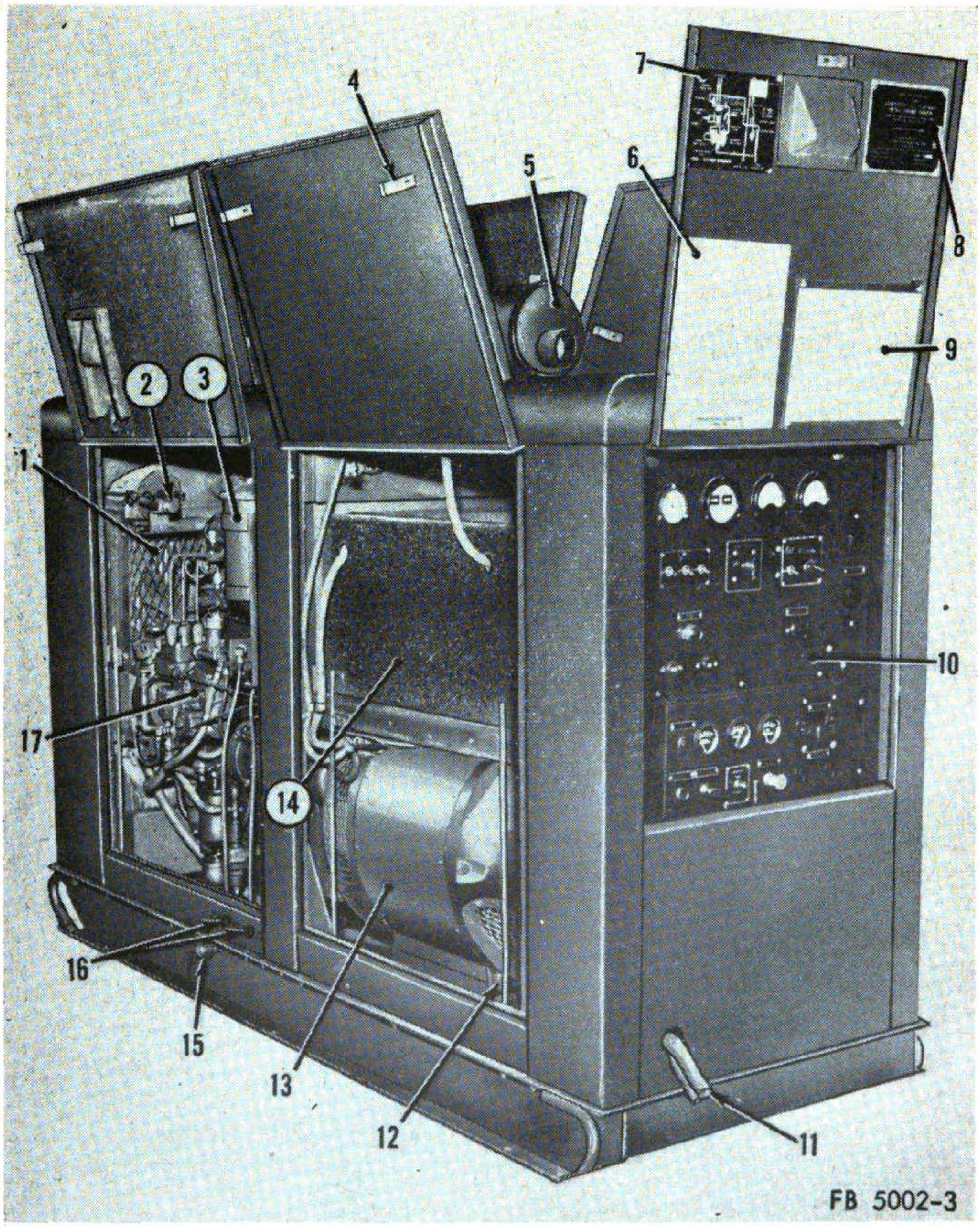


1	Battery box	5	Air cleaner	10	Voltage regulator
2	Diesel fuel tank	6	Radiator shutter	11	Engine
3	Heater exhaust flexible hose	7	Flame heater assembly	12	Engine heater
4	Engine exhaust pipe	8	Battery-charging generator	13	Generator
		9	Toolbox door	14	Frame assembly

Figure 2. Right side of generator set, door housing open.

4. Identification
(fig. 5)

The generator has four identification plates. The Corps of Engineers identification plate (A), on the switchboard door housing, specifies the nomenclature, model number, serial number, weight, manufacturer's name, date of manufacture, and stock



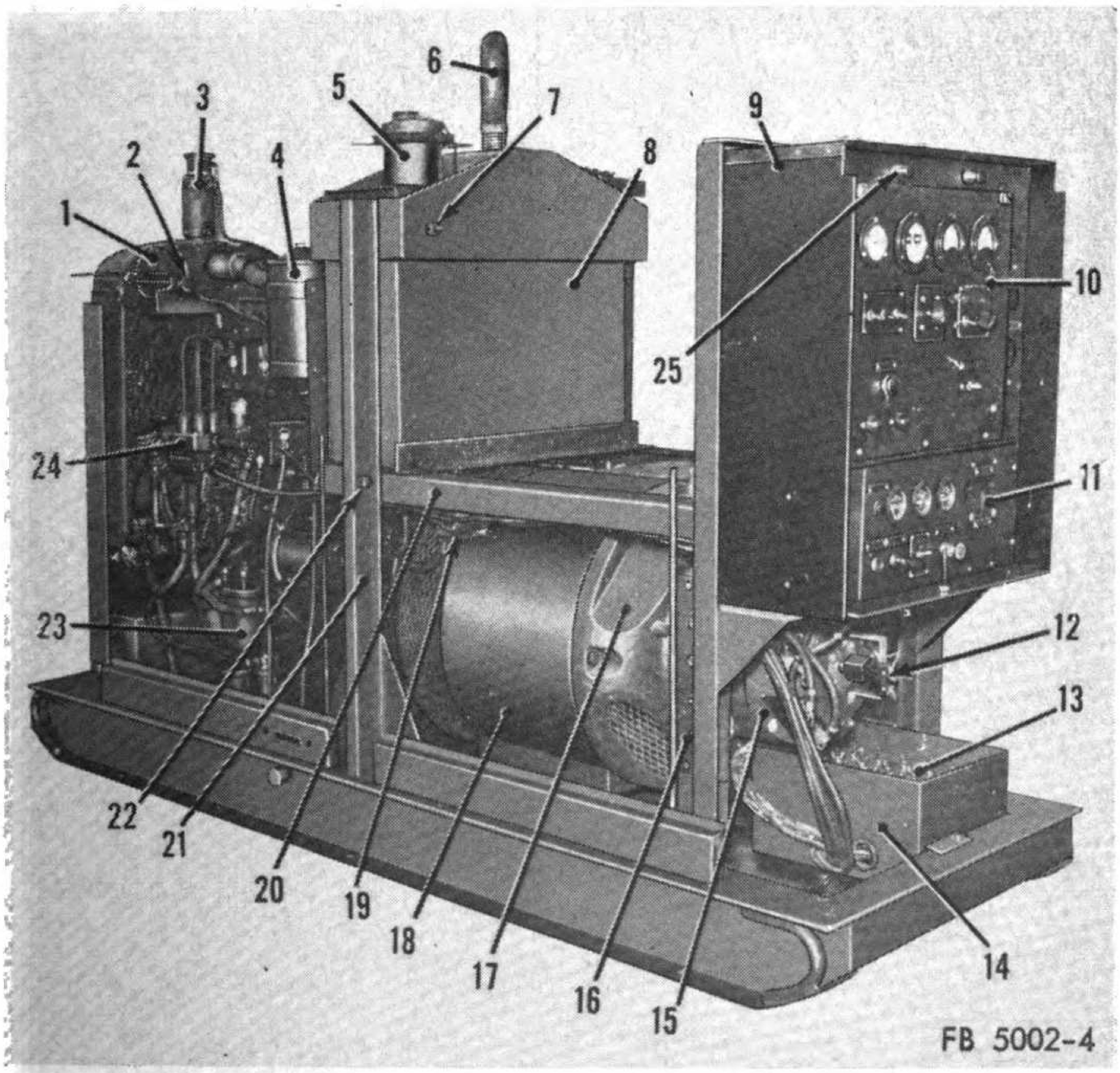
1	Radiator assembly	7	Fuel system diagram	13	A-c generator
2	Manual shutter control	8	Identification plate	14	Battery box
3	Oil filter	9	Wiring diagram	15	Oil drain nipple
4	Door latch	10	Main switchboard panel	16	Auxiliary line inlet and outlet
5	Muffler	11	Cable sleeve	17	Fuel injector pump
6	Operating instructions	12	Door latch bar		

Figure 3. Generator set, left side and control panel.

list number of the generator set. The two generator data plates (C) and (D), on the left side of the main generator, specify the manufacturer, model number, and operating data at 60 and 50 cycles respectively. The engine identification plate (B), on the right side of the engine, specifies the manufacturer and the engine number.

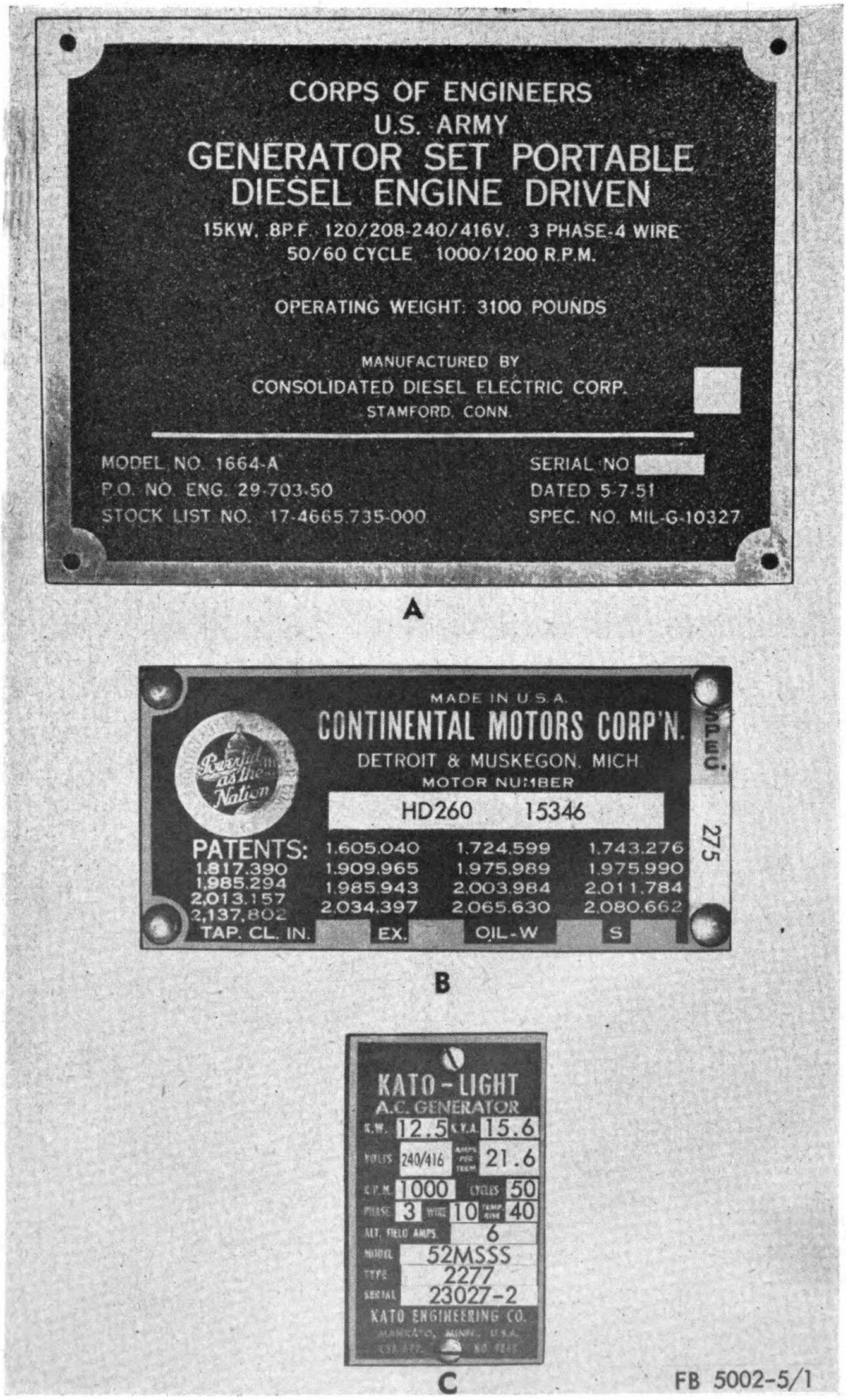
5. Differences in Models

This manual covers only the portable generator set Model 1664, purchased by the Corps of Engineers from the Consolidated Diesel Electric Corporation, of Stamford, Connecticut.



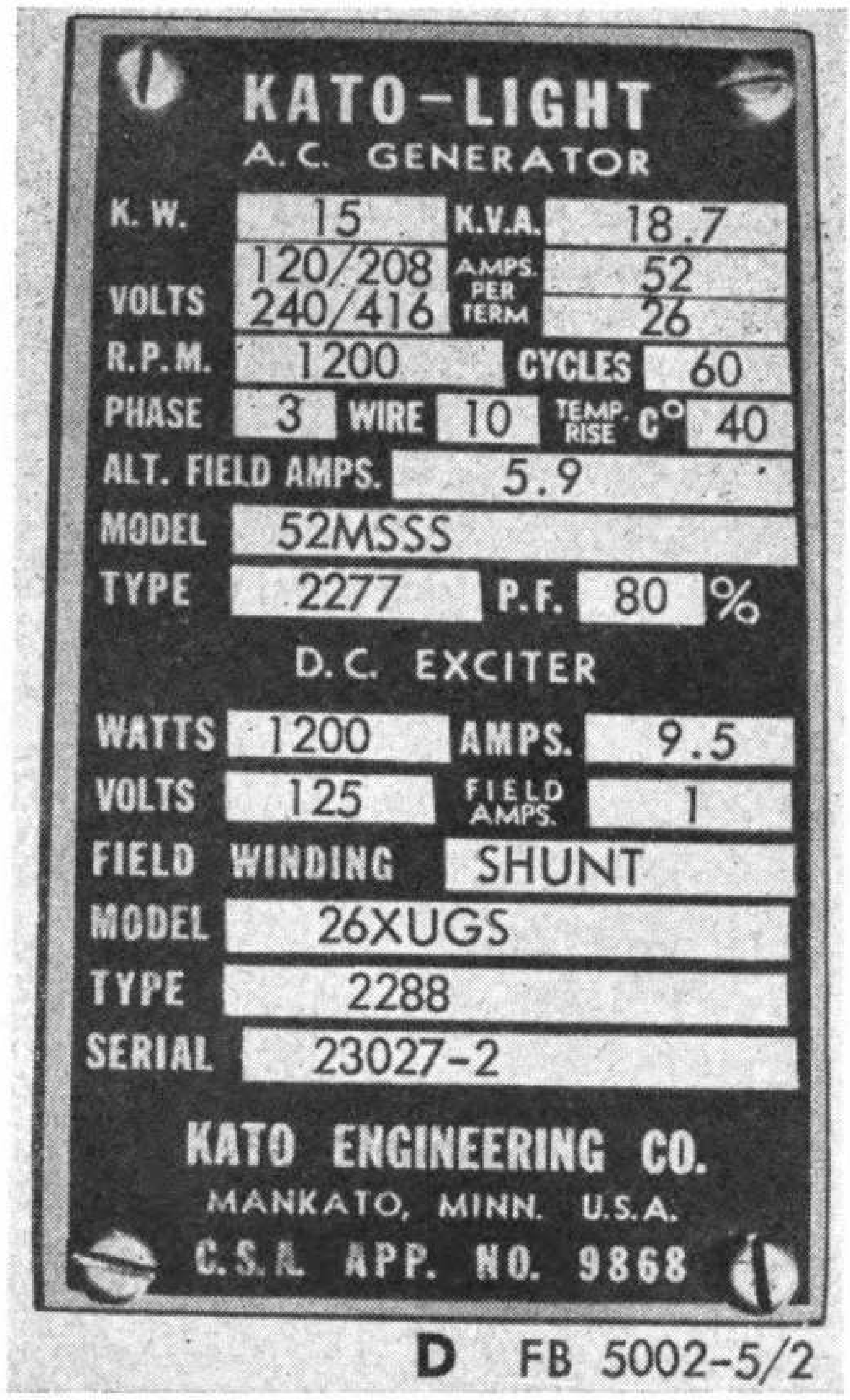
1 Radiator shutter thermostat
2 Manual shutter control
3 Radiator filler neck
4 Oil filter
5 Fuel tank filler neck
6 Lifting eyebolt
7 Receptacle ground
8 Fuel tank
9 Main switchboard panel
10 Door section switchboard panel
11 Engine control switchboard panel
12 Overspeed microswitch
13 Changeover panel
14 Transformer box
15 Exciter
16 Terminal block
17 Alternator inspection plate
18 A-c generator
19 Starter solenoid relay
20 Frame assembly
21 Lifting frame
22 Bolt w/nut and lockwasher (2 req'd)
23 Secondary fuel filter
24 Injector pump
25 Panel light

Figure 4. Generator set, housing removed.



A. Corps of Engineers identification plate. B. Engine identification plate. C. Generator data—50-cycle operation.

Figure 5. Identification plates.



D. Generator data—60-cycle operation.

Figure 5—Continued.

6. Tabulated Data

Listed below for ready reference is a tabulation of important information concerning the generator set, its main components, and accessory equipment.

a. Generator Set.

Manufacturer	Consolidated Diesel Electric Corp.
Model	1664
Length, overall	84 inches
Width, overall	30 inches
Height, overall	57½ inches
Operating weight	3,100 pounds

b. Engine.

Manufacturer	Continental Motors Corp.
Model	HD 260 Special
Type	Full diesel
No. of cylinders	4
Bore and stroke	3⅞ x 5½ inches
Piston displacement	260 cubic inches
Compression ratio	15:1
Continuous horsepower at 1,200 rpm	32.5
Continuous horsepower at 1,000 rpm	29.25
Rpm (governed speed)	1000/1200

Firing order	**1,3,4,2**
Number of main bearings	**3**
Cylinder sleeves	**Wet**
Lubrication	**Pressure and splash**
Cooling	**Liquid, centrifugal pump**
Cooling system capacity	**21 quarts**
Crankcase oil capacity	**7 quarts**
Engine fuel tank capacity	**14 gallons**
Normal operating oil pressure	**40 psi**
Normal operating water temperature	**165° F.**
Cylinder-head torque (hot)	**130 to 140 foot-pounds**
Inlet valve tappet clearance (hot)	**0.014 inch**
Exhaust valve tappet clearance (hot)	**0.014 inch**

c. Generator.

Manufacturer	Kato Engineering Co.
Model	52MSSS
Type	2277
Rated speed, 60-cycle/50-cycle	1200/1000
Alternator:	
Number of phases	3
Number of wires	10
Kw, 60-cycle/50-cycle	15/12.5
Power factor	0.8
Kva, 60-cycle/50-cycle	18.75/15.63
Volts, 60-cycle	120/208–240/416
Volts, 50-cycle	240/416
Amperes, full load, 60-cycle/50 cycle	52/21.6
Temperature rise	
Stator	40° C.
Field	40° C.
Bearings	50° C.
Number of bearings	1
Drive	Direct coupled
Exciter:	
Model	26XUGS
Type	2288
Rated kw	1.2
Voltage	125
Amperes, full load	10
Field amperes	1
Temperature rise above ambient	40° C.
Mounting	Integral, main generator shaft
Generator voltage regulator:	
Make	Electric Regulator Corp.
Type	CD–115, plug-in
Volts	120
Main circuit breaker:	
Make	Automatic Switch Co.
Type	3-pole
Amperes	60
Volts	600

d. Accessories.

Starting motor:	
Make	Auto-lite
Type	MCC–4002–T
Volts	24
Battery-charging generator:	
Make	Auto-lite
Type	GHG–6001–AT
Volts	24
Amperes	10
Battery-charging generator regulator:	
Make	Auto-lite
Type	VRV–6002–T
Volts	24
Amperes	10
Batteries:	
Number	2
Voltage per battery	12
Type	Frigid
Air cleaner (intake):	
Make	Vortox
Model	G–55
Type	Oil bath
Air cleaner (inlet cap):	
Make	Vortox
Model	6427
Type	Wire baffle
Cooling fan:	
Number of blades	6
Type	Pusher
Heater:	
Make	Perfection Stove Co.
Model	460–L–7 (Special top)
Capacity (Btu)	40,000 per hour
Fuel tank capacity	6 gallons
Fuel	Gasoline
Fire extinguisher:	
Type	Vaporizing liquid
Capacity	1 quart
Fuel injector pump:	
Make	American Bosch
Type	Single plunger
Model	PSB4A–80C–29401A
Mounting	Timing gear housing, left side of engine block
Drive	Gear
Rotation	Counterclockwise from timing gear end
Drive ratio, pump to engine speed	1:1
Fuel supply pump:	
Make	American Bosch
Type	Positive displacement

Fuel supply pump—Continued

Mounting	Integral with fuel injector pump
Drive	Integral camshaft
Primer	Hand-operated, positive action
Operating pressure	6 to 8 psi

Sediment bowl:

Make	Consolidated Diesel Electric Corp.
Type	Screw-on, gravity, with drain

Fuel filter (primary):

Make	Consolidated Diesel Electric Corp.
Model	GD157F–202
Type	Replaceable cartridge element

Fuel filter (secondary):

Make	Fram
Model	HD260F–4090
Type	Replaceable cartridge element

Governor:

Make	American Bosch
Type	Mechanical centrifugal
Mounting	Integral with injector pump
Drive	Direct
Governed speed	600 to 1200

Lubricating oil filter:

Make	Fram
Model	Military standard
Type	Replaceable cartridge element
Mounting	Frame bracket

Thermostat (engine block):

Make	Continental Motors Corp.
Opening temperature	160° F.

Thermostat (shutter control):

Make	Hardy Mfg. Co.
Opening temperature	140° F.

e. *Foundation Plan (fig. 6).*

(1) *General.* The unit is designed for field use without the need of a foundation or shelter. The unit should be leveled as nearly as possible, but it will operate satisfactorily at an angle of 15° with the horizontal. The skid base is drilled with three holes on each side and can be bolted to a concrete or wooden platform.

(2) *Foundation.*

(*a*) If a concrete foundation is to be used, select the best possible site. A base of rock, gravel, or sand is better than clay.

(*b*) Excavate a level area 9 x 13 feet to a depth of 6 inches.

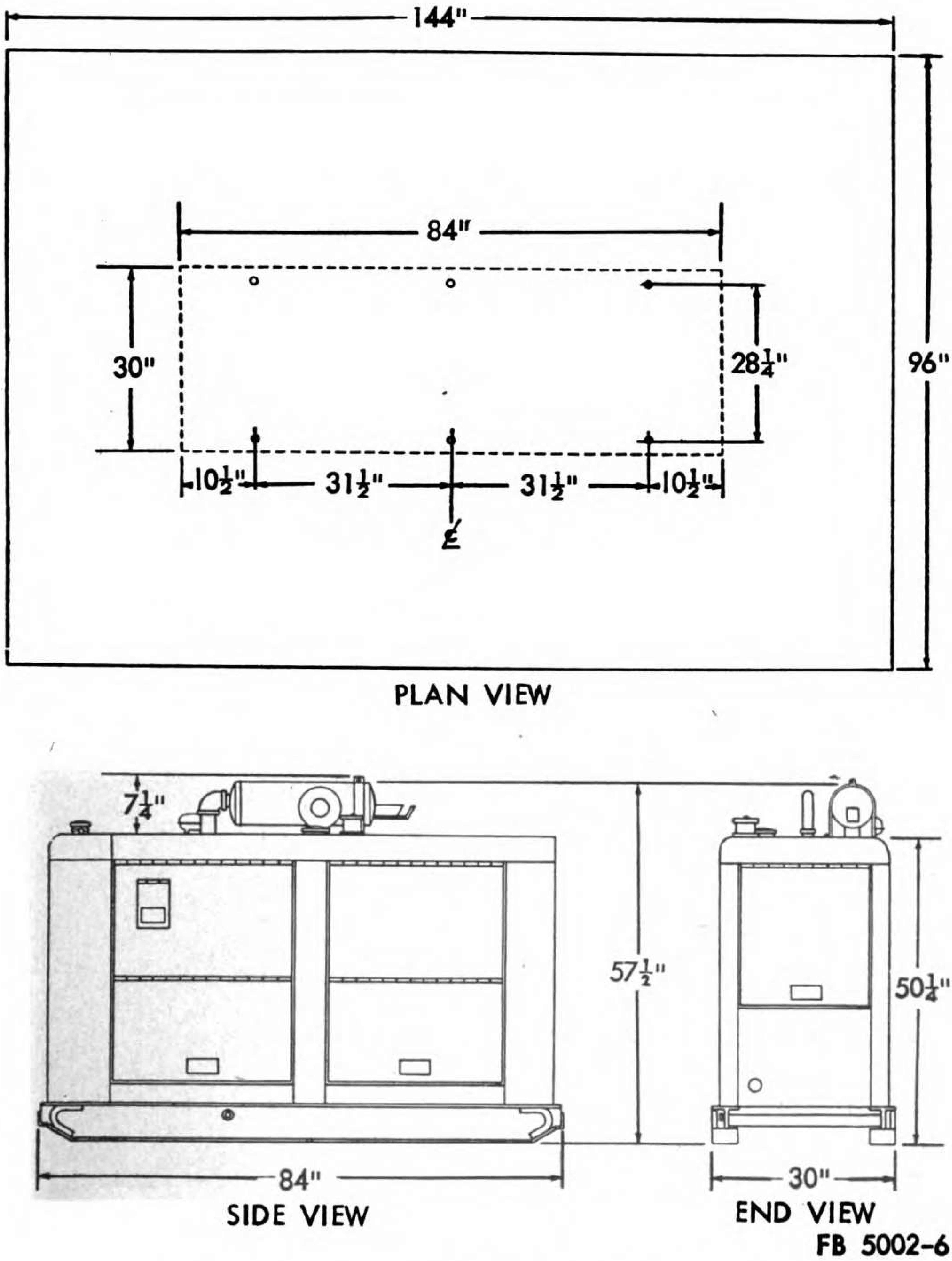


Figure 6. Overall dimensions and foundation plan.

(*c*) Dump aggregate into the excavation to a depth of about 3 inches, level and compact. About 1 yard of aggregate is required.

(*d*) Build a form having an inside dimension of 8 x 12 feet with 2 x 4 lumber or other suitable stock.

(*e*) Space six 9/16-inch anchor bolts in the aggregate at positions corresponding to the six 5/8-inch holes shown in the plan view of figure 6. The bolts should be 8 inches long and threaded to a length of between 2 and 2½ inches.

(*f*) Mix about 1 yard of concrete, using one part cement, two parts sand, and four parts stone. Pour in the frame, and level to a depth of 3 inches. Before finishing, check the location of the anchor bolts.

Note. If an old foundation is being used, locate the holes in positions corresponding to those in the skid base. Secure the generator set to the foundation, using lag screws or expansion bolts.

CHAPTER 2

OPERATING INSTRUCTIONS

Section I. SERVICE UPON RECEIPT OF EQUIPMENT

7. New Equipment

a. General. New generator sets that are processed and crated to meet military requirements for domestic and overseas shipment require certain services before being placed in operation.

b. Unloading (fig. 1). If the unit is shipped domestically without crating, it may be lifted by means of the lifting eyebolt (5). If the unit is crated for oversea shipment, lift by using slings passed under the base at the points marked on the packing crate. Use caution in handling the crate, and do not drop it or tip it on end.

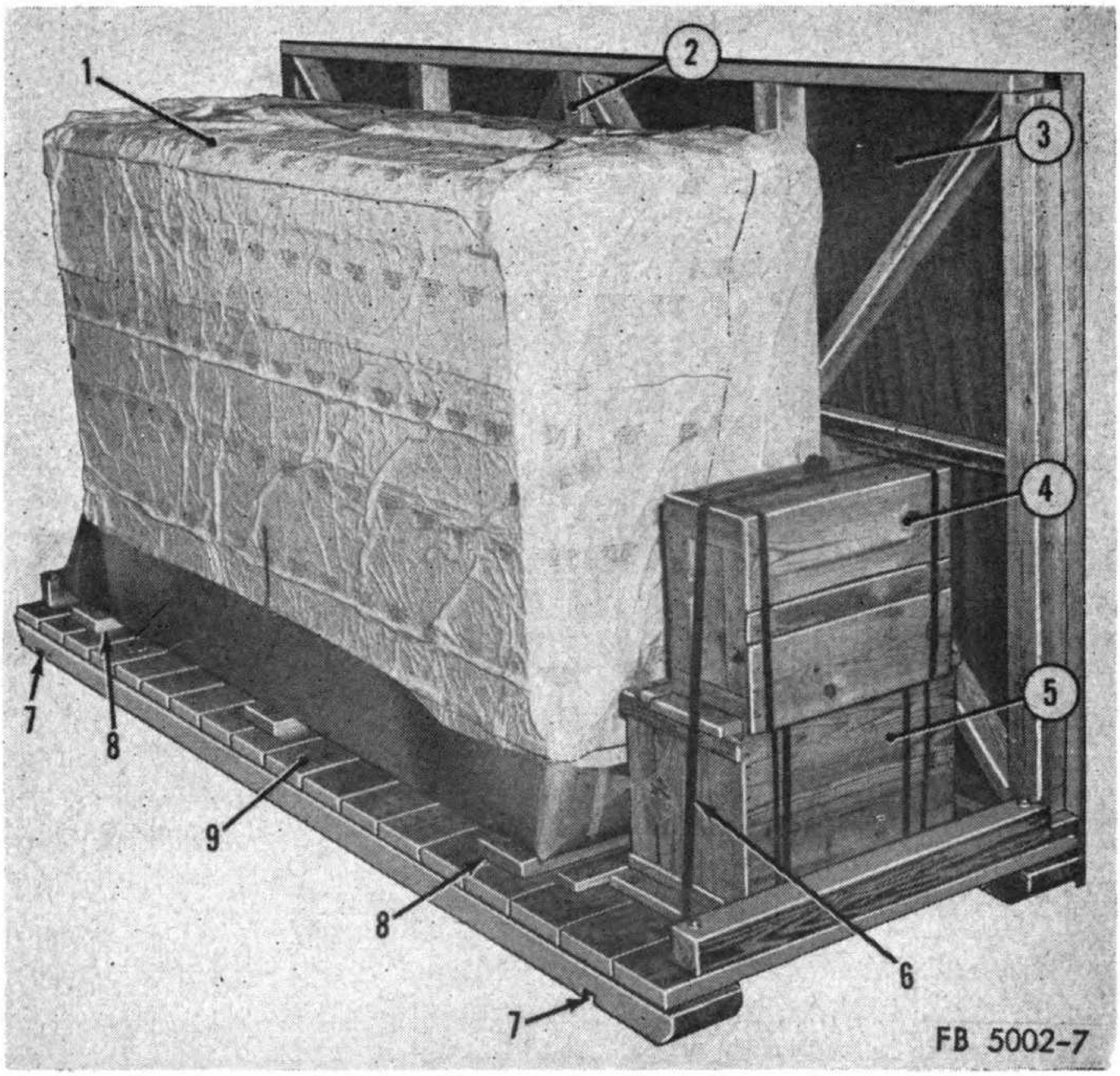
c. Uncrating (fig. 7). Place the unit as near as possible to its operating location. If the unit has been subjected to low temperatures, allow several hours for it to warm up to room temperature before uncrating. This will prevent sweating and possible damage to the generator set.

(1) Remove the crate top and sides (2) carefully because the wood has definite salvage value. The sheeting between the studs is lined with waterproof paper (3) to protect the unit.

Caution: Never use a pry-bar against the generator set.

(2) Cut the banding (6) and remove the cases from the crate skid (9).

(3) Strip the barrier bag (1) from the unit by cutting around the base with a knife. Remove the nuts holding the unit to the skid at the holddown points (8). Position the slings just inside of the holddown points (8) at each end of the unit. Raise the generator set from the crate skid with a hoist of at least 2-ton capacity.



1 Barrier bag. 2 Crate side. 3 Waterproof paper. 4 Spare parts. 5 Battery electrolyte. 6 Banding. 7 Sling points. 8 Holddown points. 9 Crate skid.

Figure 7. Uncrating generator set.

d. Removal of Bracing, Preservative Compounds, and Barrier Material.

(1) Locate and remove the muffler (6, fig. 1), eyebolt (5), and exhaust pipe (4, fig. 2). They are shipped unassembled and secured within the housing.

(2) Remove the barrier material and tape from the air cleaner (5), fan belt, starter, battery-charging generator (8), heater (12), and heater fuel tank cap (2, fig. 1).

(3) Remove all bracing and support members provided for shipment.

(4) Remove the preservative from the battery terminals and cables in the battery box (1, fig. 2). Remove sealing devices from the vent openings and fill the battery cells with electrolyte. Fill to one-half inch above the plates. If the ambient temperature is below 0° F. or if the unit

will not be operated within 12 hours after filling, the batteries should be charged.

(5) Remove the waterproof paper and tape from the instruments on the switchboard panels (10 and 11, fig. 4).

(6) Wipe the preservative compound from the external parts of the engine. Check the fuel tank to make sure there is no preservative compound inside of it.

(7) If used, remove the greaseproof barrier material from the commutator bars and sliprings of the generator (13, fig. 2). No preservative is used on the brushes or commutator, but the sliprings may be covered with a preservative lubricant. Remove the preservative lubricant with a clean cloth and make sure the brushes are properly seated.

(8) Remove the tools from the toolbox and clean and replace them. Do not remove the preservative from the spare parts until they are to be used.

e. Assembly. The generator set is shipped fully assembled except for the eyebolt (5, fig. 1), muffler (6), and exhaust pipe (4, fig. 2). Thread the right end of the exhaust pipe into the exhaust manifold. Adjust the position of the exhaust pipe so that the elbow on the upward end is facing the control panel. Thread the muffler into the elbow and clamp it to the housing. Screw the eyebolt into the threaded hole provided in the frame. Connect the batteries in series. Ground the positive terminal and connect the negative terminal to the solenoid relay (19, fig. 4).

f. Inspection. After the generator set has been completely unpacked and the muffler and eyebolt installed, systematically inspect the unit for external damage.

(1) *Engine.*

(a) Fuel system (fig. 3). The fuel system diagram (7), located on the inside of the switchboard door housing, shows the layout of the fuel system. Check all connections to see that they are tight and not damaged.

(b) Cooling system. Check upper and lower hose connections and make sure that the rod of the manual shutter control (2, fig. 4) is not bent. Examine the radiator assembly (1, fig. 3) and see that the fan is clear to turn. The fan belt should not have more than three-fourths of an inch deflection, without undue pressure, at a point midway between the charging generator and the fan drive pulley.

(c) Lubrication system (fig. 3). See that all external oil lines are tight and that the oil filter (3) is securely

mounted. See that all fittings and mounting bolts are tight.

(d) Electrical system. The wiring diagram (9, fig. 3) is mounted inside the switchboard door housing. Examine the charging generator (8, fig. 2), voltage regulator (10), and starting motor for correct and tight connections.

(e) Intake and exhaust system. The air cleaner (5, fig. 2), exhaust pipe (4), and muffler (6, fig. 1) should be securely mounted. Examine the intake and exhaust manifolds for cracks.

(f) Controls and instruments (fig. 4). The engine controls and instruments are located on the engine control switchboard panel (11). See that the instruments are not damaged and that all controls are connected.

(2) *Generator.*

(a) Vents and openings. See that the screened vents on the generator and the openings at the end of the exciter are clear.

(b) Electrical connections. The wiring diagram (9, fig. 3) is mounted inside the switchboard door housing. Generator connections are made at the changeover panel (13, fig. 4) and the load terminal block (16). See *i* below.

(c) Controls and instruments (fig. 4). The generator controls and instruments are located on the door section switchboard panel (10). See that the instruments are not damaged and that all connections are tight. Turn all switches to OFF.

g. Service. Before operating the generator for the first time, the services listed below must be performed.

(1) Lubricate the generator as directed in LO 5–5002.

(2) Perform the preventive maintenance services required (par. 36*c*). This check establishes a base for future preventive maintenance checks.

(3) Fill the fuel tank (8, fig. 4) through the filler neck (5). Fill the engine heater fuel tank through the tubing under the cap (2, fig. 1). Fill the radiator through the filler neck (3, fig. 4).

h. Installation (fig. 6). This unit is designed for field use and needs no special foundation (par. 6*e*).

(1) *Location.* Avoid muddy, sandy, or dirty locations if possible. Dirt and moisture will shorten the life of all moving parts. If it is necessary to place the unit on soft

ground, arrange a foundation of planks, logs, or concrete, with sufficient area to allow the operator access to all parts of the generator set.

(2) *Indoor installation.* If the unit is to be operated within a building or vehicle, make certain that the exhaust is conducted to the outside and that plenty of fresh air is available. Use as few bends as possible in the exhaust line, and see that all connections are gastight. At least 2 feet of space should be provided on all sides of the unit.

(3) *Leveling.* Use a carpenter's level to level the machine any time an installation is made. The set is designed so that it may be operated at an angle of 15° with the horizontal, but it is to be leveled as nearly as possible at all times. Place the level on the top of the generator set. Position boards or planks under the low end of the set to bring it to the horizontal.

i. Generator Connections.

Caution: Before making any connections, make sure that all switches are in OFF position and that the generator set is not operating.

(1) The generator set is shipped from the factory connected for 60-cycle, 120/208-volt operation (fig. 8). The changeover panel terminals are numbered or lettered, and the copper terminal connecting bars are held in place by wingnuts.

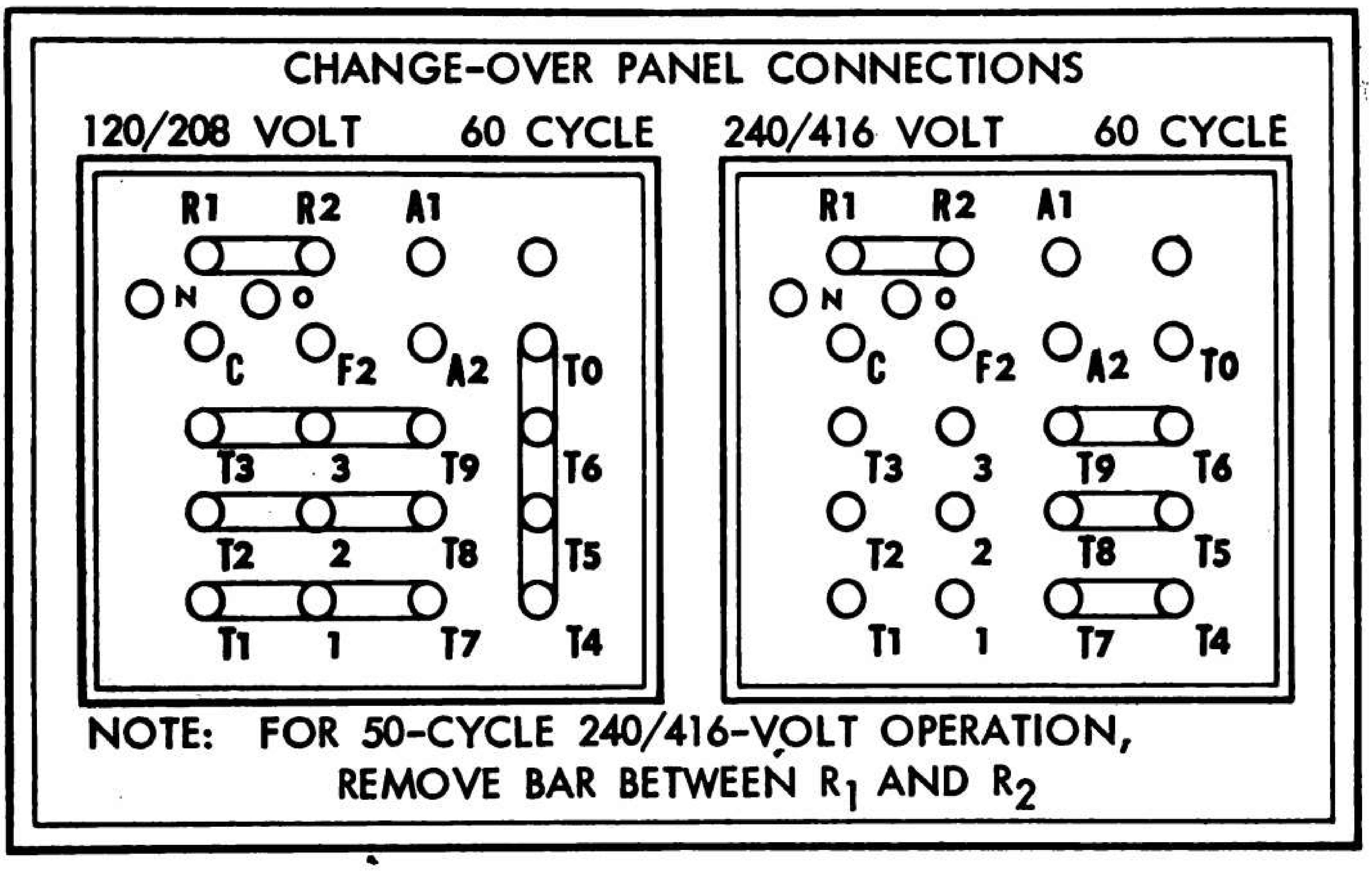
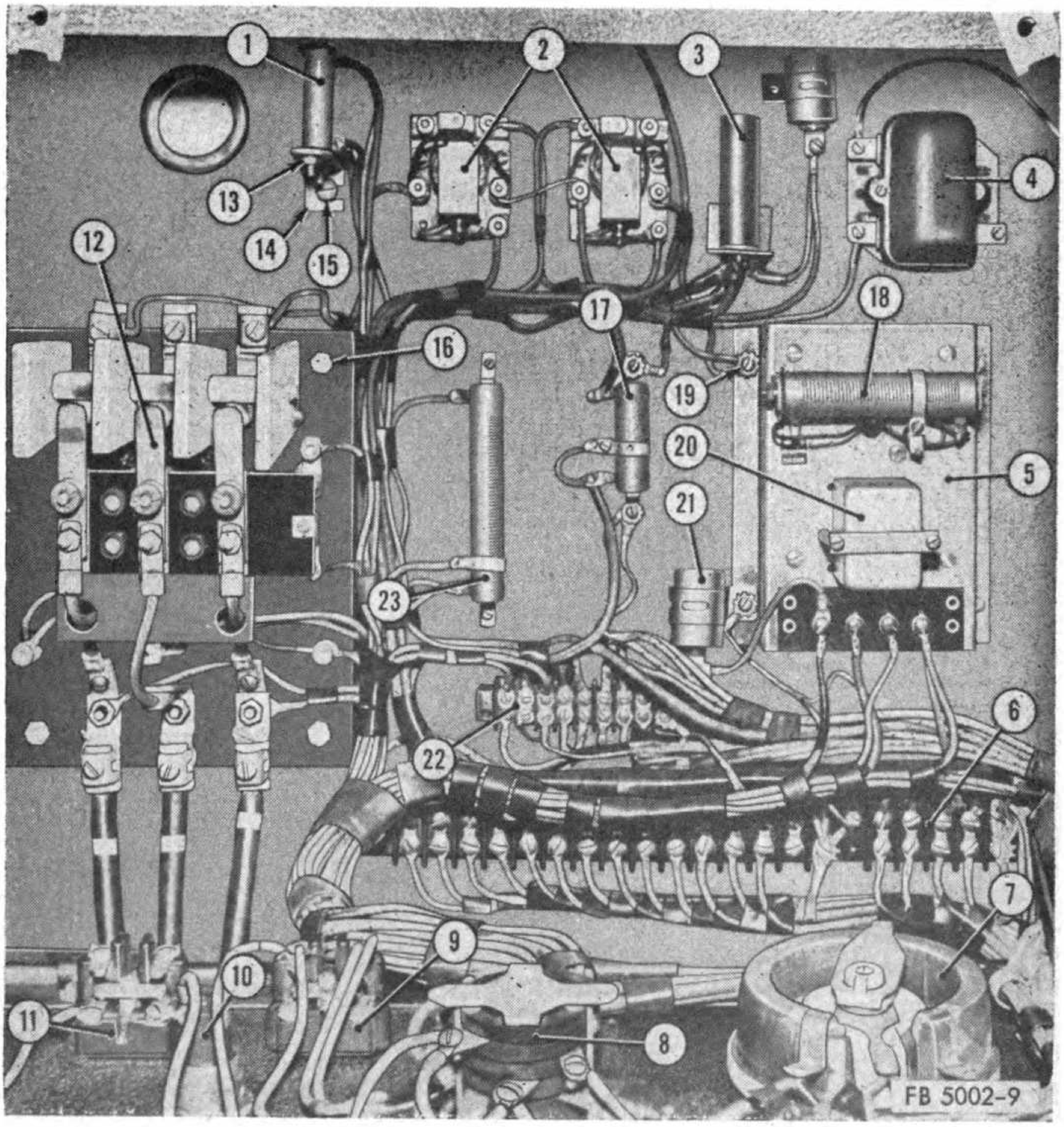


Figure 8. Changeover panel connections.

(2) To connect the unit for 60-cycle, 240/416-volt operation at 1,200 rpm, arrange the bars as indicated in figure 8. Make sure that the wingnuts are tight. For 50-cycle, 240/416-volt operation at 1,000 rpm, remove the terminal connecting bar between R1 and R2.

(3) Open the control cabinet. Make sure that all leads are secure and all screws on the terminal strips (6 and 22, fig. 9) are tight.



1 Synchronous light resistor
2 Safety control relay
3 Primer resistor
4 Time delay (high voltage) relay
5 Voltage regulator panel
6 A-c terminal strips
7 Exciter field rheostat
8 Ammeter-voltmeter switch
9 Circuit breaker ON push switch
10 Generator pilot light
11 Circuit breaker OFF push switch
12 Main circuit breaker
13 Nut (2 req'd)
14 Resistor bracket
15 Screw w/nut and lockwasher (2 req'd)
16 Cap screw w/nut and lockwasher (4 req'd)
17 High voltage relay resistor
18 Variable resistor
19 Screw w/nut and lockwasher (4 req'd)
20 Plug-in element
21 Capacitor
22 D-c terminal strips
23 Crosscurrent compensator resistor

Figure 9. View of interior of main switchboard panel.

8. Used Generators

Used generators which have been stored and shipped in conformance with Army specifications are ready for use with the same preparation as new equipment (par. 7). Any equipment that has been subjected to use and wear should be cleaned, and a careful inspection should be made to see that all connections are tight and insulation is not frayed.

Section II. CONTROLS AND INSTRUMENTS

9. General

This section describes, locates, illustrates, and furnishes the operator with sufficient information about the various controls and instruments for proper operation of the generator set. Most controls and instruments are on the main switchboard panel (10, fig. 3) which is divided into two sections. The generator controls and instruments are on the upper section, called the door section switchboard panel (10, fig. 4); the engine controls and instruments and heater controls are on the lower section, called the engine control switchboard panel (11). Panels are illuminated by lights controlled by a toggle switch (18, fig. 10).

10. Engine Controls

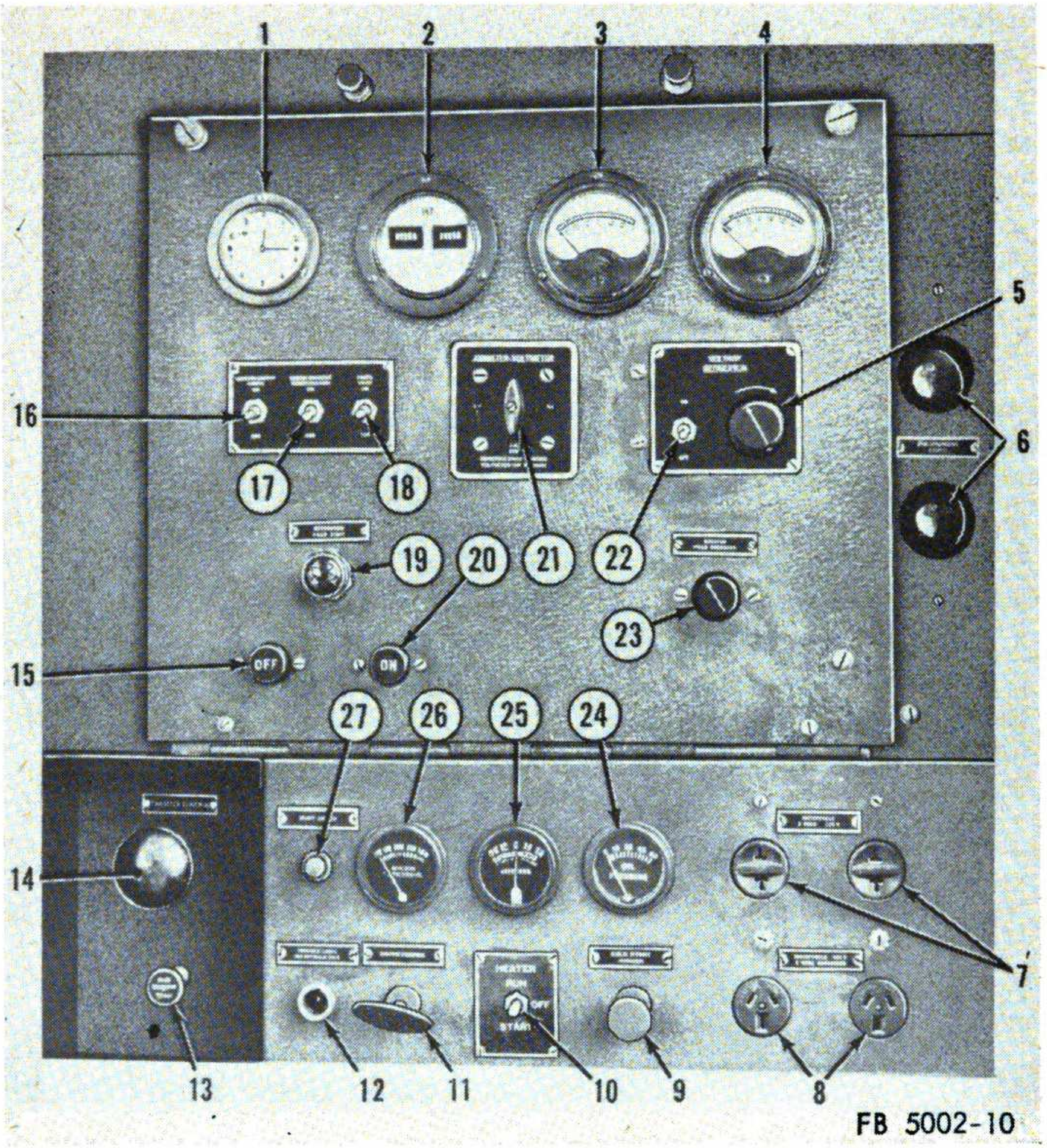
a. Starter Push Switch (fig. 10). The pushbutton switch (27) energizes the solenoid relay which closes the circuit between the battery and the starting motor to crank the engine.

b. Engine Stop Control (fig. 10). The engine stop control (13) is pulled to stop the engine. It acts on the governor and injector pump to cut off fuel to the injectors.

c. Heater Switch (fig. 10). The heater switch (10) is a two-pole, double throw, toggle switch with OFF, START, and RUN positions. The START position is spring loaded and is used only when igniting the heater. The switch is held in START until ignition and then thrown to RUN for continuous operation.

d. Engine Heater Control (fig. 10). The heater control (11) regulates the heater combustion rate by raising or lowering an internal wick. This control is pulled outward to increase the heater output and moved inward to reduce it.

e. Cold Start Primer (fig. 10). The cold start primer (9) is a small, hand-operated pump mounted on the engine switchboard panel. The primer draws fuel from the diesel fuel system and sprays it into the air intake manifold. A spark plug energized



1 Electric time meter
2 Frequency meter
3 A-c ammeter
4 A-c voltmeter
5 Voltage regulator rheostat
6 Synchronizing lamps
7 2-pole receptacles, 125-volt
8 3-pole receptacles, 125-volt
9 Cold start primer
10 Heater switch
11 Heater control
12 Trouble light receptacle
13 Engine stop control
14 Throttle control
15 Circuit breaker OFF push switch
16 Synchronizing lamps toggle switch
17 Crosscurrent compensation toggle switch
18 Panel light toggle switch
19 Generator pilot light
20 Circuit breaker ON push switch
21 Ammeter-voltmeter phase switch
22 Voltage regulator toggle switch
23 Exciter field rheostat
24 Oil pressure gage
25 Battery ammeter
26 Water temperature gage
27 Starter push switch

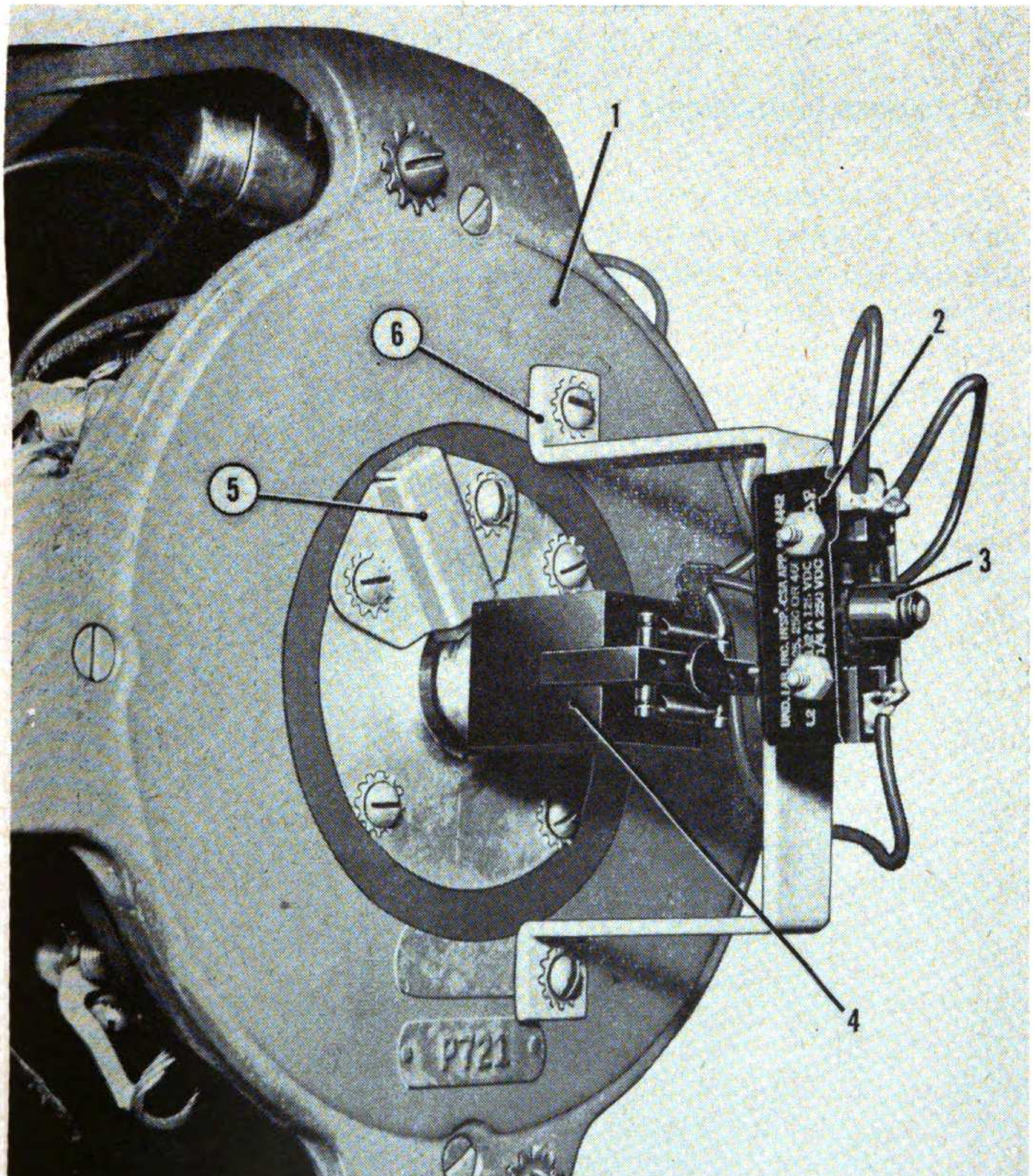
Figure 10. Switchboard control panel.

by a vibrator coil ignites the fuel to preheat the air drawn into the cylinders.

f. Throttle Control (fig. 10). The throttle control (14) regulates the speed of the engine by its action on the governor spring. Counterclockwise rotation of the control increases the speed of the engine.

g. Off-Panel Controls.

(1) *Overspeed reset.* The microswitch reset (3, fig. 11) is a pushbutton that is used to reset the microswitch (2) after the overspeed device (4) has acted to shut down the engine. Depressing the overspeed reset reestablishes



1 Exciter bell end. 2 Microswitch. 3 Microswitch reset. 4 Overspeed device.
5 Grounding brush. 6 Microswitch bracket.

Figure 11. Overspeed device reset assembly.

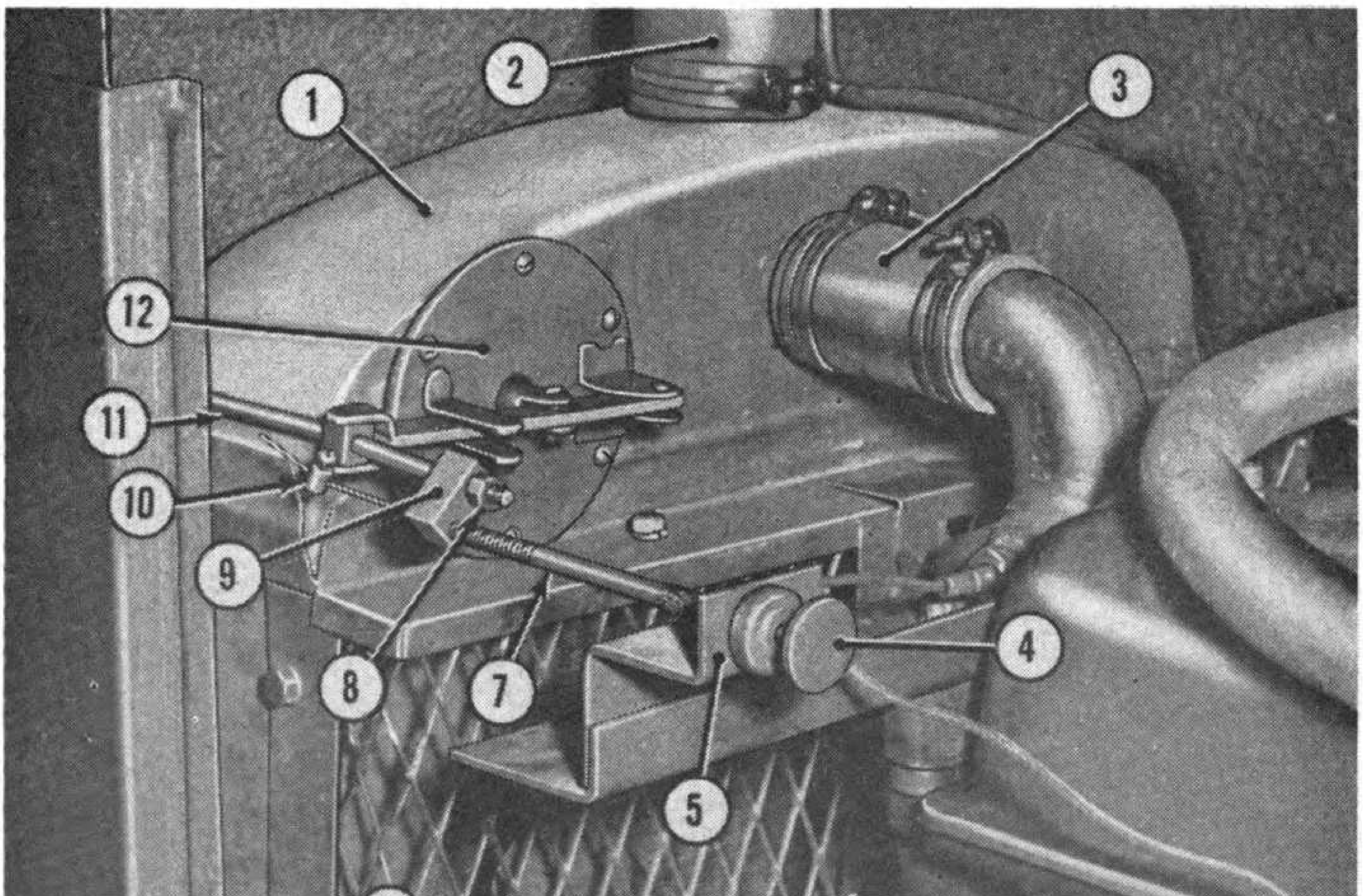
the circuit to the fuel shutoff solenoid so that the engine may again be started. To obtain access to the reset, it is necessary to remove the rear access panel (10, fig. 1).

(2) *Manual shutter control* (fig. 12). The manual shutter control (4) is a pull-type device that can be locked in position. Air flow through the radiator (1) is controlled by opening or closing the shutter.

11. Engine Instruments
(fig. 10)

a. Oil Pressure Gage (0 to 60 psi). The oil pressure gage (24) indicates the engine lubricating oil pressure. Normal oil pressure at operating temperature and speed should be 40 psi. Should the oil pressure drop as low as 15 psi, a pressure switch is actuated which deenergizes the fuel shutoff solenoid, stopping the engine.

b. Battery Ammeter (—30 to +30 amps). The battery ammeter (25) is a zero-center ammeter with discharge values to the left. The ammeter normally will show a slight charge while



1 Radiator
2 Filler neck
3 Inlet hose
4 Manual shutter control
5 Shutter control bracket
6 Guard
7 Control rod
8 Hex nut
9 Connector block
10 Clamp
11 Shutter control arm
12 Shutter control thermostat

Figure 12. Radiator shutter control.

the unit is running. A high charging rate will be indicated after a long cranking period or after a prolonged period of standby engine heating (par. 20). If batteries are in good condition and the regulator and generator are functioning properly, the rate of charge will drop back to a low level after a short period of operation.

c. Water Temperature Gage (100° to 220° F.). The gage (26) shows water temperature at the engine head. Normal operating temperature is 165° F. Should the water temperature rise to between 205° and 210° F., a thermal actuated switch deenergizes the fuel shutoff solenoid, stopping the engine.

d. Electric Time Meter. The electric time meter (1) records total time of engine operation. For a unit in continuous operation, this meter will determine the frequency of preventive maintenance services.

12. Generator Controls
(fig. 10)

a. Main Circuit Breaker Push Switches. The circuit breaker ON and OFF push switches are used to open and close the main circuit breaker. The black ON push switch (20) closes the main circuit breaker to connect the load to the generator. The red OFF push switch (15) trips the main circuit breaker, disconnecting the load from the generator.

b. Voltage Regulator Toggle Switch. The voltage regulator toggle switch (22) is used to establish automatic or manual voltage control of the exciter generator. For automatic voltage control, this switch and the crosscurrent compensation toggle switch (*c* below) are snapped to their ON positions. The output then is established by manipulating the voltage regulator rheostat (*e* below). For manual voltage control, the switch is snapped to OFF position and the output is adjusted when necessary with the exciter field rheostat (*f* below).

c. Crosscurrent Compensation (CCC) Toggle Switch. The crosscurrent compensation toggle switch (17) is used to short out the crosscurrent compensation resistance. This switch remains in the ON position when the voltage regulator is operative (automatic control) and the generator is not operating in parallel. When the generator set is operating in parallel with other units, the switch is thrown up to the OFF position.

d. Synchronizing Lamps Toggle Switch. The synchronizing lamps toggle switch (16) is placed in the ON position to connect the synchronizing lamps (6) when the unit is being synchronized for parallel operation.

e. Voltage Regulator Rheostat. The voltage regulator rheostat (5) is used to establish the value of the voltage which the regulator will hold constant. To connect the voltage regulator rheostat to the circuit, the regulator switch must be in the ON position. The generator voltage then is established by rotating the rheostat knob. Generator voltage is indicated by the a-c voltmeter (par. 13*a*).

f. Exciter Field Rheostat. The exciter field rheostat (23) is used for manual voltage control. To connect the exciter field rheostat to the circuit, the voltage regulator toggle switch (*b* above) is snapped to the OFF position. The generator voltage then is adjusted by rotating the rheostat knob. Generator voltage is indicated by the a-c voltmeter (par. 13*a*).

g. Ammeter-Voltmeter Phase Switch. The ammeter-voltmeter phase switch (21) is a rotary switch that connects the a-c dual scale ammeter (3) to read the current in each phase, and the a-c dual scale voltmeter (4) to read the voltage across each phase. The three phase positions are numbered clockwise around the switch. The switch indicator should point to the bottom (OFF) position except when phase amperage is being read on the ammeter. Voltage can be read on the voltmeter without moving the switch.

13. Generator Instruments
(fig. 10)

a. Dual Scale Voltmeter. The a-c voltmeter (4) is a dual scale voltmeter (0 to 300 volts and 0 to 600 volts). The ammeter-voltmeter phase switch (par. 12*g*) determines which phase voltage is to be indicated. The 0 to 300 scale is read when the generator is connected for 120/208-volt output, and the 0 to 600 scale when connected for 240/416-volt output.

b. Dual Scale Ammeter. The a-c ammeter (3) next to the voltmeter has two scales, 0 to 40 amps and 0 to 80 amps. The position of the ammeter-voltmeter phase switch (par. 12*g*) determines which phase current is indicated. The 0 to 80 scale is read when the generator is connected for 120/208-volt output and the 0 to 40 scale when connected for 240/416-volt output.

c. Dual Scale Frequency Meter. The frequency meter (2) is a vibrating reed meter designed to show the frequency of the generator alternating current output in cycles per second. Five reeds are used in each of two scales. The first scale reads from 48 to 52 cycles; the second, from 58 to 62.

d. Synchronizing Lamps. The two synchronizing lamps (6) indicate when two generators that are to be operated in parallel can be electrically connected. The lamps are controlled by the synchronizing lamps toggle switch (par. 12*d*).

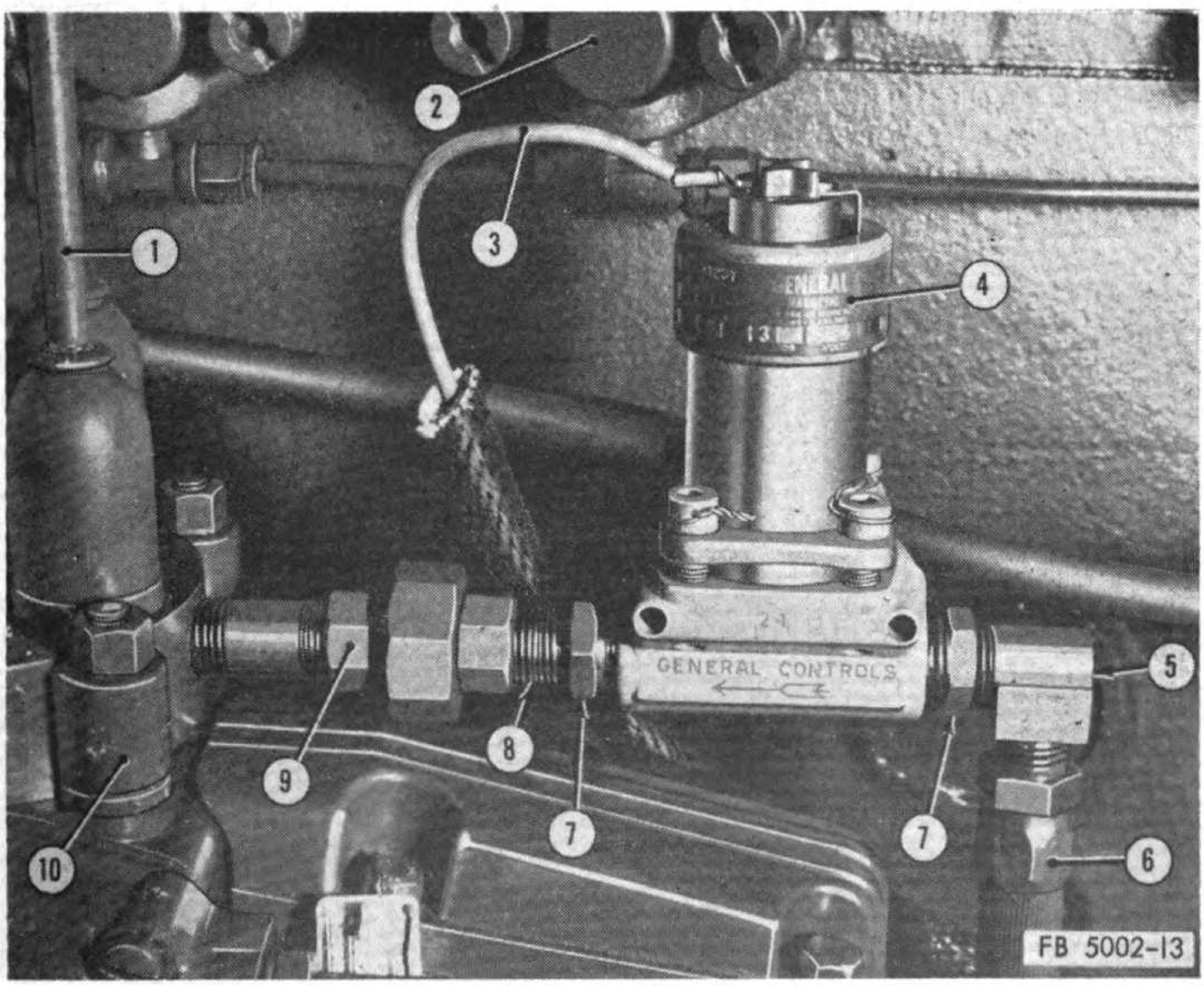
e. Generator Pilot Light. The generator pilot light (19) is illuminated when the main circuit breaker is closed by pressing the circuit breaker ON push switch (par. 12*a*).

14. Automatic Controls

a. Engine and Generator Shutoff Devices.

(1) *General.* Certain automatic controls protect the generator set against damage. These controls trip the main circuit breaker (12, fig. 9) which disconnects the load from the generator, or they deenergize the fuel shutoff solenoid (4, fig. 13) which cuts off the fuel supply and stops the engine.

(2) *Exciter time delay (high voltage) relay* (fig. 9). To protect against generator overload, a time delay relay (4) is energized to disconnect the load from the generator. This relay has a thermal element connected through a series resistor to the output terminals of the exciter. The series resistor is shorted out for 60-cycle operation



1	Injection line assembly	6	Fuel line
2	Nozzle holder assembly	7	Bushing
3	Shutoff solenoid lead	8	Nipple
4	Fuel shutoff solenoid	9	Union
5	Pipe elbow	10	Injector pump head assembly

Figure 13. Fuel shutoff solenoid.

so that the generator is equally protected in both 50- and 60-cycle operation. If the generator is subjected to loads greater than 125 percent of rated capacity, the contact of the high voltage relay closes to energize the auxiliary (safety control) relay circuit. The safety control relays (2) disconnect the load by deenergizing the closing coil of the three-pole main circuit breaker. In this instance, the engine will continue to run.

(3) *Lube oil pressure switch.* If the engine lube oil pressure drops to between 10 and 15 pounds during operation, the oil pressure switch located in the cylinder block just above the charging generator (8, fig. 2) opens, deenergizing the fuel shutoff solenoid (4, fig. 13). This valve shuts off the fuel entering the injector pump (17, fig. 3), thus stopping the engine.

(4) *Thermostatic switch.* If, during operation, the engine coolant temperature rises to between 205° and 210° F., a thermal actuated switch located in the right side of the elbow clamped to the inlet hose (3, fig. 12) opens, deenergizing the fuel shutoff solenoid (4, fig. 13) which stops the engine.

(5) *Overspeed device* (fig. 11). At the rear of the exciter bell end (1) is attached the overspeed device (4) driven by the generator shaft. Centrifugal forces at speeds of 1,350 rpm or above actuate the flyball type governor, which results in the tripping of the overspeed microswitch (2). This deenergizes the fuel shutoff solenoid and stops the engine. It is necessary to reset the overspeed microswitch (par. 10*g*) to restart the engine.

b. Radiator Shutter Thermostat (fig. 12).

(1) The radiator shutters are opened and closed automatically by a radiator shutter control thermostat (12) in the upper radiator tank. When water in the top of the radiator reaches a temperature of 140° F., the shutters begin to open. Opening is complete at a temperature of 160° F.

(2) The shutters can be opened manually with the manual shutter control (par. 10*g*(2)). Pull out the manual shutter control (4) to the desired position and lock.

15. General

a. The instructions in this section are published for the information and guidance of the personnel responsible for the operation of this generator set.

b. The operator must be able to control the machine to the limit of its capabilities. This section gives instructions on starting and stopping the engine and generator, and instructions on operating the unit alone or in parallel with other similar units to obtain the maximum output for which the unit was designed.

c. Normal ambient temperature range is 20° to 125° F. For operation in extreme temperatures, refer to paragraphs 23 and 24.

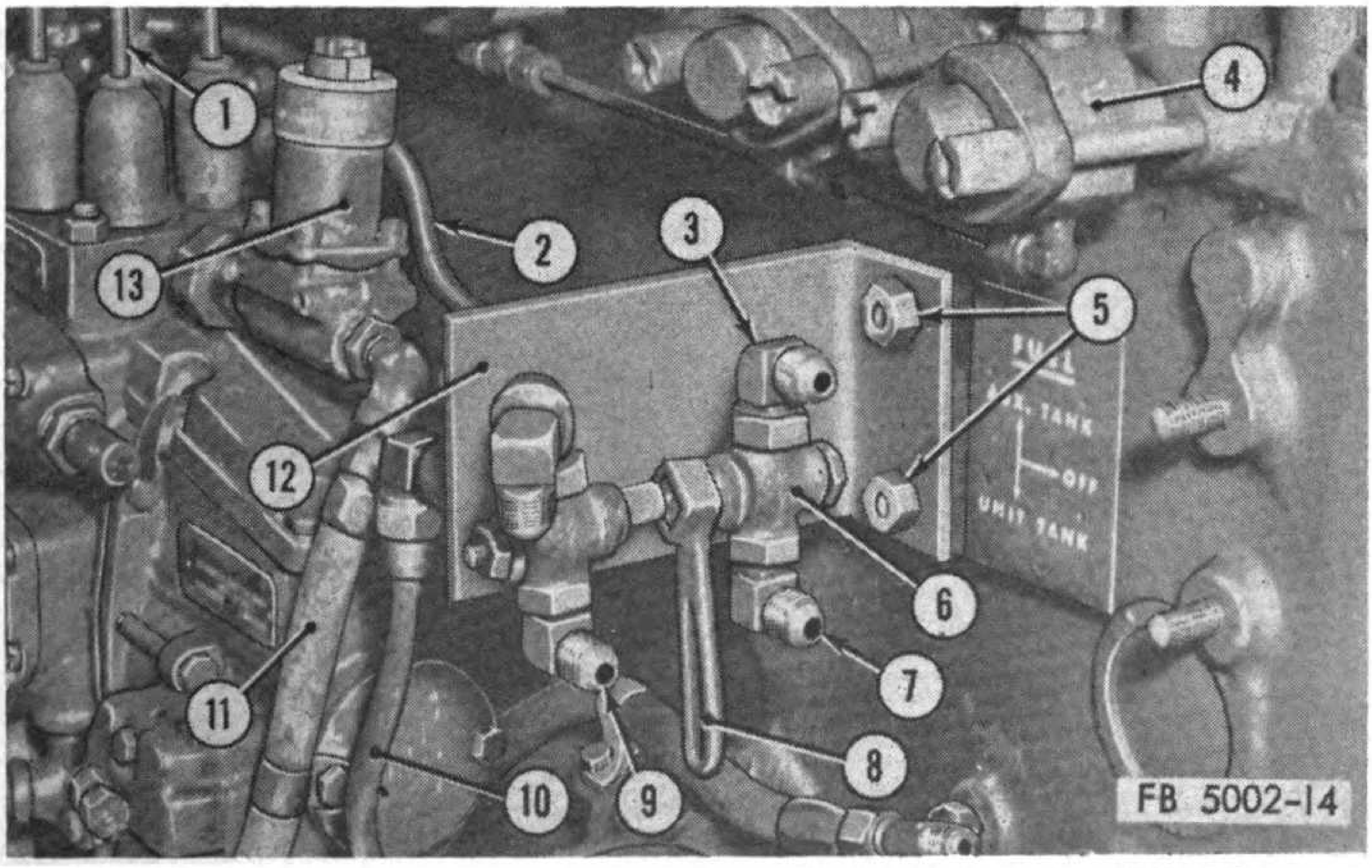
16. Starting

a. Preparation for Starting.

(1) Refer to paragraph 36*c* for before-operation services.

(2) If the engine heater is to be used for warmup purposes, refer to paragraph 20.

(3) Arrange the generator changeover panel for the required voltage output (par. 7*i*).



1 Injection line assembly
2 Pump-to-valve return line assembly
3 Connection to auxiliary fuel bracket line assembly
4 Nozzle holder assembly
5 Nuts (2 req'd)
6 Three-way valve
7 Connection for line to fuel tank
8 Three-way valve wrench
9 Connection for line from fuel tank
10 Valve-to-sediment bowl line assembly
11 Secondary filter-to-solenoid line assembly
12 Three-way valve bracket
13 Fuel shutoff solenoid

Figure 14. View of engine showing three-way valve.

(4) Open the fuel selector three-way valve (6, fig. 14) to the desired fuel source. This valve connects the fuel line to the injector pump to either the engine fuel tank or an auxiliary (outside) fuel source.

(5) Open the air vent valve in the top of the fuel tank.

(6) Place all switches in the OFF position.

(7) Open the throttle control (14, fig. 10) half way.

(8) Turn the exciter field rheostat (23, fig. 10) counterclockwise as far as possible.

b. Priming Fuel System. When starting the unit for the first time after shipment or if it has been allowed to run out of fuel, air trapped in the fuel system must be removed.

(1) Loosen the venting screw in the head of the secondary fuel filter (23, fig. 4).

(2) Unlock the hand primer on the injector pump (24) and operate the primer until a solid stream of fuel flows from the filter vent. All bubbles and foam must be removed from the fuel stream.

(3) Tighten the venting screw.

(4) Loosen the injection lines (1, fig. 14) at the nozzle holders (4) and, with the throttle in the full load position, crank the engine until the injection lines are purged and fuel oil appears at the loosened joints. Tighten the injection lines and clean the spilled oil from the engine.

c. Starting Engine (fig. 10).

(1) Press the starter switch (27). If the engine does not start in 30 seconds, wait at least 2 minutes and try again.

(2) Adjust the throttle until the frequency meter (2) indicates 48 to 50 cycles. Turning the throttle counterclockwise increases speed. Allow the engine to run at this speed until a temperature of 130° F. is reached.

(3) Check the engine gages. The oil pressure gage (24) should read 40 psi at normal operating speed. The battery ammeter should be on the charge side and should read from 1 to 10 amperes. A low charging rate is normal. If the ammeter reads discharge, stop the engine and check the engine electrical circuit and components.

(4) When operating temperature is reached, open the throttle control to obtain the desired frequency.

d. Starting Generator (fig. 10).

(1) Adjust the throttle to give a frequency meter reading 2 cycles above the required frequency.

Note. **The generator output is first adjusted by means of the exciter field rheostat (manual control) even if automatic voltage control is to be used. This establishes the approximate position of the rheostat for manual voltage control so that immediate changeover from automatic control can be made if the voltage regulator becomes inoperative.**

(2) Place the voltage regulator toggle switch (22) in the OFF position, and use the exciter field rheostat (23) to adjust generator output voltage to the correct value.

(3) Place the voltage regulator toggle switch and the cross-current compensation switch (17) in the ON position.

(4) Turn the voltage regulator rheostat (5) until voltage is again at the required value.

(5) Close the main circuit breaker by pressing the black ON push switch (20).

(6) Adjust the throttle to obtain exact frequency reading.

(7) Read the voltage and current on each phase, using the ammeter-voltmeter phase switch (21). The current should not be more than the rated value for the voltage generated.

17. Stopping

a. Press the red OFF push switch (15, fig. 10).

b. Push in the throttle control (14) and allow the engine to idle a few minutes.

c. Pull the engine stop control (13), holding it out until the engine stops.

d. Place all control and instrument switches in the OFF position.

e. Close the air vent valve on the fuel tank and turn off the fuel at the three-way valve (6, fig. 14).

18. Operating Details

a. General. Generator connections for the two rated voltages are described in paragraph 7*i*. Although the unit is provided with safety devices (par. 14), watch the instruments for preliminary signs of trouble.

b. Engine Temperature. Water temperature will rise slowly from the lowest reading and should not normally rise above 190° F. Moderate overheating may result from an overload on the generator or low coolant level in the radiator. Moderate overheating usually can be corrected by reducing the load to a maximum of 52 amperes for 120/208-volt operation and 21.6 amperes for 240/416-volt operation or by adding coolant. A boiling radiator indicates serious trouble. Stop the unit and consult the troubleshooting section to eliminate the cause for overheating.

c. Oil Pressure Gage (fig. 10). The oil pressure gage (24) will read above 55 psi immediately after starting, but should read 40 psi after the engine has warmed up. Oil pressure below 15 psi indicates low oil level, a clogged oil filter, or oil too light for operating temperature.

d. Battery Ammeter (fig. 10). The battery-charging ammeter (25) will read about 10 amperes charge until the batteries have been fully charged; then it will drop to nearly zero. An ammeter reading on the discharge side when the engine is running at full speed indicates trouble in the battery circuit. Check for short circuits or a burned out generator. Readings higher than 10 amperes charge after the engine has been running for some time indicate either a bad battery or incorrect charging generator regulator adjustment.

e. Generator Load Balance (fig. 10). The electrical load on the generator should be kept balanced between the three phases of the generator. Check for balance by turning the ammeter-voltmeter phase switch (21) and reading the line current in each phase on the ammeter (3). Lack of balance causes uneven heating of the generator windings and reduces available power output. The load can be balanced by dividing it equally among the three phases.

f. Parallel Operation.

(1) *General.* When the load requirements cannot be met by one generator set, two or more sets can be operated in parallel. Parallel operation will give the same output voltages, but will increase the available power. Following is the procedure for two-unit operation. More units can be added to the line in the same manner.

(2) *Parallel Connections and Operation.*

(*a*) Connect leads from T1, T2, T3, and TO on the load terminal block (16, fig. 4) of the first unit to the corresponding terminals of the second unit to be operated in parallel.

(*b*) Make the necessary changes and adjustments to the changeover panel (13) of each unit to provide for the required operating voltages (par. 7*i*). Start both units and adjust their no load operating voltage so they are identical (par. 16). Turn off both units and connect the load lines to the terminal block (16) of one. Connect only a part of the total load to the lines to prevent overloading the unit.

(*c*) Place one unit in operation (par. 16). Make sure that the no load voltage and frequency have been properly adjusted and the crosscurrent compensation toggle switch (17, fig. 10) is in the ON position. Close the main circuit breaker (12, fig. 9) by pressing the ON push switch (20, fig. 10).

(*d*) Start the incoming unit, bringing it up to speed and voltage output. Put its voltage regulator (automatic) into operation (par. 16) and place its crosscurrent compensation switch in the ON position.

(*e*) Recheck and adjust the voltage of the loaded unit. Both voltmeters (4) must read the same to avoid crosscurrents (circulating currents) between units.

(*f*) Place the synchronizing lamps toggle switch (16) of each unit in the ON position. The synchronizing lamps (6) will blink. If the lights on both units do not reach maximum brilliance and fade out in unison, shut down the units and check for proper connections. Usually it will be found that interchanging two of the load lines at either terminal block (16, fig. 4) will correct the condition.

(*g*) Using the throttle control (14, fig. 10), adjust the speed of the incoming unit until the synchronizing lights blink slowly.

(*h*) When the lights are dark, press the ON push swtich (20) of the incoming unit.

Caution: This must be done only when synchronizing lamps are out. If lights are blinking too rapidly, readjust speed until the condition described in (*g*) above is obtained.

(*i*) Adjust the throttle setting of both units until the ampere loads as indicated on the individual ammeters are in proportion to their output ratings. If the two units are of equal output rating, both ammeters should read the same. If one unit has twice the rating of the other, the ammeters should read in the ratio of 2 to 1. Decreasing the throttle setting of one unit will cause the other unit to take a greater share of the load.

(*j*) When adjusted for parallel operation, the voltage and frequency meters of both units will read identically.

If this adjustment is not properly made, circulating currents between generators will result. These cause loss of generating capacity and overheating.

(*k*) Turn the synchronizing lamps toggle switches (16) to OFF position.

(*l*) To remove a unit for the load lines, press the red OFF push switch (15) and proceed as in paragraph 17 to stop the generator set.

Caution: When removing one of two generator sets operating in parallel, do not have a load on the service lines that is greater than the rating of the remaining unit. If the load is greater than the capacity of the remaining unit, overloading will result.

19. Movement to New Location

a. Disconnect service lines at the load terminals. Shut off the fuel at both the engine and heater fuel tanks. If an external tank was used, disconnect the auxiliary fuel lines and stow them in the unit. Disconnect exhaust pipe extensions if used.

b. Make sure all fillercaps are tight. Disconnect the batteries. If cold weather is expected, add antifreeze or drain the cooling system.

c. Load the unit on a truck by using the lifting eye.

d. After the unit has been relocated, inspect and service it as directed in paragraph 7*f*, *g*, *h*, and *i*.

Section IV. OPERATION OF MATERIEL USED IN CONJUNCTION WITH GENERATOR SET

20. Engine Heater

a. *General* (fig. 15). The engine heater (10) used on this unit supplies heat to the oil pan shroud, battery box, and engine coolant. It is used to bring the generator set up to operating temperature or to keep the unit in a standby condition during shutdown periods at temperatures as low as —65° F.

(1) The heater is a gasoline-burning heater, equipped with electric ignition, a blower (9), and a vaporizing pot type burner. Gasoline is supplied from a gravity tank and flows through a sediment bowl.

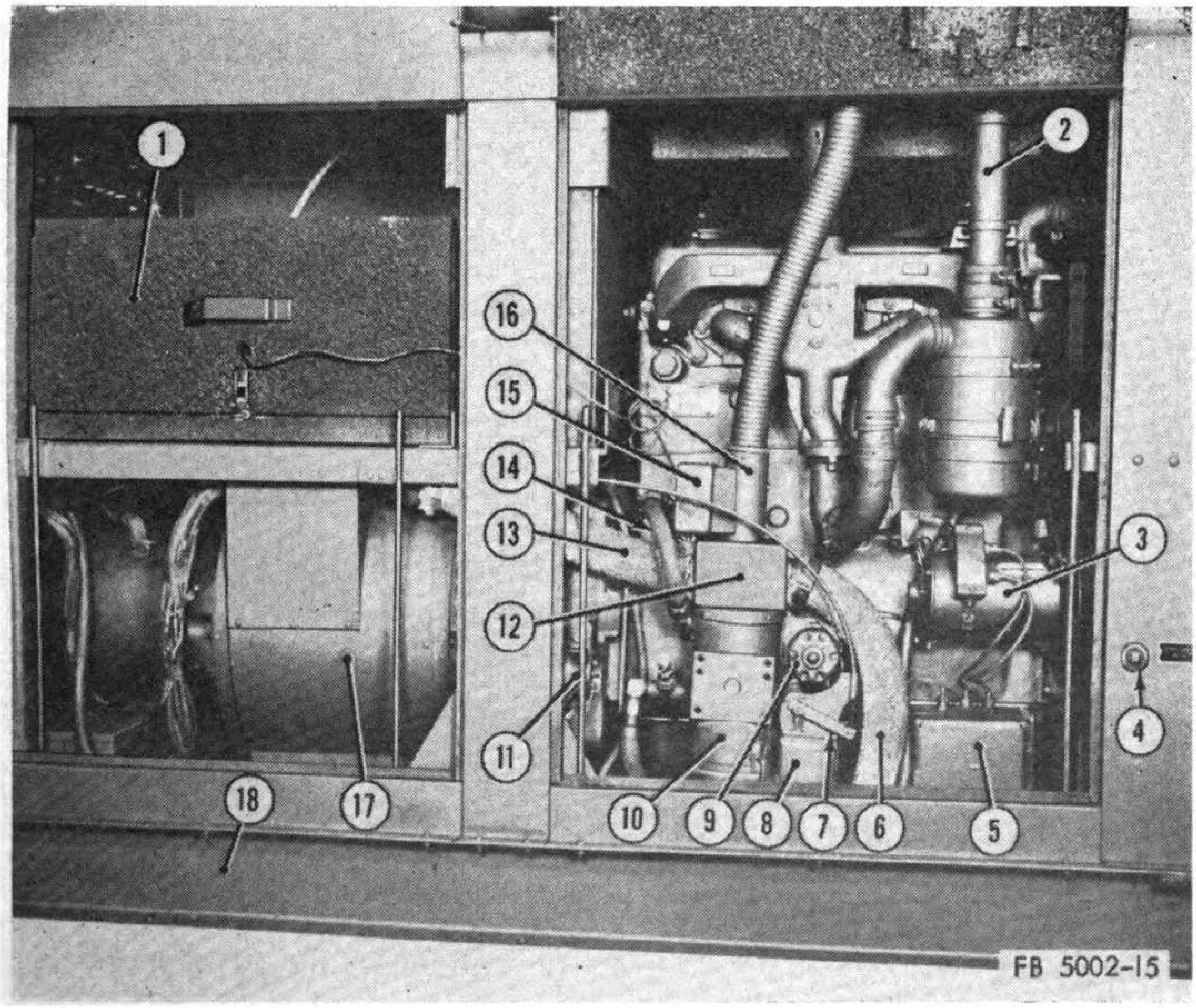
(2) Hot exhaust gases from the heater are conducted to the battery box (1) through the hose (13). The battery overheat control (15) automatically deflects the exhaust

gases into the exhaust hood (16) when the temperature of the battery box (1) reaches 120° F. The oil pan shroud is heated by gases forced through the hose (6). Engine coolant is circulated through the heat exchanger of the heater (10) and through coolant lines (14) to the engine. The coolant lines are provided with shutoff valves at the block.

b. Normal Starting Procedure. The heater controls are centered at the bottom of the engine control panel. They consist of a handle type heater control (11, fig. 10) and a heater switch (10).

(1) Open the shutoff valves on the engine coolant lines (14, fig. 15) to the heater.

(2) Open the fuel shutoff valve located on the heater fuel tank sediment bowl.



1 Battery box
2 Air cleaner inlet pipe
3 Battery-charging generator
4 Radiator drain plug
5 Voltage regulator
6 Heater-to-oil pan shroud flexible hose
7 Heater operating lever
8 Heater float valve assembly
9 Heater blower assembly
10 Engine heater assembly
11 Flame heater ignition coil
12 Pipe cross
13 Heater-to-battery box flexible hose
14 Heater-to-engine block line
15 Battery overheat control
16 Heater exhaust hood
17 Main generator
18 Skid base

Figure 15. View of generator set showing heater, heater controls, and ducts.

(3) Check the electrical system by placing the heater switch (10, fig. 10) in the RUN position and listening to the blower fan.

(4) Pull the heater control (11, fig. 10) all the way out. This moves the operating lever (7, fig. 15) to HI position, allowing fuel to enter the heater combustion chamber. Wait approximately 2 minutes for fuel to reach the burner wick. If the heater has not been used for an extended period, from 3 to 5 minutes will be required. Observe the overflow tube in the base of the float valve assembly (8). Fuel may drip from it for a short time.

Caution: If fuel is still dripping from the overflow tube, do not ignite the heater. Shut off the fuel supply and refer to paragraph 60.

(5) Move the heater switch (10, fig. 10) to START position and hold for approximately 30 seconds. This energizes both the blower and the igniter. When the fuel ignites, the sound of combustion will be audible and the exhaust outlet will become warm.

(6) Move the heater switch to RUN position. This deenergizes the igniter but continues the blower in operation.

(7) If the generator set is being placed in a standby condition, move the heater control (11) in half way. If the engine is being started from a cold condition, the heater control can be left fully out. This will allow starting the engine after about a 1-hour warmup.

c. Starting by Manual Ignition. In the event of igniter failure, the heater can be ignited manually.

(1) Move the heater switch (10, fig. 10) to OFF position.

(2) Rotate the cover in the base of the heater (10, fig. 15) and remove it.

Note. The resistor used with the engine heater is mounted on this cover. It is not necessary to disconnect the lead to the resistor when removing the cover.

(3) Pull the heater control (11, fig. 10) fully outward to move the operating lever (7, fig. 15) to HI position. Wait approximately 2 minutes for fuel to reach and saturate the wick.

(4) Insert a lighted torch through the opening to light the burner.

Caution: Wipe up any spilled gasoline and keep face away from the vicinity of the heater when using a torch to light the heater.

(5) Replace the cover.

(6) Move the heater switch to RUN position and listen for the sound of combustion. If the fire smothers, return the heater switch to OFF position and repeat the operation.

Caution: Never operate the heater with the manual ignition port open.

d. Battery Heat Control.

(1) The heater exhaust hood (16, fig. 15) contains a butterfly valve (battery overheat control (15)) that is operated by a thermocouple located in the battery box. When the temperature of the battery box reaches 120° F., the valve is open and the bulk of the hot exhaust gases from the burner is discharged into the atmosphere.

(2) The combustion rate is regulated by the heater control (11, fig. 10). Withdrawing the control actuates the operating lever (7, fig. 15) and adjusts the flow of fuel to the burner. When the heater control is half-way out, the control lever is in its LOW position. This position normally is used to hold the unit in a standby condition for starting at low temperatures.

Note. If the heater is to be operated continually to maintain the unit in standby condition, start the engine every 8 hours to charge the batteries.

e. Stopping (fig. 10).

(1) Push in the heater control (11) and wait about 30 seconds for the flame to go out.

(2) Place the heater switch (10) in the OFF position.

(3) Close the shutoff valve at the heater tank sediment bowl.

Caution: Do not permit the heater control to remain withdrawn during shutdown periods. This can result in excessive starting time, overheating, or vapor locks.

21. Fire Extinguisher

a. Description. The fire extinguisher is mounted in a bracket on the inside of the toolbox door. It is a vaporizing liquid, pump-type unit with a 1-quart capacity.

b. Operation (fig. 2).

(1) Remove the extinguisher from its bracket on the inside of the toolbox (9).

(2) Turn the handle to the left and pump, directing the stream to the base of the flames.

(3) For liquids burning in a container, direct the stream against the side of the container at a point above the surface of the burning liquid.

Warning: Extinguish fire quickly and avoid exposure to smoke and fumes.

c. *Refilling.*

(1) Lock the handle and shake the extinguisher to remove the liquid from the discharge tube.

(2) Remove the hex-head filler nut and refill with carbon tetrachloride or equivalent.

(3) Return the extinguisher to the bracket.

(4) Refer to TM 5–687 and TM 9–1799 for complete maintenance.

Section V. OPERATION UNDER UNUSUAL CONDITIONS

22. General

This section describes additional measures that must be taken when the unit is operated under extreme or unusual conditions. For satisfactory performance under any condition, keep the unit clean and dry and in good mechanical condition.

23. Operation in Extreme Cold (Below 0°F.)

a. *General.* For operation of the engine heater, see paragraph 20. The heater installation is designed to bring the unit up to operating temperature in 1 hour from an ambient temperature of —65° F. If the heater is operated continually to maintain the unit in a standby condition, the engine should be started every 8 hours to charge the batteries. Before attempting to start the engine, use the cold start primer (par. 10*e*) to preheat the air drawn into the cylinders. Press the start switch (par. 10*a*) and operate the cold start primer while the engine is being cranked. Do not operate the starting motor more than 30 seconds without a 2- or 3-minute cooling period. The instructions below include the procedure to follow if the engine heater is inoperative.

b. *Engine.*

(1) *Lubrication.* Refer to LO 5–5002 for the proper grades of oil to be used. If the engine heater is inoperative, it is advisable to drain the oil from the crankcase at the end of operation and place it in a warm room until the unit is restarted. Allow the engine to warm up at

slightly faster than idle until the water temperature gage (26, fig. 10) reaches 130° F. Do not race a cold engine.

(2) *Fuel system.* Formations of ice crystals in the fuel system will clog fuel lines and the injector pump. It is important to take every precaution to prevent water from entering the system.

(*a*) Clean all snow and ice from the filling area and dispensing equipment. Replace caps tightly.

(*b*) Keep the tanks full and use only clean containers to store or transfer fuel. Allow fuel to settle. Clean the strainer and drain the filter daily while the equipment is warm.

(*c*) If available, add one-half pint of denatured alcohol to every 20 gallons of fuel.

(3) *Cooling system.*

(*a*) To prepare the unit for cold weather operation, drain and flush the cooling system. The radiator drain is located on the lower right side of the unit. Remove the plug-in T-fitting at the lower heater coolant line to drain the heater.

(*b*) Make sure all hoses, connections, and fittings are tight. Add antifreeze according to table I. The cooling system capacity is 21 quarts plus 2 quarts for the heater and coolant lines.

(4) *Electrical system.*

(*a*) All connections and terminals are to be tight and clean. A coating of light grease on the battery terminals will prevent corrosion.

(*b*) Make sure the commutators of the charging generator and starting motor are kept clean and brush tension is adjusted.

Table I. Guide for the Initial Preparation of Antifreeze Solutions

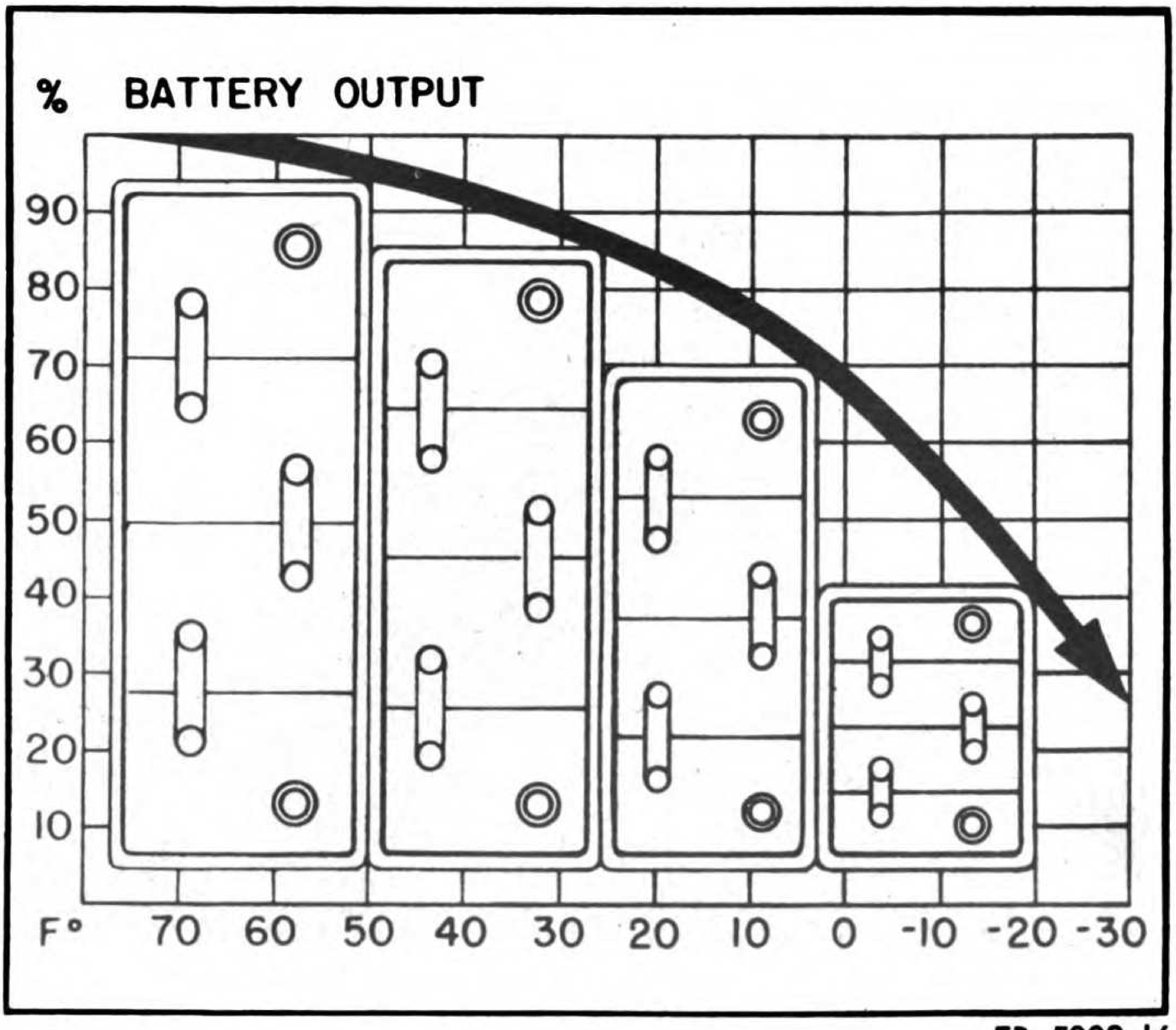
Protection to—	*Pints of antifreeze compound to be included in 1 gallon of antifreeze solution*
20° F.	1½
10° F.	2
0° F.	2¾
—10° F.	3¼
—20° F.	3½
—30° F.	4
—40° F.	4¼
—50° F.	4½
—60° F.	4¾

(*c*) To prevent the batteries from freezing, keep them fully charged. Check with a hydrometer and if the reading is below 1.270, recharge the battery. Add water to the batteries only when the set is to be operated for 1 hour or longer.

(*d*) If the engine heater is inoperative during prolonged cold weather, remove the batteries from the unit and place them in a warm room to raise the voltage. Figure 16 graphically illustrates the loss of battery power at low temperatures.

c. Generator.

(1) *General.* The generator has been designed to operate through a wide range of temperature. Sufficient field and regulator control resistance is available to operate the generator units in ambient temperatures from —65° to +125° F. without the addition of external resistors in series with the exciter field. Refer to paragraph 126 to adjust the time delay resistor.



FB 5002-16

Figure 16. Battery output graph.

(2) *Stabilization period.* After warmup when operating the generator in extreme cold, it is advisable to allow a stabilization period of about 15 minutes, where possible, prior to making any load connections.

(3) *Lubrication.* Sealed bearings are provided and do not need special lubrication or attention except at overhaul periods. Keep them dry and free of foreign material.

(4) *Wiring.* Wiring and wiring harness may become brittle in extreme cold. Do not bend brittle insulation as it will crack and cause grounds or short circuits. Warm wiring before bending or attempting rewiring operations. Keep dry at all times.

24. Operation in Extreme Heat

a. Engine.

(1) *Cooling system.*

(*a*) Make sure all connections are tight and the fan belt is properly adjusted.

(*b*) If available, use soft water in the radiator. Add rust inhibitor to coolant to prevent formation of rust and scale. Clean and flush at regular intervals.

(*c*) Check operation of the thermostat to see that it opens at the proper temperature.

(*d*) Adjust the thermostatic switch mounted in the right side of the elbow clamped to the inlet hose (3, fig. 12) to shut the unit down at a temperature between 205° and 210° F.

(2) *Lubrication.* Refer to LO 5–5002 for the proper grades of oil to be used. Check the crankcase oil level twice in every 8-hour period and keep the air cleaner clean. If sand or dust is in the atmosphere, take additional precautions (par. 25).

(3) *Batteries.* Check the battery level daily and refill with distilled water or soft drinking water. A specific gravity as low as 1.220 can be permitted safely in torrid climates.

b. Generator.

(1) *General.* Sufficient field and regulator control resistance is available to operate the generator set at temperatures up to 125° F. and to compensate for field resistance changes. Refer to paragraph 126 to adjust the time delay resistor.

(2) *Ventilation.* When operating in dirt-free air, raise the side panels to provide maximum ventilation. If operat-

ing indoors, allow sufficient room around the unit for air circulation and ventilate the room with exhaust fans.

25. Operation in Dust or Sand

a. General. Dust and sand will shorten the life of mechanical parts faster than any other natural agent. If there is a choice, locate the unit on the prevailing windward side of dusty installations, roadways, or construction work. Give the unit the benefit of any natural barrier; or, if the installation is other than temporary, erect a protective shield. Where water is plentiful, wet down the area around the generator set. Wipe down the set at regular intervals with cleaning solvent or diesel fuel.

Caution: Keep the immediate area around the generator dry. If this is not possible, place dry duckboards or insulating material at the base of the generator for the operator to walk on and prevent the possibility of grounding himself.

b. Engine.

(1) *Lubrication.* Increase the frequency of lubrication service, with particular attention to the air cleaner and crankcase breather. Keep these screens clean and well oiled. Always clean around oilcups and lubrication fittings before lubricating.

(2) *Cooling system.* Inspect the cooling system frequently for leaks and be sure that the fan belt is properly adjusted.

(3) *Fuel system.* Keep sand and dirt out of fuel storage tanks. Clean around the filler hole before removing the cap, and clean the dispensing equipment. If fuel is thought to be dirty, filter it through a chamois or several folds of cloth. Clean the fuel sediment bowl and primary filter weekly.

c. Generator. Keep the side panels and control panel doors closed as much as possible. Clean around the inspection covers and ventilators frequently. After use, blow out the generator set with compressed air and wipe it down with solvent or diesel fuel.

26. Operation in Wet or Humid Areas

If the unit is outside and not operating, put canvas or other waterproof cover over the unit during storms. Remove the cover during dry periods and open the side panels to allow the unit to dry out. Dry the unit before operating. Keep it well painted. Keep fuel tanks full to avoid condensation.

27. Operation in Salt Water Areas

Protect the unit from salt spray and wipe it down with fresh water regularly. Take all precautions directed in paragraph 26.

28. Operation in High Altitudes

The generator set is designed to operate under continuous full load at altitudes up to 5,000 feet. The thermostatic switch must be adjusted to shut the unit down at 195° F. As altitude increases, available engine horsepower decreases. Normally, the fuel injector pump timing is not altered for changes in altitude; however, timing may be advanced 1° or 2° for every 3,000 feet increase in altitude over 5,000 feet. Service the air cleaner daily as directed in LO 5–5002.

CHAPTER 3

ORGANIZATIONAL MAINTENANCE INSTRUCTIONS

Section I. ORGANIZATIONAL TOOLS AND EQUIPMENT

29. General

The only tools required to perform organizational maintenance on the Consolidated Diesel Electric generator set, model 1664 are standard mechanic's handtools.

30. Tool and Publication Set

The tool and publication set that must be requisitioned for the use of the operator is listed in appendix III.

31. Special Organizational Maintenance Tools and Equipment

No special organizational maintenance tools or equipment are required.

Section II. LUBRICATION AND PAINTING

32. General Lubrication Information

a. LO 5–5002 prescribes first and second echelon lubrication maintenance for the Consolidated Diesel Electric generator set, model 1664.

b. A lubrication order is published for each item of equipment. The lubrication order shown in figure 17 is a reproduction of the approved lubrication order for this generator set.

c. Lubrication orders prescribe approved first and second echelon lubrication procedures. The instructions contained therein are mandatory.

33. Detailed Lubrication Information
(fig. 17)

a. Care of Lubricant and Lubricating Equipment. It is important to keep dirt, grit, and water from getting into lubricants.

Keep lubricants in clean, tightly sealed containers and see that oilcans and dispensing equipment are clean at all times.

b. Points of Application. Points requiring lubrication are illustrated as reference views in figure 17. Since it is possible that such accessories as the charging generator and starting motor may be replaced with interchangeable units having different lubrication points or life-seal bearings, it is necessary that personnel inspect accessory equipment before servicing.

c. Cleaning.

(1) Before lubricating the equipment, wipe all lubrication points clean with cleaning solvent.

(2) Wipe up spilled lubricants and clean around lubrication points after servicing.

d. Operation Immediately After Lubrication.

(1) Operate the engine for 5 minutes after changing the oil and recheck the oil level. Add oil if necessary.

(2) Operate the engine for 5 minutes after adding diluent (gasoline) to the lubricating oil in cold weather. Mark the new level on the oil gage.

e. Lubrication Notes. The lubrication intervals given on LO 5–5002 are maximum for normal 8-hour day operation. Intervals should be shortened to compensate for abnormal conditions or activities.

(1) The starting motor bearing (ref. 4) and the charging generator bearings (ref. 3) require only a drop or two of oil approximately every 100 hours of operation. Excessive oil in these accessories can cause faulty commutation.

(2) After approximately 2 weeks of operation, the lubricating oil filter (ref. 8) must be serviced (par. 102*b*). Drain the oil from the filter and clean the filter thoroughly. Replace the filter element, and assemble the filter. Run the engine about 5 minutes to refill it. Check the crankcase oil level and add enough oil to bring the level to the full mark on the oil gage rod (ref. 6).

(3) Check the crankcase oil level (ref. 6) with the oil gage rod after the engine has been stopped for about 30 seconds. The crankcase oil level must reach the full mark on the rod.

(4) The oil bath air cleaner (ref. 2) must be serviced (par. 111*b*) after every 60 hours of operation. The filtering elements of the air cleaner and air cleaner breather

LUBRICATION ORDER **LO 5-5002**

GENERATOR SET, ELECTRIC, PORTABLE, DIESEL DRIVEN, SKID MOUNTED, 15 KW, 120/208 OR 240/416 VOLT, 3 PHASE, 60 CYCLE, CONVERTIBLE TO 120/208 OR 240/416 VOLT, 3 PHASE, 50 CYCLE, CONSOLIDATED DIESEL ELECTRIC MODEL 1664

Reference: TM 5-5002, TB 5-5002-1

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

Clean fittings before lubrication.

Relubricate after washing.

Clean parts with SOLVENT, Dry-Cleaning, or with OIL, fuel, Diesel. Dry before lubricating.

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

—KEY—

LUBRICANT	CAPACITY	EXPECTED TEMPERATURES			INTERVALS
		Above +32°F	+32°F to -10°F	Below -10°F	
OE —OIL, Engine		OE 30 or 9250	OE 10 or 9110	See Note 1	D- Daily
Crankcase	7 qts.				W- Weekly
Air Cleaner		OE 30 or 9250	OE 10 or 9110	OHA	2W- 2 Weeks
Other Points					
OHA —Oil, Hydraulic, Aircraft, Petroleum Base.					M- Monthly

LUBRICANT • INTERVAL INTERVAL • LUBRICANT

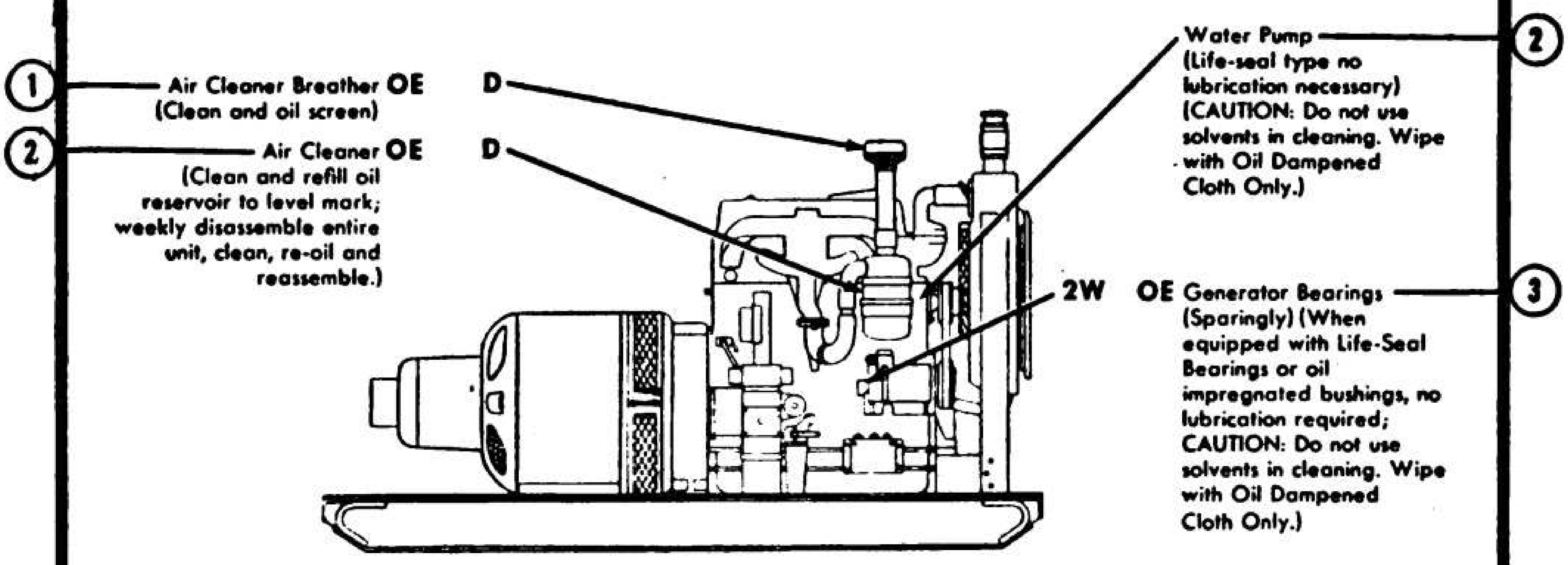


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Figure 17. Lubrication order.

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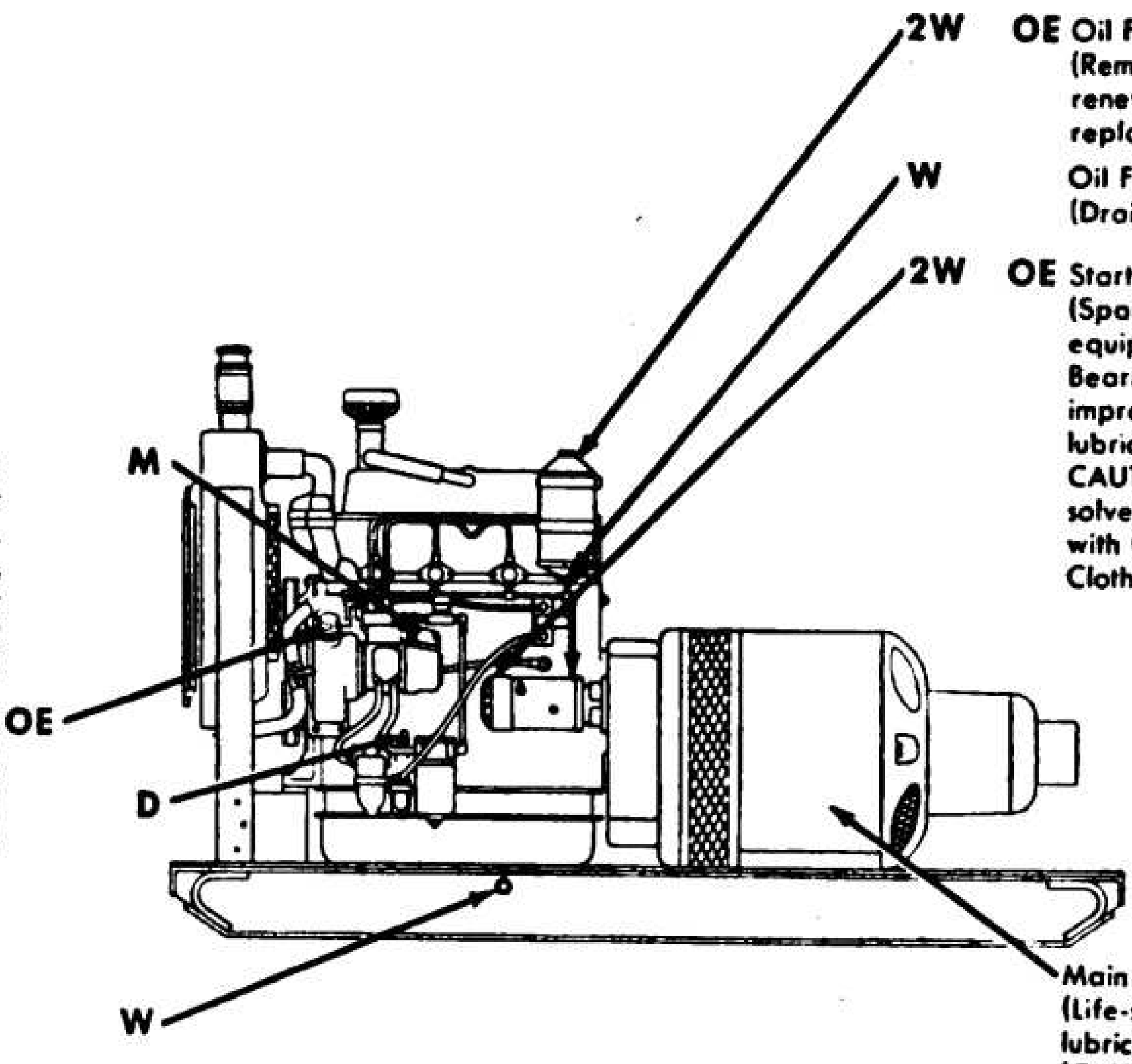

NOTES:

1. COLD WEATHER—(When winterization kit is not available.)—Every 3 days, drain crankcase and refill to "Full" mark with OE 10. Add 2 qts. of gasoline and run engine 5 minutes to mix. Mark the new level on the oil gage for future reference.
CAUTION: Every ½ day, check level and fill to "Full" mark with OE 10. If engine is to be shut down for ½ day or more, add gasoline to reach new level mark and run engine 5 minutes to mix.
NOTE: OIL, fuel, Diesel may be used as a temporary diluent only when sufficient gasoline is not available.
WARNING: Diluent used is inflammable; do not service equipment near heater or open flame.

2. FOR OPERATION OF EQUIPMENT IN PROTRACTED COLD TEMPERATURES BELOW −10°F. Clean parts with SOLVENT, Dry-Cleaning, and drain all oil housings. Relubricate with lubricants indicated in the Key for below −10°F.

3. OIL CAN POINTS—Every week lubricate with OE. Heater and shutter controls, throttle and emergency stop controls.

4. POINTS REQUIRING NO LUBRICATION—Do not lubricate main generator, fuel injection pump, governor, or water pump.

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

BY ORDER OF THE SECRETARIES OF THE ARMY AND THE AIR FORCE:

M. B. RIDGWAY
General, United States Army,
Chief of Staff

OFFICIAL:
JOHN A. KLEIN,
Major General, United States Army,
The Adjutant General

N. F. TWINING,
Chief of Staff,
United States Air Force

OFFICIAL:
K. E. THIEBAUD,
Colonel, United States Air Force,
Air Adjutant General

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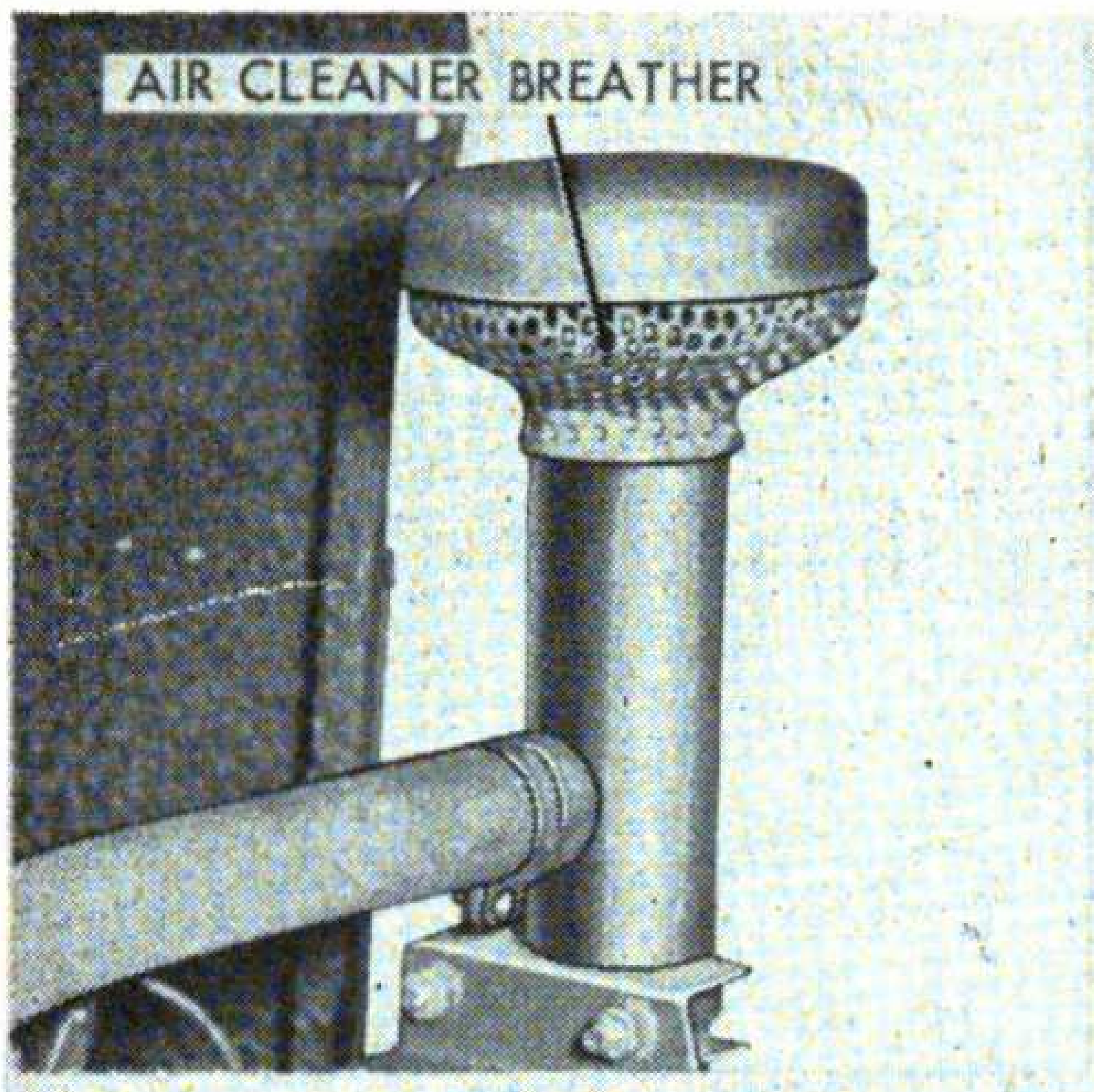
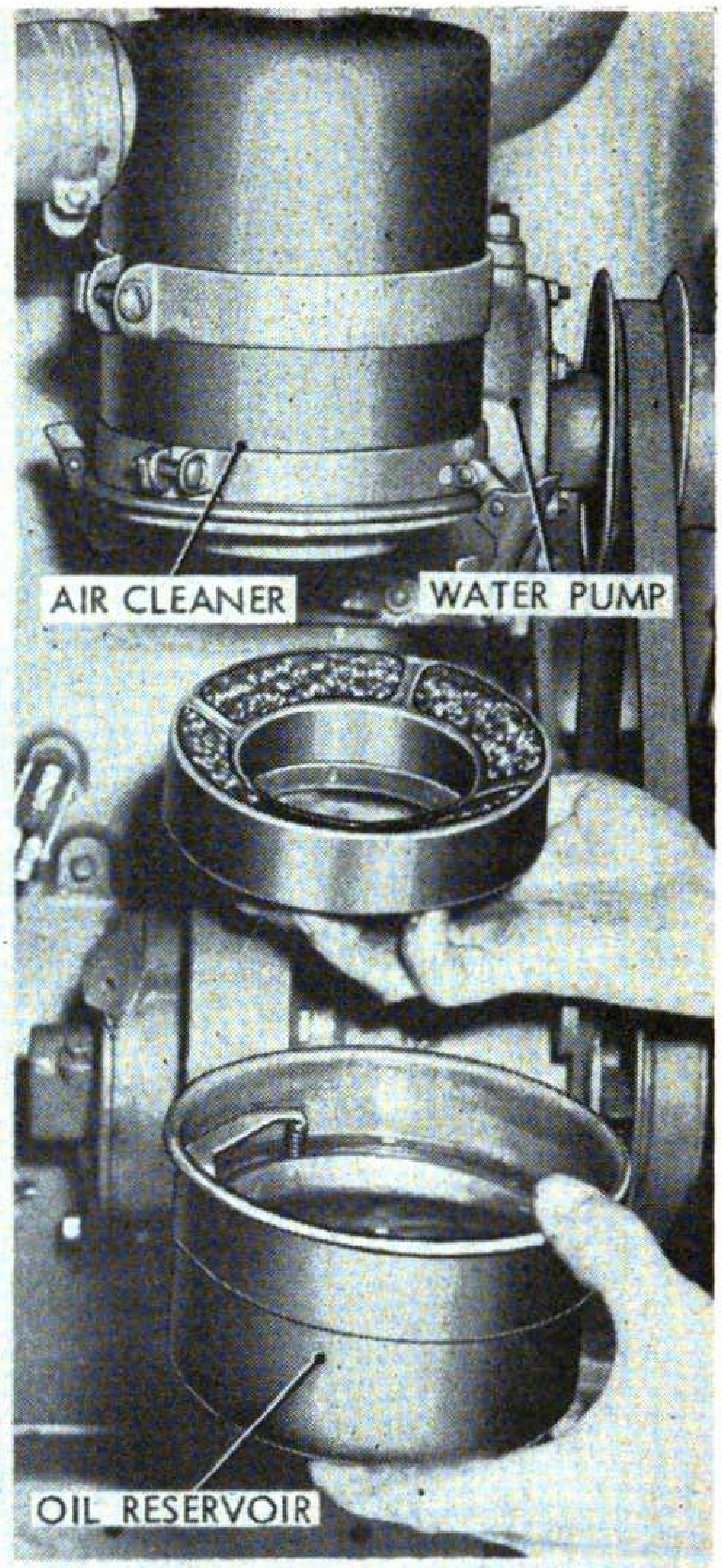
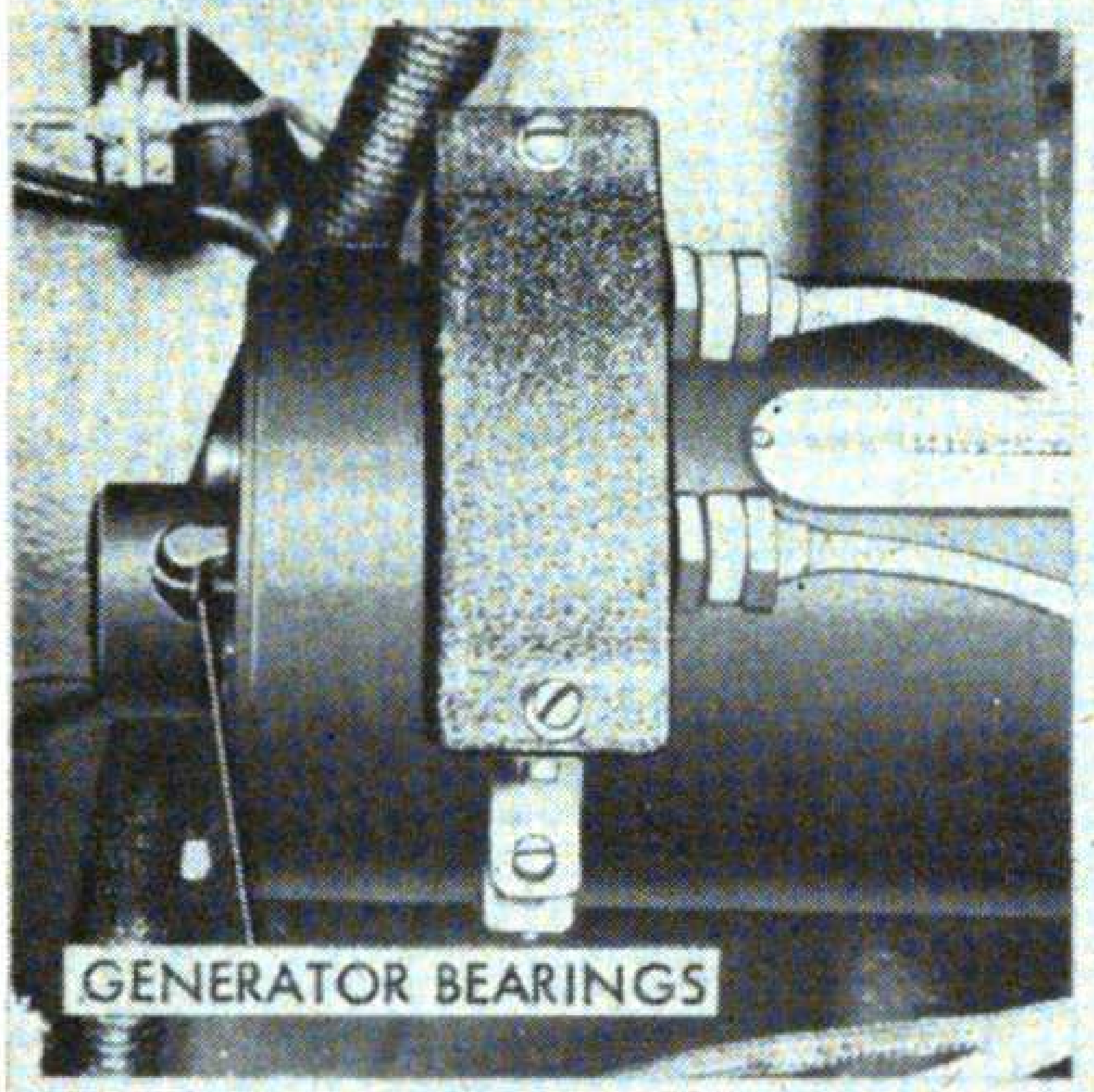
Figure 17—Continued.



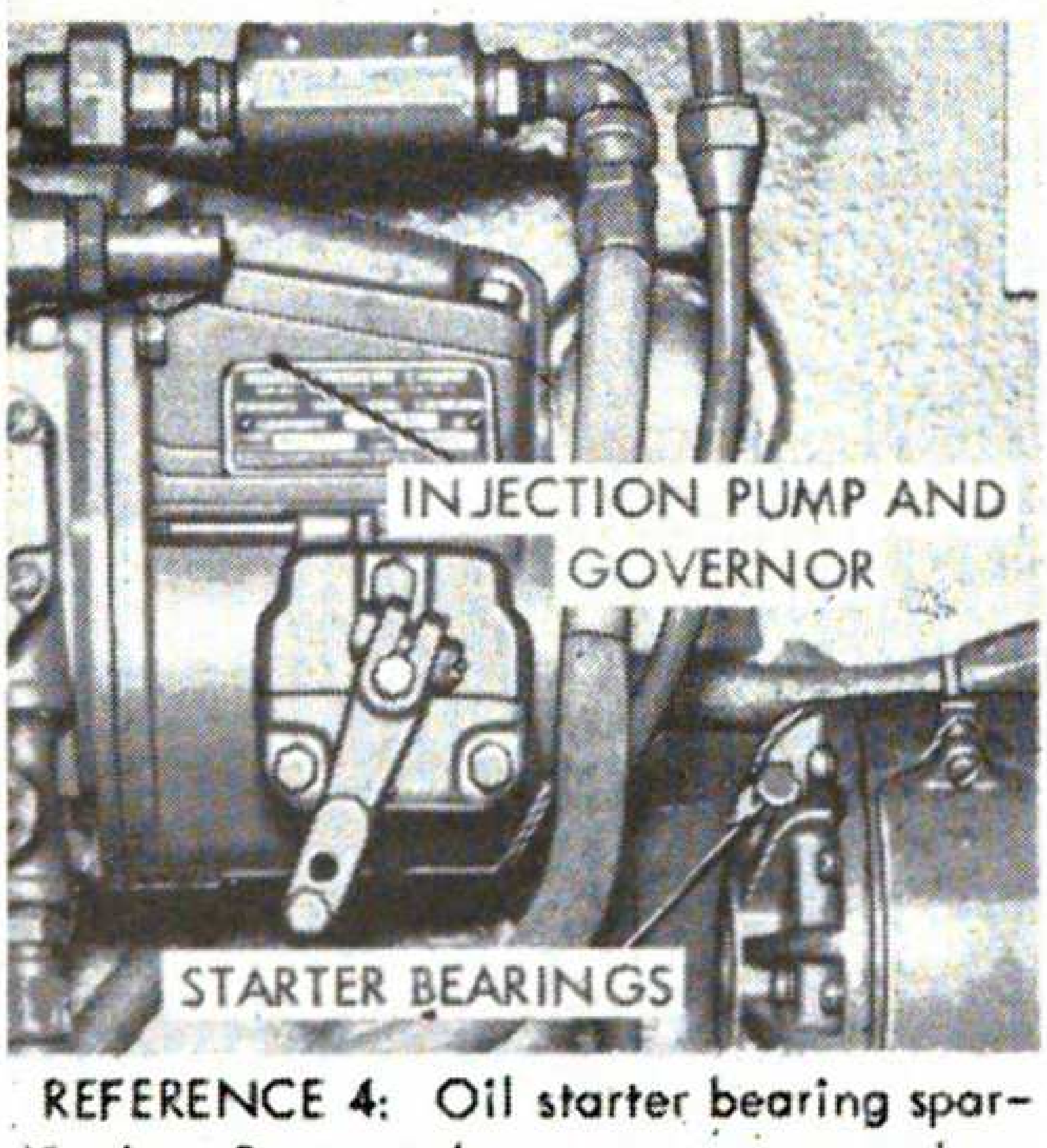
REFERENCE 1: Clean breather with solvent and re-oil.



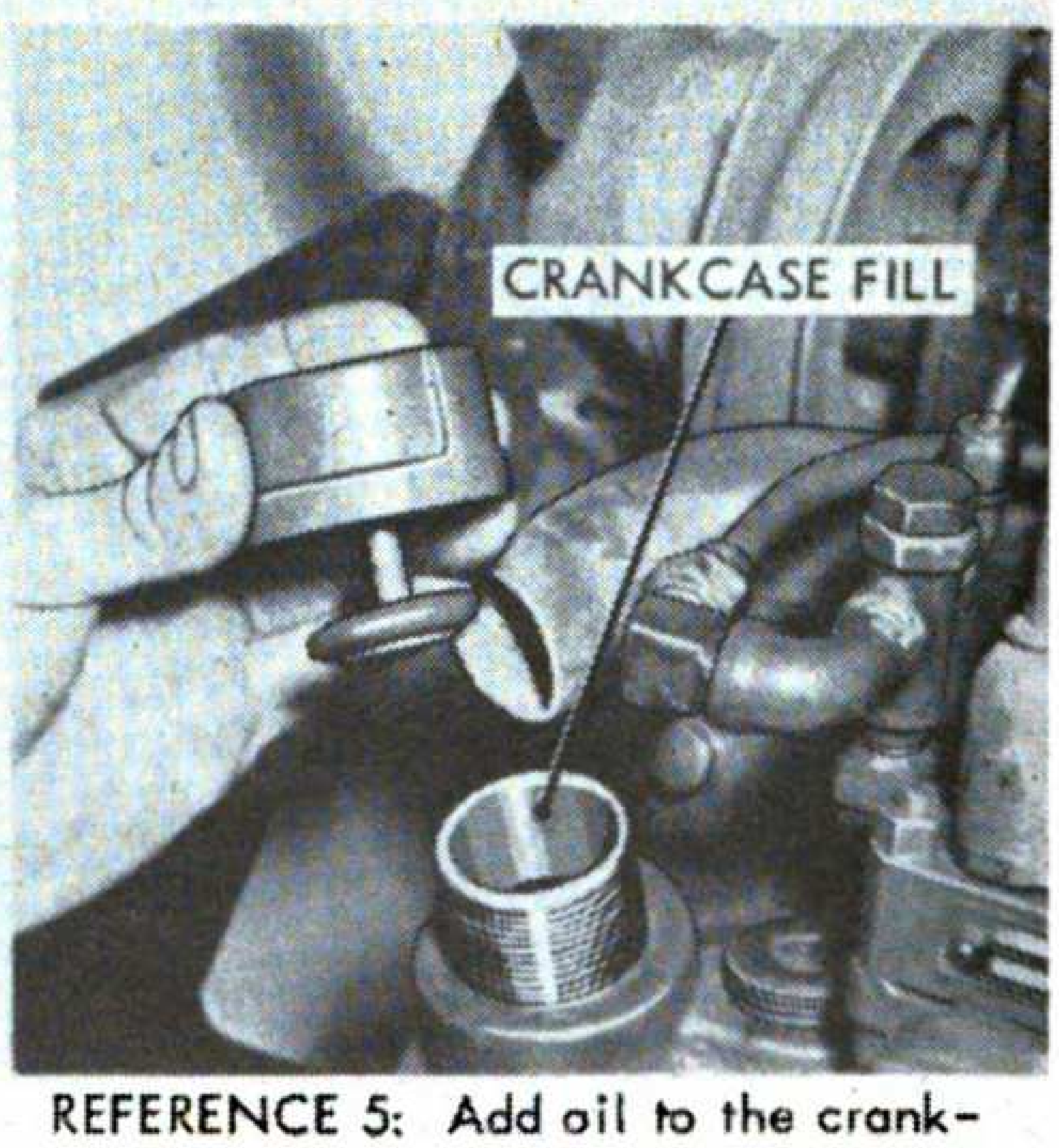
REFERENCE 2: Clean and refill oil reservoir to level mark.



REFERENCE 3: Oil bearing sparingly.



REFERENCE 4: Oil starter bearing sparingly. Remove the governor cap and filter. Clean and assemble.



REFERENCE 5: Add oil to the crankcase.

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Figure 17. Lubrication order—Continued.

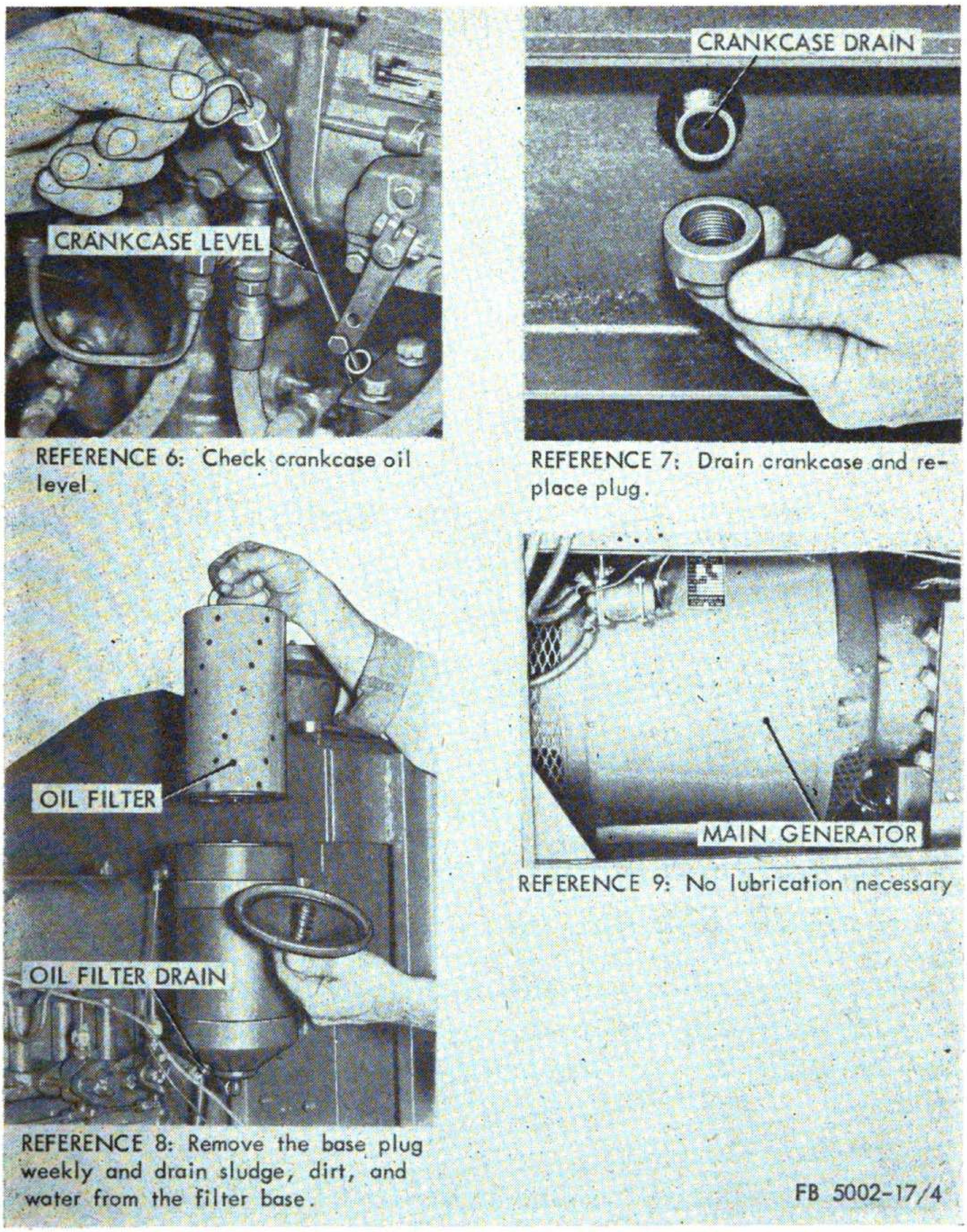


Figure 17—Continued.

(ref. 1) must be saturated with the prescribed lubrication after cleaning with the proper solvent.

(5) The crankcase should be drained (ref. 7) when the engine is at normal operating temperature so that the oil will drain completely.

(6) Clean the oil pan strainer in the bottom of the oil pan after every 250 hours of operation (par. 103*b*).

(7) After about 240 hours of operation, remove the governor cap and extract the lubricating oil filter common to the

governor and pump. Clean with cleaning solvent and install.

34. Painting

In addition to keeping the unit clean, it is necessary that the unit be inspected monthly for signs of chipped paint or corrosion. The housing and other exposed parts of the unit are particularly likely to require touchup or repainting. Extreme weather conditions will accelerate the deterioration of the paint. Surface treatment and paint is to be applied in accordance with TM 9–2851.

a. Parts To Be Painted.

(1) When required, paint the housing, skid, frame, radiator, engine, generator, changeover panel box, and accessories.

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

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

b. Parts Not To Be Painted. Do not paint threaded surfaces, sliding parts, control rods, linkages, identification plates, serial numbers, and data plates. Do not paint electrical contacts, terminal blocks, or instruments. Mask all items to be protected.

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

Caution: Be careful not to drip paint through inspection openings onto the brushes, commutator, or sliprings of the main generator.

c. Surface Treatment.

(1) Use cleaning solvent or vapor degreasing if necessary to assure an oil- and grease-free surface.

(2) Remove all loose paint and corrosion using wire brushes, sandpaper and steel wool. Wipe down with solvent to remove all dust and rust.

d. Application. The first coat of paint or primer will be applied to a dry, clean surface as soon as practicable after the cleaning or treatment of the metal. Coatings will be applied in an ambient temperature of not less than 50° F. Paint and surface will be approximately the same temperature. The paint will be applied by dip, flow coat, brush, or spray in a neat, thorough and workmanlike manner. A smooth, even surface, free from runs, sags, or other defects which might interfere with the proper application and adhesion of subsequent coats will be provided. When painting on any portion of the work is initiated, the complete operation including the priming coats and finish coats will be completed as soon as practicable, allowing sufficient drying time between coats. Baked finishes, except on materials which would be adversely affected by such treatment, will be permitted.

e. Drying Time. Air-drying time between coats, under favorable conditions, should preferably be 24 hours, but in no case will be less than the time specified for the recoating or self-lifting test in the applicable paint specification. Drying time will be extended to compensate for such adverse drying conditions as low temperature and high humidity.

f. Contact Surfaces. Metal to metal, metal to wood, and wood to wood surfaces, except those to be welded or hot riveted in the shop, will have the specified primer applied before assembly.

g. Color. The color of the finish paint will be olive drab No. 1405 Gloss, No. 2430 Semigloss, or No. 3412 Lusterless as specified by proper authority.

Section III. PREVENTIVE MAINTENANCE SERVICES

35. General

The operator of this generator set and the organizational maintenance personnel must perform their preventive maintenance services regularly, to make sure the generator set operates well and to lessen the chances of mechanical failure.

36. 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 or 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 bent or twisted; not chafed or burned; 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 on the equipment.

(3) Check of a unit to determine if it is secure is usually an external inspection, a hand-feel, or a prybar 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 part 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 generator set 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 the proper authority before the unit is put in operation.

(1) *Generator location.* The generator set should be placed on a solid level foundation and where there is the least danger of being damaged by moisture, dust, or corrosive fumes. It should be located where the shortest possible transmission lines can be used. 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. Open the drain when the engine is stopped and leave it open until the engine is started again. A horizontally inclined exhaust pipe should slope away from the engine for drainage. Make sure that the transmission lines are properly connected and are large enough to carry the current.

(2) *Fuel.* Check the engine and heater fuel supply. See that tanks are full. Check the reserve supply of fuel and replenish if necessary. Keep fuel tanks full to prevent condensation.

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

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

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

(6) *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.

(7) *Starting precautions.* Before starting the engine, press the red main circuit breaker OFF push switch. See that fuel supply valves are at their correct setting. Do not run the starting motor more than 20 seconds at a time. Start the engine (par. 16) and allow it to warm up at slightly faster than idling speed. Do not race. If the engine heater is used, make sure all coolant valves are open. When the flame heater is operated, be sure to drain surplus fuel by removing the manifold drain plug.

(8) *Instruments.* Check all instruments to see that they are securely mounted and not damaged. Check all gage readings. Record the reading of the time meter. At normal operating temperature and speed, the oil gage should read 40 psi. Pressure will be above normal while the engine is cold, and may drop below normal at idling speed after the engine has warmed up. The water temperature gage should show a gradual rise during warmup period until it reaches a maximum between 165° and 195° F. The battery ammeter should be in the charge range. The frequency meter will read 60 cycles at 1,200 rpm and 50 cycles at 1,000 rpm. The ammeter-voltmeter phase switch is left in the OFF position except when reading phase current or voltage.

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. He will perform the following specific services.

(1) *Instruments.* Check all gage and meter readings frequently. Normal readings are as follows:

Frequency meter	60 cycles at 1,200 rpm; 50 cycles at 1,000 rpm
Oil pressure	40 psi
Coolant temperature	165° to 195° F.
Battery ammeter	1 to 2 amps charge

The a-c ammeter readings will vary with the electrical load but should be the same in each phase. Listed below are the phase current and voltage indications that should be shown on the a-c ammeter and the a-c voltmeter with a given voltage connection.

	Phase-switch position	Voltage connection 120-208	Voltage connection 240-416
A-c voltmeter	1	208	416
	2	208	416
	3	208	416
	OFF	120	240
A-c ammeter	1	52 (max)	21.6
	2	52 (max)	21.6
	3	52 (max)	21.6
	OFF	OFF	OFF

(2) *Unusual operation and noises.* If the engine fails to respond to the controls, is noisy or vibrates, or if there is excessive sparking at the generator brushes, shut down the unit. Report all deficiencies to the proper authority.

e. At-Halt Services. At halts, even 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 the engine and heater fuel supply. Add fuel if necessary.

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

(3) *Water.* Check the coolant in the radiator and see that it is up to the proper level. Add coolant if necessary.

Caution: If the engine overheats because of a lack of coolant, allow it to cool before filling the radiator; otherwise, there is danger of cracking the cylinder head or block. 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 the condition

of the fan belt. If operating under extremely dusty conditions, inspect the air cleaner and service as indicated in the current lubrication order.

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

(1) *Shutdown precautions.* Press the red circuit breaker OFF switch and allow the engine to run at idling speed for a few minutes before stopping. Turn the engine heater coolant valves off when the heater is not in use.

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

(3) *Clean equipment.* Clean all dirt, excess oil, and grease from the exterior of the unit. See that the 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 toolbox door will close and fasten. Report any unserviceable tools to the proper authority.

(5) *Fuel filters.* Remove the drain plugs and drain any water and sediment from the bottom of both the primary and secondary fuel filters. Replace the plugs. Remove the vent plugs of the primary and secondary filters and operate the hand primer. Tighten the vent plugs when fuel runs out in a clear, solid stream.

(6) *Lubrication.* Lubricate as specified in the current lubrication order. 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 can be deflected without undue pressure ¾ to 1 inch midway between pulleys.

(8) *Fire extinguisher.* Check the condition of the fire extinguisher and inspect for full charge, proper working order, and secure mounting. The amount of charge in the carbon tetrachloride type can be determined by removing the filler plug. The carbon dioxide type must be weighed to determine the state of the charge. Empty and full weights are stamped on the valve body.

(9) *Protection.* See that the switchboard door housing and side panels are closed and fastened. If the generator is not under a shelter, cover it with a suitable cover. If there is any danger of coolant freezing in the radiator and antifreeze is not available, drain the cooling system and leave the drains open. Run the engine at slightly faster than idling speed for 30 seconds to make sure the water pump and all cooling system passages are completely drained. The unit also can be protected by operating the engine heater at low fire setting.

37. 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. Make all electrical connections before starting operation.

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

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

e. Keep the generator clean and dry.

Note. Complete DD Form 110 and report any worn or damaged parts requiring replacement or repair.

f. Responsibility for performance of preventive maintenance services rests not only with operators, but with the entire chain of command from section chief to commanding officer (AR 700–105).

38. Organizational Maintenance

a. Organizational preventive maintenance is performed by organizational maintenance personnel, with the aid of the operator, at weekly and monthly intervals. The weekly interval will be equivalent to 60 hours of use. The monthly interval will be equivalent to 4 weeks, or 240 hours of use, whichever occurs first.

b. The technical inspection column is provided for the information and guidance of personnel performing technical inspection, and constitutes the minimum inspection requirements for the equipment.

c. The preventive maintenance services to be performed at these regular intervals are listed and described below. The numbers appearing 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.

Technical inspection	Services: Monthly	Services: Weekly	
			GENERAL
1	1	1	*Before-operation service.* Check and perform the services listed in paragraph 36*c*.
2	2	2	*Lubrication.* Inspect the entire unit for missing or damaged oil lines and oilcups, and for indication of insufficient lubrication.
	2	2	Lubricate as necessary. Refer to the current lubrication order. Replace missing or damaged fittings.
3	3	3	*Tools and equipment.* Inspect the condition of all tools and equipment assigned to the unit. Check the condition and mounting of the toolbox.
	3	3	See that all tools and equipment assigned to the generator are clean, serviceable, and properly stowed or mounted. See that the toolbox is in good condition.
4	4	4	*Fire extinguisher.* Check the carbon tetrachloride type for full charge by removing the filler plug. See that the operating mechanism is not corroded and that the extinguisher is securely mounted. Inspect the 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 full weights are stamped on the valve body.
	4	4	See that any extinguisher deficiencies are corrected or reported to the proper authority. Keep a tag on the extinguisher showing inspection dates and condition.
5	5	5	*Publications.* See that copies of this technical manual, TB 5-5002-1, LO 5-5002, and DA Form 285 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 the proper authority.
7	7	7	*Modification.* See if all available modification work orders applying to this machine have been completed and recorded on DA Form 478.
			ENGINE AND ACCESSORIES
11	11	11	*Cylinder head, manifolds, and gaskets.* Inspect the 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 130 to 140 foot-pounds (par. 106). Valve clearance adjustment must be made after tightening head bolts (par. 107).

Technical inspection	Services		
	Monthly	Weekly	
12	12	12	*Valve mechanism.* If valves are noisy or a loss of power is noticed, check the condition of the valve mechanism. Check the tappet adjustment while the engine is hot. The correct adjustment for both intake and exhaust valves is 0.014 inch.
	12	12	Adjust the valve clearance if necessary (par. 107).
14	14	14	*Crankcase breather.* Inspect the crankcase for leaks. Check the condition, cleanness, and mounting of the crankcase breather and oil filler cap.
	14	14	Correct or report any leaks noticed. If breather or filler are dirty, remove and clean.
15	15	15	*Oil filter.* With the engine running, inspect the filter assembly and connections for leaks.
	15	15	Tighten connections or repair any leaks noticed. Service the filter as specified in the current lubrication order. Replace the filter cartridge or element if necessary.
16	16	16	*Radiator.* Inspect the radiator for leaks, insecure mounting, and obstructions in the core or shutters. Inspect all lines and connections for leaks. Check hoses for deterioration and loose connections. Check engine operating temperature and condition of coolant. If antifreeze is used, check coolant freezing point.
	16	16	Drain, flush, and refill the cooling system if coolant is contaminated with rust or dirt (par. 90). See that core air passages and guard are clean. Replace 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 plnt.
17	17	17	*Water pump, fan, and shroud.* Inspect the pump for leaks and 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 (par. 91).
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 ¾ to 1 inch from normal position, without undue pressure, at a point midway between the pulleys.
	18	18	Adjust belt tension if necessary and correct any misalinement. Replace the belt if it is frayed or badly woen (par. 91).
20	20	20	*Governor and linkage.* Check the governor for correct operation and adjustment.
	20	20	Adjust the governor if necessary (par. 87). To replace the governor spring, remove the cap at the back of the governor

Technical inspection	Services		
	Monthly	Weekly	
21	21	21	*Engine heater.* Clean dirt away from heater and be sure the assembly is securely mounted. See that coolant and fuel lines are tight, and check for leaks. Inspect all external power leads and be certain there are no breaks and the connections are tight. Remove the igniter (par. 117*c*) and test with a six-volt battery. The igniter should draw 10 to 12 amperes and heat to a bright red in a few seconds. Remove the cover and bracket assembly, and wash the wick in cleaning solvent and blow dry. See that the operating lever does not bind at any point in its travel.
	21	21	Replace a frayed wick, defective igniter, or defective wiring. Operate the heater for 30 minutes. Correct defects or report deficiencies to proper authority.
			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 (pars. 81 and 82). Tighten all loose connections.
41	41	41	*Air cleaner.* Inspect all joints between the air cleaner and intake manifold to see if they are tight.
	41	41	See that the air cleaner is securely mounted and that all connections are tight. Service the air cleaner as specified in the current lubrication order.
42	42	42	*Nozzles, injector pump, and housing.* Inspect the injector pump and all lines and connections for leaks. Note if the engine runs irregularly or if the exhaust shows an excessive amount of smoke.
	42	42	If the engine runs irregularly or the exhaust shows an excessive amount of smoke, refer to the troubleshooting section. Correct or report any leaks noticed. *Note.* Because of the precision accuracy to which nozzles are manufactured, cleanness is imperative in handling them. Hard or sharp tools, or abrasives of any kind should never be used in cleaning the nozzles.
43	43	43	*Tanks, caps, and gaskets.* Inspect the engine and heater fuel tanks for loose mounting bolts. Check for leaks in the tank and for dirty filler caps.
	43	43	See that tanks are securely mounted. Report any leaks to the proper authority. Open the draincock in the bottom of the fuel tank and drain out the 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 leaking or damaged fuel lines.

Technical inspection	Services		
	Monthly	Weekly	
			ELECTRIC SYSTEM
47	47	47	*Batteries.* Inspect the batteries for cracks, leaks, loose holddown bolts or clamps, and 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 ½ inch above the plates. Check the electrolyte and record its specific gravity.
	47	47	Remove all dirt and corrosion from the top of the batteries, posts, cables, and cable terminals. Replace damaged cables. Apply a thin film of chassis grease over the terminals after they are clamped tight. Add clean water if needed but do not overfill. If freezing temperatures prevail, the batteries must be charged long enough to mix the solution thoroughly. See that the batteries are securely mounted and that caps are tight and ventholes are open.
48	48	48	*Generator, starting motor.* Inspect for loose mounting bolts and external wiring connections.
48	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 commutator.
	48	48	See that mounting bolts and wiring connections are tight. Clean the commutator. Replace brushes if necessary.
50	50	50	*Wiring, switches.* Inspect the wiring for oil-soaked, cracked, or frayed insulation, broken wires, and loose and corroded connections. Check the operation of the switches.
	50	50	Replace defective switches and wires. See that all wiring is clean and that connections are tight.
51	51	51	*Battery-charging voltage regulator.* See that all connections are tight and not corroded or broken. It is usual to have a high charging rate immediately after starting the engine, and a low charging rate with fully charged batteries. Continued battery trouble indicates a defective generator or regulator.
			CONTROL SYSTEM
57	57	57	*Gages (engine).* Check the condition and mounting of all gages.
	57	57	Tighten any loose mounting screws and connections. Remove damaged or defective gages.
58	58	58	*Meters.* See that the a-c voltmeter, a-c ammeter, and frequency meter read correctly for all positions of the ammeter-voltmeter phase switch. See that the meters are mounted securely and that the glass is not cracked.
	58	58	Tighten loose mounting screws and connections. Replace damaged or defective meters.

Technical inspection	Services		
	Monthly	Weekly	
59	59	59	*Regulator* and *rheostats.* See that the main generator regulator and rheostat controls are securely mounted. The regulator should hold a given voltage without "hunting".
	59	59	Adjust the plug-in element dashpot screw on the regulator, or replace if defective (par. 163). Clean the rheostats to insure good contact.
			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 efective 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 dust, dirt, oil, and grease. Inspect the brushes for wear and loose wire connections. Brushes should be replaced when they are worn to half original length. See if the brushes move freely in the holders and make firm contact with the sliprings and commutator and if the brush springs have about equal pressure.
	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 holders, brush wires are in good condition, and 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 switchboard panel to see if any 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,

Technical inspection	Services		
	Monthly	Weekly	
			instruments, and other units that are visible from back of the panel. *Do not remove the cover from any of the instruments or controls.* ***Caution:*** Be sure that the main circuit breaker OFF switch is pushed. 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 the driving disk is securely mounted. If any damage to the disk is notice report the deficiency to the proper authority.

Section IV. TROUBLESHOOTING

39. 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. 152 to 223) pertain to operations that are the responsibility of the field and depot maintenance personnel. Organizational maintenance personnel should not proceed without proper authority.

40. Engine is Hard to Start or Fails to Start

Probable cause	*Possible remedy*
Improper starting procedure.	Check starting procedure (par. 16).
Insufficient fuel.	Fill fuel tank, open both fuel valves, and prime fuel system (par. 16).
Air in fuel line.	Prime fuel system (par. 16).
Battery charge low.	Replace batteries (par. 95) or use the battery-charging receptacle (par. 100) to recharge them.
Low ambient temperature.	Apply cold weather starting technique (par. 23).

Probable cause	*Possible remedy*
Valve clearance incorrect.	Adjust valves (par. 107).
Fuel supply pump defective.	Clean, test, and replace if necessary (par. 85).
Nozzle holders leaking or dirty.	Replace nozzle holder assemblies (par. 88) or clean (par. 178). See note in paragraph 39.
Timing incorrect.	Correct timing (par. 86).
Valves pitted or warped.	Reseat or replace valves (par. 107).
Piston rings worn.	Replace rings (par. 194). See note in paragraph 39.
Fuel overflow valve stuck.	Replace injector pump (par. 86) or remove and clean valve (par. 177). See note in paragraph 39.

41. Engine Misses or Runs Erratically

Probable cause	*Possible remedy*
Air in fuel line.	Prime fuel system (par. 16).
Water in fuel.	Drain fuel system, refill and prime (par. 16).
Fuel filters dirty.	Replace filters (pars. 81 and 82). Prime fuel system (par. 16).
Fuel delivery valve not seating properly.	Replace injector pump (par. 86) or remove and clean valve (par. 177). See note in paragraph 39.
Overflow valve spring worn or broken.	Replace valve (par. 79*c*).
Valve clearance incorrect.	Adjust valves (par. 107).
Nozzle holders leaking or dirty.	Replace nozzle holder assemblies (par. 88) or clean (par. 178). See note in paragraph 39.
Fuel injector pump plunger sticking.	Replace injector pump (par. 86) or clean plunger (par. 177). See note in paragraph 39.
Governor action sluggish.	Replace the pump and governor (par. 86) or disassemble and clean (par. 177). See note in paragraph 39.
Governor spring broken or weak.	Replace the pump and governor (par. 86) or replace the governor springs (par. 177). See note in paragraph 39.

42. Engine Stops Suddenly

Probable cause	*Possible remedy*
Insufficient fuel.	Fill tank and prime system (par. 16).
Fuel supply pump defective.	Replace pump (par. 85).
Air in fuel lines.	Prime fuel system (par. 16).
Fuel system clogged.	Remove fuel lines (par. 79) and clean. Clean sediment bowl (par. 83) and replace primary and secondary fuel filters (pars. 81 and 82). Prime fuel system (par. 16).

Probable cause	Possible remedy
Oil pressure low (fuel shutoff solenoid deenergized).	Fill crankcase to proper level (par. 33*e*). Clean oil pan strainer (par. 103). Adjust or clean pressure relief valve (par. 104).
Engine temperature high (fuel shutoff solenoid deenergized).	Allow engine to cool. Check coolant level and add coolant if necessary. Check for leaks or broken hoses. Adjust fan belt (par. 91).
Fuel injector pump mounting loose–pump timing off.	Secure mounting and correct timing (par. 86).
Governor defective–overspeed microswitch stops unit.	Replace injector pump and governor (par. 86). Disassemble governor and replace defective parts (par. 177). Reset switch (par. 10*g*(1)). See note in paragraph 39.
Microswitch defective or connection broken.	Inspect wiring and repair connections. Replace microswitch if necessary (par. 166). See note in paragraph 39.

43. Engine Overheats

Probable cause	Possible remedy
Lack of coolant.	Allow engine to cool and add coolant. Check for leaks.
Fan belt slipping.	Adjust fan belt (par. 91).
Thermostat defective.	Replace thermostat (par. 92).
Radiator leaking.	Repair radiator (par. 90).
Internal collapse of inlet hose at pump.	Replace hose with wire reinforced hose.
Water pump leaking.	Replace pump assembly (par. 91). Replace seal assembly (par. 170). See note in paragraph 39.
Hose connection leaking.	Tighten clamps or replace hose.
Cooling system dirty or clogged.	Clean and flush system (par. 90).
Back pressure in exhaust line.	Replace pipe or muffler (par. 113).
Timing incorrect.	Correct timing (par. 86).
Radiator frozen.	Thaw radiator and add antifreeze par. 23*b*(3)).
Lack of oil.	Fill crankcase to proper level (par. 33*e*).

44. Engine Noisy

Probable cause	Possible remedy
Excessive carbon.	Remove carbon.
Timing incorrect.	Correct timing (par. 86).
Valve clearance incorrect.	Adjust valves (par. 107).
Engine overheated.	See paragraph 43 above.
Cylinder sleeve, rings, pistons, piston pins, or connecting rod bearings worn.	Replace worn parts (pars. 194 and 195). See note in paragraph 39.
Main bearings worn.	Replace bearings (par. 199). See note in paragraph 39.

Probable cause	Possible remedy
Fuel injector pump defective.	Replace injector pump (par. 86) or clean and repair (par. 177). See note in paragraph 39.
Accessory mountings loose.	Tighten all loose mountings.

45. Engine Lacks Power

Probable cause	Possible remedy
Air in fuel lines.	Prime fuel system (par. 16).
Fuel system clogged.	Remove fuel lines (par. 79) and clean. Clean sediment bowl (par. 83) and replace primary and secondary filters (pars. 81 and 82). Prime fuel system (par. 16).
Air cleaner dirty.	Clean (par. 111).
Valve clearance incorrect.	Adjust valves (par. 107).
Valves sticking.	Remove valves, clean, and adjust (par. 107).
Fuel injector pump defective.	Replace injector pump (par. 86) or clean and repair (par. 177). See note in paragraph 39.
Fuel injector pump mounting loose.	Secure mounting and correct timing (par. 86).
Fuel injector pump plunger sticking.	Replace injector pump (par. 86) or clean plunger (par. 177). See note in paragraph 39.
Fuel delivery valve sticking or not seating properly.	Replace injector pump (par. 86) or remove and clean valve (par. 177). See note in paragraph 39).
Fuel too heavy.	Drain fuel system. Replace primary and secondary fuel filters (pars. 81 and 82). Refill with correct fuel and prime fuel system (par. 16).
Carbon in cell bodies.	Remove and clean (par. 109).
Nozzles defective.	Replace nozzle holder assemblies (par. 88) or repair (par. 178). See note in paragraph 39.
Governor not operating properly.	Adjust governor (par. 87) or replace (par. 177). See note in paragraph 39.

46. Oil Consumption High

Probable cause	Possible remedy
Oil seals worn.	Replace seals (pars. 188 and 200). See note in paragraph 39.
Leaks in lubricating system.	Check all gaskets and oil lines.
Oil too light for prevailing temperature.	Drain and refill according to current lubrication order.
Main or connecting rod bearings worn.	Replace main bearings (par. 199) or connecting rod bearings (par. 194). See note in paragraph 39.
Piston rings worn or broken, or cylinder sleeves and pistons scored.	Replace defective parts (pars. 194 and 195). See note in paragraph 39.

Probable cause	Possible remedy
Excessive oil pressure.	Adjust pressure relief valve (par. 104).

47. Exhaust Smoky

Probable cause	Possible remedy
Air cleaner dirty.	Clean (par. 111).
Valves seating improperly.	Adjust, reseat, or replace valves (par. 107).
Carbon in cell bodies.	Remove and clean (par. 109).
Head gasket leaking.	Tighten head or replace gasket (par. 106).
Fuel injector pump dirty.	Replace injector pump (par. 86) or clean (par. 177). See note in paragraph 39.
Timing incorrect.	Correct timing (par. 86).
Piston rings worn.	Replace rings (par. 194). See note in paragraph 39.
Engine overloaded.	Reduce load on generator to rated output.

48. Engine Will Not Idle Smoothly

Probable cause	Possible remedy
Air in fuel lines.	Prime fuel system (par. 16).
Valve clearance incorrect.	Adjust valves (par. 107).
Valve spring broken.	Replace valve spring (par. 107).
Valves sticking.	Remove valves, clean, and adjust (par. 107).
Valves pitted or warped.	Reseat or replace valves (par. 107).
Head gasket leaking.	Tighten head or replace gasket (par. 106).
Overflow valve sticking.	Remove and clean valve (par. 79*c*).
Fuel injector pump defective.	Replace injector pump (par. 86) or clean and repair (par. 177). See note in paragraph 39.
Piston ring worn or broken, or cylinder sleeves and pistons scored.	Replace defective parts (pars. 194 and 195). See note in paragraph 39.
Governor not operating properly.	Adjust governor (par. 87) or replace (par. 177). See note in paragraph 39.

49. Low or No Oil Pressure

Probable cause	Possible remedy
Low oil level.	Fill crankcase to proper level (par. 33*e*).
Oil pressure gage line plugged.	Clean oil line.
Oil pressure gage defective.	Replace gage (par. 134).
Pressure relief valve setting incorrect.	Replace pressure relief valve (par. 104).
Oil pump defective.	Replace oil pump (par. 104) or repair (par. 197). See note in paragraph 39.
Oil pan strainer dirty.	Clean oil pan strainer (par. 103).

Probable cause	Possible remedy
Main or connecting rod bearings worn or burned.	Replace main bearings (par. 199) or connecting rod bearings (par. 194). See note in paragraph 39.

50. Generator Fails to Build Up Rated Voltage

Probable cause	Possible remedy
Voltage regulator defective.	Replace voltage regulator (par. 163). See note in paragraph 39.
Open circuit in exciter external wiring.	Check wiring from exciter to alternator and control panel. Follow wiring diagram (fig. 68) carefully.
Exciter field rheostat circuit open.	Check leads and connections for breaks. Replace rheostat if defective (par. 157). See note in paragraph 39.
Exciter or alternator windings open circuited, short circuited, or reversed.	Inspect, test, and repair exciter (pars. 208 and 209) or alternator (pars. 214 and 218). See note in paragraph 39.
Loss of residual magnetism in exciter.	Raise brushes from commutator and connect a 6-or 12-volt battery to the positive and negative brushes for an instant to restore polarity.
Brush contact poor.	Inspect and clean commutator (par. 121), brushes (pars. 122 and 124), and sliprings (par. 123). Adjust brush spring pressure or replace brushes as required.
Engine speed low due to defective governor, defective fuel injector pump, or excess load.	Replace fuel injector pump (par. 86), clean and repair pump and governor (par. 177) or reduce load. See note in paragraph 39.
Power loss in service line.	Increase size of load lines.

51. Generator Voltage Too High

Probable cause	Possible remedy
Excessive speed.	Reduce engine speed, adjust governor (par. 87), replace fuel injector pump (par. 86), or clean and repair governor (par. 177). See note in paragraph 39.
Voltage regulator defective.	Replace voltage regulator (par. 163). See note in paragraph 39.
Field resistance not correctly adjusted.	Adjust exciter field rheostat or voltage regulator rheostat (par. 16*d*).

52. Erratic Voltage

Probable cause	Possible remedy
Changeover panel connections loose.	Shut down set and tighten all loose connections (par. 7*i*).
Voltage regulator not operating.	Check connections to regulator. Replace if defective (par. 163). See note in paragraph 39.

Probable cause	*Possible remedy*
Engine hunts.	Replace fuel injector pump (par. 86) or clean and repair governor (par. 177). See note in paragraph 39.
Brush contact poor.	Inspect and clean commutator (par. 121), brushes (pars. 122 and 124), and sliprings (par. 123). Adjust brush spring pressure or replace brushes as required.
High mica on commutator.	Undercut mica (par. 208). See note in paragraph 39.
Loose brush holder.	Check mounting of all brush holders and tighten. Check position of exciter brushes to insure they are on neutral setting (par. 212). See note in paragraph 39.
Unbalanced loads.	Balance the loads (par. 18).
Governor not operating properly.	Adjust the governor (par. 87).

53. Overheating of Generator

Probable cause	*Possible remedy*
Generator overloaded.	Reduce load to rated output.
Alternator stator windings shorted.	Inspect, test, and repair (par. 217). See note in paragraph 39.
Air passages obstructed.	Clean air passages.
Poor ventilation in operating area.	Provide as much crossventilation as possible.
Load unbalanced.	Adjust load (par. 18*e*).
Brush pressure excessive.	Adjust brush spring pressure (pars. 122 and 124).
Exciter or alternator windings shorted or grounded.	Repair (pars. 208 and 214) or replace (pars. 209 and 217). See note in paragraph 39.

54. Flickering of Lights in Service Line

Probable cause	*Possible remedy*
Loose connections.	Tighten load line connections.
Field windings shorted.	Repair or replace winding (pars. 209 and 217). See note in paragraph 39.
Defective bearing, causing uneven air gap.	Replace bearing (par. 214). See note in paragraph 39.
Low speed.	Increase speed to proper frequency.
Generator overloaded.	Reduce load.
Erratic voltage.	See paragraph 52 above.

55. Generator Noisy

Probable cause	*Possible remedy*
Bearing defective.	Replace (par. 214). See note in paragraph 39.
Loose winding.	Inspect windings and repair as required.

Probable cause	*Possible remedy*
Rotor rubbing on stator.	Check coupling alinement (par. 182). Replace bearing (par. 214). See note in paragraph 39.

56. Electrical Contactor Continues to Trip

Probable cause	*Possible remedy*
Short in service line.	Inspect line and correct short circuit.
High voltage relay resistor setting too low.	Adjust (par. 126).
Main circuit breaker closing coil defective.	Replace circuit breaker (par. 160). See note in paragraph 39.
High voltage relay defective.	Replace relay (par. 126).
Engine stops suddenly.	Refer to paragraph 42.
Generator overloaded (engine will continue to run).	Reduce load to rated output.
Loose connection or break in contact closing circuit.	Check wiring and connections in circuit to start switch, auxiliary relay, and closing coil of circuit breaker. Follow wiring diagram (fig. 68) carefully.

57. Heater Takes Excessive Time for Ignition

Probable cause	*Possible remedy*
Weak battery.	Replace batteries (par. 95) or use battery-charging receptacle (par. 100).
Low fuel rate.	Check fuel system (par. 116) for ice and dirt.

58. Heater Fails to Ignite

Probable cause	*Possible remedy*
Loose, dirty, or shorted connections.	Check all connections. Follow wiring diagram (fig. 64).
Lack of fuel.	Fill heater fuel tank.
Heater fuel shutoff valve closed.	Open valve.
Float valve needle sticks.	Move operating lever up and down rapidly. If this does not free the needle, replace the assembly (par. 116*f*).
Fuel line clogged.	Drain and clean fuel system (par. 116).
Igniter or resistor burned out. (Motor operates, unit does not ignite.)	Replace (par. 117*c* or *d*).
Burner wick excessively burned or disintegrated.	Replace (par. 116*h*).
Excessive carbon deposits in burner.	Clean burner (par. 116*h*).
Weak batteries.	Replace batteries (par. 95) or use battery-charging receptacle (par. 100).

59. Heater Fails to Keep Burning

Probable cause	*Possible remedy*
Fuel line clogged.	Clean fuel line.
Insufficient fuel.	Fill tank.
Feed wick clogged.	Clean or replace (par. 116).
Defective blower.	Replace blower (par. 117).
Poor electrical connections to blower.	Check wiring and connections in circuit to blower. Follow wiring diagram (fig. 64) carefully.
Coolant leak into burner.	Replace heat exchanger (par. 118).
Float valve needle defective.	Replace float valve assembly (par. 116*f*).
Burner clogged.	Clean (par. 116*h*).

60. Continuous Overflow of Heater

Probable cause	*Possible remedy*
Float valve needle sticks.	Move operating lever up and down rapidly. If this does not free the needle, replace the assembly (par. 116*f*).
Float valve assembly defective.	Replace assembly (par. 116*f*).

61. Surging Combustion in Heater

Probable cause	*Possible remedy*
Dirty fuel.	Drain and clean system (par. 116).
Float valve assembly defective.	Replace assembly (par. 116*f*).

62. Smoke from Heater

Probable cause	*Possible remedy*
Defective blower or low blower speed.	Replace blower (par. 117*b*).
Incorrect fuel.	Drain fuel system (par. 116) and refill with correct fuel.

63. Coolant Leaks from Heater

Probable cause	*Possible remedy*
Loose connections at heat exchanger.	Tighten connections.
Cracked or corroded heat exchanger.	Replace heat exchanger (par. 118).

64. Vapor Leaks from Heater

Probable cause	*Possible remedy*
Heater not properly assembled.	Inspect feed line, resistor assembly, and igniter. Tighten heater connections. If leak persists, remove heater for overhaul (pars. 116 through 119).
Loose or damaged ducts.	Inspect and tighten or replace ducts as necessary.

65. Flame Heater Refuses to Ignite

Probable cause	*Possible remedy*
Fuel line clogged.	Clean fuel line.
Primer defective.	Replace primer (par. 131).
Pressure switch defective.	Replace switch (par. 112).

Nozzle assembly clogged.	Clean nozzle assembly (par. 112).
Improper electrode air gap.	Adjust air gap (par. 112).
Ignition coil or resistor defective.	Replace the coil or resistor (par. 112).

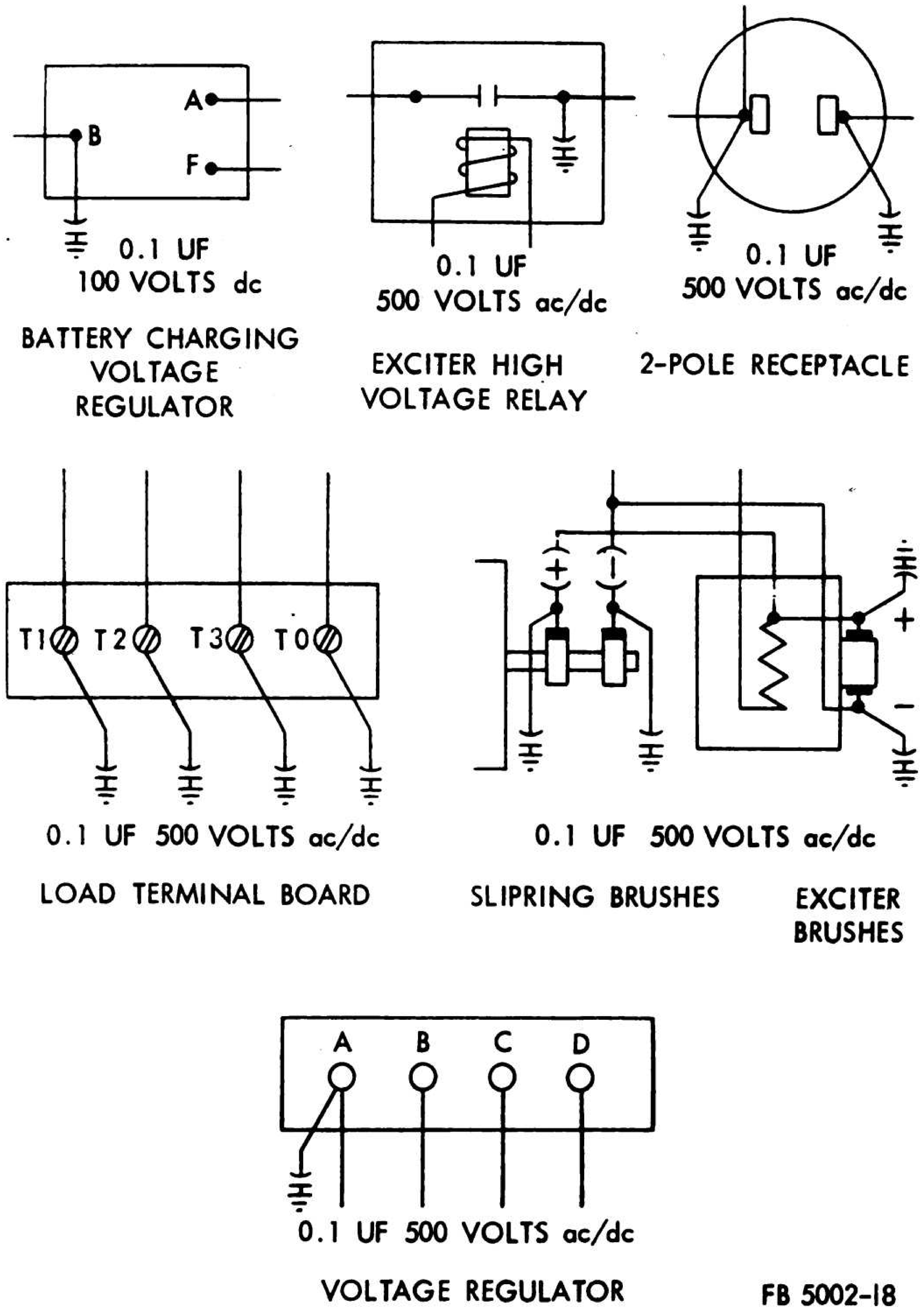


Figure 18. Radio interference suppression system.

66. Definition of Suppression

Radio interference suppression is the elimination or minimizing of electrical disturbances within the equipment which interfere with radio reception and disclose the location of the generator set to sensitive detectors. The interference is received as a static hum or pulse due to sparking contacts and radiation.

67. Source of Interference
(fig. 18)

Sparking at electrical contacts and high tension wires radiates waves of radio frequency. Interference on this generator set has been suppressed at the battery-charging voltage regulator, high voltage relay, 2-pole receptacle, load terminal board, main generator brushes, and voltage regulator as shown in figure 18.

68. Suppression Methods

Radio interference suppression functions in four ways. It collects and leads off to ground any interfering radiations and, at the same time, prevents reradiation by other conductors in the area. It traps, segregates, and grounds interfering impulses within an electrical circuit. It acts as a cushion for electrical energy within circuits, preventing arcing, and it resists the passage of interfering impulses through a circuit. Suppression equipment includes capacitors (condensers), shielded wires, and internal-external teeth lockwashers.

69. Suppression Effects

A generator set that is satisfactorily suppressed will not radiate or conduct radio interference for more than a few feet. Beyond 25 feet, the frequency range of 0.55 through 156.0 megacycles will be free of interference.

70. Suppression System Testing

a. Install a battery-powered radio receiver in good operating condition not more than 10 feet from the generator set. A wide band receiver covering the frequency range of 0.55 through 156.0 megacycles is preferred.

b. Start the equipment and tune the receiver. Turn the receiver volume control to the maximum and select three widely separated frequencies for listening. Use frequencies that are free from signals with strong carriers so that the receiver will be in its most sensitive operating condition.

c. Operate the engine throttle and listen to the receiver speaker or headset for sounds which will vary with the engine speed.

d. Systematically replace capacitors and test to see if the trouble has been eliminated.

71. Suppression Material Replacement

a. General. The capacitor on the battery-charging voltage regulator is d-c only, all others are a-c/d-c.

Warning: Always replace lockwashers and make sure the replacement capacitors are of the proper capacity.

b. Location. The capacitor on the charging voltage regulator is grounded to the regulator bracket. Capacitors on the 2-pole receptacle are grounded inside the door section of the switchboard panel. The capacitors on the high voltage relay and voltage regulator are grounded to the backwall of the switchboard panel. The load terminal board capacitors are mounted on the bracket and grounded to the housing frame. The generator brush capacitors are grounded on the generator frame.

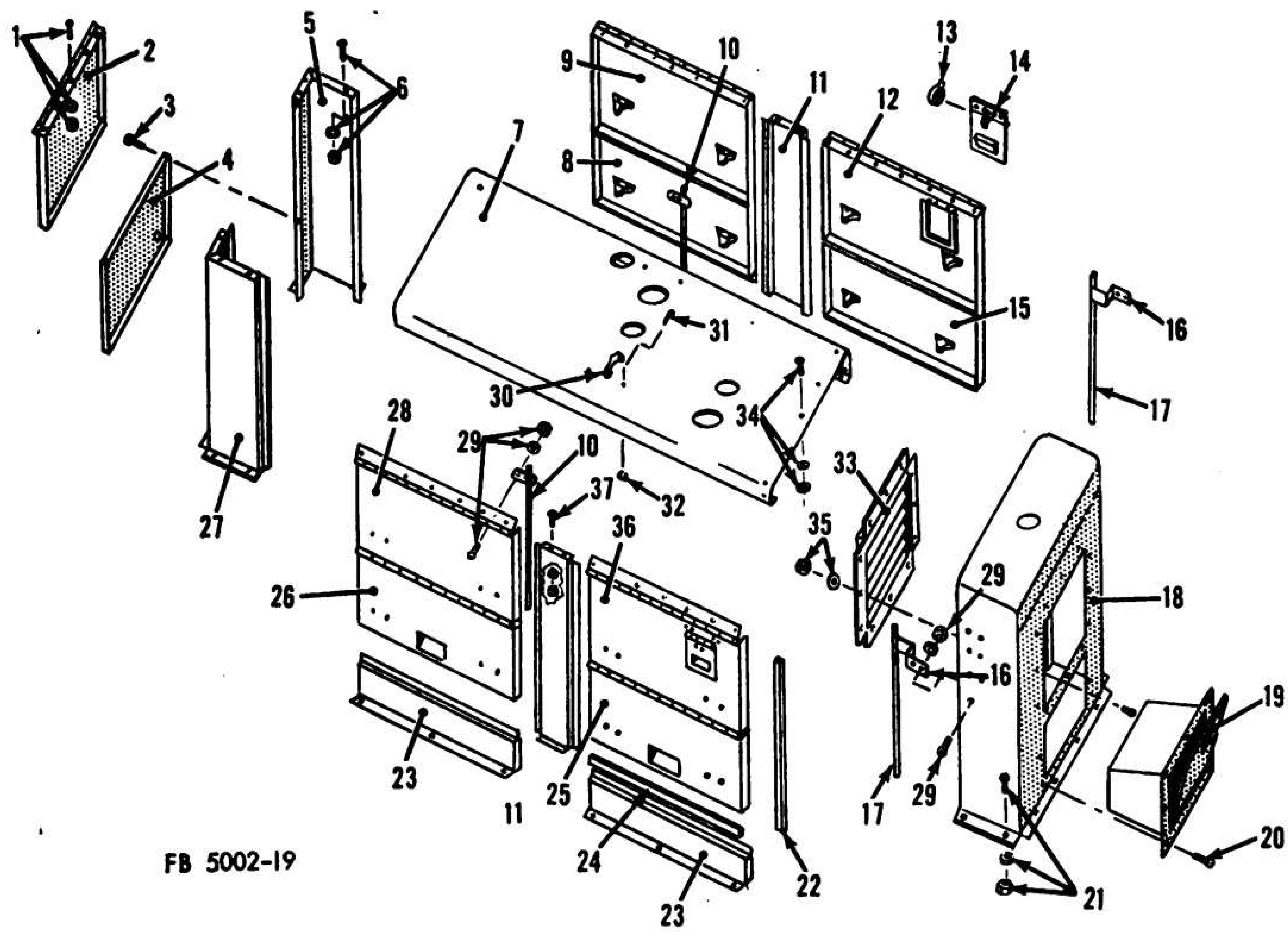
c. Replacement. To replace capacitors, disconnect the leads to the capacitors and remove the screw, lockwasher, and nut grounding the capacitor. Install capacitors of the proper capacity and connect the leads.

Section VI. HOUSING

72. Description

a. The generator set is completely inclosed in an all-metal weatherproof housing (fig. 1) bolted to a skid base and an angle iron frame. It is fitted with ventilating and access doors which pivot from piano-type hinges. All parts of the unit are readily accessible for operation, servicing, and preventive maintenance in the field.

b. The housing is fabricated of steel and composed of nine major sections; the top housing (7, fig. 19), left front top and lower door housing (12 and 15), left rear top and lower door housing (9 and 8), right front top and lower door housing (36 and 25), right rear top and lower door housing (28 and 26), front housing (18), rear access panel (4), shutter (33), and switchboard door housing (2). The sections housing the engine and radiator are shielded with felt insulation.



1	Screw with nut and lockwasher (53 req'd)	20	Screw (7 req'd)
2	Switchboard door	21	Screw with nut and lockwasher (28 req'd)
3	Screw	22	Rubber strip
4	Rear access panel assembly	23	Housing skirt
5	Left rear corner post housing	24	Rubber strip
6	Bolt with nut and lockwasher (6 req'd)	25	Right front lower door housing
7	Top housing	26	Right rear lower door housing
8	Left rear lower door housing	27	Right rear corner post housing
9	Left rear top door housing	28	Right rear top door housing
10	Center door latch bar	29	Bolt with nut and lockwasher (8 req'd)
11	Center post housing	30	Door fastener
12	Left front top door housing	31	Cotter pin (5 req'd)
13	Retaining spring	32	Flat washer
14	Ventilating door assembly	33	Radiator shutter
15	Left front lower door housing	34	Bolt with nut and lockwasher (9 req'd)
16	Latch bar bracket	35	Screw with nut and lockwasher (12 req'd)
17	Front door latch bar	36	Right front top door housing
18	Front housing	37	Bolt with nut and lockwasher (4 req'd)
19	Toolbox		

Figure 19. Housing, exploded view.

73. Housing Removal

a. Housing Section. When it is necessary to perform maintenance operations requiring removal of the top housing, it generally is easier to remove the major portion of the housing components (housing section) as an assembled unit (fig. 20). If necessary, components may be removed individually.

Note. The heater fuel tank (13, fig. 20) is mounted on the underside of the top housing (10) and generally is removed with it. Before removing the top housing either individually or with the assembled housing section, drain the tank by disconnecting the fuel line at the strainer (15) and opening the shutoff valve (14).

(1) Disconnect all load lines and power leads.

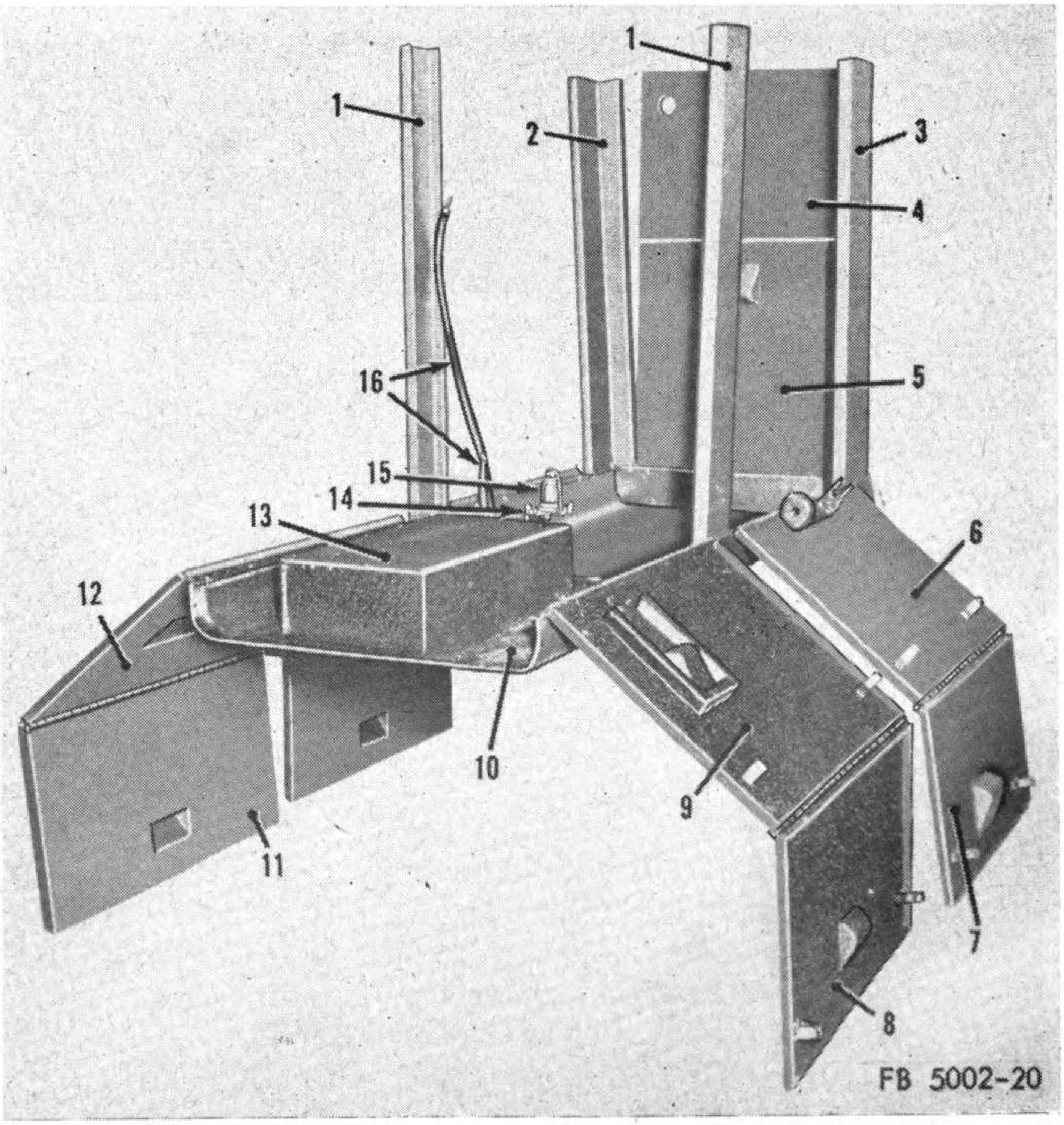
(2) Remove the muffler (par. 113).

(3) Pass a bar through the lifting eyebolt (5, fig. 1) and unscrew the bolt from the frame.

(4) Disconnect the battery-charging receptacle leads (16, fig. 20) at the starter solenoid relay (19, fig. 4) and at the receptacle ground (7).

(5) Remove the screws, nuts, and lockwashers (21, fig. 19) holding the post housings (5, 11, and 27) to the skid base.

(6) Remove the screws, nuts, and lockwashers (34, fig. 19) securing the top housing (7) to the front housing (18).



1 Center post housing
2 Left rear corner post housing
3 Right rear corner post housing
4 Rear access panel assembly
5 Switchboard door housing
6 Right rear top door housing
7 Right rear lower door housing
8 Right front lower door housing
9 Right front top door housing
10 Top housing
11 Left front lower door housing
12 Left front top door housing
13 Heater fuel tank
14 Heater fuel shutoff valve
15 Heater fuel strainer
16 Battery-charging receptacle leads

Figure 20. Housing section removed assembled.

(7) Remove the fuel tank cap (3, fig. 1).

(8) Unhook the door housings from the door latch bars (10 and 17, fig. 19) and hoist the housing section up and rearward. Rest the section on the top housing as shown in figure 20.

b. Housing Skirts. The four housing skirts (23, fig. 19) are removed from the skid base by withdrawing the screws, nuts, and lockwashers (21). Remove the rubber strips (24) from the skirts.

c. Front Housing.

(1) Remove the screws (20) and withdraw the toolbox (19) from the front housing (18).

(2) Disconnect the shutter control (2, fig. 3) from the radiator shutter arm.

(3) Remove the screws, nuts, and lockwashers (21, fig. 19) securing the housing to the skid base.

(4) Remove the bolts, nuts, and lockwashers (29) which secure the front door latch bars (17) to the front housing.

(5) Remove the radiator cap.

(6) Lift the housing from the radiator and skid base.

74. Housing Disassembly
(fig. 19)

a. Door Housings and Access Panel. To remove the access panel (4) and the door housings (2, 9, 12, 28, and 36), remove the screws (3) and screws, nuts, and lockwashers (21) that secure them to the top housing (7) and rear post housings (5 and 27).

b. Top and Post Housings. The top housing (7) is secured to the post housings (5, 11, and 27) by bolts, nuts, and lockwashers (6 and 34). Remove them to separate the components. If necessary, remove the heater fuel tank and the battery-charging receptacle (pars. 116*b* and 100).

c. Radiator Shutter. Remove the screws, nuts, and lockwashers (35) to detach the radiator shutter (33) from the front housing (18).

d. Door Latch Bars. The front pair of door latch bars (17) is welded to brackets (16) that are bolted to the front housing (18). Removing the nuts, lockwashers, and bolts (29) frees the brackets. The bars then may be withdrawn from the skid base. The center pair of door latch bars (10) is similarly secured to the frame and removed in the same manner. The remaining two pairs of latch bars are welded to the frame and are not readily removed.

e. Rubber Strips. Rubber weather strips (22) are cemented to all open seams and are not to be removed except for replacement.

f. Ventilating Door Assemblies. The ventilating door assemblies (14) are secured to the front top door housings (12 and 36) with bolts, nuts, and lockwashers (34). Remove them to free the ventilating door assemblies and their springs (13).

g. Door Fasteners. Five door fasteners (30) are used to hold the door housings in their open position. To remove the fasteners, withdraw the cotter pins (31) and washers (32) attached to the inner ends of the fasteners.

75. Housing Cleaning and Repair

Clean dirt and rust from all sections of the housing. Straighten damaged sections and repair cracks or breaks by welding. Touch up or repaint as required (par. 34). Lubricate door hinges and latches with an approved lubricant.

76. Housing Reassembly

(fig. 19)

a. Radiator Shutter Reassembly. Position the radiator shutter (33) in the front housing (18) and secure with the screws, nuts, and lockwashers (35).

b. Ventilating Door Assemblies. Secure the hinges and springs (13) of the ventilating door assemblies (14) to the inward sides of the front top door housings (12 and 36) with four bolts, nuts, and lockwashers (34).

c. Door Fasteners. Insert the straight end of the door fasteners (30) through the top housing (7). Install the washers (32) on the inward end and secure with cotter pins (31).

d. Top and Post Housings. Secure the post housings (5, 11, and 27) to the top housing (7) with the bolts, nuts, and lockwashers (6 and 34). If removed, replace the heater fuel tank (par. 116*b*) and the battery-charging receptacle (par. 100).

e. Door Housings and Access Panel. Secure the rear access panel (4) between the rear post housings with four screws (3). The hinges of the door housings (2, 9, 12, 28, and 36) are secured to the top housing (7) with screws, nuts, and lockwashers (21).

f. Door Latch Bars. Insert the ends of the center door latch bars (10) into the holes provided in the skid base. Secure to the frame with the bolts, nuts, and lockwashers (29).

g. Rubber Strips. Be sure rubber weather strips (22) are cemented to all open seams and the strips (24) are cemented to the skirts (23).

77. Housing Installation

a. Front Housing.

(1) Install the front housing (18, fig. 19) on the radiator and skid base. Make sure the latch bars (17) are inserted in the holes in the base, and secure them to the housing with the bolts, nuts, and lockwashers (29).

(2) Secure the housing to the skid base with the screws, nuts, and lockwashers (21).

(3) Connect the shutter control (2, fig. 3) to the shutter control arm and install the radiator cap.

(4) Insert the toolbox (19, fig. 19) in the housing and secure with the screws (20).

b. Housing Skirts. Position the housing skirts (23), with the rubber strips (24) cemented on them, against the skid base and install the screws (21) with nuts and lockwashers. Three of the skirts are similar. The fourth skirt has been provided with holes for the auxiliary fuel lines.

c. Housing Section.

(1) Hoist the assembled housing section (fig. 20) and lower it into position. Secure the post housings (5, 11, and 27, fig. 19) to the skid base with the screws, nuts, and lockwashers (21).

(2) Attach the top housing (7) to the front housing (18) with the bolts, nuts, and lockwashers (34).

(3) Install the fuel tank cap (3, fig. 1).

(4) Screw the lifting eyebolt (5) into the frame.

(5) Install the muffler (par. 113).

(6) Connect the battery-charging receptacle leads (16, fig. 20) to the starter relay (19, fig. 4) and receptacle ground (7).

(7) Connect the heater fuel line to the heater fuel strainer (15, fig. 20) and close the shutoff valve (14). Fill the heater fuel tank (13).

(8) Connect all load lines and leads.

Section VII. FUEL SYSTEM

78. Description
(fig. 21)

a. General. The fuel system for the generator set consists of a low-pressure supply system generated by the fuel supply pump (25), and a high-pressure system generated by the fuel injector pump (29). The source of fuel can be either the fuel tank (4) mounted integrally with the set or an external reservoir connected to the auxiliary fuel lines (14 and 16). The three-way valves (11) are actuated by the wrench (10) to determine the fuel source. All components of the fuel system are readily accessible for the performance of preventive maintenance in the field.

b. Low-Pressure Supply System. The low-pressure system exists between the fuel source and the inlet side of the fuel injector pump (29). Fuel is drawn from the fuel tank (4) or external supply and flows through the sediment bowl (13) and the primary filter (19) to the fuel supply pump (25). It then is forced through the secondary filter (17) to the fuel shutoff solenoid (28). A pressure relief valve (18) is connected across the supply pump to prevent damage to the system in the event of an obstruction in the line. The priming pump (23) is used to fill the fuel system and rid it of air, making it unnecessary to crank the engine with the starting motor. Fuel for the flame heater is drawn from the primary filter (19) when the primer pump (32) is operated. Operating this pump closes the contacts of the pressure switch (33). The fuel shutoff solenoid is actuated by the safety devices (par. 14) to stop the flow of fuel to the injector pump.

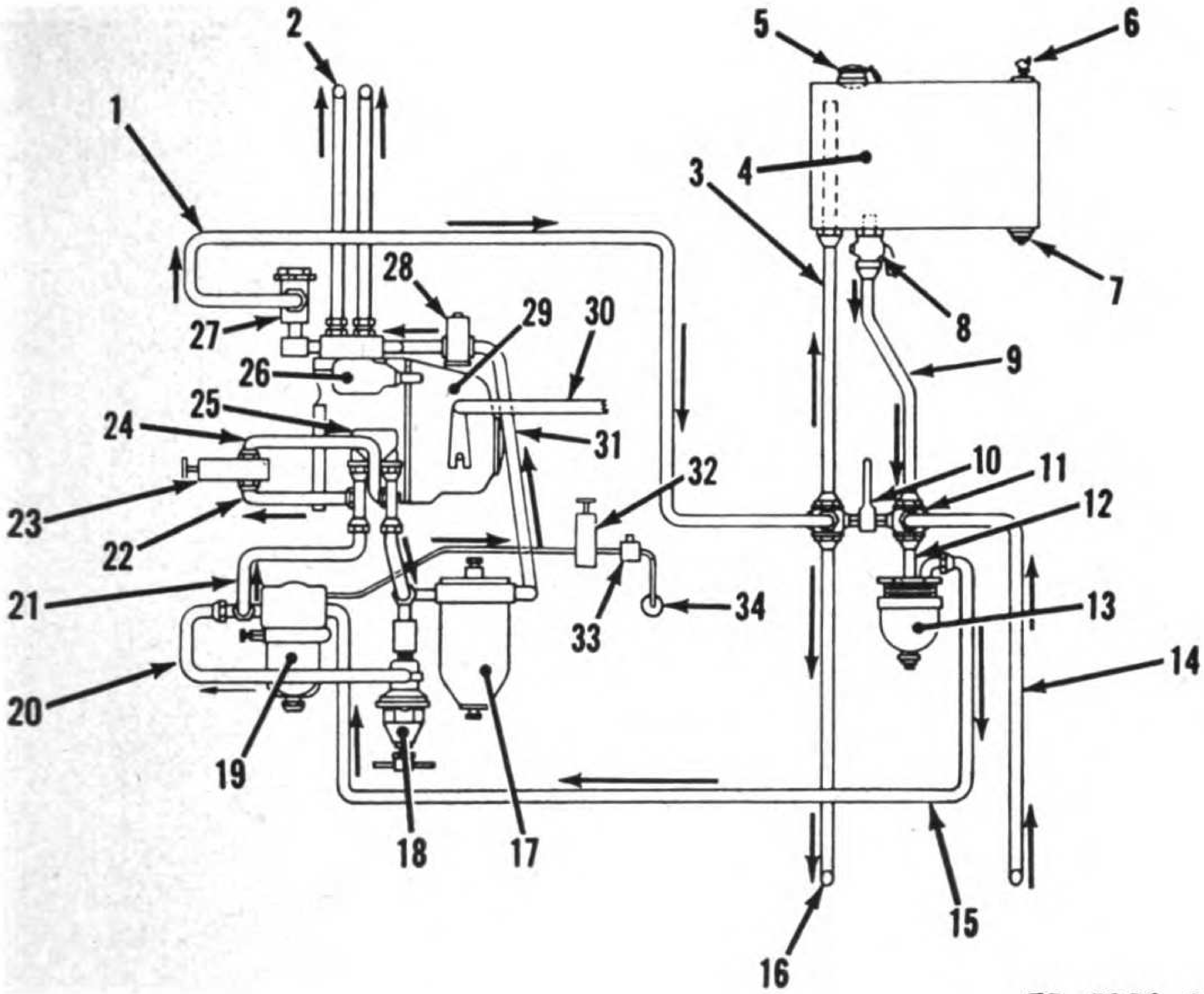
c. High-Pressure Fuel Injection System. The high-pressure system exists between the fuel injector pump (29) and the injector nozzle. The pump delivers a metered amount of fuel under pressure to the nozzles through the injection line assemblies (2). The quantity of fuel being delivered to the combustion chambers is controlled by a governor mechanism mounted integrally with the injector pump. Surplus fuel from the nozzles is directed through a leak-off manifold to the overflow valve assembly (27). All surplus fuel then is returned to the supply tank through the return lines (1, 3, or 16).

Caution: In maintenance procedures involving disassembly of fuel system components, take precautions to prevent the introduction of dirt or foreign matter into the fuel system. In cleaning parts, use cleaning solvent and lint-free rags. Work under dust-free conditions. Cover all line openings with tape or paper caps. Leave openings covered until assembling.

79. Fuel Lines and Valves

a. Lines (fig. 22).

(1) *Description.* The fuel source is connected to the fuel system at the three-way valve (32) by the supply lines (11 or 13). Lines (5, 10, 11, 12, 13, and 14), connected to the

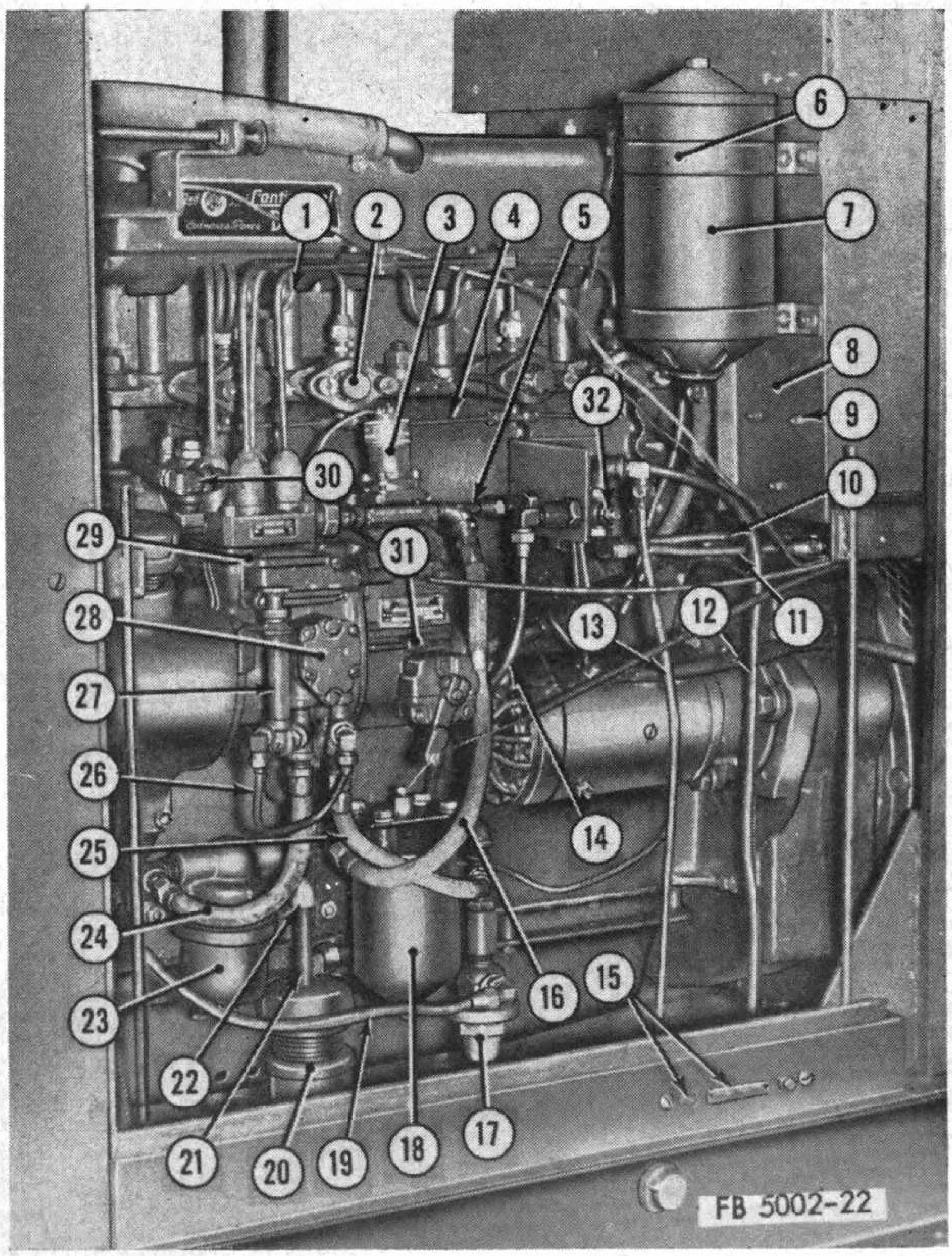


FB 5002-21

1 Pump-to-valve return line assembly
2 Injection line assembly
3 Return-to-tank line assembly
4 Diesel fuel tank
5 Fillercap
6 Air vent valve
7 Drain plug
8 Fuel shutoff valve
9 Tank-to-valve line assembly
10 Three-way valve wrench
11 Three-way valve
12 Valve-to-sediment bowl line assembly
13 Sediment bowl
14 Auxiliary fuel bracket-to-valve line assembly
15 Line to primary filter
16 Valve-to-auxiliary fuel bracket return line assembly
17 Secondary fuel oil filter
18 Relief valve
19 Primary fuel filter
20 Relief valve-to-filter line assembly
21 Primary filter-to-pump line assembly
22 Line to priming pump
23 Priming pump
24 Supply pump bypass line assembly
25 Supply pump
26 Engine shutoff
27 Overflow valve assembly
28 Fuel shutoff solenoid
29 Fuel injector pump assembly
30 Throttle control
31 Secondary filter-to-solenoid line assembly
32 Flame heater primer pump
33 Pressure switch
34 Flame heater inlet

Figure 21. Fuel system diagram.

three-way valve, are copper tubing with integral flare nuts. Lines to and from the outside source (when used) are flexible hose connected to the three-way valve at the auxiliary fuel bracket (15). The sediment bowl (20) is connected to the primary fuel filter (23) by the nipple (21) and elbow (22). Fuel travels to the secondary filter (18) via the fuel supply pump (28) through a flexible line (25). The line (26), bypassing the fuel supply pump, and the relief valve line (19) are copper tubing with integral flare nuts. The copper overflow tubes (4) from the nozzle holder assemblies (2) are joined in series to form a leak-off manifold. This is connected to the overflow valve (30) which connects to the valve return line (5). The injection line assemblies (1) are heavy copper tubing with the required coupling



1 Injection line assembly
2 Nozzle holder assembly
3 Fuel shutoff solenoid
4 Overflow tube
5 Pump-to-valve return line assembly
6 Strap
7 Oil filter assembly
8 Lube oil filter bracket
9 Bolt w/nut and lockwasher (3 req'd)
10 Return-to-tank line assembly
11 Tank-to-valve line assembly
12 Valve-to-auxiliary fuel bracket return line assembly
13 Auxiliary fuel bracket-to-valve line assembly
14 Valve-to-sediment bowl line assembly
15 Auxiliary fuel bracket
16 Secondary filter-to-solenoid line assembly
17 Relief valve
18 Secondary fuel oil filter
19 Relief-valve-to-filter line assembly
20 Sediment bowl
21 Nipple, pipe, ¼ x 3½ in. (1 req'd)
22 Pipe elbow
23 Primary fuel filter
24 Primary filter-to-pump line assembly
25 Secondary filter-to-pump line assembly
26 Supply pump bypass line assembly
27 Priming pump
28 Supply pump assembly
29 Fuel injector pump assembly
30 Overflow valve assembly
31 Governor
32 Three-way valve

Figure 22. Fuel system components installed.

nuts at each end for connection between the nozzle holder assemblies and the fuel injector pump (29). For a list of fittings, hose, and tubes, see appendix II.

(2) *Removal.* Use an adjustable or open-end wrench to make or break connections. Never use pliers, as the fittings, hoses, or tubes will be damaged. Avoid bending metal tubes that are to be reinstalled.

(3) *Reinstallation.*

(*a*) Replace damaged tubes, fuel line assemblies, and injection line assemblies with new units. Blow clear all lines before reinstalling. Avoid bending line assemblies that are to be reinstalled.

(*b*) Before installing new tubes and line assemblies of the copper tubing type, use the old unit as a pattern and form the new unit to the same contour. When bending, use a rounded surface as a form. This will retain a constant cross-section in the tubing. After installing flare nuts on tubing, use a flaring tool to spread the tube end. Inspect the flare for splits.

(*c*) When installing fuel lines, be sure to aline the attaching parts properly to avoid cross threading.

(*d*) Draw the nuts up tightly.

(*e*) Prime the fuel system (par. 16) and inspect all connections for leaks.

b. Three-Way Valve.

(1) *Description* (fig. 21). The three-way valve (11) is a three-position unit actuated by a wrench (10). When the wrench handle is down in the UNIT TANK position, only the lines to and from the set's diesel fuel tank are open. When the handle is upward in the AUX. TANK position, only the lines to and from the auxiliary fuel supply are open. When the handle is in the horizontal OFF position, both sets of fuel supply lines are closed.

(2) *Removal.*

(*a*) Close the fuel shutoff valve (8, fig. 21).

(*b*) Disconnect lines (5, 10, 11, 12, 13, and 14, fig. 22), at the three-way valve (32).

(*c*) Remove the nuts (5, fig. 14) and withdraw the three-way valve bracket (12).

(*d*) Remove the nipples and locknuts to free the valve from the bracket.

(*e*) Withdraw the cotter pin from the three-way valve wrench (10, fig. 21) and separate the valve and wrench.

(*f*) Remove all external line fittings.

(3) *Installation.*

(*a*) Connect the valve, using the valve wrench (10, fig. 21) and a cotter pin.

(*b*) Pass the single outlet ends of the valve through the bracket (12, fig. 14) and install the locknuts and nipples on protruding ends. Tighten the locknuts.

(*c*) Mount the three-way valve bracket and valve on the studs and secure with the nuts (5).

(*d*) Replace all line fittings and connect lines (5, 10, 11, 12, 13, and 14, fig. 22), to the valve (32).

(*e*) Open the fuel shutoff valve (8, fig. 21).

(*f*) Prime the fuel system (par. 16) and inspect connections for leaks.

c. Overflow Valve Assembly.

(1) *Description.* The overflow valve assembly (30, fig. 22) limits the pressure of the fuel in the sump compartment of the pump and allows the return of excess fuel to the supply tank via the pump-to-valve return line assembly (5). It also permits air and gases in the fuel to be returned to the supply tank where they can be released into the atmosphere. Replace a defective valve.

(2) *Removal* (fig. 22).

(*a*) Disconnect the overflow tube (4) from the nozzle holders (2) at the valve (30).

(*b*) Disconnect the pump-to-valve return line (5) from the overflow valve.

(*c*) Unscrew the elbows from the overflow valve.

(*d*) Remove the valve.

(3) *Installation* (fig. 22).

(*a*) Screw the overflow valve (30) into its seat.

(*b*) Thread the elbows into the valve.

(*c*) Connect the overflow tube (4) from the nozzle holders (2) to the inward elbow of the valve.

(*d*) Connect the pump-to-valve return line (5) to the overflow valve.

d. Relief Valve (fig. 22).

(1) *Description.* The relief valve (17) is connected across the supply pump (28) between the outlet side of the

primary filter (23) and the inlet side of the secondary filter (18). The valve is opened by pressures between 27 and 35 psi, preventing damage in the event of an obstruction in the system.

(2) *Removal.*

(*a*) Disconnect the relief valve-to-filter line (19) at the relief valve (17).

(*b*) Unscrew the valve from the pipe coupling.

(*c*) Unscrew the reducing bushing and elbow from the valve body.

(3) *Installation.*

(*a*) Screw the reducing bushing and elbow into the valve body.

(*b*) Thread the valve (17) into the pipe coupling.

(*c*) Connect the relief valve-to-filter line (19) to the valve elbow.

e. Fuel Shutoff Solenoid.

(1) *Description* (fig. 22). The fuel shutoff solenoid (3) is an electromagnetically operated valve. When the solenoid coil is energized, the valve is opened and fuel flows to the injector pump (29). When the coil is deenergized the valve closes, shutting off the flow of fuel to the injector pump, and stops the engine. Energizing the solenoid coil attracts a disk-type armature up a sleeve to open a port. The circuit to the solenoid coil can be broken by stopping the engine, by too low a lubricating oil pressure, by too high a coolant temperature, or by the engine overspeeding. Breaking the circuit deenergizes the coil. The armature then is driven downward by a spring, and hydraulic pressure seals the port.

(2) *Removal.*

(*a*) Disconnect the fuel line (6, fig. 13) at the pipe elbow (5).

(*b*) Disconnect the shutoff solenoid lead (3) at the fuel shutoff solenoid (4).

(*c*) Uncouple the union (9).

(*d*) Remove the fuel shutoff solenoid and unscrew the bushing (7), pipe elbow (5), pipe nipple (8), and union element.

(3) *Installation.*

(*a*) Thread the bushings (7) into the fuel shutoff solenoid (4).

(*b*) Screw the pipe elbow (5) and nipple (8) into the bushings, and the union element on the nipple.

(*c*) Install the shutoff solenoid with the arrow toward the injector pump and secure with the union (9).

(*d*) Connect the fuel line (6) to the pipe elbow.

(*e*) Connect the shutoff solenoid lead (3) to the fuel shutoff solenoid.

(*f*) Prime the fuel system (par. 16) and inspect connections for leaks.

80. Fuel Tank

a. Removal.

(1) Remove the housing section (par. 73*a*).

(2) Close the fuel shutoff valve (8, fig. 21).

(3) Disconnect the lines (10 and 11, fig. 22) at the fuel tank end.

(4) Unscrew the fuel shutoff valve (8, fig. 21) from the fuel tank elbow.

(5) Block up the frame assembly (20, fig. 4) at the front end, and remove the bolts (22) with nuts and lockwashers securing the lifting frame (21) to frame assembly.

(6) Remove eight bolts with nut and lockwasher securing the lifting frame (21) to the skid base (13, fig. 1).

(7) Hoist and tilt the lifting frame to clear the diesel fuel tank (8, fig. 4).

(8) Lift the fuel tank from the frame assembly.

b. Disassembly (fig. 23).

(1) Remove the fuel tank cap (1) from the filler neck and withdraw the fuel strainer (2) and filler neck seal (3).

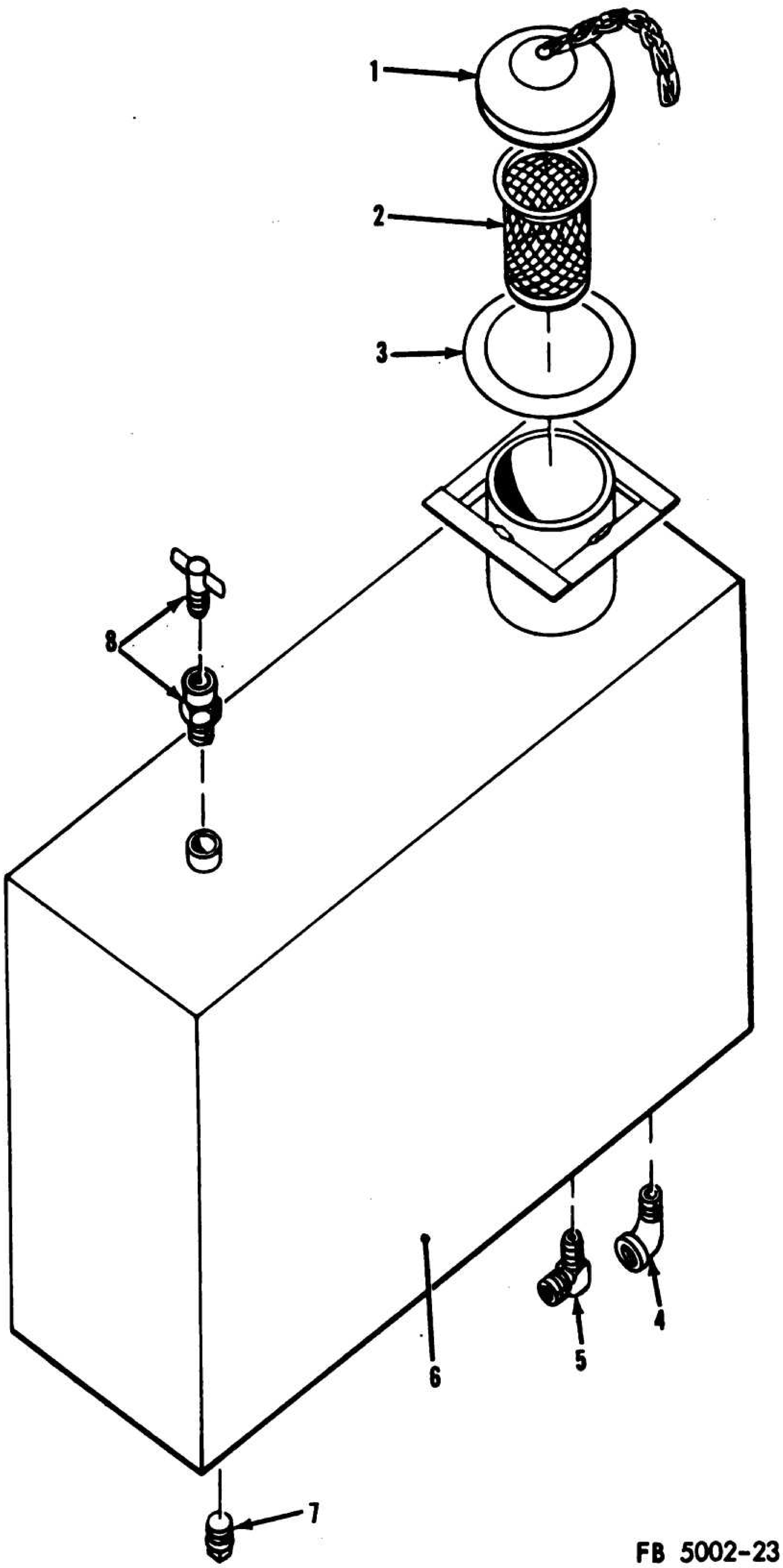
(2) Unscrew the air vent valve (8) from the fuel tank (6).

(3) Unscrew the elbows (4 and 5) and drain plug (7) from the tank.

c. Cleaning (fig. 23). The cleaning procedure for the unit fuel tank and the heater fuel tank (par. 116*b*) are the same.

Caution: Do not use gasoline to clean the diesel fuel tank. Gasoline fumes are dangerous, even after flushing. Keep tanks clear of spark or flame.

(1) Flush the tank several times with water or solvent. Hot water or steam under pressure will loosen scale or oil more rapidly than cold water. Make sure the unit fuel tank drains from the proper opening (7), as the fuel outlet has a standpipe which will prevent sediment from draining out.



1 Fuel tank cap. 2 Fuel strainer. 3 Filler neck seal. 4 Elbow, pipe, ¼ in. (5 req'd).
5 Pipe elbow. 6 Fuel tank. 7 Drain plug. 8 Air vent valve.

Figure 23. Fuel tank, exploded view.

(2) Use a wire brush to clean scale and rust from the outside, particularly along the seams.

d. Repair. The repair procedure is the same for the unit fuel tank and the heater fuel tank (par. 116*b*).

(1) To test for leaks, plug the fuel outlet, install the drain plug, and submerge the tank in water. Apply air pressure, not above 25 psi, to the tank through the filler neck. Leaks will be indicated by air bubbling up through the water.

(2) Dents in the tank often can be popped out by the application of air pressure. Do not use more than 25 psi.

(3) Clean the area around the leak and remove filler-cap and all plugs and adapters before welding or soldering.

(4) Retest for leaks before reinstalling.

e. Reassembly (fig. 23).

(1) Thread elbows (4 and 5) and drain plug (7) into the base of the fuel tank (6).

(2) Thread the air vent (8) into the top of the fuel tank.

(3) Slip the filler neck seal (3) over the filler neck and install the fuel strainer (2).

(4) Install the fuel tank cap (1).

f. Installation.

(1) Lower the fuel tank (8, fig. 4) into place on the frame assembly (20).

(2) Tilt the lifting frame (21) over the fuel tank and position on the skid base.

(3) Secure the lifting frame (21) to the skid base (13, fig. 1) using eight bolts with nuts and lockwashers, and remove the blocks under the front part of the frame assembly (20, fig. 4).

(4) Bolt the lifting frame to the frame assembly with the bolts (22) with nuts and lockwashers.

(5) Screw the fuel shutoff valve (8, fig. 21) into the elbow (4, fig. 23) at the base of the tank.

(6) Connect the return-to-tank line (10, fig. 22) to the elbow (5, fig. 23) protruding below the fuel tank.

(7) Connect the tank-to-valve line (11, fig. 22) to the fuel shutoff valve.

(8) Open the fuel shutoff valve and check for leaks at the connections.

(9) Install the housing section (par. 77*c*).

81. Primary Fuel Filter

a. Cleaning Filter Element.

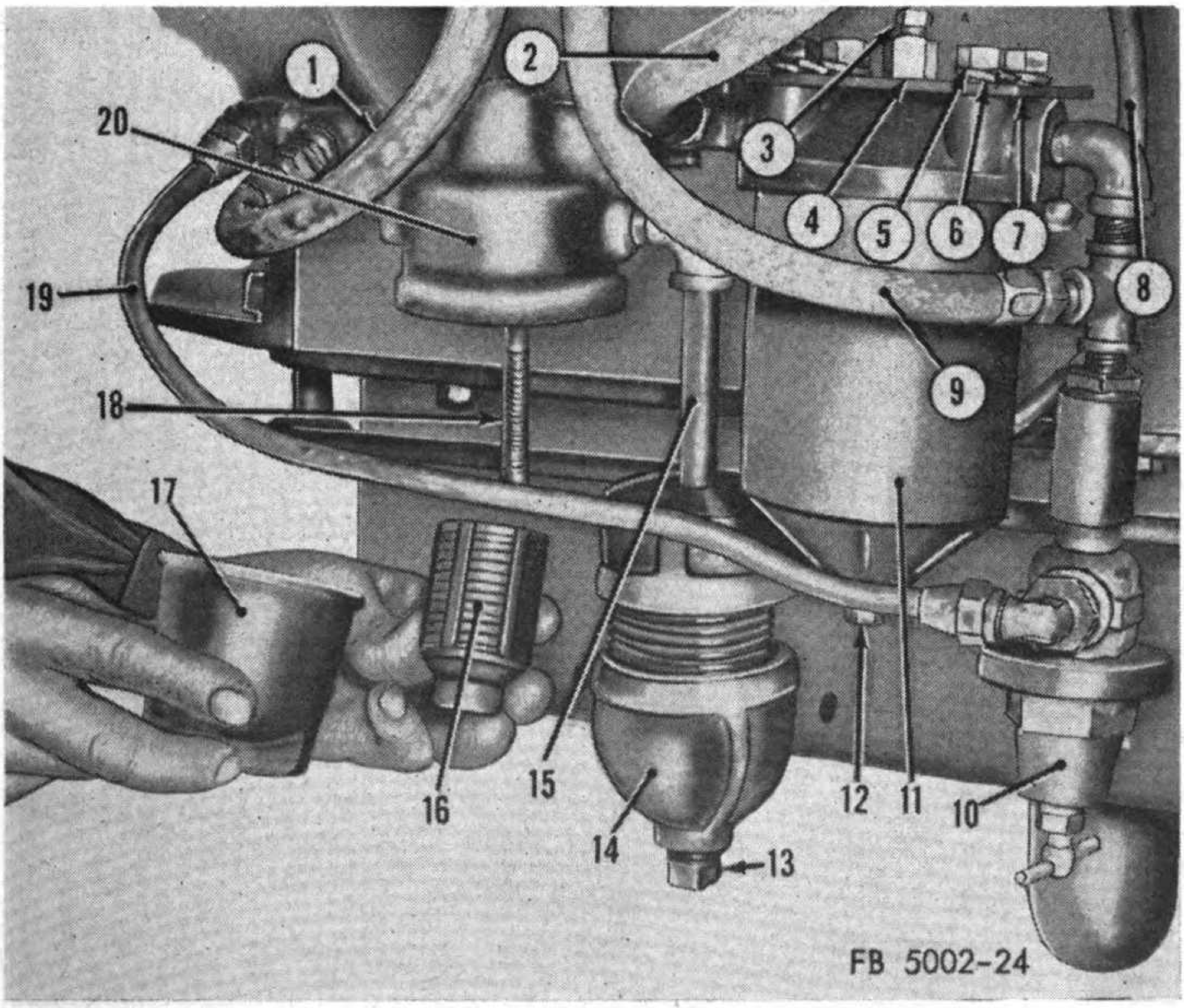
(1) Place the three-way valve (11, fig. 21) in the OFF position.

(2) Place a container under the primary fuel filter (23, fig. 22) and remove the filter drain plug.

(3) Unscrew the nut and lockwasher from the attaching stud (18, fig. 24) to free the primary filter body (17) from the head (20).

(4) Remove the gasket installed between the filter body and head.

(5) Remove the filter element (16) and wash in cleaning solvent, kerosene, or fuel oil. Do not use hard or sharp



1	Primary filter-to-pump line assembly	11	Secondary fuel oil filter
2	Secondary filter-to-solenoid line assembly	12	Pipe plug
3	Pipe plug	13	Drain plug
4	Cap screw	14	Sediment bowl
5	Cap screw (4 req'd)	15	Pipe nipple
6	Lockwasher (4 req'd)	16	Filter element
7	Filter bracket	17	Primary filter body
8	Valve-to-sediment bowl line assembly	18	Attaching stud
9	Secondary filter-to-pump line assembly	19	Relief valve-to-filter line assembly
10	Relief valve	20	Primary filter head

Figure 24. Fuel filters.

tools to clean the element as damage will result. Replace with a new part if the element is damaged.

(6) Wash the body (17) and head (20), and install the element on the stud (18).

(7) Using a new gasket, assemble the body and head and secure to the stud with a nut and lockwasher.

(8) Install the drain plug in the base of the filter body and open the three-way valve.

(9) Prime the fuel system (par. 16).

b. Removal.

(1) Place the three-way valve (11, fig. 21) in the OFF position and drain the filter (*a*(2) above).

(2) Remove the sediment bowl (par. 83*a*).

(3) Disconnect the relief valve-to-filter line (19, fig. 24) at the filter end.

(4) Disconnect the primary filter-to-pump line (1) at the filter end.

(5) Disconnect the flame heater line at the primary filter head.

(6) Remove the nuts and lockwashers from the mounting studs securing the primary filter head (20) to the engine block, and remove the primary filter.

(7) Remove all fittings from the filter head.

c. Installation.

(1) Install the fittings on the primary filter head (20, fig. 24).

(2) Mount the primary filter on the studs and secure to the block with the nuts and lockwashers.

(3) Connect the flame heater line to the primary filter head.

(4) Connect the primary filter-to-pump line (1) to the filter head.

(5) Connect the relief valve-to-filter line (19) to the filter head.

(6) Install the sediment bowl (par. 83*c*).

(7) Open the three-way valve (11, fig. 21).

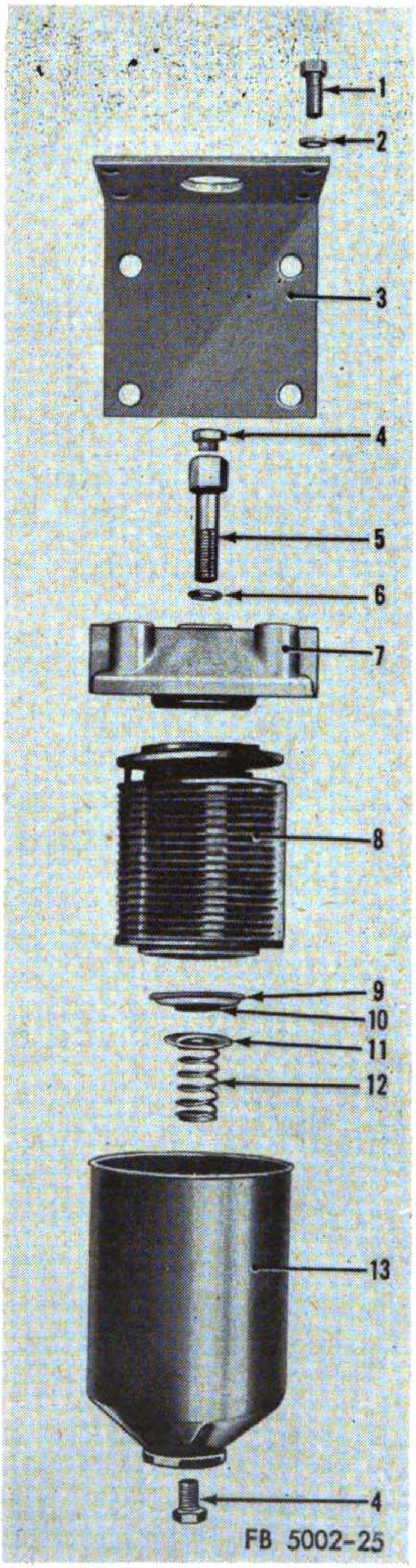
(8) Prime the fuel system (par. 16) and check for leaks.

82. Secondary Fuel Filter

a. Replacing Element.

(1) Place the three-way valve (11, fig. 21) in the OFF position.

(2) Place a container under the secondary filter (11, fig. 24).



1 Cap screw (4 req'd)
2 Lockwasher (4 req'd)
3 Filter bracket
4 Pipe plug
5 Cap screw
6 Gasket
7 Head
8 Filter element
9 Washer
10 Grommet
11 Washer
12 Spring
13 Body

Figure 25. Secondary fuel filter, exploded view.

(3) Remove the pipe plug (12) and loosen the plug (3) to drain the filter.

(4) Remove the cap screw (5, fig. 25) and gasket (6). This frees the filter body (13) from the filter head (7).

(5) Withdraw the filter element (8), washer (9), grommet (10), washer (11), and spring (12) from the body.

(6) Discard the filter element and wash the filter body in cleaning solvent.

(7) Install the spring, washers, and grommet in the body as shown in figure 25.

(8) Place a new filter element in the body.

(9) Position the assembled body under the head and secure with the cap screw (5) and gasket (6). The filter element serves as its own gasket.

(10) Install the plug (12, fig. 24).

(11) Open the three-way valve.

(12) Prime the fuel system (par. 16) and tighten the pipe plug (3).

b. Removal.

(1) Place the three-way valve (11, fig. 21) in the OFF position and drain the filter (*a*(3) above).

(2) Remove the relief valve (par. 79*d*).

(3) Disconnect the secondary filter-to-pump line (9, fig. 24) at the filter end.

(4) Disconnect the secondary filter-to-solenoid line (2) at the filter end.

(5) Remove the cap screws (5) and lockwashers (6) holding the secondary fuel filter (11) to the bracket (7).

(6) Remove the filter from the bracket.

(7) Unscrew the street elbow with assembled pipe fittings from the right side of the filter head. Do not disassemble the line unless individual parts are to be replaced.

(8) Unscrew the pipe elbow from the left side of the filter head.

(9) To remove the filter bracket from the engine block, remove the nuts and lockwashers securing the bracket to the mounting studs.

c. Installation.

(1) Mount the filter bracket (7, fig. 24) on the studs, and secure to the engine block with the nuts and lockwashers.

(2) Screw the pipe elbow into the left side of the filter head.

(3) Screw the street elbow with assembled pipe fittings into the right side of the filter head. Aline as shown in figure 24.

(4) Secure the secondary filter (11) to the bracket (7) with the lockwashers (6) and cap screws (5).

(5) Connect the secondary filter-to-solenoid line (2) to the pipe elbow at the filter.

(6) Connect the secondary filter-to-pump line (9) to the pipe tee.

(7) Install the relief valve (par. 79*d*).

(8) Open the three-way valve (11, fig. 21).

(9) Prime the fuel system (par. 16) and inspect for leaks.

83. Sediment Bowl

a. Removal.

(1) Place the three-way valve (11, fig. 21) in the OFF position.

(2) Place a container under the sediment bowl (14, fig. 24) and unscrew the drain plug (13).

(3) Disconnect the valve-to-sediment bowl line (8) at the sediment bowl elbow.

(4) Unscrew the sediment bowl head from the pipe nipple (15).

(5) Unscrew the body and elbow from the sediment bowl head.

b. Cleaning.

(1) The bowl can be superficially cleaned by draining (*a* (2) above).

(2) For thorough cleaning, remove the sediment bowl (*a* above) and wash all parts in cleaning solvent.

c. Installation.

(1) Screw the sediment bowl (14, fig. 24) on the head.

(2) Install the drain plug (13) in the sediment bowl, and the pipe elbow in the head.

(3) Install the assembled sediment bowl on the pipe nipple (15).

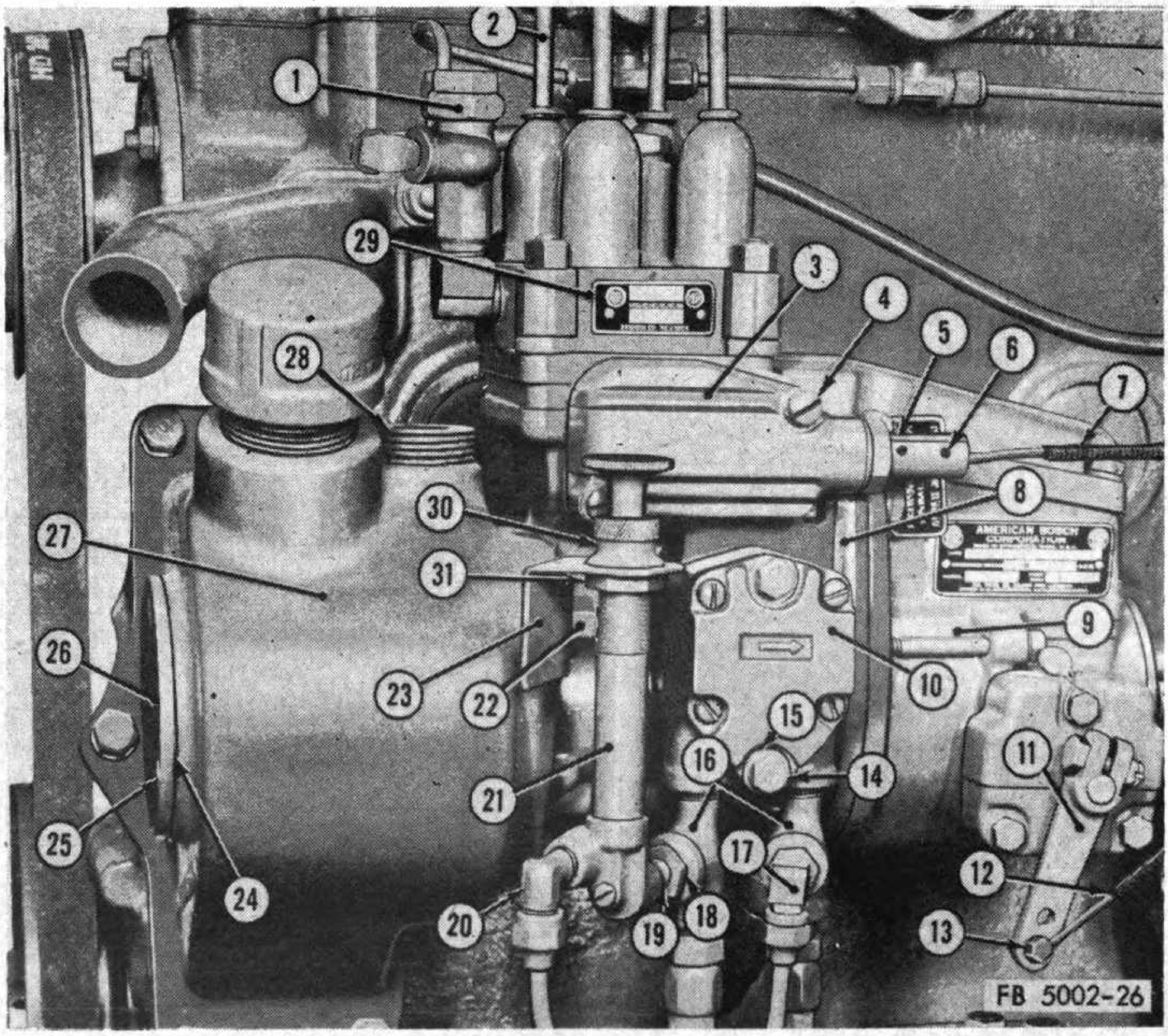
(4) Connect the valve-to-sediment bowl line (8) to the elbow.

(5) Open the three-way valve (11, fig. 21).

(6) Prime the fuel system (par. 16) and inspect the connections for leaks.

84. Priming Pump

a. Description. The priming pump (27, fig. 22) is operated manually to fill the fuel system and rid it of air (par. 16). It is installed in a line (26) bypassing the supply pump (28) which is driven indirectly by the engine. This arrangement makes it unnecessary to crank the engine with the starting motor to bleed and prime the system.



1	Overflow valve assembly	17	90° elbow
2	Number 1 injection line assembly	18	Reducing bushing
3	Timing window cover	19	Pipe nipple
4	Screw (2 req'd)	20	90° elbow
5	Shutoff fitting	21	Priming pump
6	Setscrew (1 req'd)	22	Nut (1 req'd)
7	Engine shutoff control wire	23	Priming pump bracket
8	Fuel injector pump assembly	24	Cover gasket
9	Governor	25	Screw (4 req'd)
10	Fuel supply pump assembly	26	Pump hole cover
11	Operating lever	27	Pump adapter
12	Engine throttle control wire	28	Timing viewing port
13	Clamping bolt	29	Hydraulic head
14	Fastening screw (2 req'd)	30	Priming pump head
15	Lockwasher (2 req'd)	31	Jam nut (1 req'd)
16	Pipe tee		

Figure 26. Fuel injector pump.

b. Removal.

(1) Place the three-way valve (11, fig. 21) in the OFF position.

(2) Disconnect the supply pump bypass line (26, fig. 22) at the priming pump (21, fig. 26).

(3) Remove the nut (22) holding the priming pump bracket (23) to the injector pump adapter (27).

(4) Turn the tee (16) about 20° to the right and unscrew the pump from the tee.

(5) To free the pump from the bracket, unscrew the head (30) from the pump body and separate the parts.

(6) Remove the fittings (18, 19, and 20) from the pump.

c. Installation.

(1) Install the fittings (18, 19, and 20, fig. 26), on the pump (21).

(2) Back the nut (31) down on the pump body and insert the pump in the bracket (23).

(3) Screw the pump head (30) on the body and tighten.

(4) Install the pump in the tee (16) and turn the tee about 20° to the left.

(5) Aline the pump and bracket with the adapter (27) and secure the bracket with the nut (22).

(6) Tighten the nut (31) to clamp the pump to the bracket.

(7) Connect the supply pump bypass line (26, fig. 22) to the priming pump elbow.

(8) Open the three-way valve (11, fig. 21).

(9) Prime the fuel system (par. 16) and check for leaks.

85. Fuel Supply Pump

a. Description. The fuel supply pump (10, fig. 26) is mounted on the injector pump housing. It is a positive displacement, gear-type pump which is driven by the injector pump camshaft drive gear. The supply pump draws fuel from the fuel tank and forces it through the fuel system (par. 78), maintaining a fuel supply pressure of 20 to 25 psi.

b. Testing. Many troubles with the fuel supply system attributed to the supply pump may be traced to such causes as clogged filter elements; leaks at loose line connections; air in the system; fuel flow restrictions caused by dented, crimped, or spongy supply lines; or a defective overflow valve.

(1) Connect a pressure gage with a range of 0 to 30 psi in the outlet line of the supply pump (10, fig. 26).

(2) Start the engine (par. 16).

(3) If the pressure indicated is less than 5 psi and the other probable sources of trouble mentioned above have been checked, replace the supply pump assembly.

c. Removal.

(1) Place the three-way valve (11, fig. 21) in the OFF position.

(2) Disconnect the supply pump bypass line (26, fig. 22) at the supply pump (28).

(3) Remove the priming pump (par. 84).

(4) Disconnect the primary filter-to-pump line (24) and secondary filter-to-pump line (25) at the tees (16, fig. 26).

(5) To remove the supply pump (10) and gasket from the injector pump (8), remove the screws (14) and lock-washers (15).

(6) Remove the elbow (17) and tees (16) from the pump.

d. Installation.

(1) Screw the tees (16, fig. 26) and elbow (17) into the supply pump (10).

(2) Place the gasket on the inward face of the supply pump and install the pump on the injector pump (8), making sure the supply pump gear and camshaft gear mesh. Secure with the screws (14) and lockwashers (15).

(3) Connect the primary filter-to-pump line (24, fig. 22) and secondary filter-to-pump line assembly (25) to the tees (16, fig. 26).

(4) Install the priming pump (par. 84).

(5) Connect the supply pump bypass line (26, fig. 22) to the elbow (17, fig. 26).

(6) Place the three-way valve (11, fig. 21) in the ON position.

(7) Prime the fuel system (par. 16) and inspect the connections for leaks.

86. Fuel Injector Pump

a. Description (fig. 26). The fuel injector pump assembly (8) is secured to the injector pump adapter (27) on the left side of the engine. This unit delivers accurately metered quantities of fuel to the nozzle holders for injection into the cylinders. The pump's hydraulic head (29) contains a delivery valve and a reciprocating plunger. The plunger is driven by a camshaft that is connected to the engine crankshaft through a gear train and coupling. Speed control is effected by the governor (9) which regulates the amount of fuel being discharged by the pump.

b. Removal. The governor (9, fig. 26) is integral with the fuel injector pump assembly (8) and must be removed with it.

Note. The fuel injector pump assembly has been manufactured to provide trouble-free service for an extended period. It seldom needs to be replaced. If engine operation is poor, refer to the troubleshooting section and eliminate all other possible causes before replacing the fuel injector pump assembly.

(1) Place the three-way valve (11, fig. 21) in the OFF position.

(2) Remove the fuel shutoff solenoid (par. 79*e*).

(3) Remove the overflow valve assembly (par. 79*c*).

(4) Disconnect the lines to the fuel supply pump assembly (par. 85*c*).

(5) Remove the priming pump (par. 84).

(6) Disconnect the injection line assemblies (2, fig. 26) at the hydraulic head (29).

(7) To disconnect the engine shutoff control wire (7), loosen the setscrew (6).

(8) Disconnect the oil line leading to the base of the injector pump assembly.

(9) Free the throttle control wire (12) from the operating lever (11) by loosening the clamping bolt (13).

(10) Remove four screws (25) holding the injector pump hole cover (26) to the pump adapter (27), and remove the gasket (24).

(11) Remove the nuts (22) and lockwashers securing the pump to the adapter.

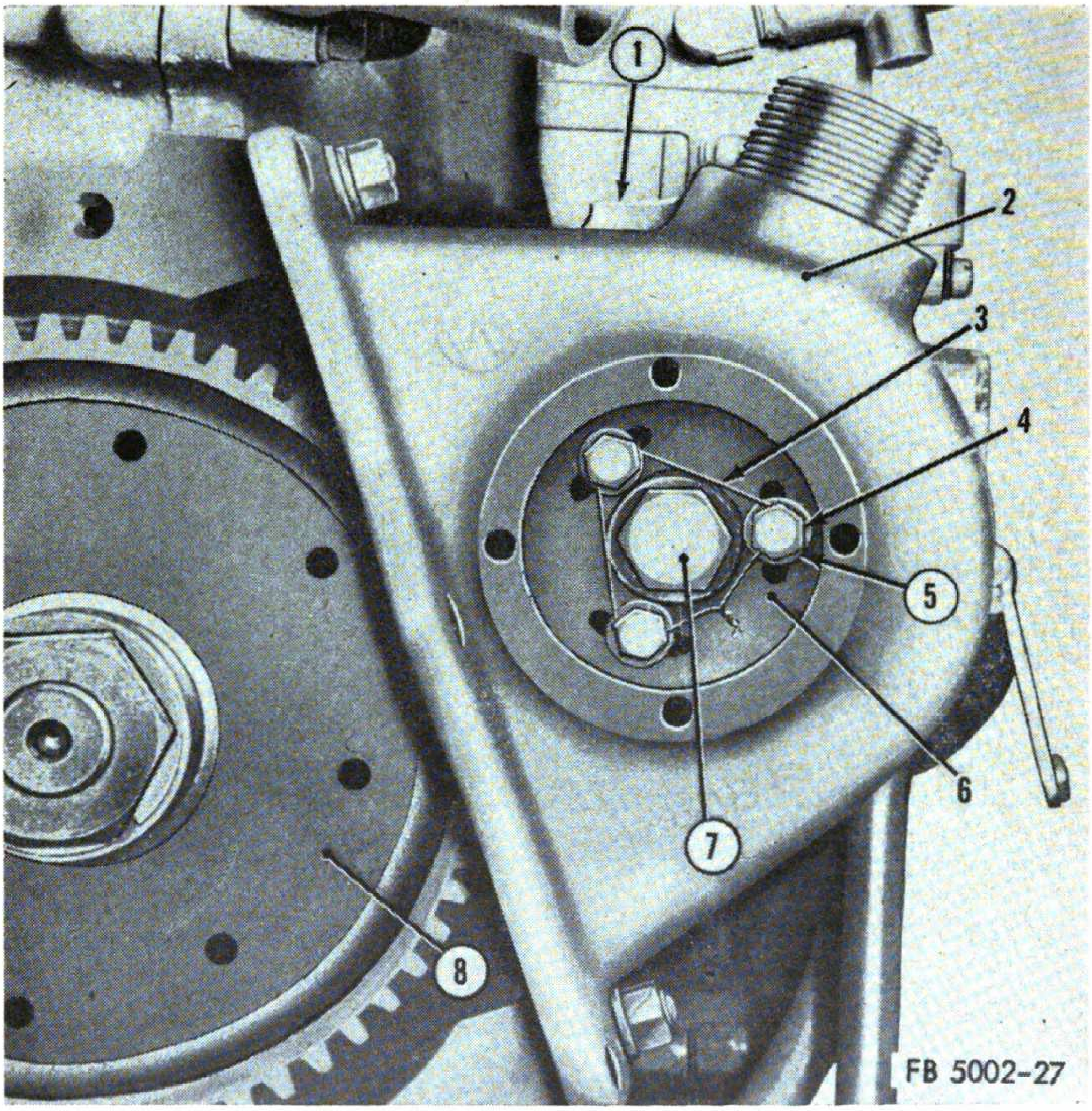
(12) Pull the injector pump assembly (8) outward from the pump adapter, disengaging its gear from the camshaft gear (8, fig. 27).

(13) If the injector pump assembly is to be replaced, it is necessary to remove the gear (6) so that it may be installed on the new pump. To remove the gear, break the lock wire (3) and remove the cap screws (4) and lockwashers (5).

(14) Separate the pump gear (6) and spacer washer from the pump hub.

c. Installation.

(1) Aline the holes in the pump gear (6, fig. 27), spacer washer, and pump hub.



1 Viewing port. 2 Injector pump adapter. 3 Lock wire. 4 Cap screw (3 req'd). 5 Lockwasher (3 req'd). 6 Pump gear. 7 Hub screw. 8 Camshaft gear.

Figure 27. Injector pump adapter and gear.

(2) Install the cap screws (4) and lockwashers (5). Do not lockwire the screws until the pump is timed.

Caution: The holes in the driving gear face are the slotted type. When installing screws, be sure the gear is positioned so that the screws are in the center of the slots.

(3) Remove the toolbox (par. 73*c*) to expose the fan drive pulley.

(4) Rotate the cover (1, fig. 28) to expose the timing marks (2) on the flywheel.

(5) Remove the cylinder head cover (par. 106*a*). Turn the crankshaft slowly in the direction of rotation until No. 1 cylinder is rising on the compression stroke which will

be shown by the closed valves. Watch the timing window in the flywheel housing for the appearance of the timing marks (2). Turn until the flywheel is at 22° before top dead center (22° B.T.D.C.), as indicated by the pointer (3).

(6) Remove the screws (4, fig. 26) and lockwashers, and withdraw the timing window cover (3) from the pump housing.

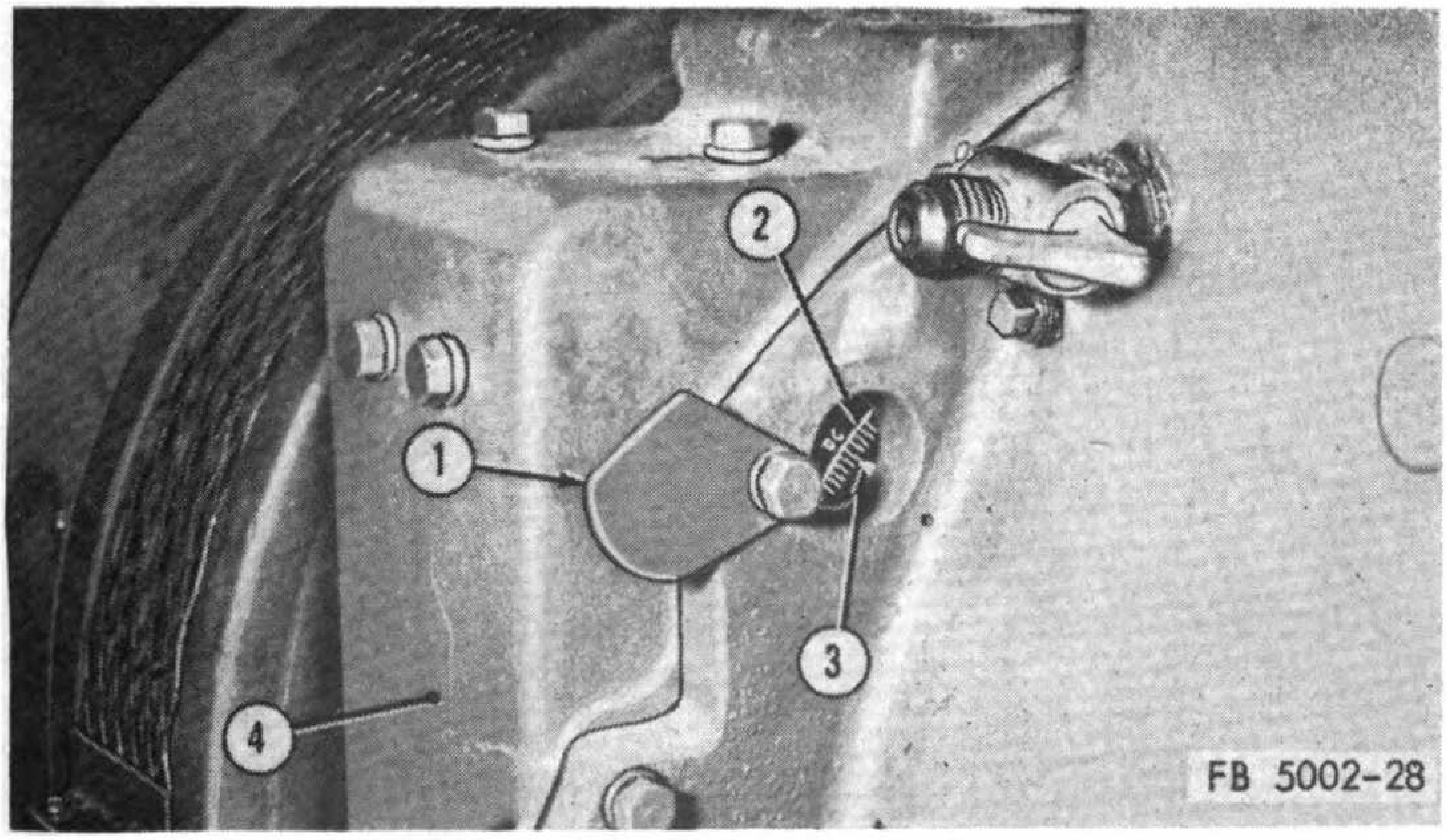
(7) Rotate the pump gear until the pointer on the forward end of the pump housing is alined with the line inscribed on the hub flange.

(8) Check the timing window (5, fig. 29) on the pump housing to see that the PC (port closing) line (3) is lined up with the index line (2) on the plunger gear (4). If these marks are not alined, it will be necessary to rotate the pump gear one more full revolution.

(9) Insert the pump gear end of the fuel injector pump assembly (8, fig. 26) in the pump adapter (27). Mesh the pump gear with the camshaft gear, and secure the pump to the studs with the nuts (22) and lockwashers.

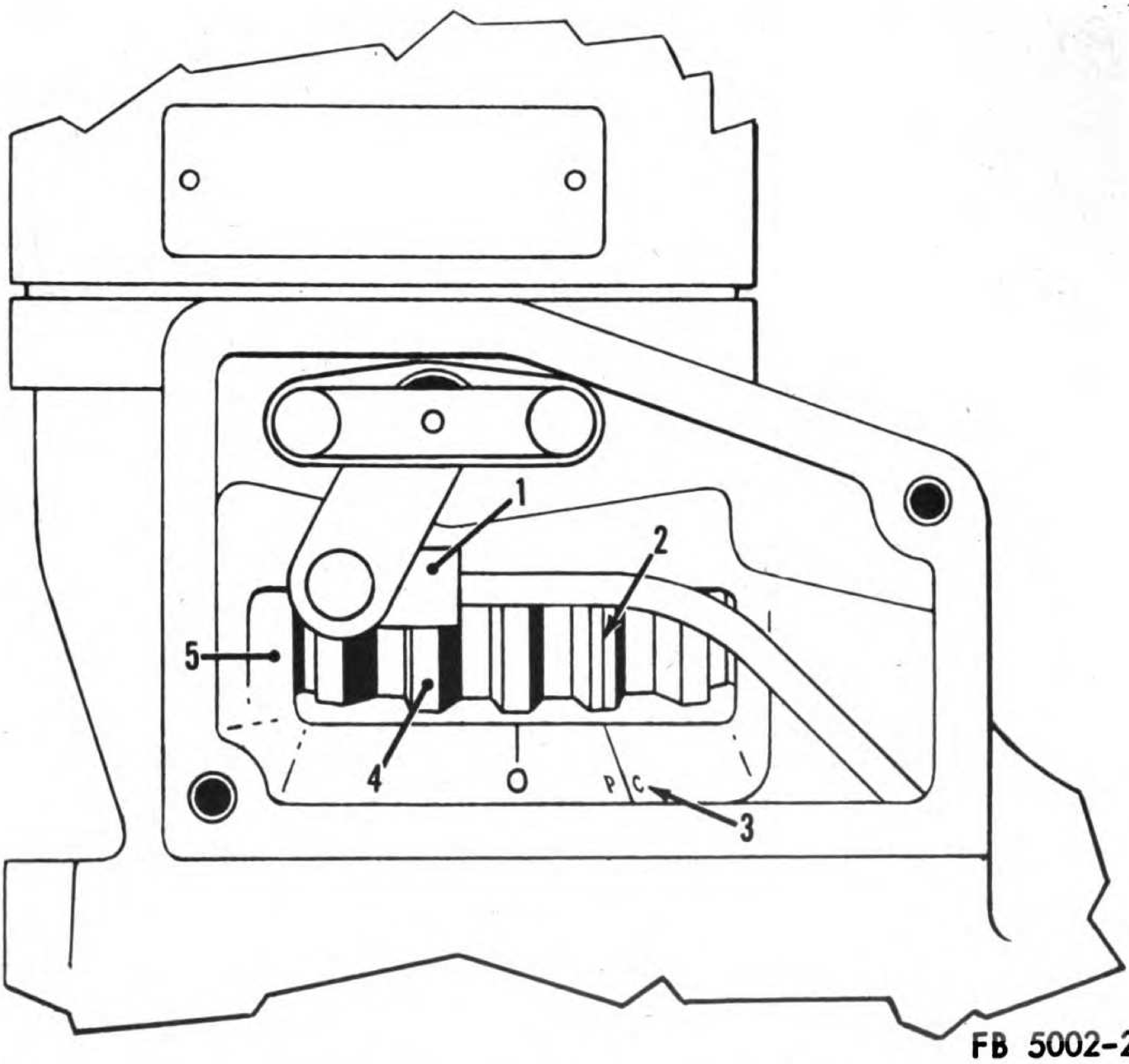
Note. To facilitate accurate alinement, a short 3¼-inch diameter pilot is provided forward of the pump mounting flange.

(10) Unscrew the pipe plug from the viewing port (28) and look into the opening. The index line (1, fig. 30) on the rim of the pump hub (2) should be in line with timing pointer (3).



1 Timing window cover. 2 Timing marks. 3 Pointer. 4 Flywheel housing.

Figure 28. Flywheel timing marks.



1 Control rod. 2 Gear tooth index line. 3 Port closing (PC) index line. 4 Plunger drive gear. 5 Timing window.

Figure 29. Plunger gear and housing timing marks.

(11) If the index line and pointer are not alined, loosen the cap screws (4, fig. 27) and rotate the hub screw (7) so that the index line and pointer are alined as shown in figure 30.

(12) Tighten the cap screws to secure the position of the pump gear (6) and hub.

(13) Turn the crank to back off the flywheel one-quarter revolution; then bring the flywheel markings again into position. The hub timing mark (fig. 30) and the plunger gear timing mark (fig. 29) should aline respectively with the pointer and housing mark.

(14) Install the lock wire (3, fig. 27) to secure the cap screws (4).

(15) Position the injector pump hole cover (26) (fig. 26) and gasket (24) over the opening in the injector pump adapter (27). Secure with the screws (25).

(16) Install the pipe plug in the viewing port (28).

(17) Position the timing window cover (3) against the pump housing and install the screws (4) and lockwashers.

(18) Connect the throttle control wire (12) to the operating lever (11) and tighten the bolt (13).

(19) Insert the engine shutoff control wire (7) in the shutoff fitting (5) and tighten the setscrew (6).

(20) Connect the oil line to the fitting in the base of the fuel injector pump assembly (8).

(21) Connect the injection line assemblies (2) to the hydraulic head (29).

(22) Install the priming pump (par. 84).

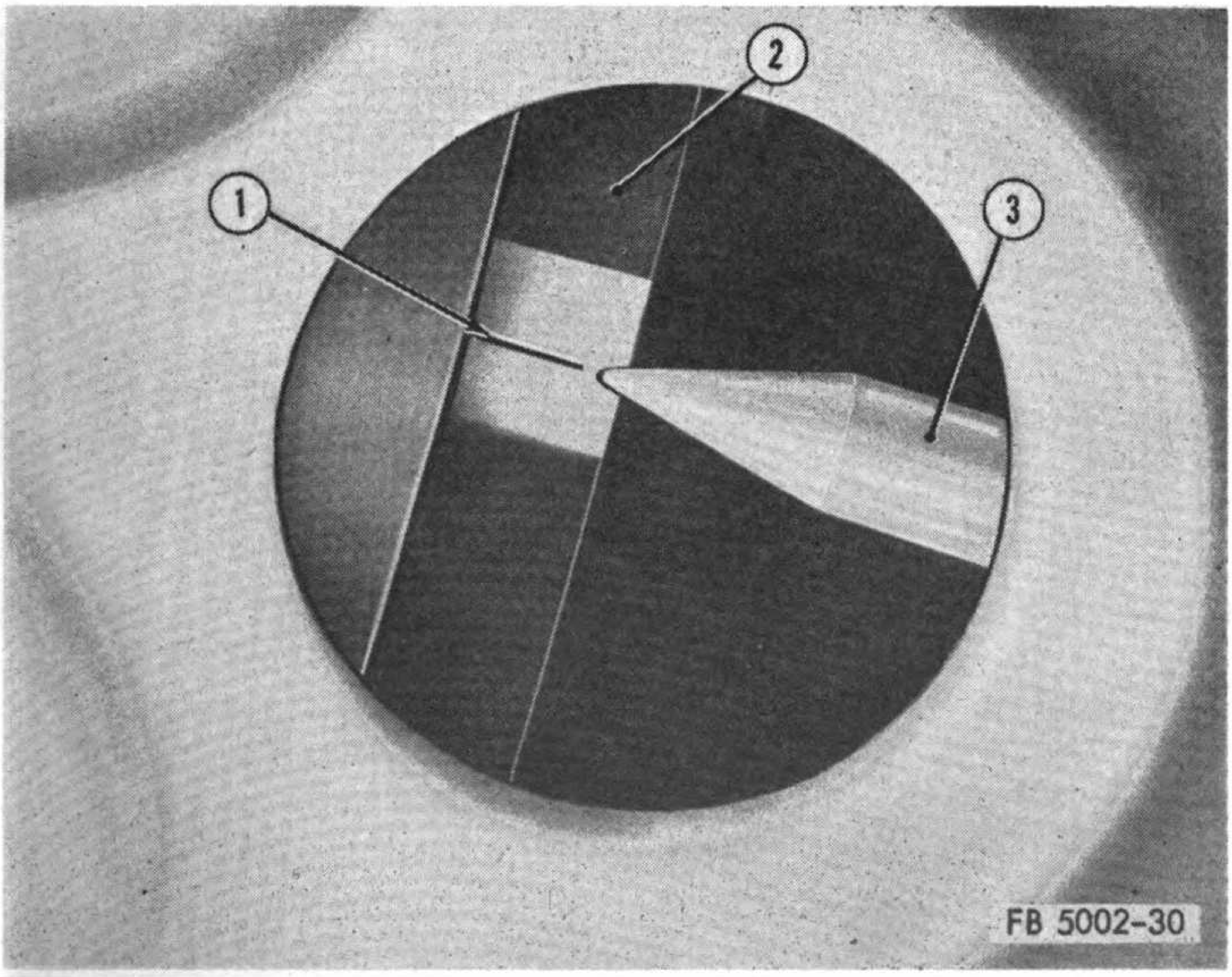
(23) Connect the lines the fuel supply pump assembly (par. 85*d*).

(24) Install the overflow valve assembly (par. 79*c*).

(25) Install the fuel shutoff solenoid (par. 79*e*).

(26) Place the three-way valve (11, fig. 21) in the OPEN position.

(27) Prime the fuel system (par. 16).



1 Index line. 2 Hub. 3 Timing pointer.

Figure 30. Injector pump hub timing mark.

(28) Install the toolbox (par. 77*a*) and the cylinder head cover (par. 106*c*).

d. Timing Adjustment. If the fuel injector pump assembly has been timed properly on installation, there is little possibility of the need for adjustment later. Increases in altitude (par. 28) may require a slight change in timing due to the change in air density. To check the timing and make minor adjustments, proceed as follows:

(1) Remove the toolbox (par. 73*c*) from the front housing to expose the fan drive pulley.

(2) Rotate the cover (1, fig. 28) away from the timing window of the flywheel housing (4) to expose the timing marks.

(3) Remove the cylinder head cover and turn the crankshaft slowly in the direction of rotation until No. 1 cylinder is on its compression stroke. On the compression stroke, both valves of the cylinder will be closed. Watch the timing window in the flywheel housing for the appearance of the timing marks. Turn until the marks (2) on the flywheel read 22° before top dead center (22° B.T.D.C.).

(4) Remove the screws (4, fig. 26) and lockwashers and remove the timing window cover (3).

Caution: When the window cover is removed, the fuel control rod (1, fig. 29) is in the running position. To avoid the danger of the engine starting when the system is full of fuel, the control rod must be pulled to the rear and secured in its shutoff position.

(5) Check the timing window (5, fig. 29) and see that the PC line (3) is lined up with the index line (2).

(6) Unscrew the pipe plug from the viewing port (28, fig. 26) and look into the opening. The index line (1, fig. 30) on the rim of the pump hub (2) should be in line with the timing pointer (3).

(7) If the index line and pointer have shifted position, remove the screws (25, fig. 26) holding the pump hole cover (26) to the adapter (27). Withdraw the cover and gasket (24).

(8) Break the lock wire (3, fig. 27). Loosen the cap screws (4) and rotate the hub screw (7) so that the index line and pointer are alined as shown in figure 30. Tighten the cap screws.

(9) Back off the flywheel one-quarter revolution; then bring the flywheel markings again in position. The hub timing mark (fig. 30) and the plunger gear timing mark (fig. 29) should not have shifted their respective positions.

(10) Install the lock wire (3, fig. 27) to secure the cap screws (4).

(11) Position the hole cover (26, fig. 26) and gasket (24) over the opening in the pump adapter (27) and install the screws (25).

(12) Install the pipe plug in the viewing port (28).

(13) Position the timing window cover (3) on the pump housing and install the screws (4) and lockwashers.

(14) Install the toolbox (par. 77*a*) and the cylinder head cover.

87. Governor

a. General. The governor (9, fig. 26) is an integral part of the fuel injector pump assembly (8). Its function is to maintain the engine speed within a set tolerance under varying load conditions. Idle and full load speeds to be maintained are established as described below. When malfunctions occur, which indicate the governor is defective, the pump assembly and governor must be replaced as a unit (par. 86). Repair of the defective governor will be accomplished by field or depot maintenance personnel.

b. Adjustment (fig. 31). The operating lever (4) is provided with two adjustable stop screws housed within the sealed cover behind the lever. These stops (2 and 3) limit the effect of the lever in the idle and high speed directions.

(1) *Settling idling speed.* The idle adjusting stop screw (2) should be set for sufficient idle speed to prevent stalling. To establish idling speed, proceed as follows:

(*a*) Loosen the locking nut (1) and withdraw the idle adjusting stop screw sufficiently to give the operating lever (4) enough movement in the idle direction to stall the engine.

(*b*) With the engine running and no load applied, establish the position of the lever for sufficient idle speed to prevent stalling.

(*c*) Screw the idle adjusting stop screw inward until contact is made. Screw the locking nut against the plate to hold the setting.

(2) *Setting full load speed.* The full load adjusting stop screw (3) should be set to permit carrying a full load

at the 60-cycle frequency, or 1,200 rpm. To establish the governed speed setting of 1,200 rpm, proceed as follows:

(*a*) Loosen the locking nut (1) and withdraw the full load adjusting stop screw sufficiently to give the operating lever enough movement in the full load direction.

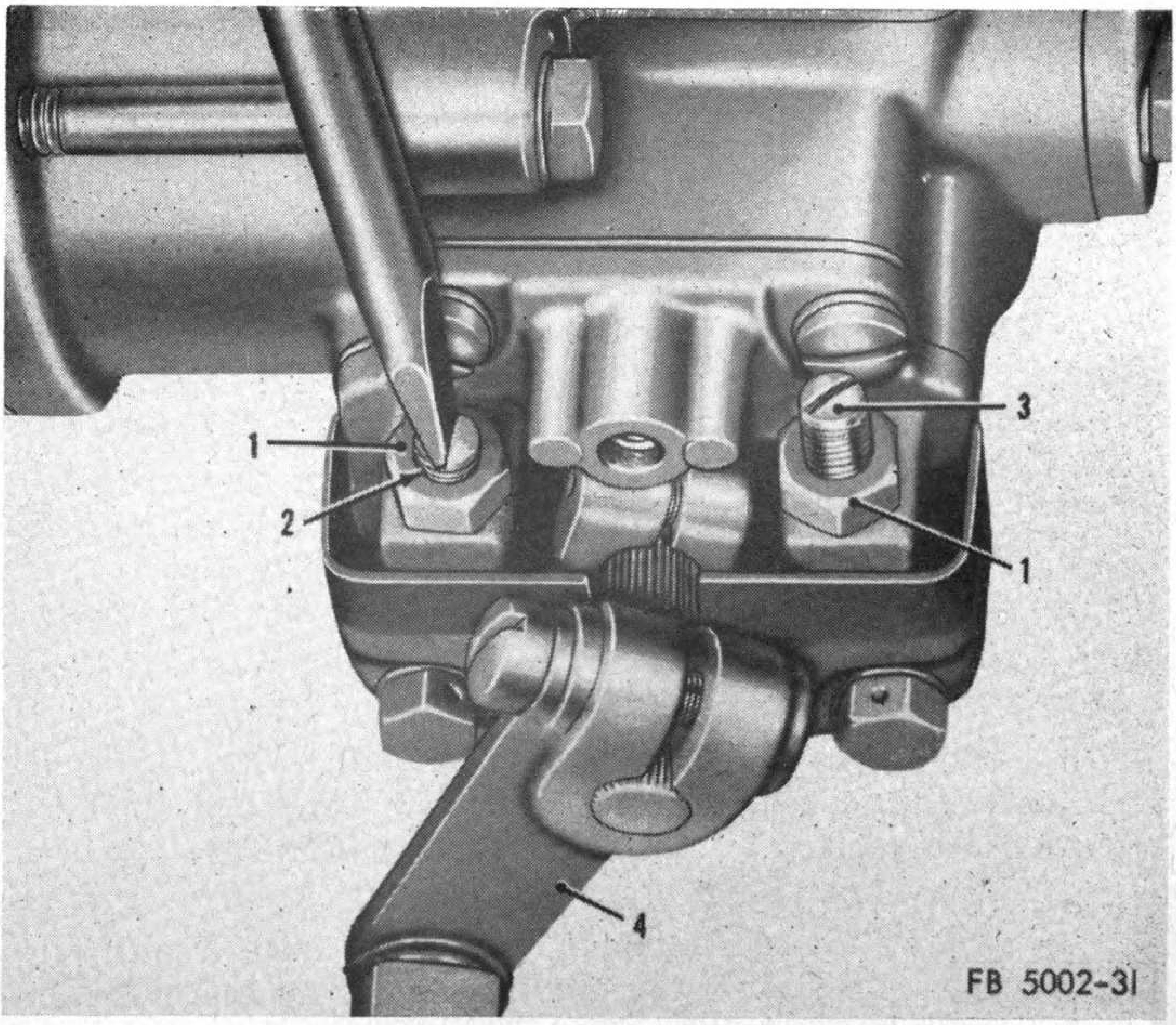
(*b*) Start the engine and place the full electrical load of 15 kw on the load lines.

(*c*) Establish the setting of the throttle for 1,200 rpm (60 cycles).

(*d*) Screw the adjusting stop screw inward until contact is made. Screw the locking nut against the plate to hold the setting.

(*e*) Install the cover and seal.

Note. If the situation dictates, the high speed setting may be increased to accommodate additional loads (over 15 kw). These overload periods should be limited to half an hour.



1 Locking nut (2 req'd). 2 Idle adjusting stop screw. 3 Full load adjusting stop screw.
4 Operating lever.

Figure 31. Setting operating lever stops.

88. Nozzle Holder Assemblies (Fuel Injectors)
(fig. 32)

a. General. The nozzle holders (3) direct the fuel into the combustion chambers in a definite spray pattern. Nozzles are hydraulically operated by the pressure of fuel being delivered by the injector pump (par. 86*a*). The holders retain the nozzles in correct position within the cylinder head and contain the means for necessary pressure adjustment. Organizational maintenance is limited to external cleaning and replacement of the entire assembly.

b. Removal.

(1) Before removing the nozzle holder (3), clean the side of the engine block, the head, and the fuel line connections with cleaning solvent. If possible, blow off with compressed air to remove all traces of dirt or dust.

(2) Disconnect the fuel injection line (1) from the connector (2).

(3) Unscrew the connecting nuts (8) and remove the overflow tubes (4 and 7).

(4) Unscrew the holddown nuts (5) and remove the nozzle holddown clamp (6) from the studs and nozzle holder assembly (3).

(5) Pull the nozzle holder from the engine block. The assembly may be stuck in the block due to carbon deposits. It usually can be loosened by twisting or rotating.

Caution: When withdrawing the nozzle holder assembly, prevent the nozzle end from striking any hard surface. If the end of the projecting pintle (nozzle body) is broken or bent, the nozzle assembly must be replaced and the defective unit turned over to field maintenance personnel for repair.

(6) Unscrew the connector (2) and tee (9) from the nozzle holder.

(7) Cover all exposed openings with paper or tape.

c. Testing.

(1) *On-engine test.* A rough test to isolate an injector that is not working correctly can be performed while the engine is running.

(*a*) Loosen the fitting of one injection line (1) at the nozzle holder (3), allowing fuel to escape and preventing it from entering the injector.

(*b*) Note the engine performance and tighten the fitting.

(*c*) Repeat for each nozzle holder in turn. The one least affecting engine performance is the defective nozzle holder.

(2) *Off-engine test.* A visual test to determine if a nozzle holder (3) is working properly can be performed.

(*a*) Remove the nozzle holder (*b* above).

(*b*) Attach the nozzle holder to its injection line (1) only.

(*c*) Start the engine. Set the speed adjustment control in full load position momentarily, and observe the spray pattern and look for leakage at the nozzle opening.

(*d*) Fuel should be sprayed, at sharply-defined intervals, smoothly and evenly from the nozzle. Unevenness or roughness of the stream or leakage of oil after the spray is completed (dribbling) indicates that the nozzle holder is dirty and must be replaced.

Caution: The fuel spray from the nozzle holder has sufficient force to penetrate the skin. The necessity for keeping all parts of the body away from a spraying nozzle cannot be overemphasized.

d. Cleaning.

(1) Clean the carbon from the exposed surfaces of the nozzle holder (3) with a soft cloth soaked in carbon solvent. Do not scrape the carbon around the area of the nozzle hole as serious damage may result.

(2) Clean the recess in the cylinder head with a small piece of wood shaped for this purpose. Pay particular attention to the seating surface. Small particles of carbon will prevent the lapped edge of the nozzle cap nut from making a perfect seal and will cause the assembly to be cocked or permit blow-by of the combustion gases.

e. Installation.

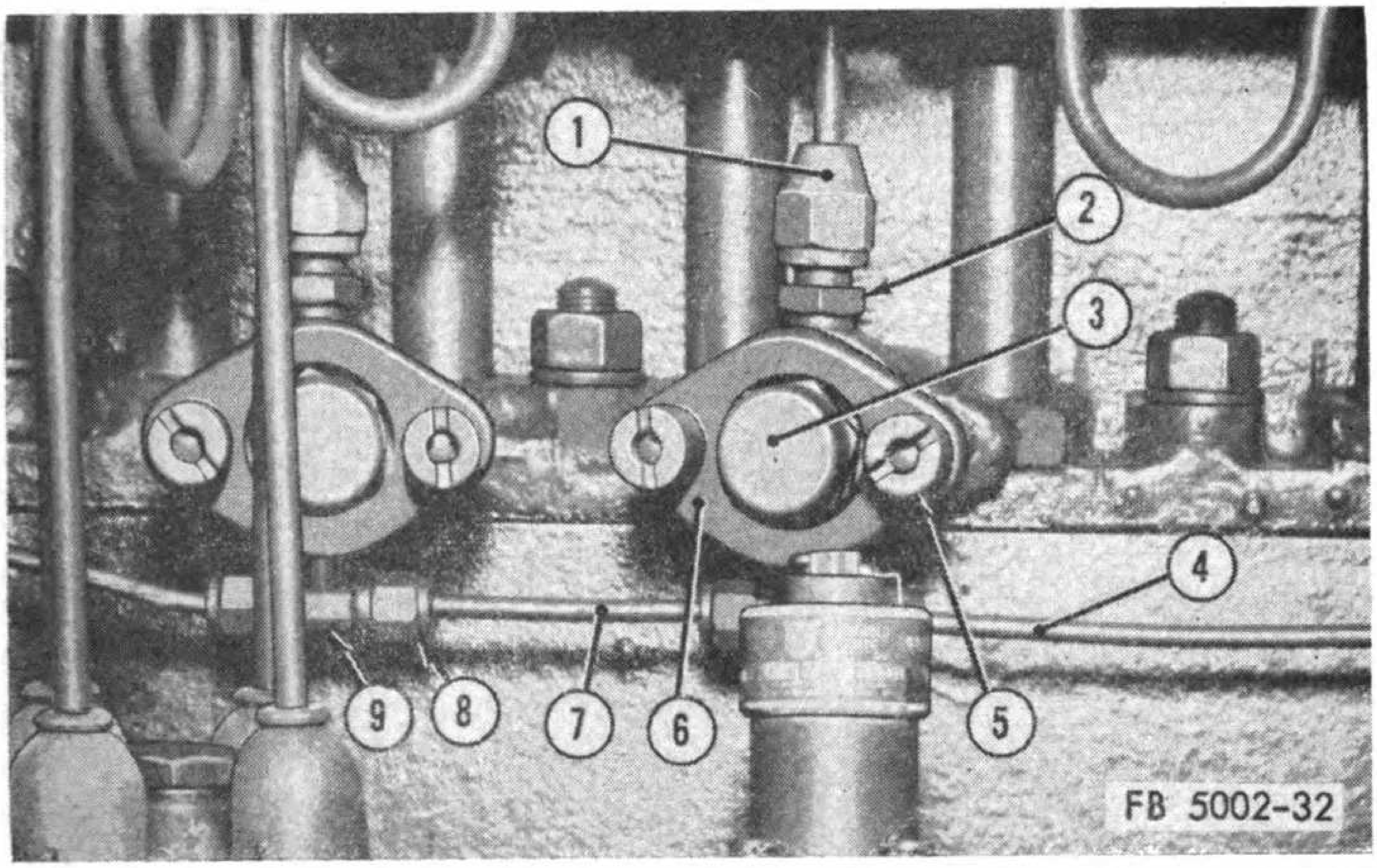
(1) Screw the connector (2) and tee (9) into the holder (3).

(2) Make sure that the nozzle recesses in the cylinder head are clean.

(3) Insert the nozzle holder (3) carefully into the opening in the cylinder head. Do not strike against the recess wall.

(4) Install the nozzle holddown clamp (6) over the holder and studs.

(5) Screw the holddown nuts (5) on the studs and tighten evenly to prevent cocking of the nozzle holder.



1 No. 2 injection line assembly. 2 Connector. 3 Nozzle holder assembly. 4 No. 2 to No. 3 nozzle overflow tube. 5 Holddown nut. 6 Nozzle holddown clamp. 7 No. 1 to No. 2 nozzle overflow tube. 8 Tube connecting nut. 9 Overflow tube connecting tee.

Figure 32. Nozzle holder assembly.

(6) Connect the overflow tubes (4 and 7) to the tee (9) with the connecting nuts (8).

(7) Connect the fuel injection line (1) to the connector (2).

(8) Prime the fuel system (par. 16) and check connections for leaks.

Section VIII. COOLING SYSTEM

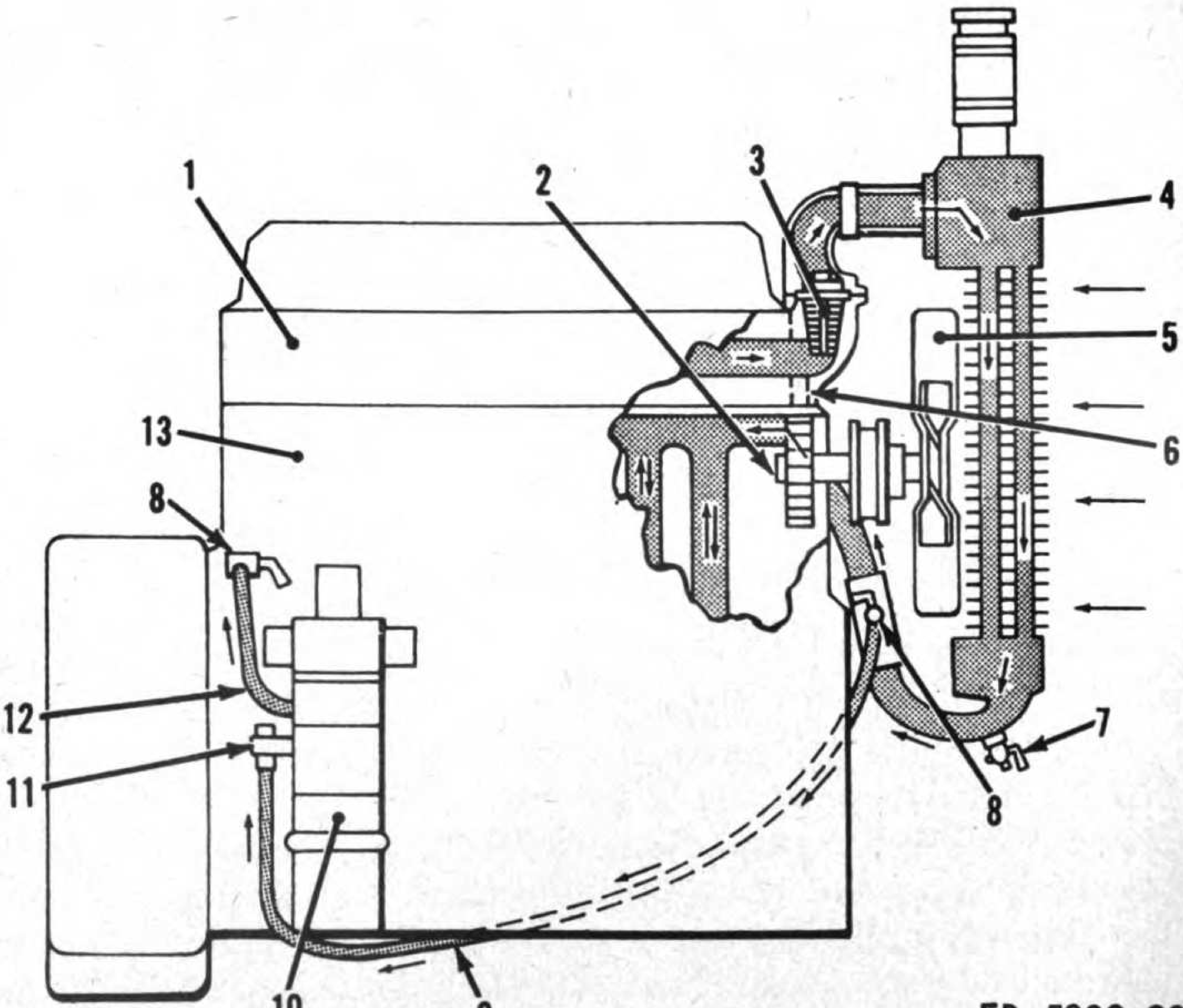
89. Description
(fig. 33)

a. The engine coolant is circulated by a pump assembly (2) located in the forward end of the engine block (13). The pump is driven by a V-belt from the crankshaft pulley. Cooler liquid enters the pump from the lower suction opening. It is then impelled through water distribution passages in the block to the hottest points. These are the areas around the valve seats in the cylinder head (1). Cylinder walls are cooled by convection currents only. The heated liquid leaves the cylinder head through the thermostat housing, where the thermostat (3) controls the opening of the bypass (6). The bypass directs the coolant to the pump to be recirculated through the block until it reaches a tempearture of 160° F. before the radiator outlet is opened.

b. The engine heater (10) is operated under cold-weather conditions to raise the coolant temperature before starting. The heater heat exchanger is connected to the engine coolant system by lines (9 to 12). Circulation through these lines and the heat exchanger is accomplished by thermo-syphon action. The lines are provided with shutoff valves (8), making it possible to remove the heater without draining the cooling system. The safety valve (11) acts as a pressure relief in the event the heater is put into operation with both shutoff valves closed.

90. Radiator and Shutter Control

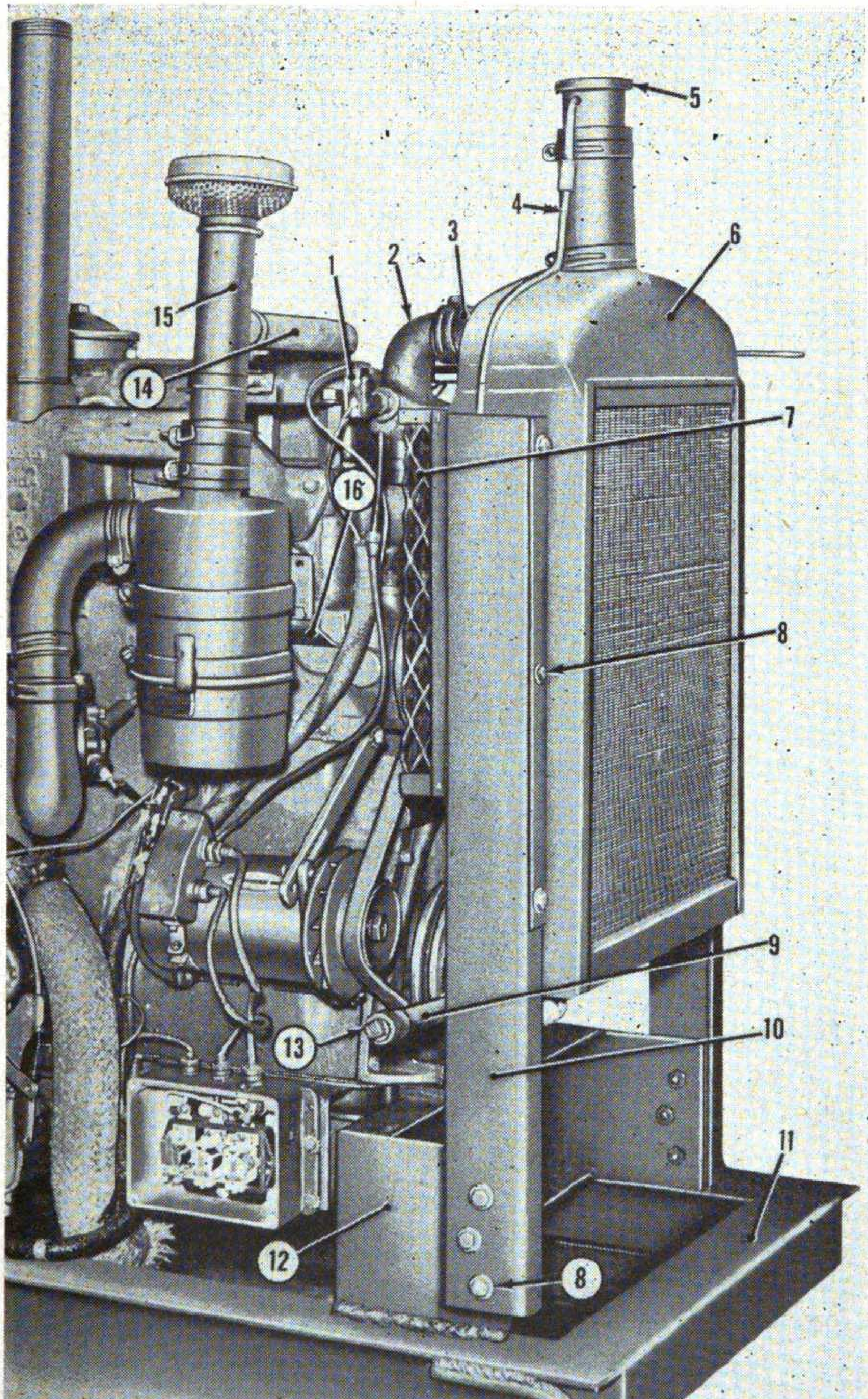
a. General. The radiator assembly (6, fig. 34) is secured to the engine mounting bracket (12) at the forward end of the generator set. It is connected to the water outlet elbow (2) at the cylinder head by the inlet hose (3), and to the water inlet elbow on the suction end of the water pump assembly (2, fig. 33) by an outlet



1 Cylinder head
2 Water pump assembly
3 Thermostat
4 Radiator assembly
5 Fan
6 Bypass
7 Radiator drain
8 Heater shutoff valve
9 Heater inlet line assembly
10 Engine heater
11 Safety valve
12 Heater-to-engine block line assembly
13 Engine block

Figure 33. Cooling system diagram.

line. The outlet line has a tee for connecting the heater inlet line assembly (9) and its shutoff valve (8). The drain line (9, fig. 34) extends through the front housing, which covers the radiator, and



1	Thermostatic switch	7	Fan guard	12	Engine mounting bracket
2	Water outlet elbow	8	Bolt w/nut and lockwasher (6 req'd)	13	Pipe plug
3	Water inlet hose	9	Drain line	14	Hose
4	Overflow tube	10	Base	15	Air inlet line assembly
5	Radiator cap	11	Skid base	16	Air cleaner bracket
6	Radiator assembly				

Figure 34. Radiator assembly.

is plugged by the pipe plug (13). The fan guard (7) protects personnel from the danger of the revolving fan. Figure 12 illustrates the manual and thermostatic controls for opening the shutters in the front housing.

b. Cleaning. Dirt and foreign matter can be removed from the radiator fins by using compressed air directed from the front of the radiator. The cooling system should be drained and flushed at least twice a year, or before adding and after draining antifreeze mixture.

(1) Warm up the engine to operating temperature. Stop the engine and remove the pipe plug (13, fig. 34) to drain the cooling system.

(2) Allow the engine to cool. Install the pipe plug and refill the system with clean water and one can of cleaning solvent.

(3) Run the engine at least 30 minutes at slightly faster than idling speed after the coolant temperature has reached 170° F.

(4) Stop the engine and again drain the system.

Caution: Always neutralize the cooling system after a cleaning solvent has been used.

(5) Allow the engine to cool. Fill the system with clean water and a neutralizing compound.

(6) Run the engine at least 10 minutes at slightly faster than idling speed after the coolant temperature has reached 170° F.

(7) Stop the engine and drain the system.

(8) Allow the engine to cool and fill the system with clean water.

(9) Run the engine until the coolant temperature reaches 170° F.

(10) Stop the engine and drain the system.

(11) Repeat the flushing procedure (8, 9, and 10) above until the drain water is clear.

c. Locating Leaks. With the system full, examine the radiator core and hose connections for leaks. A deposit of scale at a connection or on the core indicates a leak. When the radiator is leaking, remove, disassemble, and repair (*d*, *e*, and *f* below).

d. Removal.

(1) Remove the housing section and front housing (par. 73).

(2) Remove the pipe plug (13, fig. 34) and drain the cooling system.

(3) Loosen the clamp to free the water inlet hose (3) from the elbow (2). Similarly loosen the clamp holding the

outlet hose to the water inlet elbow at the suction side of the water pump.

(4) Disconnect the heater inlet line (9, fig. 33) at its shutoff valve (8).

(5) Remove the bolts (8, fig. 34), nuts, and lockwashers securing the radiator bases (10) to the engine mounting bracket (12).

(6) Raise the radiator assembly (6) upward, allowing the fan guard (7) to clear the fan, and remove it from the generator set.

(7) Remove the manual shutter control (4, fig. 12) from its bracket (5). Remove the clamp (10) and unscrew the hex nut (39, fig. 35) from the control. Remove the washer (38) and pull the manual shutter control (37) from the bracket (34).

(8) To remove the shutter control bracket, unscrew the bracket screws (36) and lockwashers (35) securing the bracket to the elbow (2, fig. 34).

e. Disassembly (fig. 35).

(1) Loosen the clamps (7) and remove the inlet hose (8). Separate the clamps and hose.

(2) Loosen the clamps (5) and separate the hose extension (6), overflow tube (1), filler neck (3), neck seal (4), and clamps.

(3) Unscrew the shutoff valve (13) and street elbow (12).

(4) Disassemble the outlet line by loosening the clamps (9) and separating the outlet hoses (10) and outlet tee (11).

(5) Remove the screws (18) and lockwashers (19) to free the outlet elbow (17) and gasket (16) from the base of the radiator assembly (28).

(6) Disassemble the drain line by unscrewing the pipe fittings (26, 25, 24, 23, 21, and 22) in succession.

(7) Remove the screws (47) and lockwashers (46) and pull the fan guards (29 and 45) from the radiator assembly. Separate the guards by removing the bolts, nuts, and lockwashers holding them together.

(8) Remove the screws (33) and lockwashers (32) and withdraw the shutter control thermostat (31) and thermostat gasket (30).

(9) To remove the shutter control arm from the thermostat, unscrew the hex nuts (40) and withdraw the connector block (41). Pull the arm from the thermostat control lever.

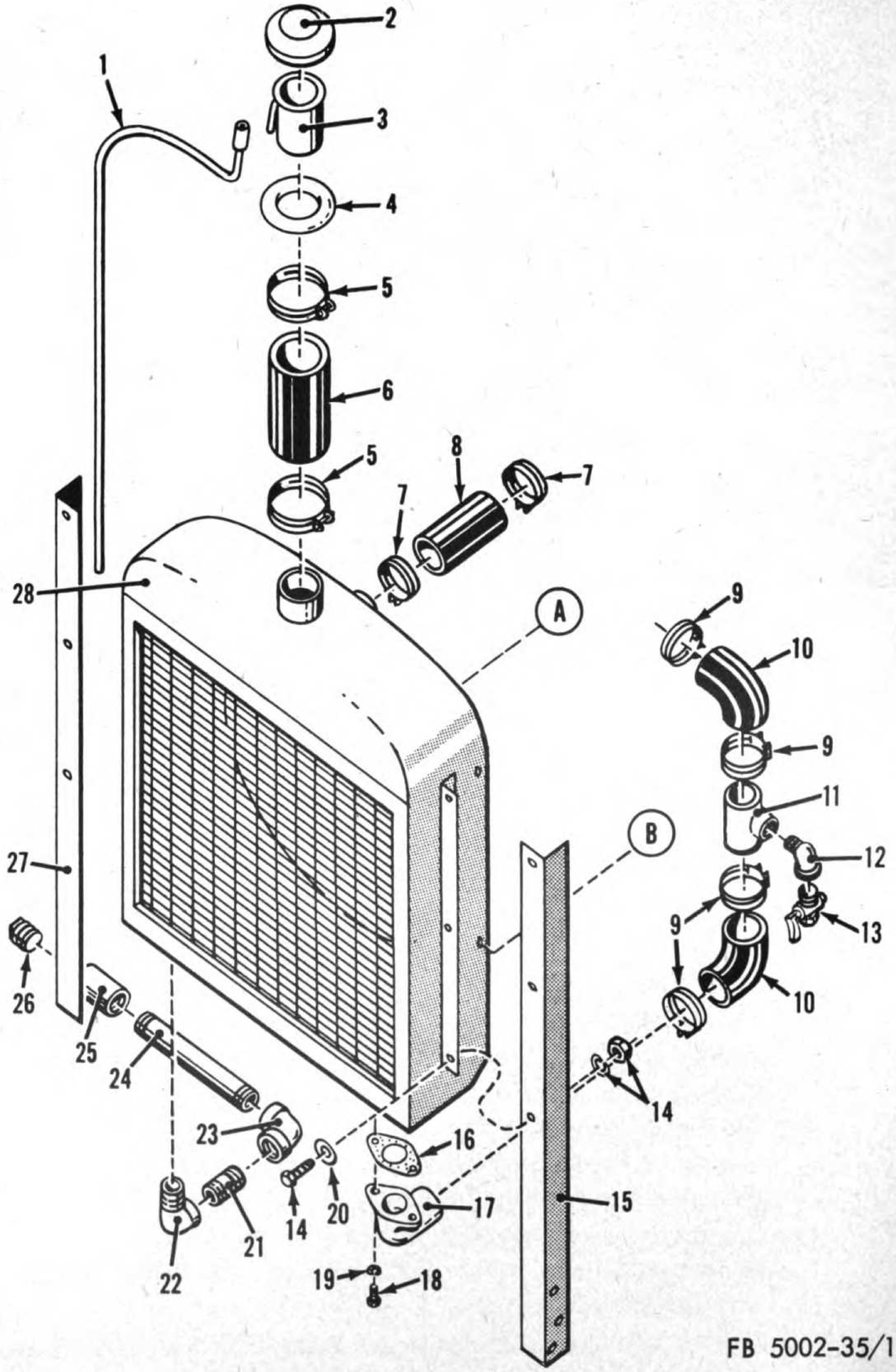
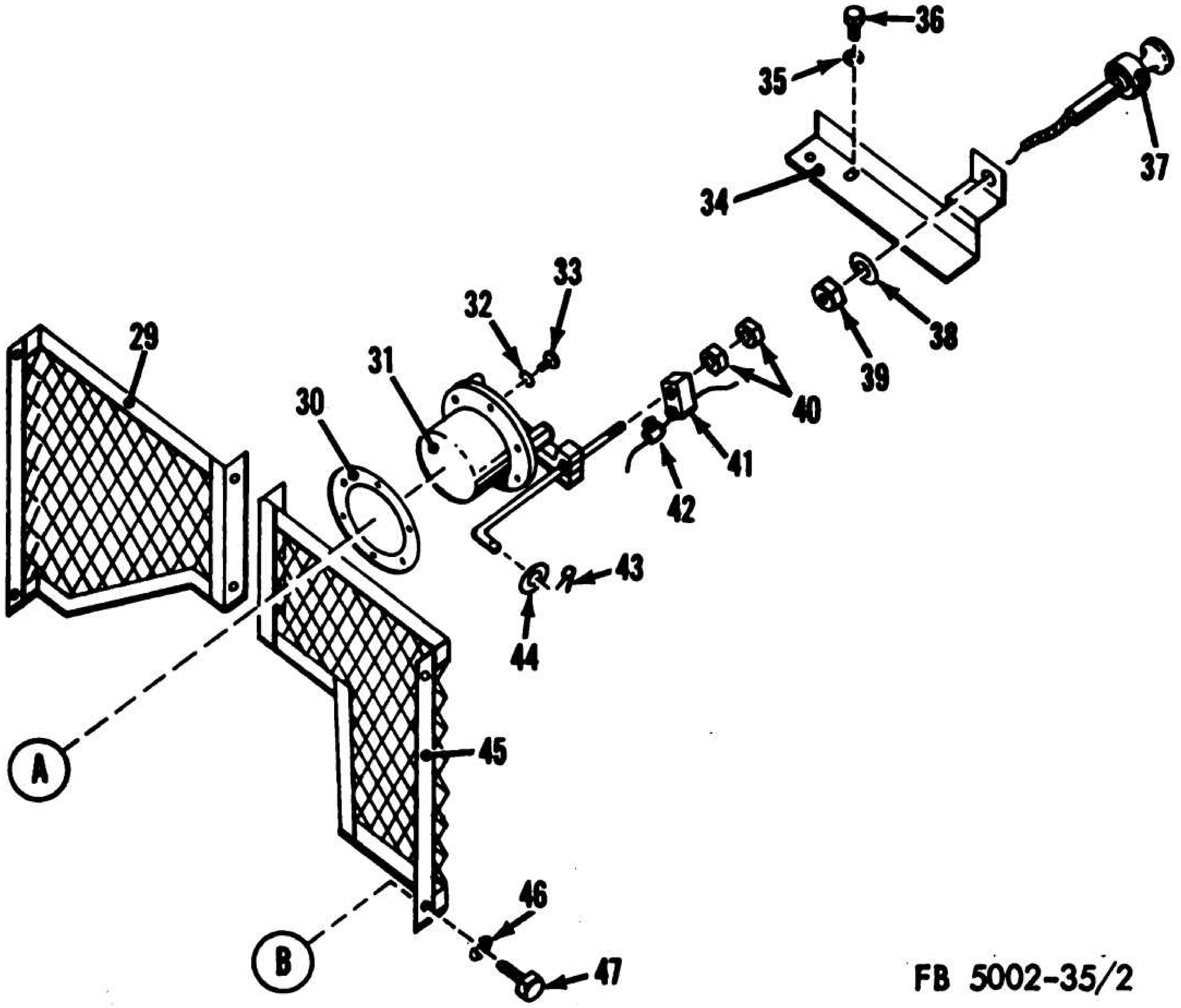


Figure 35. Radiator and shutter control, exploded view.

(10) Unscrew the bolts (14) with nuts, lockwashers, and flat washers (20) to detach the bases (15 and 27) from the radiator assembly (28).

f. Repair.

(1) If a leak in the radiator cannot be located, plug all outlets but the filler opening and place the radiator in a tank of water. Wrap a cloth around an air hose connected



1 Overflow tube
2 Radiator cap
3 Filler neck
4 Neck seal
5 Clamp
6 Hose extension
7 Clamp
8 Inlet hose
9 Clamp
10 Outlet hose
11 Outlet tee
12 Street elbow
13 Shutoff valve
14 Machine bolt w/nut and lockwasher (12 req'd)
15 Left base
16 Elbow gasket
17 Outlet elbow
18 Screw (2 req'd)
19 Lockwasher (2 req'd)
20 Flat washer (6 req'd)
21 Pipe nipple
22 Street elbow
23 90° elbow
24 Pipe nipple
25 Straight coupling
26 Pipe plug
27 Right base
28 Radiator assembly
29 Right fan guard
30 Thermostat gasket
31 Shutter thermostat
32 Lockwasher (6 req'd)
33 Mounting screw (6 req'd)
34 Shutter control bracket
35 Lockwasher (2 req'd)
36 Bracket screw (2 req'd)
37 Manual shutter control
38 Plain washer (1 req'd)
39 Hex nut (1 req'd)
40 Hex nut (2 req'd)
41 Connector block
42 Clamp
43 Cotter pin (1 req'd)
44 Plain washer (1 req'd)
45 Left fan guard
46 Lockwasher (8 req'd)
47 Mounting screw (8 req'd)

Figure 35—Continued.

to a low-pressure air source (10 to 15 psi). Insert the hose in the filler neck, using the cloth to seal the opening. Leaks will be shown by air bubbling up through the water.

(2) Solder or braze leaks in the core or tanks. If the radiator is beyond repair, replace it with a new assembly.

(3) Straighten bent fins with pliers.

(4) See that the overflow tube is not bent or broken.

(5) Replace all defective or worn parts of the radiator.

g. Reassembly (fig. 35).

(1) Secure the right and left bases (15 and 27) to the radiator assembly (28) using the flat washers (20) and the machine bolts (14) with nuts and lockwashers.

(2) Install the thermostat gasket (30) on the shutter thermostat (31). Insert the thermostat in the radiator assembly. Aline the holes and install the lockwashers (32) and mounting screws (33). Tighten securely. If the shutter control arm has been withdrawn, insert it through the opening in the thermostat control lever. Slip the connector block (41) on and secure with hex nuts (40).

(3) Secure the fan guards (29 and 45) together with the bolts, nuts, and lockwashers. Mount the guards on the radiator assembly, and install the screws (47) and lockwashers (46).

(4) Screw the street elbow (22) into the base of the radiator and assemble the drain line by installing pipe fittings (21, 23, 24, 25, and 26) in succession.

(5) Position the outlet elbow (17) and gasket (16) against the outlet opening in the base of the radiator assembly. Aline the holes and install the screws (18) and lockwashers (19). Tighten securely.

(6) To assemble the outlet line, install the outlet hoses (10) on the outlet tee (11) and secure with one pair of clamps (9). Install the second pair of clamps on the ends of the outlet hoses. Slip the outlet line over the outlet elbow and tighten the clamp (9) securely.

(7) Screw the street elbow (12) into the tee, and the shutoff valve (13) into the street elbow.

(8) Install the clamps (5) on the ends of the hose extension (6). Slip the neck seal (4) over the filler neck (3) and insert the filler neck in the hose extension. Tighten the upper clamp securely. Attach the overflow tube (1)

to the tube extension on the filler neck. Slip the lower end of the hose extension on the filler opening of the radiator assembly and tighten the lower clamp. Position the overflow tube along the right side of the radiator.

(9) Install the clamps (7) on the ends of the inlet hose (8). Slip the hose over the radiator inlet opening and tighten the front clamp.

h. Installation.

(1) Raise the assembled radiator (6, fig. 34) and position it on the front end of the generator set, allowing the fan guard (7) to shroud the fan.

(2) Secure the radiator bases (10) to the engine mounting bracket (12) with the bolts (8), nuts, and lockwashers.

(3) Slip the water inlet hose (3) on the water outlet elbow (2) and tighten the clamp securely. Similarly install and clamp the outlet hose to the water inlet elbow at the suction side of the water pump.

(4) Connect the heater inlet line (9, fig. 33) to its shutoff valve (8).

(5) Secure the shutter control bracket (34, fig. 35) to the water outlet elbow with the screws (36) and lockwashers (35).

(6) Insert the wire end of the manual shutter control (37) through the bracket. Secure with the washer (38) and hex nut (39).

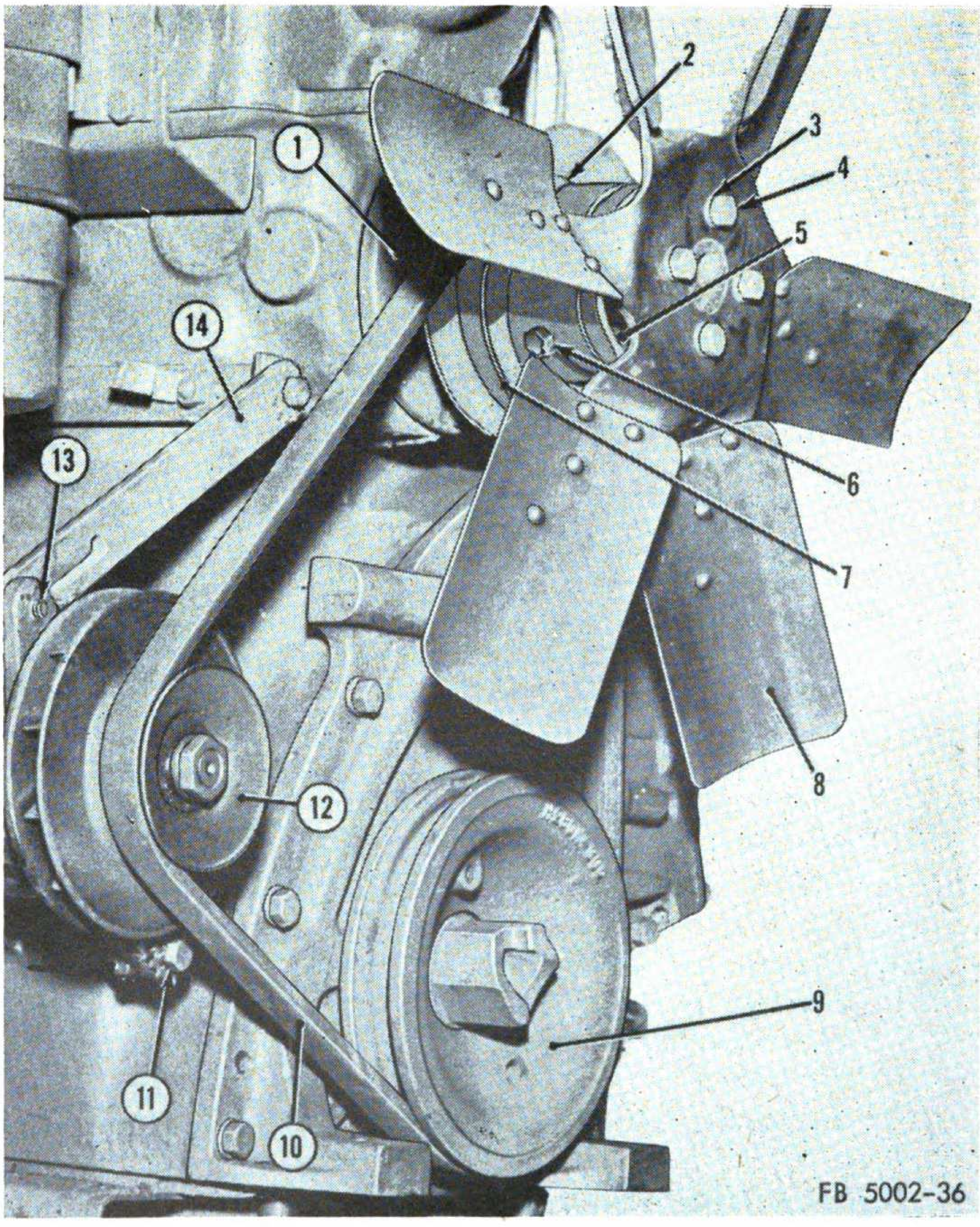
(7) Slip the wire end of the manual shutter control (4, fig. 12) through the connector block (9). Install the clamp (10) on the wire, against the block, and tighten. Be sure the shutter control arm, thermostat, and manual shutter control have been connected as shown in figure 12.

(8) Tighten all connections and fill the cooling system. Start the engine and run for a short period after operating temperature has been reached. Check all connections for leaks.

(9) Install the front housing and housing section (par. 77).

91. Fan and Water Pump Assembly

a. General (fig. 36). The fan blade (8) and water pump assembly (1) are driven from the fan drive pulley (9) by the V-belt (10). Belt tension is adjusted by altering the position of the battery-charging generator. A slight axial adjustment of the belt is possible by rotating the belt flange (7). The flange setting is held by the screw (6) and a locknut. This adjustment is used to eliminate bolt friction at the flange. The rotary motion is transmitted to the water pump impeller by the fan hub (2) which is secured to the pump shaft. The impeller is housed in the engine block.



1	Pump assembly
2	Fan hub
3	Washer, lock, 5/16 in. (4 req'd)
4	Screw (4 req'd)
5	Blade spacer
6	Screw (4 req'd)
7	Belt flange
8	Fan blade
9	Fan drive pulley
10	V-belt
11	Mounting screw (2 req'd)
12	Generator drive pulley
13	Adjusting screw
14	Adjusting strap

Figure 36. Fan and water pump drive.

b. Removal.

(1) Remove the radiator (par. 90*d*).

(2) Remove the screws (4, fig. 36) and lockwashers (3) to free the fan blade (8) and blade spacer (5).

(3) Loosen the generator mounting screw (11) and the adjusting screw (13). Pivot the generator toward the engine and remove the V-belt (10).

(4) To remove the pump assembly (1), remove the nuts and lockwashers holding the pump support (7, fig. 37) to the engine block. Remove the assembled pump and gasket (4).

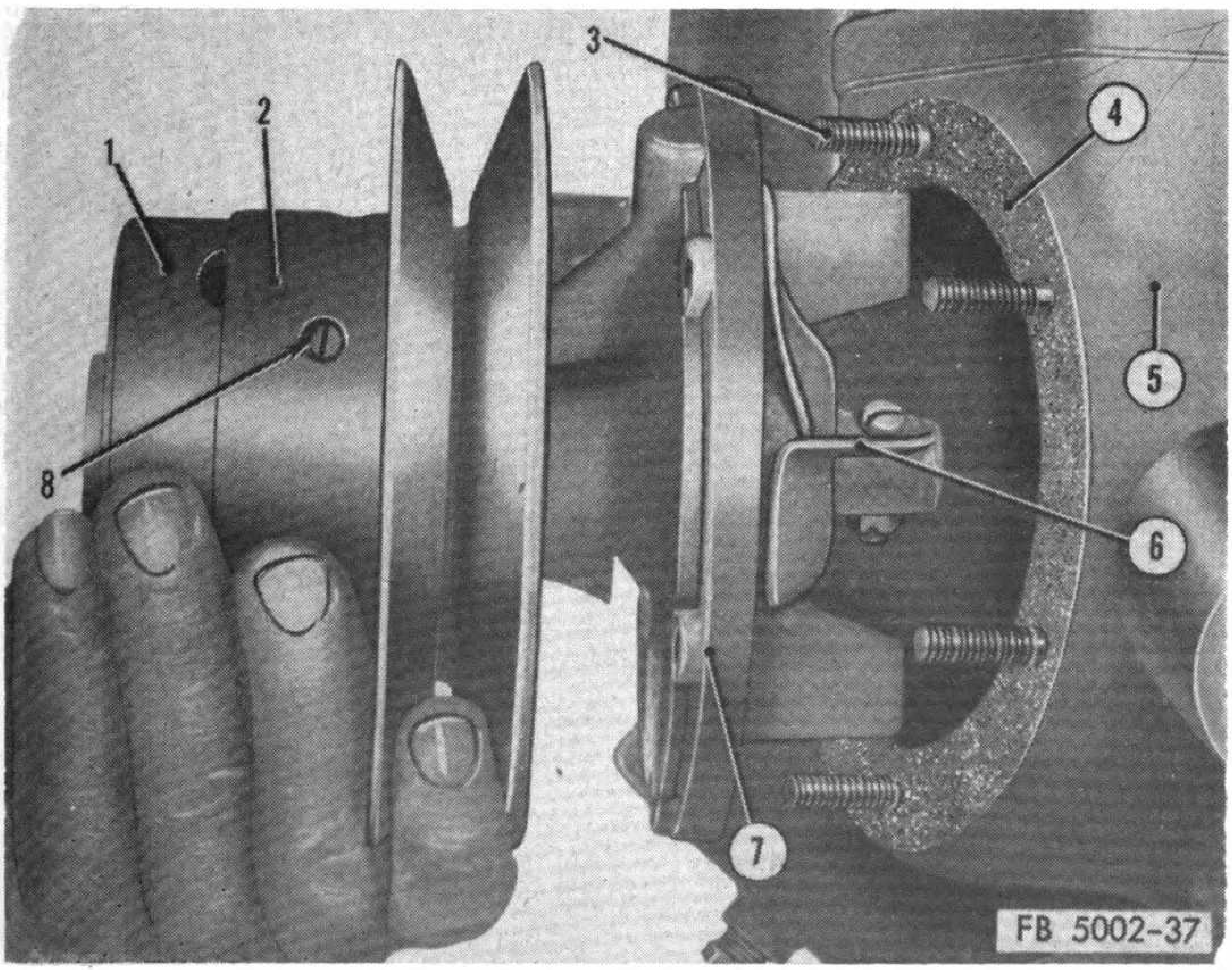
c. Disassembly.

(1) Remove the screws (6, fig. 36), lockwasher and lock-nut from the slot in the belt flange (7).

(2) Slide the belt flange (2, fig. 37) from the fan hub (1).

d. Inspection and Repair.

(1) When the pump is removed assembled (*b* above), inspect all parts without disassembling. If the fan hub, belt flange, or their securing elements are defective,



1 Fan hub assembly. 2 Belt flange. 3 Mounting stud. 4 Gasket. 5 Block. 6 Impeller 7 Pump support. 8 Setscrew (1 req'd).

Figure 37. Water pump assembly removal.

worn, or deformed, disassemble (*c* above) and replace damaged parts.

(2) If water leaks from the surface between the pump support (7, fig. 37) and the block (5), replace the gasket (4). When water is leaking from the surface between the pump support and the shaft, the pump must be replaced.

(3) If the fan blades are warped or bent, they should be straightened. Be careful to retain the same blade pitch or the fan guards may bind against the blade when the radiator is installed. When necessary, replace the fan.

(4) Replace the V-belt when worn.

e. Reassembly. Slide the belt flange (2, fig. 37) on the fan hub (1) and install the locknut, lockwasher and screws (6, fig. 36). The tab on the locknut is inserted in the slot of the belt flange to retain its position. Tighten the screw after proper flange setting has been established.

f. Installation.

(1) Cement the gasket (4, fig. 37) to the block (5).

(2) Place the impeller assembly (6) in the block and the pump support (7) on the studs. Secure with the nuts and lockwashers.

(3) Slip the V-belt (10, fig. 36) on the fan drive pulley (9), generator drive pulley (12), and fan hub (2).

(4) Aline the boltholes in the fan blade (8), blade spacer (5), and the face of the fan hub. Install the screws (4) and lockwashers (3).

(5) Adjust the V-belt tension (*g* below).

(6) Install the radiator and shutter control (par. 90*h*).

(7) Fill the cooling system and check for leaks.

g. V-belt Adjustment. When the V-belt is adjusted properly, it must deflect 3/4 to 1 inch when depressed at a point midway between the generator and the fan hub. To adjust the belt tension, proceed as follows:

(1) Loosen the generator screws (11 and 13, fig. 36).

(2) Pull outward on the battery-charging generator, until the V-belt (10) is snug.

(3) Tighten the screws to hold the new setting.

(4) Check for proper deflection of 3/4 to 1 inch without undue pressure at a point midway between the generator and the fan hub (2).

Caution: Belt tension should never be adjusted with a bar or lever to draw the generator outward.

92. Thermostats

a. General. Two thermostats are used in controlling the temperature of the cooling system. The bypass control thermostat (3, fig. 33) closes the radiator inlet line until the coolant within the cylinder block reaches 160° F. When the thermostat closes the inlet line, it simultaneously opens the bypass line (6) to recirculate the coolant. The shutter control thermostat (12, fig. 12) is used in controlling the radiator shutters. The shutters are closed until the bypass control thermostat opens the radiator inlet line. At this time, the heated coolant flows into the upper tank of the radiator where the shutter control thermostat is located. When the temperature in the upper tank reaches 140° F., the shutter control thermostat actuates the control arm (11) to open the shutters. At 160° F., the shutters are fully open.

b. Removal.

(1) *Bypass control thermostat.*

(*a*) Drain the cooling system (par. 90*d*(2)).

(*b*) Loosen the clamps to disconnect the water inlet hose (3, fig. 34) from the elbow (2).

(*c*) Disconnect the lead to the switch (1). Remove the switch and thermocouple from each side of the elbow.

(*d*) Remove three cap screws and lockwashers holding the elbow (1, fig. 38) to the cylinder head (3).

(*e*) Lift the elbow and remove the thermostat (4).

(*f*) Remove the gasket (2).

(2) *Shutter control thermostat.*

(*a*) Remove the clamp (10, fig. 12) and pull the wire from the connector block (9).

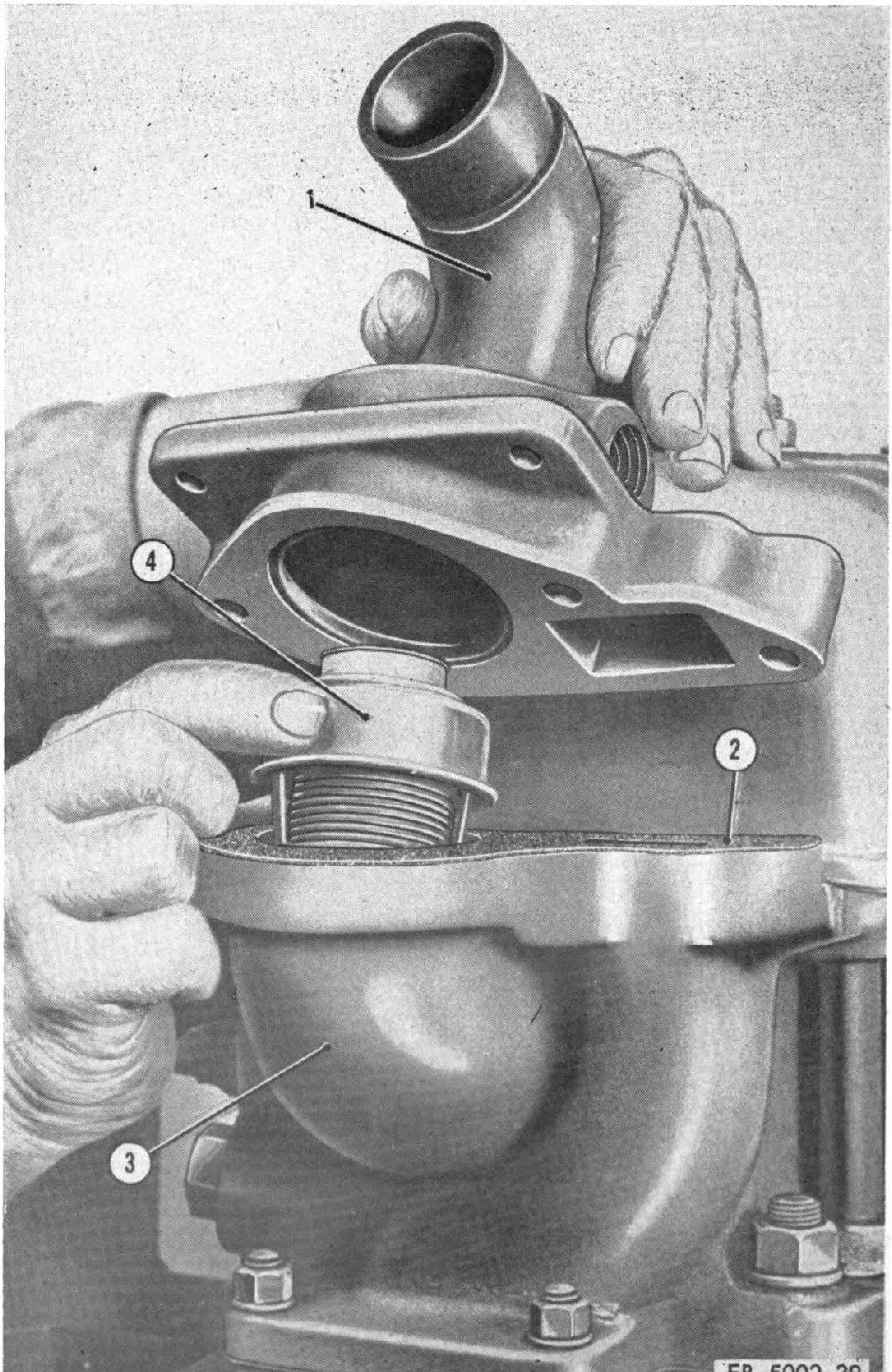
(*b*) Remove the nut (8) and connector block from the shutter control arm (11).

(*c*) Remove the screws (33, fig. 35) and lockwashers (32) and withdraw the shutter control thermostat (31) and gasket (30) from the radiator assembly (28) and shutter control arm.

c. Testing. The thermostats should be completely closed when cold.

(1) To test the bypass control thermostat (4, fig. 38), place it in a pan of water with a thermometer and heat slowly. The thermostat should be fully open when the temperature reaches 160° F.

(2) To test the shutter control thermostat (12, fig. 12), proceed as above. The thermostat should start to open at 140° F. and be fully open at 160° F.



1 Water outlet elbow. 2 Elbow gasket. 3 Cylinder head. 4 Thermostat.

Figure 38. Thermostat removal.

d. Installation.

(1) *Bypass control thermostat.*

(*a*) Cement the gasket (2, fig. 38) to the cylinder head (3).

(*b*) Place the thermostat (4) in the cylinder head.

(*c*) Install the water outlet elbow (1) over the thermostat and secure to the head with the cap screws and lockwashers.

(*d*) Slip the water inlet hose (3, fig. 34) on the outlet elbow (2) and tighten the clamps.

(2) *Shutter control thermostat.*

(*a*) Cement the thermostat gasket (30, fig. 35) to the shutter control thermostat (31). Insert the thermostat in the radiator assembly (28), allowing the shutter control arm to pass through the opening provided.

(*b*) Secure the thermostat to the radiator with the screws (33) and lockwashers (32).

(*c*) Slip the connector block (9, fig. 12) on the shutter control arm (11) and install the nut (8).

(*d*) Slip the wire of the manual shutter control (4) through the connector block. Install the clamp (10) on the wire against the block and tighten. Be sure the shutter control arm, thermostat, and manual shutter control have been connected as shown in figure 12.

(*e*) Fill the cooling system and check for leaks.

Section IX. ENGINE ELECTRICAL SYSTEM

93. Description
(fig. 39)

The 24-volt engine electrical system consists of two 12-volt batteries connected in series, a belt-driven battery-charging generator, a voltage regulator, a starter, and a relay. The engine heater, flame heater, safety controls, panel lights, and trouble light receptacle are operated from the 24-volt system. A d-c ammeter indicates the rate of battery charge or discharge. An external 24-volt power source can be connected to the circuit through the charging receptacle in the event of battery failure. The engine wiring diagram illustrates all the components of the 24-volt system. Refer to paragraph 117 for the engine heater circuit and paragraph 112 for the flame heater.

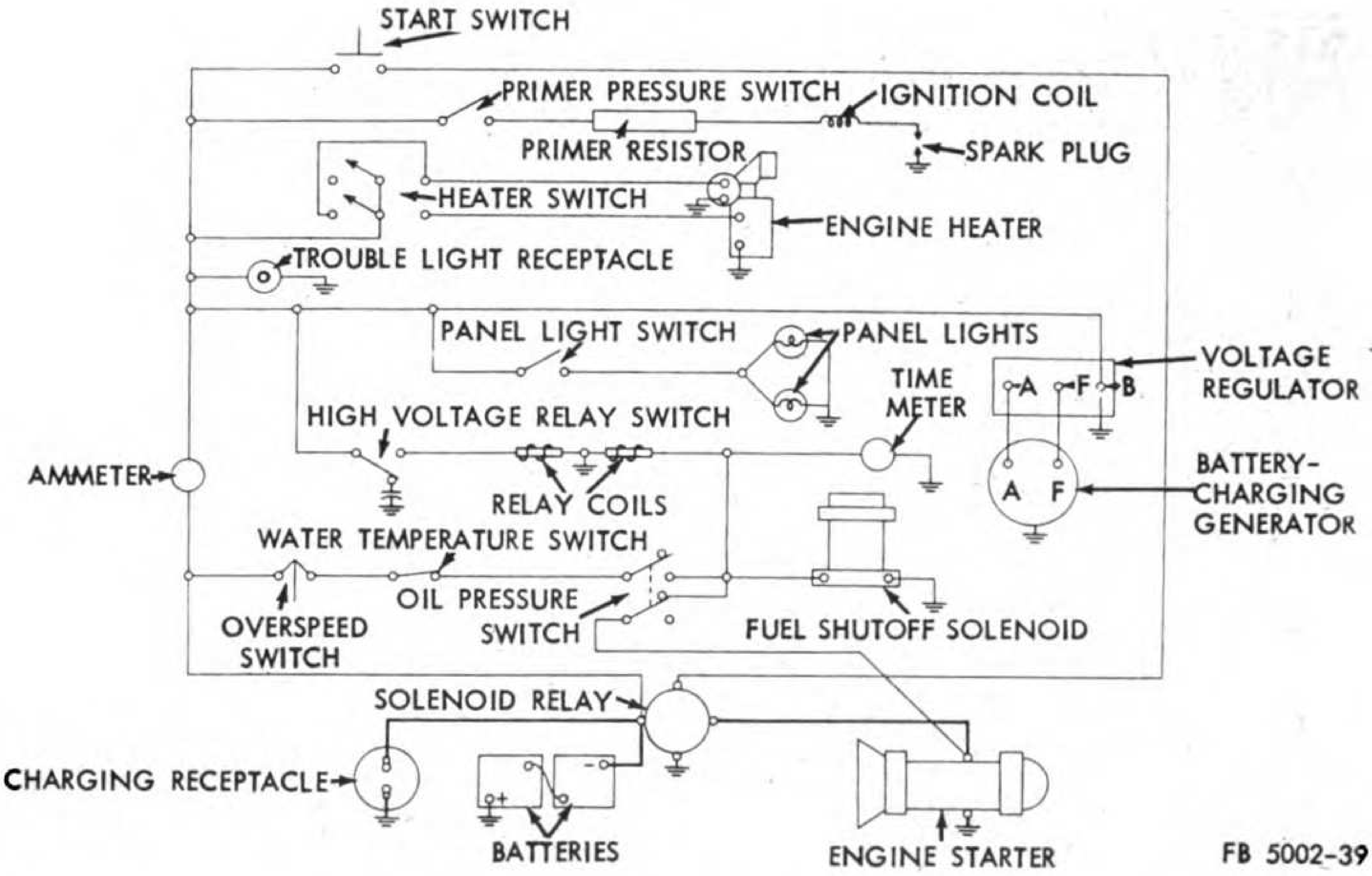


Figure 39. Engine electrical system.

94. Wiring

a. Removal. Each wire is numbered at its terminal ends to correspond with those indicated on the wiring diagram (9, fig. 3).

Caution: When removing or installing wiring, follow the wiring diagram carefully. Mark or tag wires and terminals not marked or whose markings have become unreadable.

Use open-end or adjustable wrenches to remove hex-head nuts. Assemble the washers and nuts on the terminal studs after removing the wires to insure against loss.

b. Inspection. See that insulation is not frayed, cracked, or oil-soaked. Check particularly where the wires pass through holes in the frame and baffles or over rough edges. In cold weather, wiring can be damaged by excessive bending.

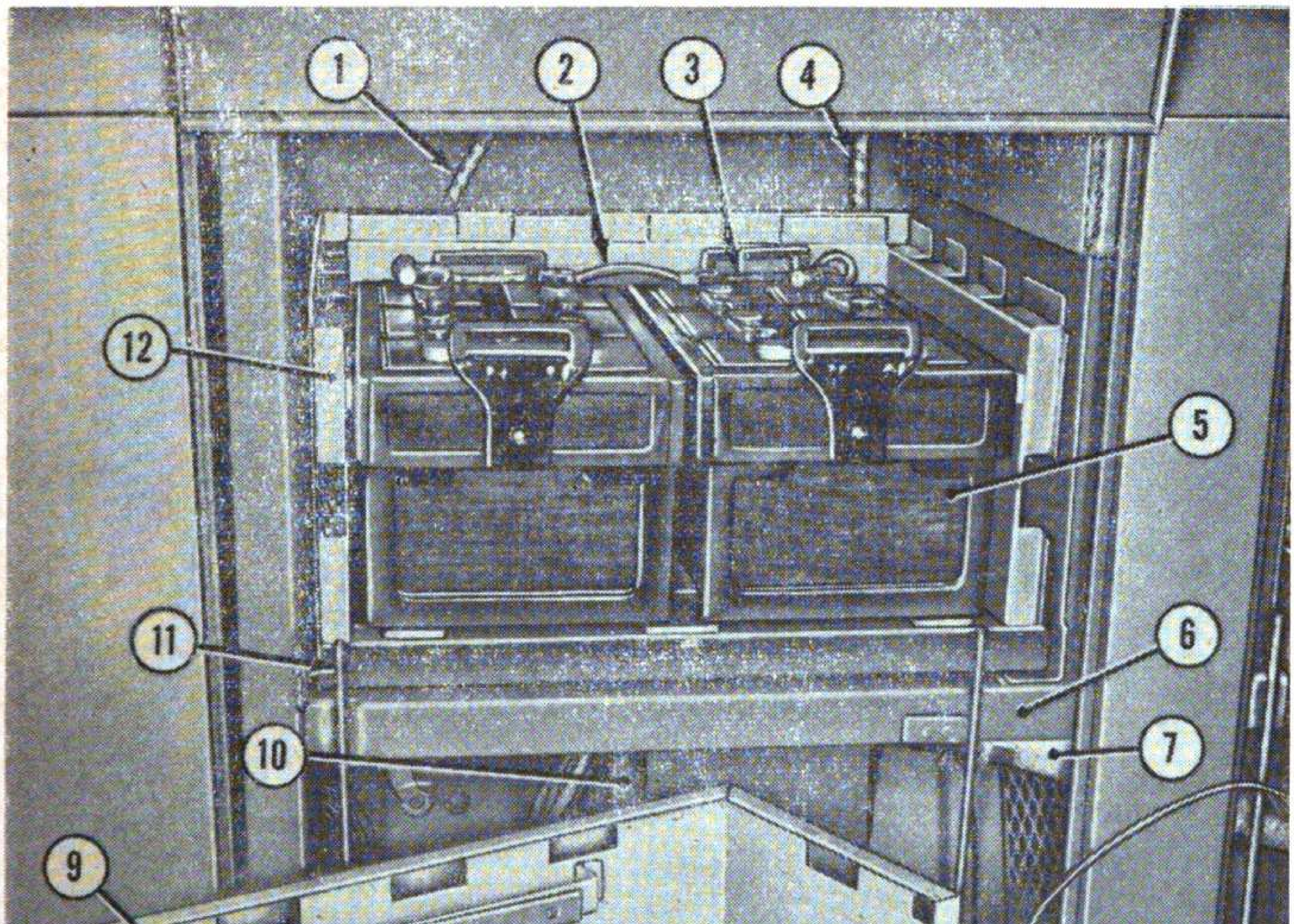
c. Replacement. Replace defective wiring. Protect the wiring by installing grommets or conduit where wires pass through baffles or over rough edges. Clean paint, dirt, and grease from terminals and ground contacts. External-internal teeth lockwashers and shielded wires are part of the radio suppression system and must be grounded firmly.

95. Batteries and Battery Box

a. Description. Two 12-volt batteries (5, fig. 40) are contained in the battery box (12) which is seated on the frame assembly (6) above the a-c generator (10). The box cover (9) can be removed after unlatching it from the box. The batteries are connected in series by a jumper lead (2) and are grounded by a lead (1). The batteries are connected to the battery-charging receptacle (4, fig. 1) by leads (3 and 4, fig. 40). These leads are joined at the solenoid relay (19, fig. 4). When the engine heater is operated, hot exhaust gases are conducted to the box through the hose (7, fig. 40). The thermocouple (8) actuates the battery overheat control (15, fig. 15) to stop the flow of gases when the temperature within the box reaches 120° F.

b. Batteries.

(1) *Service and testing.* The batteries should be kept fully charged at all times.



1	Battery-to-ground lead	7	Heater-to-battery box hose
2	Battery jumper lead	8	Thermocouple
3	Battery-to-solenoid relay lead	9	Box cover
4	Receptacle-to-solenoid relay lead	10	A-c generator
5	12-volt battery	11	Door latch bar
6	Frame assembly	12	Battery box

Figure 40. Battery installation.

(*a*) Check the electrolyte level in each cell weekly. Add enough distilled or clean water to hold the level one-half inch above the plates.

(*b*) Keep terminals tight and clean. A thin coating of grease at the terminals will prevent sulfate corrosion.

(*c*) If any electrolyte has been spilled or if the batteries are dirty, wash with ammonia, washing soda, or baking soda solution and dry carefully.

(*d*) Using a hydrometer, check the specific gravity of the electrolyte in each cell weekly. A reading of 1.270 to 1.285 indicates fully-charged batteries; 1.200 to 1.215, half charged; and 1.125 to 1.140, discharged. Do not take hydrometer readings just after adding water.

(*e*) If the battery charge is below 1.260 under normal conditions, 1.270 in extreme cold (par. 23), or 1.220 in extreme heat (par. 24), it is advisable to charge the battery. During normal operations of the generator set the batteries will be charged by the battery-charging generator. If the unit is to be shut down for a long period or if one battery has a lower charge than the other, remove them from the unit for recharging. A battery with a cell that will not take or hold a charge must be replaced.

(2) *Removal* (fig. 40).

(*a*) Withdraw the thermocouple (8) from the battery box cover (9).

(*b*) Release the latch holding the cover to the battery box (12) and remove the cover.

(*c*) Observe the polarity of the battery connections and disconnect the leads (1, 2, and 3) at the battery terminals.

(*d*) Lift out the batteries (5).

(3) *Installation* (fig. 40).

(*a*) Place the batteries (5) in the box (12) and connect the leads (1, 2, and 3) according to notation made when removing.

(*b*) Place the battery box cover (9) over the box and latch together.

(*c*) Insert the thermocouple (8) through the opening in the cover.

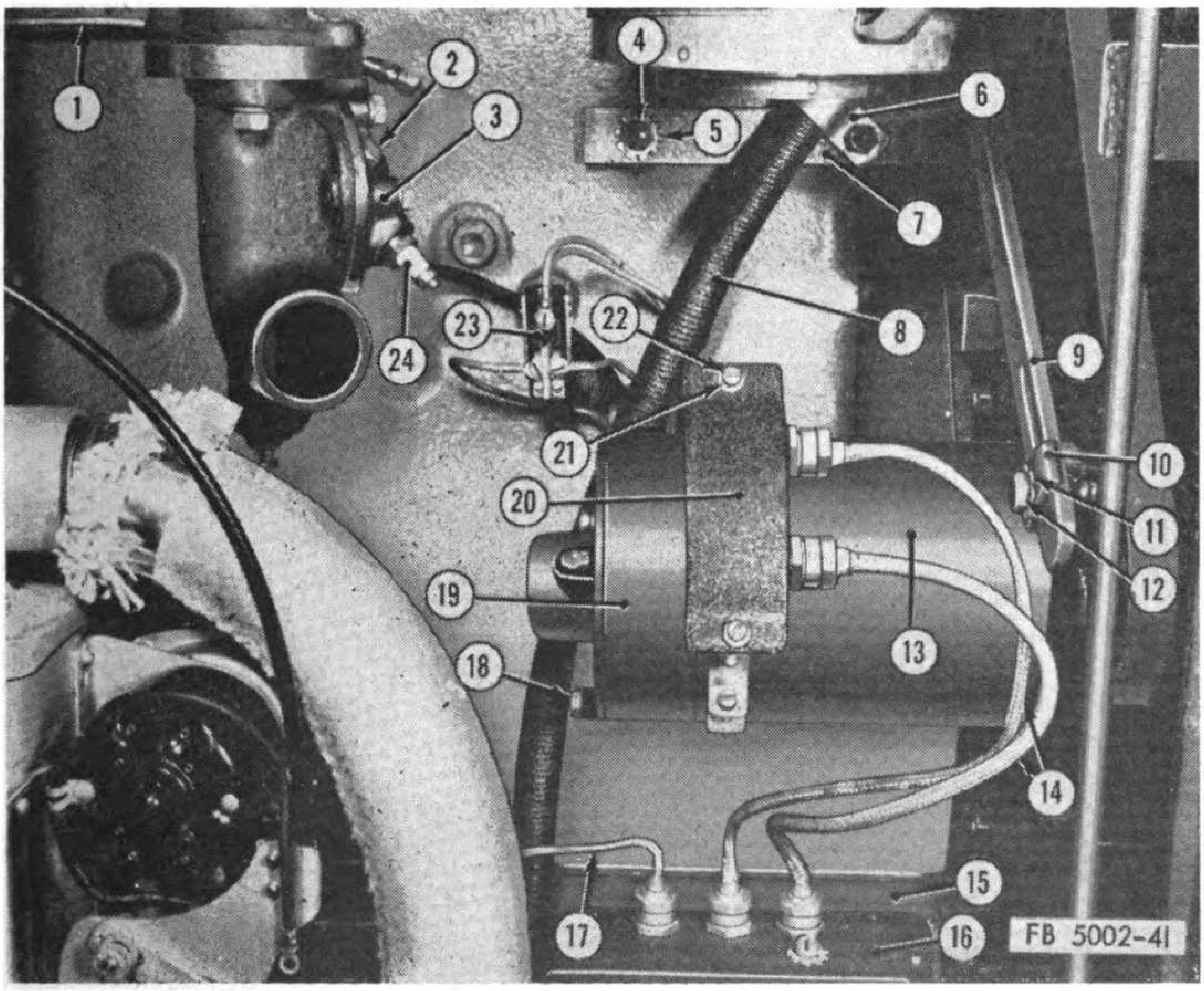
c. Battery Box (fig. 40).

(1) *Removal.* To remove the battery box (12), remove the batteries (*b* above) and disconnect the heater hose (7). Remove the cap screws and lockwashers securing the box to the frame assembly (6) and lift out the box.

(2) *Installation.* Place the battery box (12) on the frame assembly (6) and secure with the cap screws and lockwashers. Connect the heater hose (7) to the box and install the batteries (*b* above).

96. Battery-Charging Generator

a. Description. The generator (13, fig. 41) is belt-driven to generate current for battery recharge and to supply power for



1	Flame heater fuel line	13	Battery-charging generator
2	Ground electrode	14	Generator lead wire harness
3	Flame heater assembly	15	Voltage regulator bracket
4	Hex nut (2 req'd)	16	Radio suppression box
5	Lockwasher (2 req'd)	17	Battery lead
6	Conduit clip	18	Mounting screw (2 req'd)
7	Adjusting strap bracket	19	Cover band
8	Wire conduit	20	Terminal housing cover
9	Adjusting strap	21	Lockwasher (2 req'd)
10	Adjusting strap clip	22	Screw (2 req'd)
11	Lockwasher (1 req'd)	23	Oil pressure switch
12	Adjusting screw (1 req'd)	24	Flame heater spark plug

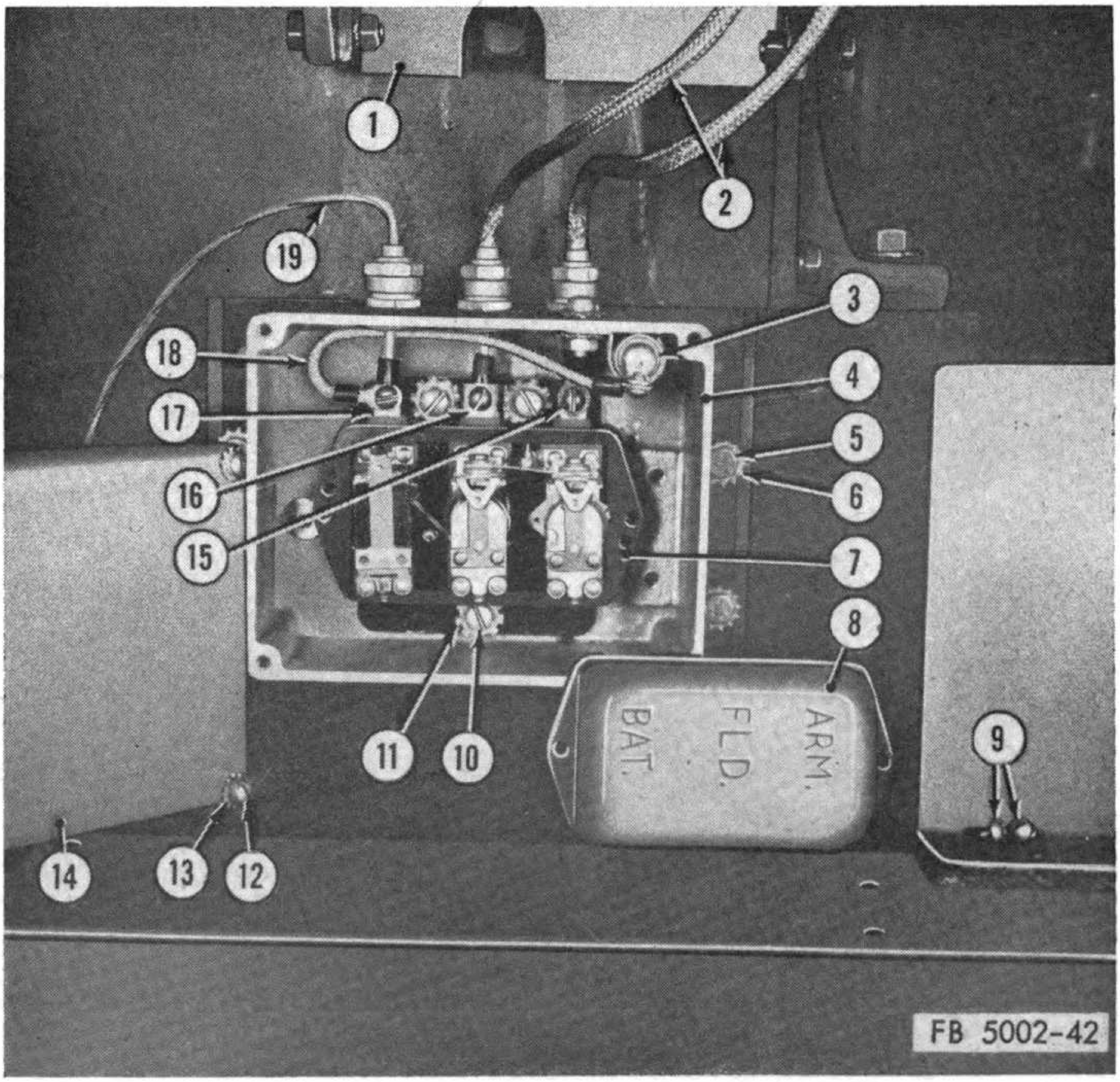
Figure 41. Battery-charging generator.

the 24-volt electrical system. A voltage regulator limits the generator output to set values. The generator is attached to the block by a strap (9), bracket (7), and a mounting bracket (1, fig. 42).

b. Inspection and Service.

(1) Remove the cover band (19, fig. 41) to expose the commutator end of the generator (13). Inspect the commutator and brushes weekly.

Caution: Do not use emery cloth to clean a commutator or to seat brushes. The abrasive material will cause short circuits and seriously damage the electrical equipment.



1 Generator mounting bracket
2 Generator lead wire harness
3 Capacitor
4 Radio suppression box
5 Mounting bolt (4 req'd)
6 Lockwasher (4 req'd)
7 Voltage regulator
8 Voltage regulator cover
9 Screw (2 req'd)
10 Mounting screw (3 req'd)
11 Lockwasher (3 req'd)
12 Screw (4 req'd)
13 Lockwasher (4 req'd)
14 Suppression box cover
15 Armature terminal
16 Field terminal
17 Battery terminal
18 Ground lead
19 Battery lead

Figure 42. Charging voltage regulator.

(2) The commutator should have a polished surface. If it is dirty, run a strip of No. 00 sandpaper under the brushes and hold against the commutator while turning the engine over a few times. Blow the sand out of the generator with compressed air.

(3) If there are high ridges of mica between the commutator segments or worn spots on the commutator, the mica must be undercut and the commutator must be turned on a lathe. Remove the generator and replace with a serviceable unit.

(4) See that the brushes move freely in their holders. Replace oil-soaked brushes and those that are worn to half their original length.

(5) To replace the brushes, disconnect the brush lead from the holder and remove. Install a new brush and connect the lead.

(6) New brushes must be seated on the commutator. With the brush in place, insert a strip of sandpaper between the brushes and commutator with the abrasive side contacting the brushes. Pull the strip back and forth until the brushes conform to the commutator surface. Use No. 00 paper. Blow out all sand and carbon dust. If available, a brush-seating stone may be used to seat brushes instead of sandpaper. This is an abrasive stick which is held against the revolving commutator. As the stick wears, particles of the abrasive are carried under the brushes which quickly seat them.

c. Testing. Defects in the generator or regulator are indicated on the ammeter by a continuous high charging rate when the batteries are fully charged or by a low or no charging rate when the batteries are low.

(1) When a high charging rate is indicated, operate the generator at half throttle and disconnect the field lead at the regulator field terminal (16, fig. 42). If the output remains high, the armature wire and field wire are shorted in the wiring harness between the generator and the regulator. If the output drops off, the trouble is in the regulator and it should be replaced.

(2) When a low or no charging rate is indicated, check for loose connections, frayed and damaged wires, or a defective battery. If none of these conditions exist, operate the generator at one-third speed and momentarily ground the field terminal of the regulator by connecting it to the armature terminal (15). An increase in the output

indicates a defect in the regulator. No increase indicates the generator is at fault. Replace the defective unit.

(3) When there is no generator output, with or without a jumper wire on the terminals, remove the terminal housing cover (20, fig. 41) and short the armature terminal to the generator frame. If a spark is seen when the ground contact is first made, the circuit breaker in the voltage regulator is not working properly. If no spark is seen, the generator is defective. Remove and replace the defective unit.

d. Removal.

(1) Remove the screws (22, fig. 41), lockwashers (21), and terminal housing cover (20).

(2) Disconnect the leads and the harness (14) from the generator terminals and housing.

(3) Remove the adjusting screw (12), lockwashers (11), and adjusting strap clip (10) to free the generator (13) from the adjusting strap (9) and fan belt.

(4) Remove the lower pair of mounting screws (18) with nuts and lockwashers to free the generator from the mounting bracket (1, fig. 42).

(5) The adjusting strap (9, fig. 41) is hinged to the bracket (7) by a screw. Remove the screw and lockwasher to free the adjusting strap.

(6) The adjusting strap bracket (7) is mounted on studs and secured to the engine block by two nuts (4) and lockwashers (5). To remove the bracket, it is first necessary to detach the oilcup from the air cleaner (par. 111). Then unscrew the nuts (4) and lockwashers (5) to free the bracket and clip (6) from the studs.

(7) The generator bracket (1, fig. 42) is mounted on two studs and held to the engine block by nuts and lockwashers. Remove the nuts and lockwashers to free the bracket.

e. Installation.

(1) Position the generator mounting bracket (1, fig. 42) on the studs on the engine block. Secure with the lockwashers and nuts.

(2) Position the adjusting strap bracket (7, fig. 41) on the studs and install the lockwashers (5), nuts (4), and conduit clip (6). Attach the oilcup to the air cleaner (par. 111).

(3) Attach the adjusting strap (9) to the front end of the adjusting strap bracket with the bolt and lockwasher.

(4) Secure the generator (13) to its mounting bracket with the screws (18), nuts, and lockwashers. The shorter of the two screws is for the front hinge. Do not tighten the screws until the belt tension is adjusted.

(5) Slip the fan belt over the drive end of the generator and connect the generator to the adjusting strap with the screw (12), lockwasher (11), and clip (10). Adjust the belt tension (par. 91*g*) and tighten the adjusting screws.

(6) Insert the generator leads through the openings in the terminal housing and connect the generator lead wire harness (14).

(7) Connect the generator field and armature leads to the correct terminals in the terminal housing. Place the terminal housing cover (20) on the terminal housing and secure with the lockwashers (21) and screws (22).

Caution: After a generator has been installed or when the leads to it have been disconnected and reconnected, the generator must be in correct polarity with the battery before starting the engine. Severe damage to the electrical equipment may result from reversed generator polarity which causes the relay contact points in the regulator to vibrate, arc, and burn.

(8) Before starting the engine, connect a jumper momentarily between the armature terminal (15, fig. 42) and battery terminal (17) of the regulator. This allows a surge of current to flow from the battery which correctly polarizes the generator.

97. Battery-Charging Voltage Regulator

a. Description. The voltage regulator (7, fig. 42) automatically controls the output of the charging generator to keep the batteries fully charged. It closes the circuit between the batteries and the generator when the generator voltage is above that of the batteries, and opens the circuit when the condition is reversed. The regulator is housed in a suppression box (4) which is attached to the block by the bracket (15, fig. 41).

b. Testing. See paragraph 96*c*.

c. Removal.

(1) Remove four screws (12, fig. 42) and lockwashers (13) and pull the cover (14) from the suppression box (4).

(2) Disconnect the generator leads at the terminals (15 and 16). Disconnect the battery lead (19) and ground lead (18) at the battery terminal (17).

(3) Remove the wire harness (2) at the suppression box and withdraw the leads.

(4) Remove the mounting screws (10), lockwashers (11), and the voltage regulator (7). If necessary, remove the voltage regulator cover (8) by removing the screws (9).

(5) To remove the radio suppression box, remove the bolts (5), nuts, and lockwashers (6).

(6) To remove the bracket (15, fig. 41), remove the cap screws and lockwashers.

d. Installation.

(1) Secure the bracket (15, fig. 41) with the cap screws and lockwashers.

(2) Position the radio suppression box (4, fig. 42) against the bracket and install the bolts (5), lockwashers (6), and nuts. Tighten the nuts securely.

(3) Aline the mounting screw holes in the voltage regulator (7) with those in the suppression box and install three screws (10) with lockwashers (11).

(4) Insert the generator and battery leads through the openings in the suppression box and connect the harness (2) to the suppression box.

(5) Connect the battery lead (19) and ground lead (18) to the battery terminal (17). Connect the generator armature lead to the terminal (15), and the generator field lead to the terminal (16).

(6) If the voltage regulator cover (8) was removed, attach it to the regulator using the screws (9). Place the end labeled BAT to the rear.

(7) Place the cover (14) on the suppression box and secure with the lockwashers (13) and screws (12).

(8) Correct the generator polarity (par. 96*e*(8)).

98. Electrical Engine Starter

a. Description.

(1) The engine starter is secured to the lefthand side of the block. This unit is a d-c motor used to crank the engine for starting. It draws power from the batteries through the lead and the solenoid relay (par. 99). The start switch actuates the solenoid relay which closes the circuit between the battery and starter. The starter arma-

ture rotates, actuating a clutch-type bendix drive mechanism. The drive pinion engages the flywheel ring gear which cranks the engine. After the engine has started, the drive pinion is disengaged from the ring gear.

(2) The starter uses eight brushes for commutation. These are seated in brush holders located under the cover band. The brushes are crimped to their electrical leads and are soldered. They are held against the commutator by springs whose bearing pressure can be adjusted.

b. On-Engine Inspection and Servicing. The engine starter normally will last through the life of the engine with no attention except for lubrication; however, the use of higher than rated voltage, dirt, dust, water, and frequent starting will shorten its life. Do not remove the starter unless troubleshooting operations definitely indicate the starter is at fault.

(1) *Commutator.* Remove the cover band by withdrawing the screw and nut. Inspect the commutator as outlined in paragraph 96*b*(2) and (3).

(2) *Brushes* (fig. 43). The starter is provided with four brush holders (2) which contain two brushes (3) each. One brush in each holder is connected by an additional lead which is an equalizer connection. If inspection shows that the brushes need replacement proceed as follows:

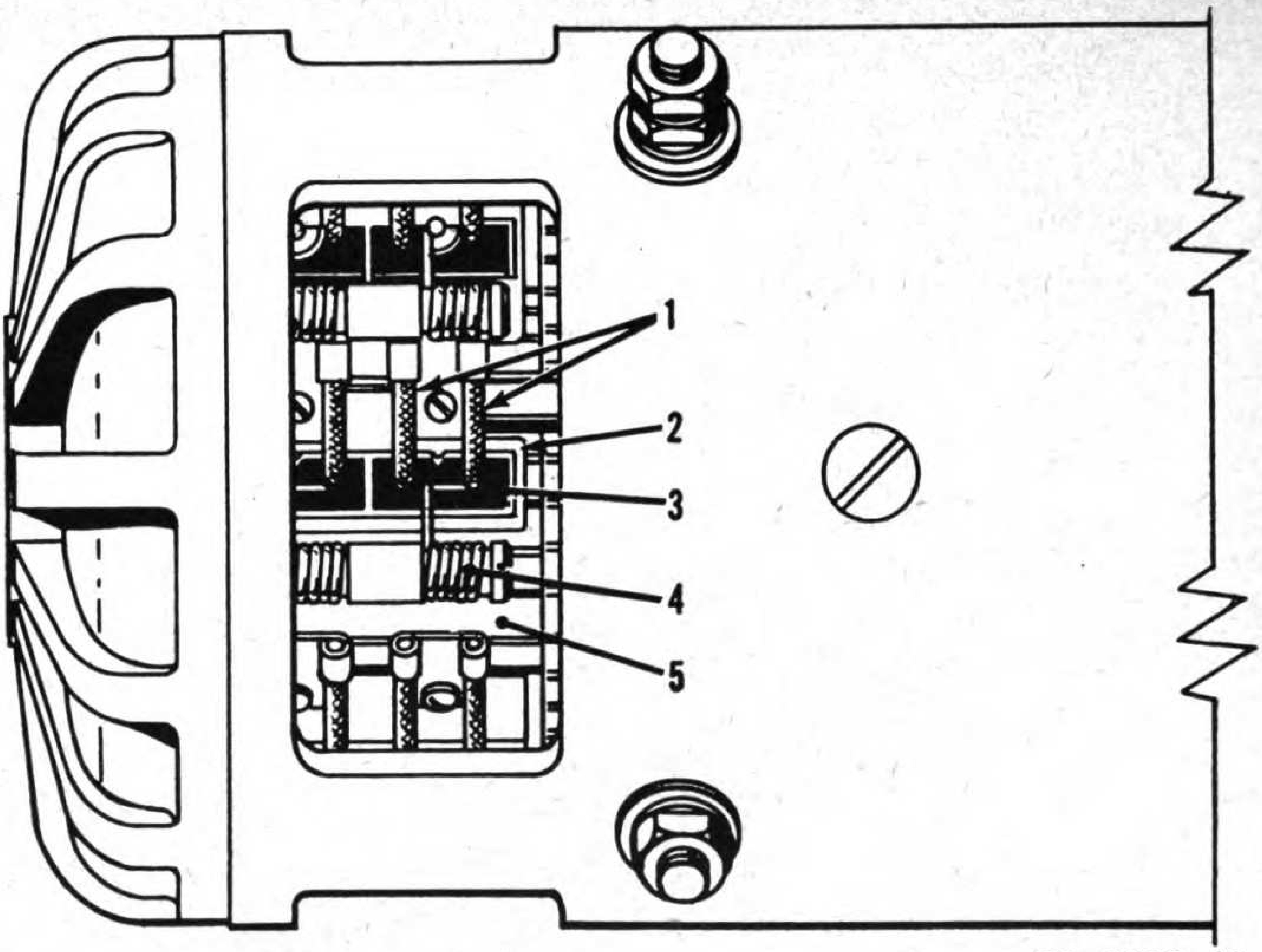
(*a*) Lift the brush springs (4) and withdraw the brushes (3) from the brush holders (2). Mark the brush holders and leads (1) to insure installing the correct leads with the brushes attached in the original brush holders.

(*b*) Break the soldered connections and unclinch the brush leads (1). Remove the worn brushes (3).

(*c*) Insert the brush leads (1) to their full depth in the connectors. One brush of each holder (2) is connected by means of two leads. Clinch the leads tightly and solder to make a low resistance connection.

(*d*) Refer to the markings made at removal and lift the brush springs (4) and install the brushes with the correct leads attached in their respective brush holders (2). Release the springs.

(*e*) Insert a strip of sandpaper, with the abrasive side up, between the brushes (3) and commutator (5). Pull the strip back and forth until the brushes conform to the commutator surface. Use No. 00 sandpaper. Blow out all sand and carbon dust.



1 Brush leads. 2 Brush holder. 3 Brush. 4 Spring. 5 Commutator.

Figure 43. Starter, commutator end.

c. Testing. Disconnect the lead at the field terminal and connect a fully charged battery to the field terminal and ground terminal. The positive lead should be connected to the ground terminal. If the motor does not rotate, the trouble is in the field or armature circuit. Under these conditions, the starter must be replaced. If the motor armature rotates but does not crank the engine, the bendix drive is defective. Remove the starter and replace the drive mechanism.

d. Removal.

(1) Disconnect the auxiliary fuel bracket lines (12 and 13, fig. 22) at the three-way valve (32) and at the auxiliary fuel bracket (15). Remove the lines.

(2) Disconnect the relay-to-starter lead at the field terminal by removing the hex nut and its lockwasher. Withdraw the relay-to-starter lead, starter-to-pressure switch lead and plain washer from the field terminal.

(3) Remove the mounting bolts and lockwashers.

(4) Pull the starter from the block.

e. Installation.

(1) Position the starter in the block.

(2) Secure with the bolts and lockwashers.

(3) Install the plain washer, starter-to-pressure switch lead and relay-to-starter lead on the field terminal. Secure with the lockwasher and hex nut.

(4) Connect the auxiliary fuel bracket lines (12 and 13, fig. 22) to the three-way valves (32) and auxiliary fuel bracket (15).

f. Starter Drive (fig. 44).

(1) *Removal.*

(*a*) Remove the starter (*d* above).

(*b*) Before removing the drive, mark the frame (1) and pinion housing (8) so they can be reassembled in their original position.

(*c*) Remove the cap screws (10) and lockwashers (11).

(*d*) Pull the pinion housing (8) from the drive (7).

(*e*) Pull the drive from the splined armature shaft (2).

(2) *Inspection.* Check for cracked or broken teeth on the drive pinion gear. Check the splines on the shaft (2) and those within the drive (7) for burs and cracks. Small burs can be removed by using a fine oil stone. If any part of the drive is defective, replace the drive as a unit. Replace the starter as a unit if the armature shaft splines are defective.

(3) *Installation.*

(*a*) Engage the splines of the drive (7) with those of the shaft (2).

(*b*) Install the pinion housing (8) over the drive so that the drive shaft enters the bearing (9). Rotate the bearing plate (6) so that the notch in the outer rim alines with the dowel pin (12).

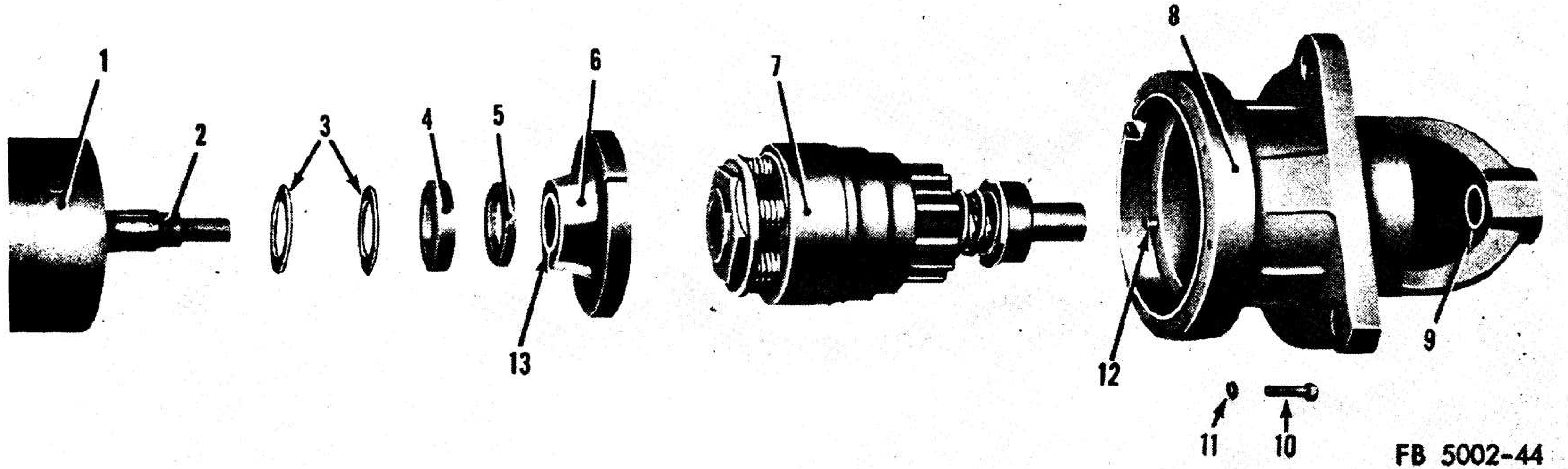
(*c*) Aline the marks on the frame (1) and pinion housing (8) and secure with the cap screws (10) and lockwashers (11).

(*d*) Install the starter (*e* above).

g. Bearing Plate (fig. 44).

(1) *Removal.* Remove the starter drive (*f* above) and remove the bearing plate (6), felt washer (5), felt retainer (4), and thrust washers (3) from the armature shaft (2).

(2) *Inspection.* If the bearing (13) is worn, scored, or scratched, replace the bearing plate assembly (4, 5, 6, and 13).



1 Frame
2 Armature shaft
3 Thrust washer
4 Felt retainer
5 Felt washer
6 Bearing plate
7 Drive
8 Pinion housing assembly
9 Bearing, plain
10 Screw, cap, hex-hd, No. 10 x ⅞ in. NF (8 req'd)
11 Washer, lock, No. 10 (8 req'd)
12 **Dowel pin**
13 **Bearing, bronze**

Figure 44. Starter drive, exploded view.

(3) *Installation.* Saturate the felt washer (5) with light engine oil and lubricate the armature shaft (2). Position the felt washer (5) and retainer (4) on the bearing plate (6). Slip the thrust washers (3) and the assembled bearing plate on the armature shaft (2). Install the starter drive (*f* above).

99. Solenoid Relay
(fig. 45)

a. Description. The solenoid relay (7) closes the starting circuit when the start switch is depressed. Its only purpose is to make and break the starting circuit. The relay requires no periodic maintenance other than an inspection to see that it is mounted securely and all connections are tight.

b. Testing. When the engine starter fails to operate and the solenoid relay is thought to be defective, connect a jumper from the battery lead terminal (10) to the relay terminal of the lead (4). This cuts out the start switch. If the starter does not turn over, disconnect the battery-to-relay lead (2) at the relay and hold it firmly against the starter lead terminal (8). If the engine starter is energized, a defective solenoid relay is indicated and replacement is necessary.

Caution: Do not use a small wire as a jumper across the battery lead terminal (10) or the starter lead terminal (8). Overheating and burning of the wire will result.

c. Removal.

(1) Disconnect the leads (1, 2, 3, 4, and 9) at the solenoid relay (7).

(2) Remove the bolts (11) with nuts and lockwashers holding the solenoid relay to its bracket (12).

d. Installation.

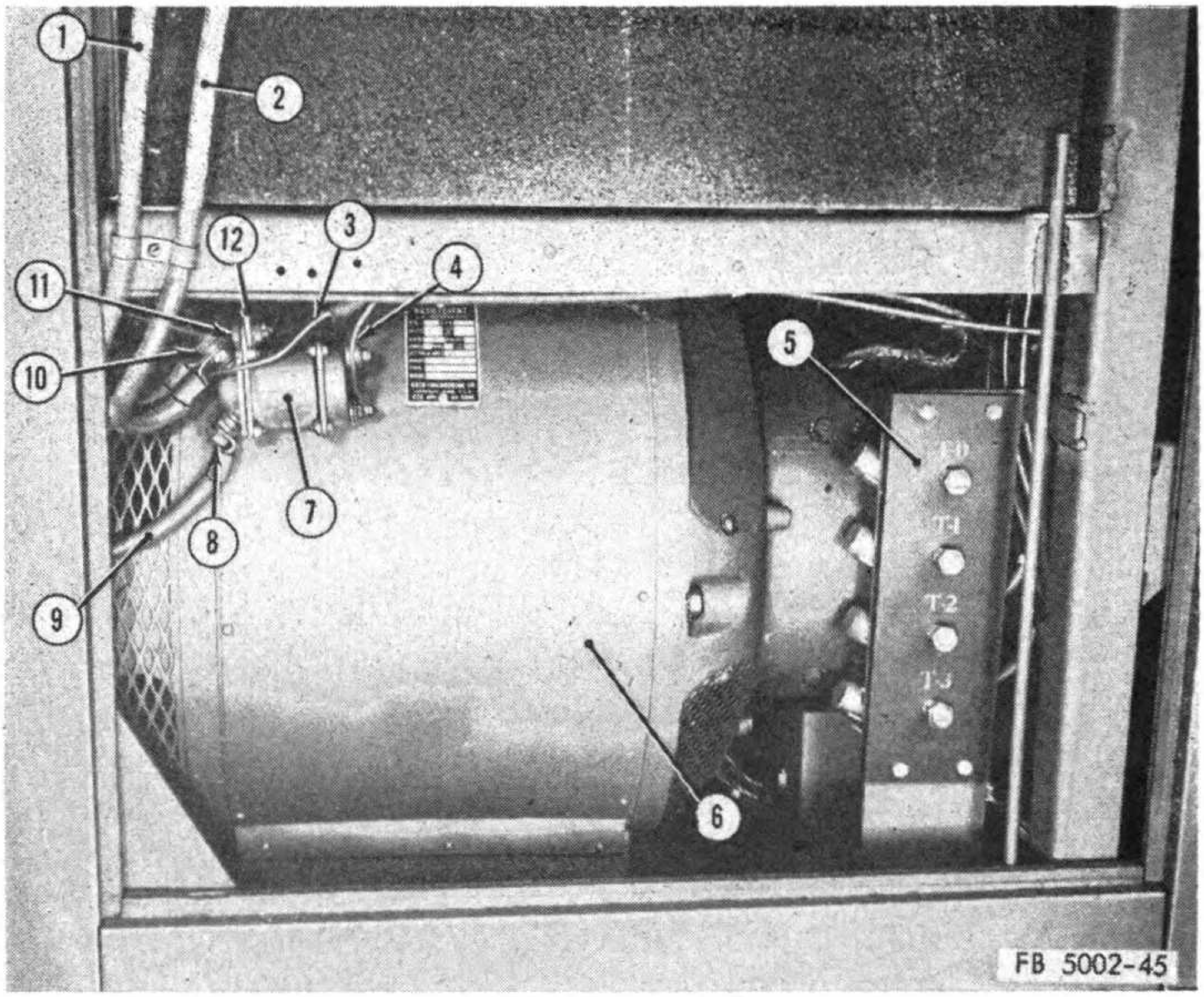
(1) Secure the solenoid relay (7) to its bracket (12).

(2) Connect the leads (1, 2, and 3) to the battery lead terminal (10).

(3) Connect the lead (9) to the starter lead terminal (8) and the lead (4) to the relay terminal.

100. Battery-Charging Receptacle

a. Description. The charging receptacle (4, fig. 1) is located in the top housing (8) close to the lifting eyebolt (5). It is used to charge the batteries when they are low without removing them from the unit or to supply power from an outside source to start the engine.



1	Receptacle-to-relay lead	7	Solenoid relay
2	Battery-to-relay lead	8	Starter lead terminal
3	Relay-to-start switch lead	9	Relay-to-starter lead
4	Start switch-to-relay lead	10	Battery lead terminal
5	Load terminal block	11	Bolt w/nut and lockwasher (2 req'd)
6	A-c generator	12	Relay bracket

Figure 45. Starter solenoid relay.

b. Removal.

(1) Remove the screws, nuts, and lockwashers attaching the receptacle (4, fig. 1) to the top housing (8).

(2) Disconnect the lead at the ground (7, fig. 4) and the lead (1, fig. 45) at the relay (7).

(3) Disconnect the leads from the receptacle.

c. Installation.

(1) Connect the lead (1, fig. 45) and the ground lead to the receptacle (4, fig. 1).

(2) Connect the leads to the ground (7, fig. 4) and the relay (7, fig. 45).

(3) Install the receptacle in the top housing (8, fig. 1) and secure with the screws, lockwashers, and nuts.

Section X. LUBRICATION SYSTEM

101. Description

a. Engine (fig. 46).

(1) The engine lubrication system is supplied by a positive displacement, gear-type pump (10) driven by the crankshaft timing gear (12). Oil pumped from the oil pan is passed through a strainer screen (9). The system is full pressure from the pump through drilled passages in the cylinder block. Oil pressure is automatically regulated by an adjustable spring in the pump body so that a minimum of 30 psi is maintained at idling speeds and a maximum of between 45 and 55 psi at governed speeds. The oil capacity of the pump is several times greater than engine requirements. Excess oil is bypassed from the line and returned to the oil pan.

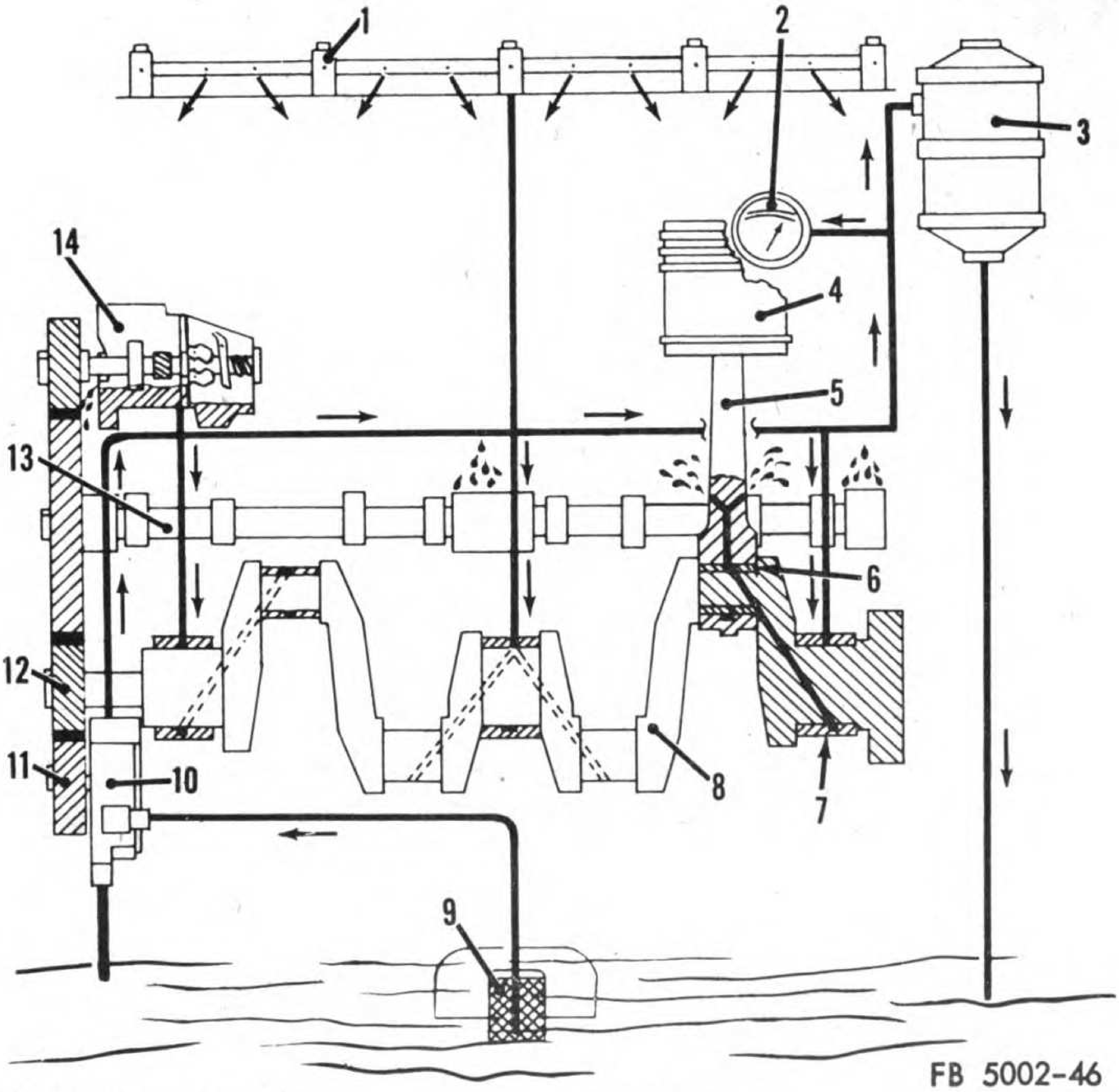
(2) After leaving the pump, oil flows through the passages to the main and connecting rod bearings (7 and 6). Another passage conducts oil to the rocker arm assembly (1). From there the overflow oil lubricates the tappets and center and rear bearings of the camshaft (13). The timing gears are lubricated by oil spray.

(3) To prevent scuffing of the pistons (4) and cylinder walls, particularly during the warmup period, and to provide proper lubrication to the piston pins, spurt holes are drilled in the large end of the connecting rods (5), directed toward the thrust side of the piston. These holes register with the passages in the crankshaft so that at properly timed intervals a controlled amount of oil is sprayed onto these parts.

(4) The fuel injector pump (14) is connected to the engine lubrication system by an external hose. The oil returns to the crankcase by draining through holes in the pump's mounting flange.

(5) Grit, sludge, and foreign particles are strained from the lube oil by a cartridge within the oil filter (3). Practically all the oil in the engine passes through the filter every half hour of engine operation. The oil pressure gage (2) is mounted on the control panel and indicates the pressure in the lubrication system.

b. Generator. The generator is equipped with bearings that are sealed for life and do not require periodic lubrication.



1 Rocker arm assembly
2 Oil pressure gage
3 Oil filter
4 Piston
5 Connecting rod
6 Connecting rod bearing
7 Main bearing
8 Crankshaft
9 Strainer screen assembly
10 Oil pump
11 Pump drive gear
12 Crankshaft timing gear
13 Camshaft
14 Fuel injector pump

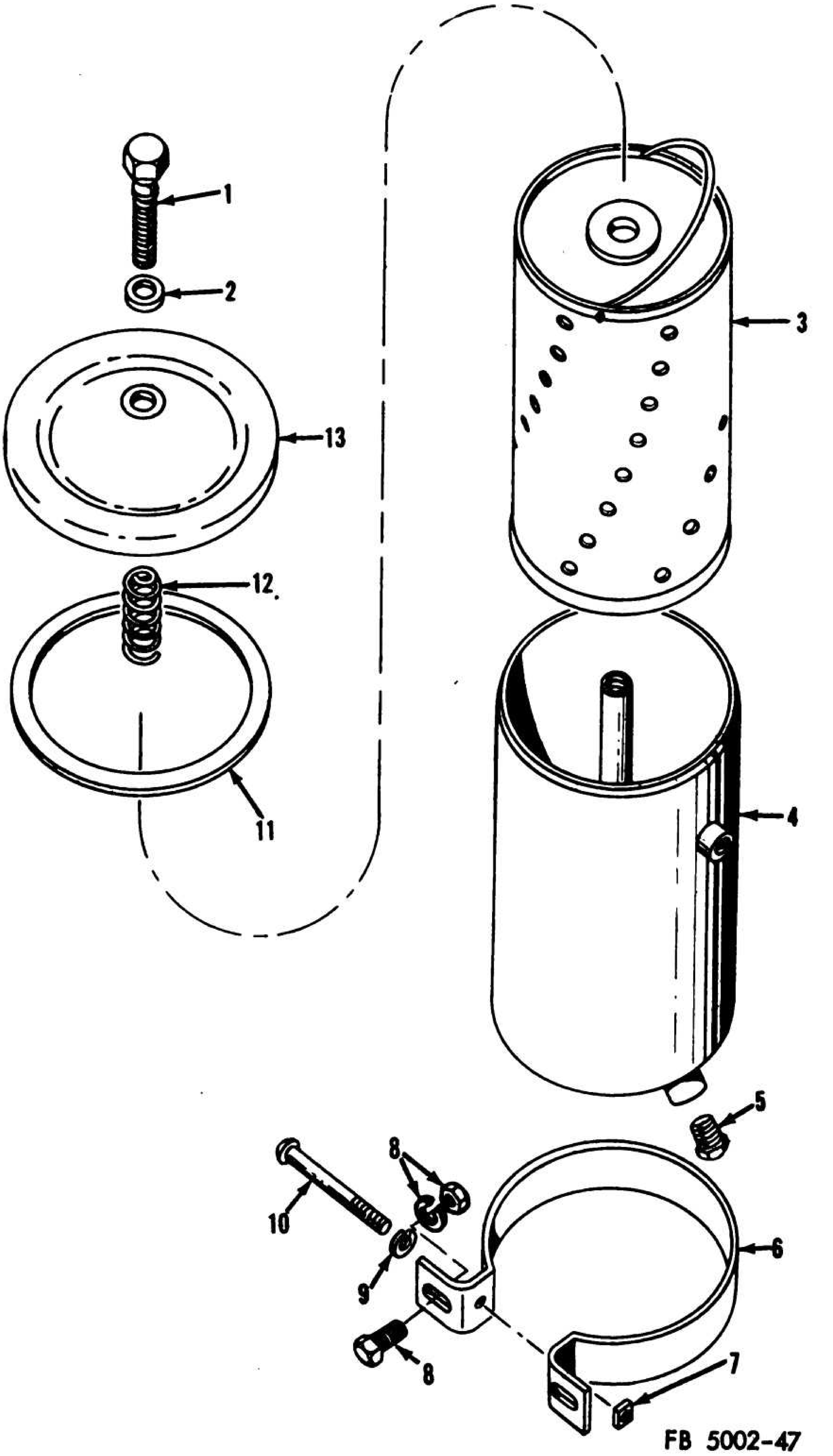
Figure 46. Engine lubrication system diagram.

102. Oil Filter Assembly

a. Description (fig. 22). The oil filter assembly (7) removes grit, sludge, and foreign particles from the circulated oil by means of a replaceable filter element. There is a plug in its base to enable periodic draining of accumulated residue. The assembly is clamped to the oil filter bracket (8) and is connected to the lubricating system by an external tube and hose. A small bleed-off tube, leading to the oil pressure gage, is connected to the filter inlet.

b. Service (fig. 47). Service intervals and operations are prescribed by LO 5–5002. To service the oil filter assembly, proceed as follows:

(1) Remove the plug (5) and allow the oil to drain from the filter assembly.



1	Cap screw	6	Strap	10	Bolt (2 req'd)
2	Cap screw gasket	7	Nut	11	Cover gasket
3	Filter element	8	Screw w/nut and lock-washer (4 req'd)	12	Cover spring
4	Filter body assembly	9	Lockwasher (2 req'd)	13	Cover
5	Drain plug				

Figure 47. Oil filter assembly, exploded view.

(2) Remove the cap screw (1), gasket (2), cover (13), gasket (11), and spring (12).

(3) Lift the filter element (3) from the filter body assembly (4). Discard the element.

(4) Clean the inner surface of the filter body assembly with solvent and a clean cloth or soft bristle brush. Do not use a scraper or a hard bristle brush. Flush out the solvent with clear water.

(5) Install a new filter element (3) in the body (4).

(6) Install the spring (12), gasket (11), and cover (13). Secure with the gasket (2) and cap screw (1).

(7) Screw the drain plug (5) into the bottom of the body assembly (4).

(8) Start the engine and allow the oil to fill the filter. Stop the engine and allow the oil to drain into the oil pan before checking the oil level with the gage rod. Add sufficient oil to bring the level up to the full mark on the rod.

c. Removal (fig. 22).

(1) Remove the plug at the bottom of the filter assembly (7) and drain the filter assembly.

(2) Disconnect the oil lines from the filter assembly (7).

(3) Loosen the two screws securing the straps (6) to the bracket (8) on the near side.

(4) Loosen the bolts clamping the filter assembly (7) in the straps (6) and remove the filter assembly from the straps.

(5) To remove the straps (6) and the bracket (8), remove the fuel tank (par. 80) and the bolts (9) with nuts and lockwashers. Remove the four screws with nuts and lockwashers securing the straps to the bracket.

d. Disassembly. To disassemble the filter, refer to *b*(2) and (3) above.

e. Reassembly. To reassemble the filter, refer to *b*(5) through (7) above.

f. Installation (fig. 22).

(1) Insert the four strap mounting screws from the rear of the filter bracket (8).

(2) Position the bracket on the frame and secure with the bolts (9), nuts, and lockwashers.

(3) Position the straps (6) on the mounting screws. Aline both straps and install the nuts and lockwashers. Tighten the pair nearest the engine only.

(4) Slip the filter assembly (7) into the straps (6) and tighten the clamping bolts when the correct position is established.

(5) Tighten the outer pair of screws securing the straps (6) to the bracket (8).

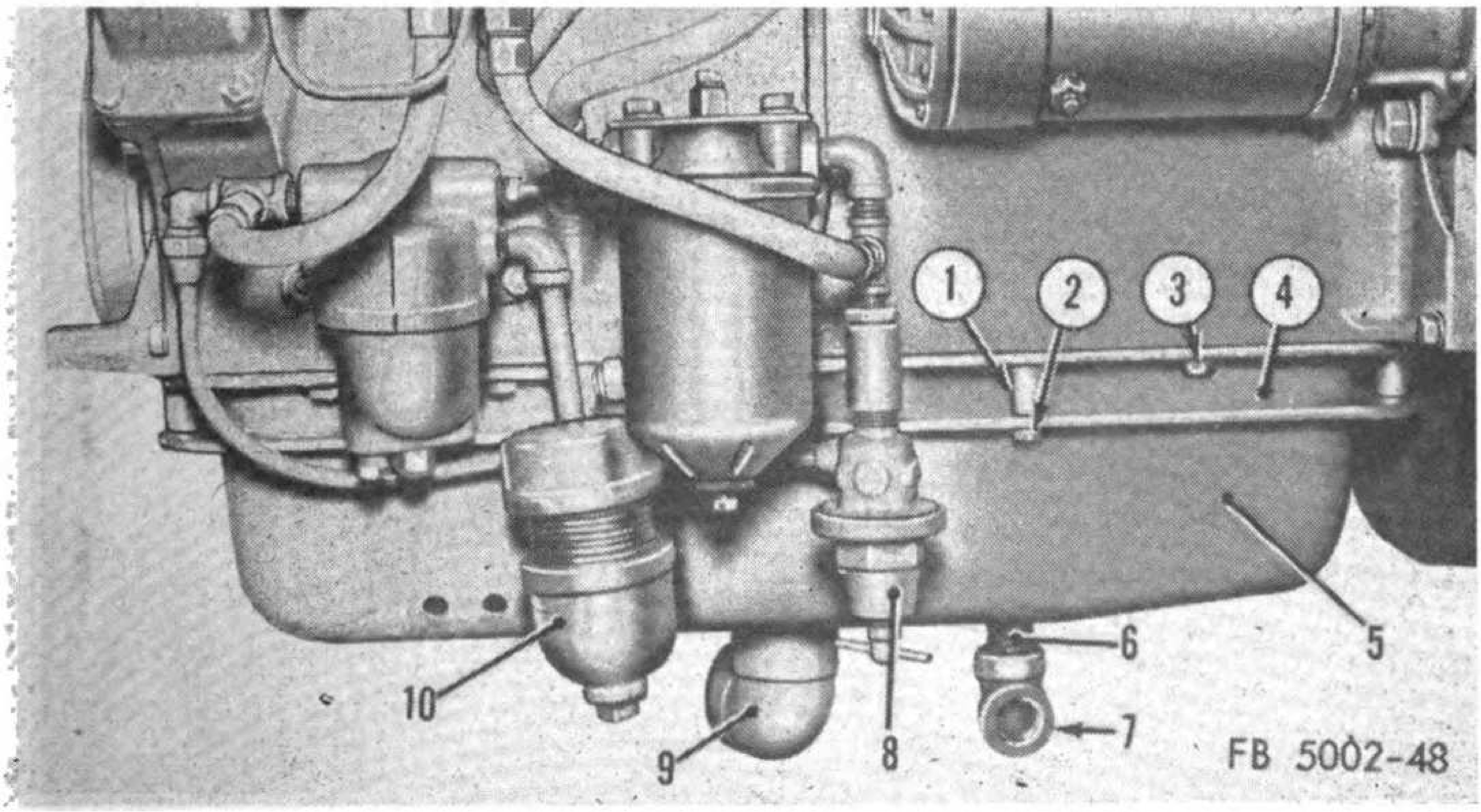
(6) Connect the oil lines to the filter assembly (7) and install the plug in the bottom.

(7) Install the fuel tank (par. 80).

(8) Start the engine and allow the oil to fill the filter. Stop the engine and allow the oil to drain into the oil pan before checking the oil level with the gage rod. Add sufficient oil to bring the level up to the full mark on the rod.

103. Oil Pan

a. Description. When filled, the oil pan acts as the oil reservoir for the lubrication system. An oil strainer screen (9, fig. 46) is used to screen the lubricant before it passes into the lubricating system. If this strainer is not cleaned regularly the oil will be shut off from the pump, stopping the flow of lubricant to the working parts of the engine. The oil pan is housed by the oil pan shroud (5, fig. 48) which is connected to the engine heater. During heater operation, warm air is forced into the space between the pan and shroud to preheat the lube oil before starting the engine.



1 Spacer
2 Screw, cap, hex-hd, ⅜ x 2 in. NC (8 req'd)
3 Cap screw (18 req'd)
4 Oil pan assembly
5 Oil pan shroud
6 Oil drain nipple
7 ¾ in. elbow
8 Relief valve
9 Elbow
10 Sediment bowl

Figure 48. Oil pan and shroud.

b. Service. The oil strainer screen assembly (9, fig. 46) should be removed and cleaned after every 250 hours of engine operation. A clogged screen will restrict oil flow and cause the pressure to drop below the minimum safety limit.

(1) *Screen removal.* Drop the oil pan shroud (*c* below) and remove the screen (*d* below).

(2) *Screen cleaning.* Clean the screen (9, fig. 46) with cleaning solvent or clean fuel oil. Do not use hard or sharp tools to clean the screen or damage may result.

(3) *Screen installation.* Install the screen in the oil pan (*f* below) and the shroud on the oil pan (*g* below).

c. Removal.

(1) Unscrew the cap from the oil drain line and allow the oil to flow into a container.

(2) Disconnect the heater-to-oil pan shroud hose (6, fig. 15) at the shroud elbow (9, fig. 48).

(3) Place the three-way valve (32, fig. 22) in the OFF position and disconnect the lines (12 and 13) at the auxiliary fuel bracket (15) and the three-way valve.

(4) Remove the housing skirt with the auxiliary fuel bracket (par. 73*b*).

(5) Remove the sediment bowl (par. 83).

(6) Remove the relief valve (par. 79*d*).

(7) Disassemble the drain line by unscrewing the nipple and elbow (7, fig. 48).

(8) Close the heater shutoff valves (8, fig. 33) and disconnect the heater inlet line (9) at the radiator.

(9) Remove the radio suppression box (par. 97).

(10) Unscrew the cap screws (2, fig. 48) holding the oil pan shroud (5) to the engine block, and withdraw the lockwashers and spacers (1).

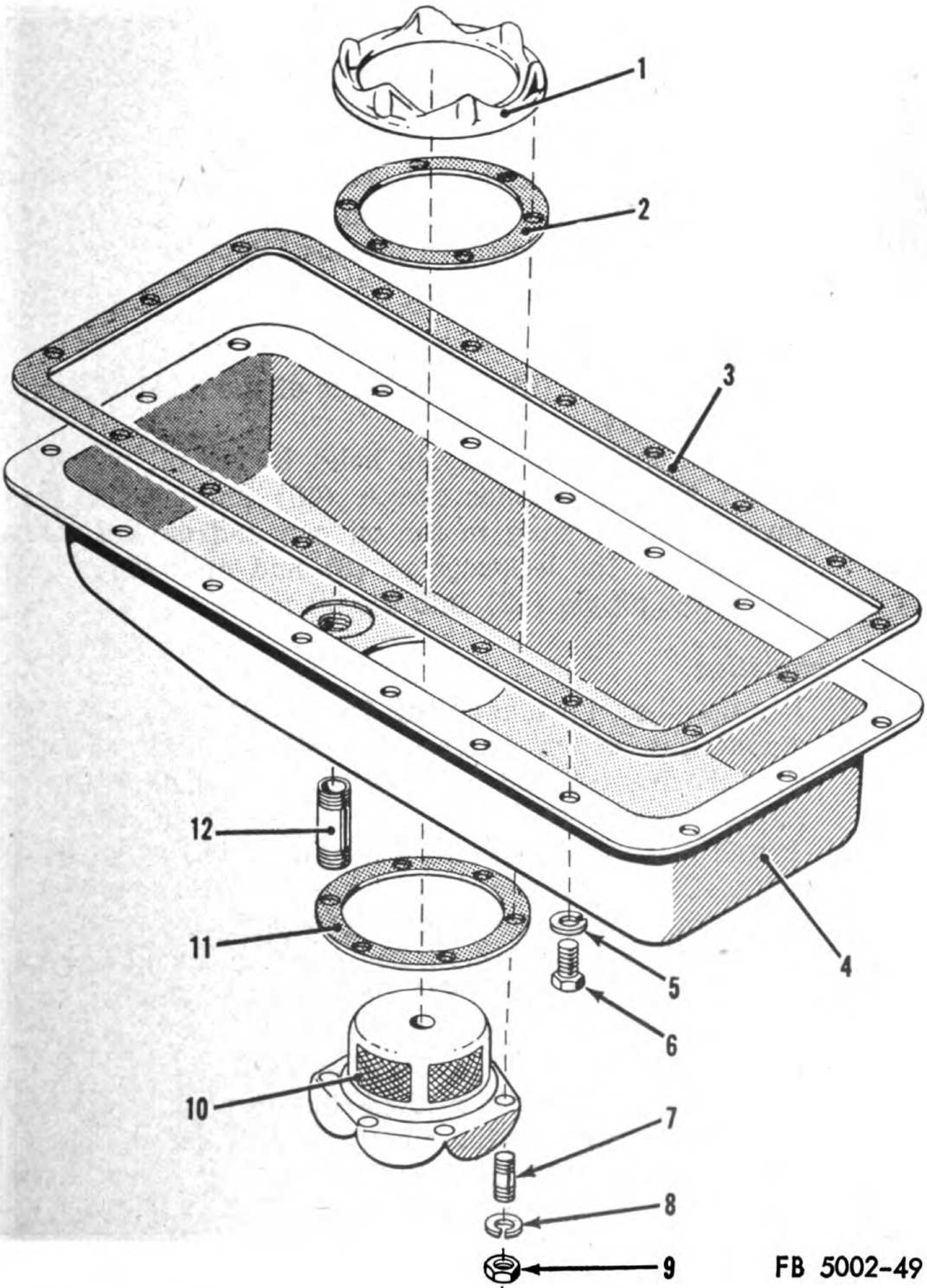
(11) Drop the oil pan shroud and remove from the generator set.

(12) Unscrew the screws (6, fig. 49) and remove the lockwashers (5), oil pan assembly (4), and gasket (3). The voltage regulator bracket (15, fig. 41) is secured by the same screws and will be removed with the oil pan.

d. Disassembly (fig. 49).

(1) Unscrew the nipple (12) from the oil pan (4).

(2) Unscrew the nuts (9) and remove the lockwashers (8), oil strainer screen (10), and gasket (11).



1 Handhole reinforcement
2 Gasket
3 Oil pan gasket
4 Oil pan assembly
5 Washer, lock, ⅜ in. (18 req'd)
6 Screw (18 req'd)
7 Oil strainer stud
8 Washer, lock, 3/16 in. (6 req'd)
9 Nut, hex, ¼ in. NC (6 req'd)
10 Oil strainer screen assembly
11 Gasket
12 Oil drain nipple

Figure 49. Oil pan, exploded view.

(3) Lift the handhole reinforcement (1), with the studs (7) and gasket (2), out of the oil pan.

e. Cleaning and Inspection (fig. 49).

(1) *Cleaning.* Clean the screen (*b* above). Use an approved cleaning solvent to clean the pan (4) and nipple (12).

(2) *Inspection.* Inspect the pan (4) for cracks or breaks. Weld or replace a damaged pan. Check the nipple (4) and studs (7) for damaged threads. Replace a defective part.

f. Reassembly (fig. 49).

(1) Place the gasket (2) on the studs of the handhole reinforcement (1).

(2) Slip the studs through the holes in the oil pan (4).

(3) Insert the oil strainer screen (10) and gasket (11) through the opening in the oil pan and on the studs. Secure with the lockwashers (8) and nuts (9).

(4) Screw the nipple (12) into the oil pan.

g. Installation.

(1) Position the oil pan assembly (4, fig. 49) and gasket (3) against the bottom surface of the engine block, allowing the tube from the oil pump to enter the hole in the oil strainer screen (10).

(2) Install the screws (6) and lockwashers (5) in alternate holes. Use two of the screws and lockwashers to secure the voltage regulator bracket (15, fig. 41).

(3) Slip the oil pan shroud (5, fig. 48) over the oil pan (4) and install the spacers (1), cap screws (2), and lockwashers. Tighten securely.

(4) Screw the elbow (7) on the nipple (6).

(5) Slip the second nipple through the opening in the skid base and screw into the elbow. Install the cap on the end of the completed oil drain line.

(6) Connect the heater inlet line (9, fig. 33) at the radiator and open the heater shutoff valves (8).

(7) Install the relief valve (par. 79*d*).

(8) Install the sediment bowl (par. 83).

(9) Install the housing skirt and the auxiliary fuel bracket (par. 77*b*).

(10) Connect the lines (12 and 13, fig. 22) at the auxiliary fuel bracket (15) and three-way valve (32).

(11) Install the radio suppression box (par. 97).

(12) Fill the crankcase with the prescribed lubricant.

(13) Connect the shroud hose (6, fig. 15) at the elbow (9, fig. 48).

(14) Prime the system (par. 16).

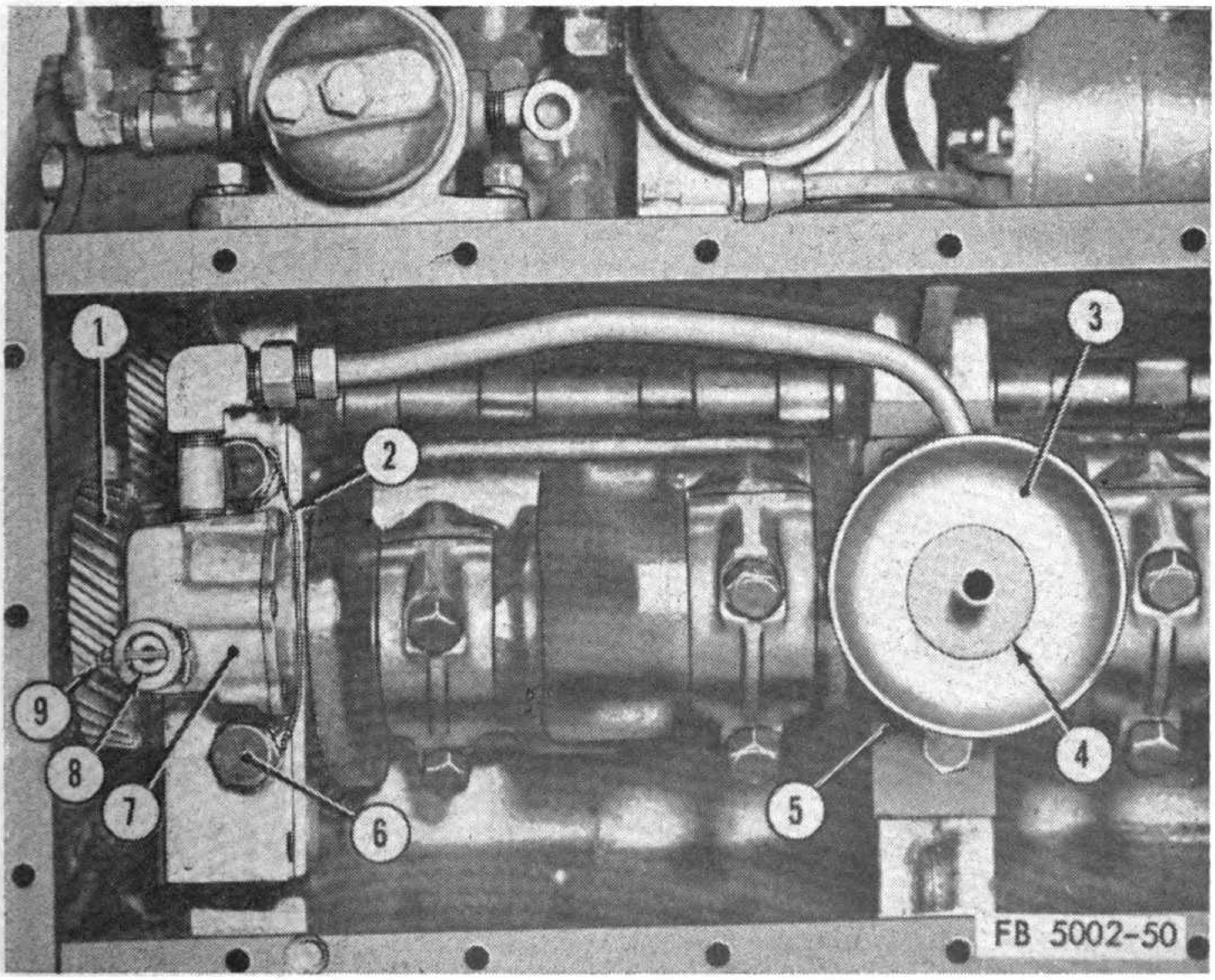
104. Oil Pump

a. Description (fig. 50). The oil pump (7) is mounted on the front bearing cap and is connected to the oil reservoir by the oil strainer tube and cover assembly (3). The pump is a positive displacement, gear type unit driven by the crankshaft through the pump drive gear (1). The oil pressure is regulated automatically by a spring and valve within the pump body. The spring has been designed to provide a normal operating pressure of between 45 and 55 pounds. The pressure at idle speeds should be about 30 pounds. When the oil pressure is low and all other possible causes have been checked, remove the oil pump for cleaning and inspection.

b. Removal (fig. 50).

(1) Remove the oil pan (par. 103*c*).

(2) Remove the screw and lockwasher holding the tube and cover assembly (3) to the center bearing cap (5).



1 Pump drive gear. 2 Lock wire. 3 Tube and cover assembly. 4 Felt washer. 5 Center bearing cap. 6 Screw (2 req'd). 7 Oil pump assembly. 8 Relief valve retainer. 9 Cotter pin (1 req'd).

Figure 50. Oil pump.

(3) Break the lock wire (2) and remove the pump mounting screws (6).

(4) Remove the pump assembly (7)and the front bearing cap.

c. *Disassembly* (fig. 51).

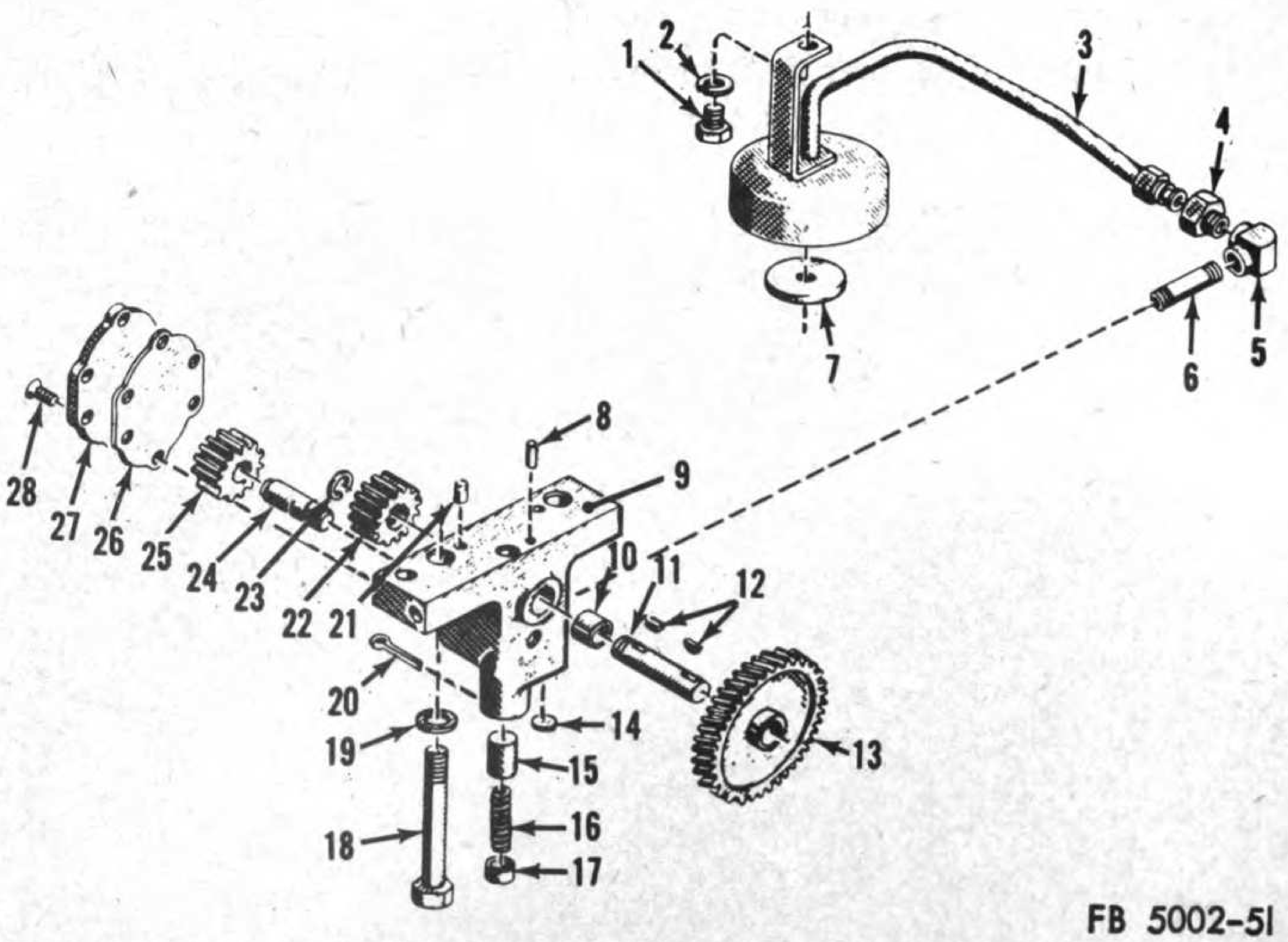
(1) Withdraw the felt washer (7) from the tube and cover assembly (3).

(2) Disconnect the tube and cover assembly (3), connector (4), inlet tube elbow (5), and tube nipple (6).

(3) Withdraw the cotter pin (20) and remove the retainer (17), spring (16), and valve (15).

(4) Withdraw the screws (28) and remove the oil pump cover (27) and gasket (26).

(5) Further disassembly of the oil pump is beyond the scope of organizational units.



1	Screw (1 req'd)	15	Valve
2	Washer, lock, ¼ in. (1 req'd)	16	Spring
3	Tube and cover assembly	17	Relief valve retainer
4	Connector	18	Screw (2 req'd)
5	Inlet tube elbow	19	Plain washer (2 req'd)
6	Tube nipple	20	Cotter pin (1 req'd)
7	Felt washer	21	Pin
8	Straight pin (1 req'd)	22	Driver gear
9	Oil pump body	23	Snap ring
10	Bushing	24	Idler gear stud
11	Drive shaft	25	Idler gear
12	Key (2 req'd)	26	Gasket
13	Drive gear	27	Oil pump cover
14	Plug	28	Screw (6 req'd)

Figure 51. Oil pump, exploded view.

d. Cleaning and Inspection (fig. 51).

(1) Clean all parts in solvent or fuel oil.

(2) If the pump fails to deliver oil at the required pressure, the valve spring (16) may need replacement. When a spring in good condition is installed correctly, the valve (15) will respond so that the proper oil pressure is obtained.

(3) When the backlash of the pump drive gear (13) becomes excessive, the shaft bushing (10) or gear teeth are worn. Replace a defective pump.

e. Reassembly (fig. 51).

(1) Install the valve (15), spring (16), and retainer (17) in the body (9). Press inward on the retainer, alining the notches in its base with cotter pin holes in the oil pump body. Install the cotter pin (20) and spread the ends.

(2) Position the oil pump cover (27) and gasket (26) on the pump body. Install the screws (28) and tighten securely.

(3) Connect the tube and cover assembly (3), connector (4), elbow (5), and nipple (6).

(4) Install the felt washer (7), on the tube and cover assembly.

f. Installation (fig. 50).

(1) Install the front bearing cap and the pump (7), making sure the gear (1) meshes with the crankshaft gear, and secure with the screws (6). Tighten to a tension of 125 to 135 foot-pounds and secure with the lock wire (2).

(2) Secure the tube and cover assembly (3) to the center bearing cap (5) with the screw and lockwasher.

(3) Install the oil pan (par. 103*g*).

Section XI. CYLINDER HEAD AND VALVE MECHANISM

105. Description

a. The cylinder head (12, fig. 52) is mounted on the block (13) to provide the cylinder combustion chambers. It is an iron casting with integral water passages to insure proper cooling. The flow of gases to and from the combustion chambers is directed through the intake and exhaust manifold (9) and is controlled by the valves. Fuel is injected into the chambers by the nozzle holder assemblies (14) which are positioned directly opposite the energy cell bodies. The cell bodies control combustion through turbulence which thoroughly mixes the fuel and air. A soft copper gasket is located between the head and block to provide a water and gas seal for the mated surfaces.

b. The valve mechanism is actuated by camshaft lobes to open the intake and exhaust ports in the proper sequence and timing. When the lobes force the valve push rods (15) upward, the rocker arms (7) pivot on the rocker arm shaft (3). This forces the valves down against the action of the valve springs (11), opening the intake or exhaust ports. The rocker arms are retained in their correct operating positions by the rocker arm shaft springs (2).

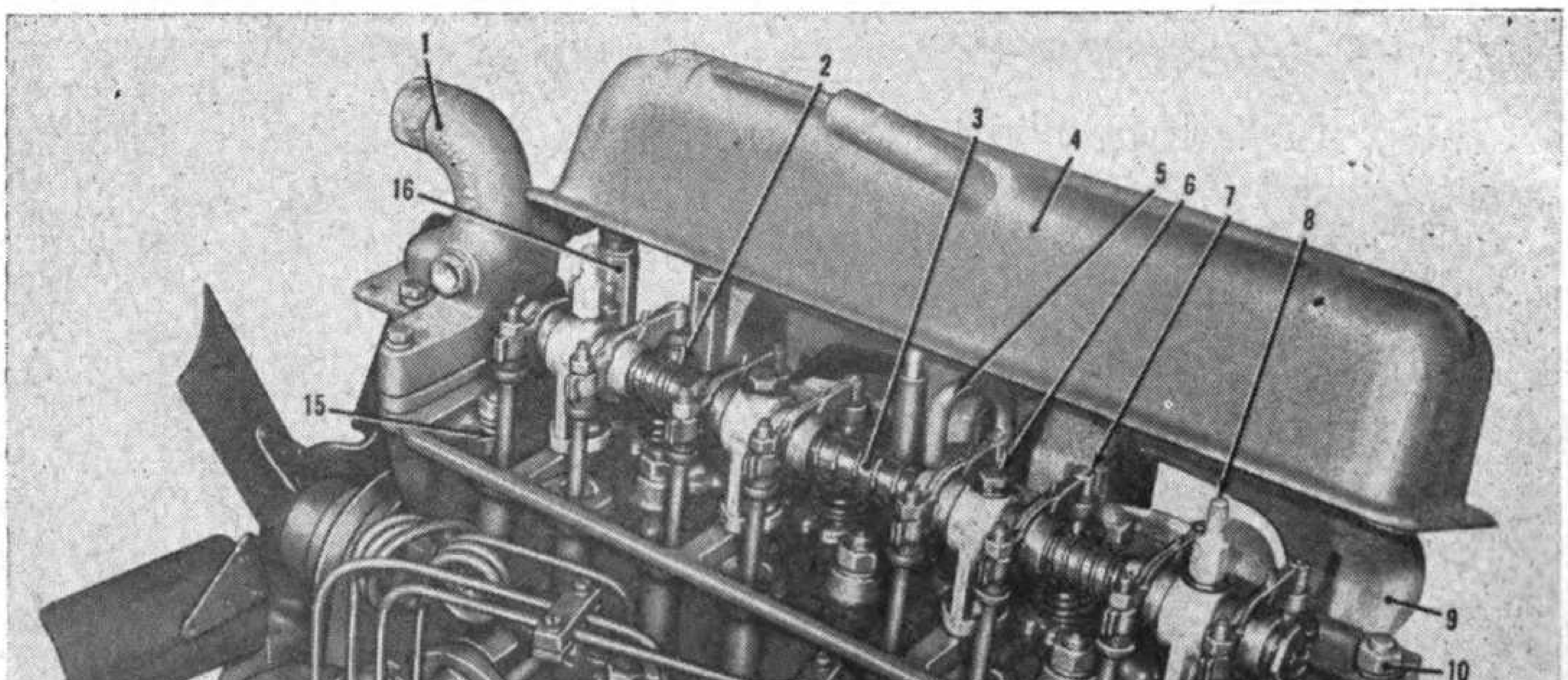
c. The valve mechanism is housed by the cylinder head cover assembly (4) which is connected to the air inlet line (15, fig. 34) by a hose (14). This arrangement provides crankcase ventilation.

106. Cylinder Head
(fig. 52)

a. Removal.

(1) Remove the housing section (par. 73*a*).

(2) Remove the nozzle holder assemblies (par. 88).



1	Water outlet elbow	9	Intake and exhaust manifold
2	Rocker arm shaft spring	10	Cylinder head nut
3	Rocker arm shaft	11	Valve spring
4	Cylinder head cover assembly	12	Cylinder head
5	Lifting eye	13	Cylinder block
6	Support screw (2 req'd)	14	Nozzle holder assembly
7	Rocker arm	15	Valve push rod
8	Special support screw	16	High hexagon nuts

Figure 52. Cylinder head and valve mechanism.

(3) Remove the thermostat (par. 92*b*(1)).

(4) Remove the cell body assemblies (par. 109).

(5) Remove the exhaust and intake manifold (par. 114).

(6) Remove the nuts and gaskets securing the cover (4) and cover gasket to the head (12).

(7) Unscrew the support screws (6 and 8) and remove the entire rocker arm assembly, valve sockets, and push rods (15). Notice the position of the special support screws (8).

(8) Remove the nuts (10 and 16), lifting eye (5), and plain washers.

(9) Lift off the head (12) and head gasket.

b. Gasket Replacement.

(1) Clean carbon, sealing compound, and foreign matter from the mating surfaces of the head (12) and block (13). Fit the gasket on the block to make sure it does not overlap the cylinder sleeves.

(2) Apply a coat of sealing compound to these surfaces to insure a leakproof installation.

(3) Place the gasket on the block and install the head (*c* below). Take care to prevent dirt or foreign matter from lodging between the gasket and the head or block.

c. Installation.

(1) Place the head (12) and new gasket on the block (13) and secure with the lifting eye (5), nuts (10 and 16), and plain washers. Tighten them progressively from the center toward the ends and sides with a torque wrench to a tension of 130 to 140 foot-pounds.

(2) Insert the push rods (15) and place the valve sockets and rocker arm assembly on the head (12). Loosen the valve adjusting screws in the rocker arms (7). Secure with the screws (6 and 8), placing the special support screws in their original positions. Adjust all valves to a temporary cold setting of 0.015 inch.

(3) Install the exhaust and intake manifold (par. 114).

(4) Install the cell body assemblies (par. 109).

(5) Install the thermostat (par. 92*d*(1)).

(6) Install the nozzle holder assemblies (par. 88).

(7) Install the housing section (par. 77*c*).

(8) Run the engine until operating temperature is reached and retighten the head nuts and readjust the valves (par. 107*a*).

(9) Install the cover (4) and cover gasket. Secure with the nuts and gaskets.

107. Valves

a. Checking and Adjusting Valve Clearance.

(1) Run the engine until operating temperature is reached; then shut it down.

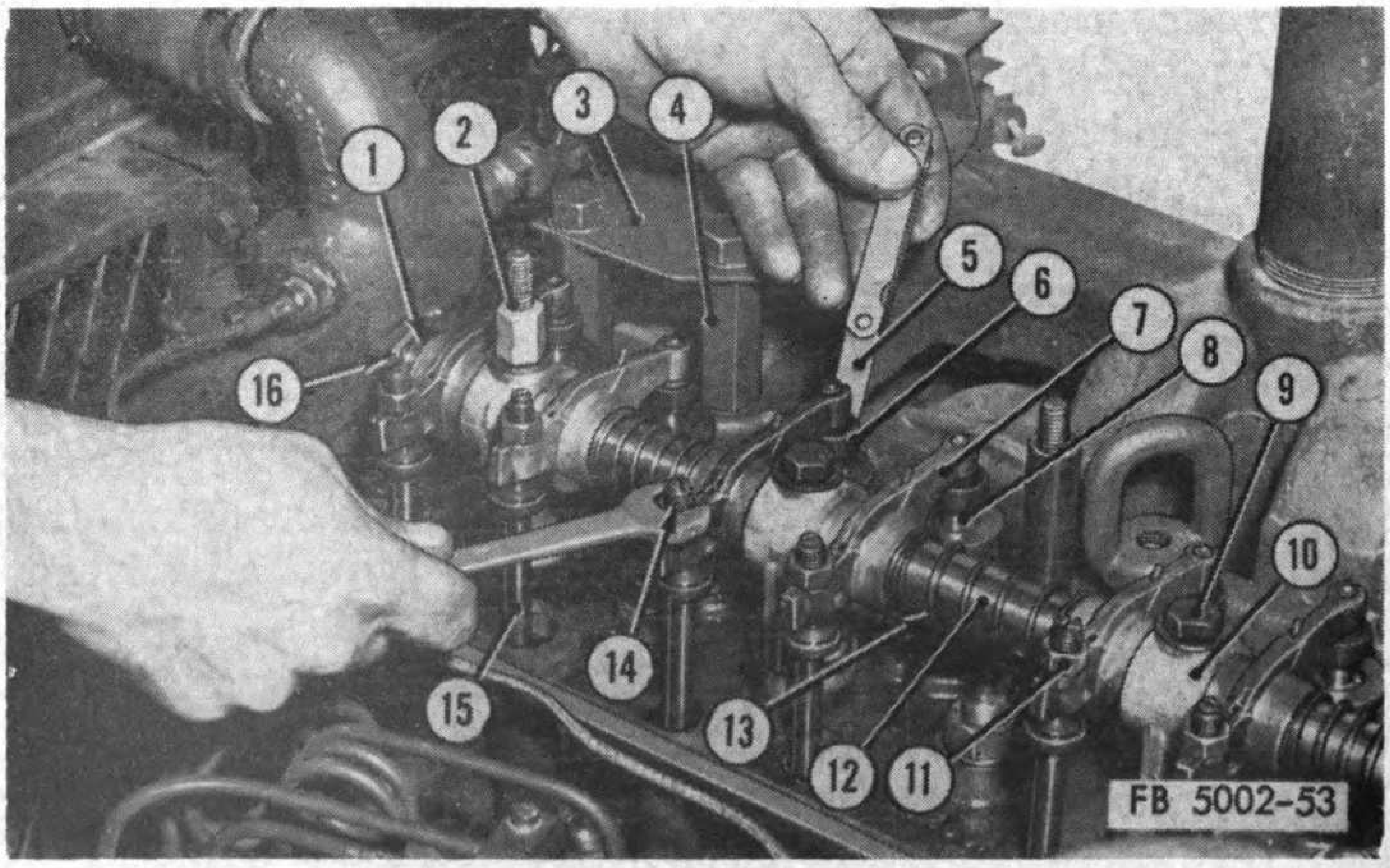
(2) Disconnect the air inlet line (15, fig. 34) at the head cover (4, fig. 52).

(3) Remove the nuts and gaskets securing the cover (4) to the head (12) and remove the cover.

(4) Rotate the crankshaft until the No. 1 piston is at the firing position, which will be indicated by the closed valves.

(5) Insert a feeler gage (5, fig. 53) between the valve stem (8) and the rocker arm (7) to check the clearance. Valve clearance for both intake and exhaust valves is 0.014-inch hot. The clearance is correct when there is a slight drag felt as the gage is moved.

(6) To adjust the clearance, loosen the locknut (11) and turn the adjusting screw (14) until the proper clearance is obtained; then tighten the locknut.



1 Short spring
2 Special support screw
3 Bracket
4 High hexagon nuts
5 Feeler gage
6 Socket
7 Rocker arm
8 Valve stem
9 Support screw (2 req'd)
10 Support
11 Locknut (8 req'd)
12 Shaft
13 Long spring
14 Adjusting screw
15 Push rod
16 Plug

Figure 53. Valve clearance adjustment.

(7) Check and adjust the second valve of the cylinder.

(8) Spot each piston in turn at the firing position and check the clearances. Adjust if necessary.

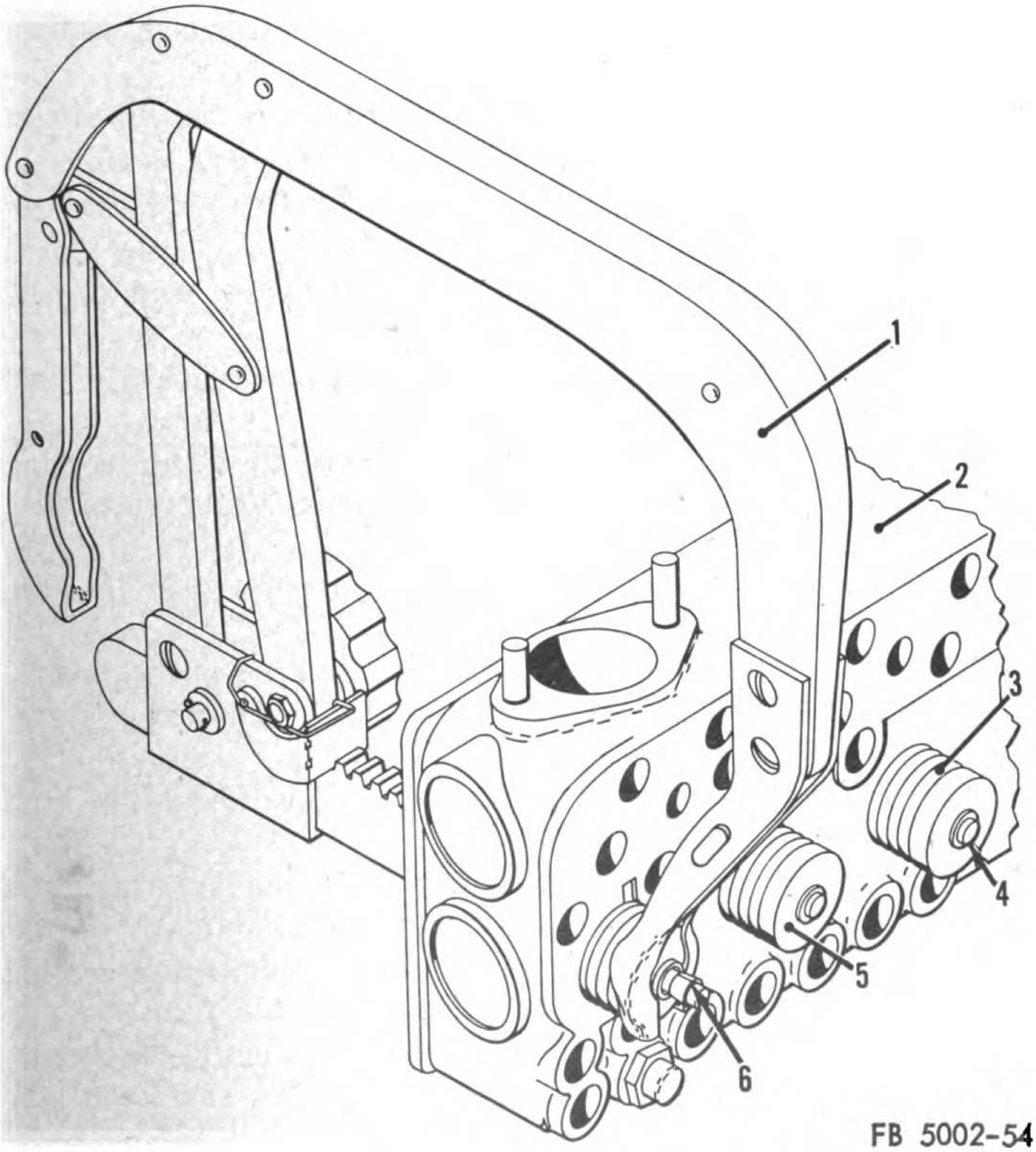
(9) Install the cover (4, fig. 52) and secure with the nuts and gaskets.

(10) Connect the air inlet line (15, fig. 34) to the cover.

b. Removing Valves (fig. 54).

(1) Remove the cylinder head (par. 106).

(2) Place the compressing tool (1) in position on the cylinder head (2).



1 Valve compressing tool. 2 Cylinder head. 3 Spring. 4 Valve stem. 5 Valve spring retainer. 6 Valve spring lock.

Figure 54. Valve spring compressor in use.

(3) Remove the retaining ring and spring lock (6).

(4) Release the compressing tool and remove the retainer (5) and spring (3).

(5) Push the valve out of the head.

(6) Mark the valve and place it in a rack so it can be installed in the same valve guide from which it was removed.

(7) Repeat the above procedure for the remaining valves.

c. Inspection.

(1) Replace the valve if the stem is warped or if the face is burned or deeply pitted. If the part of the stem that slides in the guide is worn more than 0.0025 inch for the intake or 0.005 inch for the exhaust valve, replace the valve.

(2) Replace the head if the valve seats are deeply pitted.

(3) Proper valve spring pressure is 58 to 64 pounds to compress the spring to 1⅞ inch. Replace weak springs.

d. Seating Valves (fig. 55). New valves or existing valves which are serviceable must be lapped into the valve seats to provide perfect closures before installation.

(1) Obtain a light spring with enough tension to just hold the valve (2) off the seat (4).

(2) Lubricate the valve stem (6) and apply a thin coating of medium coarse grinding compound to the valve face (3).

(3) Insert the valve with the spring on the stem into the head.

(4) Pressing down firmly with a hand or electric valve grinding tool, rotate the valve back and forth several times about a quarter of a turn.

(5) Release the pressure, rotate the valve about 20°, and repeat the grinding process.

(6) Inspect the valve and seat periodically by wiping off the compound and checking the contact areas.

(7) When the surfaces are in contact, apply a thin coating of fine compound and "finish-grind" the face.

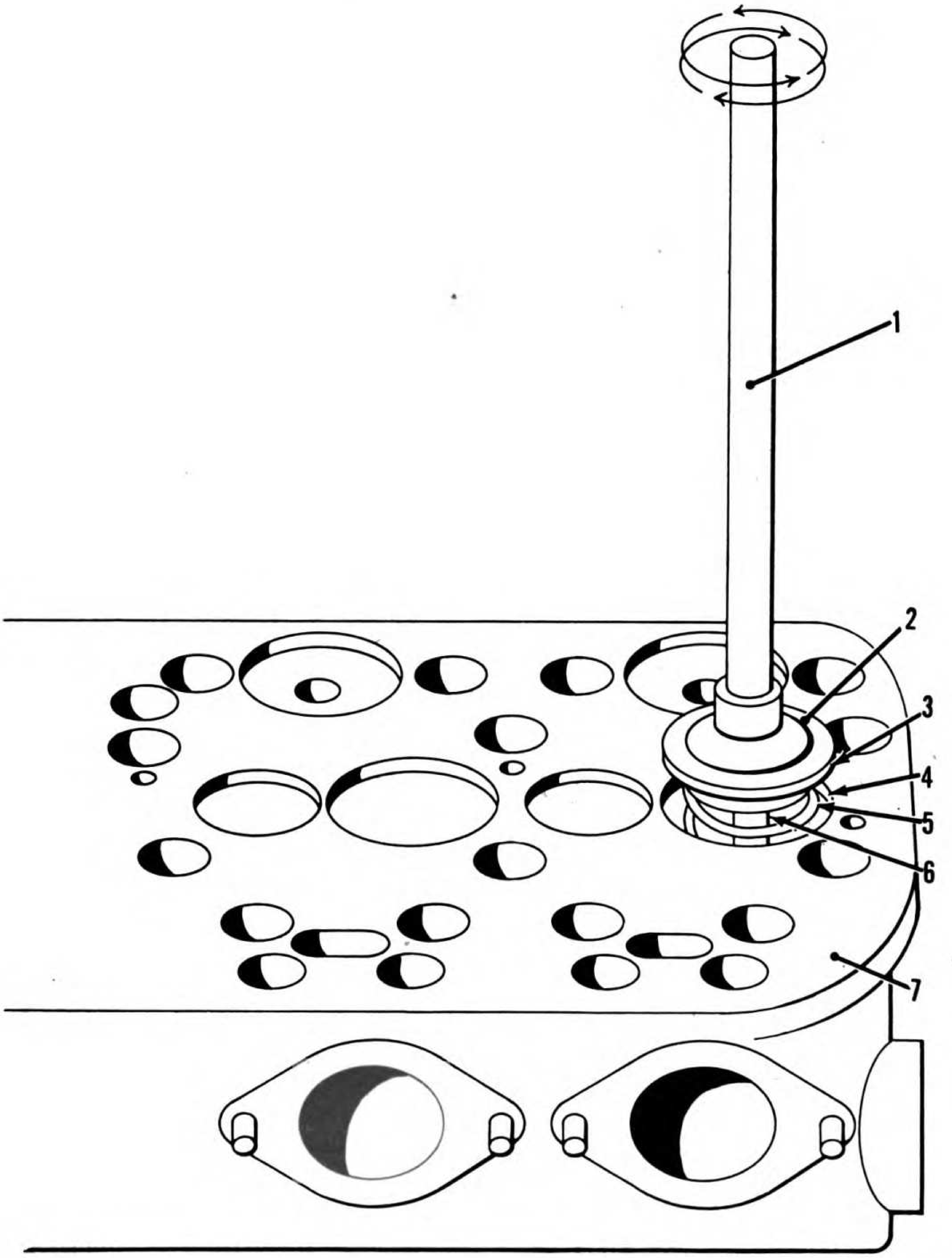
(8) Clean off the compound and make ten or twelve equally spaced pencil marks across the seating surface of the valve.

(9) Rotate the valve lightly in the seat. If the marks are wiped off, the valve is properly seated. Repeat the grinding procedure if any pencil marks are left intact.

Caution: Clean all grinding compound from the valve seats and stems before reinstalling.

e. Installation (fig. 54).

(1) Install the valves in their correct openings and place a retaining ring, spring (3), and retainer (5) on each valve stem (4).



1 Valve grinding tool. 2 Valve. 3 Valve face. 4 Valve seat. 5 Spring. 6 Valve stem. 7 Cylinder head.

Figure 55. Seating valves.

(2) Position the compressing tool (1) and compress the spring.

(3) Place the lock (6) on the stem and release the tool.

(4) Repeat (2) and (3) above for the remaining valves.

(5) When all the valves are installed, test them for leaks. Support the cylinder head with the valve heads uppermost and closed. Pour enough fuel oil in the head to cover the valves. Wrap a cloth around an air hose and insert into each exhaust and intake port in turn, admitting air not above 25 psi. If a valve is not seating properly, bubbles will appear on the surface of the oil.

(6) Install the cylinder head (par. 106) and check the valve clearance (*a* above).

108. Rocker Arm Assembly
(fig. 53)

a. Removal. Refer to paragraph 106*a*(1) through (7).

b. Disassembly.

(1) Remove the plug (16), gasket, and short spring (1) from each end of the assembly and one support (10).

(2) Disassemble, in the following sequence, rocker arm (7), long spring (13), rocker arm (7), and support (10) until the shaft (12) is stripped.

c. Reassembly.

(1) Install a support (10), short spring (1), gasket, and plug (16) on the shaft (12).

(2) Assemble the rocker arm assembly in the following sequence: a rocker arm (7), long spring (13), rocker arm (7), and support (10). Install the remaining short spring, gasket, and plug.

d. Installation. Refer to paragraph 106*c*(2) through (9).

109. Cell Body Assembly
(fig. 56)

a. Removal.

(1) Remove the plug (5), gasket (4), and retainer.

(2) With a pair of needle-nose pliers inserted into the opening, grip the point of the cell cap and pull it evenly out of the chamber.

(3) Remove the cell body (2) with a puller (3).

b. Cleaning and Inspection.

(1) Clean the cell body assembly parts with an approved cleaning solvent.

(2) Clean the seating surfaces in the head (1) thoroughly.

(3) Inspect the assembly for cracks or damaged threads. Replace defective parts.

c. Installation.

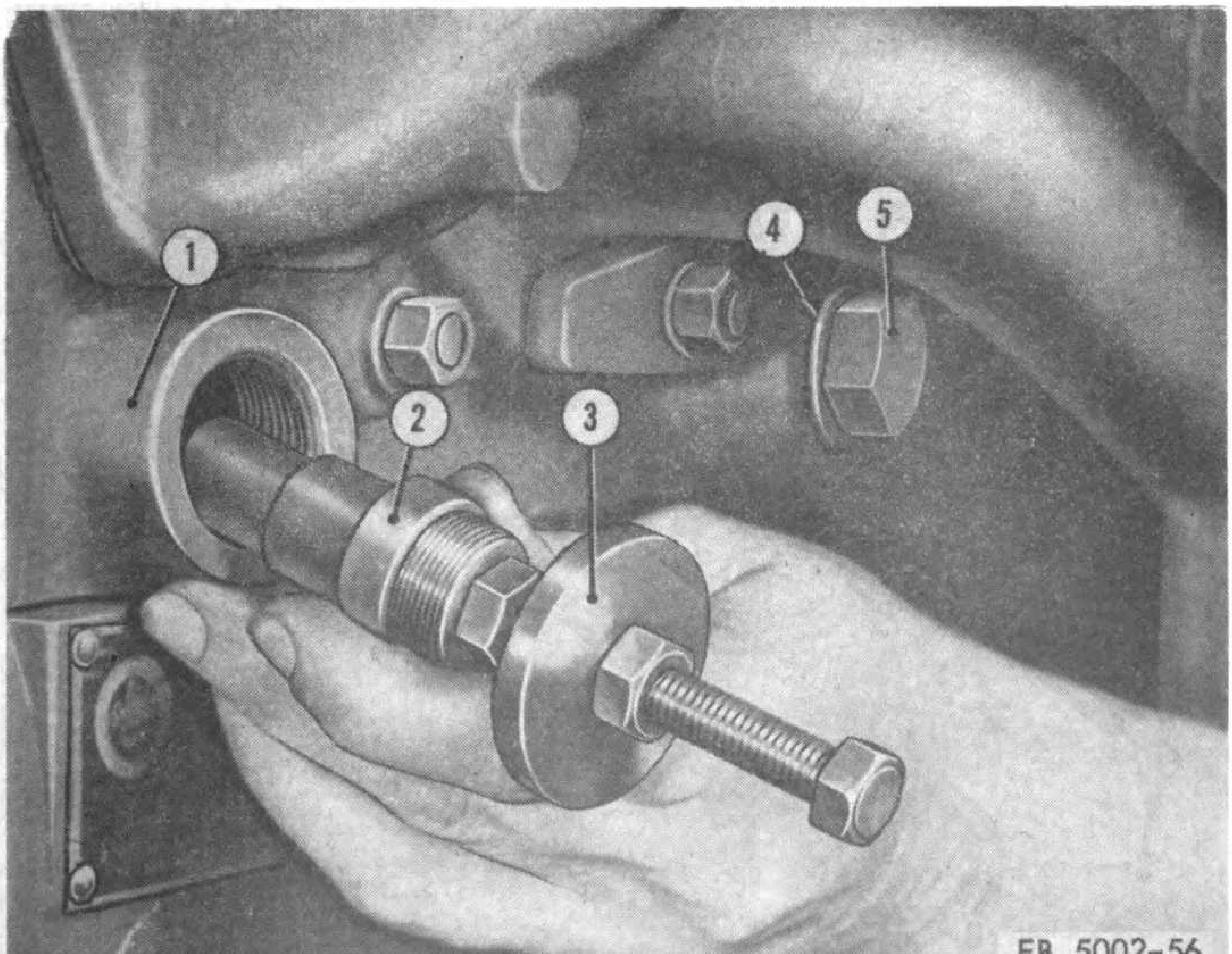
(1) Install the cell body (2), cap, and retainer in the head (1). Make sure there are no carbon particles on the seating surfaces of the parts which will prevent them from seating.

(2) Secure with the gasket (4) and plug (5).

Section XII. AIR INTAKE AND EXHAUST SYSTEMS

110. Description

The engine is equipped with an oil bath air cleaner (5, fig. 2), a flame heater (7) for preheating intake air, a horizontally mounted muffler (6, fig. 1), an exhaust pipe, and a one-piece intake and exhaust manifold (6, fig. 57) mounted on the right side of the cylinder head. Air distribution and exhaust chambers are cast into the head.



1 Cylinder head. 2 Cell body. 3 Puller. 4 Gasket. 5 Plug.

Figure 56. Removing cell body.

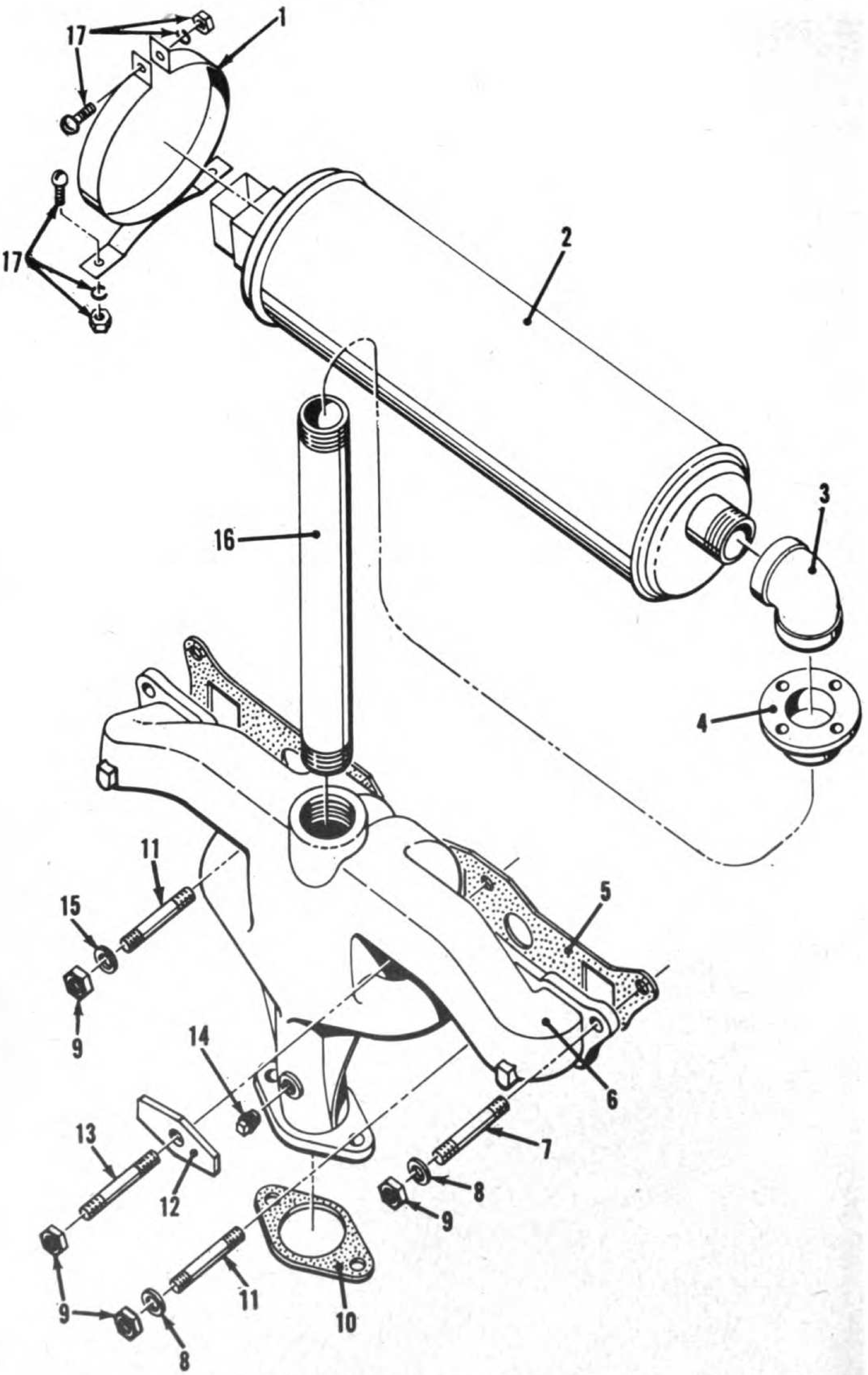


Figure 57. Air intake and exhaust system, exploded view.

1	Muffler bracket	8	Flat washer (5 req'd)	13	Manifold stud
2	Muffler	9	Manifold stud nut (11 req'd)	14	Pipe plug
3	Exhaust line elbow	10	Gasket	15	Flat washer (2 req'd)
4	Exhaust shield	11	Stud	16	Exhaust line nipple
5	Gasket	12	Manifold clamp	17	Bolt, w/nut and lockwasher (3 req'd)
6	Manifold				
7	Manifold stud				

Figure 57—Continued.

111. Oil Bath Air Cleaner

a. Description. The air cleaner (5, fig. 2), attached to a bracket at the right front side of the block above the battery-charging generator, removes dirt from the intake air. Air is drawn into the cleaner through the cap (3, fig. 58), forced through a filter (12) and oil bath, and then into the intake section of the manifold (6, fig. 57). A hose (14, fig. 34), connected to the air inlet line (15) and the cylinder head cover, vents the oil mist inside the cover and tends to aid lubrication of the rocker arm assembly with the movement of air.

b. Servicing (fig. 58).

(1) Open the catches on the bracket (11) to release the cup (14) from the body (7).

(2) Discard the oil and separate the chamber (13) and cup (14).

(3) Turn the filter (12) counterclockwise to release it from the body.

(4) Wash the filter (12), chamber (13), cup (14), and inside of the body (7) with cleaning solvent. Blow dry with compressed air.

(5) Dip the filter (12) in light engine oil, drain, and attach it to the body (7).

(6) Place the chamber (13) in the cup (14) and fill to the level mark with engine oil.

(7) Position the cup (14) and secure it to the body (7) with the catches on the bracket (11).

c. Removal.

(1) Remove the clamp attaching the bracket (3, fig. 53) and inlet line (4, fig. 58).

(2) Loosen the clamp (1) and disconnect the hose (2) from the inlet line (4).

(3) Loosen the clamp (19) and disconnect the hose (18) from the body (7).

(4) Remove the screw (10), lockwasher (21), and nut (22). Slide the cleaner out of the saddle bracket (9).

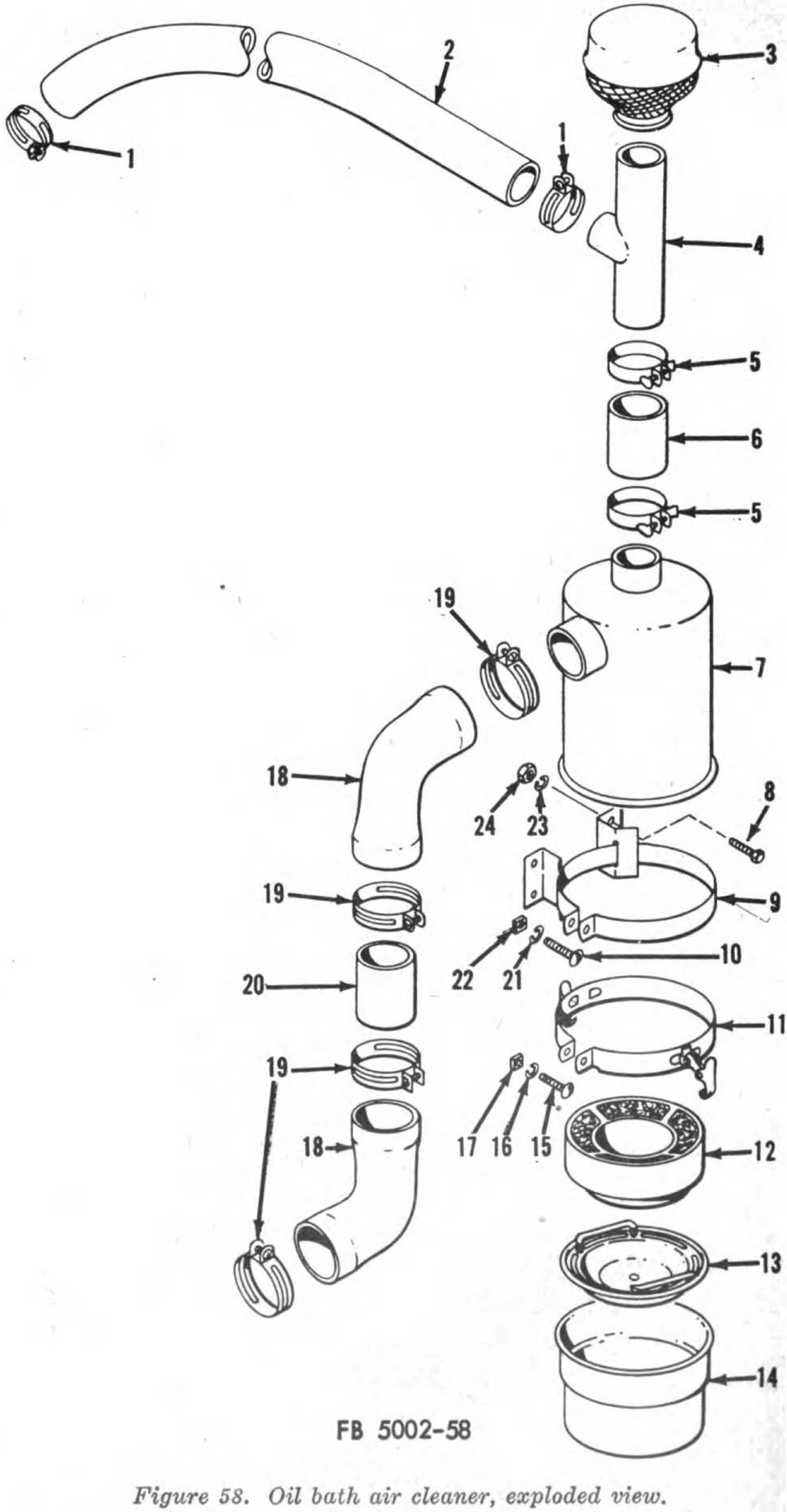


Figure 58. Oil bath air cleaner, exploded view.

1	Clamp	9	Saddle bracket	17	Nut (1 req'd)
2	Hose	10	Screw (1 req'd)	18	Hose
3	Inlet cap	11	Air cleaner bracket	19	Clamp
4	Inlet line assembly	12	Filter	20	Outlet tube
5	Clamp	13	Chamber	21	Lockwasher (1 req'd)
6	Tube-to-cleaner line assembly	14	Cup	22	Nut (1 req'd)
7	Body	15	Screw (1 req'd)	23	Lockwasher (4 req'd)
8	Screw (4 req'd)	16	Lockwasher (1 req'd)	24	Nut (4 req'd)

Figure 58—Continued.

(5) To remove the saddle bracket, remove the screws (8), lockwashers (23), and nuts (24) securing it to the bracket (16, fig. 34).

(6) To remove the inlet line, loosen the clamps (5, fig. 58) and remove the line (6).

(7) To remove the hoses (18) and tube (20) from the flame heater, loosen the clamps (19) and pull off.

d. Installation.

(1) Connect the hoses (18) and tube (20) with the clamps (19). Attach to the flame heater with the clamp (19).

(2) Assemble the inlet line (4), line (6), and body (7). Secure with the clamps (5).

(3) Secure the saddle bracket (9) to the bracket (16, fig. 34) with the screws (8, fig. 58), lockwashers (23), and nuts (24).

(4) Position the cleaner in the saddle bracket and secure with the screw (10), lockwasher (21), and nut (22).

(5) Connect the hose (18) to the body (7) with the clamp (19).

(6) Connect the inlet line (4) and hose (2) with the clamp (1).

(7) Clamp the inlet line to the bracket (3, fig. 53).

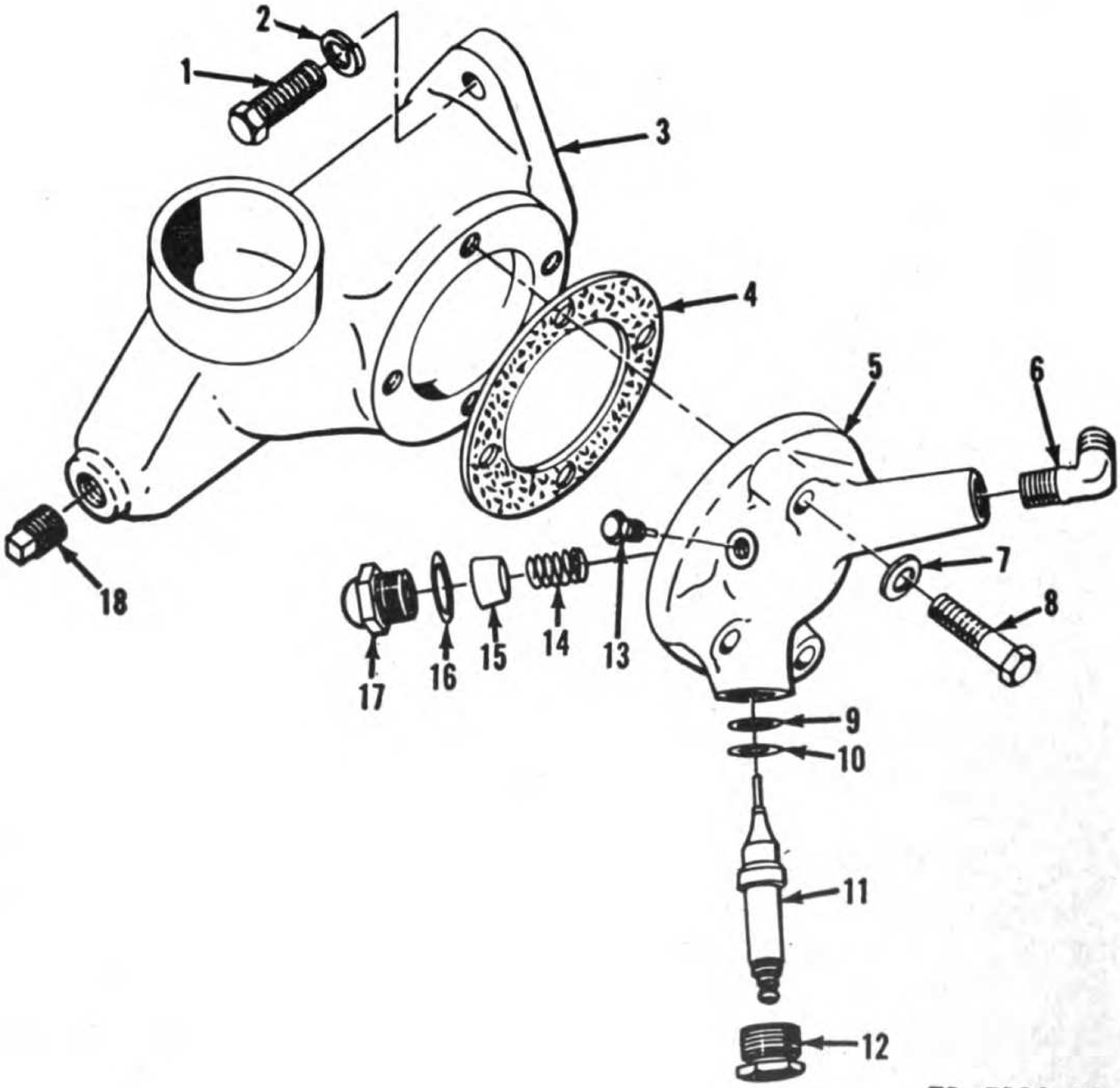
112. Flame Heater Assembly

a. Description. The flame heater is a cold weather starting aid which preheats the air entering the cylinders with an open flame. It consists of a hand-operated primer (9, fig. 10) which pumps diesel oil through a nozzle body (17, fig. 59) mounted in the heater body (5). The fuel spray is ignited by a continuous spark jumping from a spark plug (11) to a ground electrode screw (13) also mounted in the body. The engine electrical system supplies current to the spark plug through a resistor (3, fig. 9) and coil (11, fig. 15) when the fuel pressure actuates a pressure switch to close the circuit. Electrical contact and fuel flow is maintained as long as the primer is operated. Maximum heater benefit is obtained by operating the primer slowly with just enough pressure to maintain the fuel flow and keep the pressure switch contacts closed while cranking the engine. Fast priming will burn all the oxygen in the air going to the cylinders and the engine will not start. Excess fuel and sediment can be drained by removing the pipe plug (18, fig. 59).

b. *Testing.*

(1) Disconnect the hose (18, fig. 58) from the inlet elbow (3, fig. 59).

(2) Give the primer (9, fig. 10) one stroke while cranking the engine. A flame should be visible inside the elbow.



1	Elbow mounting screw (2 req'd)	7	Lockwasher (4 req'd)	13	Electrode screw assembly
2	Lockwasher (2 req'd)	8	Body mounting screw (4 req'd)	14	Filter spring
3	Manifold inlet elbow	9	Copper gasket	15	Air heater filter
4	Gasket	10	Copper gasket	16	Special washer
5	Air heater body	11	Heater spark plug	17	Nozzle body
6	Fuel inlet elbow	12	Retainer nut	18	Pipe plug

Figure 59. Flame heater, exploded view.

Caution: Keep as far away from the flame as possible to avoid injury.

(3) If the primer cannot be operated in the discharge direction, the filter (15, fig. 59) is plugged.

(4) If fuel spray is visible but will not ignite, check the pressure switch located behind the panel (11, fig. 4) near the primer (9, fig. 10). Remove the two leads from the switch and hold them together while cranking the engine and operating the primer. Combustion will indicate a defective pressure switch.

(5) If the fuel still does not ignite, the cause may be due to a defective coil (11, fig. 15) or resistor (3, fig. 9).

c. Removal.

(1) Disconnect the hose (18, fig. 58) from the inlet elbow (3, fig. 59), the fuel line from the elbow (6), and the lead to the spark plug (11).

(2) To remove the heater, remove the screws (1) and lockwashers (2) securing the elbow and gasket (10, fig. 57) to the manifold (6).

d. Disassembly (fig. 59).

(1) Remove the elbow (6) from the body (5).

(2) Unscrew the nut (12) and remove the spark plug (11) and the gaskets (10 and 9). Remove the electrode screw (13).

(3) To separate the body (5), gasket (4), and inlet elbow (3), remove the screws (8) and lockwashers (7).

(4) Unscrew the nozzle body (17) and remove the special washer (16), filter (15), and spring (14).

e. Cleaning and Inspection (fig. 59).

(1) *Cleaning.* Clean the carbon from inside the elbow (3) and body (5) and from the spark plug (11) and electrode screw (13). Wash the spring (14), filter (15), and nozzle body (17) in cleaning solvent.

(2) *Inspection.*

(*a*) Check the elbow (3) and body (5) for cracks or breaks, and the nozzle body (17) for damaged threads. Replace a defective part.

(*b*) Examine the electrode screw (13) and spark plug (11) for pits, burns, or cracked porcelain. Replace a defective screw or plug.

(*c*) Inspect the spring (14) for cracks or breaks and the filter (15) for damage. Replace a defective item.

f. Reassembly (fig. 59).

(1) Install the elbow (6), spring (14), filter (15), special washer (16), and nozzle body (17) in the heater body (5).

(2) Install gaskets (9 and 10) and spark plug (11) in the body and secure with nut (12).

(3) Install the electrode screw (13) in the body and adjust the air gap with the spark plug to 3/32-inch by turning the electrode screw in or out.

(4) Secure the body (5) and gasket (4) to the elbow (3) with the screws (8) and lockwashers (7).

g. Installation.

(1) Secure the heater and gasket (10, fig. 57) to manifold (6) with the screws (1, fig. 59) and lockwashers (2).

(2) Connect the lead to the spark plug (11), fuel line to elbow (6), and hose (18, fig. 58) to inlet elbow (3, fig. 59).

h. Pressure Switch. The pressure switch is located behind the panel (11, fig. 4) and is connected to the primer (9, fig. 10) by a short fuel line.

(1) *Removal.* Disconnect the fuel lines and leads at the switch and remove the tee-fitting.

(2) *Installation.* Screw the tee-fitting into the switch and connect the fuel lines and leads.

i. Ignition Coil. The coil (11, fig. 15) is attached to a bracket mounted on the flywheel housing.

(1) *Removal.* Disconnect the leads at the coil and remove the screws, lockwashers, and nuts securing it to the bracket.

(2) *Installation.* Secure the coil to the bracket with the screws, lockwashers, and nuts and connect the leads.

j. Resistor. The resistor (3, fig. 9) is mounted on the back-wall of the switchboard panel.

(1) *Removal.* Disconnect the leads and remove the screws, lockwashers, and nuts attaching it to the switchboard.

(2) *Installation.* Secure the resistor to the switchboard with the screws, lockwashers, and nuts and connect the leads.

k. Primer. The primer (9, fig. 10) is mounted in the panel.

(1) *Removal.* Disconnect the fuel lines to the primer and unscrew the locknut securing the primer to the panel.

Unscrew the primer barrel from the head and remove from the panel.

(2) *Installation.* Insert the primer barrel in the panel and secure with the locknut. Screw the head on the primer barrel and connect the fuel lines.

113. Muffler
(fig. 57)

a. Inspection. Check the muffler (2) for cracks. Replace a defective muffler.

b. Removal.

(1) Remove the bolt with nut and lockwasher (17) clamping the muffler (2) to bracket (1).

(2) Unscrew the muffler from elbow (3) with a pipe wrench.

(3) Unscrew the elbow and nipple (16) out of the manifold (6).

c. Installation.

(1) Screw the nipple (16) and elbow (3) into manifold (6).

(2) Install the muffler (2) in the elbow (3) and secure the muffler to the bracket (1) with the bolt (17).

114. Intake and Exhaust Manifold
(fig. 57)

a. On-Engine Inspection. Check the manifold (6) for tightness of stud nuts. With the engine running, check for leaks at the gaskets (5 and 10). Examine the area around the manifold stud holes for cracks. Replace a defective part.

b. Removal.

(1) Remove the air cleaner (par. 111), flame heater (par. 112), and muffler (par. 113).

(2) To remove the manifold (6) and gasket (5), remove the nuts (9), flat washers (8 and 15), and the clamps (12).

c. Inspection. Check the manifold for warping by placing it with the port flanges uppermost and laying a straightedge across them. Replace a defective manifold.

d. Installation. Before installing the manifold, clean any carbon deposits off the gasket seating surfaces.

(1) Secure the manifold (6) and gasket (5) to the cylinder head with the clamps (12), flat washers (8 and 15), and nuts (9).

(2) Install the muffler (par. 113), flame heater (par. 112), and air cleaner (par. 111).

Section XIII. ENGINE HEATER SYSTEM

115. Heater
(fig. 15)

a. General. For a description of the engine heater and operation procedure, refer to paragraph 20. Normal maintenance can be accomplished without removal of the heater or other components from the generator set.

b. Removal.

(1) Disconnect the hoses (6 and 13) from the pipe cross (12), and the hose from the hood (16).

(2) Disconnect the control cable from the operating lever (7) and unclamp the cable sheath from the operating lever bracket.

(3) Make sure the strainer valve below the heater fuel tank is closed and disconnect the fuel line from the special tee-fitting on the float valve assembly (8).

(4) Make sure the heater coolant shutoff valves at the block are closed and disconnect the lines (14) at the heater (10).

(5) Disconnect the lead to the resistor at the bottom of the heater, and the thermocouple lead at the battery overheat control (15).

(6) To remove the heater (10), remove the screws and lockwashers attaching it to the bracket mounted on the cylinder block.

(7) Remove the overheat control (15), hood (16), and pipe cross (12) from the top of the heater.

(8) Unscrew the safety valve and tee-fitting from the lower coolant inlet of the heater (10).

c. Installation.

(1) Screw the safety valve and tee-fitting into the lower coolant inlet of the heater (10).

(2) Install the cross (12), hood (16), and overheat control (15) on the top of the heater.

(3) Secure the heater (10) to its bracket with the screws and lockwashers.

(4) Connect the lead to the resistor at the bottom of heater (10), and the thermocouple lead to the battery overheat control (15).

(5) Connect the coolant lines (14) to the heater (10).

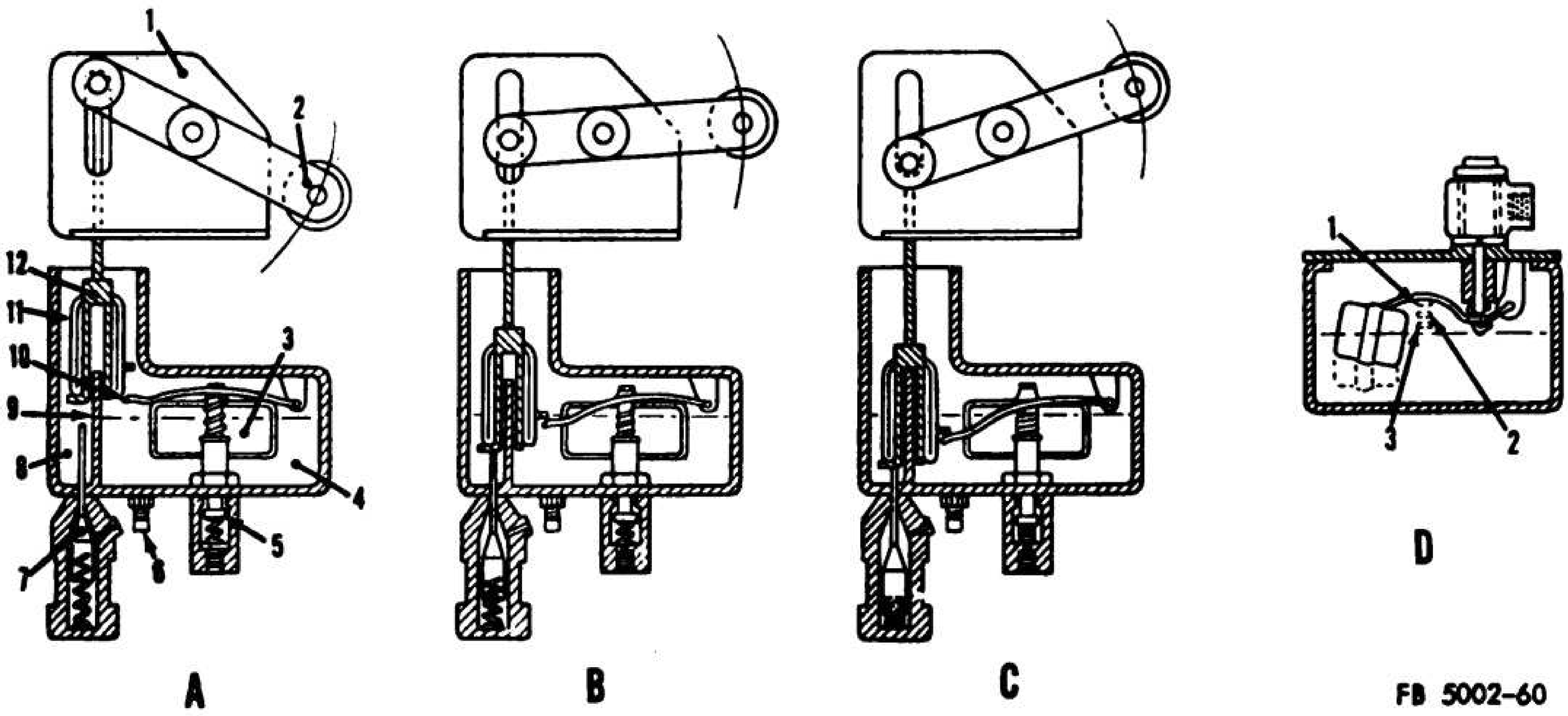
(6) Connect the fuel line to the special tee-fitting on the float valve assembly (8).

(7) Connect the control cable to the operating lever (7) and clamp the cable sheath to the lever bracket.

(8) Connect the hose to the hood (16) and the hoses (6 and 13) to the cross (12).

116. Heater Fuel System

a. Description. Fuel flows by gravity from the fuel tank (13, fig. 20) through the strainer (15) into the float chamber (4, fig. 60), where a float (3) with an overflow valve (5) controls the flow of fuel. The float chamber is separated from the feed chamber (8) by a baffle plate (9). The feed wick (11), mounted in the wick holder assembly (12), draws fuel into the feed chamber. The holder is raised and lowered by a remote control on the switchboard panel which moves the operating lever (2). A valve (7) in the feed chamber, operated by the wick holder, permits fuel to flow through a feed tube to a burner wick in the combustion chamber of the heater.



A Off position

1 Bracket assembly
2 Operating lever
3 Float
4 Float chamber
5 Overflow valve
6 Drain plug
7 Feed valve
8 Feed chamber
9 Baffle plate
10 Float locking lever
11 Feed wick
12 Wick holder assembly

B Low-fire position

C High-fire position

D End view of float

1 Off position
2 Low-fire position
3 High-fire position

Figure 60. Feed positions and float chamber.

b. Heater Fuel Tank.

(1) *Removal.*

(*a*) Close the shutoff valve (19, fig. 61) and disconnect the tubing (17) at the upper connector (12). Drain the fuel tank (3) into a suitable container.

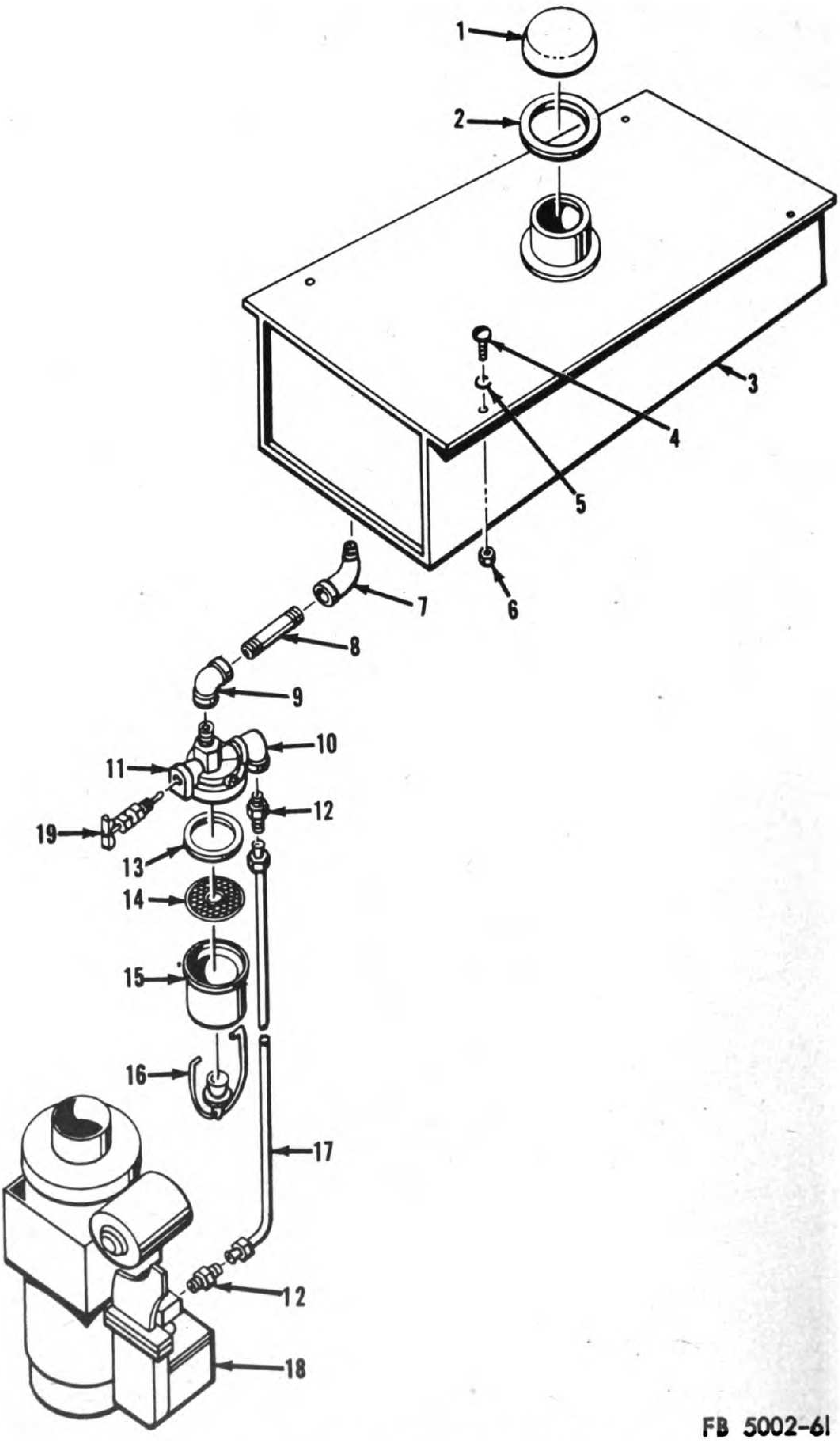


Figure 61. Heater fuel system, exploded view.

1	Cap	8	Pipe nipple	14	Screen
2	Filler neck seal	9	90° elbow	15	Metal bowl
3	Heater fuel tank	10	Street elbow	16	Bail assembly
4	Screw, machine (4 req'd)	11	Head	17	Tubing
5	Lockwasher (4 req'd)	12	Male connector	18	Engine heater
6	Nut (4 req'd)	13	Gasket	19	Shutoff valve
7	Street elbow				

Figure 61—Continued.

(*b*) Remove the bolts (6 and 34, fig. 19) with nuts and lockwashers securing the top housing (7) to the front housing (18) and the post housings (5, 11, and 27).

(*c*) Lift the top housing off the generator set and remove the tank cap (1, fig. 61).

(*d*) Remove the screws (4), lockwashers (5), and nuts (6) securing the tank and seal (2) to the top housing, and separate the parts.

(*e*) Unscrew the strainer assembly, elbows (9 and 7), and the nipple (8) from the tank.

(2) *Cleaning and repair.* Cleaning and repair procedures for the heater tank are the same as for the diesel fuel tank (par. 80*c* and *d*).

(3) *Installation.*

(*a*) Screw the strainer assembly, elbows (9 and 7), and the pipe nipple (8) into the tank (3).

(*b*) Secure the tank and seal (2) to the top housing (7, fig. 19) with the screws (4, fig. 61), lockwashers (5), and nuts (6). Install the cap (1).

(*c*) Position the top housing on the generator set and secure to the front housing (18, fig. 19) and post housings (5, 11, and 27) with the bolts (6 and 34), lockwashers, and nuts.

(*d*) Connect the tubing (17, fig. 61) to the connector (12) and fill the tank (3). Check the system for leaks.

c. Fuel Strainer (fig. 61).

(1) *Cleaning.* Close the valve (19) and loosen the bail (16). Remove the bowl (15), screen (14), and gasket (13). Wash the bowl and screen in cleaning solvent and install the gasket, screen, and bowl. Secure with the bail and open the valve.

(2) *Removal.* Drain the tank (*b*(1)(*a*) above). Remove the connector (12) at the elbow (10) and unscrew the strainer from the elbow (9).

(3) *Installation.* Screw the strainer into the elbow (9) and the connector (12) into the elbow (10). Connect the tubing (17) and fill the tank (3).

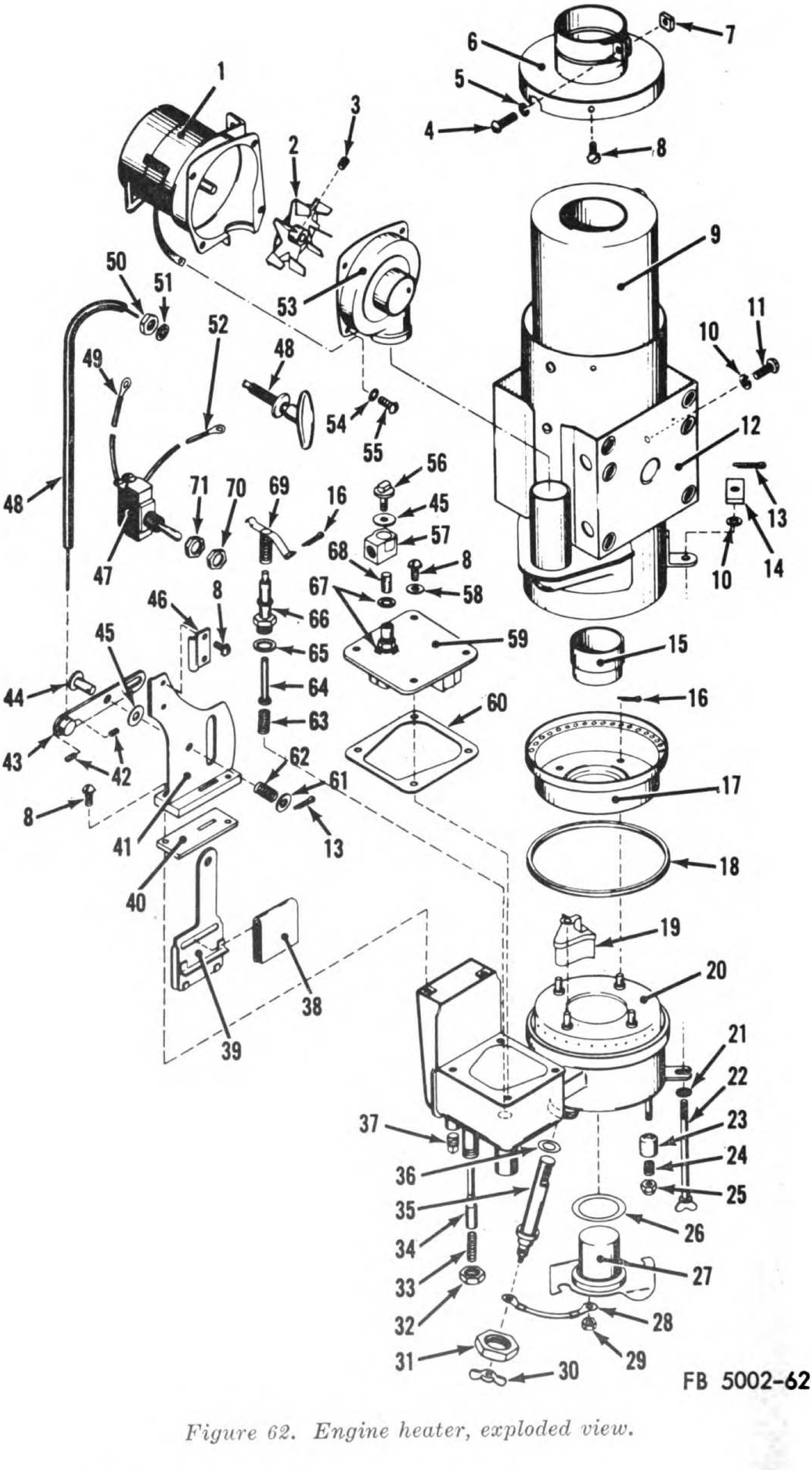


Figure 62. Engine heater, exploded view.

1 Blower motor
2 Blower wheel assembly
3 Screw, set, cup-pt, hdls, sltd, No. 10 x 1/4 in. NF (1 req'd)
4 Screw, mach, rd-hd, No. 10 x 3/4 in. NC (1 req'd)
5 Washer, lock, No. 10 (1 req'd)
6 Chamber top assembly
7 Nut, square, No. 10 NC (1 req'd)
8 Rd-hd fastener
9 Heat exchanger assembly
10 Washer, lock, 1/4 in. (2 req'd)
11 Screw, mach, rd-hd, 1/4 x 3/8 in. NC (2 req'd)
12 Combustion chamber assembly
13 Pin, cotter, 1/16 x 1/2 in. (4 req'd)
14 Thumb screw nut
15 Burner wick assembly
16 Pin, cotter, 3/32 x 3/4 in. (3 req'd)
17 Burner throat
18 Burner packing
19 Igniter shield assembly
20 Burner assembly
21 Washer, lock, int-teeth, 1/4 in. (2 req'd)
22 Thumbscrew
23 Resistor retainer
24 Spring
25 Acorn nut
26 Resistor gasket
27 Igniter resistor
28 Wire jumper assembly
29 Nut, hex, No. 10 NC (1 req'd)
30 Nut, wing, brass, No. 10 NC (1 req'd)
31 Igniter nut
32 Pipe cap assembly
33 Valve spring
34 Valve plunger
35 Igniter assembly
36 Igniter gasket
37 Chamber plug
38 Feed wick
39 Wick holder assembly
40 Felt gasket
41 Cover and bracket assembly
42 Setscrew
43 Operating lever assembly
44 Lever pin
45 Fiber washer
46 Cable clamp
47 Switch assembly
48 Control cable assembly
49 Switch-to-motor cable
50 Nut, hex, 3/8 in. NF (1 req'd)
51 Washer, lock, 3/8 in. (1 req'd)
52 Switch-to-resistor cable
53 Right scroll assembly
54 Washer, lock, int-teeth, No. 8 (6 req'd)
55 Screw, mach, rd-hd, No. 8 x 3/8 in. NC (4 req'd)
56 Inlet fitting bolt
57 Special tee
58 Fiber washer
59 Float valve assembly
60 Cover gasket
61 Washer, plain, 5/8 x 17/64 x 1/16 in. (2 req'd)
62 Lever spring
63 Valve spring
64 Overflow valve plunger assembly
65 Tube gasket
66 Overflow tube
67 Fiber gasket
68 Strainer
69 Locking lever assembly
70 Switch nut
71 Switch nut

Figure 62—Continued.

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d. Feed Wick Assembly (fig. 62).

(1) *Removal.* Disconnect the control cable (48) at the operating lever (43), and release the cable sheath from the clamp (46). Remove the screw fasteners (8), securing the bracket (41), gasket (40), and wick holder (39) to the feed chamber, and remove the parts.

(2) *Inspection.* Inspect the wick (38) without removing it from the holder (39). If dirt or moisture is deposited on the wick, wash it in cleaning solvent and blow dry with compressed air. If the wick is frayed or torn, replace it ((3) and (4) below). Check the operating lever and wick holder for free but positive action.

(3) *Disassembly.* To remove the operating lever (43), remove two cotter pins (13), two plain washers (61), two springs (62), fiber washer (45), and two pins (44). Separate operating lever, bracket (41), gasket (40), and wick holder (39). Open wick holder prongs and remove wick (38).

(4) *Reassembly.* Fold the feed wick (38) in half and insert it in wick holder (39). Fit the ends through the extension arms and lock in place by clinching the prongs over the ends of the wick. Place the gasket (40) on

bracket (41) and insert wick holder in the bracket slot. Attach the operating lever (43) to bracket and wick holder with two pins (44), fiber washer (45), two springs (62), two plain washers (61), and two cotter pins (13).

(5) *Installation.* Position the assembled wick holder (39) and bracket (41) on the feed chamber and secure with the screw fasteners (8). Connect the control cable (48) to the operating lever (43) and secure the cable sheath with the clamp (46).

e. Feed Chamber Valve (fig. 62).

(1) *Removal.* Remove the cap (32), valve spring (33), and valve plunger (34) from the valve body.

(2) *Cleaning and inspection.*

(*a*) *Cleaning.* Clean the feed chamber valve parts with an approved cleaning solvent.

(*b*) *Inspection.* Check the plunger (34) for scoring, straightness of the stem, and freedom of movement in the valve body. Examine the spring (33) for cracks or breaks, and the cap (32) for damaged threads. Replace a defective valve part.

(3) *Installation.* Insert the plunger (34) and spring (33) in the valve body. Screw on the cap (32).

f. Float Valve Assembly (fig. 62).

(1) *On-engine testing.* Remove the fasteners (8) and washers (58). Lift and hold the float assembly (59) in its normal position and move the float up and down. The fuel flow should stop when the float is in the up position. If fuel still flows, replace the float valve assembly.

(2) *Removal.* Shut off the fuel supply and disconnect the fuel line at the tee (57). Remove the screw fasteners (8) and fiber washers (58). Remove the float valve assembly (59) and gasket (60). Unscrew the inlet fitting bolt (56) and remove the fiber washer (45), tee (57), strainer (68), and gasket (67).

Note. Do not further disassemble the float valve assembly, since the settings of the needle valve and float are extremely critical. If there are any defective parts, replace the entire float valve assembly.

(3) *Cleaning and inspection.*

(*a*) Clean float valve assembly (59) with an approved cleaning solvent.

(*b*) Check condition of the float, float arm, and bearing surfaces. The float must be free of dents and the float arm should not have any buckles. Immerse float valve assembly (59) in very hot water to check for leakage. The hot water will expand the air in the float and bubbles will appear if the float leaks. Replace a defective float valve assembly.

(4) *Adjustment.* Adjust the position of the float by bending the float arm until a 13/32-inch dimension is obtained between the bottom of the float valve assembly cover and the top surface of the float when the needle valve is seated.

(5) *Installation.* Assemble gasket (67), strainer (68), tee (57), and washer (45) to float valve assembly (59). Secure with bolt (56). Install gasket (60) and float valve assembly and secure with the screw fasteners (8) and washers (58). Connect the fuel line to the tee (57), turn on the fuel, and check for leaks.

g. Locking Lever and Overflow Valve (fig. 62).

(1) *Removal.* Remove the float valve assembly (*f* above) and the cotter pin (16) attaching the locking lever (69) to the float chamber. Lift out the lever and remove the overflow tube (66) and gasket (65).

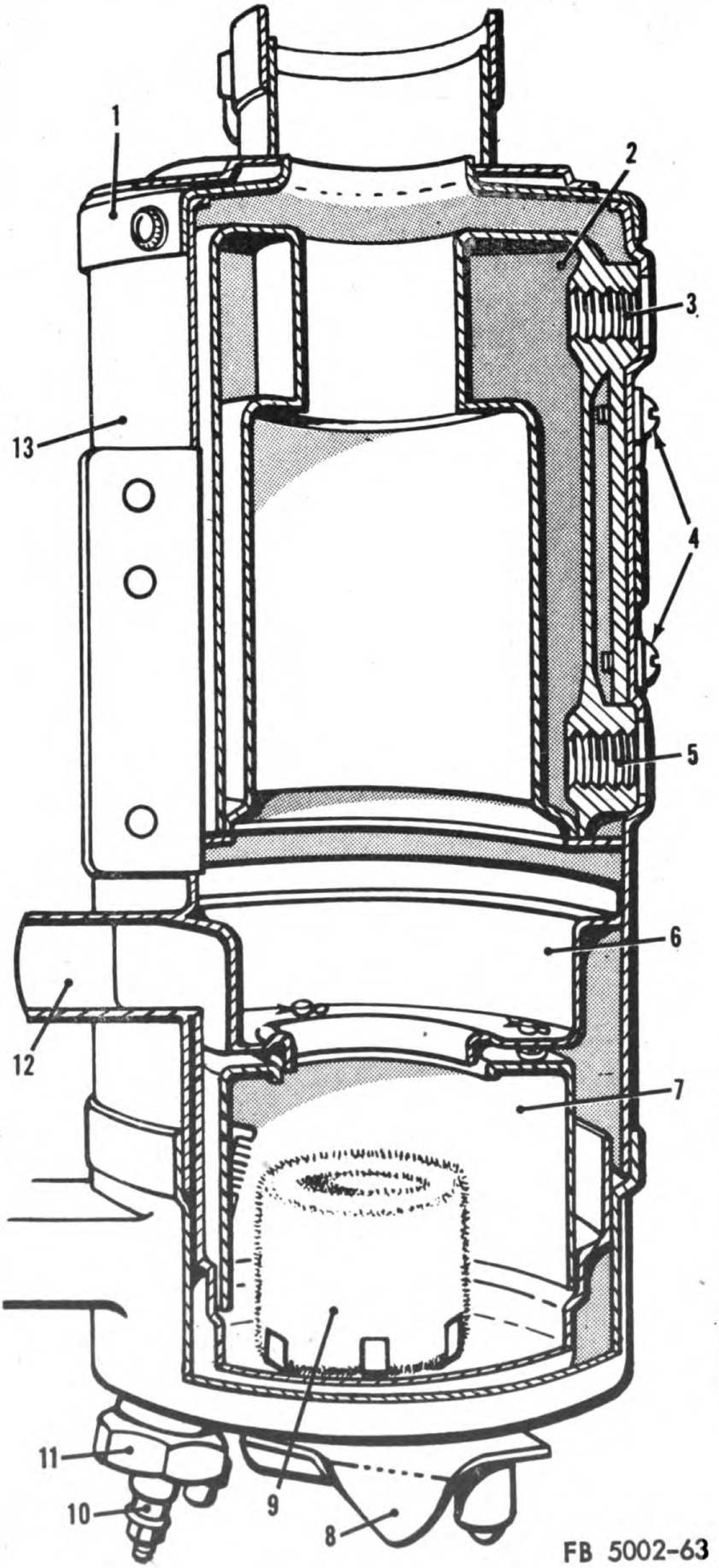
Caution: When removing the overflow tube, apply the wrench to the hex of the tube only. Remove the plunger (64) and spring (63).

(2) *Cleaning and inspection.*

(*a*) *Cleaning.* Clean the tube (66), plunger (64), and spring (63) with an approved cleaning solvent.

(*b*) *Inspection.* Proper operation of the overflow valve is determined by the condition of the washer located on the end of the plunger (64) and the seat of the overflow tube (66). If the tube gasket (65) is worn, replace with a new gasket. If the overflow tube seat is scored or damaged, replace with a new tube. Replace the plunger if any part is defective or worn. Replace the spring (63) if it is cracked or broken.

(3) *Installation.* Install the springs (63) and plunger (64) in the valve body. Position the gasket (65), and screw on the overflow tube (66). Test the valve action for freedom by finger pressure. Attach the locking lever (69) to the float chamber with the cotter pin (16), and install the float valve assembly (*f* above).



1 Combustion chamber top
2 Heat exchanger
3 Coolant outlet
4 Screw, mach, rd-hd, ¼ x ⅜ in. NC (2 req'd)
5 Coolant inlet
6 Burner throat
7 Burner
8 Manual ignition cover
9 Burner wick
10 Igniter
11 Retaining nut
12 Blower air passage
13 Combustion chamber

Figure 63. Engine heater, cutaway view.

h. Burner Assembly.

(1) *Removal* (fig. 63). Disconnect the lead to the resistor mounted in the manual ignition cover (8). Loosen two thumbscrews at the bottom of the heater and separate the burner assembly (6 through 9) from the unit.

(2) *Cleaning and inspection* (fig. 63).

(*a*) Clean the carbon from the burner assembly with an approved cleaning solvent. Clean out the holes in the throat (6) and burner (7) with a pipe cleaner or short length of wire.

(*b*) Examine the interior of the combustion chamber with a mirror and flashlight for signs of coolant leakage. If the heat exchanger (2) leaks, replace it (par. 118). Replace the burner wick (9) if it is frayed, damaged, or burned a quarter of an inch below the top of the manual lighting port tube. The wick can be installed through the burner throat (6).

Note. Once a wick has been removed from the heater, it should be replaced with a new wick. It is advisable to replace the wick at the beginning of each heating season.

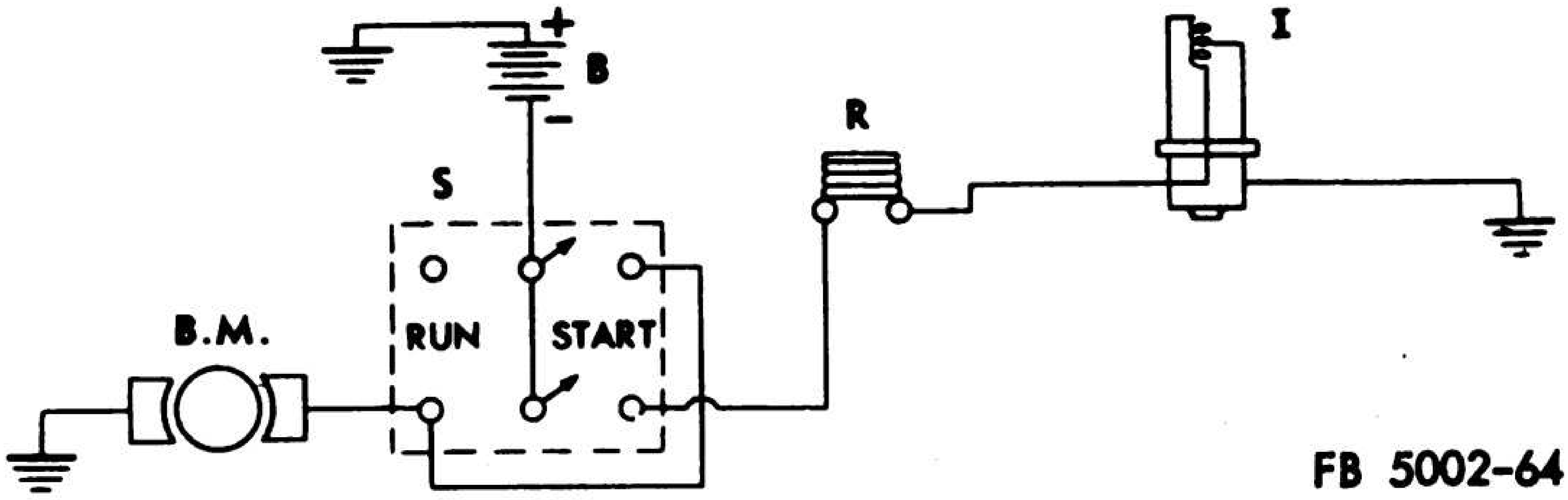
(3) *Disassembly* (fig. 62). Remove the cotter pins (16) and separate the igniter shield (19) and burner throat (17) from the burner assembly (20). Remove the wick (15), acorn nuts (25), springs (24), retainers (23), and packing (18).

(4) *Reassembly* (fig. 62). Roll a new burner packing (18) into the lip of the burner (20), making certain it does not fold over. Install the retainers (23), springs (24), and acorn nuts (25) on the burner studs and tighten the nuts. Position the igniter shield (19) and burner throat (17) on the burner and install the cotter pins (16) in the studs. Install a new wick (15) in the burner.

(5) *Installation* (fig. 63). Attach the burner assembly (6 through 9) to the unit with the thumbscrews, and connect the lead to the resistor mounted in the manual ignition cover (8).

117. Heater Electrical System

a. General. The wiring diagram (fig. 64) indicates the electrical components and wiring connections of the heater. The system consists of a switch (S) mounted on the switchboard panel, a blower motor (B.M.), a resistor (R), and an igniter (I). The resistor is connected in series with the igniter to reduce the terminal voltage to the six volts required for igniter operation.



B.M. Blower motor. S Switch. B Batteries. R Resistor. I Igniter.

Figure 64. Heater wiring diagram.

b. Blower Motor Assembly (fig. 62).

(1) *Inspection.* Inspect the blower motor (1) visually for proper direction of rotation. Rotation is clockwise when observed from the shaft end. Check the motor rpm. Rpm must be at least 5,000 when supplied with the normal rated voltage of the motor. Check the tightness of the assembly. There must be no play or movement between the scroll (53) and motor (1). The blower wheel (2) must be free to turn and must not touch the scroll at the limits of movement allowed by the end play of the motor shaft.

(2) *Removal.* Remove the heater (par. 115) and loosen the screw fasteners attaching the motor blower (1) to the combustion chamber (12). Raise the motor until the slots in the bracket clear the fasteners.

Note. The screw fasteners are peened inside the combustion chamber. Do not attempt to remove them.

Remove screws (55) and lockwashers (54) and motor ground wire from scroll (53). Separate the halves of the scroll assembly. Loosen setscrew (3) and remove blower wheel (2). Do not further disassemble the blower motor, as critical clearances are maintained between the motor and scroll assembly.

(3) *Installation.* Install the wheel (2) on the motor (1) and secure with the setscrew (3). Assemble the scroll (53) to the blower motor (1) with the screws (55) and lockwashers (54), and attach the motor ground wire to it with one of the screws. Position the motor assembly on the combustion chamber (12) and secure with the screw fasteners. Install the heater (par. 115).

c. Igniter Assembly (fig. 62). The igniter (35) consists of a coil of resistance wire, partially encased in a protective metal cartridge. When the switch is moved to START, the igniter is heated, causing the fuel in the burner wick to ignite.

(1) *Removal.* Disconnect the lead to the igniter (35), remove the nut (31), and take out the igniter and gasket (36).

(2) *Testing.* Ground the igniter tube and apply six volts to the igniter (35). An igniter in good condition will draw from 10 to 12 amperes and heat to a bright red in a few seconds.

Caution: Test the igniter with six volts only.

(3) *Installation.* Insert the igniter (35) and gasket (36) in the base of the burner (20). Make certain the indexing dot on the igniter is inserted in the groove of the igniter housing. Secure with the nut (31) and connect the lead.

d. Resistor Assembly (fig. 62). The resistor (27) is mounted in the base of the burner (20) and extends up into the burner wick (15).

(1) *Removal.* Remove the two leads and twist the resistor to release it from the retainers (23). Remove the resistor and gasket (26).

(2) *Testing.* Check the continuity through the coil of the resistor (27) with an ohmmeter when the resistor is cold. Connect the resistor across 18 volts d-c and in series with an ammeter of 15 amperes capacity. The current draw should not exceed 12 amperes after 10 seconds. Check for a short circuit between the resistor terminals and case. Connect an ohmmeter between one of the terminals and the case. An open circuit must be indicated at all times. A closed circuit indicates a short in the resistor.

(3) *Installation.* Cement the gasket (26), copper side down, to the resistor (27). Insert the resistor in the burner (20) and twist to engage the retainers (23). Connect the leads.

118. Heater Coolant System

a. General. The heater coolant system consists of a removable heat exchanger (9, fig. 62) which forms a part of the combustion chamber. Coolant lines are connected to the coolant inlet (5, fig. 63) and outlet (3) of the exchanger and connected to the cylinder block water jacket. For a description of the heater coolant system, refer to paragraph 20.

b. Inspection. To inspect the heat exchanger, remove the burner (par. 116*b*). If there are signs of coolant leakage, replace the heat exchanger. If the carbon deposit exceeds an eighth of an inch, remove and clean the exchanger.

c. Removal. Remove the heater (par. 115). Remove the fasteners (8, fig. 62) securing the top (6) to the chamber (12). Remove the screws (4, fig. 63) and lockwashers, and slide out the exchanger (2).

d. Cleaning. Thoroughly clean off the carbon with an approved cleaning solvent. Flush the interior of the exchanger (2) with a suitable solvent and neutralize.

e. Installation. Slide the exchanger (2) into the chamber (12, fig. 62) and secure with the screws (4, fig. 63) and lockwashers. Install the top (6, fig. 62) and secure with the fasteners (8). Install the heater (par. 115).

119. Heater Air System
(fig. 15)

a. General. The air system consists of a heater blower (9) and an air passage through the heater (10). The blower provides combustion air and eliminates backdrafts. Exhaust gases are forced out of the heater through a cross (12). The automatic battery overheat control (15) directs and controls heat distribution to the battery box (1) and oil pan shroud. When the control is closed the exhaust gases are forced through the hoses (6 and 13) to the battery box (1) and oil pan shroud until the battery box temperature reaches 100° F. and the control starts to open. With the control open, gases are allowed to exhaust into the air through the hood (16) and tube.

b. Blower. The blower and motor are removed and installed as a unit (par. 117*b*).

c. Hoses. Loosen the clamps to remove the heater air hoses (6 and 13).

d. Battery Overheat Control.

(1) *Removal.* Remove the cotter pin and washer securing the valve and shaft to the hood (16). Remove the screws and lockwashers securing the control (15) to the hood, and remove the control. Pull the thermocouple out of the battery box (1).

(2) *Testing.* The control (15) has a range of 100° to 135° F. To test, insert the thermocouple in water and proceed as in paragraph 92*c*.

(3) *Installation.* Assemble the control (15) and valve to the hood (16) and secure the control shaft with the washer and cotter pin. Secure the control to the hood with the

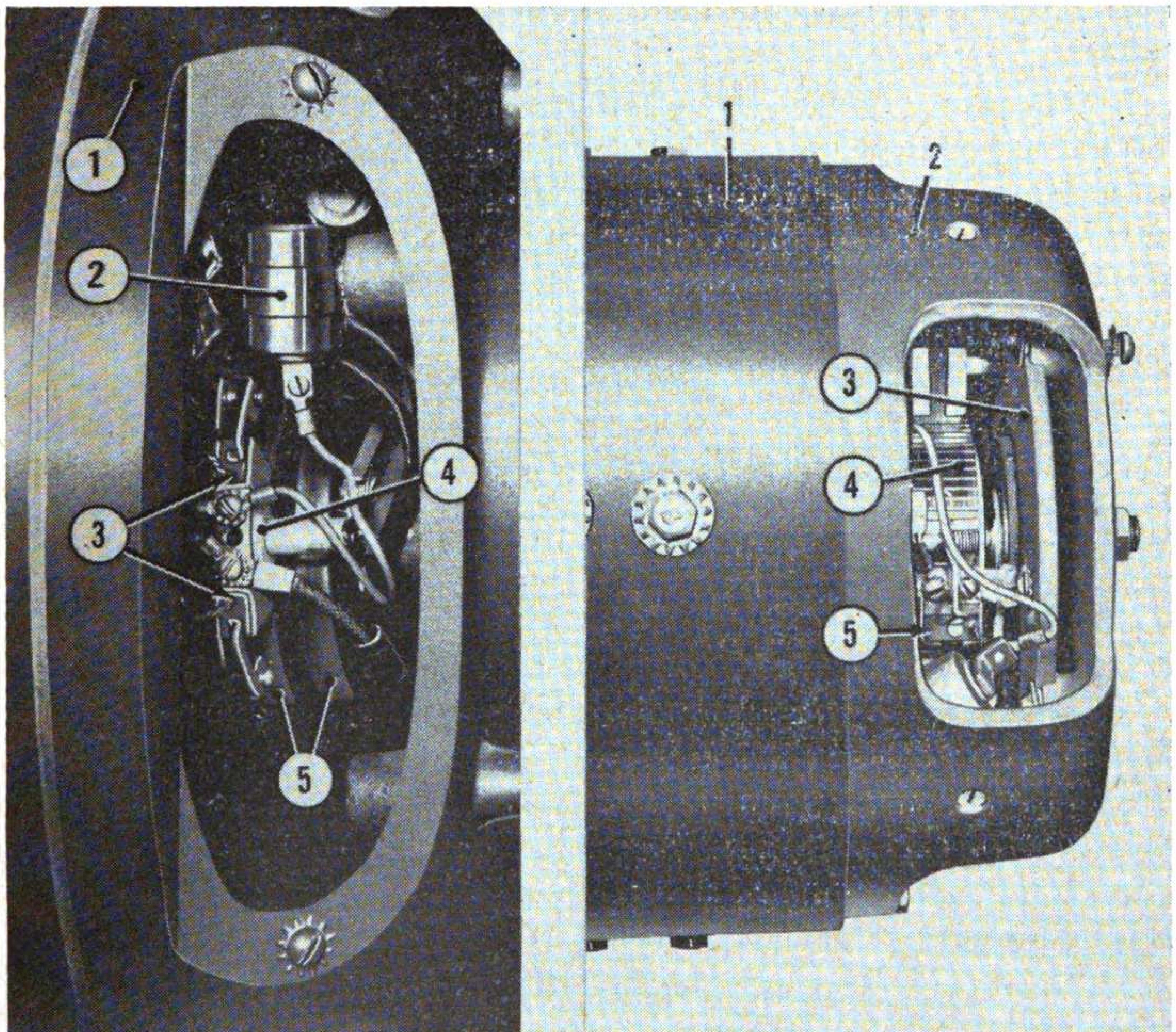
screws and lockwashers. Install the thermocouple in the battery box (1).

e. Oil Pan Shroud. To remove and install the oil pan shroud, refer to paragraph 103.

Section XIV. GENERATOR ASSEMBLY

120. Description

a. Alternator (A, fig. 65). The single bearing rotating field alternator is directly connected to the engine flywheel through a disk type flexible coupling. The shields, located on the alternator



A

1 Alternator commutator bell end
2 Capacitor
3 Alternator brushes
4 Alternator brush holder
5 Sliprings

B

1 Alternator commutator bell end
2 Exciter commutator bell end
3 Brush holder ring
4 Commutator
5 Exciter brush

Figure 65. Generator with shields removed.

commutator bell end (1) are removed to inspect and service the brushes (3), brush holders (4), or slipsprings (5).

b. Exciter (B, fig. 65). The 125-volt, d-c exciter is coupled directly to the alternator. A shield that fits over the bell end (2) is removed to inspect and service the brushes (5), brush holder ring (3), or commutator (4).

121. Commutator
(B, fig. 65)

a. Inspection. Remove the shield from the exciter bell end (2) and inspect the commutator (4) for dirt, rough and pitted appearance, and high mica between the commutator segments. A good commutator has a polished look and a light color. Even though the commutator may appear to be in good condition when inspected, it may spark badly when running. If such sparking occurs, report it to the proper authority as serious damage may result.

b. Cleaning. Clean the commutator (4) with fine sandpaper. Do not use emery cloth. Do not use a lubricant on the commutator or brushes (5). Lift the brush tension arms and lift the brushes so they are clear of the commutator. Run the sandpaper under the brushes, with the abrasive side contacting the commutator. An alternate cleaning procedure is to polish the commutator with a piece of canvas or other similar hard woven (nonlinting) material. If the commutator cannot be cleaned or if there is high mica between the segments, it will have to be machined. The generator must be partially disassembled and the commutator undercut. When machining is required, report it to the proper authority.

122. Exciter Brushes
(fig. 66)

a. Inspection. Check the brushes (3) for freedom in the brush holders (4). Make sure the brush rigging is fastened securely. See that the brush stud insulation is not cracked or broken. Examine the brush leads to see that they are tightly fastened and in good condition. Replace brushes which are less than half their original length.

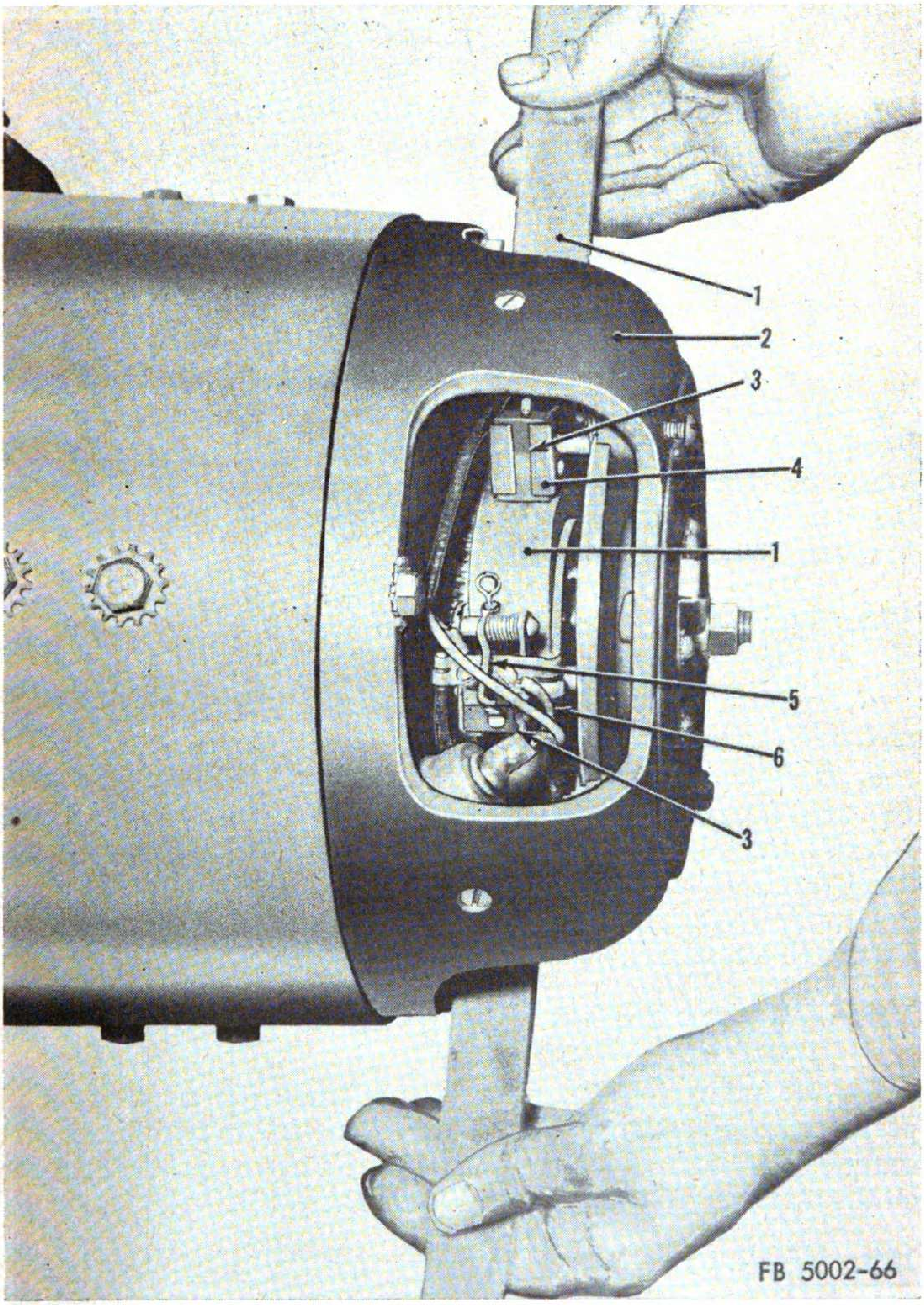
b. Cleaning. Wipe the brushes (3) and brush holders (4) clean when the generator is not operating.

c. Removal. Disconnect the brush leads (6) from the brush holders (4). Lift the tension arms (5) and remove the brushes.

d. Installation. Place the brushes (3) in the brush holders (4) and connect the leads (6) to the brush holder. Position the tension arms (5). Seat the brushes and check the spring tension (*e* and *f* below).

e. Seating Brushes.

(1) Place a strip of sandpaper (1), with the abrasive side up, between the commutator and brushes. No. 1 sandpaper can be used for the rough cut.



1 Sandpaper. 2 Exciter commutator bell end. 3 Brushes. 4 Brush holder. 5 Brush tension arm. 6 Brush lead.

Figure 66. Seating brushes.

(2) With the tension arms (5) exerting pressure, slide the sandpaper back and forth to shape the brush end to the commutator surface.

(3) After the brush is roughly shaped, use No. 00 sandpaper for the final sanding. Draw the sandpaper in the direction of commutator rotation. This prevents the brush tips from becoming rounded when the generator is started.

f. Checking and Adjusting Brush Spring Tension.

(1) Hook a small spring-type scale under the tension arm (5) and pull directly in line with the brush holder (4). Correct tension on the exciter brushes is 5 to 9 ounces.

(2) Spring tension is increased by moving the spring end into lower notches of the tension arm.

(3) If correct brush spring tension cannot be obtained, the brushes are probably too short and should be replaced.

g. Alining Brush Holders. See that the brushes (3) are centered on the commutator and that the brush holders (4) are not loose. The brush holders are clamped to the studs. If an adjustment is necessary, loosen the clamping screw and center the brushes. Then tighten the screw.

123. Sliprings
(fig. 67)

a. Inspection. See that the insulated sliprings (4) are smooth and well polished.

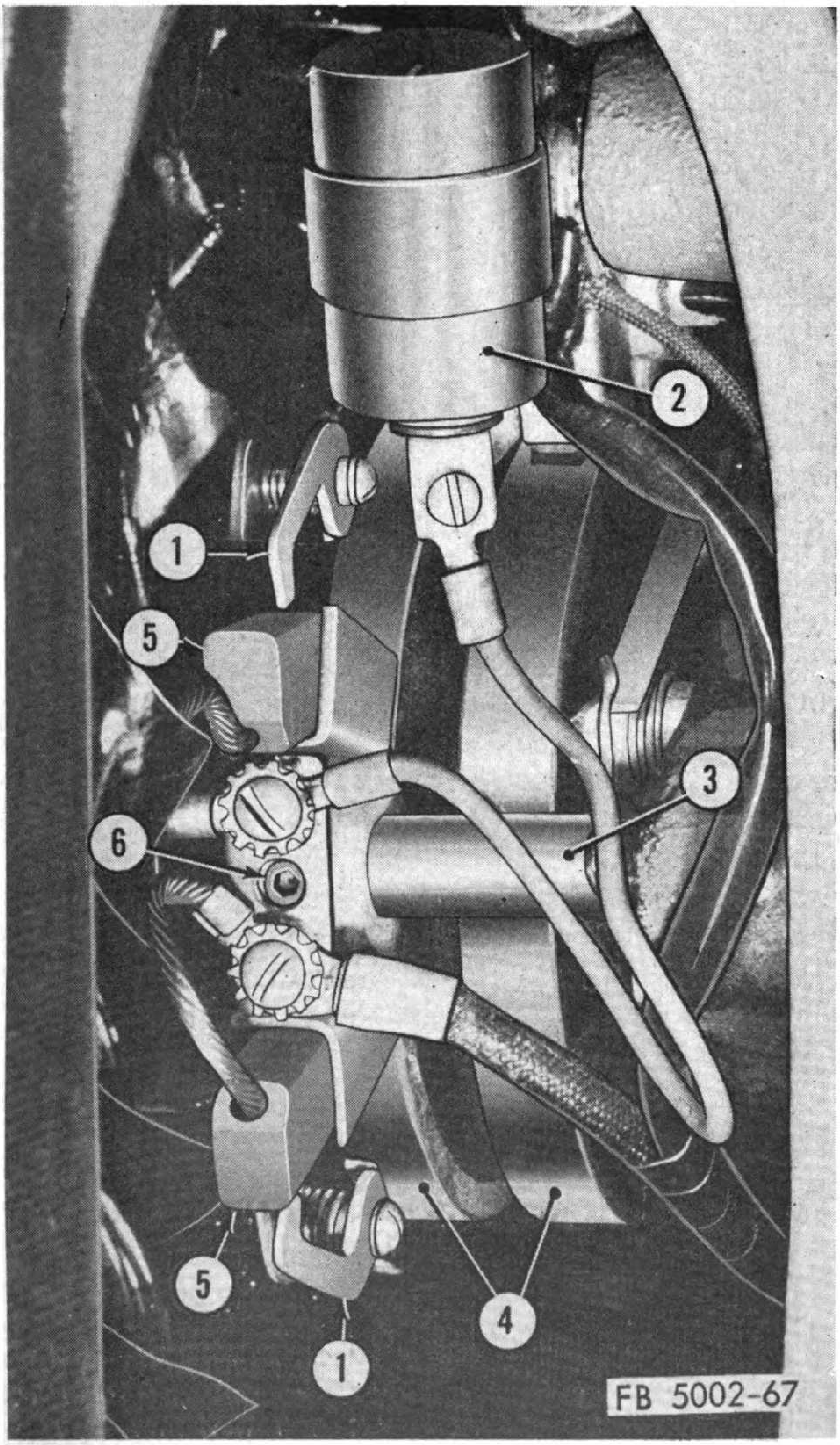
b. Cleaning. While the set is running, polish the sliprings (4) with a pad of canvas or clean, lint-free cloth fastened to the end of a dry piece of wood. If the sliprings have small pits, use a fine grade of sandpaper to remove them. If there are deep pits present or the sliprings are out-of-round, they must be replaced. Report this condition to the proper authority.

124. Alternator Brushes
(fig. 67)

Service and adjust the alternator brushes (5) as directed in paragraph 122. A single brush holder mounting two brushes is centered over each of the sliprings (4). To move the brush holder on the straight pins (3), loosen the setscrew (6).

125. Windings

a. Inspection. The small inspection holes permit only a very limited inspection of the windings. Inspect the alternator and exciter windings for excessive dirt or moisture. A normal amount of dust or dirt may be expected and should not interfere with the operation of the generator. Inspect the windings for melted varnish which indicates overheating.



1 Tension arm. 2 Capacitor. 3 Straight pin. 4 Sliprings. 5 Brushes 6 Setscrew.

Figure 67. Alternator brushes and sliprings.

b. Cleaning. If possible, use suction or dry compressed air, not over 10 psi, to clean the windings, if grease or sticky dirt is present, the generator must be partially disassembled for cleaning. Report this condition to the proper authority.

126. Time Delay Relay and Resistor

a. General (fig. 9). For a description of the relay, refer to paragraph 14*a*. No adjustment is necessary except when operating in extreme cold (par. 23) or extreme heat (par. 24), or for the installation of a new resistor (13).

b. Adjustment (fig. 9). To adjust the relay (4) so that it will trip the main circuit breaker (12) when the load exceeds 125 percent of rated capacity, loosen the slide on the resistor (17) and move it up to decrease resistance and lower the overload trip point, or down to increase resistance and raise the overload trip point. Tighten the slide and check the adjustment by operating the generator set and increasing the load until it reaches the above value. If the main circuit breaker (12) is tripped before this point, increase the resistance. If the set still operates beyond this point, decrease the resistance.

c. Relay and Bracket Removal. Disconnect the leads at the relay (4, fig. 9) and remove the screws, lockwashers, and nuts securing the relay and bracket to the switchboard panel (9, fig. 4).

d. Relay and Bracket Installation. Secure the relay (4, fig. 9) and bracket to the switchboard panel (9, fig. 4) with the screws, lockwashers, and nuts. Connect the leads.

e. Resistor Removal. Disconnect the leads at the resistor (17, fig. 9) and remove the screws, lockwashers, and nuts securing the resistor to the switchboard panel (9, fig. 4).

f. Resistor Installation. Secure the resistor (17, fig. 9) to the switchboard panel (9, fig. 4) with the screws, lockwashers, and nuts. Connect the leads.

Section XV. SWITCHBOARD PANEL AND CHANGEOVER PANEL

127. General

a. Wiring (fig. 68). Complete connections for the switchboard panel, exciter, generator, engine electrical, and heater systems are shown in figure 68. Wire and terminal markings agree with those on the equipment. For removal, inspection, and replacement of wiring, refer to paragraph 94.

Note. When removing and installing wiring, follow instructions and the wiring diagram carefully. Mark or tag any wires or terminals not marked or whose markings have become illegible.

b. Controls and Instruments. For a description of the controls and instruments, refer to paragraphs 10 through 13. Maintenance on the controls and instruments is limited to replacement of defective items.

Note. When replacing controls and instruments, install all toothed washers in the same position they were in before removing. These washers are essential parts of the radio suppression system.

c. Lights. Replace burned out lamps with new ones of the correct type and voltage.

Warning: Before doing any work on the switchboard, make sure the generator set is not operating.

128. Starter Push Switch
(fig. 10)

a. Removal. Disconnect the leads at the switch (27). Unscrew the clamping nut and remove the switch.

b. Installation. Secure the switch (27) to the switchboard with the clamping nut and connect the leads.

129. Throttle Control

a. Removal. Disconnect the control wire (12, fig. 26) at the operating lever (11). Loosen the clamps securing the control wire sheath to the frame. Remove the retaining nut from the throttle control (14, fig. 10) and pull the control from the switchboard panel.

b. Installation. Insert the control (14, fig. 10) in the switchboard panel and secure with the retaining nut. Clamp the control wire sheath to the frame and attach the control wire (12, fig. 26) to the operating lever (11).

130. Stop Control

a. Removal. Disconnect the control wire (7, fig. 26) from the fitting (5). Loosen the clamps securing the control wire sheath to the frame. Remove the retaining nut and pull the stop control (13, fig. 10) from the switchboard panel.

b. Installation. Insert the control (13, fig. 10) in the switchboard panel and secure with the retaining nut. Clamp the control wire sheath to the frame and connect the control wire (7, fig. 26) to the fitting (5).

131. Cold Start Primer
(fig. 10)

The primer (9) is covered with the flame heater assembly. For instructions on removal and installation of the primer, refer to paragraph 112*k*.

132. Heater Switch
(fig. 10)

a. Removal. Disconnect the leads at the heater switch (10) and unscrew the nut securing it to the switchboard panel.

b. Installation. Secure the switch (10) to the switchboard panel with the nut and connect the leads.

133. Heater Control

a. Removal. To remove the heater control (11, fig. 10), remove the control cable (48, fig. 62) from the operating lever (43) and clamp (46). Unscrew the retaining nut and washer securing the control to the switchboard panel and remove the control.

b. Installation. Insert the heater control (11, fig. 10) in the switchboard panel and secure with the washer and nut. Connect the control cable (48, fig. 62) to the operating lever (43) and secure with the clamp (46).

134. Oil Pressure Gage
(fig. 10)

a. Removal. Disconnect the oil line at the gage (24) and remove the screws, lockwashers, and nuts securing the gage to the bracket.

b. Installation. Secure the gage (24) to the bracket with the screws, lockwashers, and nuts. Connect the oil line.

135. Water Temperature Gage

a. Removal. To remove the gage (26, fig. 10), unscrew the thermocouple from the elbow (1, fig. 52). Remove the screws, lockwashers, and nuts attaching the gage to the bracket.

b. Installation. Secure the gage (26, fig. 10) to the bracket with the screws, lockwashers, and nuts. Install the thermocouple in the elbow (1, fig. 52).

136. Battery Ammeter
(fig. 10)

a. Removal. Disconnect the leads at the ammeter (25) and remove the screws, lockwashers, and nuts securing the ammeter to the bracket.

b. Installation. Secure the ammeter (25) to the bracket with the screws, lockwashers, and nuts. Connect the leads.

137. Voltage Regulator, Panel Light, CCC, and Synchronizing Lamp Switches

The voltage regulator switch (22, fig. 10), panel light switch (18), CCC switch (17), and synchronizing lamp switch (16) are removed and installed in the same way.

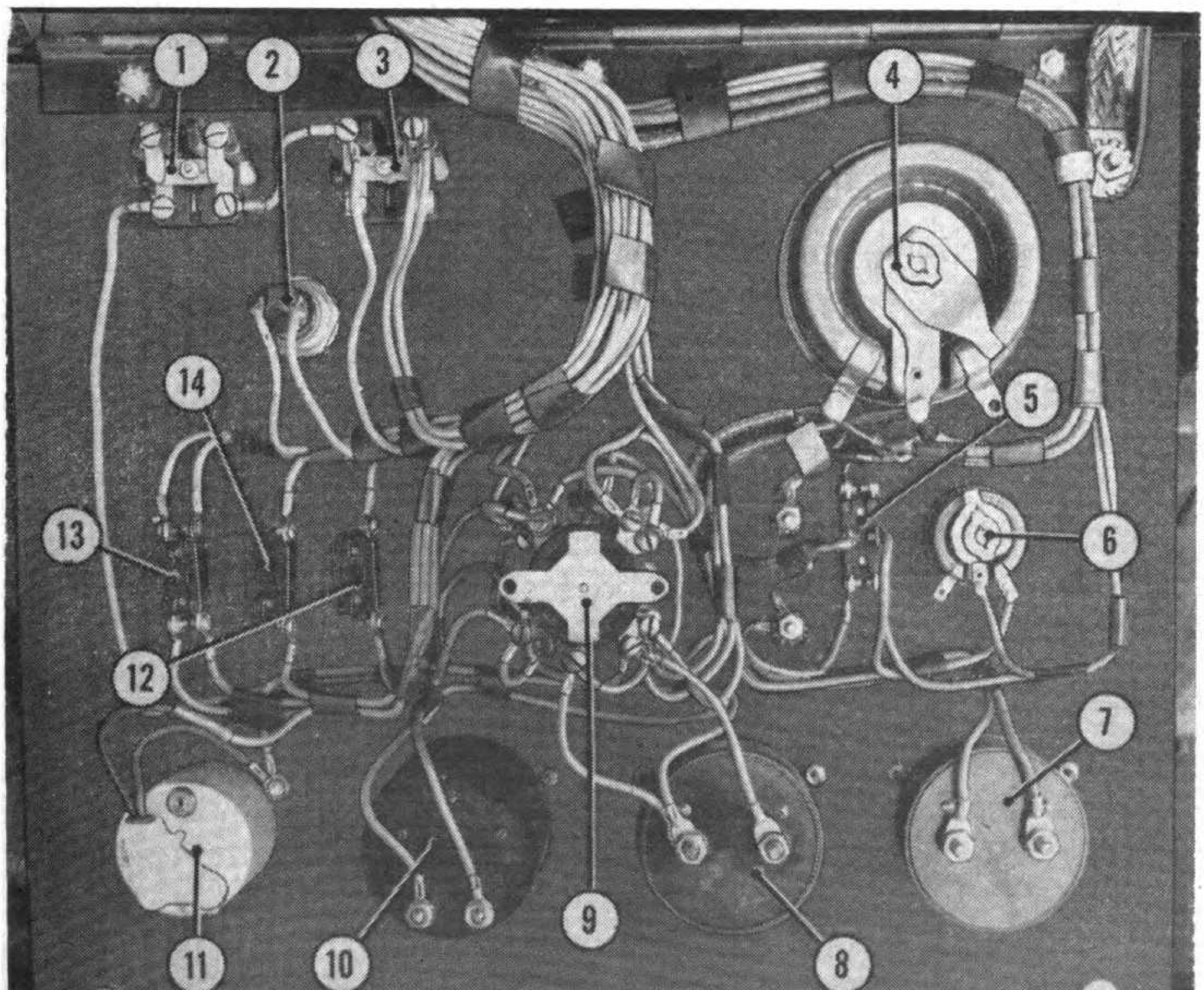
a. Removal (fig. 69). To remove any one of the switches (5, 12, 14, or 13), disconnect the leads and unscrew the nut from the front of the switchboard door panel.

Note. Tag all unmarked leads for identification.

b. Installation (fig. 69). To install the switches (5, 12, 13, or 14), secure the switch to the switchboard door panel with the nut and connect the leads to the switches.

138. Circuit Breaker Off and On Push Switches

The push switches (15 and 20, fig. 10) are removed and installed in the same way.



1 Circuit breaker OFF push switch
2 Generator pilot light
3 Circuit breaker ON push switch
4 Exciter field rheostat
5 Voltage regulator switch
6 Voltage regulator rheostat
7 A-c voltmeter
8 A-c ammeter
9 Phase switch
10 Frequency meter
11 Time meter
12 Panel light switch
13 Synchronizing lamp switch
14 CCC switch

Figure 69. Reverse side of switchboard door panel.

a. Removal (fig. 69). Disconnect the leads to the switches (1 and 3). Remove the screws securing the switches to the front of the switchboard door panel.

b. Installation (fig. 69). Secure the switches (1 and 3) to the front of the switchboard door panel with the screws. Connect the leads to the switches.

139. A-C Voltmeter

a. Removal. Disconnect the leads from the voltmeter (7, fig. 69) and remove the screws, lockwashers, and nuts securing the voltmeter (4, fig. 10) to the switchboard door panel.

b. Installation. Secure the voltmeter (4, fig. 10) to the door panel with the screws, lockwashers, and nuts. Connect the leads to the voltmeter (7, fig. 69).

140. A-C Ammeter

a. Removal. Disconnect the leads from the ammeter (8, fig. 69) and remove the screws, lockwashers, and nuts securing the ammeter (3, fig. 10) to the switchboard door panel.

b. Installation. Secure the ammeter (3, fig. 10) to the door panel with the screws, lockwashers, and nuts. Connect the leads to the ammeter (8, fig. 69).

141. Ammeter-Voltmeter Phase Switch

a. Removal. Disconnect the leads to the phase switch (9, fig. 69). Remove the screw in the switch key and pull the key off the switch (21, fig. 10). Remove the screws and lockwashers securing the switch to the switchboard door panel.

Note. Tag all leads for identification.

b. Installation. Secure the phase switch (21, fig. 10) to the door panel with the screws and lockwashers. Position the key and secure it with the screw. Connect the leads to the switch (9, fig. 69).

142. Frequency Meter

a. Removal. Disconnect the leads at the frequency meter (10, fig. 69) and remove the screws, lockwashers, and nuts securing the meter (2, fig. 10) to the switchboard door panel.

b. Installation. Secure the frequency meter (2, fig. 10) to the door panel with the screws, lockwashers, and nuts. Connect the leads to the meter (10, fig. 69).

143. Electric Time Meter

a. Removal. Disconnect the leads to the meter (11, fig. 69). Remove the screws, lockwashers, and nuts securing the meter (1, fig. 10) to the switchboard door panel.

b. Installation. Secure the time meter (1, fig. 10) and ground leads to the door panel with the screws, lockwashers, and nuts. Connect the remaining leads to the time meter (11, fig. 69).

144. Generator Pilot Light
(fig. 69)

a. Bulb Replacement. Pull the light (2) out of the switchboard door panel and remove the bulb. Replace with the correct type of bulb.

b. Removal. Pull the light (2) out of the switchboard door panel and disconnect the leads. The lens and holder are retained by a nut and insulating washer.

c. Installation. Secure the lens and holder to the switchboard door panel with the nut and insulating washer, and connect the leads to the light (2).

145. Panel Lights
(fig. 4)

a. Bulb Replacement. To replace the bulbs in the panel lights (25), pull the cover off the bulbs and remove the bulbs. Install new 24-volt bulbs.

b. Removal. To remove the lights (25), remove the bulbs (*a* above) and disconnect the leads to the light bases. Remove the nuts and lockwashers securing the light to the switchboard panel (9).

c. Installation. Secure the lights (25) to the switchboard panel (9) with the nuts and lockwashers. Connect the leads and install the bulbs (*a* above).

146. Trouble Light Receptacle
(fig. 10)

a. Removal. To remove the receptacle (12), disconnect the lead and remove the nut and spacer. Remove the receptacle from the front of the panel.

b. Installation. Attach the receptacle (12) to the panel with the spacer and nut and connect the lead.

147. Two-Pole and Three-Pole Receptacles
(fig. 10)

a. Removal. To remove either of the receptacles (7 or 8), disconnect the leads to the receptacle and remove the screws and lockwashers securing it to the panel.

b. Installation. Secure either of the receptacles (7 or 8) to the panel with the screws and lockwashers and connect the leads.

148. Changeover Panel

a. Removal. To remove the changeover panel (13, fig. 4), remove the cover (1, fig. 70) from the box (5). Unscrew the nuts (2) securing the panel (3) to the box and pull out the panel. Disconnect all leads from the reverse side of the panel at the terminals (4).

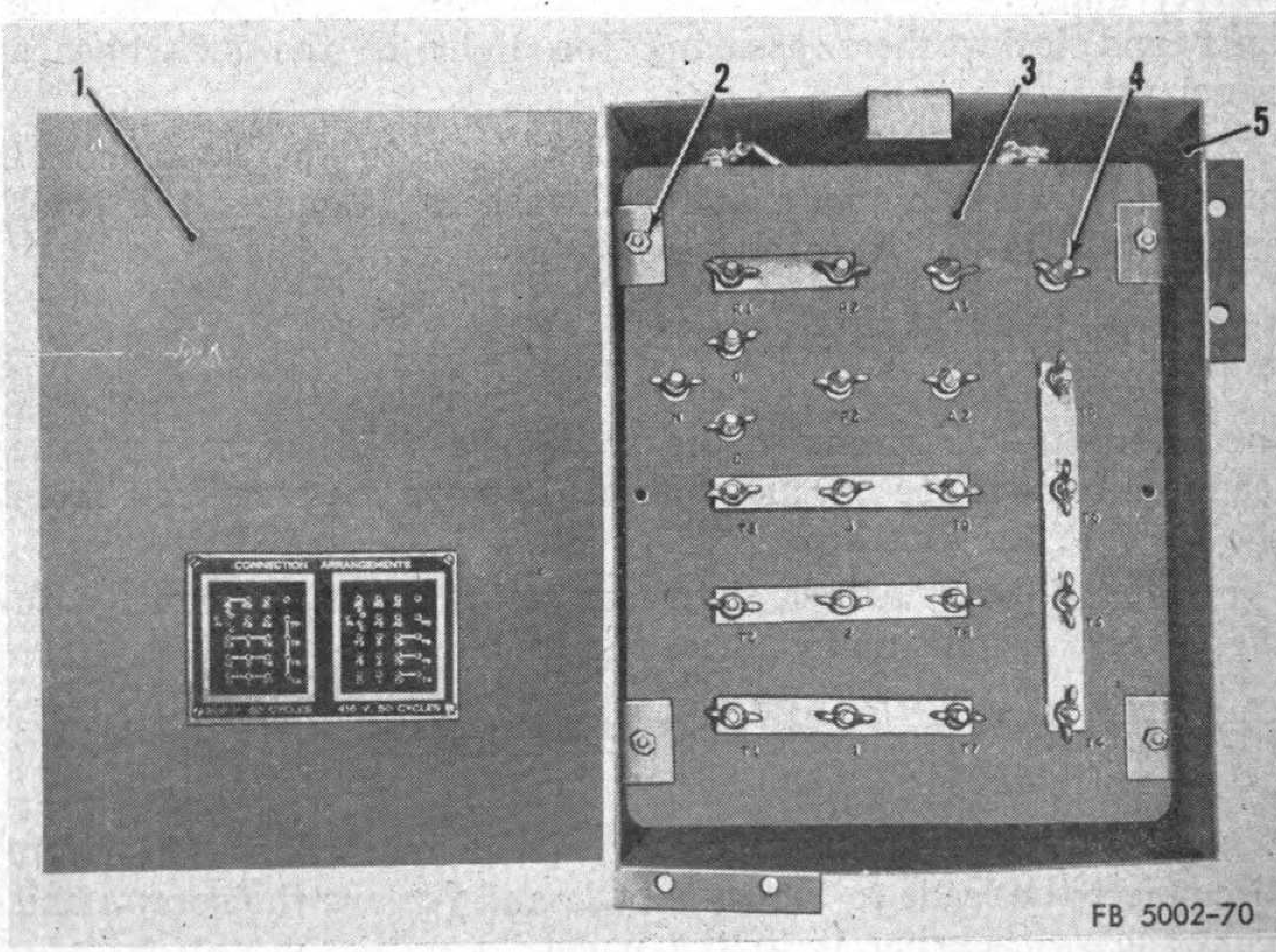
Note. Tag all leads for identification.

b. Installation (fig. 70). Connect the leads to the reverse side of the panel (3) at the terminals (4). Secure the panel to the box (5) with the nuts (2) and install the cover (1).

149. Synchronizing Lamps Resistor
(fig. 9)

a. Removal. To remove the resistors (1), disconnect the leads and remove the screws (15), lockwashers, and nuts securing the resistor bracket (14) to the switchboard panel wall. Remove the nuts (13) and lockwashers to free the resistors from the bracket.

b. Installation. Attach the resistors (1) to the bracket (14) with the nuts (13) and lockwashers. Secure the bracket to the panel wall with the screws (15), lockwashers, and nuts. Connect the leads to the resistors.



1 Cover. 2 Nut (4 req'd). 3 Changeover panel. 4 Terminal. 5 Transformer box.

Figure 70. Changeover panel and transformer box.

150. Voltage Regulator Resistor

a. Adjustment. If the required voltage cannot be obtained by the rheostat (5, fig. 10) under all operating conditions, set the rheostat in its middle range while the generator is running and observe the reading. Then stop the unit, loosen the slide screw, and move the slide of the resistor (18, fig. 9), which is mounted on the regulator panel (5), to vary the voltage until the correct reading is obtained. Secure the slide with the clamping screw.

Caution: Stop the unit before moving the resistor slide.

b. Removal (fig. 9). Disconnect the leads to the resistor (18) mounted on the regulator panel (5). Remove the nut, lockwasher, and screw securing the resistor to the panel brackets.

c. Installation (fig. 9). Secure the resistor (18) to the regulator panel (5) with the screw, lockwasher, and nut. Connect the leads to the resistor.

151. Crosscurrent Compensator (CCC) Resistor

a. General (fig. 9). The CCC resistor (23) is used with the CCC transformer to minimize circulating currents when operating generators in parallel. If circulating currents do exist (*b* below) or if this resistor is replaced, make the adjustment (*c* below).

b. Testing for Circulating Currents (fig. 10). This applies only to two or more units operating in parallel.

(1) Connect an ammeter in the external load line to read total line current in one phase.

(2) Operate the generators in parallel (par. 18*f*).

(3) Turn the phase switch (21) on each generator set to read phase current in the same phase as the external load ammeter.

(4) The sum of the readings of the generator ammeters should equal the reading of total line current. If the sum of the readings is greater than the total line current, circulating currents exist.

c. Adjusting Resistor.

(1) If replacing a resistor (23), set the sliding contact to about the same spot as on the old resistor.

(2) Test for circulating currents (*b* above) and move the sliding contact in eighth-inch steps until the circulating currents are eliminated.

d. Removal (fig. 9). Disconnect the leads to the resistor (23) and remove the screws, lockwashers, and nuts securing the resistor to the panel wall.

e. Installation (fig. 9). Secure the resistor (23) to the panel wall with the screws, lockwashers, and nuts. Connect the leads.

CHAPTER 4

FIELD AND DEPOT MAINTENANCE

Section I. INTRODUCTION

152. General

Instructions in this section and in succeeding sections of this chapter are published for the use of maintenance personnel responsible for third and higher echelons of maintenance of the generator set. They contain information on maintenance which is beyond the scope of the tools, equipment, or supplies normally available to using organizations.

153. Procedure

The following sections describe the complete disassembly, repair, and reassembly of each major unit or system comprising the generator set. Before proceeding with overhaul, check to see that replacement parts are available.

Section II. TOOLS AND EQUIPMENT

154. General

The tools and equipment as listed in this section are those that are required to perform field and depot maintenance on this generator set. Tools and equipment issued as on-equipment tools and common mechanic's handtools have not been enumerated in this section. No specially designed tools or equipment are required.

155. Field and Depot Maintenance Tools and Equipment

The tools and equipment in table II bearing identification are listed in Department of the Army ENG 3–41, ENG 5–41, and ENG 6 supply manuals. The tabulation contains only the tools and equipment necessary to perform the operations illustrated or described in this chapter. This table is included for information only and is not to be used for requisitioning tools or equipment.

Table II. Field and Depot Maintenance Tools and Equipment

Item		References Fig.	Par.	Use
Gap gage		87	177*c*	Measuring governor spring gap.
Puller		82	177*a*	Pulling injector pump camshaft.
Plunger spring compressing tool.		83	177*a*	Compressing pump plunger spring.
Extractor		84	177*a*	Removing injector pump delivery valve.
Bushing pressing tool			177*a*	Pressing injector pump camshaft bushing.
Test stand		89	177*e*	Testing and calibrating injector pump.
Nozzle centering sleeve		91	178*e*	Centering valve body in nozzle holder assembly.
Nozzle testing outfit		92	178*f*	Testing and adjusting nozzle holder assembly.
	Federal Stock No.			
Growler, electric	17-5550. 500.100	75	172*d*	Testing battery-charging generator and starter.
Megohmeter, insulation testing.	17-7215. 600.500		208*a*, 209*c*, 214*b*, 217*b*.	Testing insulation of main generator windings.

Section III. CONTROLS AND INSTRUMENTS

156. Switchboard Panel

a. General (fig. 4). The switchboard panel (9) consists of a hinged door section panel (10) and a lower engine control panel (11). All the controls and instruments necessary for operation of the generator set are mounted on the front of the switchboard panel. Wiring and electrical equipment inside the panel are accessible through the door section panel (10).

Warning: Before doing any work on the control panel, make sure the unit is not operating. Follow the instructions in paragraph 127.

Note. Tag all leads for identification before disconnecting any electrical components.

b. Removal.

(1) Remove the housing section (par. 73*a*).

(2) Disconnect the leads entering the switchboard panel at the terminal strips (6 and 22, fig. 9).

(3) Disconnect the load lines at the top of the main circuit breaker (12). The lower load lines can be disconnected at either the main circuit breaker or terminal block (16, fig. 4).

(4) Disconnect the strap grounding the panel (9) to the exciter (15) at the exciter.

(5) Free the throttle control (par. 129), stop control (par. 130), primer (par. 131), heater control (par. 133), oil pressure gage (par. 134), and water temperature gage (par. 135) so they can be removed with the panel.

(6) Remove the screws, lockwashers, and nuts securing the panel (9) to the frame (20).

c. Repair (fig. 4). Remove all instruments and controls before removing dents or welding breaks in the panel (9). If only painting is required, carefully mask all instruments, controls, and terminals.

d. Installation.

(1) Secure the panel (9, fig. 4) to the frame (20) with the screws, lockwashers, and nuts.

(2) Connect the water temperature gage (par. 135), oil pressure gage (par. 134), heater control (par. 133), primer (par. 131), stop control (par. 130), and throttle control (par. 129).

(3) Connect the ground strap at the bottom of the panel to the exciter (15).

(4) Connect the load lines to the terminal block (16) or the lower terminals of the main circuit breaker (12, fig. 9). Connect the load lines to the upper terminals of the main circuit breaker.

(5) Connect the leads to terminal strips (6 and 22).

(6) Install housing section (par. 77*c*).

157. Exciter Field Rheostat

a. Removal. Disconnect the leads from the rheostat (4, fig. 69). Loosen the setscrew and remove the knob from in front of the rheostat (23, fig. 10). Remove the nuts and two screws securing the rheostat to the switchboard door panel.

b. Installation. Secure the rheostat (23, fig. 10) to the switchboard door panel with the two screws and nuts. Position the rheostat knob and tighten the setscrew. Connect the leads to the rheostat (4, fig. 69).

158. Voltage Regulator Rheostat

a. Removal. Loosen the setscrew in the knob and remove the knob from the rheostat (5, fig. 10). Disconnect the leads from the rheostat (6, fig. 69) and remove the nut securing the rheostat to the switchboard door panel.

b. Installation. Secure the rheostat (5, fig. 10) to the switchboard door panel. Install the knob and tighten the setscrew. Connect the leads to the rheostat (6, fig. 69).

159. Synchronizing Lights

a. Lamp Replacement. Pull the light base out of the switchboard and remove the lamps (6, fig. 10). Install new 10-watt, 230-volt lamps.

b. Removal. Disconnect the leads to the light bases and pull the bases from the switchboard panel.

c. Installation. Install the light bases in the switchboard panel and connect the leads.

160. Main Circuit Breaker
(fig. 9)

a. Service. Check the contact points of the main circuit breaker (12) for burns and pits. Use a fine-cut file to clean the points. If the points are burned or pitted excessively, replace the circuit breaker.

b. Removal. Disconnect the load lines and leads at the circuit breaker (12) and remove the cap screws (16), lockwashers, and nuts securing it to the wall of the switchboard panel.

c. Installation. Secure the circuit breaker (12) to the panel with the cap screws (16), lockwashers, and nuts. Connect the load lines and leads to the circuit breaker terminals.

161. Safety Control Relays
(fig. 9)

a. Description. The safety control relays (2) trip the main circuit breaker (12) when the circuit breaker push switches are depressed or when the time delay relay (4) is energized due to a generator overload.

b. Removal. Disconnect the leads at the relays (2) and remove the screws, lockwashers, and nuts securing the relays to the panel.

c. Installation. Secure the relays (2) to the panel with the screws, lockwashers, and nuts. Connect the leads.

162. Terminal Strips
(fig. 9)

a. Removal. Disconnect the leads at the strips (6 and 22) and remove the screws, lockwashers, and nuts securing the strips to the panel.

b. Installation. Secure the strips (6 and 22) to the panel with the screws, lockwashers, and nuts. Connect the leads.

163. Generator Voltage Regulator
(fig. 9)

a. Description. The voltage regulator acts as an automatic field rheostat to maintain constant generator output voltage. It consists of a plug-in controlling element (20) and a panel (5) which mounts the control resistors and into which the element is plugged. A variable resistor (18) is attached to the panel above the plug-in element and is used to manually adjust the controlling range of the regulator.

b. Adjustments. The only adjustments are made by adjusting the resistor (par. 150) or the air dashpot screw which is located under the cover of the plug-in element (20). If hunting occurs or if the regulator is sluggish in response, turn the dashpot screw one-eighth of a turn at a time in either direction until stable operation is obtained.

Note. The reference springs and contact fingers of the plug-in element are set at the factory. No adjustment of these parts should be made in the field.

c. Testing. To test the regulator, load the generator and measure the voltage across any two of the load terminals with a voltmeter. If the voltage varies more than 5 percent from the no-load to the full-load position, replace the plug-in element (20). If regulation is still not correct, check for loose or broken connections before replacing the regulator panel (5).

d. Removal. Disconnect the leads at the regulator panel (5) and remove the screws (19), lockwashers, and nuts securing the regulator panel to the switchboard panel.

e. Installation. Secure the regulator panel (5) to the switchboard panel with the screws (19), lockwashers, and nuts. Connect the leads.

164. Transformers and Box

a. Transformers (fig. 70).

(1) *Removal.* Remove the changeover panel (par. 148) and disconnect the load lines and secondary leads at the transformers inside the box (5). Remove the screws,

lockwashers, and nuts securing the transformers to the box.

(2) *Installation.* Secure the transformers to the box (5) with the screws, lockwashers, and nuts. Connect the load lines and leads to the transformers and install the changeover panel (par. 148).

b. Transformer Box (fig. 4).

(1) *Removal.* Remove the transformers (*a* above). Remove the cap screws, lockwashers, and nuts securing the box (14) to the base.

(2) *Repair.* Remove dents and weld cracks. Refer to paragraph 34 for painting instructions.

(3) *Installation.* Secure the box (14) to the base with the cap screws, lockwashers, and nuts. Install the transformers (*a* above).

165. Load Terminal Block
(fig. 4)

a. Removal. Disconnect the load lines and capacitors at the terminal block (16) and remove the cap screws, lockwashers, and nuts securing the block to the frame brackets.

b. Installation. Secure the terminal block (16) to the frame brackets with the cap screws, lockwashers, and nuts. Connect the load lines and capacitors.

166. Overspeed Device and Microswitch
(fig. 11)

a. Description. For a description of the device (4) and microswitch (2), refer to paragraph 14*a*.

b. *Microswitch.*

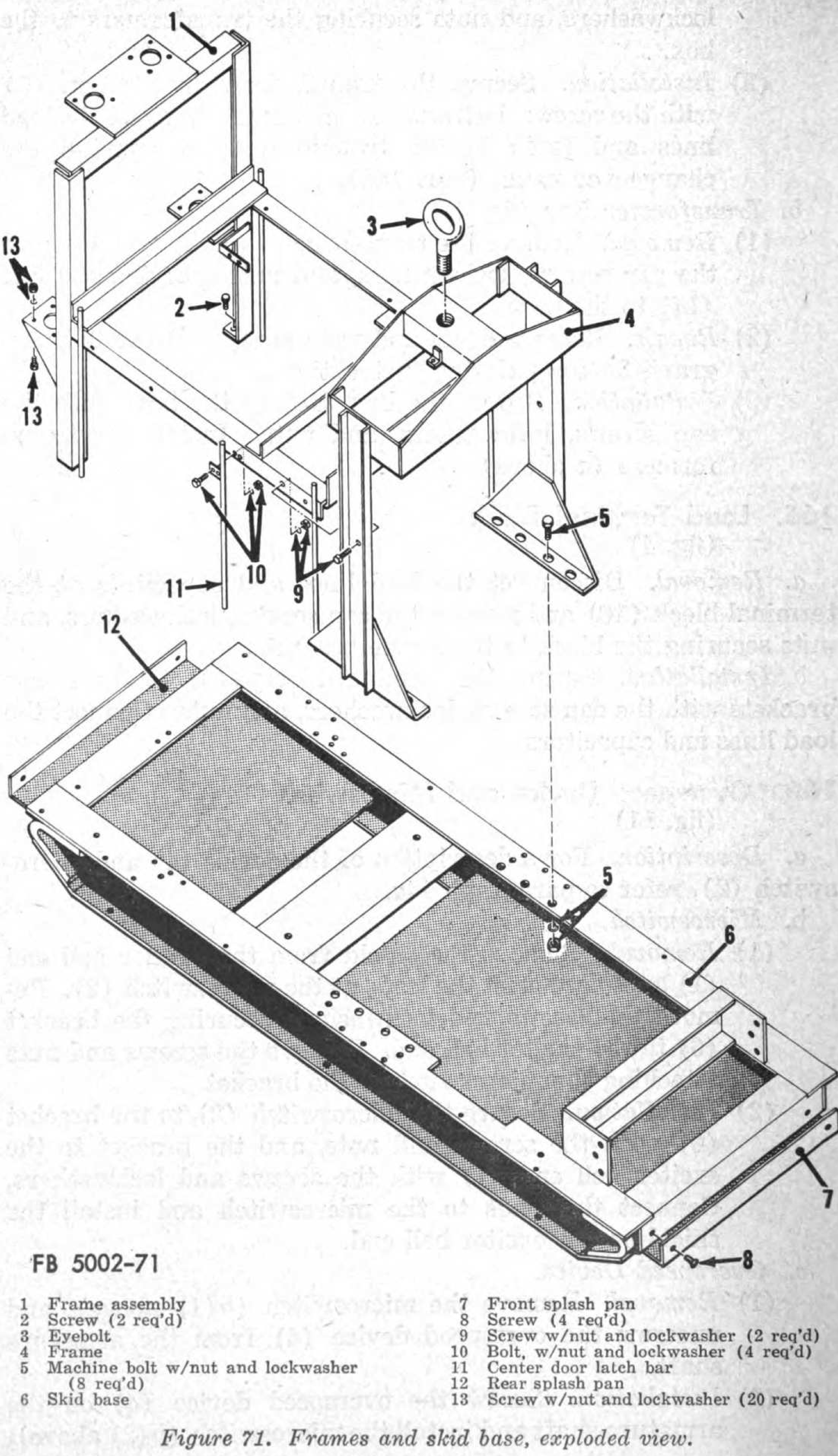
(1) *Removal.* Remove the shield from the exciter bell end (1) and disconnect the leads at the microswitch (2). Remove the screws and lockwashers securing the bracket (6) to the exciter bell end. Remove the screws and nuts attaching the microswitch to the bracket.

(2) *Installation.* Secure the microswitch (2) to the bracket (6) with the screws and nuts, and the bracket to the exciter bell end (1) with the screws and lockwashers. Connect the leads to the microswitch and install the shield on the exciter bell end.

c. Overspeed Device.

(1) *Removal.* Remove the microswitch (*b*(1) above), and unscrew the overspeed device (4) from the armature shaft.

(2) *Installation.* Screw the overspeed device (4) on the armature shaft and install the microswitch (*b*(2) above).



FB 5002-71

1	Frame assembly	7	Front splash pan
2	Screw (2 req'd)	8	Screw (4 req'd)
3	Eyebolt	9	Screw w/nut and lockwasher (2 req'd)
4	Frame	10	Bolt, w/nut and lockwasher (4 req'd)
5	Machine bolt w/nut and lockwasher (8 req'd)	11	Center door latch bar
6	Skid base	12	Rear splash pan
		13	Screw w/nut and lockwasher (20 req'd)

Figure 71. Frames and skid base, exploded view.

Section IV. FRAME

167. General

The frame consists of two steel sections, a frame assembly (20, fig. 4) and lifting frame (21) bolted to a skid base. The frames support the fuel tank (8) switchboard panel (9), oil filter (4), and battery box (12, fig. 40).

168. Lifting Frame and Frame Assembly
(fig. 71)

a. Removal.

(1) Remove the fuel tank (par. 80), battery box (par. 95), oil filter (par. 102), and switchboard panel (par. 156).

(2) Remove the screws (2) securing the frame assembly (1) to the skid base (6), and remove the frame assembly and lifting frame (4).

b. Inspection and Repair.

(1) Clean the frames and examine for cracked or broken welds.

(2) Repair broken welds and paint the frames (par. 34).

c. Installation.

(1) Position the frame assembly (1) and the lifting frame (4) on the skid base (6). Make sure the ends of the latch bars (11) are in the holes in the skid base, and secure the frame assembly with the screws (2).

(2) Block up the front end of the frame assembly and install the battery box (par. 95).

(3) Install the switchboard panel (par. 156), fuel tank (par. 80), and oil filter (par. 102).

Section V. WATER PUMP AND FAN ASSEMBLY

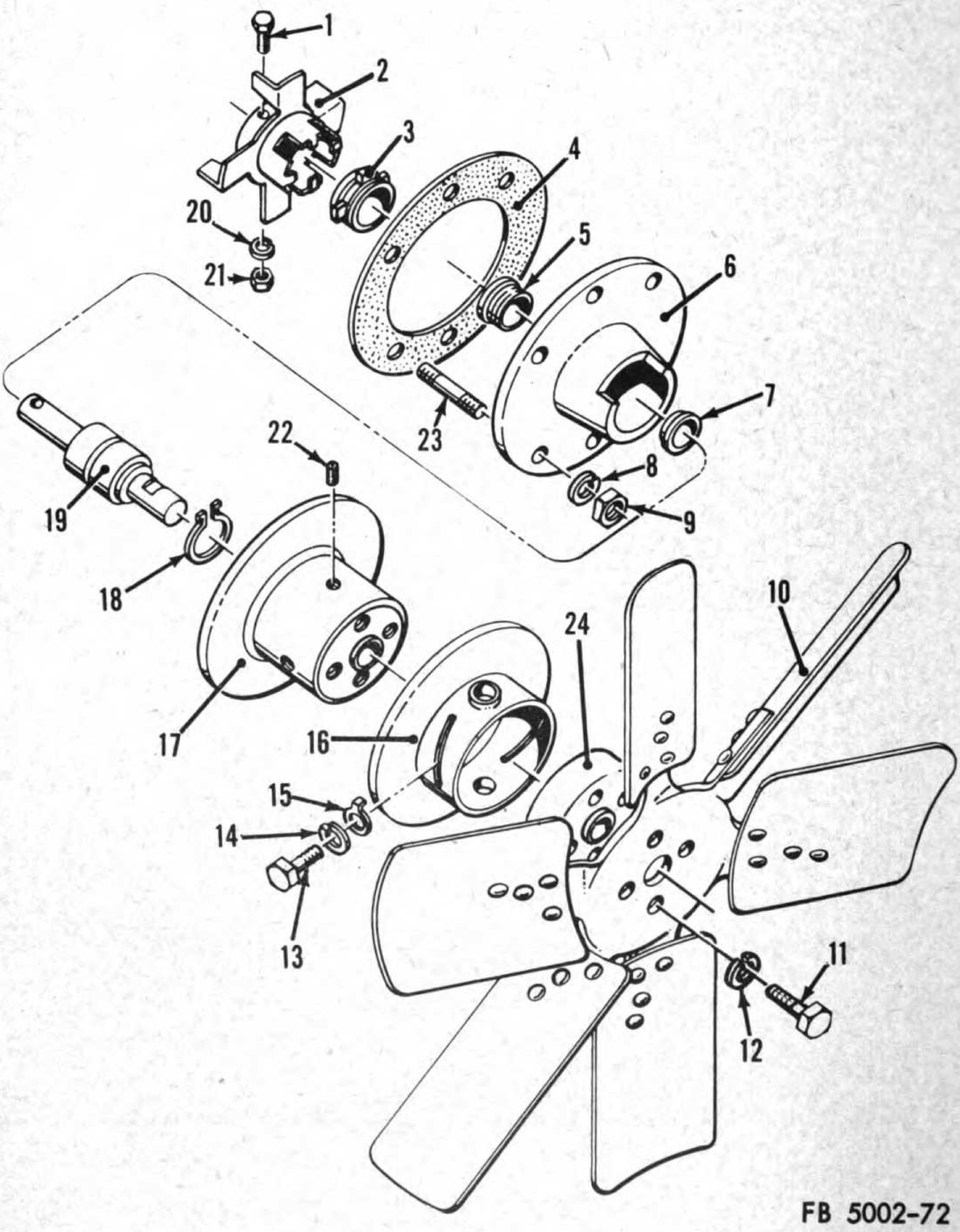
169. General
(fig. 36)

The water pump (1) and fan hub (2) are integral and must be disassembled as a unit. Refer to paragraph 91 for removal and replacement of the fan and water pump assembly.

170. Fan Hub and Water Pump
(fig. 72)

a. Disassembly.

(1) Loosen the two screws (22) and pull the hub off the shaft (19).



1	Screw, cap, hex-hd, No. 10 x 1 in. NC (1 req'd)	9	Nut (6 req'd)	16	Belt flange
2	Impeller assembly	10	Fan blade	17	Fan hub
3	seal assembly	11	Screw (4 req'd)	18	Snap ring
4	Gasket	12	Washer, lock, 5/16 in. (4 req'd)	19	Shaft assembly
5	Bushing	13	Screw (2 req'd)	20	Lockwasher (1 req'd)
6	Support	14	Washer, lock, 3/16 in. (4 req'd)	21	Nut (1 req'd)
7	Slinger			22	Screw (1 req'd)
8	Lockwasher (6 req'd)	15	Locknut	23	Stud
				24	Blade spacer

Figure 72. Water pump and fan assembly, exploded view.

(2) Remove the screw (1), lockwasher (20), and nut (21) securing the impeller (2) to the shaft and pull the impeller off the shaft.

(3) Remove the snap ring which is part of the seal assembly (3) and lift the seal assembly out of the impeller hub.

(4) Remove the snap ring (18) and press the shart (19) out of the support (6).

(5) Press the shaft out of the slinger (7) and the bushing (5) out of the support.

b. Cleaning and Inspection.

(1) *Cleaning.* Clean the hub and water pump parts with an approved cleaning solvent.

(2) *Inspection.*

(*a*) Check the impeller (2) for corrosion. Clean off any light corrosion. Replace the impeller if deeply pitted.

(*b*) Examine the sealed bearing on the shaft (19) for noisy operation or looseness. If the bearing is noisy or loose, replace the bearing and shaft.

(*c*) Check the contact surfaces of the seal assembly (3) and the bushing (5) for leaks and roughness. Replace a defective seal assembly and bushing.

(*d*) Inspect the slinger (7) for damage. Replace a defective slinger.

c. Reassembly.

(1) Press the slinger (7) on the shaft (19), and the bushing (5) into the support (6).

(2) Press the shaft in the support and secure with the snap ring (18).

(3) Insert the seal assembly (3) into the impeller (2) and secure with the seal assembly snap ring.

(4) Press the impeller on the shaft (19), lining up the holes in both. Secure with the screw (1), lockwasher (20), and nut (21).

(5) Press the hub (17) on the shaft and install the screws (22).

Section VI. BATTERY-CHARGING GENERATOR AND VOLTAGE REGULATOR

171. General

Charging and regulation of the 24-volt battery circuit is controlled by a d-c, shunt-wound generator (13, fig. 41) and a vibrat-

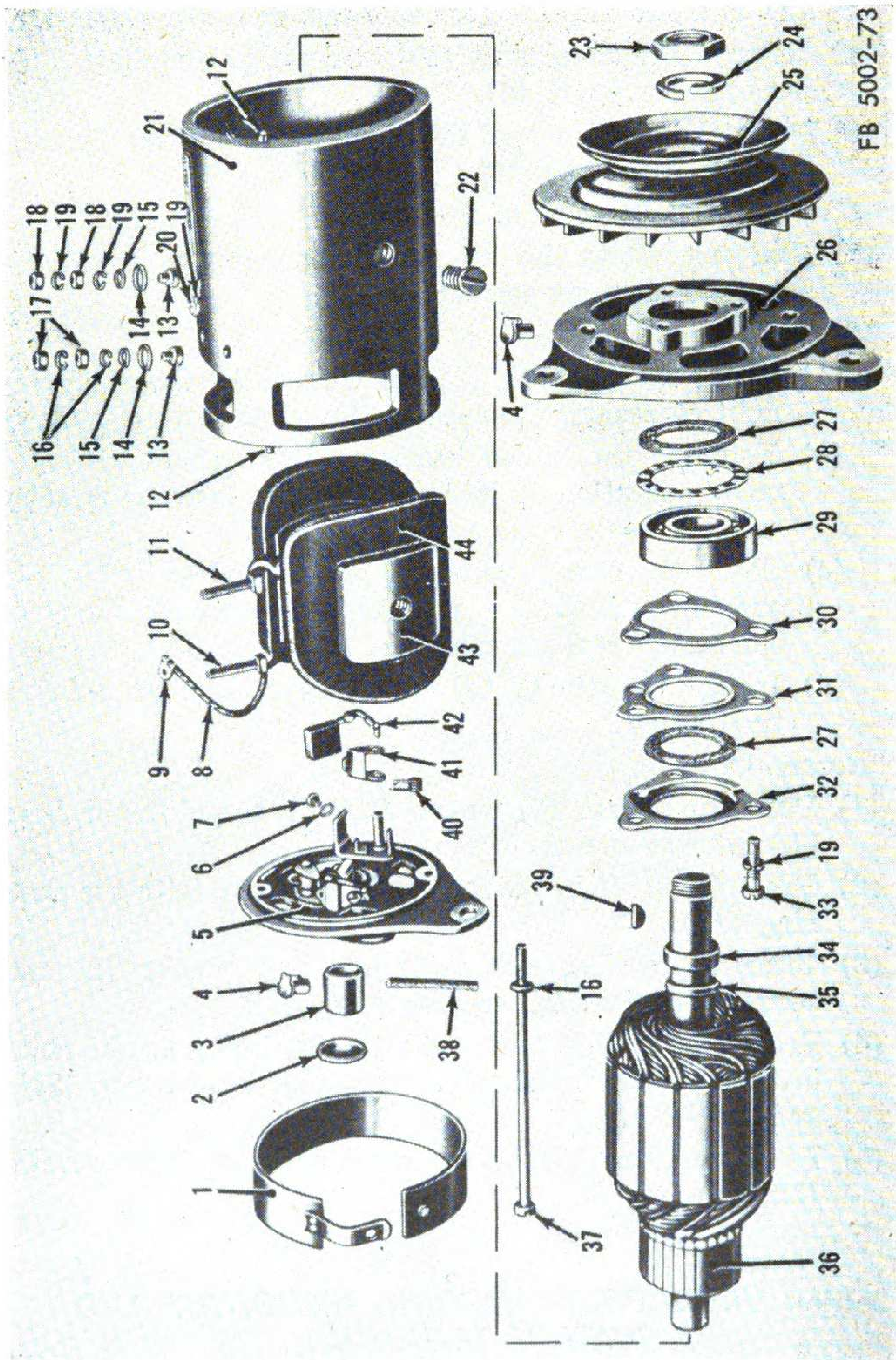


Figure 73. Battery-charging generator, exploded view.

1 Cover band
2 Bearing cover
3 Plain bearing
4 Oil cup
5 Head assembly
6 Washer, lock, No. 8 (2 req'd)
7 Screw, mach, rd-hd, No. 8 x ¼ in. NC (2 req'd)
8 Electrical lead
9 Terminal
10 Armature terminal stud
11 Field terminal stud
12 Dowel pin
13 Bushing insulator
14 Washer insulator
15 Plain washer (2 req'd)
16 Washer, lock, ¼ in. (4 req'd)
17 Nut, hex, ¼ in. NF (2 req'd)
18 Nut, hex, No. 10 NF (2 req'd)
19 Washer, lock, No. 10 (3 req'd)
20 Screw, mach, rd-hd, No. 10 x 5/16 in. NF (1 req'd)
21 Field frame
22 Pole shoe screw (2 req'd)
23 Armature shaft nut (1 req'd)
24 Shaft lockwasher (1 req'd)
25 Drive pulley
26 Drive end head
27 Felt washer
28 Outer retainer
29 Ball bearing
30 Gasket
31 Inner retainer
32 Bearing retainer
33 Screw, mach, rd-hd, No. 10 x ½ in. NF (3 req'd)
34 Washer retainer
35 Retaining ring
36 Armature
37 Through bolt
38 Felt wick
39 Key, woodruff, No. 5 (1 req'd)
40 Brush spring
41 Brush arm
42 Brush set
43 Pole shoe
44 Field winding assembly

Figure 73—Continued.

ing current voltage regulator (7, fig. 42). The generated current is carried into the circuit through the commutator and brushes. The regulator controls the generator output by regulating the field energizing current.

172. Battery-Charging Generator

a. General. The generator is a 24-volt, ventilated unit with a ball bearing in the drive end and a plain bearing in the commutator end. For servicing the commutator and brushes and removal and installation of the generator, refer to paragraph 96.

b. On-Engine Testing. Before proceeding with any electrical tests, inspect all the wiring between the generator (13, fig. 41), voltage regulator (7, fig. 42), and the batteries (5, fig. 40) to make sure that all connections are clean and tight. In addition to the rough test in paragraph 96*c* the following test can be performed to determine high resistance connections.

(1) Connect an ammeter between the regulator battery terminal (17, fig. 42) and the lead removed from this terminal.

(2) Operate the engine at governed speed and turn on the panel lights or d-c accessories to obtain a charging generator output of 3 amperes.

(3) At this charging rate, measure with an accurate voltmeter the voltage between the points listed below. The maximum allowable voltage is shown.

	Volt
Generator armature terminal to the regulator armature terminal.	0.1
Generator field terminal to the regulator field terminal.	.05
Battery negative terminal to the regulator battery terminal.	.1
Regulator ground to the generator frame.	.03
Regulator ground to the battery positive.	.03
Generator frame to the battery positive.	:03

(4) Voltmeter readings higher than those shown above indicate high resistance connections. The connections should be cleaned and tightened, or replaced if worn or rusted.

c. Disassembly (fig. 73).

(1) Remove the band (1) and disconnect the terminal (9) from the brush rigging.

(2) Remove the nut (23) and lockwasher (24). Pull the pulley (25) and key (39) from the armature shaft.

(3) Remove the through bolts (37), lockwashers (16), and commutator head (5) from the field frame (21).

(4) Remove the armature (36) with the drive end head (26) and press the armature out.

(5) Remove the screws (33), lockwashers (19), bearing retainer (32), felt washer (27), inner retainer (31), and gasket (30). Press the bearing (29) out of the drive end head and remove the outer retainer (28) and felt washer (27).

(6) Remove the cover (2) and press the bearing (3) out of the head (5).

(7) Remove the screws (7) and lockwashers (6) securing the brush leads to the holders. Pull the brush arms (41), and springs (40) from the holders.

(8) To free the terminal studs (10 and 11) from the frame (21), disassemble the nuts (17 and 18), lockwashers (16 and 19), plain washers (15), and washer insulators (14). Pull the studs out of the frame and remove the bushing insulators (13).

(9) To remove the pole shoes (43) and winding (44), remove the screws (22). Separate the shoes and winding.

d. Inspection, Testing, and Repair of the Armature. Inspect the armature (36, fig. 73) for mechanical defects. If the commutator is worn or rough, turn the commutator on a lathe. Maximum eccentricity is not to exceed 0.001 inch.

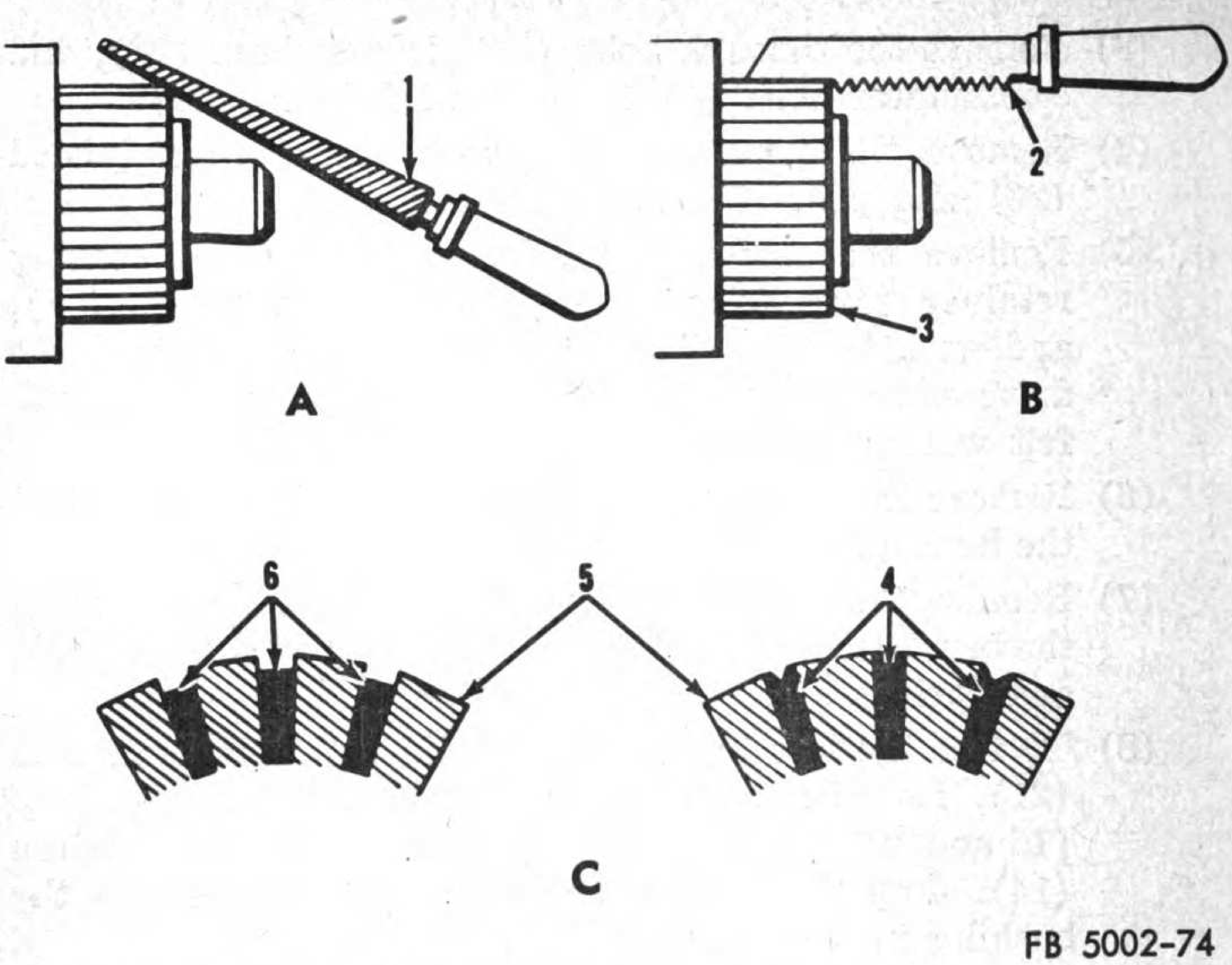
(1) *Undercutting mica* (fig. 74). If the mica between the commutator segments is high or if the commutator has been turned, undercut the mica.

(*a*) Start the groove in the mica between the commutator segments (5) with a three-cornered file (1).

(*b*) Undercut the mica with an undercutting tool (2). A hacksaw blade ground to the width of the mica can be used. Cut to 1/32-inch depth over the full width of the mica.

(*c*) The finish 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.

(2) *Use of a growler for testing* (fig. 75). Place the armature in a growler like the one shown in figure 75. The growler provides test equipment for small, heavy-duty armatures. The armatures are tested for shorts and opens in the commutator segments, coils, and soldered



1 Three-cornered file. 2 Undercutting tool. 3 Commutator. 4 Incorrect undercutting. 5 Commutator segments. 6 Correct undercutting.

Figure 74. Undercutting mica.

connections. On a double-wound growler, test the generator armature with the switch (4) in the LOW position.

(*a*) *Testing for open coil circuits.* The contact fingers (8) are used to test for open circuits in the armature coils. Place the armature in the growler and apply the contact fingers to each pair of segments in turn. No indication of current flow on the meter (5) means an open circuit in the armature coils. Replace the armature.

Caution: When using test prods (9) or contact fingers (8), never touch brush contact surfaces or bearing surfaces, since an arc will mar the finish.

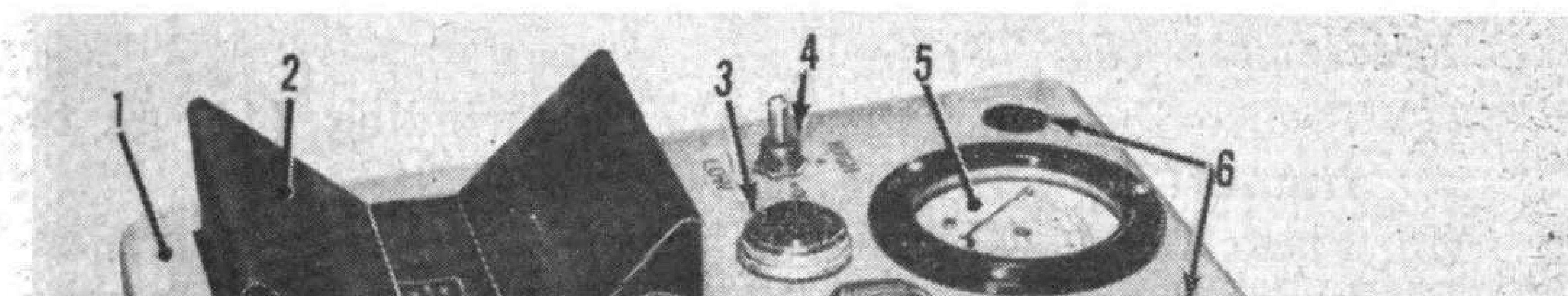
(*b*) *Testing for shorted coils.* Place the armature on the core (2) of the growler. The windings of the growler change polarity 120 times per second to duplicate the same electrical condition that the armature would create when running the generator at a speed of 3,600 rpm. Hold the test blade (10) on the core of the armature and turn the armature slowly. When a shorted armature coil comes under the test blade, it will cause the blade to vibrate and act as a buzzer. Replace a short circuited armature.

(c) *Testing for grounds.* Turn the switch (4) to OFF. Place one test prod (9) on the shaft and the other on a commutator segment. If the test light (3) glows, the segment or coil is grounded. Test each segment in turn. Replace a shorted armature.

e. Testing Frame and Field Winding Assembly. To test for an open winding, place the switch (4, fig. 75) in the OFF position and use the test prods (9). Connect the test prods to the two leads of each winding (44, fig. 73). If the test light (3, fig. 75), does not light, the winding is open and must be replaced.

Note. When materials for fungicidal treatment (*h* below) are not available, replace the frame and field winding assembly if field windings are required.

f. Testing Brush Holders (fig. 73). Using the test prods, place one prod on the brush arm (41) and the other on the head (5). If the test lamp goes on, the brush holder is grounded. Replace the head.



1	Case	5	A-c meter	9	Test prods
2	Core	6	Wells	10	Test blade
3	Test light	7	Voltage control	11	Line cord
4	Switch	8	Contact fingers	12	Ground jack

Figure 75. Electric growler.

g. Bearing Inspection (fig. 73). Check the bearings (3 and 29) for excessive wear. Metallic dust in the race and noisy operation of the bearing (29) indicate wear. Replace worn bearings.

h. Fungicidal Treatment (fig. 73).

(1) Before assembling the generator, paint the bushing insulators (13) and the brush holder insulation with red glyptol. Paint the frame (21) and field winding (44) with fungicidal varnish. Let the varnish soak into the winding. Do not paint the studs (10 and 11).

(2) Paint the drive end head (26) with fungicidal varnish. Do not paint the mounting face, bearing (29), felt washers (27), retainers (28, 31, and 32), or gasket (30).

(3) Paint the head (5) with fungicidal varnish. Do not paint the head mounting face, brush set (42), brush arms (41), or bearing (3).

(4) Paint the armature core, winding, commutator risers, and front face of the commutator with fungicidal varnish. Do not paint the commutator segments or shaft bearing surfaces.

i. Reassembly (fig. 73).

(1) Secure the pole shoes (43) and winding (44) in the frame (21) with the screws (22).

(2) Place the bushing insulators (13) in the frame and insert the studs (10 and 11) in them. Install the washer insulators (14), plain washers (15), lockwashers (16 and 19), and nuts (17 and 18) on the studs.

(3) Position the brush arms (41) and springs (40) on the holders, and secure the brush leads to the holders with the screws (7) and lockwashers (6).

(4) Press the bearing (3) into the head (5) and install the bearing cover (2).

(5) Place the felt washer (27) and retainer (28) in the drive end head (26) and press the bearing (29) into the head. Install the gasket (30), inner retainer (31), felt washer (27), and bearing retainer (32). Secure with the screws (33) and lockwashers (19).

(6) Press the drive end head on the armature (36) and insert the armature in the frame (21). Position the head so that the pin (12) engages the hole in the drive end head.

(7) Position the head (5) on the armature shaft and engage the pin (12) with the head. Install the through bolts (37) and lockwashers (16).

(8) Place the key (39) in the armature shaft and press the pulley (25) on. Secure with the lockwasher (24) and nut (23).

(9) Connect the terminal (9) to the brush rigging.

(10) Check the tension of the brush springs (40) with a spring scale. Hook the scale on the brush arm (41) and pull directly in line with the brush holder. Correct tension is 23 to 26 ounces. Install the cover band (1).

j. Bench Test. After reassembly, test the generator before installing it on the engine.

(1) *Field current draw.* Place a 24-volt battery, variable resistor, and an ammeter in series with the field winding, and a voltmeter across the terminals. Adjust the variable resistor to give a terminal voltage of 20 volts and read the ammeter. The field current at 20 volts should be 0.8 to 0.9 amperes. Readings not within this range indicate defective field windings or connections.

(2) *Motoring draw.* Connect the 24-volt battery, variable resistor, and ammeter in series with the armature terminal and frame. With the voltage adjusted to 20 volts, the current should be 1.9 to 2.6 amperes. If the reading is higher, check the bearings and armature for binding and alinement.

(3) *Current output.* With the generator connected as in (2) above, drive the generator on the test bench or on the engine with the regulator disconnected. At a generator rpm of 1,500, the current should be 10 to 15 amperes with a terminal voltage of 30 volts. If the correct 1,500 rpm and output cannot be obtained, inspect for correct brush seating (par. 96*b*), high resistance (*b* above), or a defective armature or field (*d* and *e* above).

173. Charging Generator Voltage Regulator

a. General. The vibrating-current voltage regulator (7, fig. 42) has three units, with each performing a separate function. The cutout relay (1, A, fig. 76) prevents a reverse flow of current from the batteries to the generator when the generator output voltage drops below the battery terminal voltage. The voltage regulator (1, B, fig. 76) holds the generated voltage at a predetermined value as long as the circuit values allow the voltage to build up to the operating voltage. This unit vibrates in response to a variable load on the battery circuit. The current regulator (2) limits the generator to its maximum safe output by putting resistance in and out of the generator field circuit.

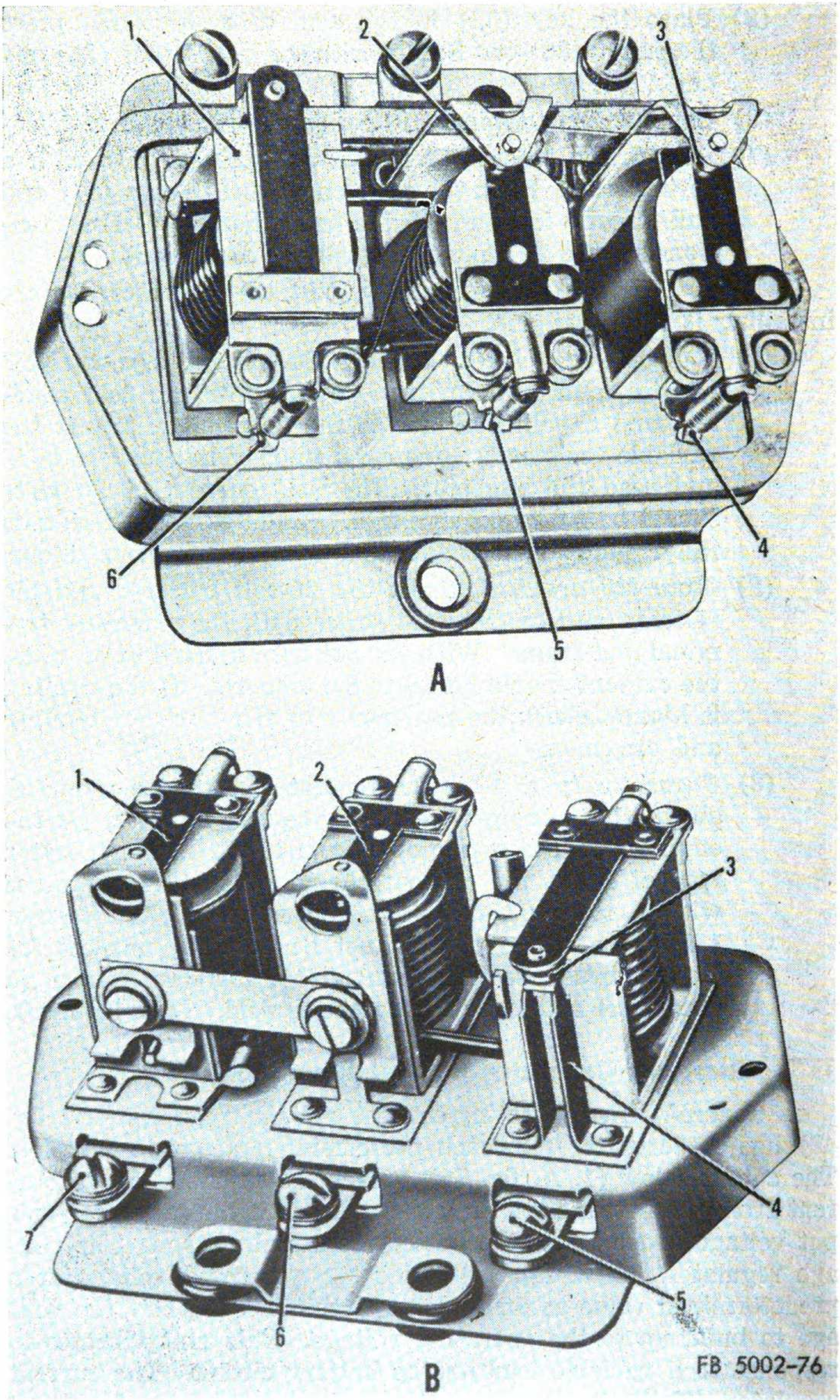


Figure 76. Charging generator voltage regulator.

Testing, removal, and installation are covered in paragraph 97. To test for high resistance connections, refer to paragraph 172*b*.

b. Inspection and Cleaning (fig. 42).

(1) *Inspection.* Remove the regulator cover (8) and inspect the units for burns, especially at the coils and contact points. Replace a burned regulator (par. 97). Check for loose connections and tighten them.

(2) *Cleaning.* Disconnect the lead to the battery terminal (17) before cleaning the points of the units. Use only a thin, fine-cut contact file to clean the points. Hold the file flat to the faces of the points and file parallel with the armature. Crosswise filing (draw filing) will form grooves in the points and cause a sticking motion. File the points until they present a smooth surface toward each other. It is not necessary to remove every trace of pitting. After filing, dampen a piece of linen or lintless tape with carbon tetrachloride and draw it between the points. Repeat with a dry piece of linen to remove any residue.

c. Cutout Relay Testing and Adjustment.

(1) Connect an ammeter between the battery terminal (17, fig. 42) and its lead.

(2) Connect a voltmeter from the armature terminal (15) to the regulator base.

(3) Place a thermometer about 2 inches from the regulator and engine so it does not touch either one. The reading will be needed for *d* below.

(4) Connect a variable resistor of 50 ohms maximum value and a current rating of at least 3 amperes between the field terminal (16) and its lead.

(5) Run the generator at about 1,000 rpm and set the resistance to its maximum value. Slowly reduce the resistance and observe the voltmeter reading just before it changes when the relay closes. The cutout relay points (3, B, fig. 76) should close between 25 and 26.5 volts.

A

1 Cutout relay
2 Current regulator points
3 Voltage regulator points
4 Voltage regulator lower spring hanger
5 Current regulator lower spring hanger
6 Cutout relay lower spring hanger

B

1 Voltage regulator
2 Current regulator
3 Cutout relay points
4 Bracket
5 Battery terminal
6 Field terminal
7 Armature terminal

Figure 76—Continued.

An accurate check on the closing of the points can be made by connecting a 2,000-ohm headphone between the battery and armature terminals (5 and 7). A click will be heard when the points open or close.

(6) Continue to reduce the resistance until the ammeter reads 5 amperes; then increase the resistance slowly and observe the ammeter reading just before it drops to zero when the points open. The current should be 1.9 to 3 amperes.

(7) To adjust the closing voltage, bend the lower spring hanger (6, A, fig. 76). Increase the spring tension to raise the closing voltage; decrease to lower the closing voltage.

(8) To adjust the opening voltage, raise or lower the stationary contact under the point opening by bending the bracket (4, B, fig. 76). Make sure the points are parallel and alined. Increasing the gap lowers the open current. Minimum gap opening is 0.015 inch.

d. Voltage Regulator Testing and Adjustment.

(1) Connect an ammeter between the battery terminal (17, fig. 42) and its lead.

(2) Connect a voltmeter from the battery terminal to the regulator base.

(3) Run the generator for 15 minutes with the cover (8) on the regulator (7) to bring the regulator up to normal operating temperature.

(4) Stop the generator, then bring the speed up slowly until the ammeter reads 5 amperes. If necessary, turn on the panel lights or d-c accessories to bring up the current output.

(5) Read the voltmeter at the ambient temperature indicated by the thermometer placed near the regulator, and check the voltage against the values listed below.

Temperature °F.	50°	60°	70°	80°	90°	100°	110°	120°
Voltage ± 0.50	28.84	28.67	28.50	28.32	28.15	27.98	27.81	27..64

(6) If the voltage does not fall within these limits, adjust the spring tension by bending the lower spring hanger (4, A, fig. 76). After each adjustment, stop the engine and restart it. Bring the generator up to speed until the ammeter reads 5 amperes before taking another reading.

(7) An accurate indication of voltage regulator operation can be obtained by connecting a 2,000-ohm headphone

between the field terminal (6, B, fig. 76) and ground to pick up the sound of the points opening and closing. If the clicks are not regular and clear, check the points for alinement and cleanliness.

e. Current Regulator Testing and Adjusting.

(1) Connect the voltmeter and ammeter as in *d* above.

(2) Run the engine at a speed which will turn the charging generator at about 3,000 rpm. Turn on the panel lights and d-c accessories to obtain maximum charging rate. The amperage must be 9.5 to 10.5 amperes.

(3) Adjust the operating amperage by bending the lower spring hanger (5, A, fig. 76). After each adjustment, stop the engine and then restart it. Bring the generator up to speed and take an ammeter reading. The cover must be on the regulator when taking readings.

Section VII. ELECTRICAL STARTER

174. General

The starter is designed to crank the engine when the solenoid relay closes the circuit between the batteries and starter. The clutch-type Bendix drive engages the ring gear on the flywheel.

175. Starter
(fig. 77)

a. General. The starter consists of the six main assemblies listed below.

(1) *Frame and field assembly.* The frame and field assembly (23) consists of the frame which supports the components of the motor, the pole shoes, and the field windings. The windings supply the magnetic field necessary for producing torque, and the pole shoes and frame supply the path for the magnetic field.

(2) *Armature.* The armature (14) consists of a shaft with a soft iron core mounted on it, a commutator consisting of a number of copper segments insulated from each other and the shaft, and the windings which are wound in the core slots and connected to the commutator.

(3) *Commutator head assembly.* The head (8) supports the brush holder plate (9) and the commutator end of the armature.

(4) *Intermediate bearing plate.* The bearing plate (32) supports the drive end of the armature.

(5) *Pinion housing assembly.* The pinion housing (26) incloses the drive (30) and provides a mounting flange for the starter.

(6) *Bendix drive.* The drive (30) includes a pinion which is shifted by screw action to engage the starter with the flywheel and crank the engine. When the engine starts, the pinion turns faster than the starter and is thrown out of mesh with the flywheel.

b. On-Engine Inspection and Testing.

(1) For servicing the commutator and brushes, and removal and installation of the starter, refer to paragraph 98.

(2) Inspect all the connections in the starting circuit and see that they are clean and tight and the insulation on the wires is not worn or damaged. Make a voltage loss test to find high resistance connections.

(3) Crank the engine and read the voltmeter. The voltage loss from the battery terminal to the starter terminal should not exceed 0.30 volt maximum for each 100 amperes. The cranking current will be slightly less than the stall torque current of 470 amperes.

(4) The loss in voltage between the battery ground terminal and the starting motor frame should not exceed 0.10 volt maximum for each 100 amperes.

(5) If the voltage loss is greater than the above limits, the voltage should be measured over each part of the circuit to locate the resistance causing the loss.

c. Disassembly.

(1) Remove the drive and bearing plate (par. 98*e*).

(2) Remove the cover band (1). Lift the brush set and remove the armature (14) and thrust washers (13 and 12).

(3) Remove the screws (37) and lockwashers (29) that hold the head (8) to the frame and field assembly (23) and the brush holder plate (9) to the head. The brush springs (10) and spacer (38) are held to the plate by the clip (11). Remove the cover (3) and felt (4).

(4) The bearings (5, 27, and 31) are removed only if they are to be replaced. Use an arbor press to remove them.

(5) Remove the brush set (15) from the terminal (24) and the frame and field assembly (23).

(6) To remove the studs (16 and 25), remove the nuts (21), lockwashers (20), plain washers (19), washer insulators (18), bushing insulator (22), and plain washer (17).

(7) The pole shoes and windings can be removed from the frame by removing the pole shoe screws.

d. Inspection and Testing.

(1) Inspect and test the armature, frame and field assembly, and brush holders (par. 172*d*, *e*, and *f*).

(2) Inspect the head (8), frame, and pinion housing (26) for cracks. Replace if defective.

(3) Check the drive (par. 98*f*).

(4) If the bearings (5, 27, and 31) are worn or loose, replace them. The bearings are of the absorbent bronze type and are to be soaked in oil before installation.

e. Fungicidal Treatment. The fungicidal treatment is the same as for the generator (par. 172*h*) except that the housing (26) is to be painted with fungicidal varnish.

f. Reassembly.

(1) If the pole shoes and windings were removed, install them in the frame and secure with the pole shoe screws.

(2) Insert the studs (16 and 25) in the frame and field assembly (23). Secure them with the plain washer (17), bushing insulator (22), washer insulators (18), plain washers (19), lockwashers (20), and nuts (21).

(3) Attach the brush set (15) to the terminal (24) and frame and field assembly (23).

(4) Press the bearings (5, 27, and 31) into the head (8), plate (32), and housing (26).

(5) Install the brush springs (10) and spacer (38) on the brush holder plate (9) and secure with the clip (11).

(6) Secure the plate (9) to the head (8), and the head to the frame and field assembly (23) with the screws (37) and lockwashers (29). Install the felt (4) and cover (3) in the head.

(7) Place the thrust washers (12 and 13) on the armature shaft and insert the armature into the frame and head bearing. Be careful not to damage the brushes.

(8) Insert the brushes in the holders and install the bearing plate and drive (par. 98*g*).

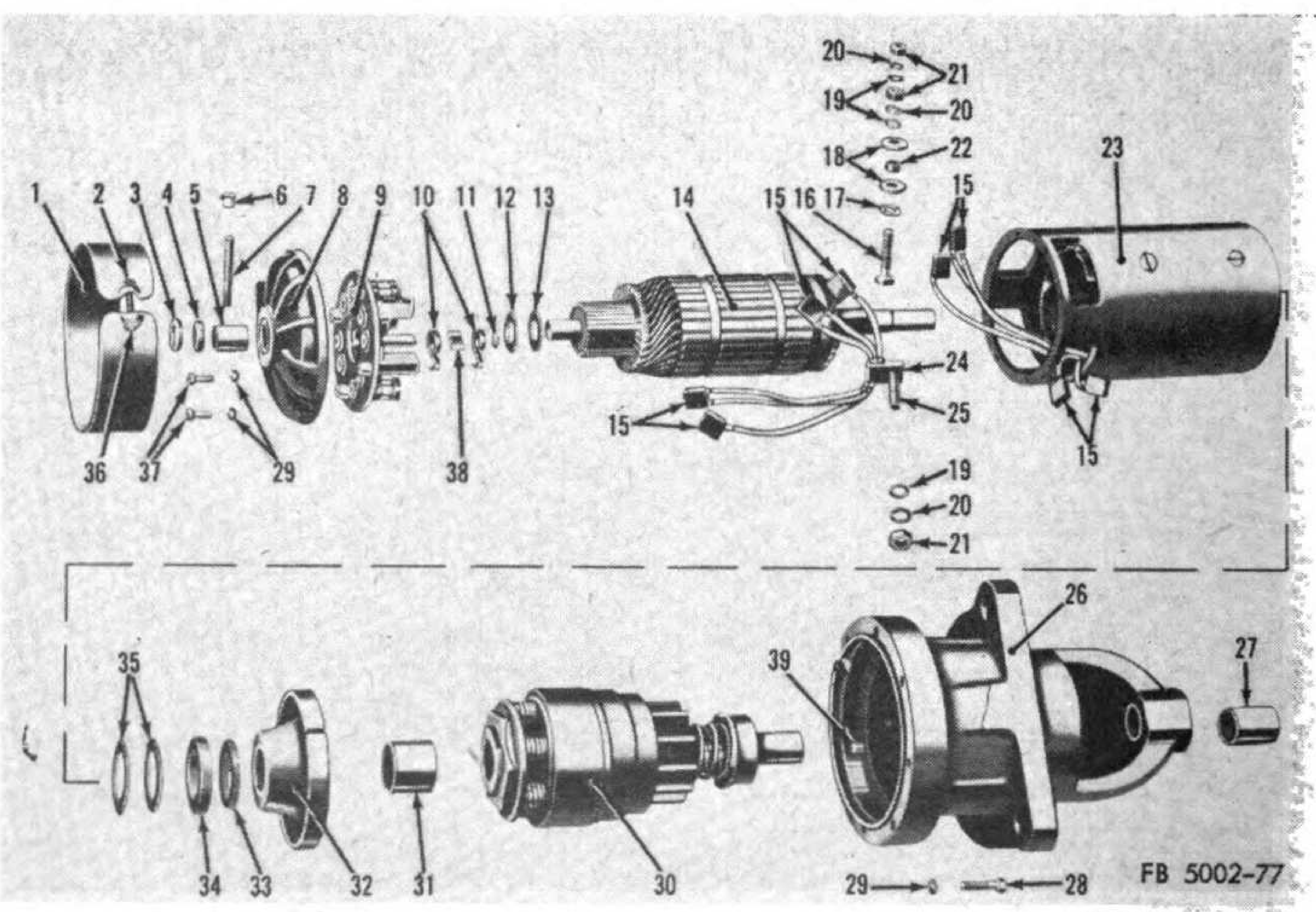
(9) Check the brush spring pressure with a spring scale. Hook the scale on the brush spring (10) and pull directly in line with the brush holder. Correct spring pressure is 23 to 26 ounces. Adjust the brush spring pressure by bending the spring at the point where it is clamped to the brush holder.

(10) Position the cover band (1) and secure with the screw (2).

g. Bench Test. Test the starter before installing it on the engine.

(1) *No-load test.* Connect a 24-volt battery in series with a load rheostat, an ammeter shunt of a capacity greater than 470 amps, and the starter terminals. Connect an ammeter to the shunt and a voltmeter to the starter terminals. With the voltage adjusted to 20 volts, the current should be 70 amperes maximum at 5,400 rpm. If the current and speed are both low, check for high resistance in the internal connections. If the current is high and the speed low, check the bearings and armature for binding and correct alinement.

(2) *Stall torque test.* With the starter connected as above, fasten a torque arm and spring scale to the armature



1 Cover band
2 Screw, mach, fil-hd, No. 10 x 1½ in. NF (1 req'd)
3 Bearing cover
4 Felt
5 Bronze bearing
6 Oilcup
7 Felt wick
8 Head assembly
9 Brush holder plate assembly
10 Brush spring
11 Clip
12 Thrust washer
13 Thrust washer
14 Motor armature
15 Brush set
16 Terminal stud
17 Plain washer (1 req'd)
18 Washer insulator
19 Washer, plain ⅜ in (3 req'd)
20 Washer, lock, ⅜ in. (3 req'd)
21 Nut, hex, ⅜ in. (3 req'd)
22 Bushing insulator
23 Frame and field assembly
24 Terminal
25 Terminal stud
26 Pinion housing assembly
27 Plain bearing
28 Screw, cap, hex-hd, No. 10 x ⅞ in. NF (8 req'd)
29 Washer, lock, No. 10 (24 req'd)
30 Drive
31 Bronze bearing
32 Bearing plate
33 Felt washer
34 Felt retainer
35 Thrust washer
36 Nut, square, No. 10 NF (1 req'd)
37 Screw, mach, fil-hd, No. 10 x ⅝ in. NF (16 req'd)
38 Brush spring spacer
39 Dowel pin

Figure 77. Starter, exploded view.

at the drive end. Adjust the rheostat to give six volts. The correct current reading is 470 amperes maximum, and a stall torque of 20 foot-pounds minimum. Stall torque is the product of the spring scale reading in pounds multiplied by the length of the torque arm in feet. If current and torque are both low, check the internal connections for high resistance and the brushes for proper contact. High current and low torque may be caused by defective armature or field windings.

Section VIII. FUEL INJECTION SYSTEM

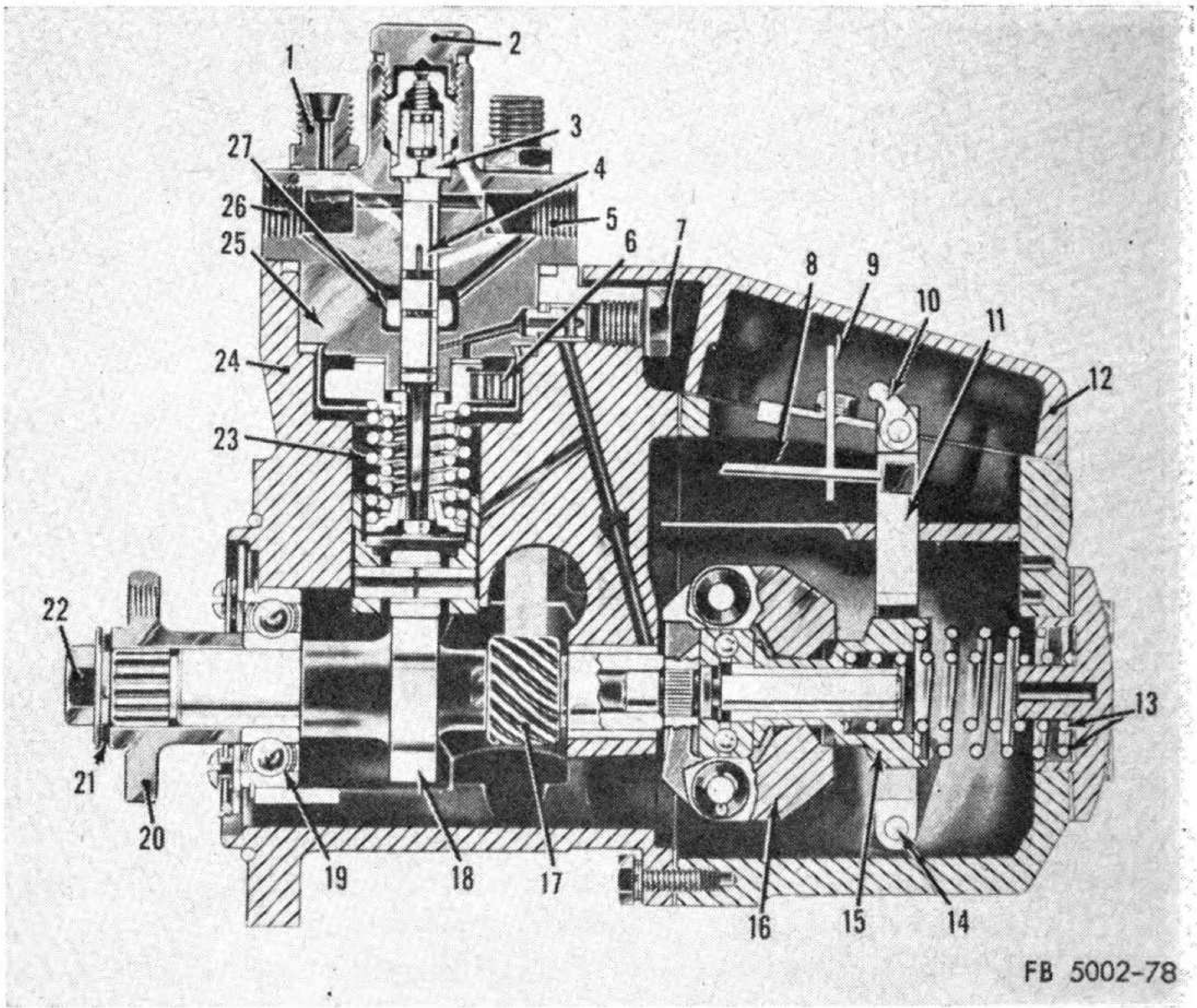
176. General

a. Fuel Injector Pump (fig. 78). The injector pump is attached to an adapter mounted on the gear cover and crankcase. It is a single plunger multi-outlet unit with the hydraulic head (25) containing the pump and valve mechanism. The two-lobed camshaft (18), driven by the camshaft gear and revolving at engine speed, operates the plunger (4) which pumps fuel to the nozzle holder assemblies. As the plunger moves up, the gear (6) rotates it to index a channel in the plunger with the proper orifice in the head leading to the cylinder to be fired. When sufficient pressure has been built up, the delivery valve (3) opens, permitting fuel to escape to the nozzle holder assembly through the plunger channel. The delivery valve closes instantly when the pressure drops, providing accurate fuel metering. For removal and installation of the injector pump, refer to paragraph 86.

b. Governor (fig. 78). The mechanical-centrifugal governor is mounted on the pump camshaft (18) and is an integral part of the injector pump. As engine speed increases, the weights (16) fly outward pushing the sleeve (15) to the rear, against the pressure of the springs (13), moving the lever (11) and rod (8). The rod, in turn, moves the control shaft and sleeve (27) to decrease fuel delivery which reduces engine speed. For adjustment, removal, and installation of the governor, refer to paragraph 87.

c. Fuel Supply Pump. For testing, removal, and installation of the pump, refer to paragraph 85.

d. Nozzle Holder Assemblies. See paragraph 88 for testing, removal, and installation of the holder assemblies.



1 Discharge fitting
2 Cap screw
3 Delivery valve
4 Plunger
5 Fuel inlet
6 Plunger drive gear
7 Filter screw
8 Control rod
9 Stop plate
10 Stop cam
11 Fulcrum lever
12 Governor housing
13 Governor springs
14 Throttle control
15 Sleeve
16 Governor weights
17 Camshaft gear
18 Camshaft
19 Bearing
20 Drive hub
21 Lockwasher
22 Hub screw
23 Plunger springs
24 Pump housing
25 Hydraulic head
26 Excess fuel outlet
27 Control sleeve

Figure 78. Fuel injector pump, cross section.

177. Fuel Injector Pump and Governor

a. Disassembly. Clean all external parts of the pump thoroughly before disassembly. All work on the pump must be performed in the cleanest location possible. Make sure the vise and workbench are clean and that no sawing, scraping, or filing is done on the bench while disassembly is in progress.

(1) To remove the window cover (48, fig. 79) and gasket (49), remove the screws (47), lockwashers (36), and plain washers (46). The shutoff rod assembly (38 through 45) is removed with the cover.

(2) To remove the supply pump (35) and gasket (30), remove the screws (37) and lockwashers (36). Remove the ring (31) from the pump shaft and pull the gear (32), key (34), and oil seal (33). Do not disassemble the pump since it is replaced as a unit.

(3) Remove the screws (7, fig. 80), lockwashers (6), and plain washers (8) to remove the cover (9) and gasket (10).

(4) Remove the filter screw (19, fig. 79) and gasket (20), and pull the strainer (21) and gasket (22) out of the pump housing (11).

(5) Remove the pin (2, fig. 80) and ring (1) to disconnect the control rod (3) from the control unit (26, fig. 79).

(6) Remove the screws (12, and 13, fig. 80), lockwashers (11), and plain washers (8) securing the governor to the pump housing. Carefully remove the governor. Guide the control rod (3) through the pump housing and release the sleeve (23) from the weights (29).

(7) Cut the lock wire (29, fig. 79) and remove the screws (28), retainer (27), control unit (26), ring (25), pin (24), and gasket (23).

(8) Remove the screws (50) and gaskets (16) securing the pad (51) and gasket (52). Rotate the camshaft (8) until the line mark on the tooth of the gear (17, fig. 81) lines up with the "O" mark on the timing window.

(9) Remove the nuts (1), and lift the head (11) and tappet assembly (13 through 15, fig. 79) from the housing (11).

(10) Cut the wire (18) and remove the locating screw (17) and gasket (16) securing the quill shaft (57). Remove the shaft assembly (31 and 53 through 57).

(11) Straighten the tabs on the lockwasher (2). Remove the hub screw (1) and pull the hub (3) off the camshaft (8).

(12) Remove the screws (4), lockwashers (5), and bearing retaining plate (6). Pull the camshaft (2, fig. 82), with its bearing (3), free of the bushing (30, fig. 80) and governor weight assembly. Do not remove the bearing unless it is to be replaced. Use an arbor press to remove the bearing.

(13) Press the bushing (30) out with the pressing tool (par. 155).

(14) Turn the hydraulic head (5, fig. 83) upside down and place in an arbor press (1). Place the tool (2) on the seat (3) and compress the spring (4) until the plunger lock (22, fig. 81) can be removed. Remove the seat (21), spring (20), and gaskets (19 and 14).

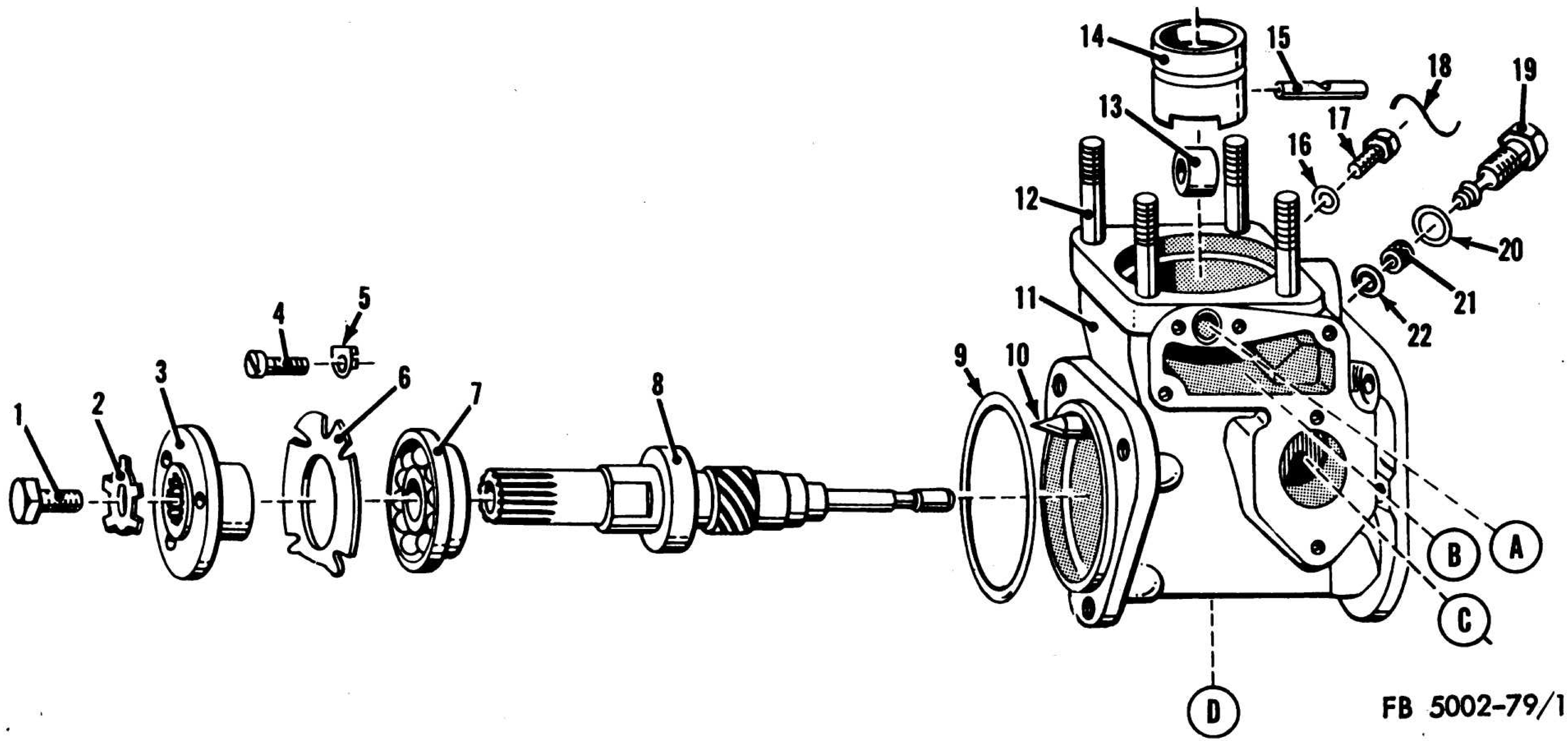
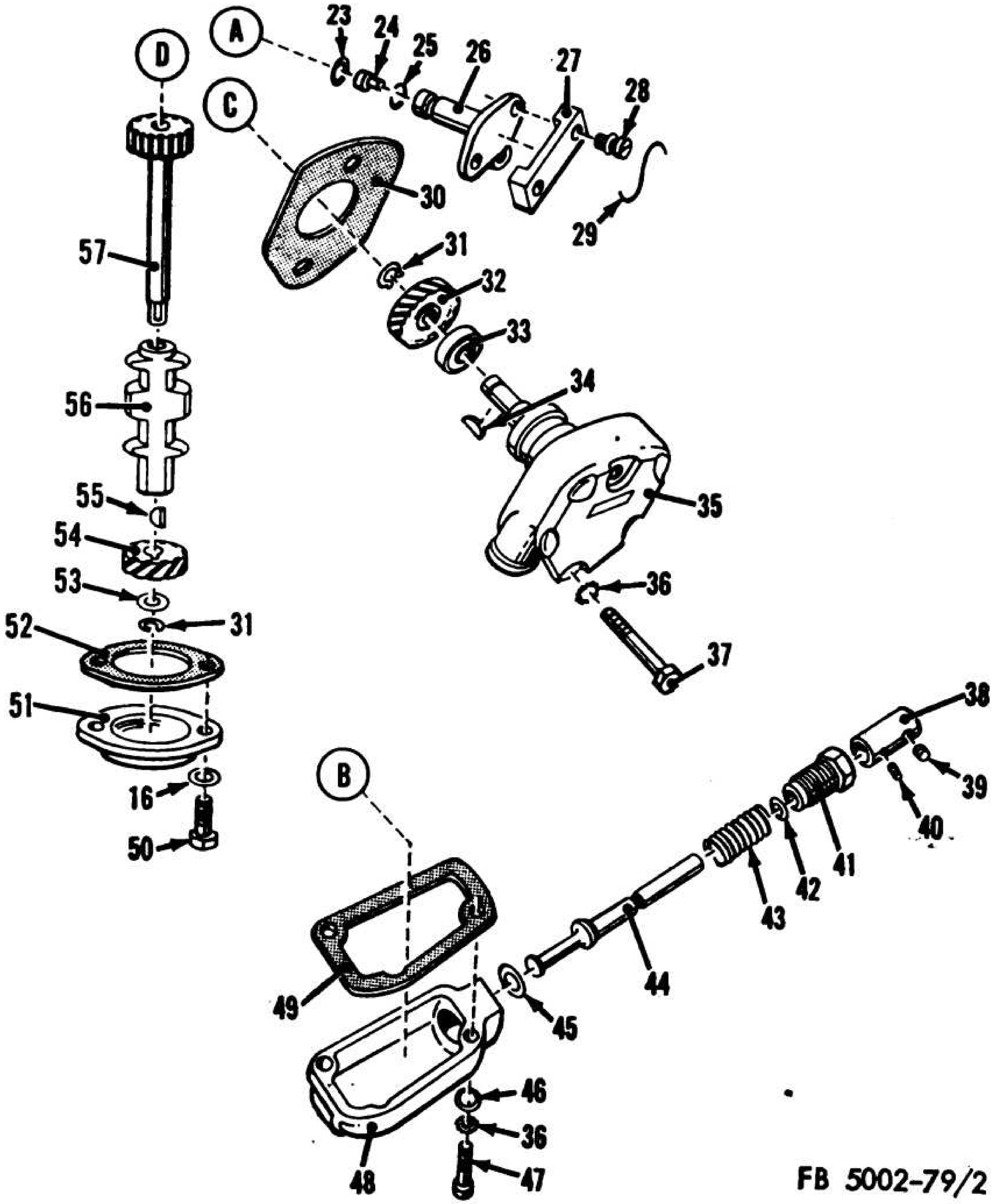


Figure 79. Fuel injector pump, exploded view.



1	Hub screw	30	Supply pump gasket
2	Lockwasher	31	Spring ring
3	Drive hub	32	Drive gear
4	Screw (4 req'd)	33	Oil seal
5	Lockwasher (4 req'd)	34	Key
6	Retaining plate	35	Supply pump assembly
7	Ball bearing	36	Lockwasher (4 req'd)
8	Camshaft	37	Screw (2 req'd)
9	Gasket	38	Shutoff fitting
10	Timing pointer	39	Setscrew (1 req'd)
11	Pump housing	40	Shutoff rod pin
12	Housing stud	41	Bearing screw
13	Tappet roller assembly	42	Rod gasket
14	Tappet guide assembly	43	Spring
15	Roller pin	44	Shutoff rod
16	Gasket	45	Gasket
17	Locating screw (1 req'd)	46	Plain washer (2 req'd)
18	Locking wire	47	Screw (2 req'd)
19	Filter screw	48	Timing window cover
20	Filter screw gasket	49	Cover gasket
21	Strainer	50	Screw (2 req'd)
22	Ring gasket	51	Quill shaft pad
23	Ring gasket	52	Gasket
24	Plunger sleeve pin	53	Plain washer
25	Spring ring	54	Gear
26	Control unit assembly	55	Woodruff key (1 req'd)
27	Retainer	56	Quill shaft bushing
28	Screw w/lockwasher (2 req'd)	57	Quill shaft
29	Lock wire		

Figure 79—Continued.

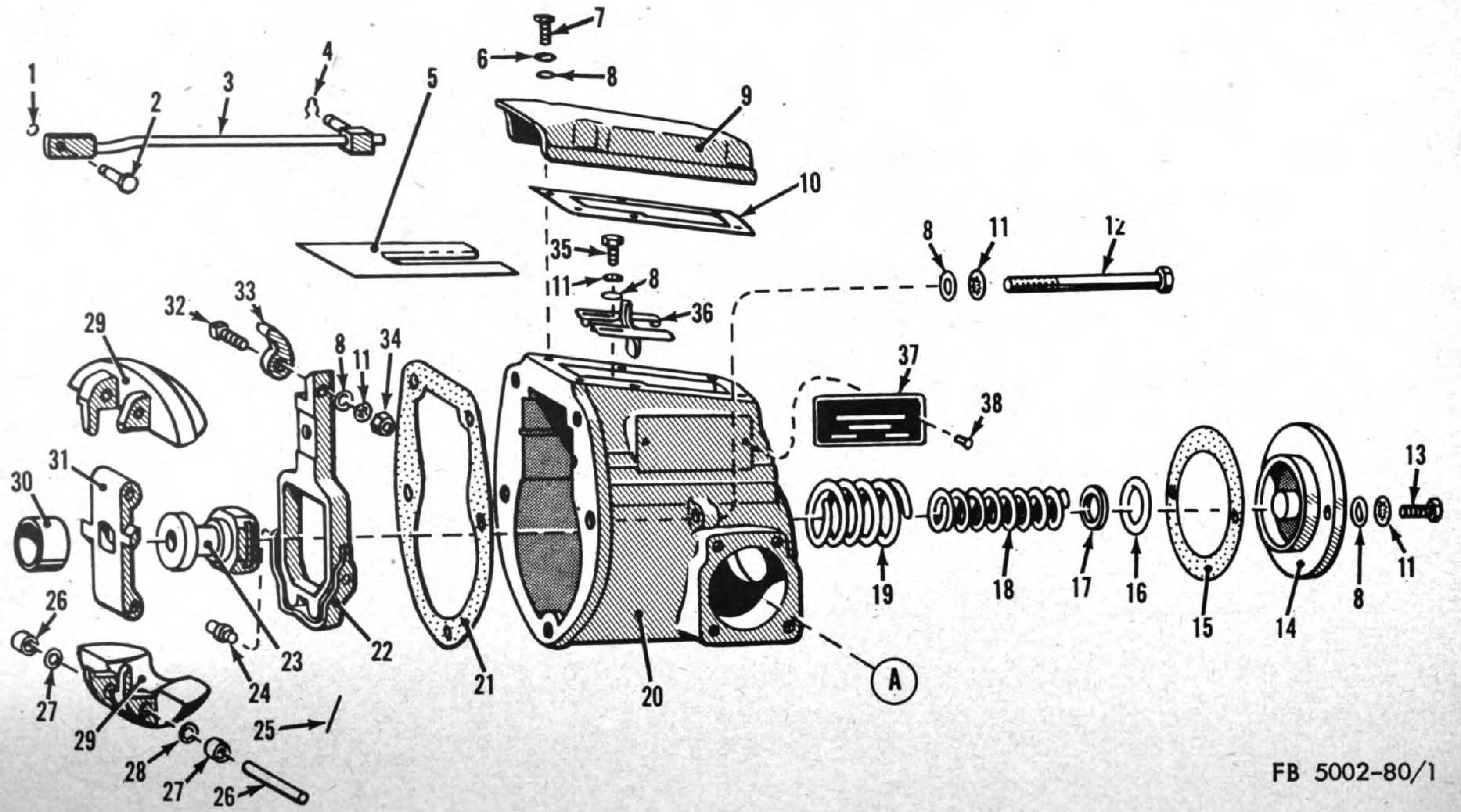
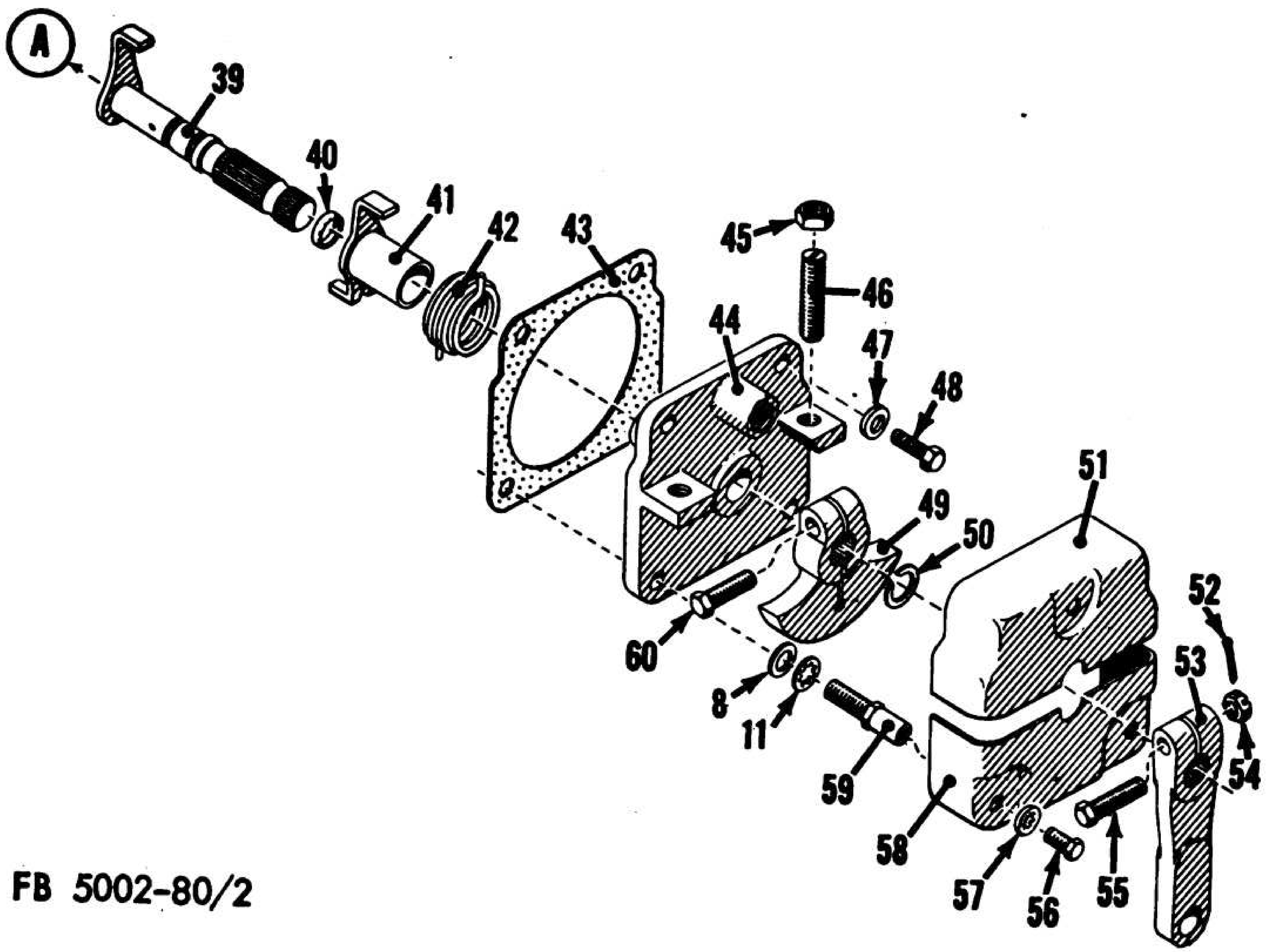


Figure 80. Governor, exploded view.



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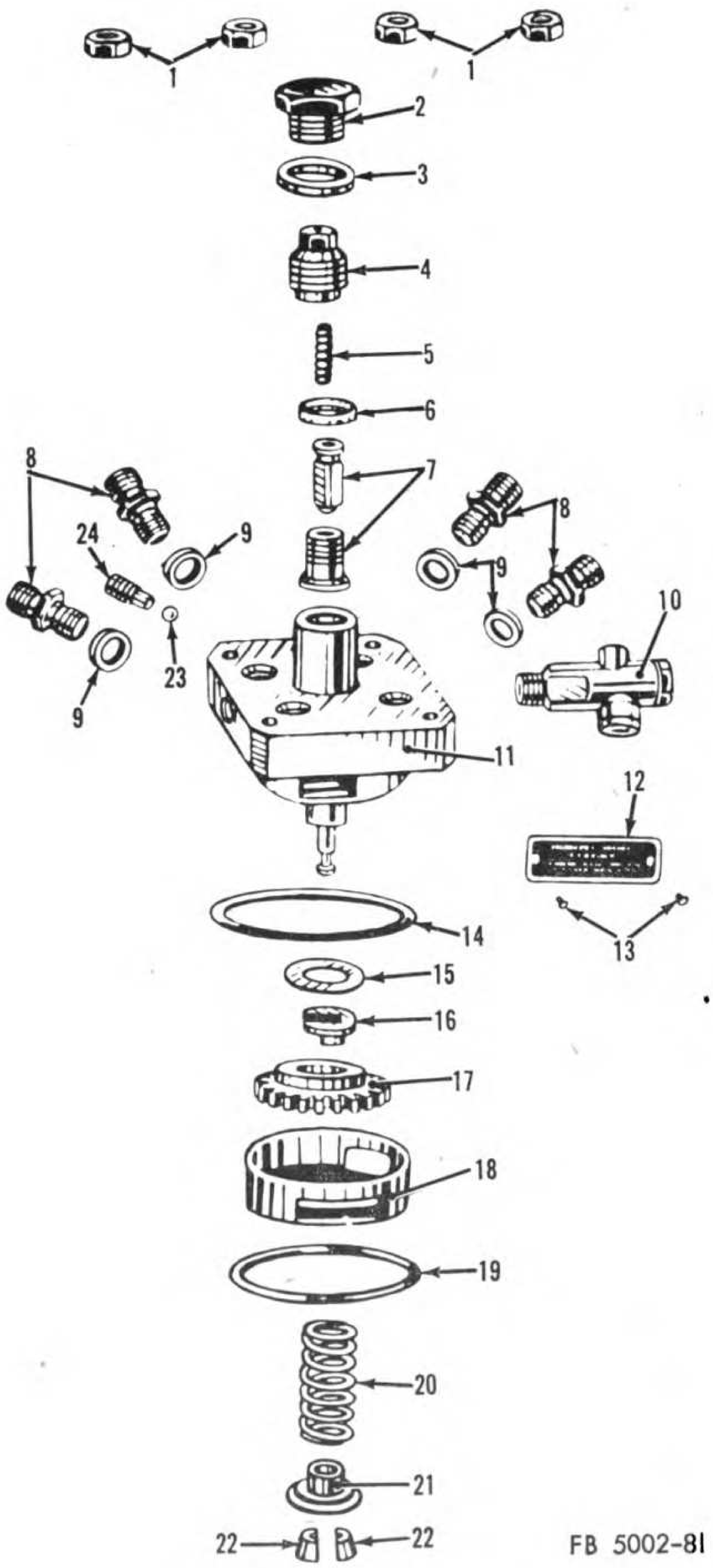
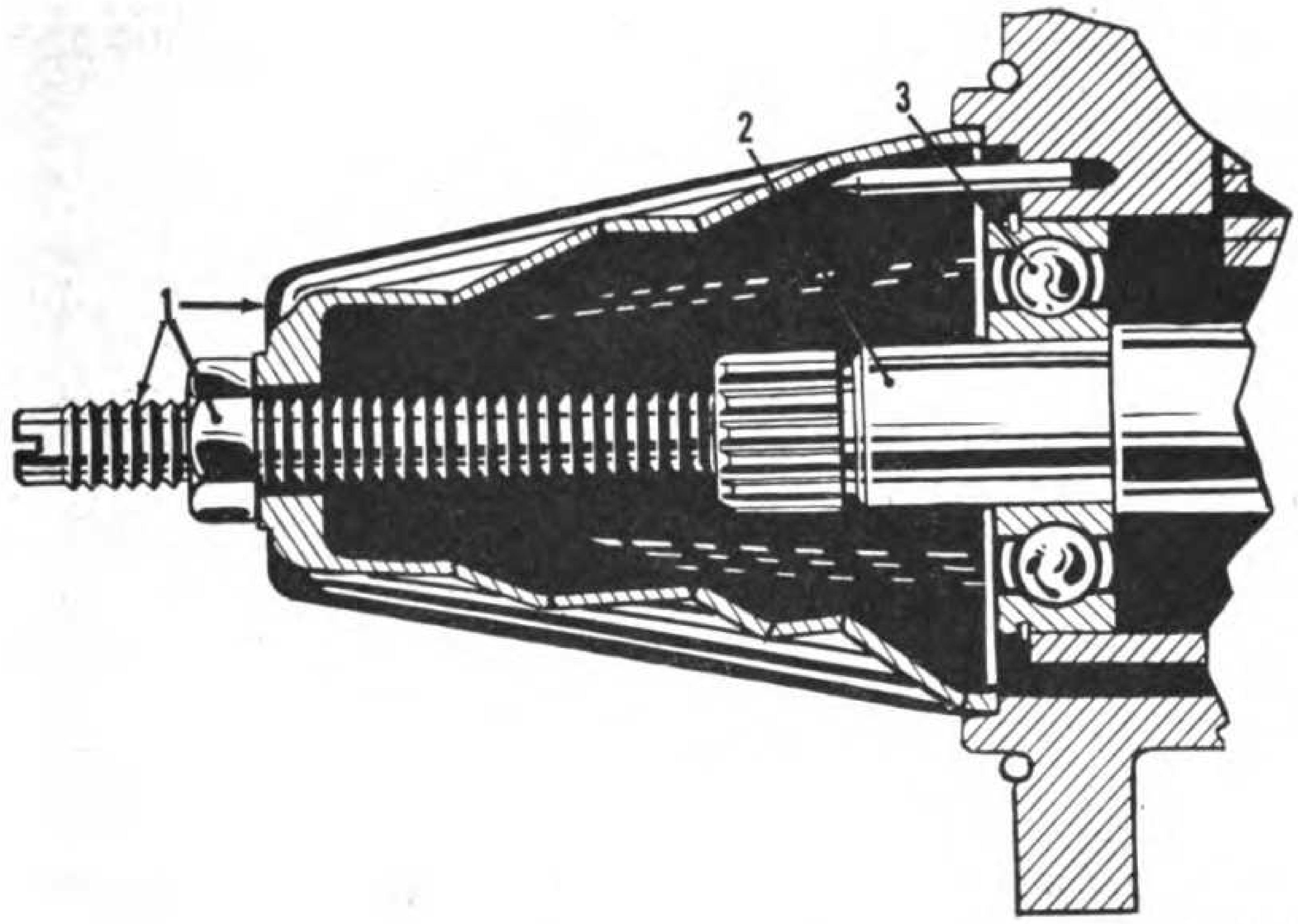
1	Spring ring	31	Weight spider
2	Control rod pin	32	Stop cam screw
3	Control rod	33	Governor stop cam
4	Hairpin	34	Cam screw nut (1 req'd)
5	Oil baffle plate	35	Screw (2 req'd)
6	Lockwasher (4 req'd)	36	Stop plate
7	Screw (4 req'd)	37	Nameplate
8	Plain washer (16 req'd)	38	Screw (2 req'd)
9	Top cover	39	Operating shaft assembly
10	Top cover gasket	40	Ring gasket
11	Lockwasher (12 req'd)	41	Spring plate assembly
12	Screw (2 req'd)	42	Lever spring
13	Screw (5 req'd)	43	Bearing plate gasket
14	End cap	44	Shaft bearing plate
15	End cap gasket	45	Hex nut (2 req'd)
16	Outer spring spacer	46	Stop screw
17	Inner spring spacer	47	Upper screw gasket
18	Inner governor spring	48	Upper screw (2 req'd)
19	Outer governor spring	49	Stop lever
20	Governor housing	50	Snap ring
21	Housing gasket	51	Upper stop lever cover
22	Fulcrum lever assembly	52	Cotter pin (1 req'd)
23	Sleeve assembly	53	Operating lever
24	Pivot pin	54	Hex nut (1 req'd)
25	Roll pin	55	Screw (1 req'd)
26	Weight pin	56	Screw (3 req'd)
27	Weight bushing	57	Lockwasher (3 req'd)
28	Plain washer	58	Lower stop lever cover
29	Weight	59	Lower plate stud
30	Camshaft bushing	60	Clamping screw (1 req'd)

Figure 80—Continued.



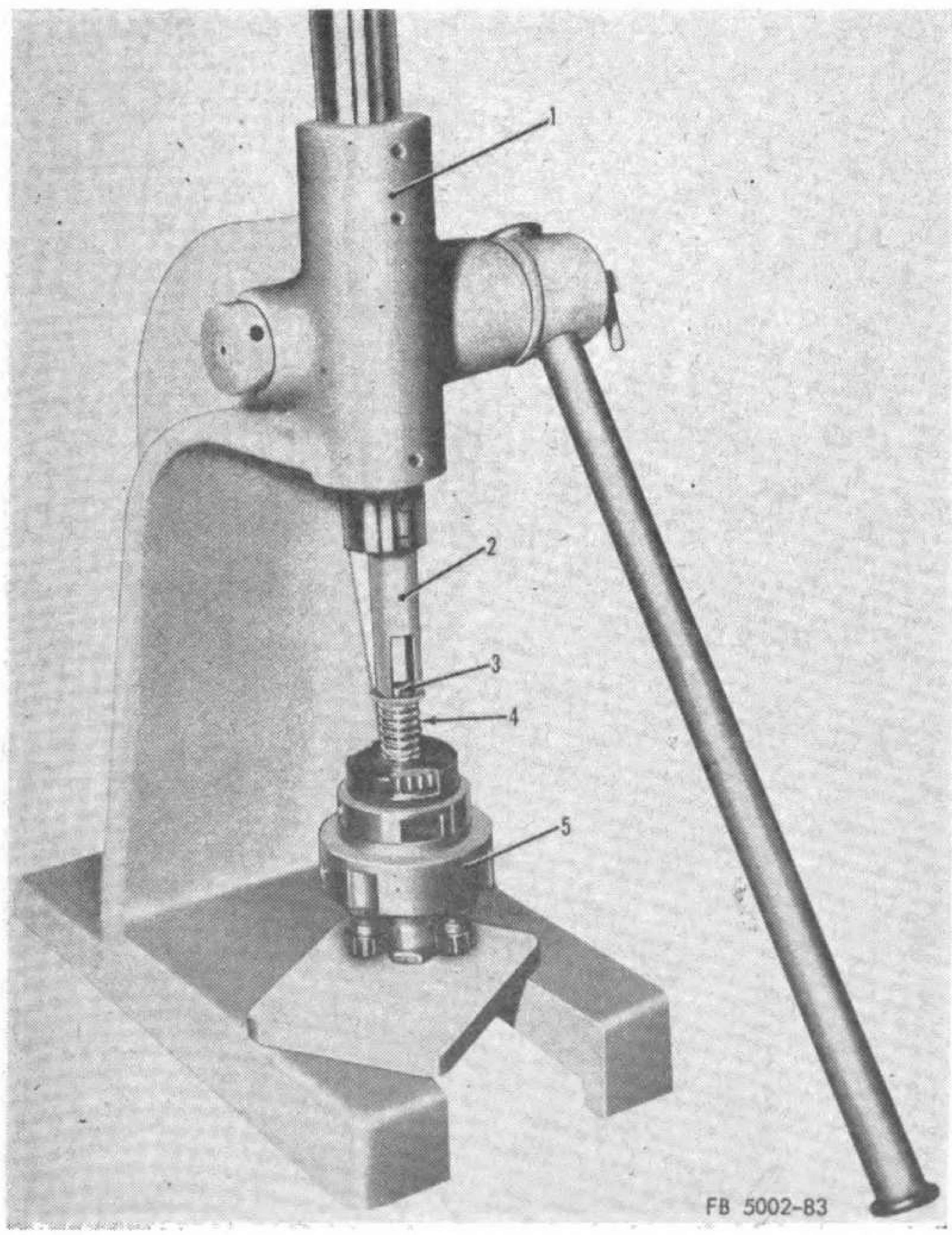
1	Nut (4 req'd)	9	Fitting gasket	17	Drive gear
2	Cap screw	10	Overflow valve assembly	18	Gear retainer cover
3	Screw gasket	11	Hydraulic head	19	Ring gasket
4	Valve holder	12	Number plate	20	Plunger inner spring
5	Valve spring	13	Screw (2 req'd)	21	Lower plunger spring seat
6	Holder gasket	14	Ring gasket	22	Plunger lock
7	Delivery valve assembly	15	Thrust washer	23	Sealing ball
8	Discharge fitting	16	Plunger guide	24	Setscrew

Figure 81. Hydraulic head, exploded view.



1 Puller. 2 Camshaft. 3 Bearing.

Figure 82. Pulling pump camshaft, section view.



1 Arbor press. 2 Pressing tool. 3 Spring seat. 4 Spring. 5 Hydraulic head.

Figure 83. Removing plunger spring.

(15) Pry off the cover (18) and remove the gear (17), thrust washer (15), and guide (6).

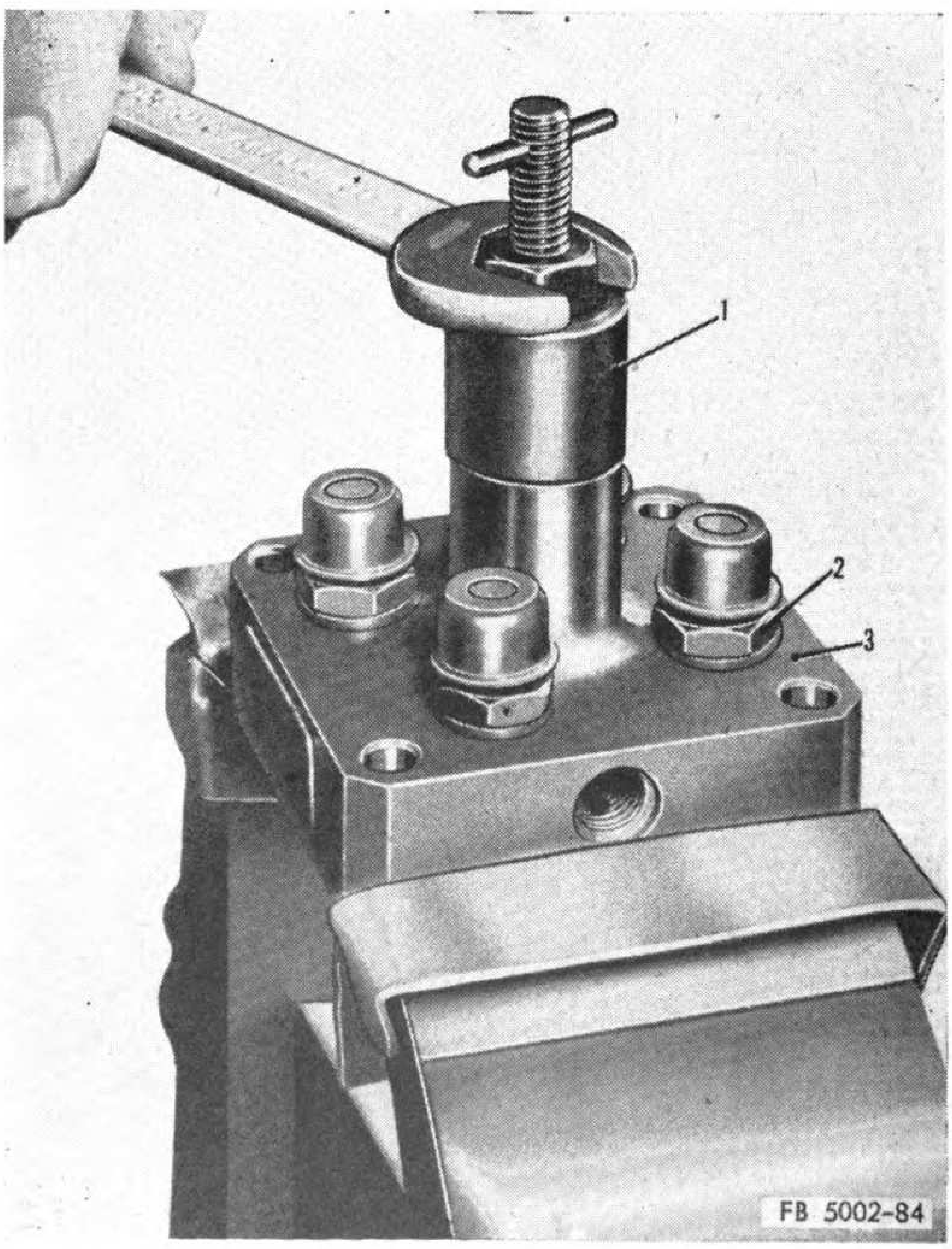
(16) The plunger and control sleeve can now be removed from the head (11). The sleeve and plunger are not interchangeable parts and must be kept together.

(17) Place the head right side up in a vise and remove the cap screw (2), gasket (3), holder (4), and spring (5).

(18) Remove the delivery valve (7) and gasket (6) with the extractor (1, fig. 84). The delivery valve parts are not interchangeable and must be kept together.

(19) Do not remove the discharge fittings (8, fig. 81) and gaskets (9) unless they are leaking or damaged.

(20) To remove the stop plate (36, fig. 80), remove the baffle plate (5), screws (35), lockwashers (11), and plain washers (8).



1 Extractor. 2 Discharge fittings. 3 Hydraulic head.

Figure 84. Removing delivery valve.

(21) Remove the screws (13), lockwashers (11), and plain washers (8) from the cap (14). Pry the cap off and remove the gasket (15), spacers (16 and 17), springs (18 and 19), and sleeve (23).

(22) Mark the position of the operating lever (53) on the shaft (39) and remove the cotter pin (52), nut (54), and screw (55). Pull the lever off the shaft.

(23) Remove the screws (56), lockwashers (57), and lever covers (51 and 58).

(24) Remove the stop screws (46) and nuts (45). Observe the position of the stop lever (49) and remove the clamping screw (60).

(25) To remove the bearing plate (44) and gasket (43), remove the screws (48), studs (59), gaskets (47), lockwashers (11), and plain washers (8).

(26) Lift out the fulcrum lever (22). To disassemble the lever, remove the hairpin (4) securing the control rod (3). Mark a line across the cam (33) and lever before removing the cam. Remove the cam screw (32), nut (34), lockwasher (11), and plain washer (8) securing the stop cam (33).

(27) Pull out the operating shaft (39) and remove the spring plate (41), gasket (40), and lever spring (42).

(28) Do not press out the pivot pin (24) unless it is to be replaced.

(29) Do not disassemble the weight assembly (25 through 29) from the spider (31), since it is replaced as a unit.

b. Inspection.

(1) *Hydraulic head.*

(*a*) Use a magnifying glass to examine the plunger and control sleeve that was pulled out of the hydraulic head (11, fig. 81). Check for scratches, scuff marks, and dull appearance of the lapped surfaces which indicate wear. If either part is worn, replace the entire hydraulic head.

(*b*) Inspect the delivery valve (7) for scratches and scuff marks. Slight scratches and scuff marks can be removed from the seats by lapping with fuel oil and talcum powder. If the valve does not seat itself by its own weight when lubricated with clean oil, apply clean mutton tallow and work the valve into the body with a back-and-forth rotary motion to remove gummy deposits. Do not use a grinding compound. Wash the valve thoroughly and recheck it. Replace the complete valve assembly if any part is defective.

(*c*) Examine the holder (4) and cap screw (2) for damaged threads. Check the spring (5) for cracks, nicks, or pits. Bending the spring will show up any cracks. Replace a defective part.

(*d*) Check the cover (18) and thrust washer (15) for damage. Replace a defective part.

(*e*) Inspect the gear (17) for damaged or worn teeth, and the guide (16) for cracks and wear. Replace a defective part.

(*f*) Replace the spring (20) if it is nicked, pitted, or cracked.

(*g*) Replace the plunger lock (22) if it is damaged.

(*h*) Check for end play between the plunger sleeve pin (24, fig. 79) and the control sleeve guide slot. Replace a worn pin.

(2) *Housing.*

(*a*) Check the studs (12) for thread damage. Replace damaged studs.

(*b*) Examine the camshaft bushing (30, fig. 80) for scores and scratches. Replace a defective bushing.

(*c*) Inspect the pump housing (11, fig. 79) for cracks, breaks, and damaged threads. Replace a defective housing.

(3) *Camshaft.* Examine the camshaft (8) for scores, scratches, or damage at the lobes, splines, internal threads, and gear teeth. Replace a defective camshaft.

(4) *Quill shaft assembly.* Check the quill shaft (57), gear (54), and bushing (56) for wear or damage. Clearance between the bushing and gear should be 0.001 to 0.006 inch. Replace a defective part.

(5) *Camshaft bearing.* Examine the bearing (7) for excessive wear and roughness, indicated by metallic dust in the races and noisy operation.

(6) *Tappet assembly.* Check for play in the pin (15) between the roller (13) and guide (14). Replace a worn part.

(7) *Governor.*

(*a*) See that the governor weights (29, fig. 80) are free in their pins (26) and that the weight noses are not worn. Replace the weight and spider assembly as a unit if any part is worn or there is play at the pins which would result in binding the governor action.

(*b*) Inspect the sleeve (23) for wear at the contact points of the weight and fulcrum lever (22), and for freedom of movement on the camshaft. Replace a defective sleeve.

(*c*) Check the fulcrum lever (22) for wear at the pivot pins, control rod, and operating shaft holes. Replace a worn lever.

(*d*) Examine the stop plate (36) and cam (33) for wear at the contact points. Replace a worn part.

(*e*) Inspect the operating shaft (39), plate (41), and spring (42) for damage and wear. Flex the spring to show up any cracks. Replace a defective part.

(*f*) Check the bearing plate (44) for wear at the operating shaft hole. Replace a worn plate.

(8) *Fuel supply pump.* Examine the gear (32, fig. 79) for worn or damaged teeth, and the seal (33) for wear. Replace a worn part. If the pump (35) is defective, replace it as a unit.

c. Reassembly. Use new gaskets when assembling the pump and governor. Make sure all parts are perfectly clean. Rinse all internal metal parts in clean fuel oil and assemble them without drying.

(1) If the pivot pin (24, fig. 80) was removed, press the new one into the housing (20).

(2) Place the hydraulic head (11, fig. 81) in a vise, with the delivery valve opening up, and insert the delivery valve (7), gasket (6), and spring (5). Secure with the holder (4) and tighten to a tension of 32 to 34 foot-pounds. Install the gasket (3) and cap screw (2) and tighten to the same tension.

(3) If the discharge fittings (8) were removed, install new gaskets (9) and the fittings, and torque to a tension of 32 to 34 foot-pounds. Place caps or tape over the fittings to prevent the entrance of dirt.

(4) Turn the head (11) upside down and install the control sleeve, plunger, thrust washer (15), guide (16), and gear (17). Check the plunger for freedom of movement by turning the gear.

(5) Install the retainer cover (18) and crimp it securely to the head.

(6) Install the spring (20) and seat (21). Compress the spring in an arbor press (1, fig. 83) with the tool (2), and insert the lock (22, fig. 81).

(7) Remove from the press and install new gaskets (14 and 19).

(8) Install the bushing (30, fig. 80) if it was removed. Make sure the oilhole lines up with the passage in the pump housing (11, fig. 79).

(9) Press the bearing (7) on the camshaft (8) and insert the camshaft into the housing (11).

(10) Install the plate (6) and secure with the lockwashers (5) and screws (4).

(11) Install the tappet assembly (13 through 15).

(12) Assemble the quill shaft (57) and bushing (56). Place the key (55) in the shaft and press on the gear (54). Install the washer (53) and secure with the ring (31).

(13) Turn the camshaft so that the center of the wide groove on the splined end lines up with the CLW mark on the plate (6). Place the hub (3) temporarily on the shaft, with a pointed setscrew inserted in one of the tapped holes of the hub flange and in line with the wide groove. Tighten the screw until the point is directly on the CLW mark and the camshaft is held firmly.

(14) Place the pump with the supply pump opening down, and insert the quill shaft assembly. Mesh the gears so that the open tooth of the spur gear lines up with the drill mark on the counterbore of the pump housing. Secure with the screw (17), gasket (16), and locking wire (18).

(15) Install the pad (51) and gasket (52) and secure with the screws (50) and gaskets (16).

(16) Install the gasket (23), pin (24), ring (25), control unit (26), and retainer (27). Leave the screws (28) off temporarily.

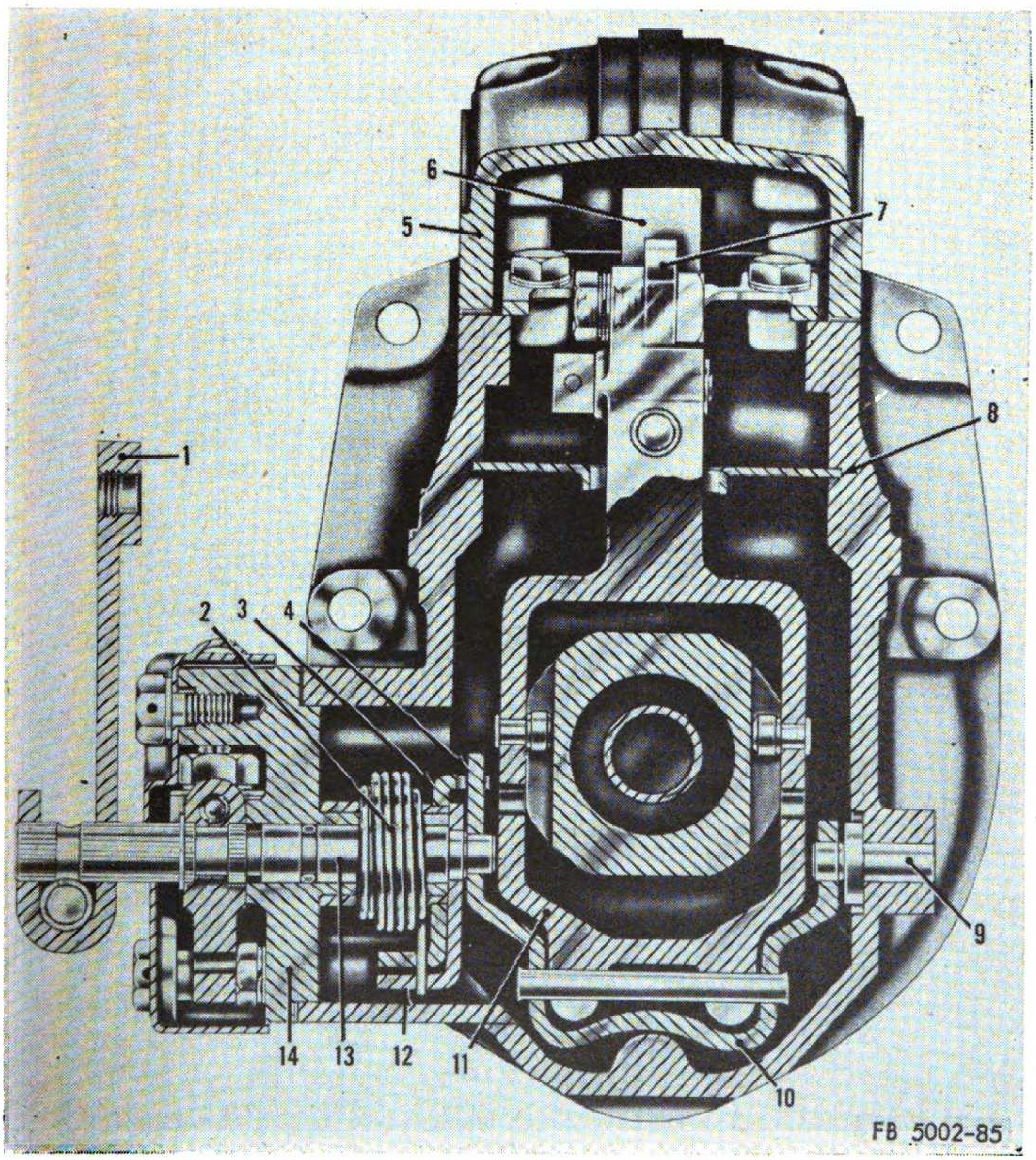
(17) Place the pump upright, and position the plunger drive gear (17, fig. 81) so that the line mark on the tooth is in the center of the widest opening of the cover (18). Install the assembled head so that the line mark on the gear alines with the "O" mark in the timing window. Secure with the nuts (1) to the studs (12, fig. 79).

(18) Place the pump with the timing window up, and move the control sleeve to midposition. Swing the control unit (26) to the lower vertical position, and the pin

(24) to the horizontal position. Carefully engage the pin (24) in the control sleeve slot and secure the control unit with the screws (28) and lock wire (29).

(19) Install the filter assembly (19 through 22) in the housing. Place the oil seal (33) on the supply pump shaft and insert the key (34). Press on the gear (32) and secure with the ring (31). Install the pump (35) and gasket (30) on the injector pump and secure with the screws (37) and lockwashers (36).

(20) Remove the pointed setscrew and hub (3).



1	Operating lever	6	Stop plate	11	Fulcrum lever
2	Lever spring	7	Stop cam	12	Bearing plate tongue
3	Spring plate	8	Oil baffle plate	13	Operating shaft
4	Yoke tongue	9	Yoke pivot pin	14	Bearing plate
5	Top cover	10	Yoke		

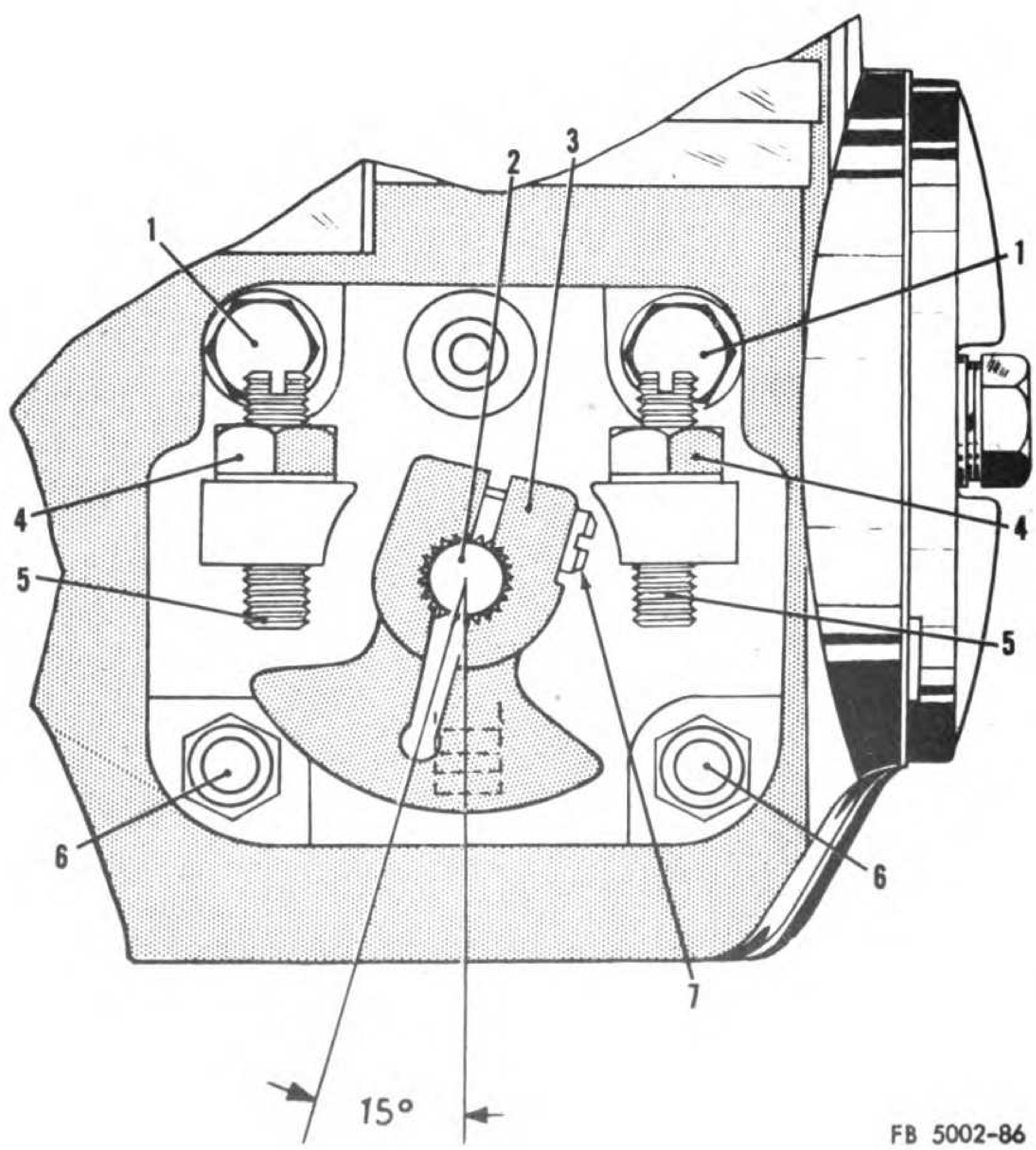
Figure 85. Governor, cross section.

(21) Press the spider (31, fig. 80) and weight assembly (25 through 29) on the camshaft with the tool (2, fig. 83) used to compress the plunger spring.

(22) Secure the control rod (3, fig. 80) to the fulcrum lever (22) with the hairpin (4). Secure the cam (33) with the screw (32), plain washer (8), lockwasher (11), and nut (34). Make sure the cam is alined with the mark on the lever to obtain the proper angle with the plate (36).

(23) Place the fulcrum lever (11, fig. 85) in the housing and engage the yoke (10) with the pivot pin (9). Insert the oil baffle plate (8) with the rolled edges down.

(24) Assemble the spring (2) to the spring plate (3) and place the plate on the bearing plate (14). Insert the operating shaft (13) through the plates (3 and 14), with the bearing plate tongue (12) sliding over the spring plate tongue and between the spring ends.



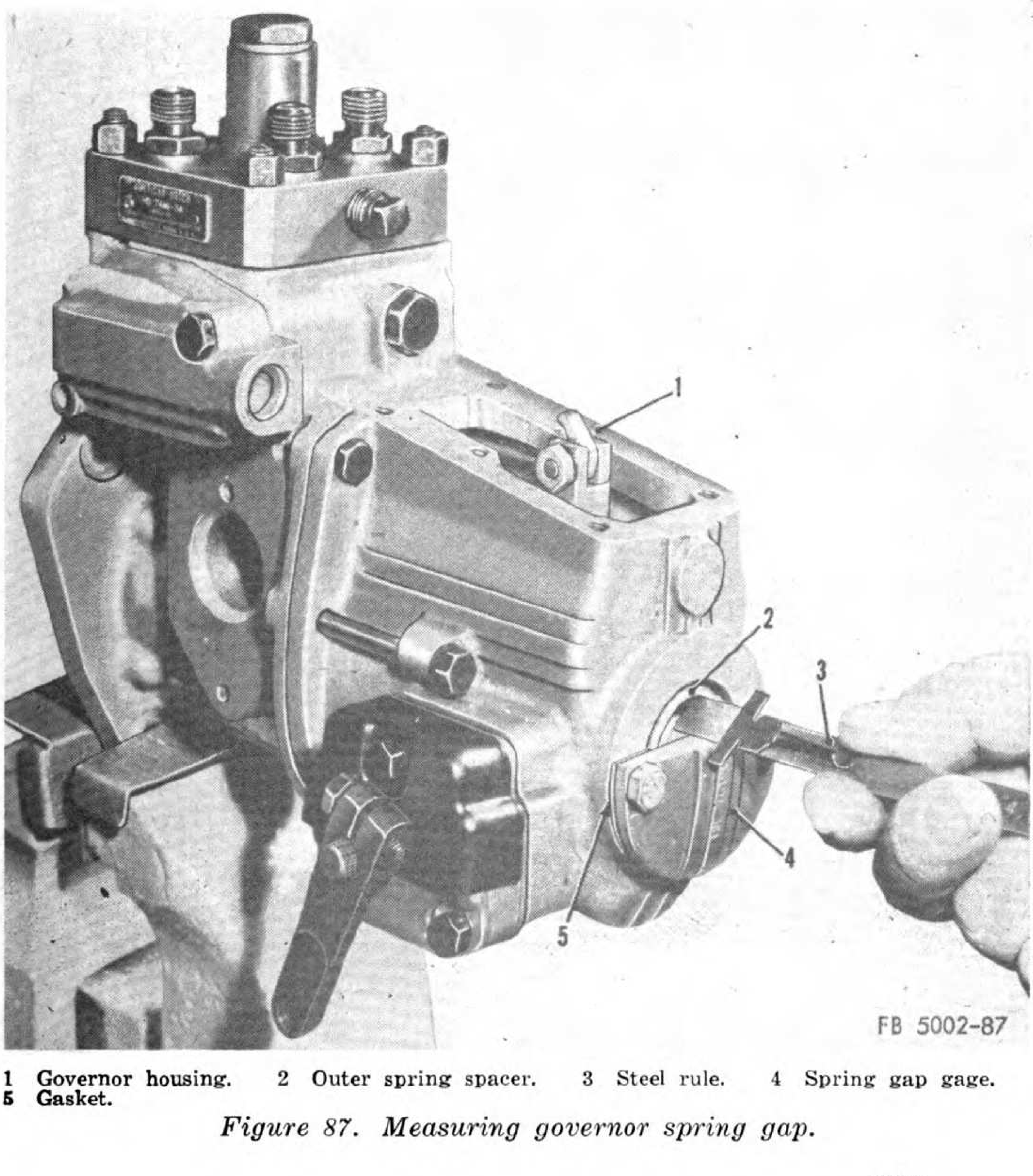
1 Screws (2 req'd)
2 Operating shaft
3 Stop lever
4 Nuts (2 req'd)
5 Stop screws
6 Studs
7 Clamping screw (1 req'd)

Figure 86. Governor stop lever.

(25) Install the stop lever (3, fig. 86) on the operating shaft (2) with the notch in the spring plate up and the lever in the position noticed on disassembly, or about 15° to the left of the vertical centerline. Adjust the clearance between the lever and bearing plate to 0.002 to 0.004 inch and tighten the clamping screw (7).

(26) Install the operating shaft assembly on the governor housing. Engage the notch of the spring plate (3, fig. 85) with the tongue (4), which automatically engages the yoke (10) with the pivot pin. Secure with the screws (1, fig. 86) and stud (6).

(27) Install the stop screws (5) and nuts (4) on the bearing plate (44, fig. 80), and the operating lever (53) on the shaft (39) in the position marked on disassembly.



1 Governor housing. 2 Outer spring spacer. 3 Steel rule. 4 Spring gap gage. 5 Gasket.

Figure 87. Measuring governor spring gap.

(28) Secure the stop plate (36) with the screws (35), lockwashers (11), and plain washers (8). Engage the sleeve (23) with the pivot pins on the fulcrum lever (22).

(29) Cement the gasket (21) to the governor housing (20), and position the assembled governor on the injector pump. Allow the sleeve to slide on the camshaft and guide the control rod (3) through the pump housing. Secure the governor with the screws (12 and 13), lockwashers (11), and plain washers (8).

(30) Secure the control rod to the control unit (26, fig. 79) with the pin (2, fig. 80) and ring (1).

(31) Install the springs (19 and 18), spacers (17 and 16), gasket (5, fig. 87), and spring gap gage (4). Secure the gage with temporary screws. Spring gap is measured from the inner edge of the gage to the spacer. Correct gap is 0.059 inch for the inner spring. The spacer is available in several thicknesses. Select the proper thickness to obtain the correct spring gap.

(32) Remove the gage and install the end cap (14, fig. 80). Secure with the screws (13), lockwashers (11), and plain washers (8).

(33) Install the window cover (48, fig. 79), gasket (49), and shutoff rod assembly (38 through 45). Secure with the screws (47), lockwashers (36), and plain washers (46). Do not install the lever covers (51 and 58, fig. 80) until the pump has been calibrated (*e* below).

d. Timing By Flow Method.

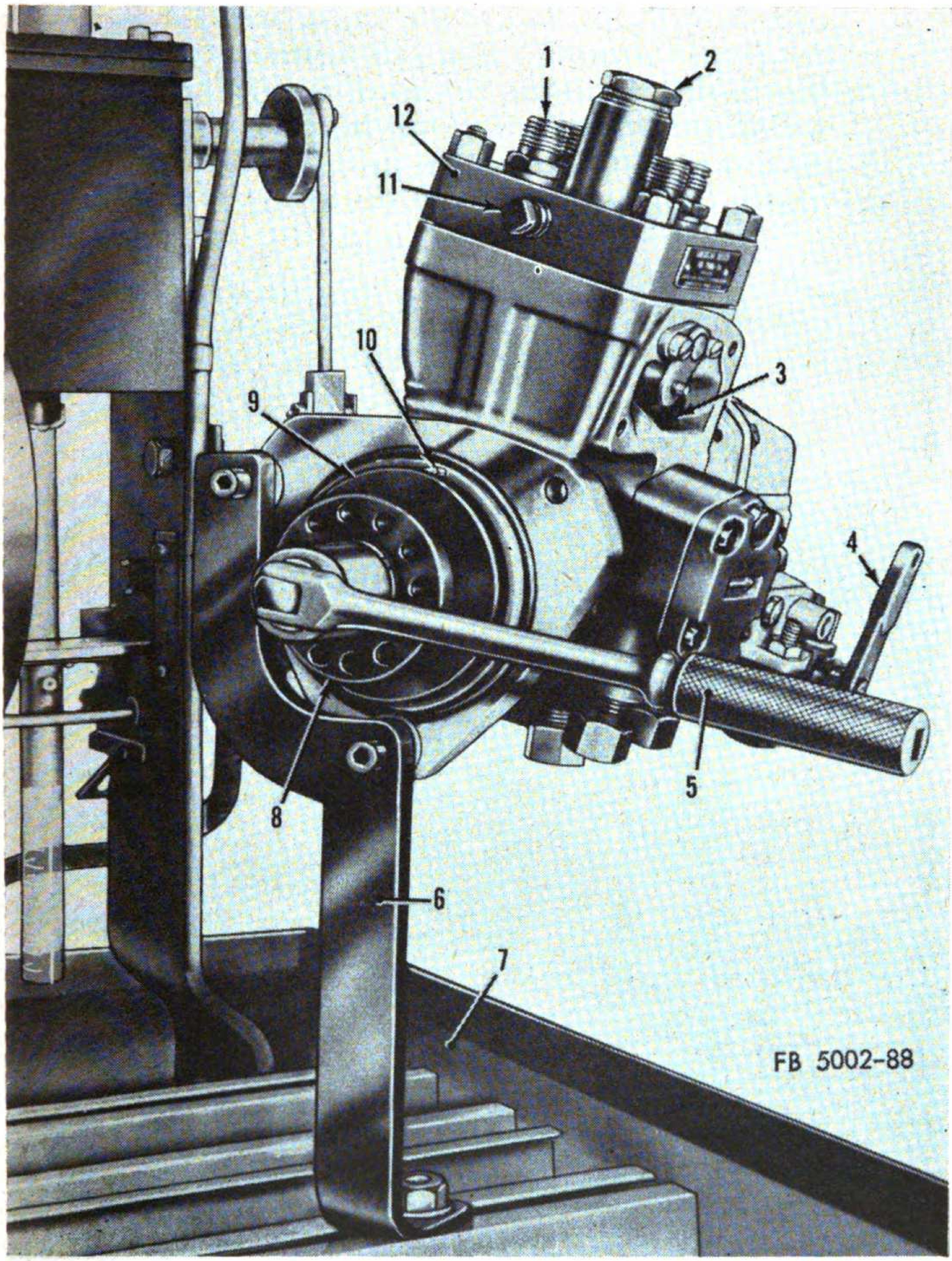
(1) Secure the injector pump to the bracket (6, fig. 88) and mount on the test stand (7).

(2) Connect a fuel line to the fuel inlet on the hydraulic head (12) and install a pipe plug (11) in place of the overflow valve.

(3) Bleed all the air out of the pump by loosening the plug (11) and turning the hub (8) until fuel flows steadily without bubbles. Tighten the plug and place the lever (4) in the full-load position.

(4) Remove the cap screw (2, fig. 81), gasket (3), holder (4), spring (5), gasket (6), and valve (7); then install the gasket (6), holder (4), gasket (3), and cap screw (2).

(5) Turn the pump camshaft with a wrench (5, fig. 88) until the marked tooth on the plunger drive gear approaches the "O" mark on the timing window (3).



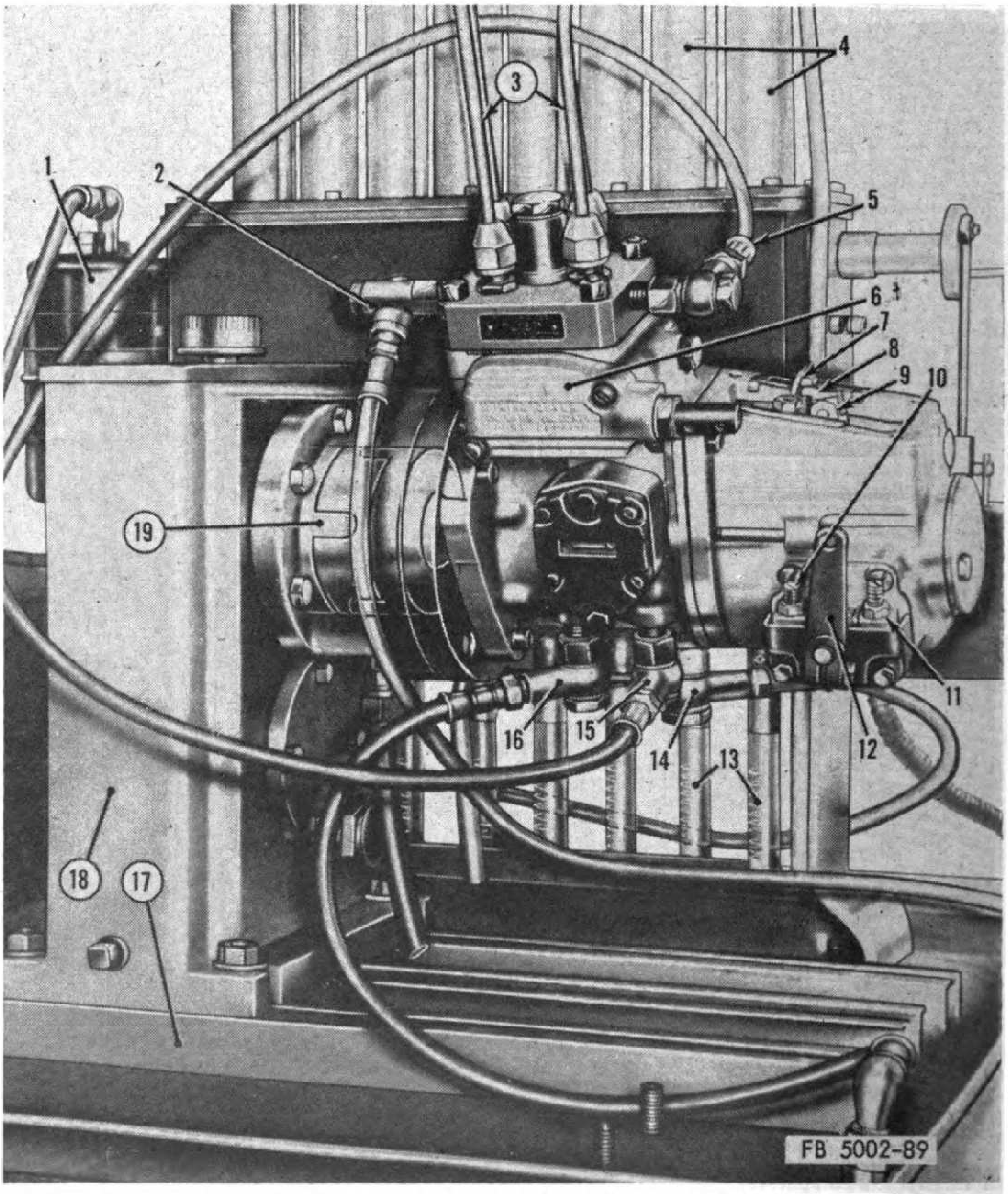
1 Outlet No. 1
2 Delivery valve cap screw
3 Timing window
4 Operating lever
5 Wrench
6 Bracket
7 Test stand
8 Drive hub
9 Hub rim
10 Timing pointer
11 Plug
12 Hydraulic head

Figure 88. Timing injector pump.

(6) Continue to turn the hub (8) slowly until the flow of oil stops at outlet No. 1 (1). At the point where the flow stops, the mark on the hub rim (9) must be exactly in line with the pointer (10), and the marked tooth must aline with the port closing (PC) mark on the timing window. If the timing marks are considerably out of

line, check the position of the timing marks on the gears for proper assembly. If a new hydraulic head (12 has been installed and the hub mark is slightly out of line, file off the mark on the rim (9) and mark correctly. Make a new PC mark on the timing window.

(7) Install the delivery valve (7, fig. 81).



1 Filter
2 Overflow valve
3 High pressure tubing
4 Nozzle holders
5 Fuel inlet
6 Timing window cover
7 Stop plate
8 Stop 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 supply pump outlet
16 Fuel supply pump inlet
17 Test stand
18 Mounting bracket
19 Intermediate mounting disk

Figure 89. Injector pump on test stand.

e. Calibrating.

(1) Remove the hub (3, fig. 79) and install the drive hub furnished with the test stand (17, fig. 89). Secure the pump to the bracket (18) with the disk (19).

(2) Connect the tubing (3) to the pump and nozzle holders (4). Connect the supply pump inlet (16) to a fuel source, and the outlet (15) to the filter (1).

(3) Connect the filter outlet to the injector pump inlet (5), and the overflow valve (2) to the fuel return line.

(4) Connect the lubricating oil inlet (14) to the supply pump on the speed changer.

(5) Start the test stand in the lowest variable speed position and gradually bring the pump up to 1,200 rpm. Move the operating lever (12) to the full-load position. If the fulcrum lever (9) oscillates, correct the play in the test stand.

(6) Move the stop plate (7) to prevent interference with the cam (8), and adjust the stop screw (11) for an oil delivery averaging 34 to 35 cubic centimeters per 500 strokes. The oil caught in the cylinders (13) must be averaged, since all the nozzles will not deliver the same quantity of oil.

(7) Adjust the stop plate (7) to just touch the cam (8) on the fulcrum lever (9) after the screw (11) is adjusted.

(8) Reduce the speed to 800 rpm with the operating lever (12) still in the full-load position. The average delivery should increase 5 to 8 percent, or about 37 cubic centimeters per 500 strokes.

(9) Reduce the speed to 400 rpm with the lever in the full-load position. If the delivery drops below that of 800 rpm and full load, the control sleeve and plunger are worn and the hydraulic head must be replaced.

(10) Increase the speed slowly until it is above 1,200 rpm. The delivery of oil should stop at 1,240 to 1,380 rpm. Adjust the stop plate (7) if necessary.

(11) Set the operating lever (12) to the idle position. Reduce the speed to 600 rpm and adjust the idle stop screw (10) to get an average delivery of 15 to 16 cubic centimeters per 500 strokes.

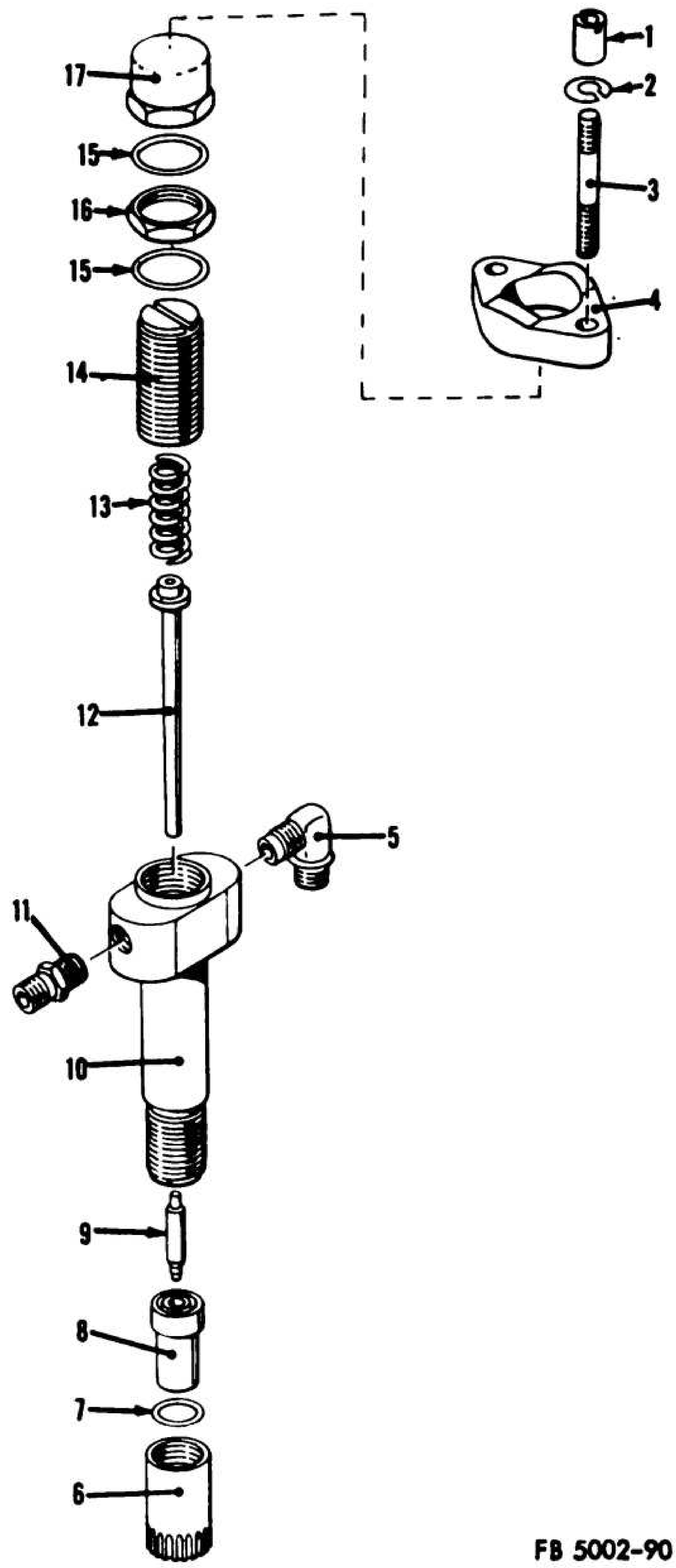
(12) Increase the speed to 700 rpm and see if the governor responds promptly. When speed is increased, the governor tends to reduce oil delivery; when speed is reduced the governor tends to increase oil delivery.

(13) Install the covers (51 and 58, fig. 80). Secure with the screws (56) and lockwashers (57).

178. Nozzle Holder Assemblies

a. General. For removal, installation and testing the nozzle holders, refer to paragraph 88.

Note. **Cleanliness is important when working on the nozzle holders. Clean all external parts with cleaning solvent before disassembling, and provide a clean workbench. Do not allow filing, scraping, or sawing on the workbench while the nozzle holders are being dismantled.**



1	Special nut	7	Gasket	13	**Spring**
2	Lockwasher	8	Body	14	**Adjusting screw**
3	Stud	9	Pintle valve	15	**Gasket**
4	Nozzle holddown clamp	10	Holder	16	**Locknut**
5	Elbow or tee	11	Connector	17	**Protecting cap**
6	Nozzle capnut	12	Spindle		

Figure 90. Nozzle holder assembly, exploded view.

Warning: Do not disassemble a nozzle holder unless a test stand is available to adjust the valve pressure on assembly.

b. Disaasembly (fig. 90).

(1) Clean all external dirt and carbon from the nozzle holder assembly.

(2) Clamp the holder (10) in a vise and unscrew the cap (17).

(3) Remove the gaskets (15), locknut (16), adjusting screw (14), spring (13), and spindle (12).

(4) Reverse the position of the holder and remove the capnut (6), gasket (7), body (8), and pintle valve (9).

(5) Unscrew the fittings (5 and 11).

c. Cleaning (fig. 90). Clean all parts with fuel oil. The interior of the body (8) and spray hole can be cleaned with an oil-soaked wood splinter. Clean the pintle valve (9) with a soft, lintless, oil-soaked rag. Clean the body seating surface for the valve with a piece of wood shaped to the angle of the seat.

Caution: Do not use abrasives, hard or sharp tools, emery paper, or crocus cloth on the parts.

d. Inspection (fig. 90). Inspect the holder (10) for distortion due to overheating or corrosion caused by acids in the fuel. Inspect the seating surfaces of the valve (9) and body (8) for wear or corrosion. If either the valve or body is defective, replace both as an assembly. Check the spring for nicks, pits, or cracks. Cracks will become apparent if the spring is flexed.

e. Reassembly.

(1) Place the holder (10, fig. 90) in a vise and install the fittings (5 and 11).

(2) Install the spindle (12), spring (13), screw (14), gasket (15), locknut (16), and cap (17) on the holder.

(3) Install the valve (9), body (8), gasket (7), and capnut (6) on the holder, using a centering sleeve (1, fig. 91) to center the body within the capnut.

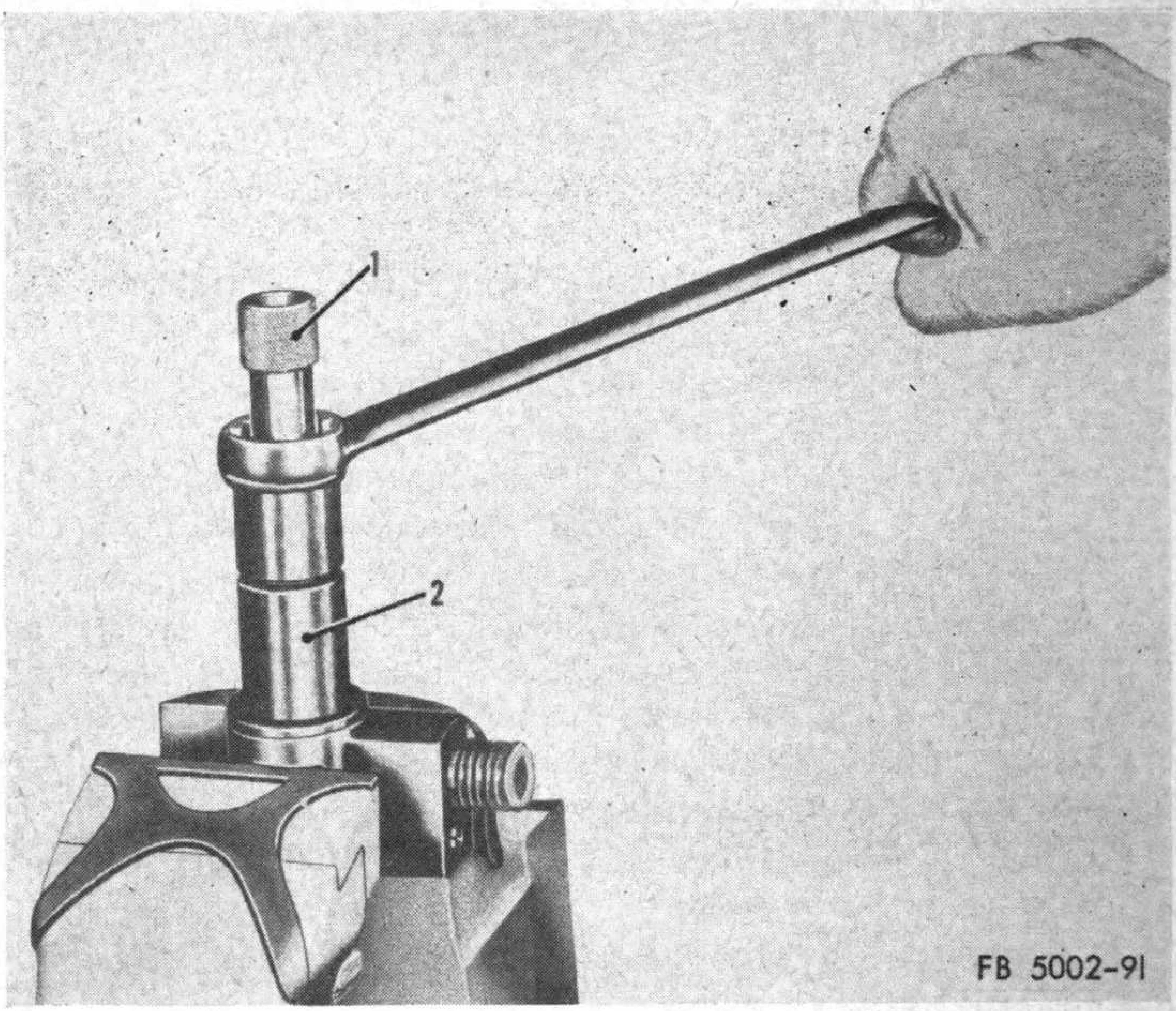
(4) Tighten the capnut and test and adjust the opening pressure (*f* below).

f. Testing and Adjustment (fig. 92).

(1) Fill the tester (6) with clean fuel oil and pump the lever (5) until oil runs out of the fitting (10).

(2) Secure the nozzle holder assembly (9) under test to the fitting.

(3) Close the gage valve (3) and make a few quick strokes with the lever (5). If the lever operates extremely hard,



1 Centering sleeve. 2 Nozzle holder.

Figure 91. Nozzle holder with centering sleeve in position.

it indicates a plugged nozzle. Disassemble and clean (*b* and *c* above).

(4) Pump the lever not less than 100 strokes per minute and watch the nozzle for leakage or dribble. If no oil is visible at pressures up to 1,650 psi, the valve is seating tightly. Stroking speeds below 100 may cause nozzle drip even though the valve is in good condition.

(5) At 1,700 psi the nozzle holder should emit a fine and symmetrical spray pattern. Fuel should be sprayed at sharply defined intervals. Unevenness or roughness of the stream, or leakage of oil out of the nozzle after the spray is completed indicates that the nozzle holder is dirty and must be cleaned.

(6) Correct opening pressure is about 1,700 psi. No adjustment is necessary if the pressure has dropped to a minimum of 1,650 psi.

(7) To adjust the opening pressure, remove the protecting cap from the top of the holder and loosen the locknut (8).

Turn the adjusting screw (7) until the correct pressure is obtained; then tighten the locknut and install the cap.

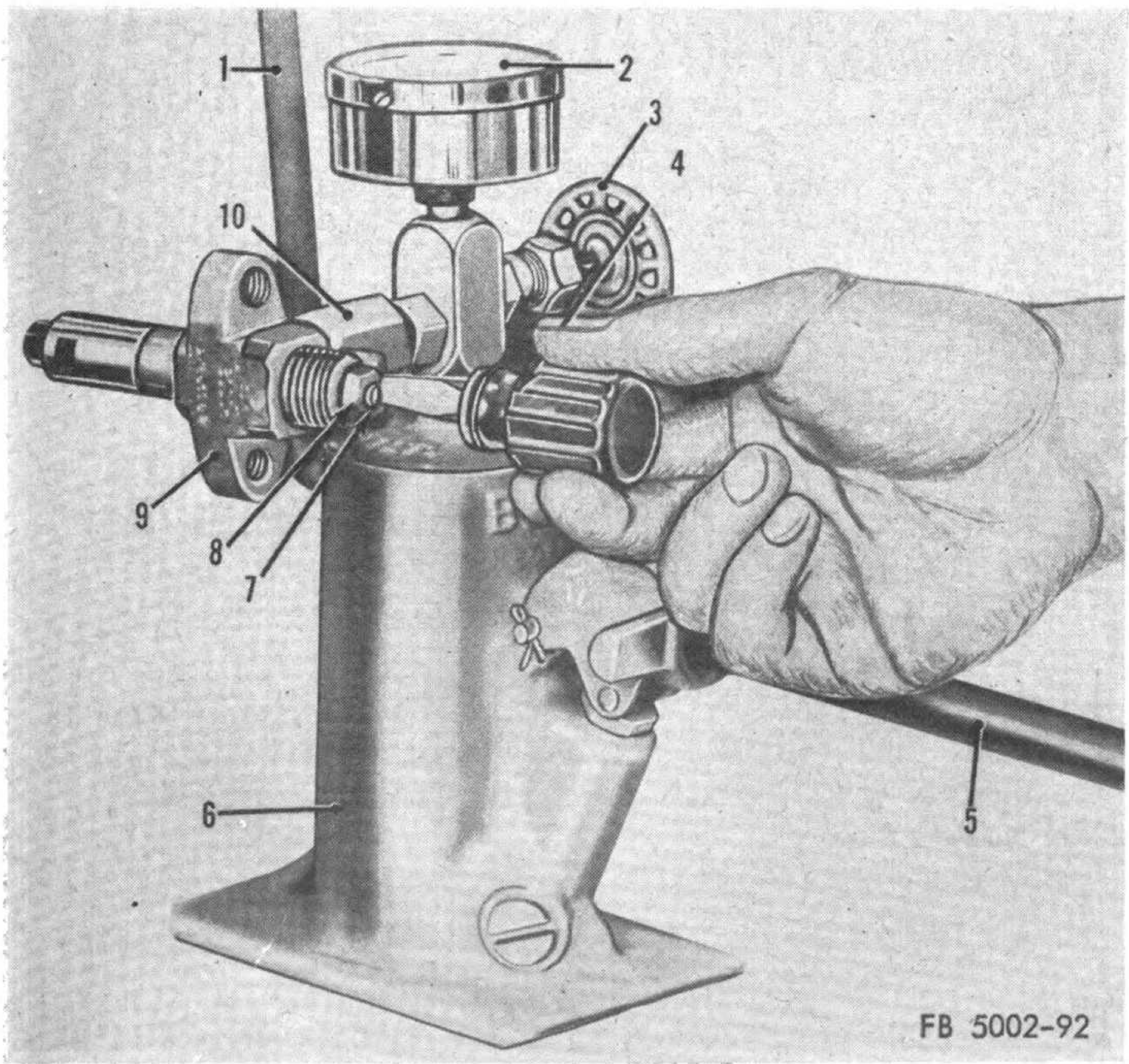
179. Adapter

a. General (fig. 27). The adapter (2) is attached to the cylinder block and timing gear cover. It mounts the injector pump and houses the pump drive gear (6). The oil pan is filled with lubricating oil through a filler neck located at the top of the adapter.

b. Removal (fig. 93).

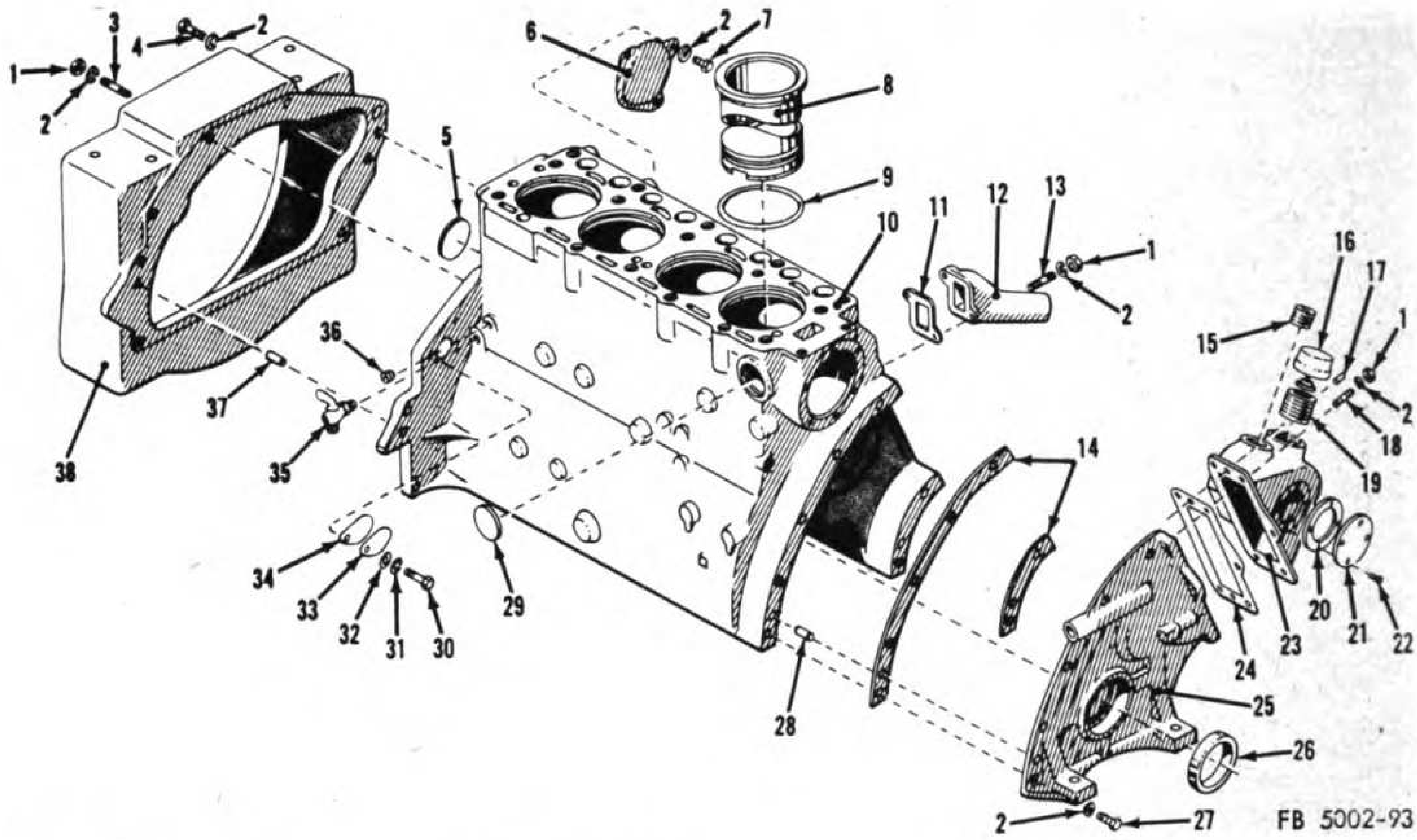
(1) Remove the priming pump (par. 84) and the injector pump (par. 86).

(2) To remove the adapter (23) and gasket (24), remove the nuts (1) and lockwashers (2) securing the adapter to the gear cover (25) and cylinder block (10).



1 Oil supply line
2 Gage
3 Gage valve
4 Screwdriver
5 Operating lever
6 Nozzle tester
7 Adjusting screw
8 Locknut
9 Nozzle holder assembly
10 Adapter fitting

Figure 92. Adjusting injection pressure.



1	Nut (9 req'd)	14	Gasket	27	Screw (7 req'd)
2	Lockwasher (20 req'd)	15	Pipe plug	28	Pin
3	Stud	16	Cap	29	Plug
4	Screw (1 req'd)	17	Dowel	30	Screw (5 req'd)
5	Plug	18	Adapter stud	31	Lockwasher (1 req'd)
6	Starter hole cover	19	Oil filler neck	32	Plain washer (1 req'd)
7	Cover screw (3 req'd)	20	Hole cover gasket	33	Flywheel pointer cover
8	Cylinder sleeve	21	Injection pump hole cover	34	Felt
9	Sleeve packing	22	Screw (4 req'd)	35	Block drain valve
10	Cylinder block	23	Injection pump adapter	36	Pipe plug
11	Gasket	24	Adapter gasket	37	Dowel
12	Water inlet elbow	25	Gear cover assembly	38	Flywheel housing
13	Stud	26	Seal		

Figure 93. Cylinder block, gear cover, adapter, and flywheel housing assemblies, exploded view.

c. *Disassembly* (fig. 93).

(1) Remove the screws (22) securing the cover (21) and gasket (20) to the adapter (23).

(2) Remove the cap (16), filler neck (19), and plug (15).

d. *Inspection* (fig. 93). Check the adapter (23) for cracks, breaks, and internal thread damage. If possible, weld cracks and paint (par. 34). Replace a defective adapter. Inspect the filler neck (19), plug (15), and cap (16) for damaged threads. Replace a defective item.

e. *Reassembly* (fig. 93).

(1) Install the filler neck (19), cap (16), and plug (15) on the adapter (23).

(2) Secure the cover (21) and a new gasket (20) to the adapter with the screws (22).

f. *Installation* (fig. 93).

(1) Place a new gasket (24) on the gear cover (25) and cylinder block (10). Position the adapter (23) on the

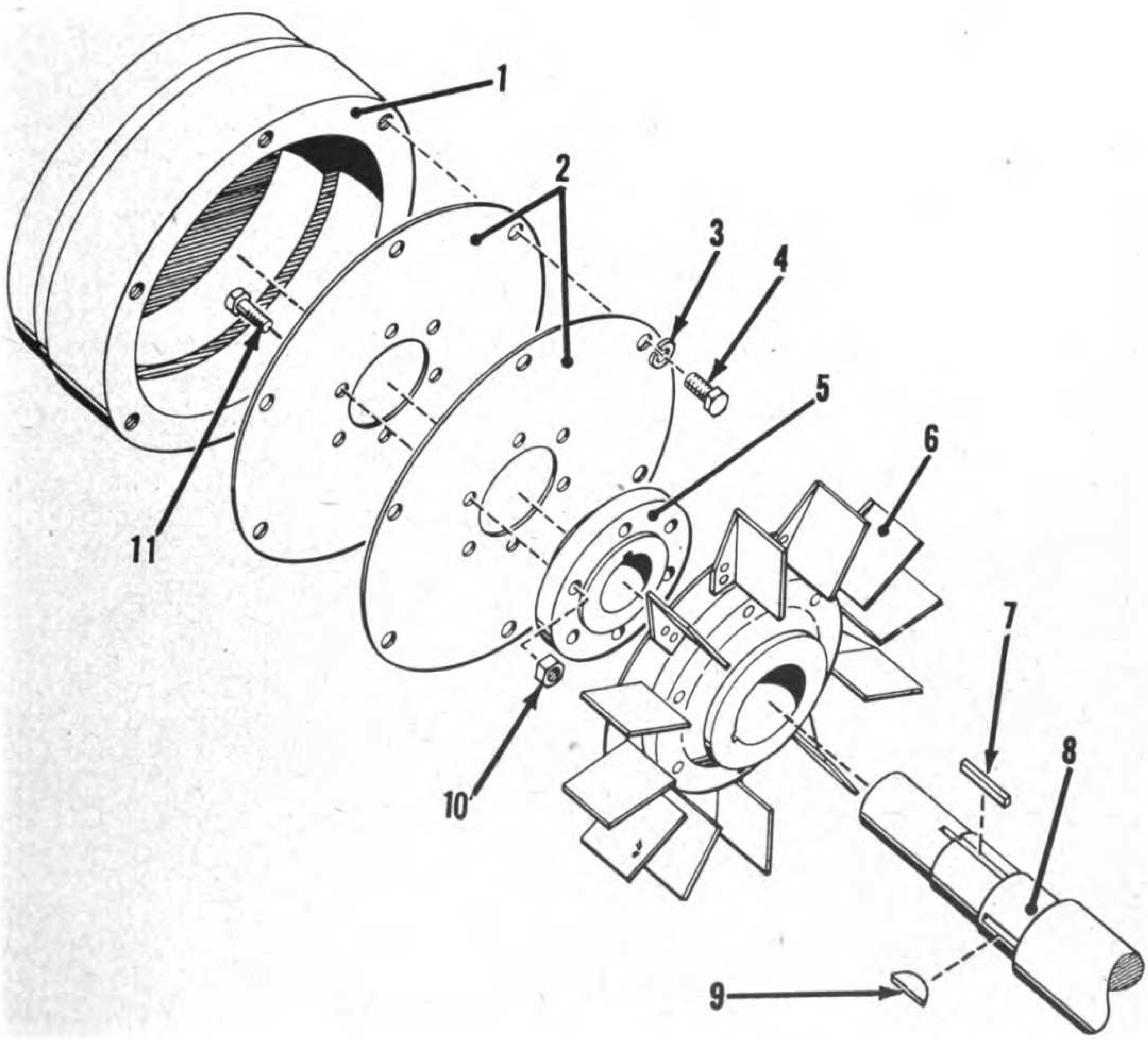
studs (18) and dowel (17), and secure with the nuts (1) and lockwashers (2).

(2) Install the injector pump (par. 86) and the priming pump (par. 84).

Section IX. ENGINE AND GENERATOR COUPLING

180. General
(fig. 94)

The engine and generator are connected through flexible disks (2) bolted to the flywheel (1) and to a hub (5) keyed on the rotor shaft (8). Driving torque is transmitted from the crankshaft to the generator rotor through the coupling assembly. The



1 Flywheel assembly
2 Coupling disk
3 Washer, lock, ½ in. (6 req'd)
4 Machine bolt (6 req'd)
5 Coupling hub
6 Fan assembly
7 Straight key
8 Rotor shaft
9 Key, woodruff, No. 25 (1 req'd)
10 Stop nut (6 req'd)
11 Machine bolt (6 req'd)

Figure 94. Engine to generator coupling and fan assembly, exploded view.

flywheel housing is bolted to the generator adapter ring, forming the rear support for the engine. The generator and front of the engine are secured to the skid base. A fan assembly (6) keyed to the rotor shaft (8) circulates air and cools the generator.

181. Engine

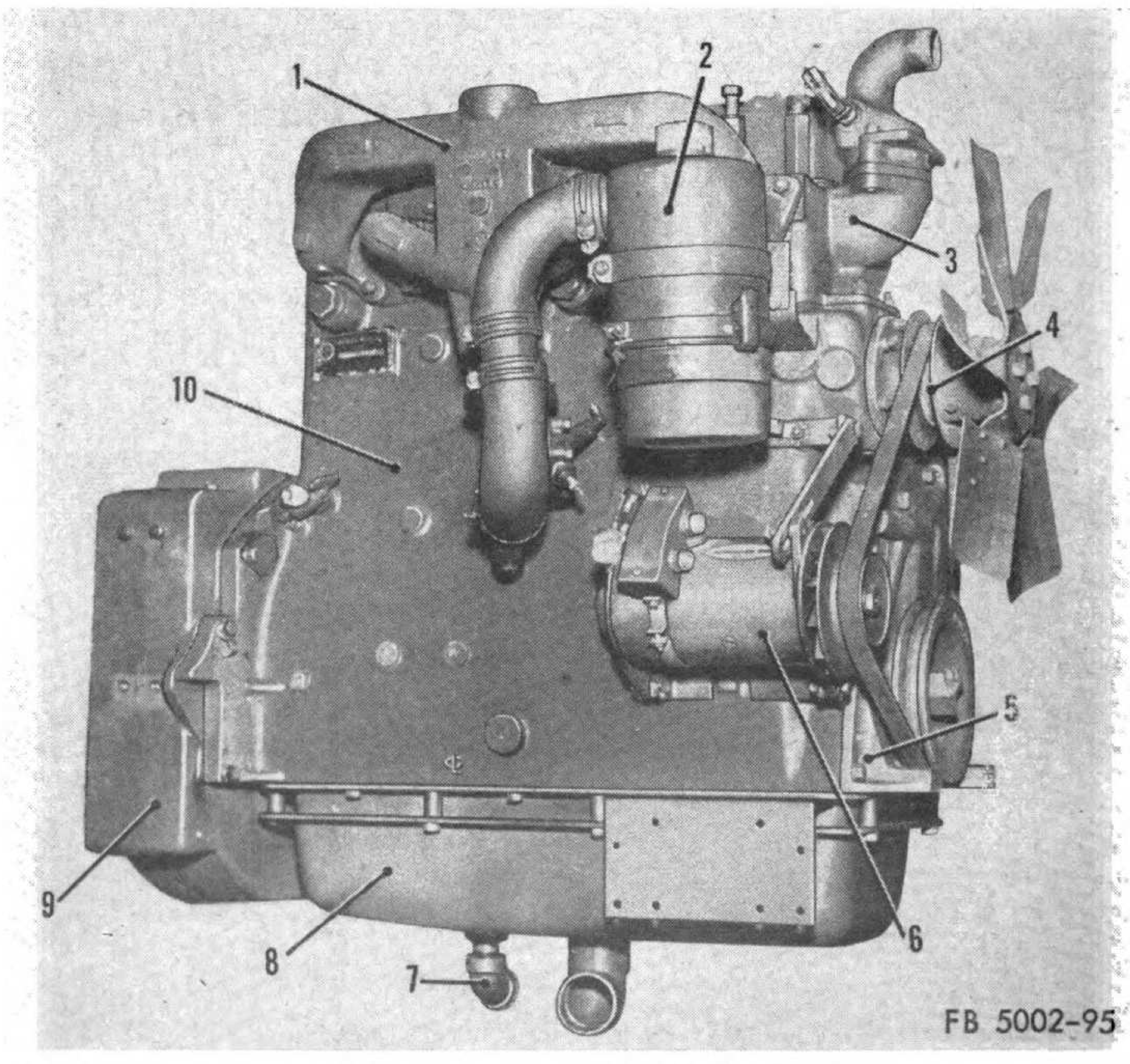
a. Removal.

(1) Remove the frames (par. 168) and the radiator (par. 90).

(2) Disconnect the microswitch leads (par. 166).

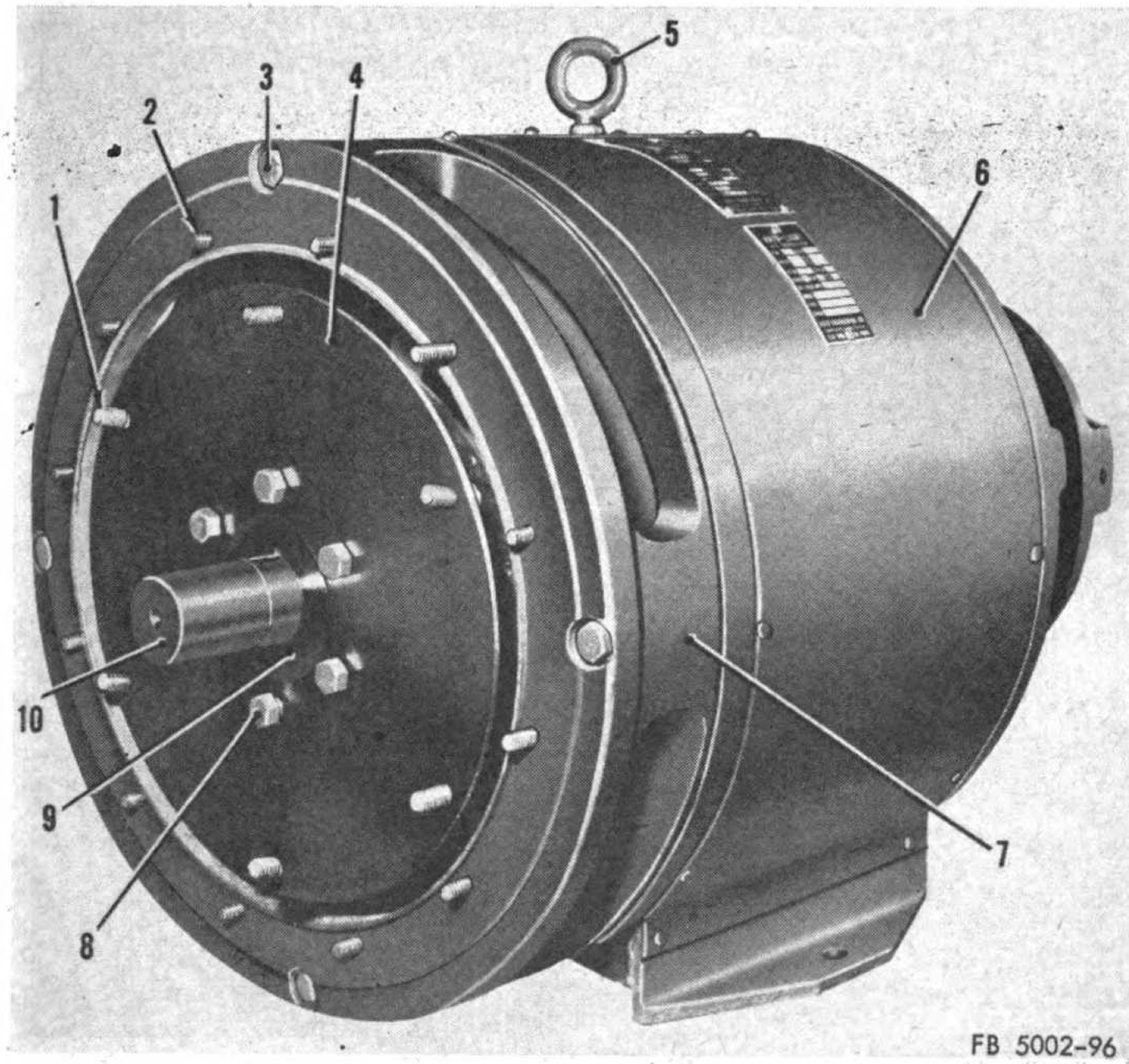
(3) Drain the crankcase and remove the drain nipple screwed into the oil pan elbow (7, fig. 95).

(4) Remove the screen from the generator adapter ring (7, fig. 96).



1	Intake and exhaust manifold	6	Charging generator
2	Air cleaner	7	Oil pan elbow
3	Cylinder head	8	Oil pan shroud
4	Fan and water pump assembly	9	Flywheel housing
5	Gear cover	10	Cylinder block

Figure 95. Engine removed from unit.



1 Disk-to-flywheel bolts (6 req'd)
2 Adapter ring-to-flywheel housing bolts (12 req'd)
3 Adapter ring-to-generator bolts (4 req'd)
4 Disks
5 Lifting eye
6 Generator
7 Adapter ring
8 Disk-to-hub bolts (6 req'd)
9 Hub
10 Rotor shaft

Figure 96. Generator removed from unit.

(5) Remove the bolts (4, fig. 94) and lockwashers (3) securing the disks (2) to the flywheel (1).

(6) Attach a lifting eye to the center stud of the cylinder head (3, fig. 95).

(7) With a hoist of about 1-ton capacity, take a slight strain on the engine.

(8) Remove the bolts (2, fig. 96) and lockwashers securing the adapter ring (7) to the flywheel housing (9, fig. 95).

(9) Remove the bolts, lockwashers, and nuts securing the engine to the skid base at the gear cover (5).

(10) Hoist the engine, moving it away from the generator.

Caution: Be sure the lifting eye and hoist are attached securely and that the hoist is of sufficient capacity to raise the engine. To avoid possible injury to personnel and damage to the equipment, do not let the engine swing when hoisting it.

b. Installation.

(1) With a hoist of about 1-ton capacity attached to the lifting eye on the center stud of the head (3, fig. 95), position the engine on the skid base and to the generator.

(2) Install the bolts in the gear cover (5) and secure to the skid base with the lockwashers and nuts.

(3) Secure the flywheel housing (9) to the adapter ring (7, fig. 96) with the bolts (2) and lockwashers. Remove the hoist and lifting eye.

(4) Secure the disks (2, fig. 94) to the flywheel (1) with the bolts (4) and lockwashers (3).

(5) Install the screen on the adapter ring (7, fig. 96).

(6) Screw the drain nipple into the oil pan elbow (7, fig. 95).

(7) Connect the microswitch leads (par. 166).

(8) Install the radiator (par. 90) and the frames (par. 168).

(9) Fill the crankcase with oil.

(10) Check the rotor shaft alinement (par. 182*c*).

182. Generator

a. Removal.

(1) Remove the frames (par. 168). Disconnect the load lines at the changeover panel (par. 148) and the microswitch leads (par. 166).

(2) Remove the screen from the adapter ring (7, fig. 96).

(3) Remove the bolts (4, fig. 94) and lockwashers (3) securing the disks (2) to the flywheel.

(4) Block up the engine under the flywheel housing (9, fig. 95) and remove the bolts (2, fig. 96) and lockwashers securing the ring (7) to the flywheel housing.

(5) Install a lifting eye (5) on the generator (6). With a hoist of about 1-ton capacity, take a slight strain on the generator.

Caution: Make sure the hoist is of sufficient capacity to raise the generator and that it is attached securely. To avoid possible injury to personnel and damage to the equipment, do not let the generator swing when hoisting.

(6) Remove the bolts, lockwashers, and nuts securing the generator to the skid base. Lift the generator, moving it backward at the same time.

(7) To remove the ring (7), remove the bolts (3) and lockwashers securing it to the generator.

b. Installation.

(1) Secure the ring (7, fig. 96) to the generator (6) with the bolts (3) and lockwashers.

(2) With a hoist of about 1-ton capacity secured to the lifting eye (5), position the generator on the skid base and to the engine.

(3) Secure the generator to the skid base with the bolts, lockwashers, and nuts. Secure to the flywheel housing (9, fig. 95) with the bolts (2, fig. 96) and lockwashers. Remove the blocks under the flywheel housing. Remove the hoist and the lifting eye.

(4) Secure the disks (2, fig. 94) to the flywheel (1) with the bolts (4) and lockwashers (3). Check the shaft alinement (*c* below).

(5) Connect the leads to the microswitch (par. 166) and the load lines to the changeover panel (par. 148).

(6) Install the frames (par. 168).

c. Rotor Shaft Alinement.

(1) Use a dial indicator mounted as shown, to check the runout of the coupling disks. If the runout exceeds 0.008 inch, realine the generator (6, fig. 96). Add shims under the generator base if necessary.

(2) Check the air gap between the rotor and stator of the generator. The gap must measure the same all around. Reposition the generator, adding shims under the base if necessary.

(3) Install the screen on the adapter ring.

183. Coupling and Generator Fan Assembly
(fig. 94)

a. Coupling Removal.

(1) Remove the generator from the skid base (par. 182).

(2) Remove the bolts (11) and nuts (10) securing the disks (2) to the coupling hub (5), and mark the location of the hub on the shaft.

(3) Pull the hub and key (7) from the rotor shaft (8).

b. Coupling Installation.

(1) Place the key (7) in the rotor shaft (8).

(2) Press the hub (5) on the shaft at the same location, and secure the disks (2) with the bolts (11) and nuts (10).

(3) Install the generator on the skid base (par. 182).

c. Fan Assembly Removal.

(1) Remove the coupling (*a* above).

(2) Pull the fan assembly (6) and key (9) off the rotor shaft (8).

d. Fan Assembly Installation.

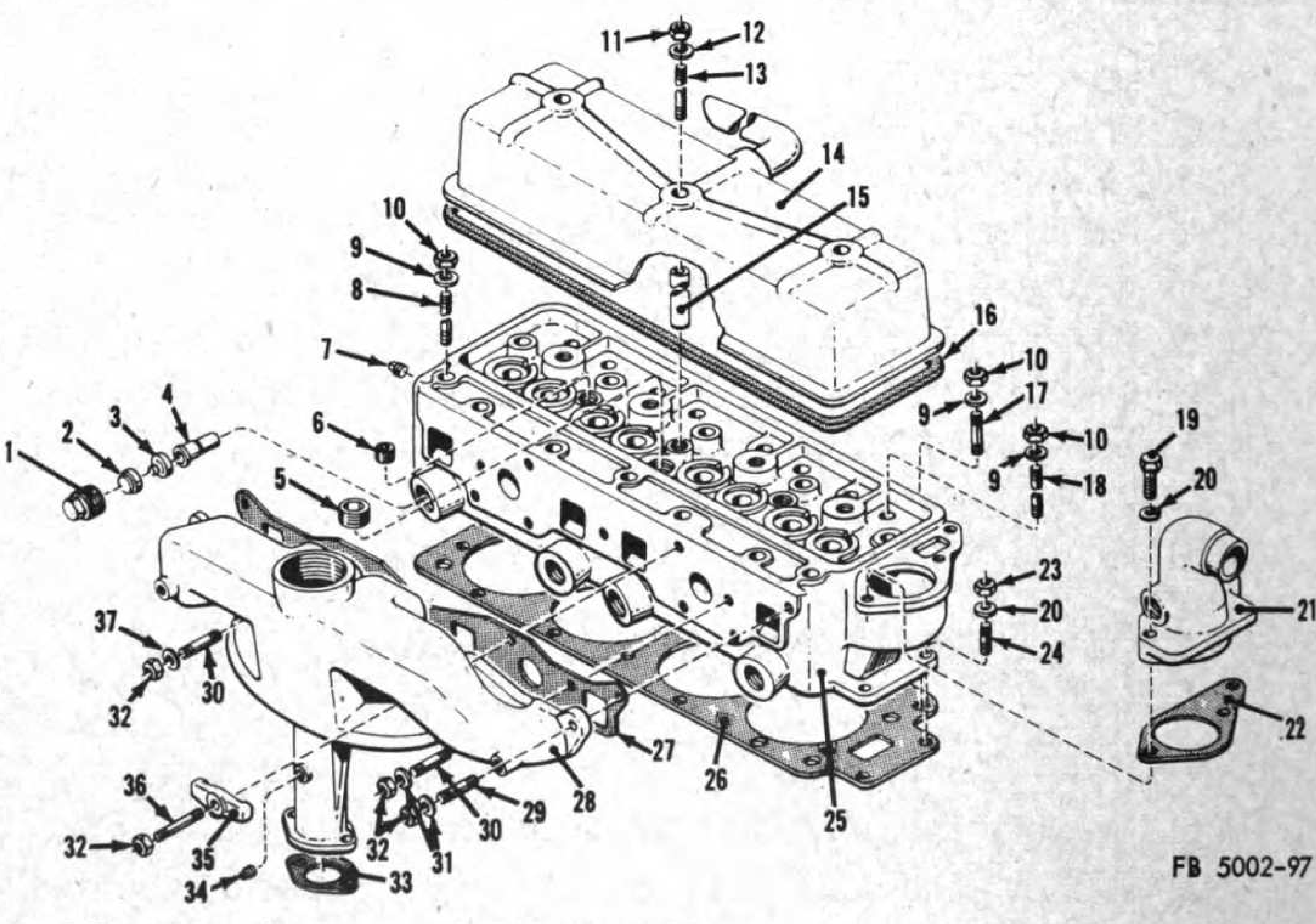
(1) Place the key (9) in the shaft (8) and press on the fan assembly (6).

(2) Install the coupling (*b* above).

Section X. CYLINDER HEAD AND VALVES

184. General

The description of the head and valves is covered in paragraph 105. For removal and installation of the head and valves, refer to paragraphs 106 and 107.



FB 5002-97

1	Cell retainer plug	14	Cover assembly	27	Gasket
2	Cell retainer	15	Retainer	28	Manifold
3	Cell cap	16	Cover gasket	29	Manifold stud
4	Cell body assembly	17	Cylinder head stud	30	Stud
5	Pipe plug	18	Stud	31	Flat washer (5 req'd)
6	Pipe plug	19	Screw (3 req'd)	32	Manifold stud nut (11 req'd)
7	Pipe plug	20	Lockwasher (5 req'd)	33	Gasket
8	Cylinder head stud	21	Water outlet elbow	34	Pipe plug
9	Flat washer (19 req'd)	22	Gasket	35	Manifold clamp
10	Cylinder nut (19 req'd)	23	Nut (2 req'd)	36	Manifold stud
11	Nut (3 req'd)	24	Stud	37	Flat washer (2 req'd)
12	Gasket	25	Cylinder head assembly		
13	Cover stud	26	Gasket		

Figure 97. Cylinder head and manifold, exploded view.

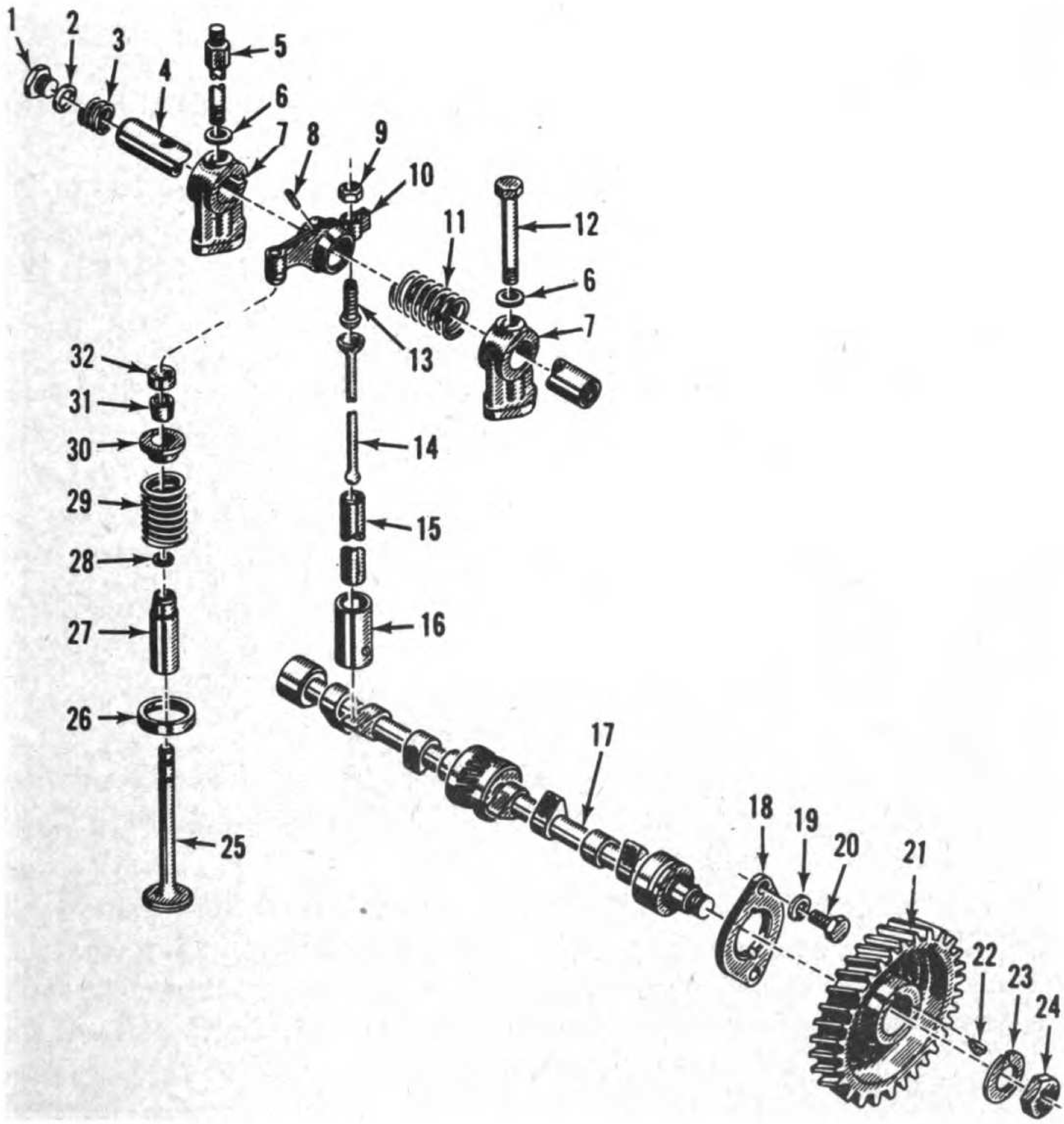
185. Cylinder Head

a. Disassembly.

(1) Remove the studs (17, 29, 30, and 36, fig. 97).

(2) Remove the plugs (5, 6, and 7).

(3) Press the guides (27, fig. 98) out of the head if they are to be replaced.



FB 5002-98

1	Plug	12	Screw (2 req'd)	22	Key (1 req'd)
2	Gasket	13	Adjusting screw	23	Locknut
3	Short spring	14	Valve push rod	24	Nut (1 req'd)
4	Rocker arm shaft	15	Push rod tube	25	Valve
5	Screw	16	Valve tappet	26	Insert
6	Plain washer (4 req'd)	17	Camshaft	27	Valve stem guide
7	Shaft support	18	Thrust plate	28	Retaining ring
8	Oil wick	19	Washer, lock ⅜ in. (2 req'd)	29	Valve spring
9	Locknut (8 req'd)	20	Screw (2 req'd)	30	Spring retainer
10	Rocker arm	21	Camshaft gear	31	Spring lock
11	Long spring			32	Ball socket

Figure 98. Valve operating mechanism, exploded view.

(4) If the exhaust valve inserts (26) are to be removed, position the hook-shaped extracting tool in the valve opening and catch the edge of the insert with the end. Strike the side of the tool sharply with a hammer to unseat the insert.

b. Cleaning and Inspection.

(1) *Cleaning.* Clean the cylinder head (25, fig. 97) with an approved cleaning solvent. Make sure that all carbon and lime deposits are removed from the passages and recesses.

(2) *Inspection.*

(*a*) Inspect the cylinder head (25) for cracks. Replace a defective head.

(*b*) If the valve seats are deeply pitted, reface them (*d* below).

(*c*) Replace all worn, loose, or damaged studs (17, 29, 30, and 36).

(*d*) Replace worn, loose, or damaged plugs (5, 6, and 7).

(*e*) Inspect the valve guides (27, fig. 98) for scoring and wear. Proper clearance with the valve stem is 0.0001 to 0.002 inch for the intake valve and 0.0035 to 0.005 inch for the exhaust valve. The desired clearance when using new valves and guides is 0.002 inch for the intake valves and 0.004 inch for the exhaust valves.

c. Reassembly.

(1) Install the studs (17, 29, 30, and 36, fig. 97).

(2) Install the plugs (5, 6, and 7).

(3) If the guides (27, fig. 98) are replaced, press them into the head and line ream to an inside diameter of 0.4360 to 0.4365 inch.

(4) If new inserts (26) are to be installed, make sure the recesses are clean and free from any foreign matter which would prevent the inserts from seating properly. Chill the new inserts with dry ice and position them on the recess. Drive them into place with a driving tool and hammer until they are seated. An alternate method is to seat the inserts using an arbor press and the tool. Inserts that require finishing may be ground and the concentricity of the valve seat to the guide checked as in *d* below.

d. Refacing Valve Seats.

(1) Insert a pilot in the guide and position a valve seat refacing tool with a 45° stone on the intake valve seats and grind until a new cut shows evenly around the seat.

(2) If the exhaust valve inserts are to be ground, use a 45° stone suitable for grinding hardened inserts.

(3) Proper valve seat width is 3/32-inch. Use a 15° stone in the refacing tool to narrow the seats to this dimension.

(4) Check the concentricity of the seats to the valve stem guides with a dial indicator. Insert a pilot in the guide and attach a dial indicator to the pilot. Set the indicator to the valve seat and rotate it around the axis of the pilot. If the eccentricity is 0.002 inch or more, regrind the valve seats using a new stone or one that has been trued up.

186. Valves
(fig. 98)

a. Inspection. Inspect the valves for deep pits, burns, and warped stems. To determine the degree of stem warpage, chuck the valve in a lathe and set a dial indicator to the valve head. Rotate the valve slowly. If the eccentricity is or exceeds 0.002 inch or deep pits and burns are present, replace the valve.

b. Refacing Valves. Mount the valve (25) in a refacing machine, with the valve face at a 45° angle to the abrasive wheel. Bring the valve face into contact with the wheel. The first cut should be a light one. Remove only enough metal to give a smooth 45° surface around the valve face. If too much metal is removed, the upper edge of the valve head will be ground sharp and the valve will tend to run hot and probably burn or warp.

c. Seating Valves. Seat the valves (par. 107*d*).

Section XI. TIMING GEAR COVER AND GEARS

187. General

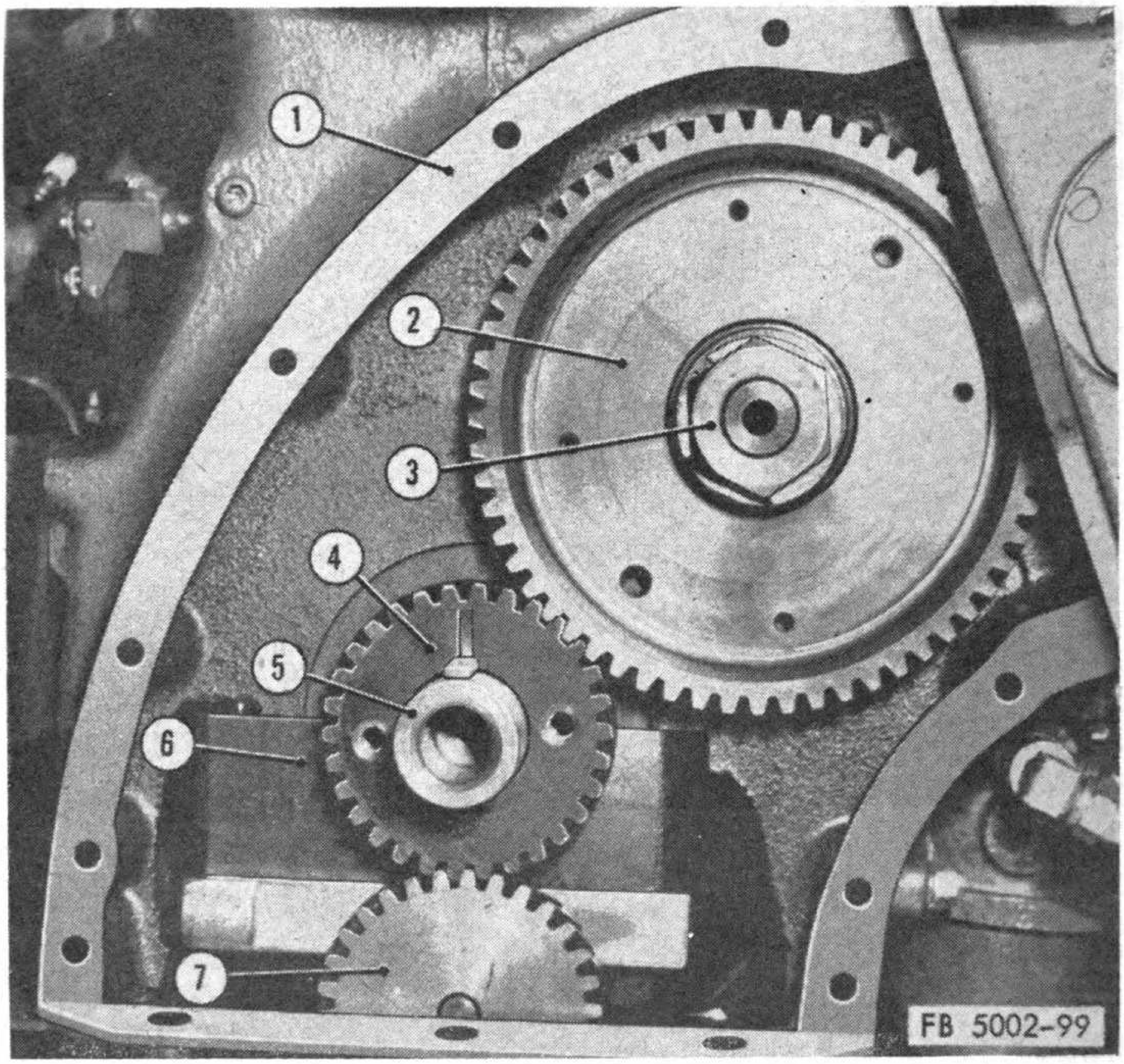
The gear cover (25, fig. 93) incloses the gear train at the front of the engine and also forms the front support for the engine. The gear train consists of the crankshaft gear (4, fig. 99), camshaft gear (2), and the oil pump drive gear (7). The gears (2 and 4) can be removed without removing either the crankshaft (5) or camshaft. The oil pump must be removed (par. 104) with the gear (7).

188. Gear Cover

a. Removal.

(1) Remove the engine from the base (par. 181).

(2) Remove the cranking jaw (20, fig. 100), washer (19), pulley (18), and seal (17).



1 Cylinder block. 2 Camshaft gear. 3 Camshaft nut (1 req'd). 4 Crankshaft gear.
5 Crankshaft. 6 Front main bearing cap. 7 Oil pump drive gear.

Figure 99. Timing gear train.

(3) To remove the gear cover (25, fig. 93) and gasket (14), remove the screws (27) and lockwashers (2). Pull the seal (26) from the gear cover.

b. Cleaning and Inspection (fig. 93).

(1) *Cleaning.* Clean the gear cover (25) with an approved cleaning solvent.

(2) *Inspection.* Check the gear cover (25) for cracks. Weld and paint (par. 34) or replace a cracked cover. Examine the seal (26) for signs of oil leakage and roughness. Replace a defective seal.

c. Installation.

(1) Install the seal (26, fig. 93) in the gear cover (25).

(2) Cement a new gasket (14) to the block (10) and secure the cover with the screws (27) and lockwashers (2).

(3) Install the seal (17, fig. 100), pulley (18), washer (19), and cranking jaw (20) on the crankshaft (6).

(4) Install the engine on the base (par. 181).

189. Timing Gears

a. Cleaning and Inspection. Remove the gear cover (par. 188) to inspect the gears. Clean the gears with a rag dampened with an approved cleaning solvent.

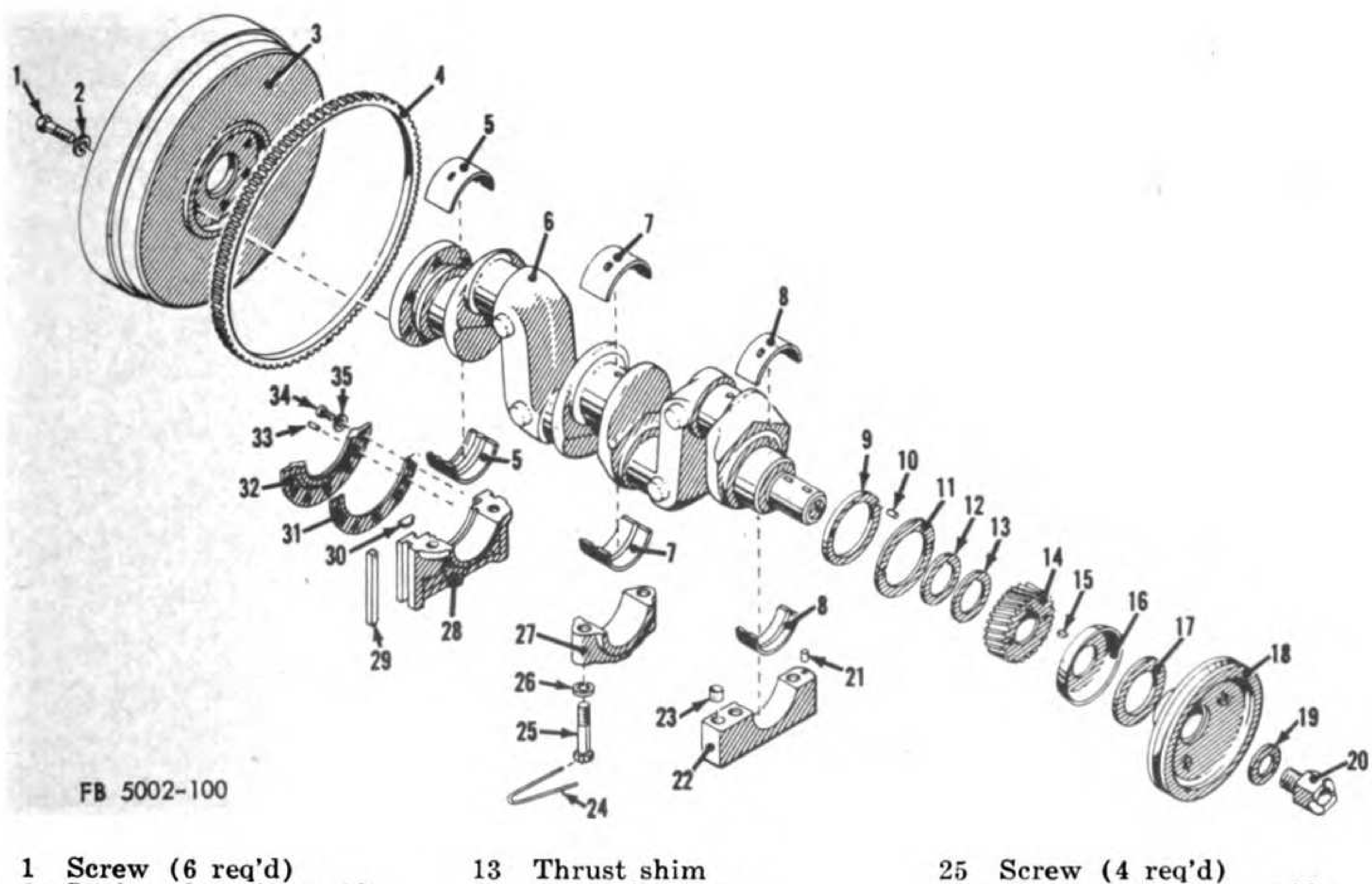
(1) Check the gears (2 and 4, fig. 99) for damaged or worn teeth. Replace a defective gear and transfer the timing marks (*d* below).

(2) Check the gears for excessive backlash. If the backlash is 0.002 inch or more, replace the worn gear.

(3) Check the crankshaft end thrust for a clearance of 0.005 to 0.008 inch. Check the camshaft end thrust for a clearance of 0.005 to 0.009 inch. Replace a worn plate (18, fig. 98) or shims (12 and 13, fig. 100).

b. Removal.

(1) Remove the gear cover (par. 188).



1	Screw (6 req'd)	13	Thrust shim	25	Screw (4 req'd)
2	Lockwasher (6 req'd)	14	Crankshaft gear	26	Plain washer (4 req'd)
3	Flywheel	15	Key (1 req'd)	27	Center bearing cap
4	Ring gear	16	Oil thrower	28	Rear bearing cap
5	Rear main bearing	17	Dust seal	29	Cork
6	Crankshaft	18	Fan drive pulley	30	Gasket
7	Center main bearing	19	Washer (1 req'd)	31	Gasket
8	Front main bearing	20	Cranking jaw	32	Oil seal
9	Thrust washer	21	Dowel pin (2 req'd)	33	Bearing seal pin
10	Straight pin (3 req'd)	22	Front bearing cap	34	Screw (10 req'd)
11	Flat washer	23	Dowel	35	Washer (10 req'd)
12	Thrust shim	24	Lock wire		

Figure 100. Crankshaft and flywheel, exploded view.

(2) To remove the crankshaft gear (14, fig. 100), remove the oil thrower (16) and pull the gear and key (15) from the crankshaft.

(3) To remove the camshaft gear (21, fig. 98), remove the nut (24) and locknut (23). Pull the gear and key (22) from the camshaft (17).

(4) If the thrust plate (18) is to be replaced, remove the screws (20) and lockwashers (19).

c. Installation. Make sure the gear timing marks line up when installing gears.

(1) If the thrust plate (18) was replaced, install the new one and secure it with the screws (20) and lockwashers (19).

(2) Place the key (22) in the camshaft and press on the gear (21), with the transferred timing marks (*d* below). Make sure the expansion plug (5, fig. 93) is not bumped out of position by the end of the camshaft. Secure the gear with the locknut (23, fig. 98) and nut (24). Check for proper end thrust of 0.005 to 0.009 inch.

(3) Install the shims (12, and 13 fig. 100) if the old ones were removed. Place the key (15) in the crankshaft (6) and press on the gear (14). Check to see that the timing mark has been transferred, and check for proper end thrust of 0.005 to 0.008 inch.

(4) Install the oil thrower (16) and the gear cover (par. 188).

d. Transferring Timing Marks (fig. 101).

(1) Lay the old gear (2) on the new gear (4) and line up the keyways with a small steel bar (1).

(2) Place a steel rule (3) vertically against the gears and in line with the mark on the old gear.

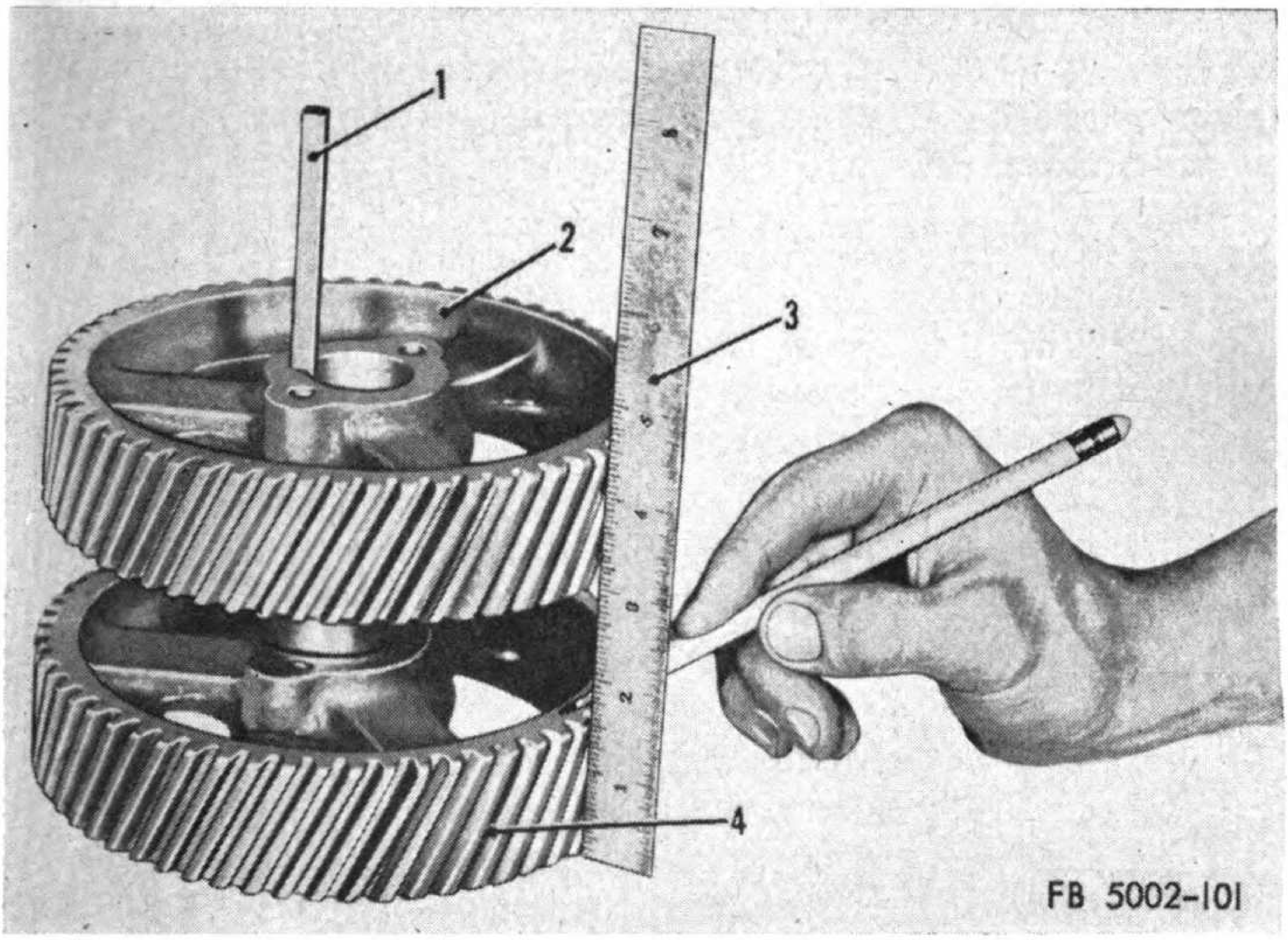
(3) Make a pencil mark on the new gear to indicate the point where it should be punched.

(4) Place a punchmark on the pencil mark.

Section XII. FLYWHEEL AND FLYWHEEL HOUSING

190. General

The flywheel (3, fig. 100) is attached to the crankshaft (6) at the rear of the engine. A ring gear (4), which meshes with the starter pinion to turn the engine over, is shrunk on the forward circumference of the flywheel. The generator is directly connected to the flywheel through a flexible disk-type coupling. The flywheel



1 Steel bar. 2 Old gear. 3 Steel rule. 4 New gear.

Figure 101. Transferring timing gear marks.

housing (38, fig. 93), bolted to the cylinder block (10), forms a covering for the flywheel. The housing also is secured to the generator adapter ring, making it the rear support for the engine.

191. Flywheel
(fig. 100)

a. Removal.

(1) Remove the engine from the base (par. 181).

(2) Remove the screws (1) and lockwashers (2) securing the flywheel (3) to the crankshaft (6). Lift off the flywheel.

b. Cleaning and Inspection.

(1) Clean the flywheel (3) with an approved cleaning solvent.

(2) Inspect the flywheel (3) for elongation of the screw holes, and the screws (1) for thread damage. Replace a defective flywheel or screws.

(3) Inspect the ring gear (4) for broken or worn teeth. Replace a defective ring gear.

c. Replacing Ring Gear. To replace a ring gear (4), heat it evenly around the entire circumference with a torch and drive it off the flywheel (3). Install a new gear which has been heated to not less than 500° F. and not more than 600° F. See that the gear is properly seated on the flywheel and that the tooth chamfer faces toward the front of the engine before allowing the gear to cool to a shrink fit.

Note. If facilities are available, the gear can be heated by boiling in oil for 15 minutes.

d. Installation.

(1) Secure the flywheel (3) to the crankshaft (6) with the screws (1) and lockwashers (2).

(2) Install the engine on the base (par. 181).

(3) Set a dial indicator to the rear face of the flywheel on a radius of not less than 5 inches to measure the runout. It should not exceed 0.008 inch. Replace the flywheel if the reading is excessive.

(4) With a dial indicator set to the inner circumference of the flywheel bore, check the concentricity of the flywheel. It should not exceed 0.008 inch total. Reposition the flywheel if the reading is excessive.

192. Flywheel Housing
(fig. 93)

a. Removal

(1) Remove the flywheel (par. 191).

(2) To remove the flywheel housing (38), remove the nuts (1), screws (4), and lockwashers (2).

b. Cleaning and Inspection. Clean the housing (38) with an approved cleaning solvent. Inspect the housing for cracks and breaks. If possible, weld a cracked housing and paint (par. 34); otherwise replace it.

c. Installation.

(1) Secure the housing (38) to the cylinder block (10) with the nuts (1), screws (4), and lockwashers (2).

(2) With a dial indicator set to the inner circumference of the housing bore and clamped to the crankshaft flange, measure concentricity of the housing to the crankshaft. This should not exceed 0.008 inch. Reposition the housing if necessary and check again.

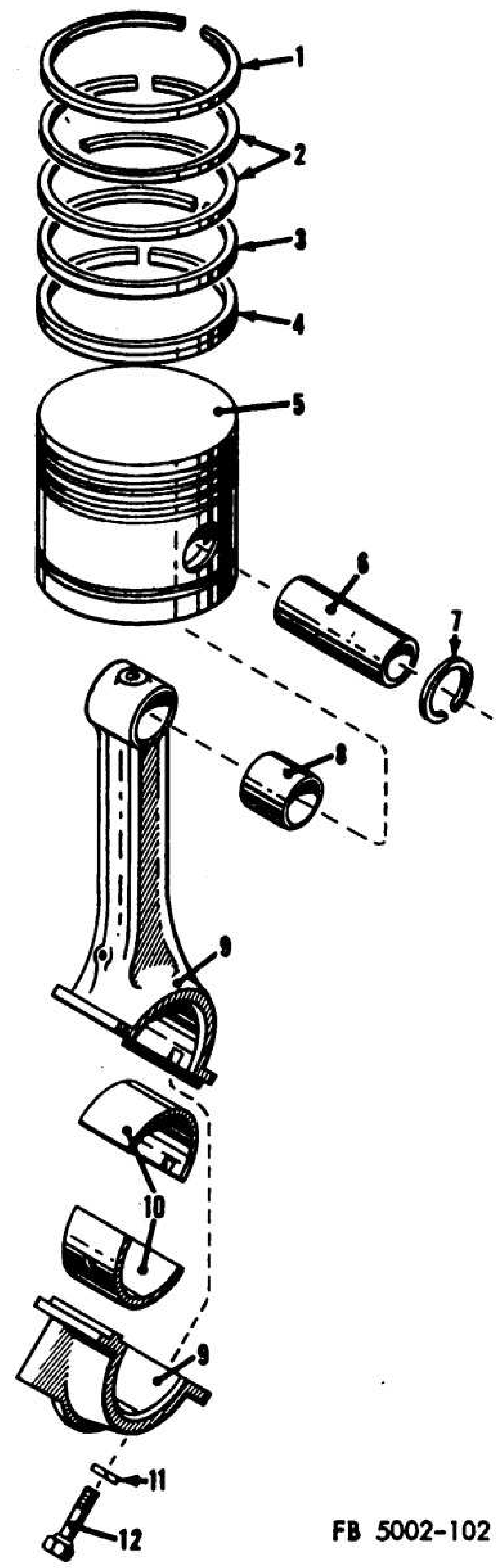
(3) With the dial indicator clamped to the crankshaft flange, measure the rear face of the housing (38) for squareness. It should not exceed 0.008 inch total. Replace the housing if the reading is excessive.

(4) Install the flywheel (par. 191).

Section XIII. CONNECTING RODS, PISTONS, AND CYLINDER SLEEVES

193. General

The connecting rods and caps (9, fig. 102) are matched pairs and cannot be interchanged. The bearings (10) are of the precision type and require no shims or scraping. The aluminum alloy pistons (5) have five rings (1 through 4). The rod and piston are removed as a unit. The removable, wet type cylinder sleeves (8, fig. 93) are made of alloyed cast iron. The sleeve packings (9),



1	Piston ring	6	Pin	10	Bearing
2	Piston ring	7	Retaining ring	11	Washer (8 req'd)
3	Piston ring	8	Bushing	12	Connecting rod bolt
4	Piston ring	9	Connecting rod assembly w/cap		
5	Piston				

Figure 102. Connecting rod and piston, exploded view.

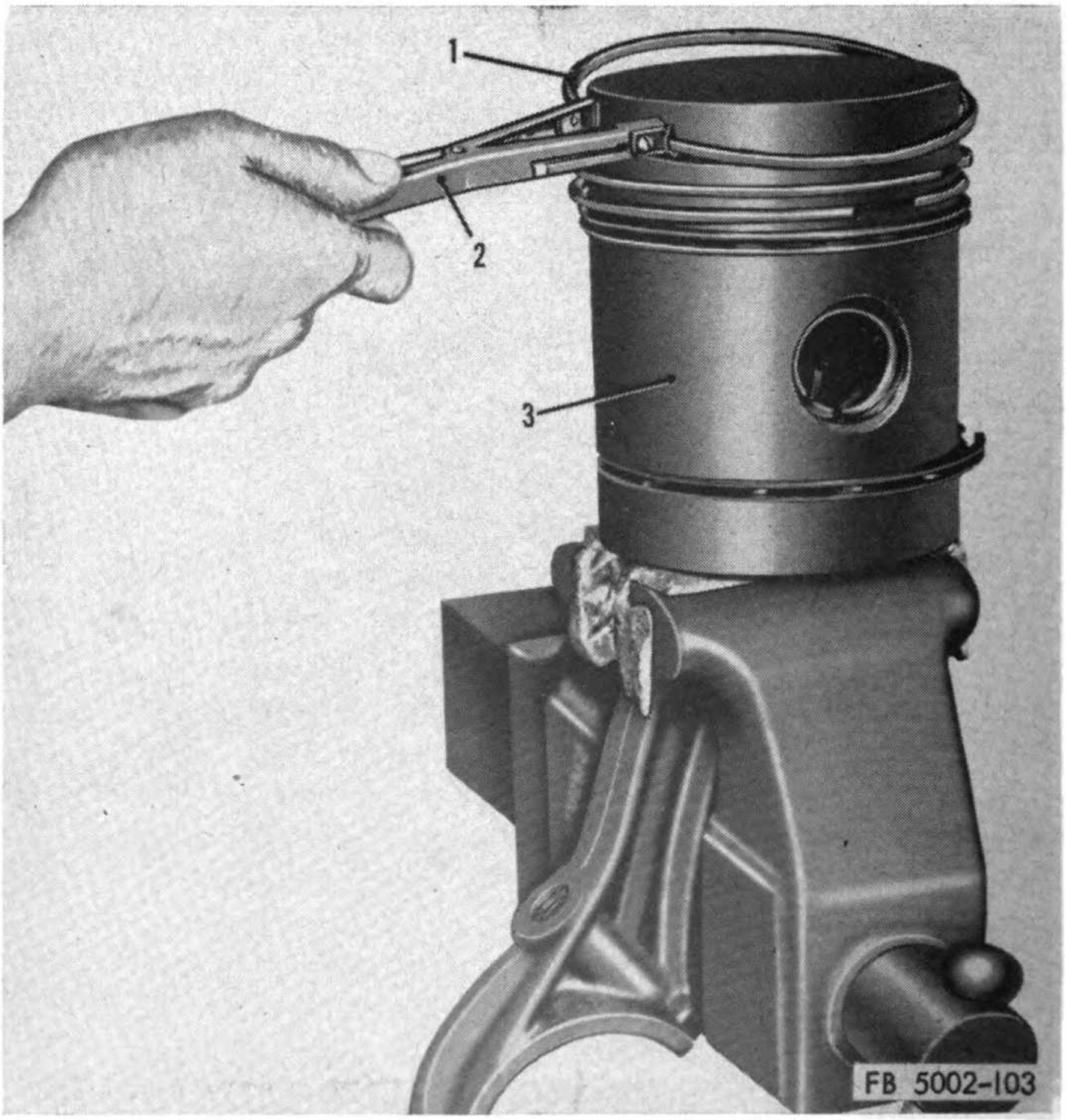
fitting into grooves in the lower outside ends of the sleeves, prevent coolant leakage into the crankcase. The sleeves are sealed at the top by a flange which fits into a machined recess in the cylinder block (10).

194. Connecting Rods and Pistons

a. Removal.

(1) Remove the cylinder head (par. 106) and the oil pan (par. 103).

(2) Clamp or bolt a piece of 2 x 4-inch lumber over the cylinder openings to hold the cylinder sleeves (8, fig. 93) in place. Rotate the crankshaft until two of the pistons (5, fig. 102) are at bottom dead center. Remove the bolts



1 Ring. 2 Ring expander. 3 Piston.

Figure 103. Piston rings removal.

(12), washers (11), caps (9), and the lower half of the bearing (10). Remove the 2 x 4.

(3) Position a ridge removing tool in the cylinder sleeve and expand the cutting blades of the tool to make the correct cut. Turn the tool with the socket wrench until the ridge is removed. Remove the tool and clean out all metal chips and carbon thoroughly.

(4) Wrap or tape the end of the connecting rod, and push the rod and piston assembly out through the cylinder.

(5) Repeat the above for the remaining rod and piston assemblies.

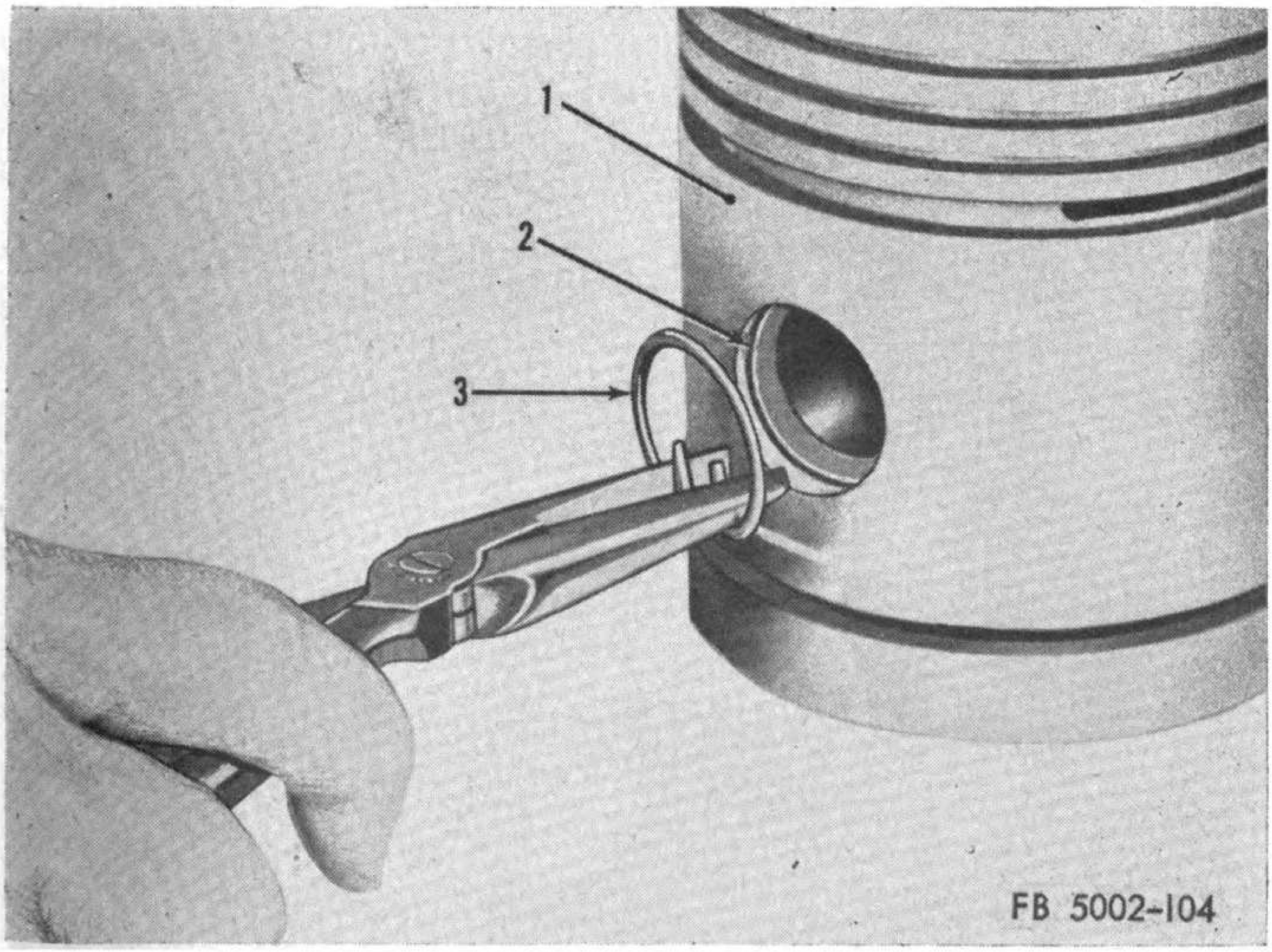
b. Disassembly.

(1) Remove the rings (1, fig. 103) with a ring expander (2).

(2) Remove the upper half of the bearing (10, fig. 102).

(3) Remove the retaining rings (3, fig. 104) and push out the pins (2).

(4) Lift off the piston (5, fig. 102) and press the bushing (8) out of the rod (9).



1 Piston. 2 Piston pin. 3 Retaining ring.

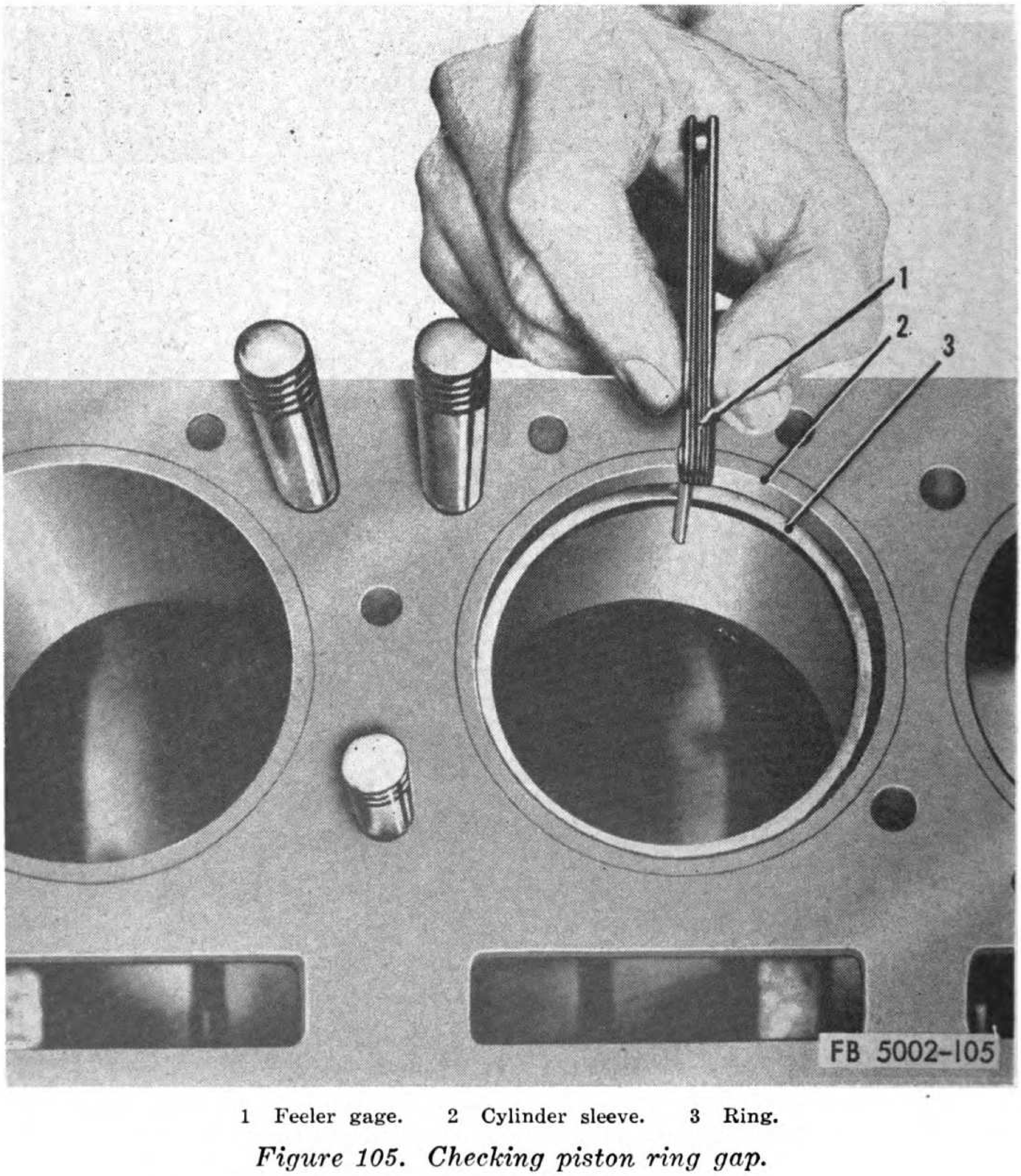
Figure 104. Piston pin retaining ring removal.

c. Cleaning and Inspection. Before inspection, clean carbon and dirt from all parts with an approved cleaning solvent and clear the oil passages.

(1) Inspect the connecting rod journals on the crankshaft (6, fig. 100) for roughness or scoring. Polish the journals with crocus cloth to remove any marks and clean thoroughly.

(2) Check the bearings (10, fig. 102) for excessive wear (*g* below).

(3) Inspect the piston pin (6) and bushing (8) for excessive wear. Replace a pin that is worn to a minimum diameter of 1.2495 inch. Replace a bushing with a maximum inside diameter of 1.2514 inch.



1 Feeler gage. 2 Cylinder sleeve. 3 Ring.

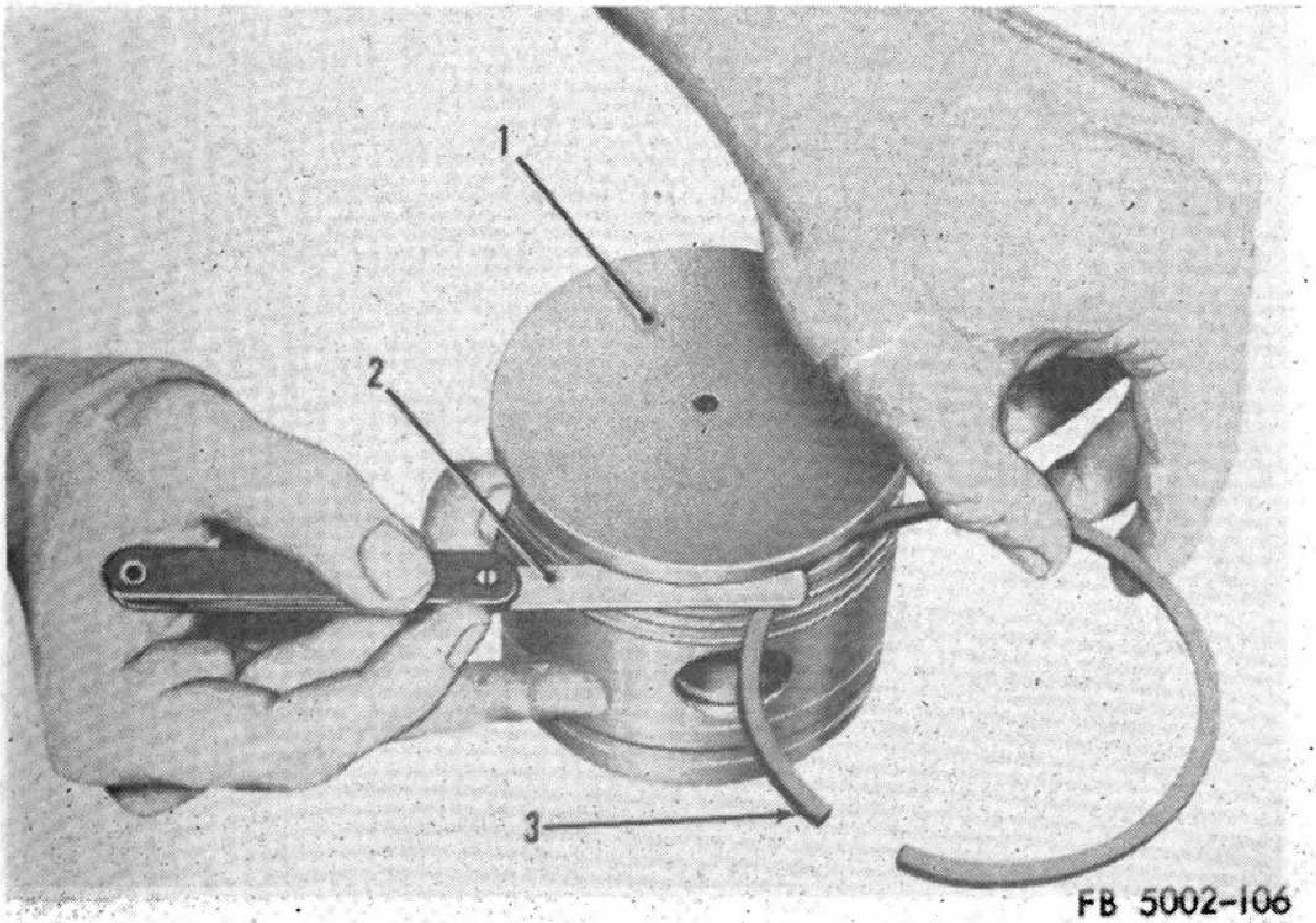
Figure 105. Checking piston ring gap.

(4) Check the piston pin clearance in the piston (5). The pin is a push fit and the maximum clearance is 0.001 inch. Replace a worn pin and piston.

(5) Inspect the piston for cracks or damage. Replace a defective piston. If a new piston is used, check the clearance of the lower part of the skirt with the cylinder sleeve. Maximum clearance is 0.010 inch.

(6) Check the rings (1 through 4) for excessive wear and proper gap. Compression ring gap is 0.007 to 0.017 inch for the top ring; 0.009 to 0.017 inch for the next two; and 0.007 to 0.017 inch for the remaining. If new rings are used, insert the rings (3, fig. 105) in the cylinder sleeve (2) and check the gaps to the tolerances above with a feeler gage (1). If it is necessary to increase the gap, file the ends of the rings, being careful to keep them parallel.

(7) Check the rings (3, fig. 106) with a feeler gage (2) for groove clearance. Proper groove clearance for the top three rings is 0.005 to 0.006 inch with a maximum of 0.010 inch. The fourth and fifth ring clearances are 0.004 to 0.005 inch with a maximum of 0.009 inch. If new rings are used, roll them completely around their respective grooves in the piston to check for free movement. If the



1 Piston. 2 Feeler gage. 3 Ring.

Figure 106. Checking piston ring groove clearance.

rings are tight, they can be lapped slightly on very fine emery cloth laid on a flat surface. Use a light, uniform pressure.

(8) Inspect the bolts (12, fig. 102) and caps (9) for damage. Replace defective bolts. If the caps are defective, replace the rod and cap as a unit.

d. Reassembly.

(1) Press the bushing (8, fig. 102) into the rod (9), and line ream to a clearance of 0.002 to 0.006 inch with the piston pin (6).

(2) Heat the piston (5) in boiling water for 5 minutes. Assemble the rod (9) to the piston with the piston pin, and install the retaining rings (7).

(3) Check the connecting rod alinement (*e* below).

(4) Install the rings (1, fig. 103) with the ring expander (2), staggering the gaps around the piston.

e. Connecting Rod Alignment (fig. 107).

(1) Clamp the rod and piston assembly on the mandrel (4) of the alining fixture, with the connecting rod bearing in place.

(2) Swing the rod (3) parallel to the floor, and hold the piston (6) diagonally to the rod with the head (2) pointing toward the floor.

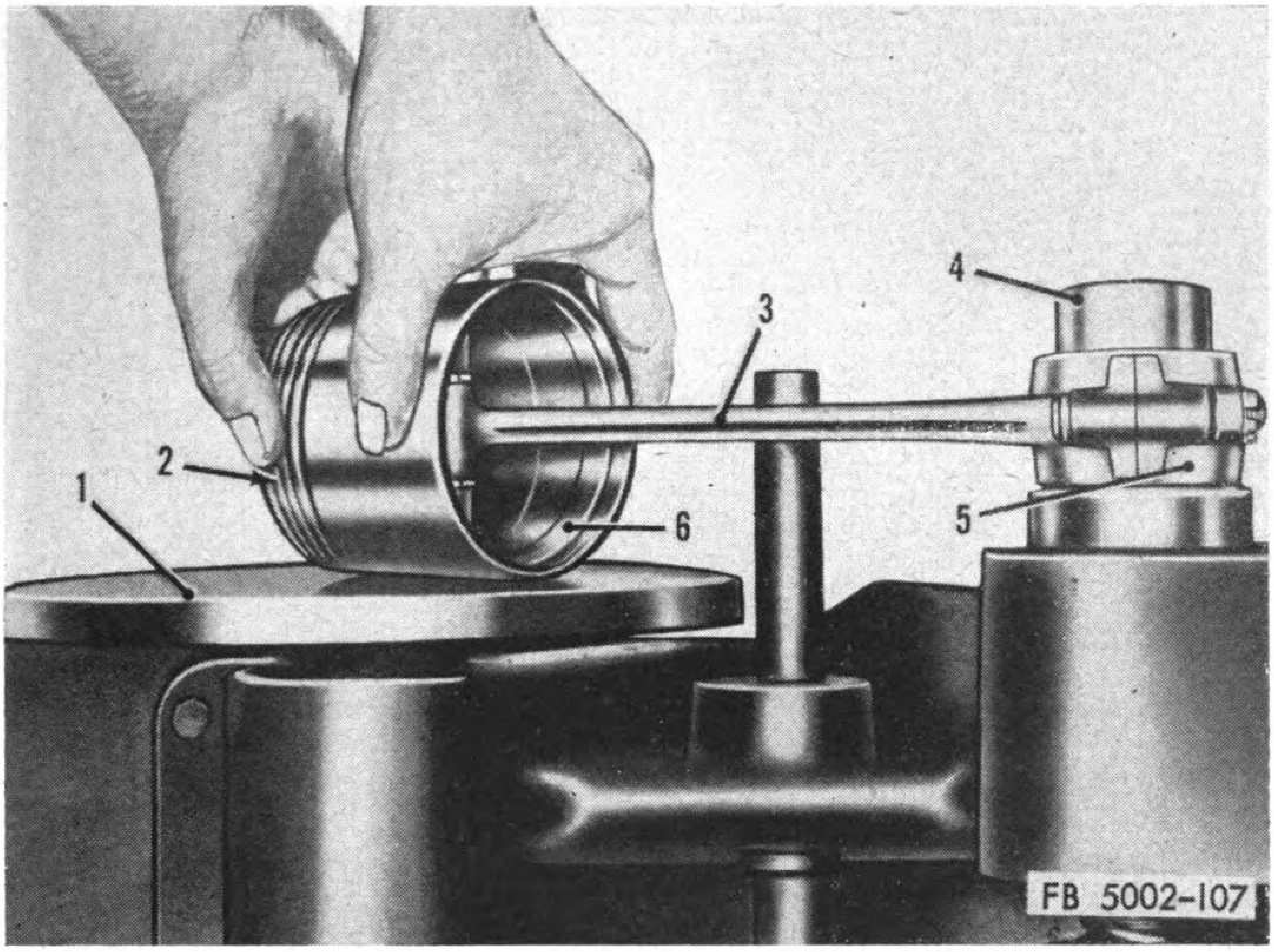
(3) Check the gap between the surface plate (1) and the piston along the piston skirt, with the piston held at several angles to the rod. Do not check the gap at the upper ring lands, as they are of a smaller diameter than the skirt. If the gap is not the same for all positions of the piston, the rod is twisted.

(4) A twisted rod sometimes can be straightened by using a large wrench. If badly twisted, replace the rod.

(5) To check for a bent rod, keep the rod parallel to the floor and hold the piston parallel to the rod. If the gap between the piston skirt and the surface plate is not even for the length of the skirt, the rod is bent. Drop the rod until it is vertical with the mandrel (4), and bend the rod until it is straight. Replace the rod if it cannot be straightened.

f. Installation.

(1) Select the proper rod and piston assembly for each cylinder and lubricate the piston rings with engine oil before installing the ring compresser.



1 Surface plate. 2 Piston head. 3 Connecting rod. 4 Mandrel.
5 Connecting rod cap. 6 Piston.

Figure 107. Checking connection rod alinement.

(2) Position a ring compresser (2, fig. 108) on the piston (1), and carefully push the assembly into the cylinder sleeve. Make sure the rod is in line with the journal on the crankshaft. If necessary, tap the piston down with a hammer handle or block of wood. Release the compresser.

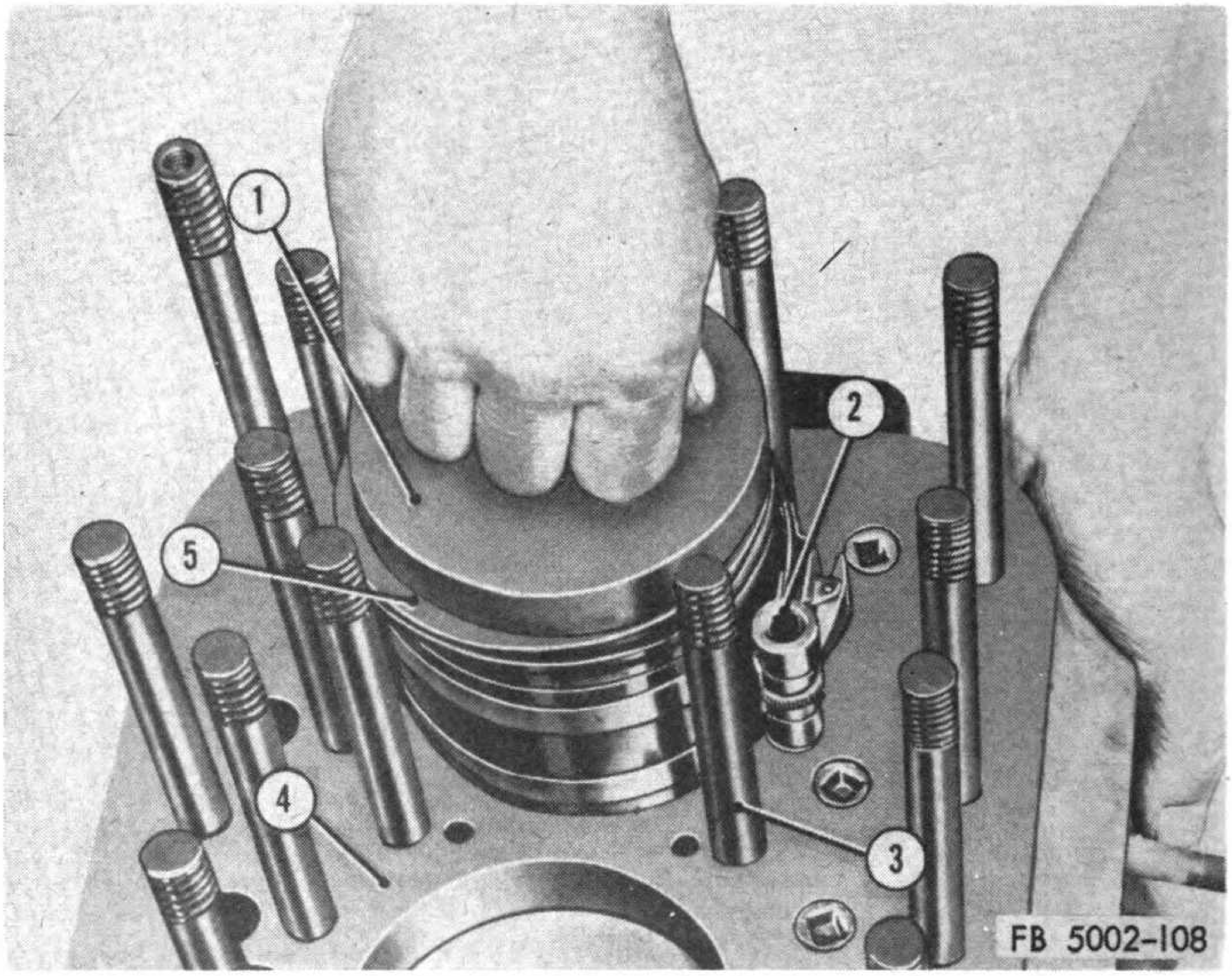
(3) Compress the remaining upper rings and push the piston down until the piston rings are below the top edge of the cylinder sleeve. Remove the compresser.

(4) Insert the upper half of the bearing (10, fig. 102) in the rod (9), and pull the rod down on the crankshaft (6, fig. 100).

(5) Place a $\frac{1}{4}$ x $\frac{1}{2}$ x 0.004-inch piece of feeler stock between the cap and the lower half of the bearing (10, fig. 102).

(6) Assemble the cap to the rod and secure with the bolts (12) and washers (11).

(7) Tighten the bolts to a tension of 100 to 110 foot-pounds and try the rod for side movement. The rod should move sideways with a firm pressure of the hands. This is a check for the proper bearing-to-journal clearance of 0.0015 to 0.0035 inch, with a maximum of 0.0045 inch.



1 Piston. 2 Ring compresser. 3 Stud. 4 Cylinder block. 5 Ring

Figure 108. Piston and rod assembly installation.

(8) Check the rod for a desired side clearance of 0.006 inch minimum.

(9) Loosen the cap and remove the piece of feeler stock.

(10) Tighten the bolts to the proper tension ((6) and (7) above), and try the side movement of the rod. It should move easily.

(11) Install the oil pan (par. 103) and the cylinder head (par. 106).

g. Connecting Rod Bearing Replacement (fig. 102).

(1) To determine if the connecting rod bearings need replacement, remove the oil pan (par. 103) and detach the rods (*a*(2) above). Proceed as in *f*(5) through (7) above, adding progressively thicker pieces of feeler stock until the actual oil clearance is obtained. A clearance of more than 0.0045 indicates the bearings must be replaced.

(2) Install new bearings (10) in the connecting rod assembly (9) and check for proper oil clearance again. If the clearance is still excessive with the new bearings, the crankshaft must be ground (par. 200) and undersize bearings installed.

(3) Install the oil pan (par. 103) and break in the engine (par. 205).

195. Cylinder Sleeves

a. Cleaning and Inspection (fig. 93). Inspection of the cylinder sleeves (8) requires prior removal of the connecting rods and pistons (par. 194). Clean the sleeves with a rag dampened with an approved cleaning solvent.

(1) Check the sleeves (8) for excessive wear, scores, and scratches. Maximum wear diameter is 3.890 inch. Replace a defective sleeve.

(2) Check the sleeves with an inside micrometer at the upper end of the ring travel, parallel to the crankshaft, and then in a position at right angles to the first reading. The difference between these readings shows the amount the sleeves are out-of-round. To obtain the taper, measure the bottom of the sleeve in the same way. Compare the top parallel reading with the bottom parallel reading, and the top right angle reading with the bottom right angle reading. If the out-of-round and taper is more than 0.008 inch, replace the sleeve and check the piston for proper clearance (par. 194*c*).

b. Removal.

(1) Place the cylinder sleeve fixture (3, fig. 109) in position on top of the block (5), with the fixture set to pull up the sleeve (4).

(2) Turn the screw (2) and pull up the sleeve.

(3) Remove the sleeve packings (9, fig. 93), being careful not to mar the grooves in the sleeves.

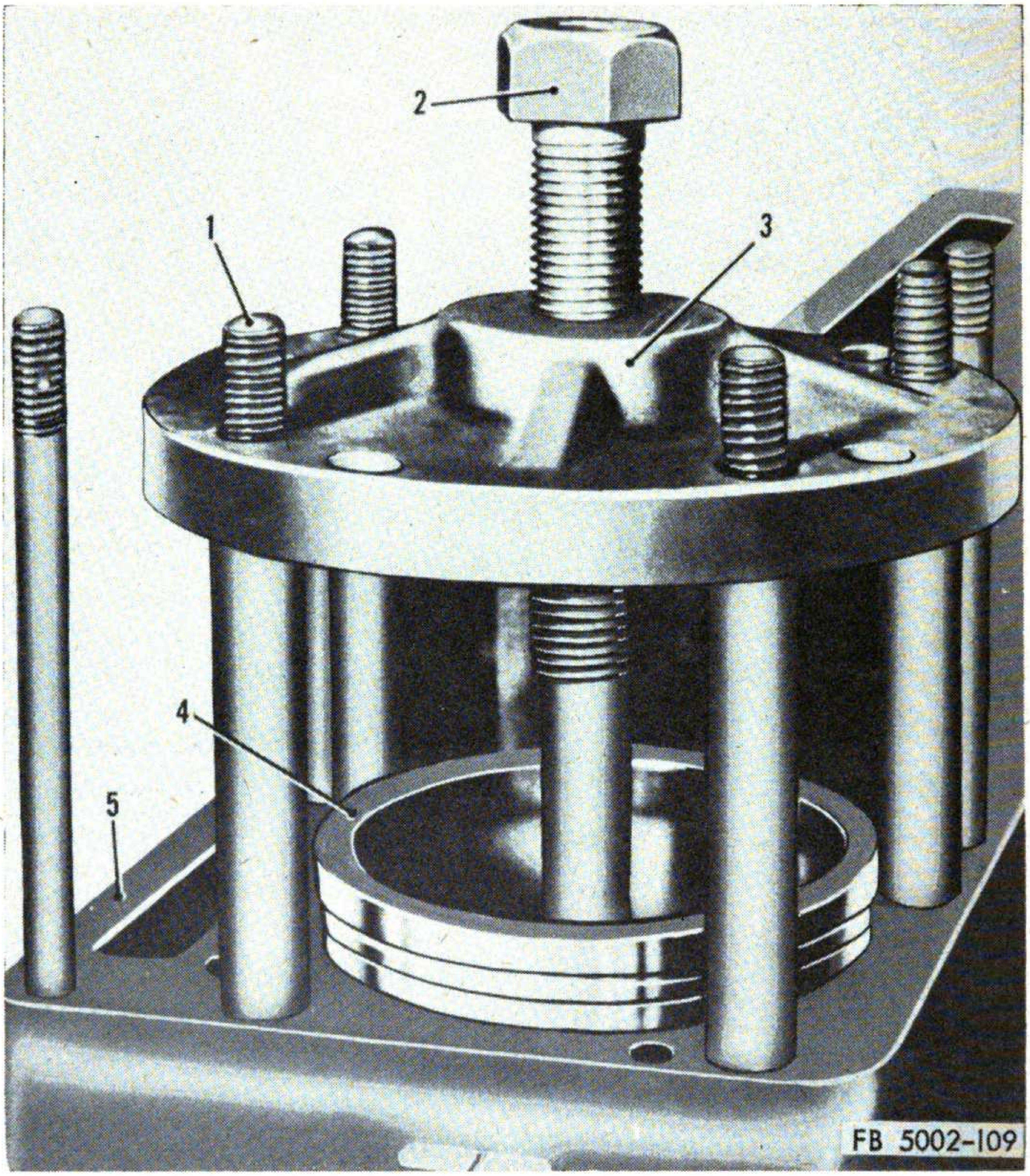
c. Installation.

(1) Check the sleeve (8, fig. 93) in the block without the packings (9), for freedom.

(2) Roll the packings into the grooves in the sleeve, making sure they are not twisted.

(3) Soap the packings with vegetable soap and insert the sleeve in the block.

(4) Set the sleeve fixture (3, fig. 109) in position for pressing the sleeve (4) into the block (5), and install the sleeve. Do not let the sleeve extend more than 0.001 to 0.004 inch above the block. File the top of the sleeve or install shims in the block recess as necessary to obtain this dimension.



1 Cylinder head studs. 2 Fixture screw. 3 Cylinder sleeve fixture. 4 Cylinder sleeve. 5 Block.

Figure 109. Cylinder sleeve removal.

(5) Check the piston clearance (par. 194*c*(5)).

(6) Install the connecting rods and pistons (par. 194).

(7) Break in the engine (par. 205).

Section XIV. OIL PUMP ASSEMBLY

196. General

(fig. 50)

The oil pump (7) is attached to the front bearing cap. Oil is drawn up through the tube and cover assembly (3) and discharged directly into the block through drilled passages in the cap and block. For removal and installation of the pump, refer to paragraph 104.

197. Oil Pump
(fig. 51)

a. Disassembly.

(1) Disassemble the relief valve and tube and cover assembly (par. 104*c*).

(2) To remove the cover (27) and gasket (26), remove the screws (28).

(3) Pull the drive gear (13) and key (12) off the shaft (11).

(4) Remove the gear assemblies from the body (9).

(5) Remove the ring (23) and press the shaft (11) and stud (24) out of the gears (22 and 25). Remove the key (12) from the shaft (11).

(6) Remove the bushings (10) from the body (9).

b. Cleaning and Inspection. Wash all metal pump parts in an approved cleaning solvent. Examine the gears (13, 22, and 25) for damaged or worn teeth, and the bushings (10) for scores and scratches. Replace a defective item.

c. Reassembly.

(1) Install the bushings (10) in the body (9).

(2) Place the key (12) in the shaft (11) and press the gears (22 and 25) on the shaft (11) and stud (24). Secure the gear (22) with the ring (23).

(3) Place the gear assemblies in the body (9) and install the key (12) and gear (13) on the shaft (11).

(4) Check for a clearance of 0.001 to 0.003 inch between the outer diameter of the gears (22 and 25) and the body (9).

(5) Lay a straightedge on the body over the gears and check for a clearance of 0.001 to 0.003 inch.

(6) Secure the cover (27) and gasket (26) with the screws (28).

(7) Assemble the relief valve and tube and cover assembly to the pump (par. 104*e*).

Section XV. MAIN BEARINGS AND CRANKSHAFT

198. General
(fig. 100)

The main bearings (5, 7, and 8) are the removable shell type, with one part in the block and the other in the caps (22, 27 and 28). The rear and center caps are very rigid forgings securely fastened to the block by the screws (25). The front cap is secured by the oil pump screws. The crankshaft (6) is a machined forging with the bearing journals surface-hardened and drilled for pressure lubrication of the main and connecting rod bearings. It is balanced statically and dynamically to insure evenness in performance and reduce vibration.

199. Main Bearings

a. General (fig. 100). The main bearings (5, 7, and 8) are of the two-piece, precision insert type. Worn bearings will produce a crankshaft knock that is especially noticeable when the engine is under a heavy load. Remove one cap at a time when inspecting or replacing bearings.

b. Cleaning and Inspection (fig. 100).

(1) To determine if the bearings (5, 7, or 8) need replacement, remove the oil pan (par. 103) and the bearing cap (par. 200*a*).

(2) Remove the bearing half from the cap and clean with an approved cleaning solvent.

(3) If the cap half of the bearing shows any flaking or scoring, replace the entire bearing.

(4) Check the thickness of the bearing half with a micrometer. If the thickness is 0.0919 inch or less, replace the entire bearing. Correct thickness is 0.0924 to 0.0929 inch.

c. Removal.

(1) Remove the lower half of the bearing from the cap (*b* above).

(2) To remove the upper half of the bearing, insert a cotter pin in the crankshaft oilhole and rotate the shaft so the pin will push the bearing out. Remove the pin.

d. Installation (fig. 110).

(1) Place the upper half of the bearing (3) on the crankshaft journal.

(2) Insert a cotter pin (2) in the crankcase oilhole and rotate the shaft so that the pin will push the bearing in place. Remove the cotter pin.

(3) Install the lower half of the bearing in the cap.

(4) Place a piece of feeler stock, ½-inch wide an ⅛-inch shorter than the length of the bearing a a thickness of 0.0045 inch, in the lower half of t ing.

(5) Install the cap and tighten the screws to a ter 100 to 110 foot-pounds.

(6) With new bearings of the correct thickness, it sho be possible to turn the crankshaft by hand. If it i ble to turn it by hand, remove the crankshaft (pa and grind the crankshaft journals to the nearest ard undersize. Install undersize bearings.

(7) If the original bearings were installed, the method should result in a slight drag when the cranksl turned by hand. Free movement indicates a worn shaft which must be removed and ground to the n standard undersize with an equivalent change in be size.

(8) Remove the feeler stock and install the cap (par. 2

(9) Install the oil pan (par. 103).

(10) Break in the engine (par. 205).

200. Crankshaft

(fig. 100)

a. Removal.

(1) Remove the crankshaft gear (par. 189), flywheel (191), connecting rods and pistons (par. 194), an pump (par. 104).

(2) Remove the front bearing cap (22), dowel (23), lower half of the bearing (8).

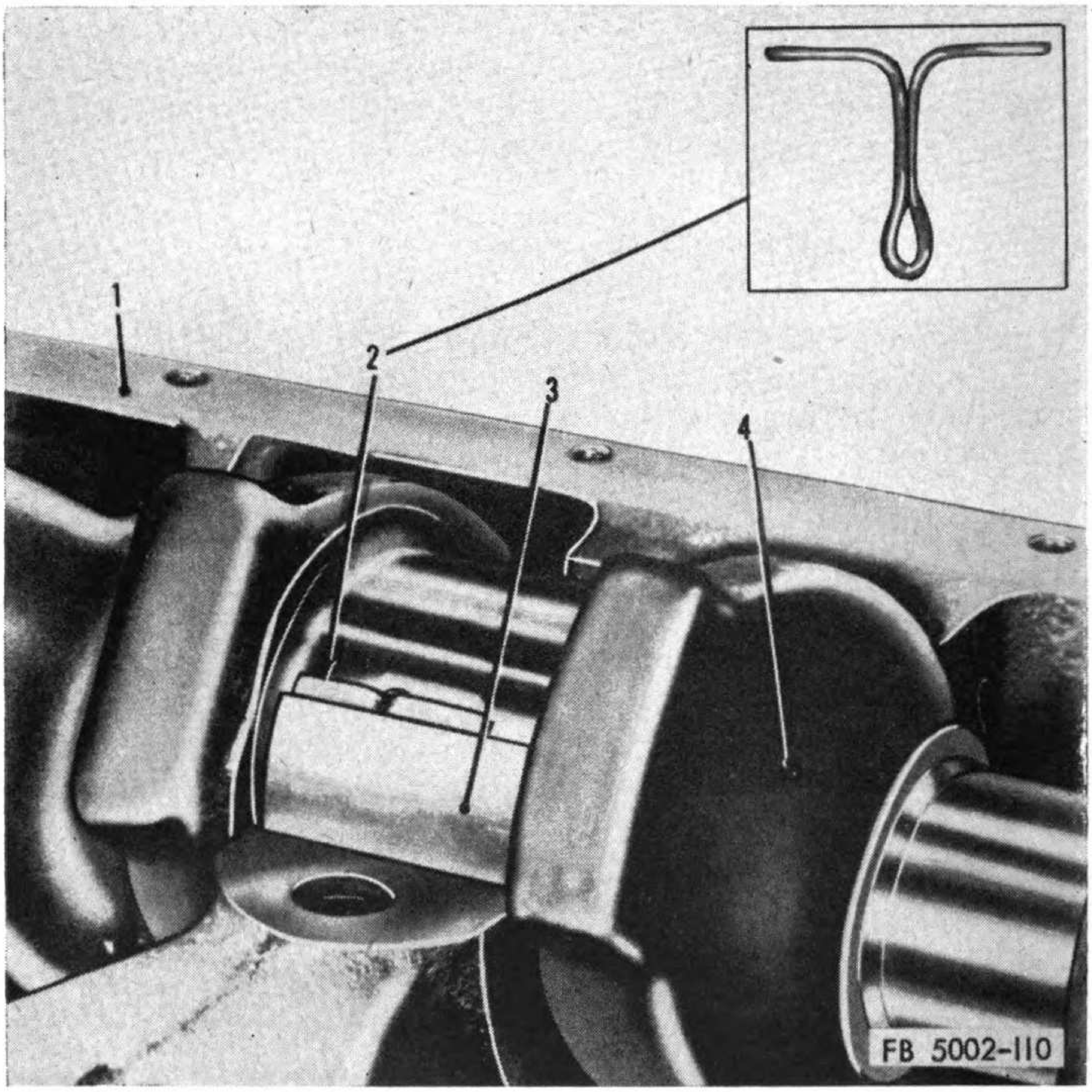
Note. As each cap is removed, mark each bearing half so it be replaced in its respective position.

(3) To remove the center bearing cap (27) and bearing (cut the lock wire (24) and remove the screw (25) plain washer (26).

(4) To remove the rear bearing cap (28), seal assembly (through 35), and bearing (5), cut the lock wire (2 and remove the screw (25) and plain washer (26).

(5) To disassemble the oil seal, remove the cork (29), g ket (30), screws (34), washers (35), seal (32), a gasket (31).

(6) Lift out the crankshaft (6) and mark each upper h of the bearings so they can be replaced in their prop location.



1 Block. 2 Cotter pin. 3 Bearing. 4 Crankshaft.

Figure 110. Main bearing installation.

b. Cleaning and Inspection.

(1) Clean the crankshaft, metal parts of the oil seal, bearings, and caps with an approved cleaning solvent.

(2) To check for taper of the crankshaft journals, find the smallest diameter of the journal, which is usually at one end, and take three readings in the same plane on the journal. This will indicate the taper of the journal for the one plane. Take three readings in the same way at a point 90° from the first readings. This will indicate the taper of the same journal for that plane. For the amount of out-of-round, compare the first reading of one plane with the first reading of the other, the second reading of one plane with the second reading of the other, and the third reading of one with the third reading of the

other. Repeat this procedure for all the journals. I: journal wear exceeds 0.002 inch, regrind the journals t the nearest standard undersize. The journal diamete: for a standard crankshaft is 2.873 to 2.874 inch.

(3) To check for alinement of the crankshaft (6), plac V-blocks under the front and rear journals and checl the runout of the main bearing journals with a dial indi cator. Total indicator reading should not be more thaı 0.003 inch total.

(4) Inspect the crankshaft flange for nicks. Smooth then if necessary. Check the flange screwholes for wear, an the crankshaft threads for damage. Clean all the oi passages. If magnafluxing equipment is available, chec: the crankshaft for cracks.

c. Installation.

(1) Place the upper halves of the bearings (5, 7, and 8) i their proper locations.

(2) Place the crankshaft (6) in the block.

(3) Cement the gaskets (30 and 31) and the cork (29) t the rear bearing cap (28). Secure the seal (32) wit the washers (35) and screws (34).

(4) Place the bearing (5) in the rear cap and secure to tl block with the washers (26) and screws (25).

(5) Place the bearing (7) in the center bearing cap (2 and secure with the washers (26) and screws (25).

(6) Place the bearing (8), cap (22), and dowel (23) on t block and install the oil pump (par. 104).

(7) Tighten the bearing cap screws to a tension of 100 110 foot-pounds and secure with the lock wire (24).

(8) Install the connecting rods and pistons (par. 194), wheel (par. 191), and crankshaft gear (par. 189).

(9) Break in the engine (par. 205).

Section XVI. CAMSHAFT

201. General
(fig. 98)

The camshaft (17) is driven by means of the gear (21) w meshes with the crankshaft gear and is supported at three p by the block. The camshaft, through the tappets (16), rods (14), and rocker arms (10), opens and closes the valves

202. Camshaft

(fig. 98)

a. Removal.

(1) Remove the cylinder head (par. 106) and the camshaft gear (par. 189).

(2) Pull the camshaft (17) out of the block, guiding it carefully to avoid damaging the lobes.

b. Cleaning and Inspection.

(1) Clean the camshaft with an approved cleaning solvent.

(2) Check the camshaft journals for wear. If the minimum diameter of the journals exceeds 1.995 inch for the front, 1.745 inch for the middle, and 1.6825 for the rear, replace the camshaft.

(3) If the wear is found to be in the bearing bores, line bore the block. Build up the camshaft journals with hard chrome plate and grind to the new diameter, allowing 0.0015 inch oil clearance.

c. Installation.

(1) Guide the camshaft (17) carefully into the block to avoid damaging the lobes.

(2) Install the camshaft gear (par. 189) and the cylinder head (par. 106).

Section XVII. CYLINDER BLOCK

203. General

a. Description. The one-piece construction of the cylinder block permits carrying the water jacket the full length of the cylinder bore. This results in uniform cooling of the piston and cylinder wall. Passages are drilled in the block for carrying oil under pressure to the main bearings and other parts requiring forced feed lubrication.

b. References. Disassembly of the block requires removal of the cylinder head (par. 106), timing gears (par. 189), flywheel (par. 191), flywheel housing (par. 192), oil pump (par. 104), connecting rods and pistons (par. 194), cylinder sleeves (par. 195), crankshaft (par. 200), and camshaft (par. 202).

204. Cylinder Block
(fig. 93)

a. Disassembly.

(1) Remove all the components listed in paragraph 203*b*.

(2) Remove the plugs (5 and 29).

(3) Remove the drain valve (35) and pipe plug (36).

(4) Remove all studs from the assembly.

b. Cleaning.

(1) Clean all parts with cleaning solvent.

(2) Thoroughly clean all oil passages in the assembly.

c. Inspection.

(1) Check the cylinder block (10) for cracks. Replace a cracked block.

(2) Inspect the top of the block for pits or corrosion. Clean light corrosion and shallow pits. Resurface the block if deep pits and corrosion exist.

(3) Inspect all studs, the valve (35), and plug (36) for thread damage and looseness. Replace a defective item.

d. Reassembly.

(1) Install the studs, the drain valve (35), and the plugs (36). Replace the plugs (5 and 29).

(2) Install the engine components referenced in paragraph 203*b*.

205. Engine Break-In Period

Whenever the engine is overhauled or the piston rings are replaced, the engine must be operated with light loads and at lower speeds for a short period of time. A schedule for operation is as follows:

a. Run the engine at idling speed and check for oil, fuel, and coolant leaks.

b. Run the engine for 1 hour at 600 rpm and no load.

c. Run the engine for 1 hour at 800 rpm and no load.

d. Run the engine for 1 hour at 800 rpm and 50 percent load.

e. Run the engine for 1 hour at 1,200 rpm and 75 percent load.

f. Run the engine for 3 hours at 1,200 rpm and full load.

g. After the end of the test run, allow the engine to idle for a few minutes and cool slowly to avoid damage due to warping.

h. Check the entire engine for loosened nuts, bolts, and cap screws, particularly at the cylinder head, oil pan, and manifold.

i. Check the valve clearance (par. 107).

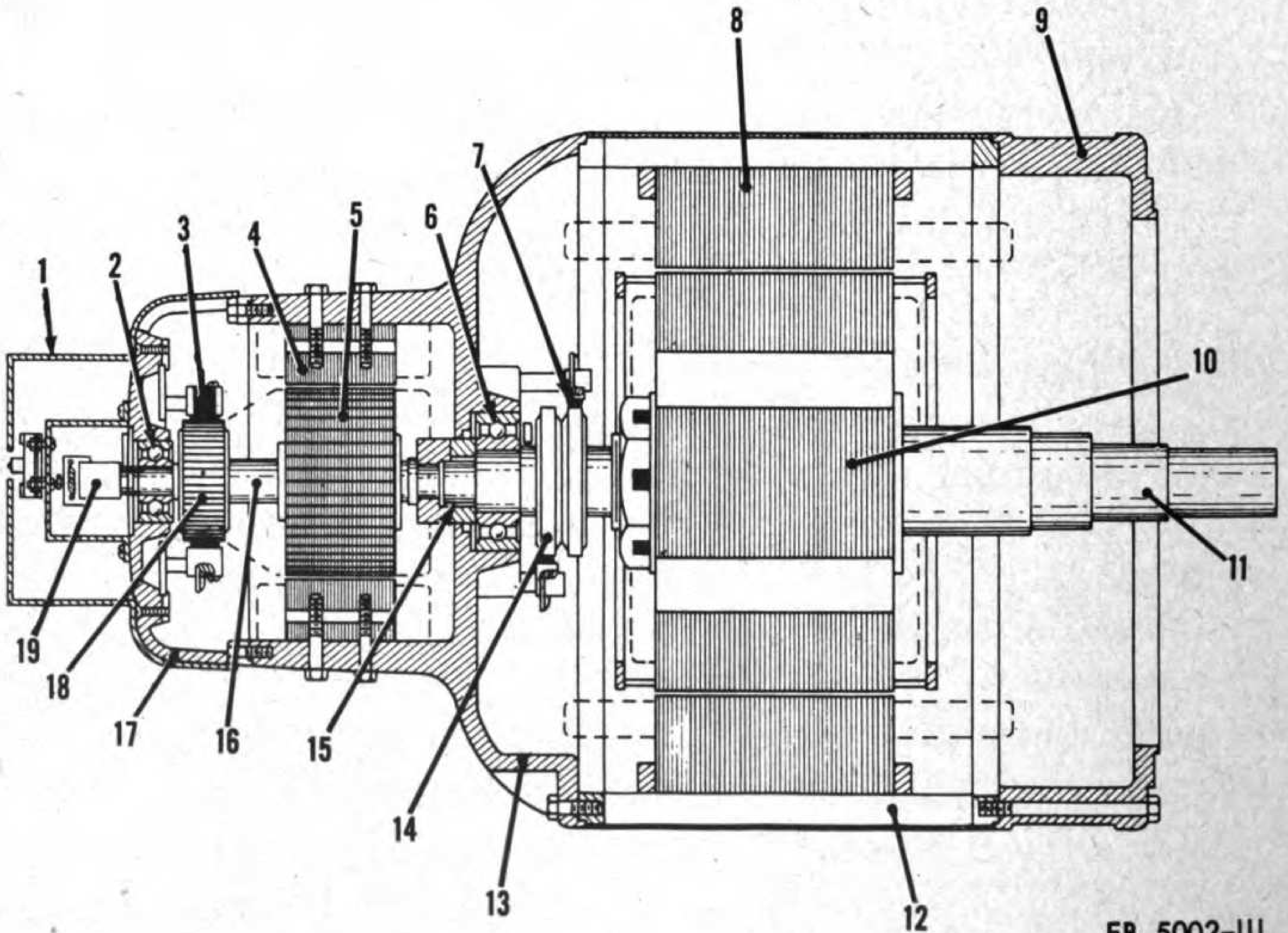
Section XVIII. GENERATOR ASSEMBLY

206. *General*

For inspection and cleaning of the commutator, see paragraph 121. To replace brushes and adjust brush spring tension, refer to paragraphs 122 and 124. Inspection and cleaning of the slip-rings and windings are covered in paragraphs 123 and 125. Instructions on removal of the generator from the skid base are given in paragraph 182.

207. Exciter

a. Description (fig. 111). The conventional, self-excited, d-c generator is directly coupled to the rotor shaft (11) by the coupling assembly (15). As the unit is brought up to operating speed, a voltage is generated in the exciter armature assembly (5) due to the residual magnetism of the poles in the exciter field winding set (4). The d-c current generated is controlled by the exciter field rheostat. It flows from the commutator (18) through



1	Shield	11	Rotor shaft
2	Exciter ball bearing	12	Frame
3	Exciter brush	13	Alternator commutator bell end
4	Exciter field winding set	14	Slipring assembly
5	Armature assembly	15	Coupling assembly
6	Bearing	16	Exciter shaft
7	Alternator brush	17	Exciter commutator bell end
8	Stator winding	18	Commutator
9	Adapter ring	19	Overspeed device
10	Rotor		

Figure 111. Generator, sectional view.

the exciter brushes (3), and enters the rotor (10) through the alternator brushes (7) and slipring assembly (14). Changes in the d-c excitation current will change the level of the generated a-c current. The alternator bell end (13) mounts the exciter field winding set and supports the bearing (6).

b. Removal (fig. 112).

(1) Remove the generator from the skid base (pa. 182).

(2) Remove the bolts (1) and lockwashers (2) and pull the shield (3) from the exciter.

(3) Remove the overspeed device (par. 166).

(4) Disconnect all the leads at the holder ring assembly (12) and brush holder assemblies (24).

(5) Lift the tension arms and remove all the brushes.

(6) Remove the cap screws (48) and lockwashers (49) and pull the bell end (10), with the armature assembly (53), off the bell end (22).

(7) Remove the armature assembly (53) from the bell end (10).

(8) The grounding brush (47), ball bearing (11), and holder ring assembly (12) are mounted to the bell end (10). The field winding set (16) and field poles (17) are secured inside the bell end (22).

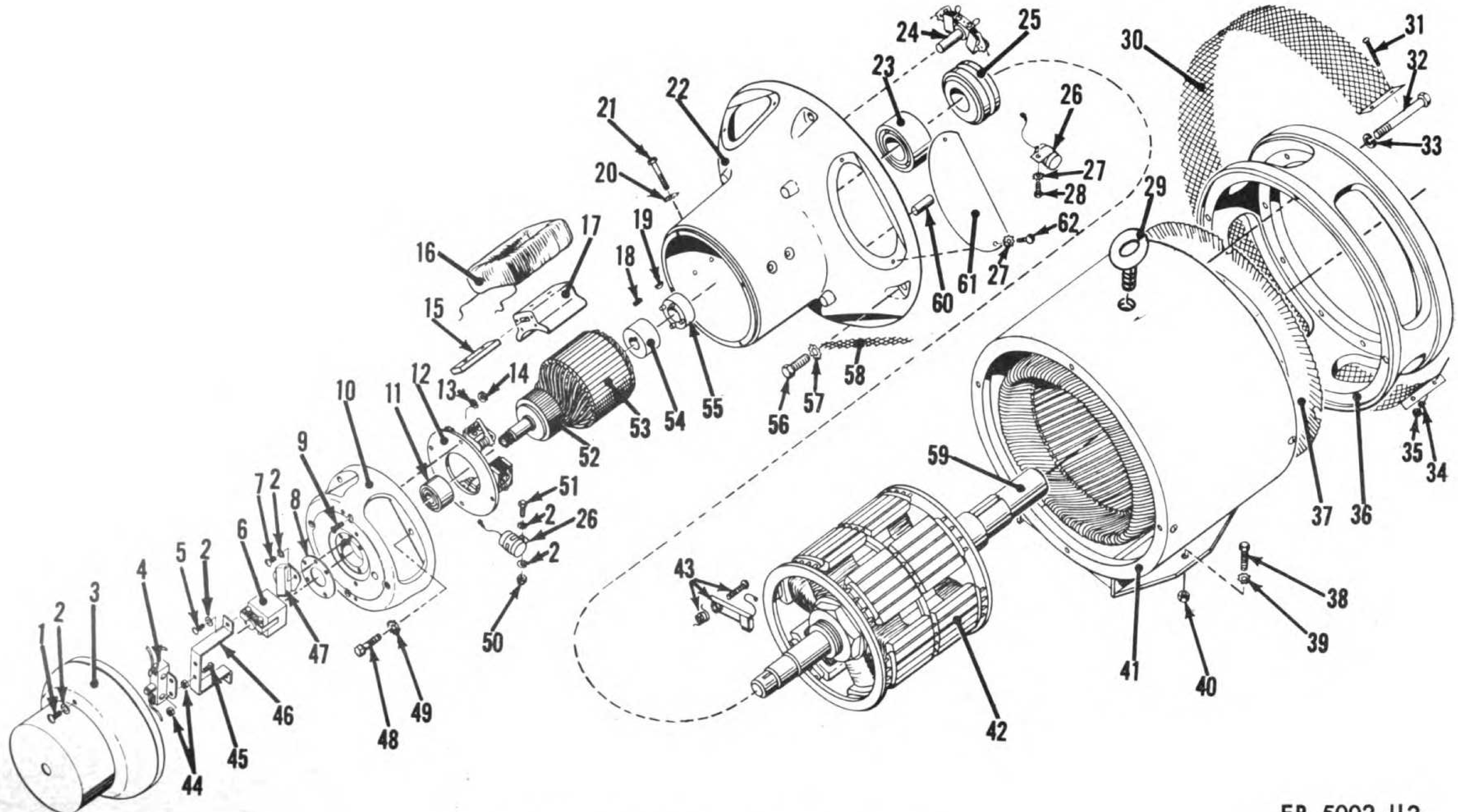
208. Exciter Armature

Inspection, testing, and repair methods for the charging generator armature (par. 172*d*) are applied to the exciter armature. Instructions are given for undercutting mica and using a growler to test commutator segments and armature windings. A defective armature must be replaced or rewound (*c* below).

a. Insulation Resistance. Test the insulation resistance with a megger. This test indicates the condition of the insulation. A high megger reading shows a low insulation leakage. Moisture and dirt will affect insulation resistance and result in lower megger values. Since the armature windings are closed, make the test from the commutator segments to ground. Keep a record of these readings for comparison purposes and compare with previous data.

Note. If the armature has not been removed from the unit, be sure to lift the brushes before taking the reading.

b. Coupling (fig. 112). See that the coupling (54) is securely keyed to the armature shaft. When mated with the coupling (55), there should be no play or backlash. If the coupling is loose or worn, remove with a puller and replace, inserting a new key (18).



FB 5002-112

Figure 112. Generator, exploded view.

1 Machine bolt (4 req'd)
2 Washer, lock, Shakeproof, int-ext-teeth, No. 10 (14 req'd)
3 Shield
4 Overspeed microswitch
5 Machine bolt (2 req'd)
6 Overspeed device
7 Screw, mach, rd-hd, No. 10 x ⅜ in. NC (2 req'd)
8 Inspection cover plate
9 Screw (4 req'd)
10 Commutator bell end
11 Ball bearing
12 Holder ring assembly
13 Washer (4 req'd)
14 Nut (4 req'd)
15 Pole piece bar
16 Field winding set
17 Field pole
18 Coupling key
19 Key, woodruff, No. 5 (1 req'd)
20 Washer, lock, Shakeproof, int-ext-teeth, ⅜ in. (8 req'd)
21 Screw, cap, hex-hd, ⅜ x 1¾ in. NC (8 req'd)
22 Commutator bell end
23 Bearing
24 Brush holder assembly
25 Slipring assembly
26 Capacitor
27 Washer, lock, Shakeproof, int-ext-teeth, ¼ in. (10 req'd)
28 Screw, cap, hex-hd, ¼ x ¾ in. NC (1 req'd)
29 Lifting bolt
30 Screen
31 Screw (2 req'd)
32 Screw, cap, hex-hd, ½ x 5½ in. NC (4 req'd)
33 Washer, lock, ½ in. (4 req'd)
34 Washer (2 req'd)
35 Hex nut (2 req'd)
36 Adapter ring
37 Baffle
38 Machine bolt (2 req'd)
39 Washer, lock, ⅝ in. (2 req'd)
40 Nut (2 req'd)
41 Frame
42 Rotor assembly
43 Grounding brush assembly
44 Nut (4 req'd)
45 Screw (2 req'd)
46 Microswitch bracket
47 Grounding brush
48 Screw, cap, hex-hd, 5/16 x 1¾ in. NC (4 req'd)
49 Washer, lock, Shakeproof, int-ext-teeth, 5/16 in. (4 req'd)
50 Nut, hex, No. 10 NC (3 req'd)
51 Screw, mach, fl-hd, No. 10 x ¾ in. NC (3 req'd)
52 Commutator
53 Armature assembly
54 Coupling
55 Coupling
56 Screw, cap, hex-hd, ½ x 1½ in. NC (4 req'd)
57 Washer, lock, Shakeproof, int-teeth, ½ in. (4 req'd)
58 Endbell cover shield
59 Shaft
60 Straight pin
61 Endbell cover shield
62 Screw, mach, rd-hd, ¼ x ½ in. NC (8 req'd)

Figure 112—Continued.

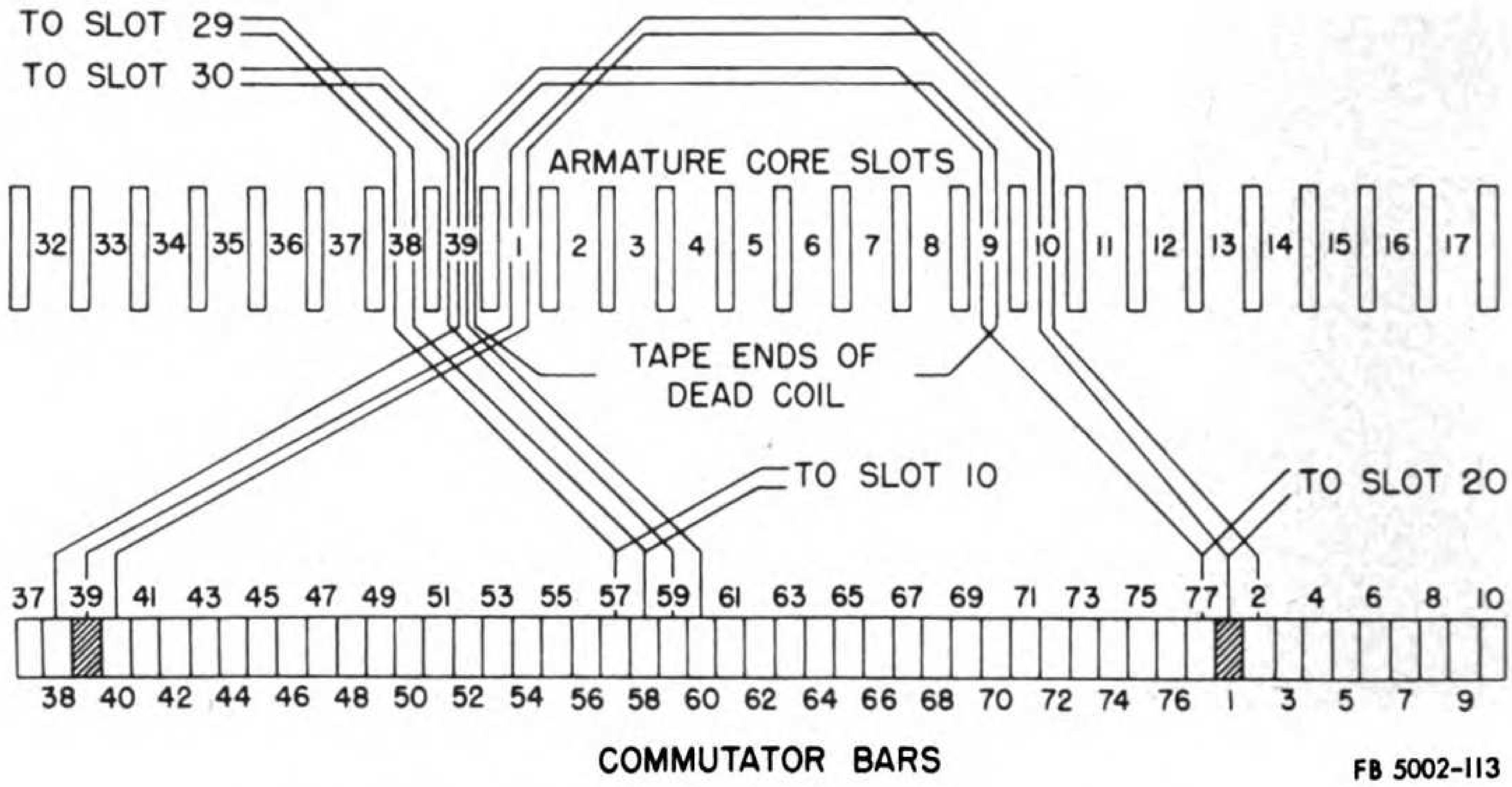


Figure 113. Exciter armature winding diagram.

c. Rewinding (fig. 113). The exciter armature is machine wound and should be replaced as a unit if the winding is defective. If there is no replacement available, a skilled workman can remove the old winding and rewind the armature. Wire size and winding pitches are given in paragraph 223. Figure 113 schematically illustrates the pitch of 1 to 10 slots, the connection pitch of 1 to 39 bars, and the alinement of slot number 13 with bar number 1. If the armature is rewound, it must be thoroughly dried, given four coats of insulating varnish, and baked for 4 hours at 180° F. This varnish treatment will not be satisfactory unless proper dipping and baking equipment is used. Apply airdrying fungicidal varnish to the winding. Balance the armature after rewinding and check the neutral setting of the brushes (par. 212*b*).

209. Exciter Field Windings

a. Description. The field winding set (16, fig. 112) and poles (17) are held to the inside of the bell end (22). The winding set is connected in series with a field rheostat and an automatic regulator, and in parallel with the armature as shown in figure 114.

b. Testing (fig. 112).

(1) Test the field winding set (16) for an open coil by connecting the test prods of a growler to each end of the field circuit. If the test lamp fails to light, one of the coils is open and must be replaced. Check each coil to find the open coil.

(2) Test the field winding set for a grounded winding by placing one prod on the bell end (22) and the other on a field winding lead. If the test lamp lights, one of the

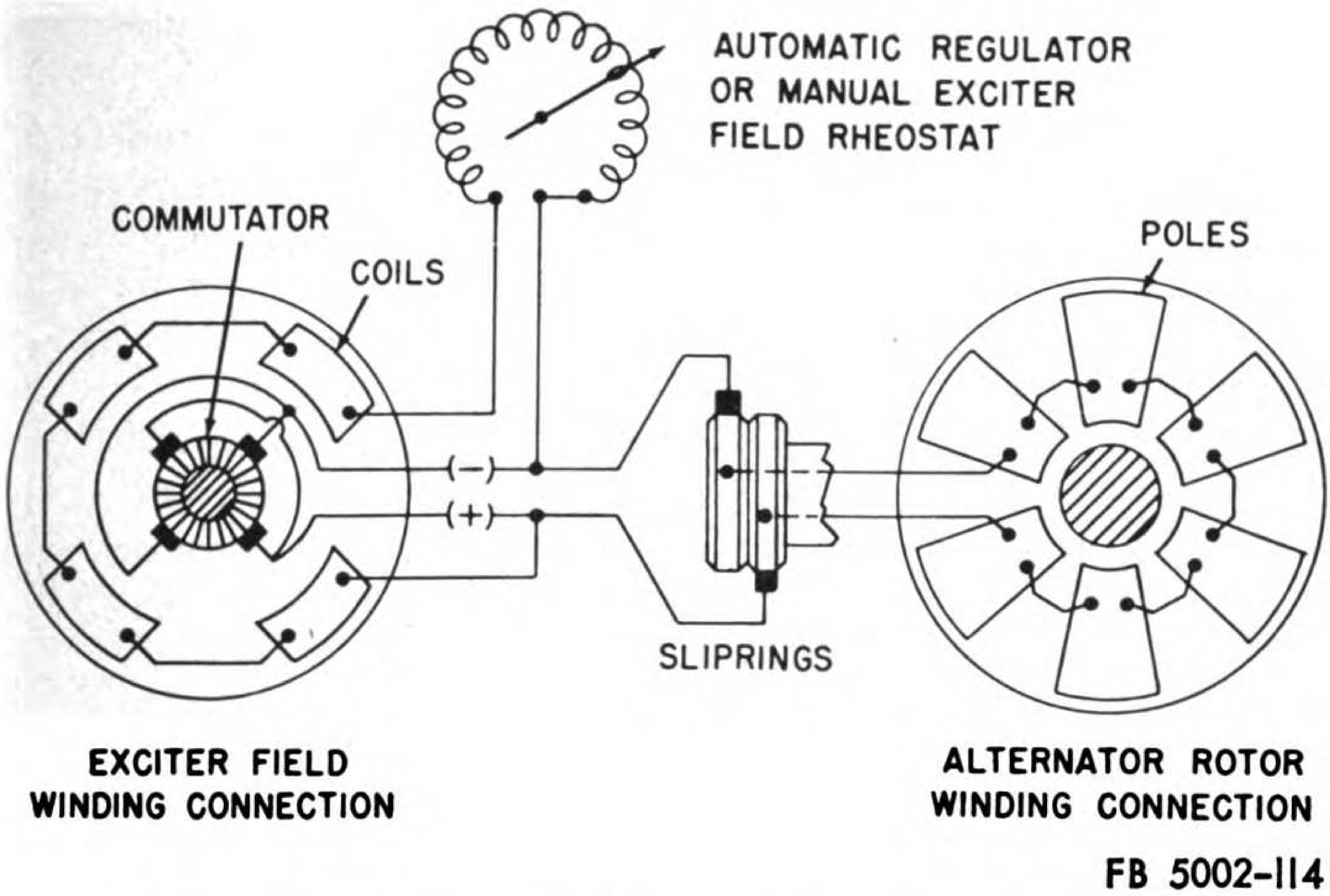


Figure 114. Exciter and alternator field winding connections.

coils is grounded. Check each coil and replace the grounded coil.

c. Insulation resistance. Use a megger to test the insulation resistance. Disconnect both field leads and measure from either lead to ground. Record for comparison with previous data.

d. Replacement (fig. 112). Break the splice between the adjacent windings and remove the cap screws (21) and lockwashers (20). Remove the pole (17), bar (15), and winding set (16). Assemble the new winding set over the pole and bar (15) and secure to the bell end (22) with the cap screws and lockwashers. Solder the winding set leads in series with the other sets and check the field resistance, which should not be greater than 170 ohms at 25° C.

210. Exciter Holder Ring Assembly

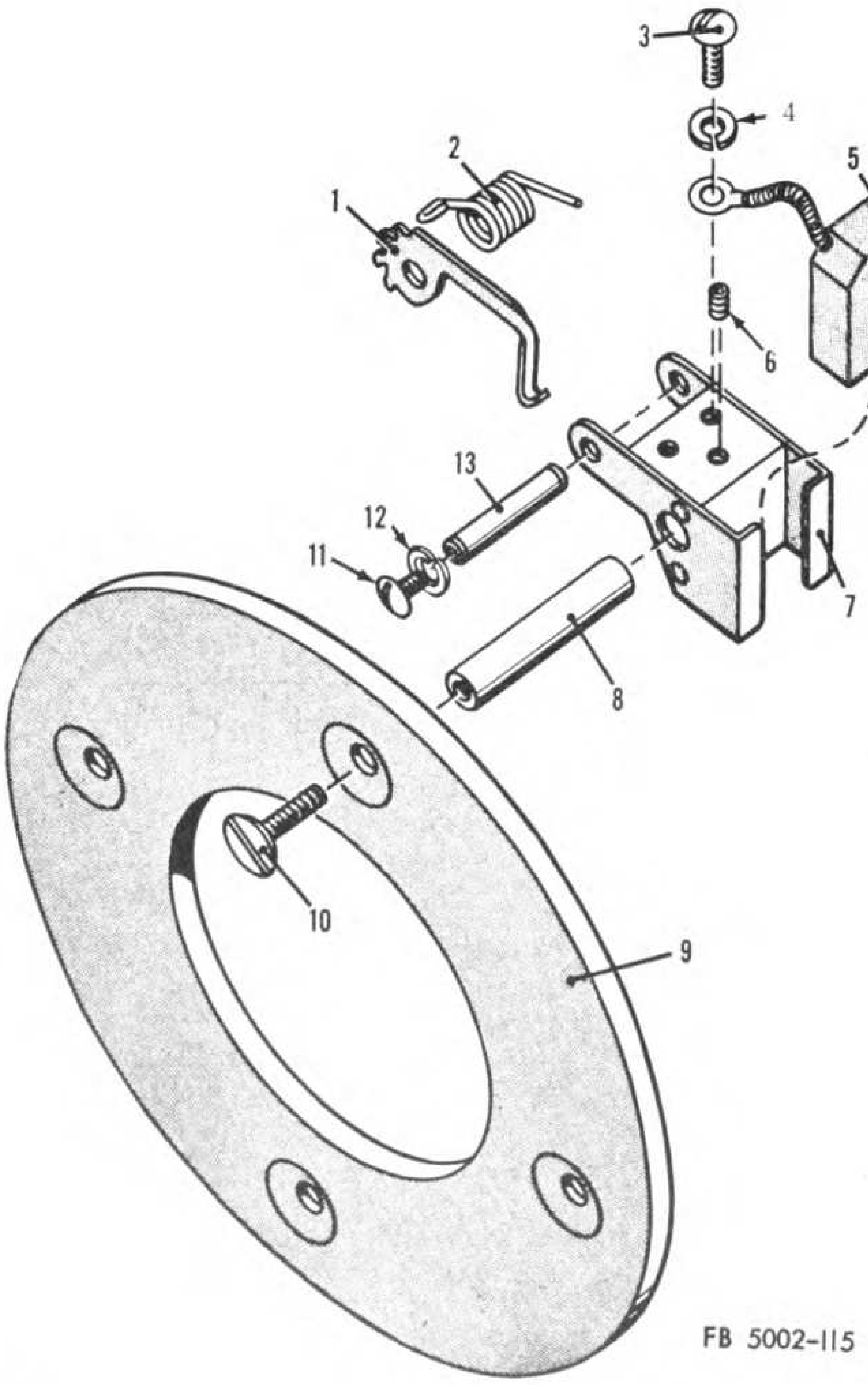
The holder ring assembly (12, fig. 112) is secured to the bell end (10) and is not to be removed unless a worn or damaged part is being replaced.

a. Removal (fig. 112). Place a file or chisel mark on the bell end (10) and ring assembly (12) to indicate the position of the ring before disassembly. Remove the nuts (14), washers (13, and screws (9).

b. Testing (fig. 112). The brush holders insulate the brushes from the bell end (10). To test, place one test prod on the ring and the other on the holder. If the lamp lights, the holder is grounded and must be replaced.

c. Disassembly (fig. 115). Remove the screw (10) and separate the ring (9) and brush holder assembly. Loosen the setscrew (6) and slide the holder off the stud (8). Remove the screw (3) and pull the brush (5) out of the holder. Remove the screws (11) and lockwashers (12) from the hub (13) to remove the tension arm (1) and spring (2).

d. Reassembly (fig. 115). Place the tension arm (1) and spring (2) in place in the holder (7) and insert the hub (13). Secure with the screws (11) and lockwashers (12). Attach the brush (5) to the holder with the screws (3) and lockwashers (4).



1 Brush tension arm
2 Brush spring
3 Screw, mach, rd-hd, No. 8 x 3/8 in. NC (4 req'd)
4 Washer, lock, No. 8 (4 req'd)
5 Brush
6 Screw, set, hex-socket, No. 10 x 1/4 in. NC (4 req'd)
7 Brush holder
8 Holder stud
9 Brush holder ring
10 Screw, mach, fl-hd, No. 10 x 1 in. NF (4 req'd)
11 Screw, mach, rd-hd, No. 6 x 1/4 in. NC (4 req'd)
12 Washer, lock, No. 6 (4 req'd)
13 Hub arm

Figure 115. Holder ring assembly, exploded view.

Slide the holder assembly on the stud (8) and secure with the setscrew (6). Attach the ring (9) to the brush holder assembly with the screw (10).

e. Installation (fig. 112). Attach the holder ring assembly (12) to the bell end (10) with the screws (9), washers (13), and nuts (14). Do not tighten the nuts until the alinement mark on the holder assembly lines up with the mark on the bell end. Check and reset the neutral position of the brushes (par. 212*b*).

211. Grounding Brush and Ball Bearing (fig. 112)

a. Grounding Brush.

(1) *Removal.* To remove the grounding brush (47), remove the screws (7) and lockwashers (2).

(2) *Cleaning and inspection.* Wipe the brush (47) with an approved cleaning solvent. Check the brush for freedom of movement in its holder. Replace an oil soaked brush or one worn to less than half its original length.

(3) *Installation.* Secure the brush (47) to the cover plate (8) with the screws (7) and lockwashers (2). Seat a new brush with a brush seating stone or sandpaper (par. 96*b*(6)).

b. Ball Bearing.

(1) *Cleaning and Inspection.* Wipe the bearing (11) with an oil-dampened cloth only. Examine the bearing for signs of metal dust in the races. When rotated by hand, it should turn freely and silently. If the bearing is noisy or worn, replace it.

(2) *Removal.* Press the bearing (11) out of the bell end (10).

(3) *Installation.* Press the bearing (11) into the bell end (10).

212. Exciter Installation and Brush Neutral Setting

a. Installation (fig. 112).

(1) Assemble the coupling (54) over the key (18) on the armature shaft, and insert the armature assembly (53) in the bell end (22) to engage the coupling (55).

(2) Insert the commutator end of the armature shaft in the bearing (11), and secure the bell end (10) to the bell end (22) with the cap screws (48) and lockwashers (49).

(3) Install the brushes and connect all the brush leads to the ring assembly (12) and brush holder assemblies (24).

(4) Install the overspeed device (par. 166).

(5) Set the brushes on neutral (*b* below).

(6) Secure the shield (3) to the bell end with the bolts (1) and lockwashers (2).

(7) Install the generator on the skid base (par. 182).

b. Setting Brushes on Neutral. The exciter brushes must be set on the neutral point to obtain satisfactory commutation. If the armature has been rewound or replaced or if the ring assembly (12, fig. 112) has been removed or replaced, the brush neutral position should be checked and reset if necessary. An indication of improper setting is sparking of the commutator when the brushes and commutator are in good condition. The diagram of the circuit to set the brushes on neutral is shown in figure 116.

(1) Disconnect the exciter field winding (1, fig. 116) and the alternator brush leads at the exciter brushes.

(2) Connect a low-reading, zero-center voltmeter (3) to the exciter brushes.

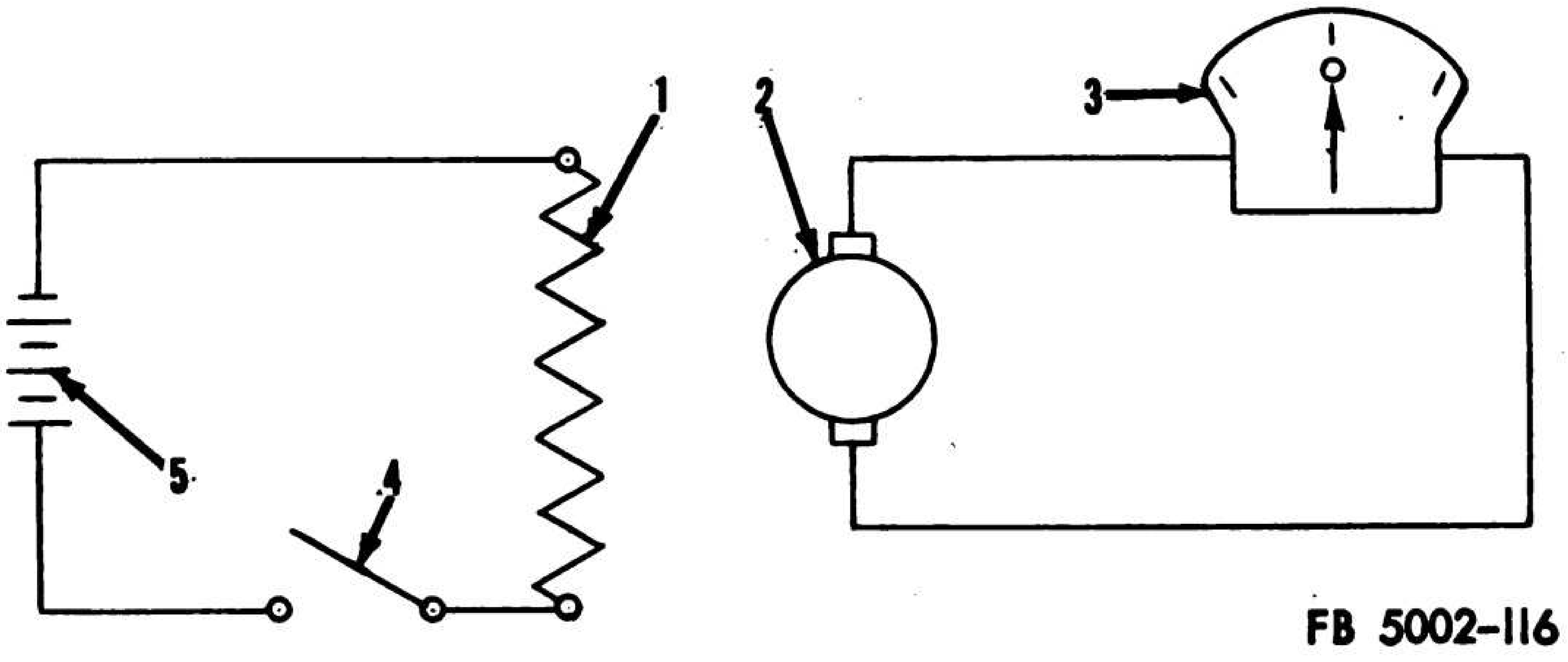
(3) Connect a 24-volt, d-c power source (5) through a switch (4) to the field winding.

(4) Close the switch for a few seconds; then open it and observe accurately the deflection of the voltmeter needle.

(5) Loosen the screws (9, fig. 112) ; move the ring assembly (12) slightly; and tighten the screws. Repeat the voltmeter test above.

Caution: Always tighten the screws before testing with the voltmeter to prevent the ring assembly from shifting.

(6) Move the ring assembly until the voltmeter deflection is at its lowest value. The brushes will be on neutral and will insure the best performance for a no-load condition.



1 Exciter field winding. 2 Exciter armature. 3 Voltmeter. 4 Switch.
5 24-volt d-c power source.

Figure 116. Circuit diagram for setting brushes on neutral.

(7) Disconnect the voltmeter (3, fig. 116) and the power source (5) from the exciter.

(8) Connect the alternator brush leads to the exciter brushes and the exciter field winding (1).

(9) Observe the generator under full load and observe the exciter brushes. If sparking still occurs, move the ring slightly in the direction of rotation.

213. Alternator

a. Description (fig. 111). The field of the alternator or a-c generator, which is referred to as the rotor (10), consists of windings on the poles of electromagnets. The rotor is supplied with a d-c excitation current through the slipring assembly (14). Alternating current is generated in the stator windings (8) and is tapped at the changeover panel where voltage is selected. The rotor shaft (11) is connected to the engine flywheel by a flexible coupling and is supported by the bearing (6).

b. Disassembly (fig. 112).

(1) Remove the exciter (par. 207).

(2) Remove the coupling and fan assembly (par. 183).

(3) Disconnect the exciter field leads and remove the cap screws (56) and lockwashers (57).

(4) Carefully work the bell end (22) and rotor assembly (42) out of the frame (41). Support and guide the shaft (59) so that the rotor and stator are not damaged.

(5) Press the rotor assembly out of the bell end. Be careful not to damage the grounding brush assembly (43).

214. Alternator Rotor

a. Testing. The windings on the poles of the rotating field are connected in series and pass through the shaft to connections at the sliprings (fig. 114).

(1) Test the rotor windings for grounds by touching one test prod to either slipring and the other prod to the rotor shaft. If the lamp lights, the rotor winding is grounded. Replace the rotor or rewind (*f* below).

(2) Test the rotor windings for an open circuit by touching one test prod to each slipring. If the test lamp does not light, the circuit is open. Replace the rotor or rewind (*f* below).

b. Insulation Resistance. Test the rotor insulation resistance with a megger. A high megger reading indicates low insulation leakage. Check from either slipring to ground. Record the reading for comparison purposes.

Note. If the rotor is not removed, be sure to lift the brushes before taking the reading.

c. Coupling (fig. 112). See that the coupling (55) is securely keyed to the shaft. When mated with the coupling (54), there should be no play or backlash. If the coupling is loose or worn, remove with a puller and replace, inserting a new key (19).

d. Bearing (fig. 112). Rotate the bearing (23) and see that it runs smoothly and quietly. Examine the races for signs of metallic dust which indicate wear. If the bearing is noisy or worn, pull it out of the bell end (22) and replace with a new part.

e. Slipring Assembly (fig. 112). Check the slipring assembly (25) for wear, burs, or pits. Smooth with No. 00 sandpaper, or replace if the surface is damaged or out-of-round.

f. Rewinding Rotor (fig. 112).

(1) The rotor windings are inclosed in a welded copper and brass squirrel cage damper assembly. The damper bars and rings prevent excessive hunting when operating the generator in parallel. It is recommended that the rotor assembly (42) be replaced if the windings are defective.

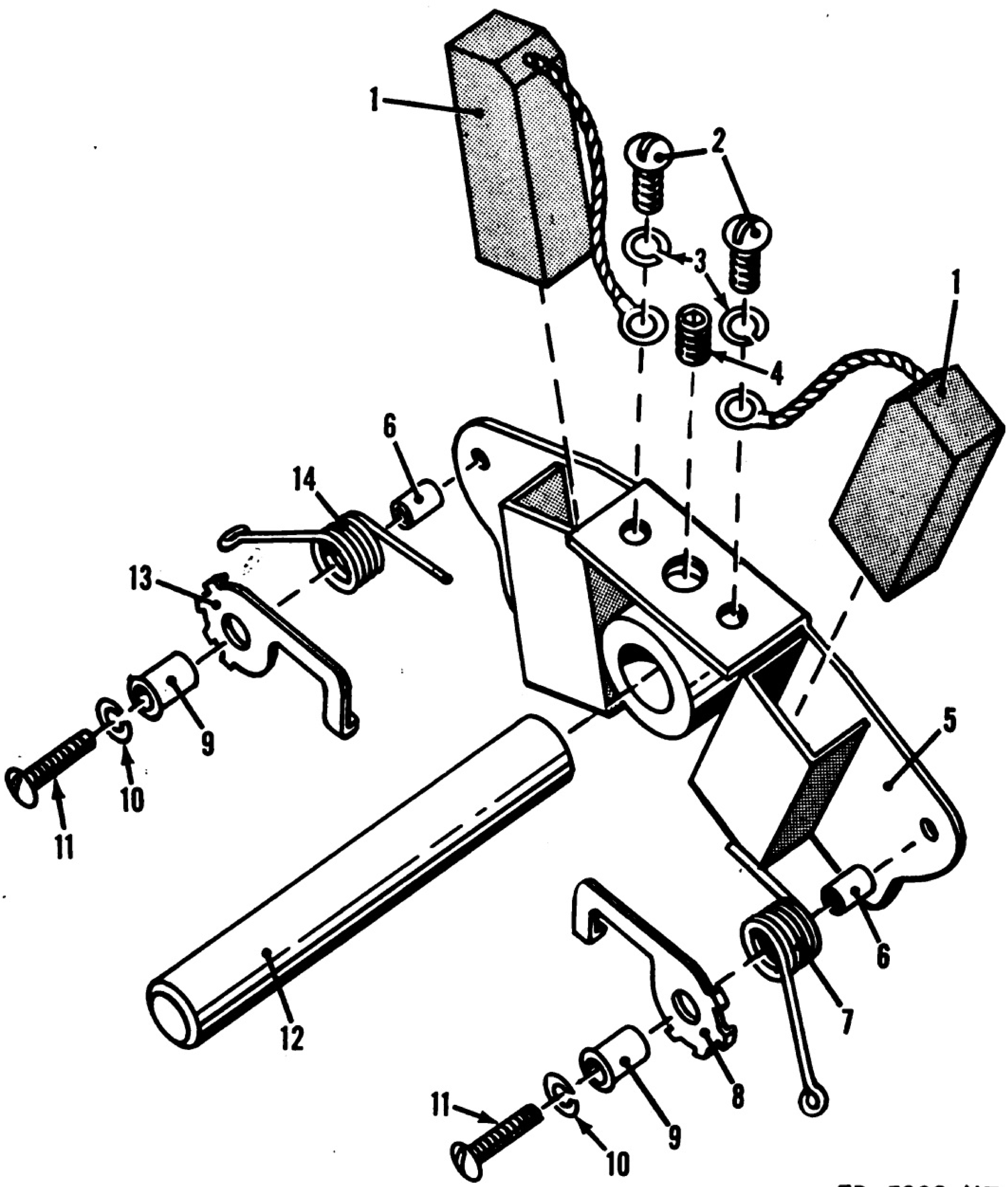
(2) If it is necessary to rewind the rotor, refer to paragraph 223 for the number of turns per pole and the correct wire size. The pole windings are connected in series as shown in figure 114. After rewinding, tape the windings and give four dips in insulating varnish. Bake after each dip for 6 hours at 280° F., except the last bake which should be 15 hours. Apply one coat of air-drying fungicidal varnish. The rotor must be balanced dynamically after rewinding.

215. Commutator Bell End (fig. 112)

The bell end (22) serves as a frame for the exciter field windings (par. 209) and retains the bearing (23) and brush holder studs. Examine the casting for cracks and damage and replace if necessary.

216. Alternator Brush Holder Assembly (fig. 117)

a. Testing. The brush holders must insulate the brushes from the bell end. To test, place one prod on the holder (5) and the other on the pin (12). If the lamp lights, the holder is grounded and must be replaced.



1 Brush
2 Screw, mach, rd-hd, No. 10 x ⅜ in. NF (4 req'd)
3 Washer, lock, No. 10 (4 req'd)
4 Screw, set, hex-socket, ¼ x ¼ in. NC (2 req'd)
5 Brush holder
6 Insulator
7 Right brush spring
8 Right tension arm
9 Spring bushing
10 Washer, lock, No. 6 (4 req'd)
11 Screw, mach, rd-hd, No. 6 x ⅝ in. NC (4 req'd)
12 Straight pin
13 Left tension arm
14 Left brush spring

Figure 117. Alternator brush holder assembly, exploded view.

b. Removal. The brush holders each retain two brushes and are secured to the pins (12) in the bell end. Loosen the setscrew (4) and slide the holder off the pin.

c. Disassembly. The brush tension arms (8 and 13) and the springs (7 and 14) can be replaced by removing the screw (11), lockwasher (10), bushing (9), and insulator (6).

d. Reassembly. Assemble the lockwasher (10) and insulator (6) on the screw and insert through the bushing (9), tension arms. and springs.

e. Installation. Slide the brush holder assembly on the pin (12) and secure with the setscrew (4) so that the brushes are in line with the surfaces of the slipring assembly.

217. Alternator Stator
(fig. 118)

a. Testing. The stator winding diagram (fig. 118) shows the windings of the coil groups in the stator slots. The winding data is listed in paragraph 223. Individual winding groups are not replaceable. The 10 terminal wires from the stator are led to the changeover panel where operating voltage is selected and where the following tests can be performed:

(1) Check the stator for open circuits by placing the test prods in series with each winding in turn. This is from T1 to T4, T2 to T5, T3 to T6, T0 to T7, T0 to T8, and T0 to T9. If the test lamp does not light, there is an open circuit and the stator must be replaced or rewound.

(2) Check the stator windings for grounded coils by holding one prod to the stator frame and touching each terminal

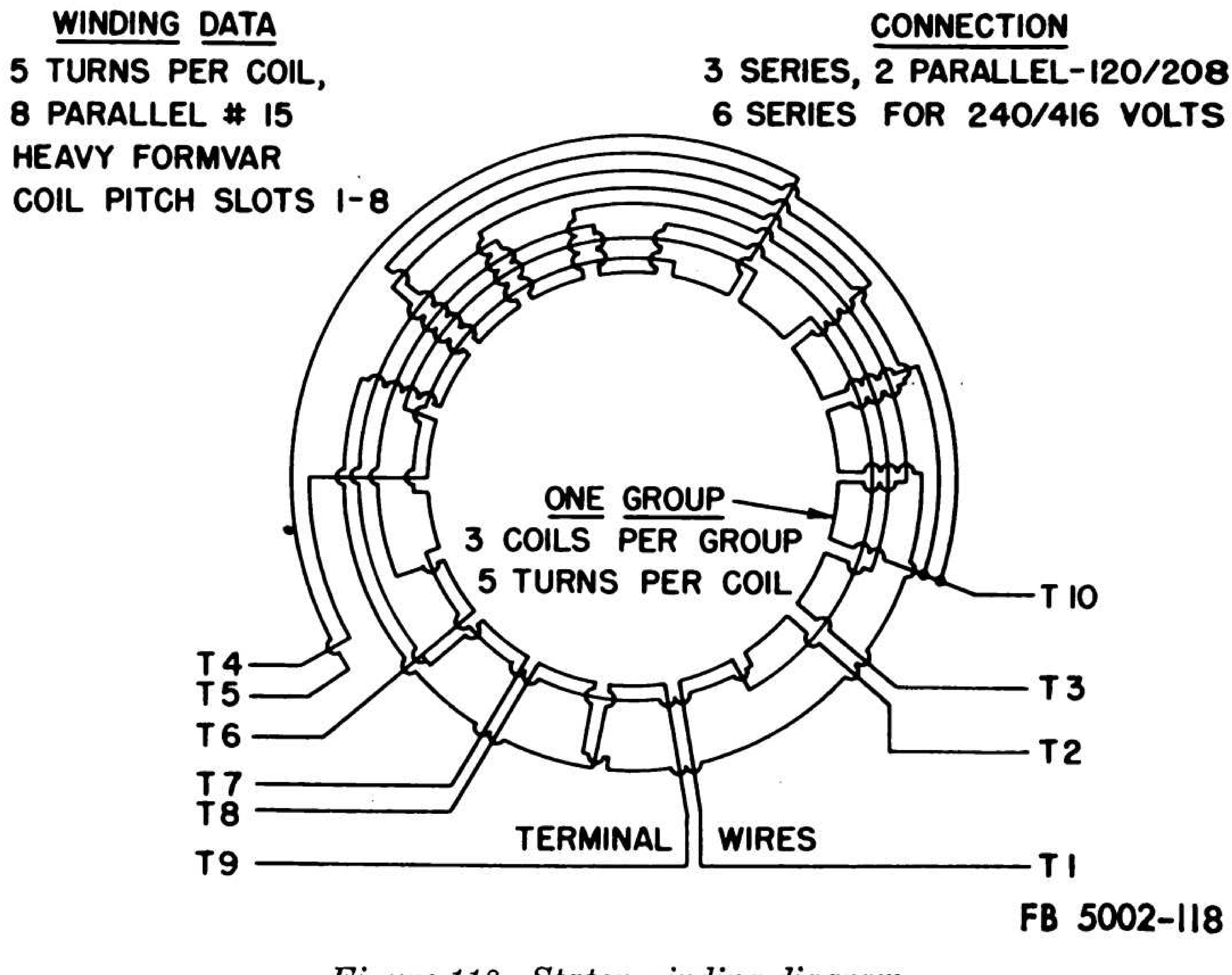


Figure 118. Stator winding diagram.

wire in turn. If the test lamp lights, one of the coils is grounded. Replace or rewind the stator.

b. Insulation Resistance. Measure the insulation resistance with a megger. Check from each terminal wire to ground and record the readings. The readings from T0, T7, T8, and T9 to ground should be the same since they are tied to the neutral wire T0. The readings from T1, T2, T3, T4, T5, and T6 to ground should be about the same value. If any of the readings are very low, recheck that coil group for a short circuit.

c. Rewinding. Complete winding data is given in paragraph 223.

(1) In an emergency, it is possible for an experienced winder to cut out a defective winding group and jump its connections. This is not recommended since it will result in lower voltage in one phase and overheating.

(2) After rewinding the stator, give three dips in insulating varnish and bake each dip for 6 hours at 280° F. Cool the stator and apply air-drying fungicidal varnish.

218. Alternator Assembly
(fig. 112)

a. Press the bell end (22) on the rotor assembly (42), being careful not to damage the grounding brush assembly (43).

b. Guide the end of the rotor shaft (59) into the frame (41) and secure the bell end to the frame with the cap screws (56) and lockwashers (57).

c. Check the air gap between the rotor and the stator. It should measure 0.050 inch all around.

d. Center the brush holder assemblies (24) over the surfaces of the slipring assembly (25), and seat the brushes.

e. Install the coupling and fan assembly (par. 183).

f. Install the exciter (par. 207) and connect the exciter field leads.

Section XIX. SKID BASE

219. General
(fig. 71)

The skid base (6) is of welded steel construction. The only removable parts are the front and rear splash pans (7 and 12). The design of the base permits the generator set to be towed for short distances. The set can be attached to a fixed location by bolting the base to a wooden or concrete platform.

220. Base
(fig. 71)

a. Inspection and Repair. Inspect the base (6) and pans (7) and (12) for corrosion, dents, and breaks. Clean off all rust. Straighten out the dents, and weld cracks or breaks. Repaint as necessary (par. 34).

b. Removal.

(1) Remove the engine (par. 181) and generator (par. 182).

(2) To remove the splash pans (7 and 12), remove the screws (8).

c. Installation.

(1) Secure the splash pans (7 and 12) to the base (6) with the screws (8).

(2) Install the engine (par. 181) and generator (par. 182).

Section XX. ENGINEERING DATA

221. General

The tabulated data in this section includes general manufacturing tolerances, adjustment and alinement tolerances, and torque information required in rebuilding the Consolidated Diesel Electric Corporation generator set Model 1664.

222. Engine

The information furnished in this paragraph applies to the Continental diesel engine Model HD–260 Special, as furnished to the Corps of Engineers and described in paragraph 6*b*.

a. Limits and Clearance Data.

(1) *Engine Model HD–260.*

Bore	3⅞ in.
Stroke	5½ in.
Displacement, cu. in.	260
Compression ratio	15.0:1
Firing order	1–3–4–2

(2) *Valve guide.*

	Intake	*Exhaust*
Length		2-21/32 in.
Outside diameter	0.752/0.751 in.	0.752/0.751 in.
Stem hold diameter (reamed)	0.4365/0.436 in.	0.4365/0.436 in.
Wear limits, maximum diameter	0.438 in.	0.438 in.
Distance, top of guide to face of valve seat	2-9/64 in.	1-19/64 in.

(3) *Valves, intake.*

Overall length	6.9798/6.9548 in.
Stem diameter	0.4352/0.4344 in.
Wear limits, minimum diameter	0.4324 in.
Head diameter	1.520/1.510 in.
Seat angle	45°
Angle of valve face	45°
Stem clearance limit	0.0021/0.0008 in.
Wear limits, maximum clearance	0.0041 in.
Desired stem clearance	0.0015 in.

(4) *Valves, exhaust.*

Overall length	5.8079/5.7829 in.
Stem diameter	0.4325/0.4315 in.
Wear limits, minimum diameter	0.4295 in.
Head diameter	1.395/1.385 in.
Seat angle	45°
Angle of valve face	45°
Stem clearance limit	0.005/0.0035 in.
Wear limits, maximum clearance	0.007 in.
Desired stem clearance	0.004 in.

(5) *Valve springs.*

Outside diameter	1.302/1.282 in.
Wire gage	0.162 in.
Spring length, valve closed	1⅞ in.
Spring load, valve closed	58–64 lbs
Wear limits, minimum weight	52 lbs
Spring length, valve open	1.521 in.
Spring load, valve open	115–123 lbs
Wear limits, minimum weight	105 lbs

(6) *Camshaft.*

Bearing journal, diameter No. 1	1.9965/1.996 in.
Wear limits, minimum diameter	1.995 in.
Bearing journal, diameter No. 2	1.7465/1.746 in.
Wear limits, minimum diameter	1.745 in.
Bearing journal, diameter No. 3	1.684/1.6835 in.
Wear limits, minimum diameter	1.6825 in.
Cam lift	0.220 in.
Tappet clearance:	
Intake	0.014 in.
Exhaust	0.014 in.
Endplay	0.009/0.005 in.

(7) *Connecting rods.*

Length, center to center	9.502/9.498 in.
Bushing hole diameter	1.3753/1.3743 in.
Bearing hole diameter	2.6245/2.624 in.
Bearing thickness	0.06175/0.0615 in.
Wear limits, minimum thickness	0.0610 in.
Diameter crank pin	2.499/2.498 in.

Wear limits, minimum diameter	2.497 in.
Clearance limits	0.0035/0.0015 in.
Desired clearance	0.0025 in.
Wear limits, maximum clearance	0.0045 in.
Width at bearing end	1.804/1.802 in.
Desired side play	0.006 in. minimum

(8) *Main bearings.*

Diameter of bearing bore in block	3.0622/3.0615 in.
Bearing shell thickness	0.0929/0.0924 in.
Wear limits, minimum thickness	0.0919 in.
Diameter of main bearing journal	2.874/2.873 in.
Wear limits, minimum diameter	2.872 in.
Clearance limits	0.0035/0.0015 in.
Desired clearance	0.002 in.
Wear limits, maximum clearance	0.0045 in.
Crankshaft endplay	0.008/0.005 in.
Wear limits, maximum endplay	0.010 in.

(9) *Pistons.*

Actual inside diameter of sleeves	3.877/3.875 in.
Wear limits, maximum diameter	3.885 in.
Piston pin hole diameter	1.2500/1.2498 in.
Wear limits, maximum diameter	1.2502 in.
Ring groove diameter:	
1st	3.444/3.434 in.
2d and 3d	3.497/3.487 in.
4th	3.457/3.447 in.
5th	3.497/3.487 in.
Ring groove width:	
1st, 2d, and 3d	0.129/0.128 in.
Wear limits, maximum width	0.131 in.
4th	0.253/0.252 in.
Wear limits, maximum width	0.255 in.
5th	0.1905/0.1895 in.
Wear limits, maximum width	0.1925 in.
Ring land diameter:	
1st, 2d, and 3d	3.848/3.843 in.
4th	3.823/3.818 in.

(10) *Rings.*

Type of ring:	
1st, 2d, and 3d	Compression
4th and 5th	Ventilated oil
Ring width:	
1st	0.124/0.1235 in.
Wear limits, minimum width	0.1215 in.
2d and 3d	0.124/0.123 in.
Wear limits, minimum width	0.121 in.
4th	0.249/0.2485 in.
Wear limits, minimum width	0.2465 in.
5th	0.1865/0.186 in.
Wear limits, minimum width	0.184 in.

Ring thickness:	
1st	0.194/0.184 in.
2d, 3d, 4th, and 5th	0.167/0.157 in.
Ring gap clearance:	
1st, 4th, and 5th	0.017/0.007 in.
2d and 3d	0.017/0.009 in.
Ring side clearance:	
1st	0.0055/0.004 in.
Wear limits, maximum clearance	0.0075 in.
2d and 3d	0.005/0.003 in.
Wear limits, maximum clearance	0.0075 in.
4th and 5th	0.0045/0.003 in.
Wear limits, maximum clearance	0.0065 in.

(11) *Piston pins.*

Length	3.314/3.307 in.
Diameter	1.2500/1.2498 in.
Wear limits, minimum diameter	1.2495 in.
Desired fit	Light push
Bushing hole diameter finished	1.2504/1.2502 in.
Wear limits, maximum diameter	1.2514 in.
Pin clearance in bushing	0.0006/0.0002 in.
Desired pin clearance	0.0004 in.
Wear limits, maximum clearance	0.0016 in.
Length (bushing)	1.260/1.240 in.
Outside diameter (bushing)	press fit in 1.3753/1.3743 in. hole

b. Torque Specifications.

(1) *Cylinder head.*

⅜ in.	35–40
7/16 in.	70–75
½ in.	100–110
9/16 in.	130–140
⅝ in.	145–155

(2) *Main bearing caps and connecting rods.*

5/16 in.	20–25
⅜ in.	35–40
7/16 in.	70–75
½ in.	85–95
9/16 in.	100–110

(3) *Flywheel.*

5/16 in.	20–25
⅜ in.	35–40
7/16 in.	70–75
½ in.	85–95
9/16 in.	100–110
⅝ in.	145–155

(4) *Manifolds.*

5/16 in.	15–20
⅜ in.	25–30
7/16 in.	50–55
½ in	80–90
9/16 in.	100–110
⅝ in.	130–140

(5) *Gear covers, water pumps, front and rear end plates, oil pans.*

5/16 in.	15–20
⅜ in.	25–30
7/16 in.	50–55
½ in.	80–90

(6) *Flywheel housing.*

5/16 in.	15–20
⅜ in.	25–30
7/16 in.	50–55
½ in.	80–90
9/16 in.	115–125

223. Generator

The information furnished in this paragraph applies to the Kato a-c Generator Model 52MSSS, Type 2277 as furnished to the Corps of Engineers and described in paragraph 6*c*.

a. Stator.

Number of phases	3
Number of wires	10
Number of groups	3 alternate connected in series
Number of coils per group	3
Number of turns per coil	5 turns parallel of 8 No. 15 heavy formvar
Number of slots	54
Coil pitch	1–8

The resistance of 3 groups in series (one phase group such as from T1 to T4) is 0.050 at 25° C.

b. Rotor.

Number of poles	6 in series
Number of turns per pole	290 turns of No. 15 heavy formvar
Length of mean turn	21 inches
Field resistance	9.95 ohms at 25° C.

c. Exciter Field Coils.

Number of coils	4 in series
Number of turns per coil	1930 turns of No. 22 single formvar
Length of mean turn	16½ inches
Field resistance	170 ohms at 25° C.

d. Exciter Armature (Wave Wound).

Number of armature slots	39
Number of commutator bars	77
Number of coils	76 (+ one dead)
Number of turns per coil	7 turns of No. 16 S.C.C. or heavy formvar
Coil pitch	1–10 slots
Connection pitch	1–39 bars
Alinement	bar 1 with slot 13
Resistance	0.75 ohms at 25° C.

e. Miscellaneous.

Exciter brush size	¾ by ⅜ in.
Alternator brush size	⅝ by ⅜ in.
Brush spring tension	10 to 16 ounces
Rotor to stator air gap	0.050 inch all around
Generator bearing temperature rise	50° C. maximum

CHAPTER 5

SHIPMENT, LIMITED STORAGE, AND DEMOLITION TO PREVENT ENEMY USE

Section I. SHIPMENT AND LIMITED STORAGE

224. Limited Storage

a. Inspection. Refer to paragraph 38. 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 accumulated water, oil, or grease from inside the base of the set.

(3) Thoroughly clean off any rust or corrosion.

(4) Paint all parts on which the paint film has been damaged or removed. See paragraph 34.

c. Complete Lubrication. See paragraphs 32 and 33.

d. Protection in Storage.

(1) Drain and flush the cooling system. Add antifreeze according to table I. Protect to 15° below the lowest expected temperature. Check the freezing point of the coolant.

(2) Coat all exposed metal parts with a temporary preservative such as light engine oil or grease.

(3) In extremely cold climates, disconnect and remove the batteries (par. 95). Clean the battery terminals and cable lugs and apply a coating of vaseline to the terminals and lugs. Pack or store the batteries separately in a warm dry place. If the batteries are not used within a month, they must be given a booster charge to keep them ready for service. If the batteries remain in the generator set, keep them filled and fully charged at all times.

(4) Cover the generator set with a waterproof cover.

(5) Exercise the generator set at least once every 10 days. Run the set long enough to bring it up to operating temperature to assure complete lubrication of all bearings, gears, and the like.

(6) During this exercise period, inspect the generator set for any unusual condition such as damage, rusting, accumulation of water, pilferage, and leakage of lubricants, fuels or coolants.

(7) Perform a technical inspection on the generator set every 30 days.

225. Domestic Shipment

a. General.

(1) For short distance shipping and immediate reuse, refer to paragraph 19. In addition, cover the set with a waterproof covering.

(2) To prepare the generator set for shipment involving an idle time of not more than 30 days, refer to paragraph 224.

b. Crating

(1) Cover the unit with a waterproof bag or paper, and bolt the generator set to wooden skids at least 2-by 6-inches.

(2) Construct a crate with diagonal bracing.

(3) Pack the batteries separately in closed, braced cases which will prevent movement of the batteries, and secure inside the generator crate. Mark the cases so they will always be secured right side up.

(4) Pack the battery electrolyte in separate cases but do not secure inside the generator crate.

c. Hoisting and Blocking

(1) *Hoisting.* Attach the slings to the lifting points marked on the crate. Lift the crated generator set with a hoist of at least 2-tons capacity.

Caution: Do not let the set swing and strike personnel or any solid object. Lower gently to the bed of the carrier.

(2) *Blocking.* Spike wedge-shaped blocking to the skid beams and bed of the carrier at each end of the crate to prevent forward or back movement. Place planks lengthwise to the skid beams and spike to the carrier bed to prevent lateral movement. Tie down the crated set to the carrier with straps in at least two places. The cases of electrolyte are secured in a similar manner.

Section II. DEMOLITION OF GENERATOR SET TO PREVENT ENEMY USE

226. 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. Based on this decision, orders are issued which cover the desired extent of destruction. Whatever method of demolition is employed, it is essential to destroy the same vital parts of all generator sets and all corresponding repair parts.

227. Preferred Demolition Methods

Explosives and mechanical means, either alone 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. Explosives (fig. 119). 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 injector pump and the engine block, and a ½-pound charge at each nozzle holder assembly.

(2) A 4-pound charge on the alternator shaft. Insert the charge through the inspection openings.

Note. The above charges are the minimum requirement for this method.

(3) A 1-pound charge behind the switchboard panel.

(4) A 1-pound charge on the starter, charging generator, and water pump.

(5) A ½-pound charge on the engine heater.

b. 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 injector pump, injection tubes, and nozzle holders.

(2) The sliprings, brush holders, and generator windings.

Note. The above steps are the minimum requirement for this method.

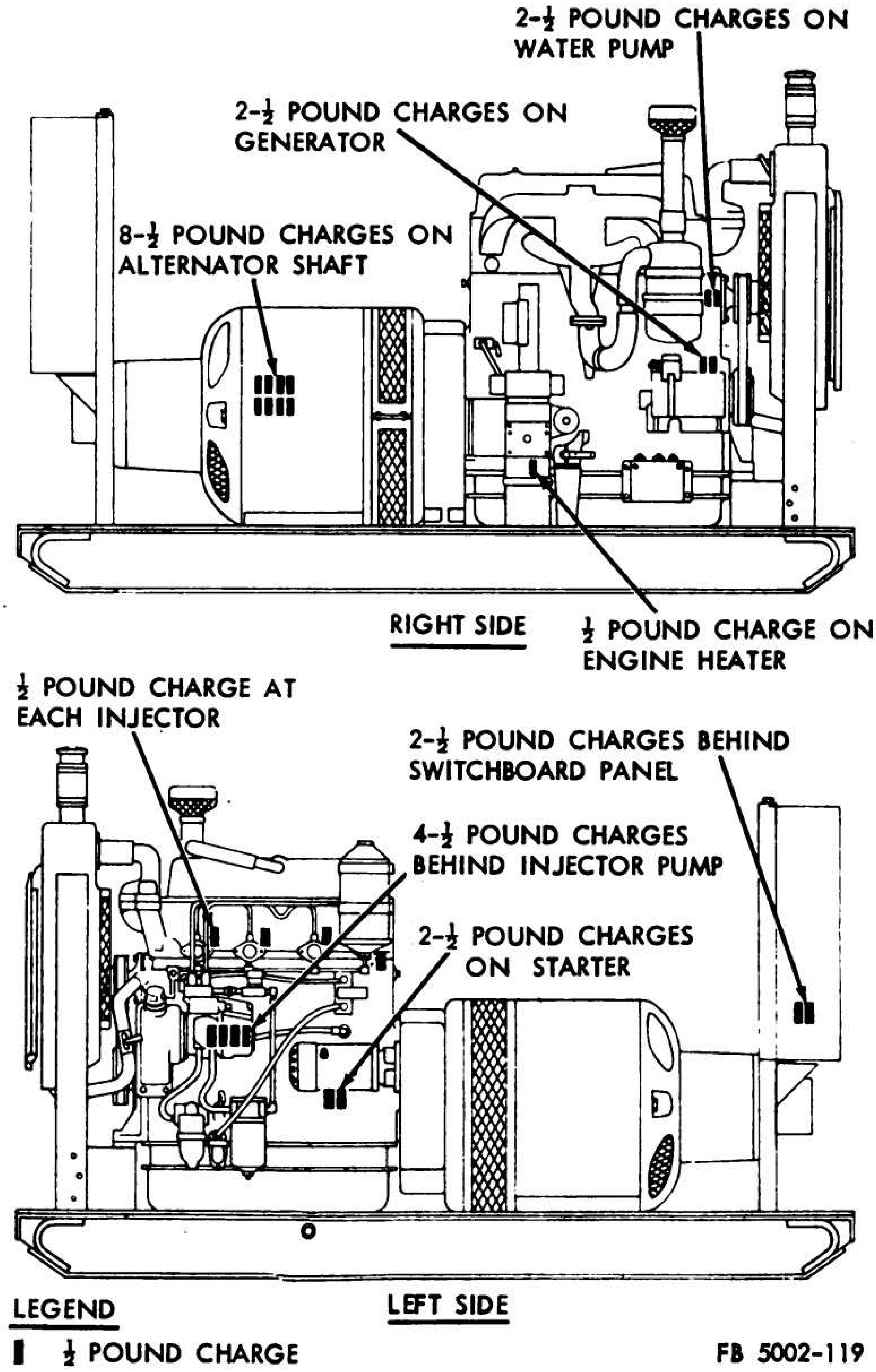


Figure 119. Placement of charges.

(3) All switches and instruments on the switchboard panel and the wiring.

(4) The radiator core, batteries, and engine block.

(5) The engine heater, ducts, and oil pan shroud.

228. Other Demolition Methods

a. Weapons Fire. Fire on the generator set with the heaviest weapons available. Direct fire at both engine and generator.

b. Scattering and Concealment. Remove all easily accessible parts such as the injector pump, nozzle holders, alternator 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. Burning. Pack rags, clothing, or canvas under and around the unit, and inside the alternator and exciter. 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. 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. Misuse. Perform the steps listed below to make the unit inoperative.

(1) Remove the fuel solenoid relay and connect the fuel line directly to the injector pump.

(2) Drain the radiator and oil pan.

(3) Expose the inspection openings of the generator.

(4) Start the engine.

(5) Drop small tools, bolts, nuts, or metal scraps into the generator.

(6) Set the throttle so that the engine will run at maximum speed until failure occurs, and abandon the unit.

229. 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, when 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. Accessory Equipment

TM 5–687 Inspection and Preventive Maintenance Services for Fire Protection Equipment and Appliances.

TM 9–1799 Ordnance Maintenance: Fire Extinguishers.

2. Dictionaries of Terms and Abbreviations

SR 320–5–1 Dictionary of United States Army Terms.

SR 320–50–1 Authorized Abbreviations.

3. Lubrication and Painting

LO 5–5002 Generator Set, Portable, Diesel Driven, Skid Mounted, 15-KW, 120/208 or 240/416-Volt, 3-Phase, 60-Cycle, Convertible to 120/208 or 240/416-Volt, 3-Phase, 50-Cycle, Consolidated Diesel Electric Model 1664.

TM 9–2851 Painting Instructions for Field Use.

4. Preparation for Export Shipment

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 Engineer Equipment.

5. Preventive Maintenance

TB 5–5002–1 Preventive Maintenance Services: Generator Set, Portable, Diesel Driven, Skid Mounted, 15-KW, 120/208 or 240/416-Volt, 3-Phase, 60-Cycle, Convertible to 120/208 or 240/416-Volt, 3-Phase, 50-Cycle, Consolidated Diesel Electric Model 1664.

TM 5–505 Maintenance of Engineer Equipment.

6. Publication Indexes

DA Pam 108–1 Index of Army Motion Pictures, Television Recordings and Film Strips.

DA Pam 310–3 Index of Training Publications.

DA Pam 310–4 Index of Technical Manuals, Technical Regulations, Technical Bulletins, Supply Bulletins, Lubrication Orders, and Modification Work Orders.

DA Pam 310–25 Index of Supply Manuals . . . Corps of Engineers.

SR 310–20–6 Index of Blank Forms.

7. Supply Manuals

ENG 1 Introduction.

8. Training Aids

FM 21–8 Military Training Aids.

APPENDIX II

IDENTIFICATION OF REPLACEABLE PARTS

1. General

The data in this appendix are not to be used as a basis for requisitioning spare parts. Refer to Department of the Army Supply Manual ENG 7 and 8–5002 for parts available through supply channels.

2. Standard Hardware

Section I contains a listing of standard hardware used in the generator set. The hardware is arranged alphabetically by noun name and in ascending order according to size.

3. Parts List

Section II is a listing of parts used in the generator set, less standard hardware. The parts are arranged by noun name in the order they appear in illustrations of the manual.

Section I. STANDARD HARDWARE

Part nomenclature	Quantity per unit	Part nomenclature	Quantity per unit
ELBOW, pipe, ¼ in.	5		
KEY, woodruff:		(continued)	
No. 5	2	No. 10 x 5/16 in. NF	1
No. 25	1	No. 10 x 3/8 in. NC	6
NIPPLE, pipe, ¼ x 3½ in.	1	No. 10 x ½ in. NF	3
NUT, hex, S:		No. 10 x ¾ in. NC	1
No. 10 NC	4	¼ x 3/8 in. NC	2
No. 10 NF	2	¼ x ½ in. NC	8
¼ in. NC	6	SCREW, set, hex-socket, S:	
¼ in. NF	2	No. 10 x ¼ in. NC	4
3/8 in. NC	3	¼ x ¼ in. NC	2
3/8 in. NF	1	SCREW, set, hdls, cup-pt,	
NUT, square, S:		sltd, S:	
No. 10 NC	1	No. 10 x ¼ in. NF	1
No. 10 NF	1	WASHER, lock, Shakeproof,	
NUT, wing, brass, No. 10 NC	1	int-ext-teeth, S:	
PIN, cotter, split, S:		No. 10	14
1/16 x ½ in.	4	¼ in.	10
3/32 x ¾ in.	3	5/16 in.	4
SCREW, cap, hex-hd, S:		3/8 in.	8
No. 10 x 7/8 in. NF	8	WASHER, lock, Shakeproof,	
No. 10 x 1 in. NC	1	int-teeth, S:	
¼ x ¾ in. NC	1	No. 8	6
5/16 x 1¾ in. NC	4	¼ in.	2
3/8 x 1¾ in. NC	8	½ in.	4
3/8 x 2 in. NC	8	WASHER, lock, spring, S:	
½ x 1½ in. NC	4	No. 6	8
½ x 5½ in. NC	4	No. 8	6
SCREW, mach, fil-hd, S:		No. 10	32
No. 10 x 5/8 in. NF	16	3/16 in.	8
No. 10 x 1½ in. NF	1	¼ in.	7
SCREW, mach, fl-hd, S:		5/16 in.	4
No. 10 x ¾ in. NC	3	3/8 in.	24
No. 10 x 1 in. NF	4	½ in.	10
SCREW, mach, rd-hd, S:		5/8 in.	2
No. 6 x ¼ in. NC	4	WASHER, plain, S:	
No. 6 x 5/8 in. NC	4	3/8 in.	3
No. 8 x ¼ in. NC	2	5/8 in.	2
No. 8 x 3/8 in. NC	8		

Section II. PARTS LIST

Fig. No.	Index No.	Corps of Engineers stock No.		End item mfg. part No. and/or prime mfg. part No.		Fed. commodity class and item ident. No.	Part nomenclature	Quantity per unit
1	4	178	664–327	178	664–327		RECEPTACLE	1
3	10	178	664–157	178	664–157		PANEL, switchboard, main	1
4	10	178	664–158	178	664–158		PANEL, switchboard, door section	1
	11	178	664–159	178	664–159		PANEL, switchboard, engine control	1
	16	178	664–66	178	664–66		BLOCK, terminal	1
	25	178	664–187	178	664–187		LIGHT ASSEMBLY	2
9	1	178	664–171	178	664–171		RESISTOR, 4,000 ohm, 10 watt	2
	2	178	664–199	178	664–199		RELAY, safety control	2
	3	178	664–219	178	664–219		RESISTOR, 10 ohm, 50 watt, side wire, w/bracket.	1
	4	178	664–182	178	664–182		RELAY, time delay	1
	5	178	664–175	178	664–175		PANEL, voltage regulator	1
	12	178	664–161	178	664–161		CIRCUIT BREAKER, main	1
	17	178	664–220	178	664–220		RESISTOR, 500 ohm, 25 watt, w/bracket	1
	23	178	664–197	178	664–197		RESISTOR, 10 ohm, 50 watt, cross current compensator.	1
10	1	178	664–160	178	664–160		METER, time, electric	1
	2	178	664–166	178	664–166		FREQUENCY METER, dual scale	1
	3	178	664–180	178	664–180		AMMETER, dual scale	1
10	4	178	664–181	178	664–181		VOLEMETER, dual scale	1
	5	178	664–174	178	664–174		RHEOSTAT, regulator	1
	7	178	664–185	178	664–185		RECEPTACLE, 2 pole, 135v	2
	8	178	664–186	178	664–186		RECEPTACLE, 3 pole, 125v	2
	12	178	664–195	178	664–195		RECEPTACLE, trouble light	1
	16	178	664–164	178	664–164		SWITCH, toggle	1

	17	178	664–163	178	664–163		SWITCH, toggle	1
	18	178	664–163	178	664–163		SWITCH, toggle	1
	19	178	664–167	178	664–167		LIGHT	1
	20	178	664–162	178	664–162		SWITCH, push	1
	21	178	664–179	178	664–179		SWITCH, toggle	1
	22	178	664–165	178	664–165		SWITCH, toggle	1
	23	178	664–192	178	664–192		RHEOSTAT, exciter field	1
	24	178	664–176	178	664–176		GAGE, pressure, dial indicating, oil pressure	1
	25	178	664–178	178	664–178		AMMETER	1
	26	178	664–177	178	664–177		GAGE, water temperature	1
	27	606	XA456E	617	F226M–213		SWITCH, push	1
19	1				664–119		SCREW, w/nut and lockwasher	53
	2	178	664–108	178	664–108		HOUSING, door, switch board, w/handle and hinge.	1
	3						SCREW	4
	4	178	664–104	178	664–104		PANEL ASSEMBLY, access, rear	1
	5	178	664–101	178	664–101		HOUSING, corner post, rear, left	1
	6	178	664–103	178	664–103		BOLT, w/nut and lockwasher	6
	7	178	664–97	178	664–97		HOUSING, top	1
	8	178	664–116	178	664–116		HOUSING, door, left rear lower, w/hinge and handle.	1
	9	178	664–115	178	664–115		HOUSING, door, left rear top, w/hinge	1
	10	178	664–132	178	664–132		BAR, door latch, center	2
	11	178	664–99	178	664–99		HOUSING, center post	2
	12	178	664–113	178	664–113		HOUSING, door, left front top, w/hinge	1
	13	178	664–124	178	664–124		SPRING, retaining, ventilating door	2
	14	178	664–123	178	664–123		DOOR ASSEMBLY, ventilating, w/hinge and retaining cam.	2
	15	178	664–114	178	664–114		HOUSING, door, left front lower, w/hinge and handle.	1
	16	178	664–133	178	664–133		BRACKET, latch bar to corner posts	2
	17	178	664–131	178	664–131		BAR, door latch, front	4

Fig. No.	Index No.	Corps of Engineers stock No.		End item mfg. part No. and/or prime mfg. part No.		Fed. commodity class and item ident. No.	Part nomenclature	Quantity per unit
19	18	178	664-92	178	664-92		HOUSING, front	1
	19	178	664-95	178	664-95		TOOL BOX, with latch	1
	20	178	664-96	178	664-96		SCREW, tool box	7
	21				664-120		SCREW, w/nut and lockwasher	28
	22	178	664-127	178	664-127		RUBBER STRIP, 16 ft.	1
	23	178	664-137	178	664-137		SKIRT, housing	3
	23	178	664-138	178	664-138		SKIRT, housing	1
	24	178	664-126	178	664-126		RUBBER STRIP, 60 ft.	1
	25	178	664-110	178	664-110		HOUSING, door, right front lower, w/hinge and handle.	1
	26	178	664-112	178	664-112		HOUSING, door, right rear lower, w/hinge and handle.	1
	27	178	664-102	178	664-102		HOUSING, corner post, rear, right	1
	28	178	664-111	178	664-111		HOUSING, door, right rear top, w/hinge	1
	29	178	664-134	178	664-134		BOLT, w/nut and lockwasher	8
	30	178	664-128	178	664-128		FASTENER, door	5
	31	178	664-129	178	664-129		PIN, cotter	5
	32	178	664-130	178	664-130		WASHER, flat	5
	33	178	664-93	178	664-93		SHUTTER, radiator	1
	34	178	664-98	178	664-98		BOLT, w/nut and lockwasher, No. 10 x ½ in.	9
	35				664-94		SCREW, w/nut and lockwasher	12
	36	178	664-109	178	664-109		HOUSING, door, right front top, w/hinge	1
	37	178	664-100	178	664-100		BOLT, w/nut and lockwasher	4
22	3	178	664-290	178	664-290		SOLENOID, fuel shutoff	1
	8	178	664-41	178	664-41		BRACKET, lube oil filter	1
	9	178	664-43	178	664-43		BOLT, machine, w/nut and lockwasher	3
	23	699	F360-2X2T2	178	GD157F-202		FILTER, fuel	1

23	1	178	664–278	178	664–278		CAP, fuel tank	1
	2	178	664–277S	178	664–277S		STRAINER, fuel	1
	3	178	664–153	178	664–153		SEAL, fuel tank filler neck	1
	5	178	664–318	178	664–318		ELBOW, pipe to tube, $\frac{1}{4}$ x $\frac{3}{8}$ in.	1
	6	178	664–277	178	664–277		TANK, diesel fuel	1
	7				664–280		PLUG, drain, $\frac{1}{4}$ in.	1
	8	178	664–279	178	664–279		VALVE, air vent	1
24	16	699	F6X12T2	699	F6X12T2		FILTER ELEMENT	1
25		097	F1125APBT4	617	HD260F–4090		FILTER, oil	1
	1						SCREW, cap, hex-hd	4
	2						WASHER, lock	4
	3						BRACKET, secondary filter	1
	4						PLUG, pipe	2
	5						SCREW, cap	1
	6	097	101487	097	101487		GASKET, cap screw	1
	7						HEAD	1
	8	097	5739	097	5739		FILTER ELEMENT	1
	9						WASHER	1
	10						GROMMET	1
	11						WASHER	1
	12						SPRING	1
	13						BODY	1
26	21	617	RD6F2380	617	RD6F–2380		PUMP	1
	23	617	HD260F336	617	HD260F–336		BRACKET	1
35	1	178	664–5	178	664–5		TUBE, overflow	1
	2	178	664–4	178	664–4		CAP, radiator, pressure type	1
	3	178	664–3	178	664–3		NECK, filler	1
	4	178	664–151	178	664–151		SEAL, filler neck	1
	5				664–8		CLAMP, $2\frac{3}{4}$ in. od	2
	6	178	664–7	178	664–7		EXTENSION, hose, filler neck	1
	7	178	664–16	178	664–16		CLAMP, $1\frac{7}{8}$ in. od	2
	8	178	664–13	178	664–13		HOSE, inlet	1

Fig. No.	Index No.	Corps of Engineers stock No.		End item mfg. part No. and/or prime mfg. part No.		Fed. commodity class and item ident. No.	Part nomenclature	Quantity per unit
35	9				664–16		CLAMP, 1⅞ in. od	4
	10				664–14		HOSE, outlet	2
	11				664–17		TEE, radiator, outlet	1
	12						ELBOW, street	1
	13						VALVE, shutoff	1
	14	178	664–11	168	664–11		BOLT, machine	12
	15	178	664–10	178	664–10		BASE, left	1
	16						GASKET, outlet elbow	1
	17						ELBOW, radiator outlet	1
	18						SCREW	2
	19						WASHER, lock	2
	20	178	664–12	178	664–12		WASHER, flat	12
		178	664–18	178	664–18		DRAIN, radiator (includes items 21–26)	1
	21				664–18C		NIPPLE, pipe, ½ in.	1
	22				664–18A		ELBOW, street, ½ in.	1
	23				664–18B		ELBOW, 90°, ½ in.	1
	24				664–18E		NIPPLE, pipe, ½ x 5 in.	1
	25				664–18D		COUPLING, straight, ½ in.	1
	26				664–18F		PLUG, pipe, ½ in.	1
	27	178	664–9	178	664–9		BASE, right	1
	28	178	664–2	178	664–2		RADIATOR ASSEMBLY, w/guard (includes items 29, 47).	1
	29						GUARD, fan, right	1
	30						GASKET, thermostat	1
	31	178	664–19	178	664–19		THERMOSTAT, radiator shutter	1
	32						WASHER, lock	6
	33						SCREW, mounting, thermostat	6

35	34	178	664–21	178	664–21		BRACKET, shutter control	1
	35						WASHER, lock	2
	36						SCREW, control bracket	2
	37	178	664–20	178	664–20		CONTROL, manual shutter	1
	38						WASHER, plain	1
	39						NUT, hex	1
	40						NUT, hex	2
	41						BLOCK, connector	1
	42						CLAMP	1
	43						PIN, cotter	1
	44						WASHER, plain	1
	45						GUARD, fan, left	1
	46						WASHER, lock	8
	47						SCREW, fan guard mounting	8
40	5	ORD		178	664–319		BATTERY, 12 volt	2
	9	178	664–322	178	664–322		COVER, box	1
	12	178	664–321	178	664–321		BATTERY BOX	1
42	7	606	VRV7002AT	617	HD260M–308		REGULATOR, voltage	1
45	7	606	WSE4101A	617	RD6M–405		RELAY, solenoid	1
47		097	F31P2	617	HD260L–5000	426–2011	FILTER ASSEMBLY, oil	1
	1				11580		SCREW,cap	1
	2				11581		GASKET, cap screw	1
	3	097	C31P2				FILTER ELEMENT	1
	4				5214		BODY ASSEMBLY, filter	1
	5				11584		PLUG, drain	1
	6				102153		STRAP	2
	7				12384		NUT	2
	8						SCREW, w/nut and lockwasher	4
	9				10113		WASHER, lock	2
	10				12420		BOLT	2
	11	097	11582	097	11582		GASKET, cover	1
	12				11583		SPRING, cover	1

Fig. No.	Index No.	Corps of Engineers stock No.		End item mfg. part No. and/or prime mfg. part No.		Fed. commodity class and item ident. No.	Part nomenclature	Quantity per unit
47	13				11559		COVER	1
49	1	617	A600B302	617	A600B-302		REINFORCEMENT, handhole	1
	2				A600B-214		GASKET	1
	3				H260B-320		GASKET, oil pan	1
	4	617	H260B5010	617	H260B-5010		PAN ASSEMBLY, oil	1
	6	617	15XX3942	617	15X-X-3942		SCREW	18
	7	617	X4002	617	X-4002		STUD, oil strainer	6
	10				H260L-3040		SCREEN ASSEMBLY, oil strainer	1
	11				A600B-211		GASKET	1
	12	178	664-22	178	664-22		NIPPLE, oil drain	1
51		617	H260L5001	617	H260L-5001		PUMP ASSEMBLY, oil (includes items 8-14, 21-28).	1
	1				X-3056		SCREW, 1/4 x 5/8 in. NC	1
	3	617	H260L4000	617	H260L-4000		TUBE AND COVER ASSEMBLY, oil strainer	1
	4	617	X5035	617	X-5035		CONNECTOR, inlet tube	1
	5	617	H260L215	617	H260L-215		ELBOW, inlet tube	1
	6	617	X5067	617	X-5067		NIPPLE, pump inlet tube	1
	7				X-14227		WASHER, felt	1
	8	617	6TG101	617	6TG-101		PIN, straight, headless	1
	9				H260L-5002		BODY, oil pump	1
	10	617	H260G-200	617	H260G-200		BUSHING	2
	11				H260L-205		SHAFT, drive, oil pump	1
	12				X-504		KEY	2
	13				H260H-301		GEAR, drive, oil pump	1
	14				X-2211		PLUG, Hubbard	2
	15	617	VT3298	617	VT-3298		VALVE	1
	16	617	F400L219	617	F400L-219		SPRING	1

51	17	617	VT3221	617	VT-3221		RETAINER, relief valve		1
	18	617	X2901	617	X-2091		SCREW, 9/16 x 4½ in. NC		2
	19	617	5XX14230	617	5X-X-14230		WASHER, plain		2
	20	617	X619	617	X619		PIN, cotter		1
	21				X-1756		PIN, oil pump to bearing cap		1
	22				H260H-200		GEAR, driver, oil pump		1
	23				D600L-204		RING, snap		1
	24				H260L-206		STUD, oil pump idler gear		1
	25				H260H-201		GEAR, idler, oil pump		1
	26				H260L-207		GASKET		1
	27				H260L-203		COVER, oil pump		1
	28				X-3088		SCREW, ¼ in. NC		6
	57	1	664-36	178	664-36		BRACKET, muffler		1
	2	178	664-32	178	664-32		MUFFLER		1
	3	178	664-34	178	664-34		ELBOW, exhaust line		1
	4	178	664-35	178	664-35		SHIELD, exhaust		1
	[1] 5-15								
	16	178	664-33	178	664-33		NIPPLE, exhaust line		1
	17	178	664-37	178	664-37		BOLT, machine, w/nut and lockwasher		3
58	1				R600K-231		CLAMP, 1⅜ in. id		2
	2	ORD	H0070100180		X-2448		HOSE	(2)	
	3	789	6427	617	H260F-211		CAP, air cleaner inlet		1
	4	617	H260F4060	617	H260F-4060		LINE ASSEMBLY, air cleaner inlet		1
	5	617	X2399	617	X-2399		CLAMP		4
	6	617	X2449	617	X-2449		LINE ASSEMBLY, inlet tube to air cleaner		1
		789	G55	617	H260F204		AIR CLEANER (includes items 7, 11-17)		1
	7						BODY		1
	8						SCREW		4
	9	789	6094	617	H260F-206		BRACKET, saddle		1
	10						SCREW		1

[1] For identification of items 5-15 refer to figure 97, items 27-37
[2] Feet as required.

Fig. No.	Index No.	Corps of Engineers stock No.		End item mfg. part No. and/or prime mfg. part No.		Fed. commodity class and item ident. No.	Part nomenclature	Quantity per unit
58	11						BRACKET, air cleaner	1
	12						FILTER	1
	13						CHAMBER, vortex	1
	14						CUP	1
	15						SCREW	1
	16						WASHER, lock	1
	17						NUT	1
	18	178	664-39	178	664-39		HOSE, air cleaner, 2 in. right angle	2
	19				664-40		CLAMP, 2¼ in. id	4
	20						TUBE, outlet	1
	21						WASHER, lock	1
	22						NUT	1
	23						WASHER, lock	4
	24						NUT	4
59		178	664-337	178	664-337		HEATER ASSEMBLY, flame	1
	1						SCREW, mounting, inlet elbow	2
	2						WASHER, lock	2
	3	617	H260F405	617	H260F-405		ELBOW, manifold inlet	1
	4						GASKET, air heater body	1
	5	178	RD6F301	178	RD6F301		BODY, air heater	1
	6						ELBOW, fuel inlet	1
	7						WASHER, lock	4
	8						SCREW, mounting, heater body	4
	9	178	RD6F241	178	RD6F-241		GASKET, copper	1
	10	178	RD6F240	178	RD6F-240		GASKET, copper	1
	11	178	RD6F212	178	RD6F-212		SPARK PLUG, air heater	1
	12	178	RD6F237	178	RD6F-237		NUT, retainer, spark plug	1

	13	178	RD6F213	178	RD6F-213		SCREW ASSEMBLY, air heater spark electrode.	1
	14	178	RD6F214	178	RD6F-214		SPRING, filter	1
	15	178	RD6F215	178	RD6F-215		FILTER, air heater	1
	16	178	X14237	178	X-14237		WASHER, special	1
	17	178	RD6F216	178	RD6F-216		BODY, nozzle	1
	18						PLUG, pipe	1
61	1	178	664-360	178	664-360		CAP, heater fuel tank	1
	1	178	664-154	178	664-154		SEAL, heater fuel tank filler neck	1
	3	178	664-359	178	664-359		TANK, fuel, heater	1
	4						SCREW, mach, rd-hd	4
	5						WASHER, lock	4
	6						NUT	4
	7						ELBOW, street	1
	8						NIPPLE, pipe	1
	9						ELBOW, 90°	1
	10						ELBOW, street	1
		178	664-361	178	664-361		STRAINER, fuel, metal bowl	1
	11						HEAD	1
	12						CONNECTOR, male	2
	13						GASKET	1
	14						SCREEN	1
	15						BOWL, metal	1
	16						BAIL ASSEMBLY	1
	17	178	664-365	178	664-365		TUBING, ¼ in.	1
	18	178	664-331	178	664-331		HEATER, engine	1
	19						VALVE, shutoff	1
62					C2959-G6		BLOWER AND MOTOR ASSEMBLY, 24v (includes items 1-3, 53-55).	1
	1				B2355-G6		MOTOR, blower, 24v w left scroll	1
	2				A3106		WHEEL ASSEMBLY, blower	1
	6				C4031-1		TOP ASSEMBLY, combustion chamber	1

Fig. No.	Index No.	Corps of Engineers stock No.		End item mfg. part No. and/or prime mfg. part No.		Fed. commodity class and item ident. No.	Part nomenclature	Quantity per unit
62	8				18–8		FASTENER, rd-hd, No. 10 x ⅜ in.	12
	9	916	C3121–1	916	C3121–1		EXCHANGER ASSEMBLY, heat	1
	12				C3003–G1		CHAMBER ASSEMBLY, combustion, complete (includes items 10 (2 only), 13, 14, 21, 22).	1
	14				A2001		NUT, thumb screw	2
					D3002–G5		BURNER ASSEMBLY, complete (includes items 8 (8 only), 13 (2 only), 15–20, 23–25, 32–34, 37–46, 56–69).	1
	15	916	A2312	916	A2312		WICK ASSEMBLY, burner	1
	17				B3194		THROAT, burner	1
	18				A2297		PACKING, burner	2
	19				B10440		SHIELD ASSEMBLY, igniter	1
	20	916	D4146–1	916	D4146–1		BURNER ASSEMBLY	1
	22				A3062–1		SCREW, thumb	2
	23				A2305		RETAINER, resistor	2
	24				A2306		SPRING	2
	25				COMM		NUT, acorn, brass, No. 10 NC	2
	26				A4675		GASKET, resistor	1
	27	916	B2357G2	916	B2357–G2		RESISTOR, burner igniter	1
	28				A3688		JUMPER ASSEMBLY, wire	1
	31				A1620		NUT, igniter	1
	32				A3125–G1		CAP ASSEMBLY, pipe	1
	33				A3099		SPRING, feed chamber valve	1
	34				A4000		PLUNGER, feed chamber valve	1
	35	916	B1613G2	916	B1613–G1		IGNITER ASSEMBLY, complete	1
	36				A1624		GASKET, igniter	1

	37				A3133		PLUG, float chamber	1
	38				A5675		WICK, feed	1
	39				B5644-1		HOLDER ASSEMBLY, wick	1
	40				A3075		GASKET, felt	1
	41				B3134-1		COVER AND BRACKET ASSEMBLY	1
	42				COMM		SCREW, set, cup-pt, hdls, sltd, No. 10 NF	2
	43				A3053		LEVER ASSEMBLY, operating	1
	44				A3054		PIN, operating lever	2
	45				A3046		WASHER, fiber	2
	46				A3080-1		CLAMP, cable	1
	47				A3173		SWITCH ASSEMBLY	1
	48				B3111		CABLE ASSEMBLY, control	1
	49						CABLE, switch to motor	1
	52						CABLE, switch to resistor	1
	53				B2964		SCROLL ASSEMBLY, right half	1
	56				A3083		BOLT, inlet fitting	1
	57				A3092		TEE, special	1
	58				COMM		WASHER, fiber, No. 10	4
	59	916	B3117	916	B3117		VALVE ASSEMBLY, float	1
	60	916	B4016	916	B4016		GASKET, cover	1
	62				A2996-1		SPRING, operating lever	2
	63				A3036		SPRING, overflow valve	1
	64				A4002		PLUNGER ASSEMBLY, overflow valve	1
	65				A3068		GASKET, tube	1
	66				A3067		TUBE, overflow	1
	67				A3047		GASKET, fiber	2
	68	916	A3044	916	A3044		STRAINER	1
	69				A3077		LEVER ASSEMBLY, locking	1
	70				A3170		NUT, switch	1
	71				A3171		NUT, switch	1
70		178	664-73	178	664-73		TRANSFORMER	5
	1	178	664-75	178	664-75		COVER	1

Fig. No.	Index No.	Corps of Engineers stock No.		End item mfg. part No. and/or prime mfg. part No.		Fed. commodity class and item ident. No.	Part nomenclature	Quantity per unit
70	3	178	664–77	178	664–77		PANEL, changeover	1
	5	178	664–74	178	664–74		BOX	1
71	1	178	664–135	178	664–135		FRAME ASSEMBLY, w rear latch bars	1
	2						SCREW	2
	3	178	664–140	178	664–140		BOLT, eye	1
	4	178	664–136	178	664–136		FRAME, w lifting eye nut	1
	5	178	664–139	178	664–139		BOLT, machine, ⅝ x 1 in. w nut and lockwasher.	8
	6	178	664–91	178	664–91		BASE, skid	1
	7	178	664–117	178	664–117		PAN, splash, front	1
	8	178	664–121	178	664–121		SCREW	4
	9	178	664–141	178	664–141		SCREW, w nut and lockwasher, ½ x 1½ in.	2
	10	178	664–134	178	664–134		BOLT, w nut and lockwasher	4
	11	178	664–132	178	664–132		BAR, door latch, center	2
	12	178	664–117A	178	664–117A		PAN, splash, rear	1
	13	178	664–248	178	664–248		SCREW, w nut and lockwasher, ⅜ x 2 in., USS, mounts.	16
	13	178	664–249	178	664–249		SCREW, w nut and lockwasher, ⅜ x 2 in., USS, mounts.	4
72		616	H260K3171	617	H260K–4111		PUMP ASSEMBLY, water (includes items 1–9, 13–23).	1
	2				H260K–3000		IMPELLER ASSEMBLY	1
	3	617	VTA–804	617	VTA–804		SEAL ASSEMBLY	1
	4				H260K–204		GASKET	1
	5				H260G–202		BUSHING	1
	6				H260K–411		SUPPORT	1

		617	H260K-2001	617	H260K-2001		SHAFT AND BEARING ASSEMBLY (includes items 7, 19).	1
	7				VT-3326		SLINGER	1
	8				15X-X-201		WASHER, lock	6
	9				15X-X-1800-C		NUT	6
	10	617	F226K213	617	F226K-213		BLADE, fan, pusher-type	1
	11	617	15XX3168	617	15XX-3168		SCREW	4
	13	617	X-3938	617	X3938		SCREW	2
	15	617	8UK-205	617	8UK-205		LOCKNUT, belt adjusting	2
	16	617	12AK203	617	12AK-203		FLANGE, belt	1
	17				H260K-312		HUB, fan	1
	18				VT-3327		RING, snap, retainer	1
	19				H260K-200		SHAFT ASSEMBLY	1
	20				2X-X-200		WASHER, lock	1
	21				X-18272		NUT, No. 10 NC	1
	22	617	X5717	617	X-5717		SCREW	1
	23				15X-X-1904-B		STUD	6
	24	617	J382K200	617	J382K-200		SPACER, fan blade	1
73		606	GHG6001AT	606	GHG-6001AT		GENERATOR	1
	1				GGW-1024B		BAND, cover	1
					GHG-2002S		HEAD, commutator end, assembly (includes items 2, 3, 4 (1 only), 5, 38, 40, 41).	1
	2				GAL-40E		COVER, bearing	1
	3	606	GGU38A	606	GGU-38A		BEARING, plain, sleeve	1
	4				X-489A		CUP, oil	2
	5				GGW-1002E		HEAD ASSEMBLY, partial (includes items 3, 40, 41).	1
					GHG-2001S		FRAME AND FIELD ASSEMBLY (includes items 8-22, 43, 44).	1
	8						LEAD, electrical	1
	9						TERMINAL	1
	10						STUD, terminal, armature	1

Fig. No.	Index No.	Corps of Engineers stock No.		End item mfg. part No. and/or prime mfg. part No.		Fed. commodity class and item ident. No.	Part nomenclature	Quantity per unit
73	11						STUD, terminal, field	1
	12						PIN, dowel	2
	13						INSULATOR, bushing	2
	14						INSULATOR, washer	2
	15						WASHER, plain	2
	21						FRAME, field	1
	22						SCREW, pole shoe	2
	23				GBM-21C		NUT, armature shaft	1
	24				12X-864		LOCKWASHER, shaft	1
	25				SP-1936A		PULLEY, drive	1
		606	GGW-1003B	606	GGW-1003B		END BRACKET, electrical rotating equipment (includes items 4 (1 only), 19 (3 only), 26-33).	1
	26				GGW-3B		HEAD, drive end	1
	27				GG-164A		WASHER, felt	2
	28				GBM-128A		RETAINER, felt washer, outer	1
	29	522	203K	606	X-295	144-8505	BEARING, ball, annular	1
	30	606	GBM124	606	GBM-124		GASKET	1
	31				GBM-125A		RETAINER, felt washer, inner	1
	32				GBM-127A		RETAINER, bearing	1
	34				GR-32B		RETAINER, felt washer	1
	35				GAR-171A		RING, retaining	1
	36	606	GHG2006FT	606	GHG-2006FT		ARMATURE (includes item 35)	1
	37				GK-20C		BOLT, through	2
	38				GGW-41		WICK, felt	1
	40				GGY-45A		SPRING, brush	2
	41				GCJ-26B		ARM, brush	2

	42	606	GFL2012AS	606	GFL–2012AS		BRUSH SET, electrical contact		1
	43						SHOE, pole		2
	44	606	GHG1005		GHG–1005		WINDING ASSEMBLY, field		1
77		606	MCC4002T	617	HD260M–400		STARTER, engine, electrical		1
	1				MBD–1024L		BAND, cover		1
	3				GAL–40F		COVER, bearing		1
	4				MAD–110		FELT		1
		606	MBD2236E	606	MBD–2236E		END BRACKET, electrical rotating (includes items 5–11, 29 (4 only), 37 (4 only), 38).		1
	5	606	GBF79	606	GBF–79		BEARING, bronze		1
	6				X–1573A		CUP, oil		1
	7				MBD–150		WICK, felt		1
	8				MBD–1236C		HEAD ASSEMBLY, partial (includes item 5)		1
	9	606	MBD2079C	606	MBD–2079C		PLATE ASSEMBLY, electrical brush holder (includes items 10, 11, 38).		1
	10				MBD–19C		SPRING, brush		8
	11				GG–81B		CLIP, brush holder post		4
	12				MAK–61A		WASHER, thrust		1
	13				MU–54		WASHER, thrust, 1/32 in.	[3]	
	13				MU–54A		WASHER, thrust, 1/64 in.	[3]	
	13				MU–54B		WASHER, thrust, 3/64 in.	[3]	
	14	606	MCC2021T	606	MCC–2021T		ARMATURE, motor		1
	15	606	MBD1012AS	606	MBD–1012AS		BRUSH SET, electrical contact		1
	16						STUD, terminal		1
	17						WASHER, plain		1
	18						INSULATOR, washer		2
	22						INSULATOR, bushing		1
	23				MCC–2032S		FRAME AND FIELD ASSEMBLY (includes items 15–25).		1
	24						TERMINAL		1
	25						STUD, terminal		1

[3] Each as required

Fig. No.	Index No.	Corps of Engineers stock No.		End item mfg. part No. and/or prime mfg. part No.		Fed. commodity class and item ident. No.	Part nomenclature	Quantity per unit
77	26				PS-1278A		HOUSING ASSEMBLY, pinion (includes items 27, 39).	1
	27	606	MBD257	606	MBD-257		BEARING, plain, sleeve	1
	30	606	EBB13A	606	EBB-13A		DRIVE	1
	31				MBD-314		BEARING, absorbent, bronze	1
	32	606	MBD1315B	606	MBD-1315B		PLATE, bearing, intermediate (includes items 31-34).	1
	33				MBD-313		WASHER, felt	1
	34				MBD-312		RETAINER, felt	1
	35				MBD-311		WASHER, thrust, intermediate	2
	38				MBD-47A		SPACER, brush spring	4
	39				MAB-88B		PIN, dowel	1
79, 80, 81		604	PSB4A80C 2940A2	617	HD260F-265		PUMP ASSEMBLY, fuel injector	1
79	1				SC 908		SCREW, hub, camshaft, 7/16 in.	1
	2				WA 7623		WASHER, lock, hub screw	1
	3				HB 907		HUB, drive	1
	4				SC 1555		SCREW, fastening, ball bearing retaining plate.	4
	5				WA 901		WASHER, lock, fastening screw	4
	6				PL 907		PLATE, retaining, ball bearing	1
	7				BB 1023		BEARING, ball, camshaft	1
	8				SH 9013A		CAMSHAFT	1
	9				GA 76200		GASKET, rubber ring	1
	10				PO 765		POINTER, timing	1
	11				HG 9015A		HOUSING, pump (includes item 12)	1

12				SD 903		STUD, housing		4
				TP 902A		TAPPET ASSEMBLY (includes items 13–15)		1
13				RL 903A		ROLLER ASSEMBLY, tappet		1
14				GU 905A		GUIDE ASSEMBLY, tappet		1
15				PN 9013		PIN, tappet roller, diameter 0.3745 in.		1
16				GA 7616		GASKET, fastening screw		3
17				SC 1140		SCREW, locating, quill shaft bushing		1
18				WI 1073		WIRE, locking, fastening screw	([4])	
19				SC 903		SCREW, filter		1
20	604	GA7965	604	GA 7965		GASKET, alter screw		1
21	604	FE901		FE 901		STRAINER		1
22	604	GA1012	604	GA 1012		GASKET, ring, filter screw		1
23				GA 1014		GASKET, ring, control unit		1
24				PN 906		PIN, plunger sleeve		1
25				RG 1015		RING, spring, control shaft		1
26				CU 906–3A		UNIT ASSEMBLY, control (includes item 25)		1
27				RN 906		RETAINER, control unit		1
28				SC 1689		SCREW, w/lockwasher, fastening, control unit.		2
29				WI 901		WIRE, lock, control unit fastening screw		1
30	604	GA903	604	GA 903		GASKET, supply pump		1
31				RG 1014		RING, spring		2
32				GE 908		GEAR, drive, supply pump shaft		1
33				PK 7910		SEAL, oil, supply pump shaft		1
34				KY 901		KEY, supply pump shaft		1
35	604	SGB15B1	604	SGB 15B1		PUMP ASSEMBLY, supply (includes items 31 (1 only), 32–34).		1
36	604	WA22–8BL	604	WA 22–8 BL		WASHER, lock, fastening screw		4
37	604	SC 1516	604	SC 1516		SCREW, fastening, supply pump		2
				RD 908A		ROD ASSEMBLY, shutoff (includes items 38–44).		1

[4] As required.

Fig. No.	Index No.	Corps of Engineers stock No.	End item mfg. part No. and/or prime mfg. part No.	Fed. commodity class and item ident. No.	Part nomenclature	Quantity per unit
79	38		FI 902		FITTING, shutoff	1
	39		SC 325–4 BL		SCREW, set	1
	40		PN 1026		PIN, shutoff rod	1
	41		SC 904		SCREW, bearing	1
	42		GA 1019		GASKET, shutoff rod	1
	43		SP 904		SPRING, shutoff rod	1
	44		RD 903		ROD, shutoff	1
	45		GA 1036		GASKET, shutoff rod	1
	46		WA 1143		WASHER, plain, fastening screw	2
	47		SC 27–18 BL		SCREW, fastening, timing window cover	2
	48		CV 905		COVER, timing window	1
	49		GA 909		GASKET, timing window cover	1
	50		SC 1140		SCREW, fastening, quill shaft pad	2
	51		CV 903C		PAD, quill shaft	1
	52		GA 904		GASKET, quill shaft pad	1
			SH 908A		SHAFT ASSEMBLY, quill (includes items 31 (1 only), 53–57).	1
	53		WMS 2157/400X		WASHER, plain, 0.002 in. thick	(4)
	53		WMS 2157/1X		WASHER, plain, 0.004 in. thick	(4)
	53		WMS 2157/2X		WASHER, plain, 0.008 in. thick	(4)
	53		WMS 2157/3X		WASHER, plain, 0.020 in. thick	(4)
	54		GE 908		GEAR, camshaft driven	1
	55		KY 1006		KEY, Woodruff, quill shaft	1
	56		BG 905		BUSHING, quill shaft	1
	57		SH 909A		SHAFT, quill, w/gear	1
80	1		RG 901		RING, spring, control rod	1
	2		PN 9010		PIN, control rod	1

3				RD 9016–1A		ROD, control (includes item 1)	1
4				PN 1122		HAIRPIN, control rod	1
5	604	BA 901	604	BA 901		PLATE, oil baffle	1
6				WA 22 BL		WASHER, lock, fastening screw	4
7				SC 1110		SCREW, fastening, top cover	4
8				WA 1143		WASHER, plain	16
9				CV 902C		COVER, top, governor housing	1
10				GA 908		GASKET, top cover	1
11	604	WA22–8BL	604	WA 22–8 BL		WASHER, lock	12
12				SC 1351		SCREW, fastening, governor housing, long	2
13				SC 1140		SCREW, fastening	5
14				CP 901C		CAP, end, governor housing	1
15	604	GA 902	604	GA 902		GASKET, end cap	1
16	604	SR7914/1	604	SR 7914/1		SPACER, outer spring, 0.020 in. thick	(4)
16	604	SR7914/2	604	SR 7914/2		SPACER, outer spring, 0.042 in. thick	(4)
16	604	SR7914/3	604	SR 7914/3		SPACER, outer spring, 0.058 in. thick	(4)
16	604	SR7914/4	604	SR 7914/4		SPACER, outer spring, 0.083 in. thick	(4)
17	604	SR799/1	604	SR 799/1		SPACER, inner spring, 0.020 in. thick	(4)
17	604	SR799/2	604	SR 799/2		SPACER, inner spring, 0.042 in. thick	(4)
17	604	SR799/3	604	SR 799/3		SPACER, inner spring, 0.058 in. thick	(4)
17	604	SR799/4	604	SR 799/4		SPACER, inner spring, 0.083 in. thick	(4)
18	604	SP7950–4	604	SP 7950/4		SPRING, governor, inner	1
19				SP 7951/12		SPRING, governor, outer	1
20				HG 901		HOUSING, governor	1
21				GA 907		GASKET, governor housing	1
22	604	LE9025–1A	604	LE 9025–1A		LEVER ASSEMBLY, fulcrum	1
23	604	SV901A	604	SV 901A		SLEEVE ASSEMBLY	1
24				PN 901A		PIN, pivot, fulcrum lever	1
				WT 9012A		WEIGHT AND SPIDER ASSEMBLY (includes items 25–29, 31).	1
25				PN 1104		PIN, roll	4

[4] As required.

Fig. No.	Index No.	Corps of Engineers stock No.		End item mfg. part No. and/or prime mfg. part No.		Fed. commodity class and item ident. No.	Part nomenclature	Quantity per unit
80	26				PN 905A		PIN, weight	2
	27				BG 903		BUSHING, weight	4
	28				WA 1448-1		WASHER, plain, 0.036 in. thick	(4)
	28				WA 1448-2		WASHER, plain, 0.038 in. thick	(4)
	28				WA 1448-3		WASHER, plain, 0.040 in. thick	(4)
	28				WA 1448-4		WASHER, plain, 0.044 in. thick	(4)
	28				WA 1448-5		WASHER, plain, 0.048 in. thick	(4)
	29				WT 905A		WEIGHT (includes item 27)	2
	30				BG 7649		BUSHING, camshaft	1
	31				HP 9012		SPIDER, weight	1
	32	604	SC1136	604	SC 1136		SCREW, governor stop cam	1
	33	604	CA 796	604	CA 793		CAM, governor stop	1
	34	604	NT8-8BL	604	NT 8-8 BL		NUT, cam screw	1
	35				SC 1140		SCREW, fastening, stop plate	2
	36				PL 904		PLATE, stop	1
	37				NP 901		PLATE, name	1
	38				SC 150-2		SCREW, fastening, name plate	2
	39				SH 901A		SHAFT ASSEMBLY, operating	1
	40				GA 76195		GASKET, ring, shaft	1
	41				PL 902A		PLATE ASSEMBLY, spring	1
	42				SP 902		SPRING, operating lever	1
	43				GA 901		GASKET, shaft bearing plate	1
	44				BG 904		PLATE, shaft bearing	1
	45				NT 6-8 BL		NUT, hex, stop screw	2
	46				SC 350-16 BL		SCREW, stop, stop lever	2
	47				GA 7616		GASKET, fastening screw, upper	2
	48				SC 1356		SCREW, fastening, shaft bearing plate, upper	2

	49				BL 901		LEVER, stop, operating shaft	1
	50				SP 1066		RING, snap, shaft	1
	51				CV 7945		COVER, stop lever, upper	1
	52				PN 2–20 BL		PIN, cotter, fastening screw	1
	53				LE 79113		LEVER, operating	1
	54				NT 7919		NUT, hex, fastening screw	1
	55				SC 7961		SCREW, fastening, operating lever	1
	56				SC 1354		SCREW, fastening, stop lever covers	3
	57				WA 22–6 BL		WASHER, lock, fastening screw	3
	58				CV 7946		COVER, stop lever, lower	1
	59				SD 902		STUD, shaft bearing plate, lower	2
	60				SC 901		SCREW, clamping, stop lever	1
81					HD 3104A		HEAD ASSEMBLY, hydraulic, complete (includes items 2–9, 11–24).	1
	1				NT 1127		NUT, fastening, hydraulic head	4
	2				SC 902		SCREW, cap, delivery valve	1
	3				GA 906		GASKET, cap screw	1
	4				HP 903		HOLDER, delivery valve	1
	5				SP 7655		SPRING, delivery valve	1
	6				GA 905		GASKET, delivery valve holder	1
	7				VA 901A		VALVE ASSEMBLY, delivery	1
	8				FI 901		FITTING, discharge	4
	9				GA 9010		GASKET, discharge fitting	4
	10				VA 7928A		VALVE ASSEMBLY, overflow	1
	11				HD 9013–4A		HEAD, hydraulic, w/8.0 mm diameter plunger and sleeve, round.	1
	12				NP 902		PLATE, part number	1
	13				SC 150–2		SCREW, fastening, part number plate	2
	14				GA 1010		GASKET, ring	1
	15				WA 1362		WASHER, thrust, plunger drive gear	1
	16				GU 903		GUIDE, plunger	1

[4] As required.

Fig. No.	Index No.	Corps of Engineers stock No.		End item mfg. part No. and/or prime mfg. part No.		Fed. commodity class and item ident. No.	Part nomenclature	Quantity per unit
81	17				GE 909		GEAR, plunger drive	1
	18				RN 901		COVER, gear retainer	1
	19				GA 1009		GASKET, ring	1
	20				SP 901		SPRING, inner, plunger	1
	21				GU 904		SEAT, plunger spring, lower	1
	22				HP 902		LOCK, plunger	1
	23				BB 1024		BALL, sealing, setscrew	1
	24				SC 1352		SCREW, set, sealing ball	1
90		604	AKB95S2242A	617	HD260F-2490		HOLDER ASSEMBLY, nozzle	4
	1				CA2-HD260F-264		NUT, special	8
	2				CA2-X-202-B		WASHER, lock	8
	3				CA2-X-1963-A		STUD	8
	4				CA2-RD6F-209		CLAMP, nozzle holddown	4
	5				CA2-X-12478		ELBOW, $\frac{3}{16}$ in.	1
	5				CA2-X-12479		TEE, $\frac{3}{16}$ in., Nos. 1, 2, 3 nozzle holders	3
	6				CA2-HD260F-249		NUT, nozzle cap	4
	7						GASKET	4
		604	ADN12SD12	617	HD260F201		NOZZLE, tip (includes items 8, 9)	4
	8						BODY	4
	9						VALVE, pintle	4
	10						HOLDER	4
	11						CONNECTOR	4
	12						SPINDLE	4
	13						SPRING	4
	14						SCREW, adjusting	4
	15						GASKET	8
	16						NUT, lock	4

	17						CAP, protecting	4
93	1				X-1802-G		NUT	9
	2	617	15XX203	617	15X-X-203		WASHER, lock	20
	3	617	X4200	617	X-4200		STUD	2
	4				X-3252		SCREW	1
	5	617	X2215	617	X-2215		PLUG	1
	6	617	WIDB302	617	WIDB-302		COVER, starter hole	1
	7	617	X3334	617	X-3334		SCREW, cover	3
	8	617	H260A400	617	H260A-400		SLEEVE, cylinder	4
	9				H260A-205		PACKING, cylinder sleeve	8
	10	617	HD260A505	617	HD260A-505		CYLINDER AND CRANKCASE ASSEMBLY.	1
	11				H260K-203		GASKET	1
	12	617	H260K404	617	H260K-404		ELBOW, water inlet	1
	13				15X-X-4228		STUD	2
	14				H260B-401		GASKET	1
	15				X-113		PLUG, pipe, 1 in.	1
	16	617	D600L2270	617	D600L-2270		CAP	1
	17				6EK-215		DOWEL	2
	18	617	X19004	617	X-19004		STUD, adapter	5
	19				X-12210		NECK, oil filler	1
	20				HD260B-209		GASKET, hole cover, injection pump	1
	21				HD260B-211		COVER, hole, injection pump	1
	22				X-3256		SCREW	4
	23				HD260B-501		ADAPTER, injection pump	1
	24				H260B-200		GASKET, injection pump adapter	1
	25	617	H260B5002	617	H260B-5002		COVER ASSEMBLY, gear	1
	26				M600L-214		SEAL	1
	27	617	15XX3942	617	15X-X-3942		SCREW	7
	28	617	6EK215	617	6EK-215		PIN	2
	29	617	X2215	617	X-2215		PLUG	4
	30	617	X3258	617	X-3258		SCREW	5

Fig. No.	Index No.	Corps of Engineers stock No.		End item mfg. part No. and/or prime mfg. part No.		Fed. commodity class and item ident. No.	Part nomenclature	Quantity per unit
93	31				X–297		WASHER, lock	1
	32	617	UB110	617	UB–110		WASHER, plain	1
	33	617	F400C206	617	F400C–206		COVER, flywheel pointer	1
	34				F400C–208		FELT	1
	35	896	145	617	X–1005		VALVE, drain, block	1
	36	617	15XX137A	617	15X–X–137A		PLUG, pipe	3
	37	617	X17003	617	X–17003		DOWEL	2
	38			617	HD260B–504		HOUSING, flywheel	1
94	1	617	HD260C4060	617	HD260C–4060		FLYWHEEL ASSEMBLY	1
	2	178	664–58	178	664–58		DISK, coupling	2
	4	178	664–62	178	664–62		BOLT, machine	6
	5	178	664–59	178	664–59		HUB, coupling	1
	6	652	T1200–7	652	T–1200–7		FAN ASSEMBLY	1
	7						KEY, straight, 2 x ½ x ¼ in.	1
	8				C–343		SHAFT, rotor	1
	10	178	664–61	178	664–61		NUT, stop	6
	11	178	664–60	178	664–60		BOLT, machine	6
97	1	617	HD260A205	617	HD260A–205		PLUG, cell retainer	4
	2	617	HD260A204	617	HD260A–204		RETAINER, energy cell	4
	3	617	HD260A203	617	HD260A–203		CAP, cell	4
	4	617	HD260A2010	617	HD260A–2010		BODY ASSEMBLY, cell	4
	5	617	15XX112	617	15X–X–112		PLUG, pipe, ¾ in.	1
	6	617	15XX101	617	15X–X–101		PLUG, pipe, ½ in.	3
	7	617	15XX120	617	15X–X–120		PLUG, pipe	1
	8	617	X20029	617	X–20029		STUD, cylinder head	10
	9	617	X14179	617	X–14179		WASHER, flat	19
	10	617	15X3X1890	617	15X–3X–1890		NUT, cylinder	19

	11	617	15XX1802G	617	15X2X-1802-G		NUT, 3/8 in., 16 threads per in.	3
	12				X-211-A		GASKET	3
	13	617	X19898	617	X-19898		STUD, cover	1
	14	617	HD260A5060	617	HD260A-5060		COVER ASSEMBLY, cylinder head	1
	15	617	HD260A204	617	H260A-204		RETAINER	1
	16				H260A-306		GASKET, cylinder head cover	1
	17	617	15XX19987	617	15X-X-19987		STUD, cylinder head	5
	18	617	X20049	617	X-20049		STUD	2
	19	617	15XX3261	617	15X-X-3261		SCREW	3
	20	617	15XX203	617	15X-X-203		WASHER, lock	5
	21	617	H260K215	617	H260K-215		ELBOW, water outlet	1
	22				H260K-209		GASKET, 1/16 in. thick	1
	23	617	15XX1802G	617	15X-X-1802-G		NUT	2
	24	617	15XX422	617	15X-X-422		STUD	2
	25	617	HD260A6011	617	HD260A-6011		HEAD ASSEMBLY, cylinder	1
	25	617	HD260A6012	617	HD260A-6012		HEAD	1
	26				HD260A-320		GASKET	1
	27				H260E-309		GASKET	2
	28	617	H260E402	617	H260E-402		MANIFOLD, exhaust and intake	1
	29	617	15XX20041	617	15X-X-20041		STUD, manifold	2
	30	617	15XX19987	617	15X-X-19987		STUD	5
	31	617	15XX14294	617	15X-X-14294		WASHER, flat	5
	32	617	X18278	617	X-18278		NUT, manifold stud	11
	33				S4F-203		GASKET	1
	34	617	15XX100	617	15X-X-100		PLUG, pipe	1
	35	617	HD260E203	617	HD260E-203		CLAMP, manifold	4
	36	617	15XX19095	617	15X-X-19095		STUD, manifold	4
	37	617	X1430	617	X-1430		WASHER, flat	2
98	1	617	D600I202	617	D600I-202		PLUG	4
	2				X-336		GASKET	4
	3	617	R600I218	617	R600I-218		SPRING, rocker arm, short	2
	4	617	H260I400	617	H260I-400		SHAFT, rocker arm	1

Fig. No.	Index No.	Corps of Engineers stock No.		End item mfg. part No. and/or prime mfg. part No.		Fed. commodity class and item ident. No.	Part nomenclature	Quantity per unit
98	5	617	H260I206	617	H260I-206		SCREW	2
	6	617	X14221	617	X-14221		WASHER, plain	4
	7	617	H260I300	617	H260I-300		SUPPORT, rocker arm shaft	4
	8				H260I-212		WICK, oil, rocker arm	8
	9	617	X3292	617	X-3292		NUT, lock	4
	10	617	R600I3000	617	R600I-3000		ARM, rocker	8
	11	617	H260I202	617	H260I-202		SPRING, rocker arm shaft, long	3
	12	617	X3384	617	X-3384		SCREW	2
	13	617	21RI230	617	21RI-230		SCREW, adjusting	4
	14	617	HD260I200	617	HD260I-200		ROD, push, valve	8
	15	617	H260A201	617	H260A-201		TUBE, push rod	8
	16	617	D600I269	617	D600I-269		TAPPET, valve	8
	17	617	HD260I501	617	HD260I-501		CAMSHAFT	1
	18	617	M600I202	617	M600I-202		PLATE, thrust	1
	20	617	X3955	617	X-3955		SCREW, $\frac{3}{8}$ x $\frac{7}{8}$ in. NC	2
	21	617	HD260H400	617	HD260H-400		GEAR, camshaft	1
	22	617	X507	617	X-507		KEY	1
	23	617	M600I215	617	M600I-215		NUT, lock, camshaft gear	1
	24	617	M600I214	617	M600I-214		NUT	1
	25	617	HD260I301	617	HD260I-301		VALVE, exhaust	4
	25	617	HD260I300	617	HD260I-300		VALVE, intake	4
	26	617	HD260A210-010	617	HD260A-210		INSERT, exhaust valve seat, 0.010 in. oversize.	4
	27	617	J382I200	617	J382I-200		GUIDE, valve stem	8
	28	617	15RT220	617	15RT-220		RING, retaining	8
	29	617	A600I238	617	A600I-238		SPRING, valve	8
	30	617	H260I203	617	H260I-203		RETAINER, spring	8

	31	617	E604I202	617	E604I-202	----------	LOCK, valve spring----------	16
	32	617	R600I213	617	R600I-213	----------	SOCKET, valve actuaitng ball----------	8
100	1	617	15XX3537	617	15X-X-3537	----------	SCREW----------	6
	2	617	15XX296	617	15X-X-296	----------	WASHER, lock----------	6
	------	617	HD260C4060	617	HD260C-4060	----------	FLYWHEEL ASSEMBLY (includes items 3, 4).	1
	3	------	----------	------	HD260C-406	----------	FLYWHEEL----------	1
	4	617	HD260C302	617	HD260C-302	----------	GEAR, ring----------	1
	5	617	HD260G3011	617	HD260G-3011	----------	BEARING, main, crankshaft, rear upper and lower.	1
	5	617	HD260G3011-020	617	HD260G-3011-020	----------	BEARING, main, crankshaft, rear upper and lower, 0.020 in. undersize.	1
	5	617	HD260G-3011-040	617	HD260G-3011-040	----------	BEARING, main, crankshaft, rear upper and lower, 0.040 in. undersize.	1
	6	617	HD260C203	617	HD260C-203	----------	CRANKSHAFT----------	1
	6	617	HD260C203-020	617	HD260C-203-020	----------	CRANKSHAFT, 0.020 in. undersize----------	1
	6	617	HD260C203-040	617	HD260C-203-040	----------	CRANKSHAFT, 0.040 in. undersize----------	1
	7	617	HD260G3051	617	HD260G-3051	----------	BEARING, main, crankshaft, center upper and lower.	1
	7	617	HD260G3051-020	617	HD260G-3051-020	----------	BEARING, main, crankshaft, center upper and lower, 0.020 in. undersize.	1
	7	617	HD260G3051-040	617	HD260G-2051-040	----------	BEARING, main, crankshaft, center upper and lower, 0.040 in. undersize.	1
	8	617	HD260G3001	617	HD260G-3001	----------	BEARING, main, crankshaft, front upper and lower.	1
	8	617	HD260G3001-020	617	HD260G-3001-020	----------	BEARING, main, crankshaft, front upper and lower, 0.020 in. undersize.	1
	8	617	HD260G3001-040	617	HD260G-3001-040	----------	BEARING, main, crankshaft, front upper and lower, 0.040 in. undersize.	1
	9	617	E604G200	617	E604G-200	----------	WASHER, thrust----------	1
	10	617	6TG101	617	6TG-101	5315-255-2360	PIN, straight, headless----------	3
	11	617	H260C208	617	H260C-208	----------	WASHER, flat----------	1

Fig. No.	Index No.	Corps of Engineers stock No.		End item mfg. part No. and/or prime mfg. part No.		Fed. commodity class and item ident. No.	Part nomenclature	Quantity per unit
100	12	617	20RC215	617	20RC–215		SHIM, thrust, 0.002 in. thick	(4)
	13	617	20RC216	617	20RC–216		SHIM, thrust, 0.008 in. thick	(4)
	14	617	H260H300	617	H260H–300		GEAR, crankshaft	1
	15	617	X528A	617	X–528–A		KEY	1
	16	617	H260C201	617	H260C–201		THROWER, oil	1
	17				H260K–213		SEAL, dust, fan drive pulley	1
	18	617	H260K310	617	H260K–310		PULLEY, fan drive	1
	19	617	15XX14206	617	15X–X–14206		WASHER	1
	20	617	T427–0–201	617	T427–0–201		JAW, cranking	1
	21	617	X1756	617	X–1756		PIN, dowel, rear crankshaft retainer	2
	22	617	H260B318	617	H260B–318		CAP, bearing, front	1
	23	617	8TC200	617	8TC–200		DOWEL	1
	24	617	X13004	617	X–13004		LOCK WIRE, 11 in. long	3
	25	617	X3587	617	X3587		SCREW	4
	26	617	5XX14230	617	5X–X–14230		WASHER, plain	4
	27	617	H260B301	617	H260B–301		CAP, bearing, center	1
	28	617	H260B409	617	H260B–409		CAP, bearing, rear	1
	29				H260B–210		CORK, rear bearing filler block	2
	30				H260B–202		GASKET, rear bearing filler block	2
	31				H260B–209		GASKET, rear bearing oil seal to crankcase	1
	32				H600B–200		SEAL, oil, crankcase bearing, rear	2
	33	617	X1779	617	X–1779		PIN, bearing seal	4
	34	617	15XX3762	617	15X–X–3762		SCREW	10
	35	617	X1442	617	X–1442		WASHER	10
102		617	HD260A4051A	617	HD260A–4051–A		PISTON ASSEMBLY (includes items 1–7)	4
		617	HD260A4051E	617	HD260A–4051–E		PISTON ASSEMBLY (includes items 5–7)	4
	1	617	HD260A308	617	HD260A–308		RING, piston (1st groove)	4

	2	617	H260A310	617	H260A-310		RING, piston (2d and 3d groove)	8
	3	617	HD260A306	617	HD260A-306		RING, piston, oil control	4
	4	617	HD260A307	617	HD260A-307		RING, piston (5th groove)	4
	5	617	HD260A405	617	HD260A-405		PISTON	4
	6	617	HD260A211	617	HD260A-211		PIN	4
	7	617	20RA245	617	20RA-245		RING, retaining	8
	8	617	H260D203	617	H260D-203		BUSHING	4
	9	617	H260D5003	617	H260D-5003		ROD ASSEMBLY, connecting w/cap (includes items 8, 10-12).	4
	10	617	HD260G307	617	HD260G-307		BEARING	8
	10	617	HD260G307-020	617	HD260G-307-020		BEARING, connecting rod, 0.020 in. undersize.	8
	10	617	HD260G307-040	617	HD260G-307-040		BEARING, connecting rod, 0.040 in. undersize.	8
	11	617	X288	617	X-288		WASHER	8
	12	617	H260D200	617	H260D-200		BOLT, connecting rod	8
112		652	X9778				GENERATOR	1
	1	652	7624	652	7624		BOLT, machine	4
	3	652	X495	652	X-495		SHIELD, bell end and overspeed switch	1
	4	178	664-72	178	664-72		SWITCH, over speed micro	1
	5	652	7624	652	7624		BOLT, machine	2
	6						DEVICE, overspeed	1
	8	652	1594	652	1594		PLATE, inspection cover	1
	9						SCREW	4
	10	652	A201	652	A-201		BELL END, commutator	1
	11	369	360J	652	1534		BEARING, ball, annular	1
	12	652	V2150	652	V-2150		RING ASSEMBLY, brush holder	1
	13						WASHER	4
	14						NUT	4
	15				983		BAR, pole piece	4
	16	652	EX1131	652	EX 1131		WINDING SET, field	1

[4] As required.

Fig. No.	Index No.	Corps of Engineers stock No.		End item mfg. part No. and/or prime mfg. part No.		Fed. commodity class and item ident. No.	Part nomenclature	Quantity per unit
112	17	652	Z912	652	Z-912		POLE, field	4
		652	2516	652	2516		COUPLING ASSEMBLY (includes items 18, 19, 54, 55).	1
	18				A3200 3/4		KEY, coupling	1
	22	652	X299	652	X-299		BELL END, commutator, generator	1
	23	652	1533	652	1533		BEARING, commutator end	1
	24	652	X2225	652	X-2225		HOLDER ASSEMBLY, electrical contact brush, generator.	2
	25	652	1328	652	1328		RING ASSEMBLY, slip	1
	26	178	664-85	178	664-85		CAPACITOR	4
	29				7755		BOLT, lifting, ½ in.	1
	30				1416		SCREEN	1
	31						SCREW	2
	34						WASHER	2
	35						NUT, hex	2
	36	652	X85	652	X-85		RING, adapter, fan housing	1
	37				T-1266		BAFFLE	1
	38	178	664-55	178	664-55		BOLT, machine	2
	40	178	664-57	178	664-57		NUT	2
	41				7938		FRAME	1
	42	652	B7043	652	B-7043		ROTOR ASSEMBLY (includes item 59)	1
	43				A-5456		BRUSH, grounding, assembly	1
	44						NUT	4
	45						SCREW	2
	46	178	664-90	178	664-90		BRACKET, micro switch	1
	47				2275		BRUSH, grounding	1
	52	652	786	652	786		COMMUTATOR	1

	53				B-570		ARMATURE ASSEMBLY (includes item 52)	1
	54				3349		COUPLING	1
	55				3348		COUPLING	1
	58				433-A		SHIELD, endbell cover	2
	59				C-343		SHAFT, rotor	1
	60	652	Y1788	652	Y-1788	5315-260-9616	PIN, straight, headless	1
	61				433		SHIELD, endbell cover	2
115		652	V2150	652	V-2150		RING ASSEMBLY, brush holder	1
	1				1776-L		ARM, tension, brush	4
	2				1768-L		SPRING, brush	4
	5	652	1919	652	1919		BRUSH, electrical contact	4
	7				1750		HOLDER, brush	4
	8				1797		STUD, holder	4
	9				1866-U		RING, brush holder	1
	13				1642-A		HUB, arm	4
117		652	X2225	652	X-2225		HOLDER ASSEMBLY, electrical contact brush, generator.	2
	1	652	1909	652	1909		BRUSH, electrical contact, generator	4
	5						HOLDER, brush	2
	6				X-1658		INSULATOR	4
	7				Y1764R		SPRING, brush, right	2
	8				X1773R		ARM, tension, brush, right	2
	9				X-1649		BUSHING, spring	4
	12	652	Y1787	652	Y-1787		PIN, straight, headless	1
	12	652	Y1788	652	T-1788	5315-260-9616	PIN, straight, headless	1
	13				X1773L		ARM, tension, brush, left	2
	14				X1764L		SPRING, brush, left	2

APPENDIX III.

TOOL AND PUBLICATIONS SET

Engineer stock number		Nomenclature	Quantity
Code No.	Part number		
GE	95–3822.210.500	Tool and Publication Set	1
		Department of the Army Lubrication Order 5-5002 (For Model 1664 Generator and Engine).	1
		Department of the Army Lubrication Order 5–5331 (For Model 1775 Generator and Engine).	1
		Department of the Army Supply Manual ENG 7 & 8-5002.	1
		Department of the Army Technical Bulletin 5–5002–1 (For Model 1664 Generator and Engine).	1
		Department of the Army Technical Bulletin 5–5331–1 (For Model 1775 Generator and Engine).	1
GE	99-1999.000.010	Modification Kit, MWO ENG 1999–1, for Lubrication Guides, Check Cards and Manuals; MIL–P–11743.	1
GE	13–5496.050.400	Oiler; steel; rd; push bottom type; ½ pt cap.; 4 in. rigid spout; straight FS RR–O–376; Type I; class A.	1
GE	41–5976.300.060	Pliers, combination: slip joint; regular w/cutter; FS GGG–P–471; Type F; class 1; style 1; 6 in.	1

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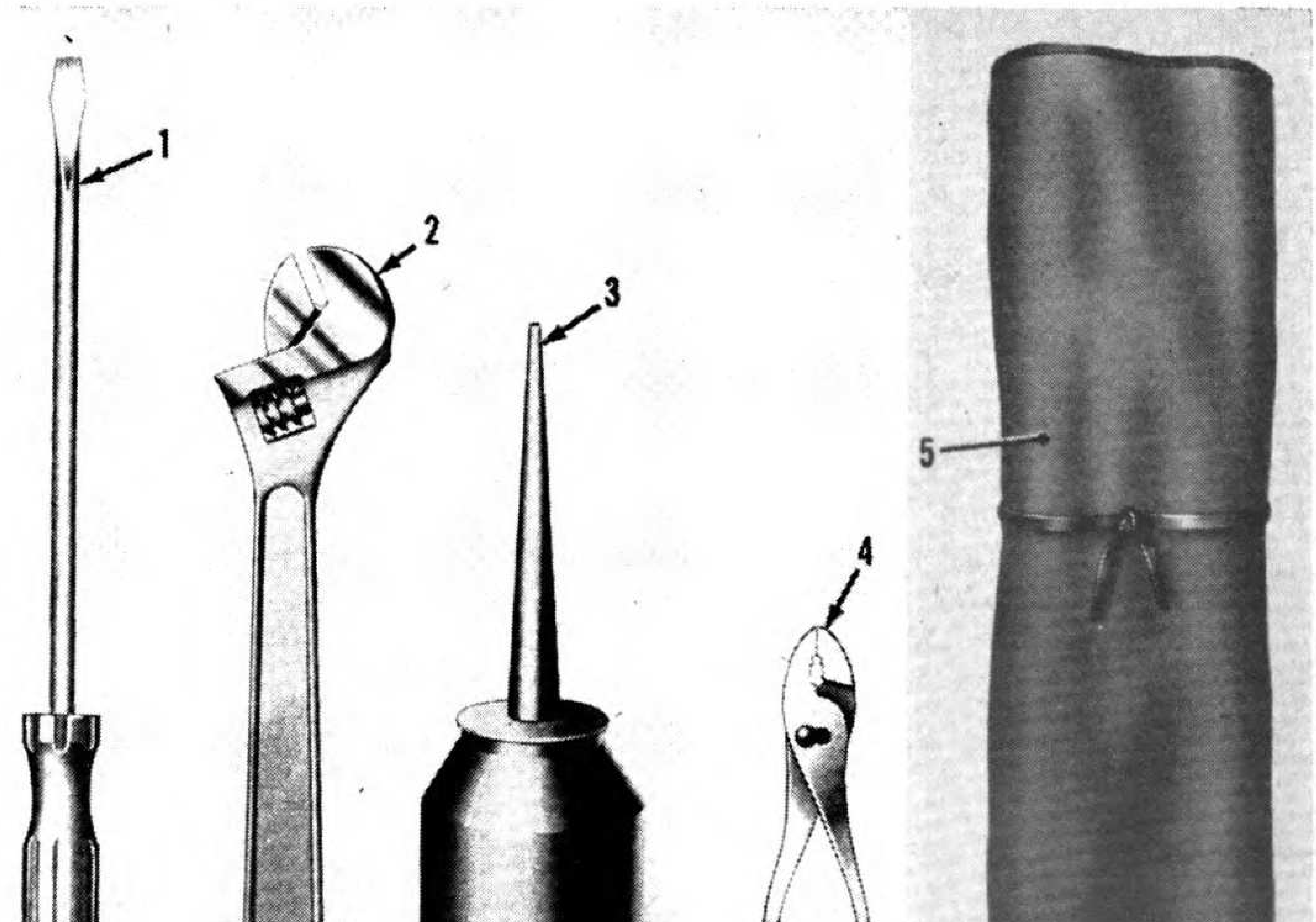

1 Screwdriver. 2 Wrench. 3 Oiler. 4 Pliers. 5 Modification kit.

Figure 120. On-equipment tools.

[AG412.41 (20 Apr 55)]

BY ORDER OF THE SECRETARY OF THE ARMY:

MAXWELL D. TAYLOR,
General, United States Army,
Chief of Staff.

OFFICIAL:

JOHN A. KLEIN,
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5–262, Hq & Hq Co, Engr Maint-Sup Gp (2)
5–267, Engr Depot Co (2)
5–278A, Engr Depot Maint Co (2)
5–279A, Engr Parts Depot Co (2)

NG: State AG (6); Units—Same as Active Army except allowance is one copy to each unit.

USAR: None.

For explanation of abbreviations used see SR 320–50–1.

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